February 1953

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Plungers in dielectric sleeves tune cavities over wide range

NOISE IN TRANSISTOR AMPLIFIERS, by Edward Keonjian and Johannes S. Schaffner
How to take transistor noise into consideration when designing amplifiers

FREQUENCY CHANGER FOR RESISTANCE WELDING, by M. E. Bivons
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VACUUM-TUBE T-PAD LOGARITHMIC ATTENUATOR, by E. C. Miller
Circuit used to provide high percentage of modulation in communications transmitter

GRAPHICAL SOLUTION OF SKY-WAVE PROBLEMS (Reference Sheet), by R. A. Helliwell
Chart simplifies antenna calculations and speeds design

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ELECTRONICS — February, 1953

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**FIGURES OF THE MONTH**

**RECEIVER PRODUCTION**
(Source: RTMA) Nov. '51 Oct. '52 Nov. '52
Television set... 415,332 724,117 780,486-p
Home sets... 477,734 314,459 389,853-p
Clock Radios... 180,841 185,639
Portable sets... 64,112 113,552 153,503-p
Auto sets... 206,069 163,494 195,200-p

**RECEIVER SALES**
(Source: RTMA) Oct. '52 Nov. '52
Television sets, units... 847,219 803,327
Radio sets (except auto)... 580,077 486,800

**RECEIVING TUBE SALES**
(Source: RTMA) Nov. '51 Oct. '52 Nov. '52
Rec. tubes, total units 32,710,369 41,880,318 36,942,664
Rec. tubes, new sets 20,405,712 29,132,608 25,898,849
Rec. tubes, replacements 8,539,275 8,791,404 8,568,037
Rec. tubes, export 1,371,886 1,050,005 1,712,080
Rec. tubes, export, export 2,393,494 851,841 2,763,698
Rec. tubes, to mfrs., 460,566 862,431 754,060

**BROADCAST STATIONS**
(Source: FCC) Dec. '51 Nov. '52 Dec. '52
TV Stations on Air... 108 116 129
TV Stns.-Applications... 479 836 612
AM Stations on Air... 2,331 2,374 2,391
AM Stns.-Applications... 77 139 133
FM Stations on Air... 637 626 616
FM Stns.-Applications... 13 14 14

**COMMUNICATION AUTHORIZATIONS**
(Source: FCC) Nov. '51 Oct. '52 Nov. '52
Aeronautical... 31,415 33,630 34,187
Marine... 33,700 37,914 36,166
Police, fire, etc., 9,969 11,772 11,956
Industrial... 11,233 15,090 15,347
Land Transportation... 5,362 5,346 5,421
Amateur... 99,292 116,102 117,069
Citizens Radio... 674 1,788 1,803
Disaster... 28 80 87
Experimental... 452 519 503
Common carrier... 835 1,032 1,020

**TV AUDIENCE**
(Source: NBC Research Dept.) Dec. '51 Nov. '52 Dec. '52
Sets in Use—total... 15,176,200 19,731,200 20,439,400
Sets in Use—new & k conn. 14,363,700 19,720,900 20,408,500
Sets in Use—NY City... 2,720,000 3,180,000 3,240,000
Sets in Use—Philadelphia... 106,000 1,270,000 1,320,000
Sets in Use—Chicago... 1,060,000 1,290,000 1,325,000

**NETWORK BILLINGS**
(Source: Pub. Info. Bureau) Nov. '51 Oct. '52 Nov. '52
AM/FM-ABC... $3,220,760 $2,887,571 $2,612,761
AM/FM-CBS... $5,257,454 $5,817,930 $5,419,533
AM/FM-MBS... $1,583,291 $2,304,804 $2,172,465
AM/FM-NBC... $4,315,646 $4,230,576 $4,075,971
TV—ABC... $1,911,243 $1,453,811 $1,368,552
TV—CBS... $4,605,506 $6,754,231 $6,525,176
TV—DuMont... $847,373 $995,376 $1,026,566
TV—NBC... $5,535,907 $7,805,668 $7,957,417

**EMPLOYMENT AND PAYROLLS**
Prod. workers, electronic... 287,500 297,100-r 307,100-p
Av. wkly. earnings, elect.... $63.87 $66.90-r $67.80-p
Av. wkly. earnings, radio... $60.41 $63.24-r $63.45-p
Av. weekly hours, elect... 41.5 41.5 41.8-p
Av. weekly hours, radio... 40.9 41.2 41.2-p

**STOCK PRICE AVERAGES**
(Source: Standard and Poor's) Dec. '51 Nov. '52 Dec. '52
Radio—TV & Electronics... 265.6 321.9 322.7
Radio Broadcasters... 252.6 300.3 304.4

**INDUSTRIAL EQUIPMENT ORDERS**
(Source: NEMA) 3rd '51 2nd '52 3rd '52
Dielectric Heating... $210,000 $220,000 $230,000
Induction Heating... $4,060,000 $2,410,000 $1,760,000
Welding Control... $1,280,000 $1,480,000 $1,810,000
Other Electronic Control... $720,000 $1,020,000 $920,000

**INDUSTRIAL TUBE SALES**
(Source: NEMA) 3rd '51 2nd '52 3rd '52
Vacuum (non-receiving)... $8,420,000 $12,110,000 $10,580,000
Gas or vapor... $2,620,000 $3,150,000 $2,950,000
Phototubes... $2,060,000 $2,304,804 $2,172,465
Magnetrons and velocity... $3,740,000 $9,830,000 $8,500,000
modulation tubes... p—provisional; r—revised; e—estimated

February, 1953 — ELECTRONICS
TV Manufacturers Get Set For 1953

New models are introduced as companies forecast banner sales for this year.

Christmas rush for tv sets was hardly over before the television receiver industry began introducing new tv sets for 1953 and predicting top sales for the new year. Nearly every set manufacturer introduced new tv models during January. Many of them displayed complete new lines of as many as 30 sets. Radios were also in the limelight as industry leaders predicted that nearly 8 million would be sold this year.

One Line—Many tv receiver manufacturers endorse the idea of one line a year and carried 1952 sets into 1953. Manufacturers such as Admiral, DuMont and GE added only a few new models to their 1952 receivers at January showings. Some manufacturers brought out complete new lines however. They feel that it will be some time before the industry as a whole is able to give the one-line-a-year policy a real try. They believe that too many new developments are still in the making, that these could not be held back even if sales were at a peak.

New Sets—Actually, new merchandise introduced last month was not far different from 1952 receivers. Prices were pretty much in line with last year’s. Some were a little higher and some lower. More 21-inch and 27-inch sets were displayed and fewer high-priced radio-tv-phonograph combinations were in the lines. Provisions for uhf were stressed and new uhf tuners and converters were introduced. Most major tv manufacturers incorporated built-in uhf-vhf antennas in their sets.

Predictions—With 1953 merchandise ready to roll, leading manufacturers looked at the year ahead and came up with a highly optimistic picture. They saw from 75 to 200 new tv stations coming on the air in 1953, bringing tv entertainment to 5 million more families and tv sales of at least 1.5 million sets in these new markets alone.

Gains were also predicted for replacement and second-set sales. It was estimated that nearly half of the sets now in use have screens smaller than 16 inches in size and that more than 4 million sets are at least 3 years old. Total production of at least 6 million receivers was expected by most manufacturers. Many predicted that the tv industry would reach a going rate of $6 billion in 1953.

Transistors Replace Hearing Aid Tubes

Users pay extra for units but save on a much lower annual battery cost

Announcements of transistorized hearing aids have been coming in thick and fast in the past few weeks. This comes as no surprise, because of the transistor’s inherent high efficiency and ability to operate at low voltages.

First to show a working model was Sonotone, with a 3-oz. unit using two subsubminiature tubes and a junction-transistor output stage. Tubes are used in the input and driver stages because of their low noise characteristics. With
this design a B battery is still required, but B-battery drain has been cut more than 80 percent by the transistorized output circuit.

Other hearing aid manufacturers, some of whom are oldtimers in the business, and some of whom are new, are coming up with all-transistor amplifiers completely eliminating the need for a B battery. Maico has a three-transistor unit "on the market", and Acoustic has one ready to go. Most popular transistor appears to be Raytheon's CK718, which is similar to their mass-produced CK721.

- Market—A vivid picture of the potential market for hearing aids was painted by Sonitone president Irving Schachtel, who said "Today in America, 15 million people have hearing deficiencies, and 3 to 5 million need some sort of hearing aid to get along in the social and business worlds. Of these, only one million are now using hearing aids."

Prices for transistorized hearing aids range anywhere from $75 to $250 and more. At the higher price this figure is to be around $75 an ounce.

This evaluation makes transistor hearing aids considerably more valuable than their equivalent weight in just about anything we can think of.

is well below that offered by private industry.


**Combatting Shortages of Engineers**

Trends include farming out routine engineering work, deferring retirements

To ease the strain on their engineering staffs, 55 percent of the electronic manufacturing firms responding to a recent survey are farming out some of their work to engineering consulting firms; 31 percent of these companies use drafting contract firms, 26 percent use research organizations, 20 percent use retired engineers and 9.8 percent use non-citizen engineers.

- Consultants—The job-shop type of consulting firm performs the complete engineering job of translating a manufacturer's idea or rough design into a finished package ready for the production line. In contrast, the service-type of consulting firm sells man-hours of engineers who work closely with the manufacturer's engineers. The chief drawbacks noted here are that premium rates are sometimes charged for scarce engineering talent, and the outside consultants "take too much of our own engineers' time".

- Retired Engineers—Where retirements are being deferred to keep engineers on the job longer, a less strenuous work schedule is usually provided. Engineers eligible for retirement may thus come in four days a week the first year, three days a week the next year, two days a week the next, and then on a limited one-day or several-hour schedule or purely on a consulting basis. Use of retired engineers depends greatly on the individual's ability, physical and mental condition.

Relaxation of hiring standards is helping, too. Of the firms reporting, 26 percent have relaxed age standards, 28 percent educational requirements, 39 percent requirements in experience and 19 percent have relaxed standards on physical condition.

- Part-Time Profs—To a lesser extent, college engineering professors and instructors are being used for part-time jobs and counseling work. This has the long-term advantage of providing the additional pay incentive needed to encourage graduates to enter teaching. For the academic year, the average salary for an instructor is only $3,151 and for professors $5,980. Starting salaries in the teaching professions average about $250 a month, which
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tronics which have multiplied approximately 8 times. No dip or stretch out is anticipated in electronic items for the next two years.

If contractors do not get payments from the U.S. before June 30, there is likely to be considerable delay in getting settlements. Money not expended returns to treasury.

Bing’s Mirror To Reflect in December

Device for magnetic tape recording of video signals is readied for production

BING CROSBY money has helped develop the machines used for all types of commercial sound recording work.

Not content with being able to hear himself sing, Crosby apparently wants to see himself act on television. The only mirror presently available is the kinere-cording, in effect a special motion picture made from the images on a picture tube.

► Cutting Out Steps—Engineers have long dreamed of putting video signals on magnetic tape to be played back through the equivalent of a television receiver rather than a movie projector. The same tapes, played into a television transmitter, would eliminate the camera and film projector for recorded shows.

Until recently, it has been possible to record frequencies only up to the limit of normal human hearing (around 15,000 cycles). This requires a tape speed of 15 inches a second. To record television signals with a frequency range up to about 4,000,000 cycles, Crosby’s engineer John T. Mullin had to speed his tape up to 100 inches a second.

► Splitting the Picture? — Although technical information has been frozen for the next six or eight months, it is known that today’s tape pictures are inferior to present TV programs but capable of improvement. Since the magnetic tape used is an inch wide (sound recorders use quarter-inch tape) engineers think the Crosby technique is to split up the picture frequencies and record strips of frequencies separately but simultaneously, combining them in the reproducing equipment. Half-inch tape will be used in the next prototype model.

Production models are promised in November or December at about $60,000.

RTMA Picks Up Ball On TV Interference

Manufacturers set up task committees for receivers, transmitters and coordination

At a recent meeting in New York City, W. R. G. Baker, director of the engineering department of the Radio and Television Manufacturers Association, advised television receiver makers to clean house before FCC is tempted to step into control of their product through back-door legislation.

By far the bulk of discussion centered on problems of receiver interference, although machinery was also set up to deal with infrequent transmitter spurious signals.

► Who Hits Whom—Degradation of television service by radiation from other sets in the neighborhood is serious enough. When local oscillator signals leak out strong enough and far enough to distort VOR airport navigation (as has happened) FCC begins to have legal grounds for requesting that each receiver come under its jurisdiction.

Although RTMA has set up certain standards that should improve reception and limit radiation, these are presently more often honored in the breach than in the observance. Among them is a recommendation for an intermediate frequency of 41.25 mc (ELECTRONICS, p 22, Jan. 1953).

But some manufacturers have had

(Continued on page 10)

Der Bingle, electronic gadgets (background), magnetic tape recorder and friend represent the essentials of a recorded video program. Tape cost is estimated at $80 a half hour as against $150 for kinescope film.

February, 1953 — ELECTRONICS
Printed circuits like those shown here offer important advantages in radio and TV production—fewer parts to purchase, inspect, handle, and stock; fewer soldering operations and quicker assembly with minimal wiring errors: faster and easier inspection; greater compactness; and lighter weight. And usually they cost less than the individual capacitors and resistors they replace!

BULPLATE Printed Circuits are a logical outgrowth of Sprague-Herlec BULPLATE Multiple Ceramic Capacitors, first to use the active dielectric as a supporting medium for printed wiring. The printed resistor elements of these plates have proved to be highly stable, another important Sprague contribution.

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to ship out relatively expensive wave traps because of interference from land mobile two-way radio systems operating near this frequency.

Committee Plans—Working in cooperation with the Joint Technical Advisory Committee (which includes the Institute of Radio Engineers) RTMA has appointed a committee on receivers charged with responsibility for limiting oscillator radiation and establishing target dates. Another group will perform a similar function in the transmitter field. A third committee will coordinate the work of the other task groups and keep them in touch with JTAC, IRE and FCC.

One practical stumbling block for both receiver and transmitter control is lack of inexpensive measurement equipment, particularly for the new uhf channels.

Small Fields Lighted By Pilots in Flight

Radio-controlled field lights are turned on by pilot as plane approaches airport

PILOTS who are forced to make emergency landings in small airports at night do so at extreme risk because most small fields are unlighted and unattended during hours of darkness.

An electronic system for making these fields safe for night use is now being used at Kingman, Arizona in connection with operation of the Bonanza Airlines. A pilot may turn on the field lights by pressing the ‘talk’ button of his regular vhf transmitter three times at half-second intervals from as far as 100 miles from the field. Lights are turned off by five similarly-transmitted signals.

Bonanza’s radio-controlled lighting system is being studied for possible application to other commercial runs, and suggestions have been handed the CAA that a special frequency be set aside for controlling field lights.

Phonograph Field Makes New Gains

Volume climbed to 5-year peak in 1952; further increases are expected this year

RECORD PLAYERS and records are continuing to grow as an important segment of the electronics industry. Although phonograph and record statistics vary with the source, all figures indicate a rising sales trend, as shown in the charts.

Indications that production of phonographs and sales of phonograph records in 1952 reached the highest point since 1947. It is estimated that between 3 and 4 million phonographs were produced last year and that the dollar volume of records was between $157 and $200 million. Continued growth for both products is forecast for 1953.

Phonographs—The total number of turntables in use in the U.S. has risen steadily since the war from an estimated 12 million in 1947 to about 26 million at the end of 1952. Of nearly 22 million phonos in use at the end of 1951, about 8 million were capable of playing 45-rpm records and 7 million could be used for 33¿-rpm records.

Despite the increased production of phonographs, fewer of them are being sold in tv and radio receivers. Only 10 percent of all tv models now on the market are equipped with phonographs and even less have a phonojack. According to RTMA figures, the percentage of tv sets produced with phonographs dropped from 14.1 percent in 1947 to 6.2 percent in 1951. Fewer radio sets incorporate phonographs. In 1950, 277-100 table-model radio-phonographs were produced as against 235,177 in 1951. Console radio-phonographs declined from 844,100 in 1950 to 463,713 in 1951. New lines just introduced are continuing the trend but sales of self-contained phonographs are evidently more than able to take up the slack.

Records—Phonograph record sales have increased along with turntable output since 1947. With the exception of 1948 when a musicians’ work stoppage occurred, dollar volume of records has climbed steadily even with disruptions caused by the introduction of new speeds. Final figures for 1952 are expected to show that more than 170 million U.S. records of all speeds and types were produced, representing over $160 million in retail sales.

Breakdown of record sales in 1952 is expected to show a continuation of the sales trend toward the 45-rpm and 33¿-rpm record speeds. In 1949 the percentage of total sales accounted for by each speed was: 78 rpm, 88 percent; 33¿ rpm, 8 percent; 45 rpm, 4 percent. In 1951 the percentages were: 78 rpm, 66 percent; 33¿ rpm, 16 percent; 45 rpm, 18 percent.

Future—Phonograph manufacturers who were hindered by a...
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lack of motors in 1952 due to sparse steel supplies feel that, with additional steel allocations by NPA, this year will be one of their best. Action of CBS who will soon begin selling a higher priced hi-fi phonograph, and Emerson, who takes over Webster-Chicago, seems to substantiate this forecast. It is also reported that Zenith will bring out a new hi-fi phonograph this year.

Record manufacturers see new volume highs for 1953 and are preparing for them. Through R'AA (Record Industry Association of America) they plan to run a test sales campaign and market survey to determine the long-range effect on record sales of increased sales of phonographs. The results of the test and survey may lead to changes in phonograph record advertising and promotion.

**Top Management Reviews Its Paychecks**

Higher net sales helped to up executive salaries but taxes and living costs also rose

Compensation of principal executives in the radio and television industry increased substantially between 1949 and 1951, reflecting an even healthier increase in net sales for firms they represented. However, higher income taxes and rising costs tempered the effects of both, according to a study made by the National Industrial Conference Board of company reports to the Security and Exchange Commission.

**Set Manufacturers**—The study shows that between 1949 and 1951 the net sales of 10 representative radio and television receiver manufacturers increased an average of 38 percent. In 1949 they ranged from $6.1 million to $396 million, while in 1951 the span was from $12 million to $599 million. For the same companies the total officers' payroll rose 24 percent during the period. Total executive payroll ranged between $57,000 and $1.6 million in 1949. In 1951 the range was between $93,000 and $2.1 million.

As a percentage of sales, top management salaries represented 0.5 percent of total net sales in 1949 and 0.6 percent in 1951. For individual set makers the percentage ranged from 0.4 percent to 1.4 percent in 1949 and from 0.3 percent to 1.2 percent in 1951.

**Parts Manufacturers**—Management salaries also rose substantially in radio and television parts companies, according to the SEC report study. Between 1949 and 1951 the net sales of 8 leading parts manufacturers increased over 10 percent and total officer salaries during the three-year period rose 35 percent. In 1949 the net sales of these firms ranged from $600,000 to $15.5 million, while in 1951 the span was from $1 million to $33 million. Total pay to parts company officials ranged from $54,000 to $310,000 in 1951. The bracket was $11,000 to $70,000 in 1949.

Total executive salaries for the parts companies surveyed represented as a percentage of net sales 1.5 percent in 1949 and 1.6 percent in 1951. For individual parts companies, the percentage ranged from 0.7 percent to 5 percent in 1949 and from 0.7 percent to 5.4 percent in 1951.

**Top Man**—The highest-paid executive in each of the radio and television set manufacturing firms surveyed received a salary in 1949 ranging from $18,800 to $200,000. The top salary of $200,000 didn't change in 1951 but the lowest salary reported increased to $25,000. Although bonus reports were incomplete, figures available indicate that they also increased substantially. A bonus high of $120,700 was reported in 1951. In 1949 the high was $49,300.

Among the radio and tv parts manufacturers surveyed the salary of the highest-paid executive in each of these firms ranged from $11,000 to $70,000 in 1949. In 1951 the spread was from $32,000 to $79,300. Executive bonus checks remained relatively stable.

**Costs**—The average executive who earned $50,000 in 1949 had a net after taxes of $33,000. In 1951 his take-home pay from the same amount was $31,100. The cost of living as measured by the Consumer's Price Index also had its effect. It stood at 161.3 in 1949 but by 1951 had risen to 174.5.

**Robot Responds To Spoken Numbers**

Digits from 1 through 0 are made into patterns, matched with memory standards

An experimental unit in Bell Labs responds to spoken numbers by lighting the proper light for each digit from 1 to 0. The response is accurate when circuits are adjusted to the individual voice, if enunciation is clear. Signals could equally well perform other functions, such as operating dial mechanisms.

In this developmental stage the engineers are cautious, putting customer vocal dialing somewhere in the future. But they hope Audrey—the 'automatic digit recognizer'—can be taught to respond to additional sounds, perhaps even say a few words on command.

**Audrey's Nerves**—Circuits and relays used in modern dial systems were used in the unit's construction. The voice sounds are sorted into electrical categories which conform to sound wave patterns.
Builder Claims Smooth Performance and Quiet Operation thru the use of Barrymounts in Dehydrator

Miniaturized Vibration Isolators Help Cut Space and Weight in Fuel-Gauge Power Unit

The 2-way protection given by Barrymounts is applied in AUTO-DRYAIRE® dehydrators as a design feature of these automatic pressurizing units for high-frequency transmission lines.

In this service, Type C-2000 Barrymounts prevent transmission of air-compressor vibration to the supporting surface. They also cushion the mounted apparatus to protect active parts, piping, and controls within the dehydrator from external shock and vibration.

The maker of AUTO-DRYAIRE®, Communication Products Company, Inc. of Marlboro, N. J., states: "We have used Barry Isolators for several years. The excellent service they have rendered in our equipment is the primary reason for their continued use."

Type 2000 Barrymount

Barry "cup" mounts are satisfying a wide variety of needs in industrial, mobile, and marine service. Ask our Field Engineering Department for help with YOUR vibration problems. FREE CATALOG 504-B tells about these and other vibration isolators.

78% size reduction and 50% weight reduction — with no loss of performance — is the effective miniaturization obtained in the new Minneapolis-Honeywell aircraft-fuel-gauge power unit. Miniature, air-damped Barrymounts, Type 6465, helped MH engineers in this achievement. These vibration isolators, in which size and weight have been cut while operating characteristics have been maintained, will help you redesign for miniaturization.

Check these useful features of miniaturized Barrymounts.

- Light weight — only 5/16 ounce each.
- Small size — 1" diameter 11/32" loaded height.
- Resonant frequency — 9 cps
- Transmissibility at resonance — 3
- Wide load range — 0.1-3 pounds
- 4 different styles available — for plate or stand-off mounting.

Write for data sheets 605 and 606 giving details of dimensions and load ratings.

FREE CATALOGS
- 523-A — Air-damped Barrymounts for aircraft service, also mounting bases and instrument mountings.
- 509-A — ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504-B — Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 — How to cut maintenance costs by using Barrymounts with punch presses.

THE BARRY CORP.
707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN
Atlanta Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

ELECTRONICS — February, 1953
Want more information? Use post card on last page.
Television Expands Overseas

Sets abroad top 2.4 million, 21 countries have service; Latin America best US market

TELEVISION is making significant progress abroad. Stations are on the air in 21 foreign countries and regular service is scheduled for seven more by the end of the year. Sets in use total 2.4 million, up 50 percent over 1951 figures. Ganging-up 10 or 15 people to a set is common and the viewing audience is estimated at 24,450,000.

Latin American countries have shown great interest in television and this area is potentially an important market for American manufacturers. Picture standards are in general the same as in U. S. Elsewhere, Japan has adopted our standards and is planning a TV network that may include 30 stations or more. However, fourteen Japanese-electronic firms reportedly are gearing up for mass production of TV receivers. Japan looks as a competitor rather than customer in the world market.

**Cuba**—Fourth in number of sets in use, Cuba has complete television coverage. Two competitive networks cover the island and 100,000 sets are in use. Havana has two stations, with a third planned for 1954. Ten additional stations are planned.

**Mexico**—Mexico, with five stations on the air, has only 40,000 sets in use. One major problem is the 60 and 60-cps power service in Mexico City. A heavy import duty on finished sets has been partially circumvented by shipping chassis to assembly plants in Mexico. Some manufacturers have considered making sets in Mexico for export elsewhere in Latin America to take advantage of the favorable tariffs between Mexico and other Latin American countries. Spain enjoys similar tariff advantages and this may be one reason why a large U. S. TV manufacturer will operate from there.

**Brazil**—Beset with foreign exchange troubles, Brazil, nonetheless, is showing great interest in TV. An electronics industry has already taken root in the Sao Paulo area and television sets may soon be manufactured internally. Radio sets and components are now

Continued from page 18

INDUSTRY REPORT—Continued

These categories are matched, in a memory cell, against electronically-drawn standard reference patterns. When the electrical pattern of the spoken number matches the standard pattern, the proper light flashes.

Voice-operated devices have been used for years in transoceanic telephony, but until now none of them have had to distinguish between different words. The key to Audrey's success is the visible study of speech patterns done in Bell Labs on the sound spectrograph and similar machines.

Electronics Surplus Is Still Big Business

Obsolete and overstocked supplies continue to pour out of warehouses

Far from petering out with dribbles of World War II equipment, the electronics surplus industry is growing, according to the Institute of Surplus Dealers, Inc.

At the recent surplus show in New York, Eugene P. Connolly, the Institute's president, guessed a $25,000,000 volume this year in surplus electronic gear. And Connolly thinks it will never end. Surplus, he says, is here to stay, a part of our economy and a pretty large part at that.

**Organization**—The Institute has compiled a list of 2,200 dealers across the country, but there are many more not listed or disguised under other business operations.

A manufacturer looking for surplus supplies has two ways to go. He can watch the ads in publications and surplus dealers' circulars, or he can write to the Institute (673 Broadway, New York City). He may find what he wants but, if he doesn't, that is no sure indication the surplus goods are not there. Surplus dealers by large aren't electronics men; they don't know a 6V6 from a megawatt.
The Type 1604-A Comparison Bridge is a unique, direct-reading impedance measuring device which materially reduces test and measuring time. It enables the rapid and precise measurement of both impedance and dissipation factor of capacitors, resistors and inductive components. A component of a production lot or an appropriate standard is used for comparison against the unknown.

In operation, “Impedance Difference” and “Dissipation Factor Difference” dials conveniently and accurately indicate the degree by which these characteristics differ from those of the selected standard. For real high-speed sifting, the cathode-ray tube indicator is easily calibrated at the desired tolerance and used to give an instantaneous visual “go no-go” indication. The instrument is completely self-contained; it includes a bridge circuit, internal 1 kc and 5 kc oscillators, a high-gain non-linear amplifier terminated in a CRO visual detector, and an internal power supply.

The Type 1604-A Comparison Bridge —

★ is ideal for checking ganged potentiometers, condensers and inductors that must track each other to very close tolerances
★ is extremely useful for precisely setting and checking the tap of center-tapped windings or for comparing two windings on the same core.
★ permits rapid and reliable adjusting of one variable component to the value of another ... the approach to balance is continuously and instantly indicated
★ can be used to measure directly small capacitors in the 1 µuf range.
★ In laboratory, shop or production line the Comparison Bridge will prove invaluable for adjusting, selecting and pairing components within given tolerances.

FEAT URES

Two IMPEDANCE DIFFERENCE Ranges — 0 to ± 5% range for accurate comparisons — 0 to ± 20% for checking components within the common ± 10% and ± 20% tolerances

Accuracy of Impedance Measurements

<table>
<thead>
<tr>
<th>Resistance</th>
<th>Capacitance</th>
<th>Inductance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kc: 2Ω – 20MΩ</td>
<td>50 µf – 50 µuf</td>
<td>500 µh – 250 h</td>
</tr>
<tr>
<td>5 kc: 4Ω – 4MΩ</td>
<td>2 µf – 50 µuf</td>
<td>200 µh – 10 h</td>
</tr>
</tbody>
</table>

For these impedances, accuracy is ± 0.1% for the 5% switch position.

DISSIPATION FACTOR DIFFERENCE

<table>
<thead>
<tr>
<th>Range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 0.15 at 1 kc</td>
<td>± 0.75 at 5 kc</td>
</tr>
</tbody>
</table>

CRO Visual Detector — horizontal band of light is used as the indicator — highly non-linear detector amplifier gives indication on scope over wide ranges of imbalance — continual resetting of gain control is eliminated.

Zero Adjustment — adjustable index mark on scope can be offset and locked to compensate for deviation of the standard from the desired nominal value — permits use of any component as a standard

Dimensions — 12" x 14½" x 10"; Net Weight — 22½ lbs.
being made. Manufacture of electron tubes including crt's is envisioned.

Brazil has 45,000 sets in use, three transmitters on the air, nine planned and four under construction. The city of Rio de Janiero may soon become operator of the hemisphere's first educational tv station. Brazilians are enthusiastic about television and projection receivers are frequently seen in public places, parks and even vacant lots.

 Elsewhere—Argentina imported 9,293 tv sets during the first eight months of 1953. No additional transmitters are contemplated. There is presently only one station, in Buenos Aires.

Venezuela has a high standard of living and a large market is expected here despite different picture standards. Two stations in Caracas should be on the air by now. A third is scheduled for late 1953.

Television transmitter deals recently fell through in Uruguay and Colombia.

U. S. manufacturers of tv transmitting equipment have reported serious inquiries from El Salvador, Peru, Costa Rica, Republic of the Philippines, New Zealand and Union of South Africa. Inquiries of a more casual nature have been received from Honduras, Formosa, Indonesia, Malaya and Greece.

Average Laboratory Uses 254 Instruments

Financial Roundup

MERGER action by two major manufacturers, along with profit reports and security transactions of other companies in the field, highlight the current financial picture of the electronics industry.

Board of directors of Webster-Chicago and Emerson Radio have recommended merger of the two companies. After approval by stockholders of both companies, Emerson will issue 337,500 shares of its capital stock for the 450,000 shares of Webster-Chicago now outstanding, which is in the ratio of 3/4 share of Emerson for 1 share of Webster-Chicago. These shares will be in addition to the 1,935,187 presently outstanding shares of capital stock of Emerson, which will remain unchanged. After the merger, Webster-Chicago will be operated as a division of Emerson.

Profit Reports—The following companies issued net profit statements for the first 9 months:

<table>
<thead>
<tr>
<th>Company</th>
<th>1952</th>
<th>1951</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T*</td>
<td>325,813,780</td>
<td>330,949,438</td>
</tr>
<tr>
<td>Aves</td>
<td>6,647,079</td>
<td>7,880,372</td>
</tr>
<tr>
<td>Minnesota Mining</td>
<td>11,442,337</td>
<td>11,427,754</td>
</tr>
<tr>
<td>Reliance Electric</td>
<td>1,818,140</td>
<td>1,727,218</td>
</tr>
</tbody>
</table>
| Remington Rand** | 9,567,491   | 9,836,491     | *Not operating income for 18 months **Earnings for 8 months

Securities Sold—Aerovox purchased for cash the entire outstanding stock of Acme Electronics of Pasadena. It will be operated as a wholly-owned subsidiary.

Radioactive Products sold 52,176 shares of class A convertible stock at $1.25 per share. The proceeds were added to the company's working capital to facilitate increased volume.

Kentucky Coal Deposit Ups Germanium Supply

GERMANIUM for transistors and crystal diodes has been found in coal ash from an eastern Kentucky deposit. Although the new source may increase substantially the amount of germanium available,
The NOBATRON® maintains stabilized DC voltage under changing line and/or load conditions. A complete line of catalog models are available, with output voltages of 6, 12, 28, 125, and 200 VDC, from 5 to 350 amperes.

Sorensen Nobatrons eliminate battery and generator troubles. They combine high regulation accuracy with maximum dependability and minimum maintenance.

All models are attractively finished. Most can be furnished either for relay rack mounting or in cabinets for bench-top use. Most units are metered; all are adequately protected against overload by suitable fuses and breakers.

**COMMON NOBATRON SPECIFICATIONS**

| Input voltage range | 95-130 VAC, single 6, 50-60 ~ High-current units 208/115, 3p, 4-wire, wye. |
| Output voltage range | Adjustable ± 10% with rated accuracy, — 25% with lesser accuracy. |
| Regulation accuracy | ± 0.2% from 1/10 to full load. |
| Ripple voltage | 1% RMS. Time constant 0.2 seconds. |


**WIDER OUTPUT VOLTAGE RANGE MODELS**

Nobatron-RANGERS® are designed to meet the demand for power supplies similar to the Nobatron but with wider output voltage ranges.

Nobatron-RANGERS are continuously adjustable over extended output ranges, yet provide regulation accuracies of ±0.25% against line and/or load. Other specifications are identical to those of the standard Nobatrons.

Three models are available, the SR-30, SR100, SR-2. Capacities, respectively, are 3-30 VDC at 3-30 amperes, 3-135 VDC at 1-10 amperes, and 100-300 VDC at 1-10 amperes.

Investigate NOW the cost of a NOBATRON installation versus the overall cost of less satisfactory DC sources.

**OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:**

- B-NOBATRONS (high-voltage, low-current DC Supplies)
- FREQUENCY CHANGERS
- VARIABLE AUTO TRANSFORMERS
- SATURABLE CORE REACTORS
- AC LINE REGULATORS

For Complete Information Write

SORENSEN & COMPANY, INC.
375 Fairfield Avenue
Stamford, Conn.
demand is expected to keep its price firm at $350 a pound.

Germanium production has been running about 1,000 pounds annually; demand may reach 15,000 pounds when transistor production swings into high gear. Original source for the increasingly important material was smoke from zinc furnaces.

### Automatic Pilot Speeds River Barges

**At First Glance,** an automatic pilot for a tugboat seems about as useful as lace curtains at the windows of the pilot house. But when the seconds and minutes saved by its use add up to hours or even days less for a given trip the idea begins to make sense.

Sperry Gyro, which claims a preponderance of the hundred-odd radar installations on tugs plying the Mississippi-Ohio rivers system, has been working for at least two years on a gadget that will tie radar to the rudder. The final result is a control that can be hung on the outside of the radar console or in any other convenient small space. Linkage between the two, so far, is via the pilot.

**Steady as You Go**—The pilot's control is a small housing not unlike the throttle of a Diesel locomotive. With the handle in the lower circular slot, he can steer the tug electronically by means of a magnetic amplifier in a box mounted nearby. By moving the handle upwards into the top slot, the last course setting is held with the help of a gyrocompass. Movement of the handle corrects to any new desired course.

Pushing a 1,000-foot string of barges up the Mississippi is slow work at best, sometimes as slow as a knot an hour. Even a good pilot is likely to oversteer a little, especially at night. Whenever he does, he must turn his rudder in the other direction. And while steering, he slows his progress. With the automatic pilot, it may be possible to cut a fifteen-day trip to ten days.

On the Hudson River-Champlain Canal system there is one skipper who saves two hours out of every twenty-four with the new device.

---

**Television Assumes Role in Cold War**

East and West stations vie in divided Berlin; relay spans Red Zone

**Regular** television broadcasting in Germany has opened a new battlefield in the propaganda war for men's minds. Programs are now

(Continued on page 22)

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Ph.D. in Telecommunications

Executive of German-Canadian Radio

**February, 1953 — ELECTRONICS**
Select the right
KROHN-HITE OSCILLATOR
in the ULTRA-LOW FREQUENCY RANGE

REMEMBER: All KROHN-HITE OSCILLATORS provide sine and square wave simultaneously

SPECIFICATIONS:

- COMPACT and LOW PRICED
  - model 400-A
  \[ \text{price } \$35000 \]

- STANDARD RACK MOUNTING
  - model 400-C
  \[ \text{price } \$37500 \]

- SINGLE ENDED OR BALANCED OUTPUT
  - model 410-A
  \[ \text{price } \$95000 \]

SPECIFICATIONS:

- WIDE RANGE
- ULTRA-LOW DISTORTION
- EXCELLENT AMPLITUDE CONSTANCY
  \[ \text{price } \$95000 \]

KROHN-HITE
INSTRUMENT COMPANY
580 MASSACHUSETTS AVENUE
DEPT. E, CAMBRIDGE 39, MASS.

All Krohn-Hite Instruments fully guaranteed for one year against defective materials and workmanship. Prices net - F.O.B. Cambridge. Write for free catalog.
Lawrence Tri-Color Tube In Production

NOW CALLED 'CHROMATRON', the tri-color tube (p 81 and 146, Nov. 1951) developed by E. O. Lawrence of the University of California is being produced in pilot-plant quantities by Chromatic Television (Paramount Pictures) of Oakland, Calif. At a closed-circuit demonstration for the press in New York City, Richard Hodgson, president of Chromatic, said 200 have already been made. The tube is 22 inches in diameter but, due to the wire grid arrangement integral to construction, it produced an 18-in. picture.

► Claims—Demonstrated with a flying-spot scanner and Kodachrome slides, the picture was very bright. Hodgson said less scanning power is now needed for the color sync pulses, as a result of increasing the number of vertical grid wires and other improvements. A major advantage claimed for the new tube is its adaptability to mass assembly methods. Mass-produced color grids and mass-produced phosphor-striped screens may be mass-assembled without much hand tailoring, giving a color tube for about twice the cost of conventional monochrome types.

The tube was demonstrated on the CBS color system but is adaptable to NTSC signals. It can be made as short as monochrome tubes usually are.

Militronic Equipment: Too Complex?

"Perhaps," say top brass as drive gains to reduce both cost and upkeep

LEVELED jointly at military men and equipment designers is the charge that excess gimmicks and gadgets in modern weapons are killing our boys with kindness. Critics also contend that weapons cost more than they are worth, that they should be far simpler in design and construction. The charge is popular with economy-minded congressmen and a widespread conclusion has been drawn that we are designing ourselves into bankruptcy.

Much of the complexity arises from wider application of electronic devices. A modern battle-

ship uses 9,000 electron tubes, a B-36 heavy bomber depends upon 2,100 tubes for navigation and control. An F-86 Sabrejet employs 600. In all, 15,000,000 tubes are currently used in military equipment. Costwise, electronic gear aboard a destroyer brings $3,000,000 today as against $40,-

000 during World War II.

Maintenance costs likewise measure complexity of new weapons. Experience shows that each 100 million dollars worth of military electronic equipment needs one billion dollars worth of maintenance before it wears out.

► How to Simplify—Interest is mounting in simple and reliable equipment. Department of De-

(Continued on page 24)
IMMEDIATE INFORMATION on reservations for American Airlines' 1000 flights a day is available to airline personnel through the use of The Teleregister Corporation's Magnetronic Reservisor,* the first completely automatic reservations system.

With its 1500 tubes and 1400 CLARE relays, the Reservisor* is also a high-speed computer, a storage and filing system, data transmission system, display device, and a logging or recording unit.

In their vast experience with electrical controls, Teleregister's engineers have acquired a knowledge of relays that is wide and deep. The importance which they attached to selecting the best possible relays for the Magnetronic Reservisor* stands out in these their own words, "Choice of components, equipment layout, and circuitry were aimed at reliability. First of all, the incidence of trouble should be held to the minimum. This has been accomplished by using only the finest components and by using a sturdy relay instead of a vacuum tube wherever possible." Their deliberate choice of CLARE relays is therefore charged with meaning for industrial designers.

CLARE sales engineers are located in principal cities to cooperate in the development or "custom-building" of relays to meet your most difficult design applications. Call them or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable address: CLARELAY.

*Trade Mark of The Teleregister Corp.
fense procurement officials are offering incentive contracts rewarding manufacturers who design and perfect weapons that do their job and are simpler than predecessors. Britain's RAF recently ordered 25 'poor-man's' radar sets. Hand-operated, the sets cost £11,200 and use only 50 tubes. Shying from 'cheap-and-dirty' equipment, U.S. military men too have nevertheless embarked on a program of simplifying equipment and reducing upkeep through unitization and automatic fault location.

**Plug-In Radar** — Unitization means building up equipment with independent black boxes that can be plugged in when needed. A unitized radar set aboard a battleship would be replete with all extras while the same set, stripped to its essentials, would serve adequately aboard an LST.

Fault-locating devices of sufficient sensitivity to predict failure simplify maintenance in an emergency. Repair consists of plugging in a complete spare unit, with overhaul chores deferred to a convenient time and place.

**Transistor Weds Magnetic Amplifier**

Ceremony yields rugged servo system with high gain, fast response and high power output

Use of transistors in conjunction with magnetic amplifiers was suggested shortly after the transistor was announced. Each was known to be extremely rugged. The absence of standby power inherent in both devices showed promise.

The transistor is an efficient amplifier at low power levels and the magnetic amplifier excels at high power levels.

The marriage is in a servo amplifier by the Industrial Control Co. of Wyandanch, New York. The transistor acts, in effect, as a preamplifier for the magnetic amplifier power stage.

**Simple Circuit**—The circuit used is quite simple, and yet it offers power gains of several thousand with a speed of response limited only by the operating frequency.

Input and output may be either d-c or a-c, and negligible power is consumed by the amplifier when no power is being delivered to the load.

Work is still going on to develop new designs, although the existing circuit is directly applicable to a wide variety of control applications in its present form.

A number of improvements are expected to result from use of better transistors, when they become available in sufficient quantity to make their use in commercial equipment feasible. Higher gains may be obtained by using cascaded transistors.

The new development makes available to industry a highly efficient and versatile packaged servo amplifier that is virtually indestructible and may be expected to have a long life. With present models power levels of a fraction of a watt to 500 watts may be controlled by such low-power devices as thermocouples, synchros, small potentiometers and photocells. The transistor-magnetic amplifier may also be used in other applications where low-frequency amplification is desired.

**TV Servicing Business Patterns**

Survey of dealers reveals large variations in efficiency of operation and charges for work

The pattern of radio and television service business operation shows up as hectic and varied in a recent GE survey of 2,175 full-time dealers.

Average dollar volume for all dealers in 1951 ranged from $6,150 per technician in the small shop to $8,200 per technician in shops having over 10 technicians. Corresponding figures for shops specializing in tv work are $7,330 to $8,500.

**Jobs Per Technician**—An average of 35 jobs is completed per week by each technician, but the average is by no means representative. Some of the six to nine man shops fixed over 60 sets per week per technician, while others got less than 14 jobs per week out of each technician.

Billing per service call also showed an extreme variation from the $8 average figure for tv and $5.50 for radio. Combining all dealers, the extremes show 9 percent of the firms averaging $3 per call as a low and $14 per call as a high. On the other hand, over 75 percent had average billings in the range of $5 to $10.

**Contracts**—In firms having under 5 technicians, less than 10 percent of the tv calls were under service contract. With large firms specializing in tv service, a surprisingly high figure was reported for 1951; 75 percent of the calls were under service contract.

Percent of service jobs completed in the home on tv sets ranged from 78 percent for the small dealer to 86 percent for those having over 40 technicians.

**Triple-Use Waveguide**

For TV, Phones, Power?

"Barlow's Tube" in London has U. S. counterpart at Bell Labs and Signal Corps

For many years, power companies have also been using their high-tension lines stretching across the country as carriers for wired-wireless radiotelephone communication. More recently, the Signal Corps has been experimenting with...
A GOOD NAME TO REMEMBER
WHEN YOU NEED DEPENDABLE
COMPONENTS...faster!

STACKPOLE

FIXED and VARIABLE RESISTORS

Electronic Components Division
Stackpole Carbon Company, St. Marys, Pa.

Also LINE AND SLIDE SWITCHES • CERAMAG (ferrite) CORES • IRON CORES • MOLDED COIL FORMS • GA "GIMMICK" CAPACITORS, etc.

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
the G-string, a single wire coated with enamel or plastic along which very high-frequency currents travel. Radar has made familiar the use of the waveguide, a hollow tube through which microwaves pass.

Marriage of Convenience-H. M. Barlow, a professor at the University of London, proposes the use of a pair of hollow copper tubes that will carry multiple telephone conversations within, television signals on the outside surface and power within the copper. So far, he has confined his research primarily to the radio phase of the problem.

Bell Telephone Laboratories engineers, whose main concern likewise is communications, admit to "strenuous activity" in the development of long-distance techniques using circular waveguides at 50,000 megacycles—only slightly different from those employed by Barlow.

The new Bell type L-3 coaxial cable system handles 1,800 circuits. The number might be more than doubled with the waveguide technique.

Business Briefs

Cheaper, better transistors may not be far away, if a new "substance" recently announced by Brown-Allen Chemicals, Inc. of New York City lives up to claims made for it.

Super-sniffer that smells gas leaks by electronics and sounds an alarm if all is not well is now being used to detect leaks in hermetically sealed aircraft equipment.

Swiss financial group representing the Union des Banques Suisses may invest in tv set manufacturing in Italy. It has been estimated that 100,000 sets could be absorbed by the Italian market in 1953.

If the Bureau of Internal Revenue takes over Grand Central Palace for office space later this year, as has been reported, the 1954 IRE National Convention will be held in the Kingsbridge Armory, Bronx, N. Y., according to an announcement by J. W. McRae, president, and G. W. Bailey, executive secretary of the Institute.

Australia will spend a total of $20 million on military electronic equipment with local manufacturers. New types of radar equipment will not, however, be developed in Australia as previously planned because of insufficient time. U. S. and British designed radar will be used. It will be made by local firms having overseas affiliations.

Satellite tv station for Hawaii may be put into operation this year by KGMB-TV in Honolulu as part of a plan to extend tv service to six major islands extending over a chain 300 miles long.

Power consumption of tv home receivers adds an estimated $200 million a year to the utility industry's revenues, according to C. B. Jolliffe of RCA. Tv studios and transmitters increase income another $2.5 million. In New York alone, an income of $12 million during the year ending June 30, 1952 is attributed to home tv usage.

MEETINGS

FEB., 4-6: Western Computer Conference, Hotel Statler, Los Angeles, Calif.
FEB., 5-7: IRE Southwestern Conference and Electronics Show, Plaza Hotel, San Antonio, Texas.
FEB., 5-7: Audio Fair, Alexandria Hotel, Los Angeles, Calif.
MARCH 9-12: NEMA, Edgewater Beach Hotel, Chicago, Ill.
MARCH 22-25: Sixth Annual Conference for Protective Relay Engineers, A & M College of Texas, College Station, Texas.
MARCH 23-26: IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.
MARCH 23-27: Western Metal Exposition, Pan-Pacific Auditorium and Western Metal Congress, Statler Hotel, Los Angeles, Calif.
APRIL 18: Seventh Annual Spring Technical Conference, Cincinnati IRE, Cincinnati, Ohio.
APRIL 28-MAY 1: Seventh Annual NARTB Broadcast Engineering Conference, Burdette Hall, Philharmonic Auditorium, Los Angeles, California.
MAY 1: American Association of Spectrographers Symposium, Chicago, Ill.
MAY 11-13: IRE National Conference on Airborne Electronics, Dayton, Ohio.
MAY 18-21: 1953 Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.
MAY 24-28: NAED, 45th Annual Convention, Conrad Hilton Hotel, Chicago, Ill.
JUNE 20-OCT. 11: German Communication and Transport Exhibition, Munich, Germany.
AUG. 29-SEPT. 6: West German Radio and Television Exhibition, Dusseldorf, Germany.
SEPT. 1-3: International Sight and Sound Exhibition, Palmer House, Chicago, Ill.
FILTRON'S Engineering division, with its completely equipped screen room facilities, is always available to measure and recommend RF Interference Filters for your equipment, to meet and exceed the Radio Interference requirements of MIL-I-6181.

FILTRON'S production facilities are supplying more RF Interference Filters for use in military electronic equipment than ever before, to meet the nation's requirements.

FILTRON... the LEADER IN RF INTERFERENCE FILTERS... has pioneered:

- Sub-miniature Filters
- High-temperature Filters
- Wide band Multi-section Units
- RF Filters "Custom Designed" to meet YOUR requirements

Wide band Multi-section Units
RF Filters "Custom Designed" to meet YOUR requirements
What does this 126
year old Patent mean to you?

One hundred twenty-six years of experience, know-how, inventiveness—call it what you will—is something we alone can give you in our particular field.

For Chester Stone, the inventor of the washing machine of this patent, was the father of our founder, and the great uncle of our president.

One hundred twenty-six years later to the month, we continue to be very much interested in washing machines, but in a different way. Today we manufacture insulating bushings for the electric motors, fibre bobbins for the time controls, and laminated paper base phenolic sleeves for mounting insulation.

The United States has become a nation of specialists in the years since John Quincy Adams, the President; Henry Clay, the Secretary of State; and William Wirt, the Attorney General, signed this patent in 1827.

We have become specialists in the manufacture of spiral wound insulating tubing, sleeves, and bobbins. They can be furnished in diameters as small as $3/8''$ ID, various wall thicknesses and lengths, and of many materials including hi-dielectric kraft, fish paper, and plastic films. We can produce these custom-made quality products to close tolerances. They are low in cost and our service is unsurpassed.

The use of our products by many hundreds of America’s leading manufacturers is ample testimony that this heritage of one hundred twenty-six years has well equipped us to satisfactorily fulfill a large number of their specific requirements.

Sales representatives are located in principal cities. We would welcome an opportunity to serve you.

STONE PAPER TUBE COMPANY INCORPORATED

900-922 Franklin Street, N. E. Washington 17, D. C.

ELECTRONICS — February, 1953 Want more information? Use post card on last page.
High-Voltage CAPACITORS?

Plastic Capacitors, Inc., achieve capacitor designs in smaller sizes and higher working temperatures with increased life expectancy.

This is accomplished by uniquely processing plastic films for use as the solid dielectric in their capacitors.

Our catalog describes these features including capacitors with voltage range up to 60 Kv. but AC capacitors and higher voltage DC capacitors are available on special order.

Your inquiries are invited.

Plastic Capacitors, Inc.
PLASTIC FILM CAPACITORS • HIGH VOLTAGE POWER PACKS • PULSE FORMING NETWORKS
2511 WEST MOFFAT STREET • CHICAGO 47, ILLINOIS
KEEP YOUR PRODUCTION ROLLING!

Thin wall 3-core construction assures flux continuity...prevents "dry" joints.

Contains only Virgin tin & lead. Tin - 99.75% pure. Lead - 97.97% pure.

Only Multicore has Ersin Flux - high grade water-white rosin, homogeneously activated.
Non-corrosive even after long exposure to humidity.
Wets metal rapidly due to reduced surface tension.
Vigorous fluxing action.
Leaves only pure rosin after soldering.
Perfect joints on difficult metals & alloys even if oxidized.
Total % flux to solder less than many single cored solders.
Rigid quality control insures same standards in every Multicore reel.
Conforms with QQ-S-571-b and all other pertinent Federal Specifications.

On the Assembly line...time is money!
Save the time lost in producing "rejects"; the time lost with ordinary "slow" solders on difficult metals; the time lost in finding "dry" joints.
Save the time...save the money...the efficiency of your plant...the good name of your product!
In every part of the World, leaders in Electronics are insuring their production efficiency with Multicore.
Nothing less will do... MULTICORE IS THE WORLD'S FINEST SOLDER!
NE-11-20-S SPECTRUM ANALYZER

Description
The Spectrum Analyzer is test equipment designed primarily for use with aircraft radar and beacon equipment operating over a frequency range of 8470 to 9630 mc/s. Housed in a compact portable carrying case, the whole assembly weighs approximately 90 pounds.
In operation, the Spectrum Analyzer displays on an oscilloscope a pattern representative of the distribution of energy among the various frequencies in the output of a pulsed oscillator. This equipment is equal to our government models TS-148/UP.

Applications
This very sensitive micro-wave receiver will provide accurate measurement of the spectra of radio frequency oscillations in radar and beacon equipment. It will also measure, within its own range, frequencies of echo boxes, magnetrons, test sets, local oscillators and a variety of resonant cavities. It can also be used to check magnetron pulling and AFC circuits, and as a frequency-modulated oscillator to tune T/R Boxes and R/T Boxes in transmitter-converters.
The Analyzer is so sensitive that the magnetron signal can usually be picked up at some distance from the source, thus making the equipment easy to use in any convenient location.

Specifications
Power Supply .......................... 50-1200 Cps; 105-125 Volts; 125 Watts
Frequency-meter Range .......................... Calibrated directly from 8470 mc/s to 9630 mc/s
Sweep Frequencies .......................... Continuously Variable from 10 to 30 Cps
Attenuation (Spectrum Amplitude) .......................... Uncalibrated. Variable from 3 to 70 db.
Operating Temperature Range .......................... —40°C. to +55°C.
Frequency swing of analyzer r-f oscillator (sawtooth FM) .......................... 40 to 50 mc/s
Overall i-f bandwidth at half power points .......................... 50 kc/s
Sensitivity to CW — Spectrum Amplified Pos. — 80 db. below 1 watt for 1 inch of deflection on Oscilloscope Screen.
— Spectrum Position — 55 db. below 1 watt for 1 inch of deflection of Oscilloscope Screen.
Maximum dispersion of spectra .......................... 1.5 mc/s per inch
Maximum error .......................... ± 5 megacycles
We will gladly furnish all details regarding specifications, prices, and delivery.

Write, wire or telephone for information.

NORTHEASTERN ENGINEERING
Manchester, New Hampshire

Telephone 2-6485

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS

www.americanradiohistory.com
James Prescott Joule
1818-1889

This English physicist was one of the first propounders of the principle of the conservation of energy. His experiments in 1843 determined the value for the equivalent quantities of heat and work. He also proved by experiment that the heat produced in a wire by the passage of electricity varies directly with the resistance of the wire and with the square of the current [Heat = \( \frac{1}{2308} \) R].

The Joule, a standard unit for measuring work or energy, was so named in his honor.
ALL-CERAMIC • POWER TYPE

Tap Switches

**FIVE SIZES**

<table>
<thead>
<tr>
<th>AMPS.</th>
<th>MODEL No.</th>
<th>MAX. V. (A-C)</th>
<th>TAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>111</td>
<td>15C</td>
<td>2 to 11</td>
</tr>
<tr>
<td>15</td>
<td>212</td>
<td>15C</td>
<td>2 to 12</td>
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<tr>
<td>25</td>
<td>312</td>
<td>30C*</td>
<td>2 to 12</td>
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<tr>
<td>50</td>
<td>412</td>
<td>30C*</td>
<td>2 to 12</td>
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<tr>
<td>100</td>
<td>608</td>
<td>30C</td>
<td>2 to 8</td>
</tr>
</tbody>
</table>

*150 volts between taps

**COMPACT DEPENDABLE**

Here's the most complete line of power type, rotary tap switches. These rugged units have high current capacity ... plus six outstanding features!

1—Ceramic construction, to provide permanent insulation, unaffected by arcing.
2—Extreme compactness, with terminals convenient for wiring.
3—Silver-to-silver contacts to eliminate contact maintenance.
4—Self-cleaning rotor contact. 5—“Slow-break” mechanism, with positive cam-and-roller for “slow-break, quick-make” action for A-C.
6—“Dead” switch shaft, insulated by strong ceramic hub.

OHMITE MANUFACTURING COMPANY
481a Flournoy Street
Chicago 44, Illinois

Write on company letterhead for this comprehensive OHMITE catalog.

Be Right with **OHMITE** RHEOSTATS • RESISTORS • TAP SWITCHES
...has everything you need for PRINTED CIRCUITS

First to provide Tubes and Transistors that are correctly designed for quick, efficient printed circuit assembly. For the ultimate in portable performance, combine Raytheon's high-efficiency, filamentary Sub-miniature Tubes with Raytheon's Junction Transistors.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
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<tr>
<td>1AG4 Output Pentode</td>
<td>1.25</td>
<td>40</td>
<td>41.4</td>
<td>+3.6</td>
<td>2.4</td>
<td>0.6</td>
<td>1000</td>
<td>357</td>
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<td>1AH4 RF Pentode</td>
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<td>45</td>
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<td>0.15</td>
<td>0.2</td>
<td>759</td>
<td>50</td>
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<tr>
<td>1A15 Diode-Pentode</td>
<td>1.25</td>
<td>40</td>
<td>45</td>
<td>0</td>
<td>1.0</td>
<td>0.3</td>
<td>425</td>
<td>1.5</td>
<td>0.3</td>
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<tr>
<td>1V6 Mixer-Pentode</td>
<td>1.25</td>
<td>40</td>
<td>45</td>
<td>0</td>
<td>0.4</td>
<td>0.15</td>
<td>200**</td>
<td>1.0</td>
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<tr>
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<td>45</td>
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<td>0.75</td>
<td>0.2</td>
<td>750</td>
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<tr>
<td>1AX5 Diode-Pentode</td>
<td>1.25</td>
<td>20</td>
<td>45</td>
<td>5 megs</td>
<td>0.5</td>
<td>0.2</td>
<td>280</td>
<td>40</td>
<td>0.4</td>
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*Type 1V6 is a high performance, low battery drain converter. Note the comparison with 1R5 using 45 volt supply.

**PNP JUNCTION TRANSISTORS**
(Average Characteristics at 30°C)

<table>
<thead>
<tr>
<th>CK722</th>
<th>CK722</th>
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<tr>
<td>Collector Voltage (volts)</td>
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<tr>
<td>Collector Current (ma.)</td>
<td>-0.5</td>
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<tr>
<td>Base Current (ua.)</td>
<td>-6</td>
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<tr>
<td>Current Amplification Factor*</td>
<td>40</td>
</tr>
<tr>
<td>Power Gain* (db)</td>
<td>38</td>
</tr>
<tr>
<td>Noise Factor* (1,000 cycles) (db)</td>
<td>22</td>
</tr>
</tbody>
</table>

*Grounded Emitter connection

Raytheon Manufacturing Company
Excellence in Electronics


Raytheon Makes All These:

Reliable Subminiature and Miniature Tubes • Germanium Diodes and Transistors • Nuclearic Tubes • Microwave Tubes • Receiving and Picture Tubes

Electronics — February, 1953

Want more information? Use post card on last page.
TIME TO STOP...IN TIME!

SPLITTING THE SPLIT SECOND at the Bendix-Westinghouse Engineering Research Department laboratories is absolutely essential in exploring every possible braking requirement for transportation tomorrow.

STANDARD ELECTRIC TIME has been serving industry, government and educational institutions for almost seventy years with fine precision instruments and equipment for the accurate measurement of time.

STANDARD ELECTRIC MODEL S-1 Clocks are a part of the modern laboratory controls testing equipment and timing devices shown in this photograph...they accurately measure air brake application and release transmission time to one-hundredth of a second...The timers are started instantaneous to brake pedal movement transmitted through an electronic circuit and are stopped by means of a highly sensitive electro pneumatic switch located at pre-determined stations in the air brake system.

THE STANDARD ELECTRIC TIME COMPANY
97 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
New Waldes Truarc E-Ring Dispenser
Speeds Assembly, Cuts Time and Costs

For greater time-saving, more efficient handling and assembly of Waldes Truarc E-rings, here is an automatic, precision tool. Designed for one-at-a-time repeating action, the Truarc E-ring Dispenser can be easily operated by any assembly worker.

Waldes Truarc E-rings (sizes 5133-9 to 50 inclusive) are now available packed on stackrods in quantities ranging from 250 to 500 pieces per rod. Stackrods are precision-made, allow re-loading in seconds. No interruptions to continuous flow in assembly.

*Dispensers for Waldes Truarc Crescent Rings (series 5103) also available.

**Simple 1, 2, 3 Assembly Operation**

1. Truarc applicator is pushed forward and grips a single E-ring.
2. Applicator withdrawn (new ring automatically feeds into place).
3. Ring is installed in groove on shaft. No waste time or motion.

Write, today, for complete brochure on Waldes Truarc E-Ring Dispenser

Waldes Kohinoor, Inc.
47-16 Austel Place, L. I. C. 1, N. Y.

☐ Please send me the new Waldes Truarc E-ring Dispenser brochure.
☐ I am also interested in dispensers for Crescent Rings.

NAME ____________________________

TITLE ____________________________

COMPANY _________________________

BUSINESS ADDRESS __________________

CITY _______________________ ZONE ____ STATE ______

Waldes Kohinoor, Inc., Long Island City 1, New York

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
DIODE FILTERS

\[ \begin{align*}
C_1 & \quad \text{1403-01} \\
C_2 & \quad \text{1403-02} \\
R & \quad \text{1403-03}
\end{align*} \]

TRIODE PLATE COUPLERS

\[ \begin{align*}
R & \quad \text{1404-01} \\
C_1 & \quad \text{1404-02} \\
C_2 & \quad \text{1404-03}
\end{align*} \]

VERTICAL INTEGRATOR

\[ \begin{align*}
R & \quad \text{1405-01}
\end{align*} \]

PENTODE PLATE COUPLERS

\[ \begin{align*}
R & \quad \text{1407-01} \\
C_1 & \quad \text{1407-02} \\
C_2 & \quad \text{1407-03}
\end{align*} \]

AUDIO OUTPUT CIRCUITS

\[ \begin{align*}
R & \quad \text{1408-01} \\
C & \quad \text{1408-02}
\end{align*} \]

**ERIE electronic printed circuits**

**PERFECTED BY MORE THAN A DECADE OF DEVELOPMENT**

...OFFER THESE ADVANTAGES

- Fewer soldered connections mean less installation time.
- Fewer connections mean fewer wiring errors.
- Circuit stability is improved through simplification.
- Costs for procurement and stock maintenance are considerably reduced.
- Space is saved by substituting a single installation for several installations.
- Reduced space requirements permit reduced size and weight of complete product.
- Other material costs are reduced by smaller size, lighter weight.

ERIE Electronic Printed Circuits achieve miniaturization by bonding the complete or partial circuit to a ceramic base plate, thus combining the work of several capacitors in one installation unit.

ERIE began the development of Printed Circuits in 1940, and today they are widely used by manufacturers of electronic products to effect a reduction in size, weight, and cost; and to improve performance. ERIE Electronic Printed Circuits have helped to solve design and production problems in radio and television receivers, hearing aids, military equipment, and many other products employing electronic control. Write for catalog and samples.

**ERIE components are stocked at leading electronic distributors everywhere.**

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

Main Offices: ERIE, PA.
Sales Offices: Cliffside, N. J. • Philadelphia, Pa. • Buffalo, N. Y. • Chicago, Ill. • Detroit, Mich. • Cincinnati, Ohio • Los Angeles, Calif.
Factories: ERIE, PA. • LONDON, ENGLAND • TORONTO, CANADA

Want more information? Use post card on last page. February, 1953 — ELECTRONICS
in instruments where reliability is imperative

SILASTIC works
where other materials fail

To assure maximum service life and accuracy, engineers at Lear, Incorporated, planned to protect their new vertical gyro-mechanism from corrosion by housing it in a completely inert and dehydrated atmosphere.

Sealing the housing, however, proved to be more easily said than done. Despite the most elaborate precautions, solder and flux fumes often penetrated the joint and contaminated the delicate mechanism. Once sealed, it was impossible to reopen the case without loss of the expensive cover and harness.

To both of these problems a simple and ingenious solution was found. A thin O-ring of Silastic molded to fit snugly under the cover flange is used to exclude the corrosive fumes generated in soldering a metal strip over the entire joint. The Dow Corning silicone rubber O-ring is not damaged by soldering temperatures. And, the gyro-mechanism is just as accessible for repairs as the contents of a hermetically sealed can of coffee.

Lear also uses a large ring washer of Silastic at each end of the housing to serve as resilient, shock-absorbing cushions for the apparatus at stratospheric temperatures.

And that's just one of hundreds of examples of how Silastic is used to improve the performance of products ranging from cable to traction motors, from domestic steam irons to aircraft.

For more information about the properties or fabricators of Silastic, mail this coupon today or phone our nearest branch office.

Dow Corning Corporation, Dept. BE-2, Midland, Mich.
Please send me:
☐ Silastic Facts 10a with new data on properties and applications of all Silastic stocks and pastes.
☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.
Name _______________________________ Title _______________________________
Company _______________________________
Address _______________________________
City __________ Zone __________ State __________

MIDLAND, MICHIGAN

Another Machlett Contribution Toward Better,
More Reliable Tubes for Industrial Service

ML-6257 is the latest addition to Machlett's line of tubes specially designed and processed for use in electronic heating equipment. It fulfills a long-standing requirement for a long life tube which can safely provide 3 kw of heater output with reliability and economy.

ML-6257—with its companion tubes ML-6256 and ML-6258—makes available design and performance characteristics which provide a higher standard of value for all applications—including AM, FM & TV broadcasting.

ML-6257 is rated 5 kw plate dissipation with cooling provided through an integral anode water jacket. Type ML-6256 with the same ratings uses the Machlett automatic seal water jacket. Type ML-6258 designed for forced-air cooling is rated at 3 kw plate dissipation.

Phone, wire or write for more information—Machlett Field Engineers will be glad to assist in any tube application problem.

RATINGS AND CHARACTERISTICS

Electrical Data—General

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament voltage</td>
<td>12.6 Volts</td>
</tr>
<tr>
<td>Filament current</td>
<td>27 Amps</td>
</tr>
<tr>
<td>Amplification Factor</td>
<td>21</td>
</tr>
<tr>
<td>Interelectrode Capacitances:</td>
<td></td>
</tr>
<tr>
<td>Grid-Plate</td>
<td>20 uuf</td>
</tr>
<tr>
<td>Grid-Filament</td>
<td>22 uuf</td>
</tr>
<tr>
<td>Plate-Filament</td>
<td>0.7 uuf</td>
</tr>
</tbody>
</table>

Maximum Ratings—Class C Telegraphy
(Key down conditions per tube without modulation)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-C Plate Voltage</td>
<td>5500 Volts</td>
</tr>
<tr>
<td>D-C Grid Voltage</td>
<td>1500 Volts</td>
</tr>
<tr>
<td>D-C Plate Current</td>
<td>1.5 Amps</td>
</tr>
<tr>
<td>D-C Grid Current</td>
<td>22 Amp</td>
</tr>
<tr>
<td>Plate Input</td>
<td>7 kW</td>
</tr>
<tr>
<td>Plate Dissipation</td>
<td>5 kW</td>
</tr>
</tbody>
</table>
Outside diameter of tubes and rods as small as .062" diameter centerless ground to tolerance of ±.0001".

Rods free of camber for precision shafts.

Rods and tubes centerless polished to 5 micro inch RMS finish ±

Cylindrical parts ground both inside and outside to diameter tolerance of ±.0005" with concentricity of .001" TIR. Sizes up to 8½" O.D. by 24" long are available.

Holes as small as .187" diameter can be economically lapped to tolerance of ±.001".

Plates and discs up to 50 square inches can be precision ground. Flat parts up to 4 square inch area are ground flat and parallel simultaneously on two sides; flat within .0002", parallel within .0005", and thickness tolerance .001" is practical.

Parts lapped flat within a few light bands. Special parts have been lapped to .008" thickness.

As a rule of thumb: On critical dimensions which lend themselves to grinding, AlSiMag ceramics can be furnished with the accuracy of comparable precision metal parts. AlSiMag ceramics are more wear resistant than steel and, in many designs, can be manufactured to close tolerances at lower cost.

Precision Tolerances

CUSTOM MADE TECHNICAL CERAMICS

Each year we have added more equipment and gained more skill and experience in grinding AlSiMag ceramics. We like difficult and complicated problems. If you have a tough one, send it to us. We'll tackle it.

Available in

51ST YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE
New Materials — New Techniques — New Advantages
Features in 4 New IRC Resistors

1 IRC Type BOC Boron-Carbon 1/2-Watt PRECISTOR Meets All Requirements of MIL-R-10509 Specification

No other non-wire-wound resistor combines the advantages of this all-new Boron-Carbon unit. Type BOC reduces the temperature coefficient of conventional deposited carbon resistors — provides high accuracy and long-time stability — replaces high value wire wound precisions at savings in space and cost. You'll find it adaptable to a host of critical circuitry needs — in electronics and avionics, communications, telemetering, computing and service instruments. Send for full details in Catalog Data Bulletin B-6.

Approximate Temperature Coefficient

<table>
<thead>
<tr>
<th>Temperature Coefficient</th>
<th>Parts Per Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Type 1, Nickel C</td>
<td>100</td>
</tr>
<tr>
<td>Wire Type 2, High Resis</td>
<td>150</td>
</tr>
<tr>
<td>IRC Type BOC, Boron-C</td>
<td>200</td>
</tr>
<tr>
<td>Non-ceramic, All-Carbo</td>
<td>250</td>
</tr>
</tbody>
</table>

Type BOC conforms to all requirements of MIL-R-10509. Exposed to a temperature of 65°C for one hour, the new BOC shows a resistance change of less than 0.2%. High temperature operation with reliability is now possible. Voltage coefficient is less than 20 parts per million per volt. Load life is outstanding; on a 500-hour test at ambient temperature of 40°C, resistance change will not exceed 2%. 

www.americanradiohistory.com
New IRC Type DCC (Deposited Carbon)
Small-Size, High-Stability Resistors

This is the latest small-size addition to IRC's famous line of deposited carbon PRECISTORS. Conservatively rated at \( \frac{1}{2} \) watt, it combines accuracy and economy—assures high stability, low voltage coefficient, and low capacitive and inductive reactance in high frequency applications. Recommended for—Metering and voltage divider circuits requiring high stability and close tolerance—High frequency circuits demanding accuracy and stability—Other critical circuits in which characteristics of carbon compositions are unsuitable and wire-wound resistors too large or expensive. Type DCC meets Signal Corps Specification MIL-R-10509. Complete technical data in Catalog Bulletin B-3.

New IRC Type FS Fuse Resistor

This completely insulated unit functions as a resistor under normal conditions and as a fuse under abnormal conditions. Small, compact, stable, it can be wired into a circuit as easily as a molded wire-wound resistor. Bulletin B-3.

4 New IRC Type WW Precision Wire Wounds Surpass JAN-R-93 Characteristic B Specifications

Here is the most reliable and stable of all wire-wound precision... by unbiased test! Actually, new Type WW's far surpass JAN-R-93 Characteristic B Specifications. New winding forms hold more wire for higher resistance values. New winding technique and rigid insulation tests eliminate possibility of shorted turns or winding strains. New type insulation withstands humidity, assures long life, provides stability and freedom from noise. New terminations except in small size WW-10 are rugged lug terminals for solder connection. Full data in Catalog Bulletin D-3.

<table>
<thead>
<tr>
<th>No.</th>
<th>Original</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>Resist</th>
<th>Total</th>
<th>% Change</th>
<th>% Change</th>
<th>% Change</th>
<th>% Change</th>
<th>% Change</th>
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<tr>
<td></td>
<td>Cycle</td>
<td>Cycle</td>
<td>Cycle</td>
<td>Cycle</td>
<td>Load</td>
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<td>Life</td>
<td>% Load</td>
<td>% Load</td>
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Tested side-by-side with competing resistors, new IRC Type WW's proved superior to all. Severe cycling and 100-hour load tests resulted in virtually zero changes in resistance. Other stringent tests proved Type WW's high mechanical strength, freedom from shorting, resistance to high humidity.

For full information on these products, or assistance in adapting them to any specific application, write IRC. Types BOC and DCC are currently available on short delivery cycles to manufacturers of military equipment only.

IRC
International Resistance Company
403 N. Broad St., Philadelphia 8, Pa.

Send me full data on the following: [ ] Type BOC Boron-Carbon PRECISTORS [ ] Type WW Precision Wire Wounds [ ] Type DCC Deposited Carbon PRECISTORS [ ] Type FS Fuse Resistors

Mail Coupon Today for Full Details of These New IRC Resistors

INTERNATIONAL RESISTANCE CO.,
403 N. BROAD ST., PHILADELPHIA 8, PA.

Please send me full data on the following checked items:

Name and Address of Nearest IRC Distributor

MAIL COUPON TODAY FOR FULL DETAILS OF THESE NEW IRC RESISTORS

INTERNATIONAL RESISTANCE CO.,
403 N. BROAD ST., PHILADELPHIA 8, PA.

Please send me full data on the following checked items:

Name and Address of Nearest IRC Distributor

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Name and Address of Nearest IRC Distributor

MAIL COUPON TODAY FOR FULL DETAILS OF THESE NEW IRC RESISTORS

INTERNATIONAL RESISTANCE CO.,
403 N. BROAD ST., PHILADELPHIA 8, PA.
The Kepco Model 700 features one regulated voltage supply with excellent regulation, low ripple content and low output impedance.

**SPECIFICATIONS**

**OUTPUT VOLTAGE DC:** 0-350 volts continuously variable.

**OUTPUT CURRENT DC:** 0-750 milliamperes continuous duty.

**REGULATION:** In the range 30-350 volts the output voltage variation is less than ½% for both line fluctuations from 105-125 volts and load variation from minimum to maximum current.

**RIPPLE VOLTAGE:** Less than 10 millivolts.

**FUSE PROTECTION:** Input and output fuses on front panel. Time delay relay is included to protect rectifier tubes.

**POWER REQUIREMENTS:** 105-125 volts, 50-60 cycles.

**OUTPUT TERMINATIONS:** DC terminals are clearly marked on the front panel. Either positive or negative terminal of the supply may be grounded. DC terminals are isolated from the chassis. A binding post mounted on the front of the panel is available for connecting to the chassis. All terminals are also brought out at the back of the chassis.

**METERS:**
- Ammeter: 0-1 ampere, 4" rectangular.
- Voltmeter: 0-500 volts, 4" rectangular.

**PHYSICAL SPECIFICATIONS:** Cabinet height 22¾", width 21¾", depth 15¼". Rack panel height 21", width 19", color gray, panel engraved.

**CONTROLS:** Power on-off switch, H.V. on-off switch, H.V. control.

**ADDITIONAL MODELS AVAILABLE IN THE 700 SERIES VOLTAGE REGULATED POWER SUPPLIES**

<table>
<thead>
<tr>
<th>Volts</th>
<th>Current</th>
<th>Model</th>
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<tr>
<td>0-350</td>
<td>0-0.75 Amp.</td>
<td>700</td>
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<td>0-350</td>
<td>0-1.50 Amp.</td>
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<td>0-350</td>
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<td>0-600</td>
<td>0-3.00 Amp.</td>
<td>780</td>
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</tbody>
</table>

FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. #1

KEPCO LABORATORIES, Inc.
131-38 SANFORD AVENUE
FLUSHING 55, NEW YORK

Want more information? Use post card on last page.
Specialist engineers and quality production have enabled HERMETIC to develop the Tubular Seals shown and many others with these advantages:

- Labor saving due to elimination of 1 solder joint per terminal
- Parts saving because leads can be brought through from equipment to final terminal board connection
- Higher current carrying capacity through use of copper leads
- Space saving, both inside and outside unit, resulting from minimum lengths of tubing
- Available in extra lengths for current carrying and evacuation
- Wide variety of sizes, layouts and tubings for every application

Pictured are typical Tubular Feed-Throughs from 1.00", 21 tubes (1502-21) to 1/8" single tube (1470) and other standard and special designs.

HERMETIC SEAL PRODUCTS CO.
31 South Sixth Street, Newark 7, New Jersey

Write detailing your problem for immediate attention, and ask for your FREE copy of HERMETIC's informative brochure, the most complete presentation ever offered on hermetic seals.
Here's How CRITICAL QUALITY CONTROL Assures You

LASTING STABILITY in Midland CRYSTALS

Midland Quality Control is Midland's own system of making sure you get a crystal that takes the beating of extreme heat without excessive drift. Quality control starts with exacting selection of quartz and extends through every step of processing.

For example, slicing of the crystal is guided by X-ray checks to maintain highest accuracy. Correct angular relationships are strictly maintained. After lapping, X-ray is again used to detect any deviation from precision standards. And finally, after sealing, tests are made again—tests far more punishing than conditions found in actual use.

That's why STABILITY is something you can count on in your Midland crystal—and why Midland quality will give you years of dependable service in every respect.

Whatever your crystal need, conventional or highly specialized...

When It Has to Be EXACTLY RIGHT... Contact

Midland
MANUFACTURING CO., INC.
3155 Fiberglas Road
Kansas City, Kansas

Manufacturer of Quartz Crystals for Electronic Frequency Control

*TYPE ML-6 - RANGE:
1.4 - 75.0 mc
Supplied per Mil type CR-18; CR-19; CR-23;
CR-27; CR-28; CR-32;
CR-33; CR-35; CR-36 when specified.

*TYPE ML-1A - RANGE:
2.0 - 16.0 mc
Supplied per Mil type CR-1A when specified.

*TYPE ML-4 - RANGE:
1.0 - 10.0 mc
Supplied per Mil type CR-6; CR-6; CR-8; CR-10 when specified.
FRIEZ engineers faced three basic requirements in specifying fasteners for the AN/AMT-4A Radiosonde. First, fasteners had to be light-weight, since the device is set free and carried to upper altitudes by balloon. Second, this equipment is expendable, making economy a prime factor. And third, because the Radiosonde transmits vital weather data back to the ground, its precise nature demands rigid, vibration-resistant fasteners for proper operation. Tinnerman SPEED NUT Coil Form fasteners were selected by Friez after checking many various attaching methods. They more than met the 3-count performance requirement, giving added savings in materials and handling over elaborate machined types. No matter what your fastening problem, you can rely on a Tinnerman Fastening Analysis to lead the way to production savings. See your Tinnerman representative for details on this free service for your products. And, write today for your copy of SPEED NUT Savings Stories, a booklet of amazing savings to industry: TINNERMAN PRODUCTS, INC., Department 12, Box 6688, Cleveland 1, Ohio.


Now, light-weight, low-cost, vibration-proof SPEED NUT Coil Form fasteners snap into place on this plastic terminal board...saving time, weight and materials.
LIMIT SWITCHES—Even under severe service, this double-break switch will stand up well. Its 2 independent circuits are alternately held open and closed solely by small Carboloy permanent magnets. The magnets assure positive contacts, cleaner breaks without strain or appreciable wear on operating parts, plus a higher degree of accuracy within limits. Also cut down costs of materials, assembly. A typical case of product improvement with Carboloy magnets.

How you can improve controls size, weight, cost with

OUTSTANDING ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

1. Cool—generate no heat
2. Require no electrical energy
3. Cost nothing to operate
4. Eliminate coils, windings, wiring, etc.
5. Need no maintenance—no coils to burn out, no slip rings to clean or replace, etc.
6. Simplify mechanical assemblies—exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication simple
7. Save space—great magnetic strength in small sizes
8. Powerful—and power is constant
9. Combine electrical and mechanical features—transform electrical energy into mechanical motion; mechanical motion into electrical energy
10. No power failures ever
11. Resist moisture—no coils to collect dampness
12. Give uninterrupted operation
13. Create savings—often eliminate costly, power-supplying parts
14. Simple—no operating parts
15. Reduce weight, product size
16. Supply a permanent source of energy

TENSION BRAKES—Three tiny Carboloy permanent magnets are used in this new magnetic brake that controls the winding of yarn and fine fibres. The magnets (shown in cutaway) provide even tension through magnetic drag, cut down on abrasion, slippage, static electricity—give wider tension and speed ranges. Carboloy permanent magnets never need maintenance, never fail.
PLUGGING CONTROLS — New device for brakeless stopping of motors features Carboloy magnets. Eddy-current disk rotates in magnetic assembly, creates torque. As motor's speed nears zero with power reversed, torque interrupts circuit, cuts stopping time from 20 seconds to 1 second.

CIRCUIT BREAKERS — Here, a Carboloy magnet assembly simplifies trip element. It eliminates a coil and polarizing connection . . makes possible reverse-current tripping independent of system voltage. Breaker weighs less, costs less to build, eliminates nuisance trips in circuits.

SNAP SWITCHES — Three reasons Minneapolis-Honeywell uses a Carboloy permanent magnet in this fan control and high-limit switch: 1) It occupies a small space and gives a higher degree of magnetic energy per unit per space. 2) It offers higher stability. 3) The cost is low.

...trim down their Carboloy Permanent Magnets

Here are 5 compact controls that now work better, weight less and cost less to build, thanks to engineering foresight and Carboloy permanent magnets.

Do you manufacture controls or similar devices? If so, chances are excellent that you can profit from Carboloy permanent magnets, too.

For these magnets are simple, self-containing sources of energy that never fail. Powerful in small sizes, they need no external power supply, never require maintenance. They reduce fabrication costs by eliminating wires, coils and operating parts. They let you simplify designs ... build lighter, smaller, finer-performing products at substantial savings.

Check the controls on these pages. Then check Carboloy magnet engineers. These experts can likely tell you in a hurry just where and how a magnetic assembly can help you. And, of course, they're at your service whenever you want a hand in magnet design and application.

Look to Carboloy production lines, too, for uniform, high-quality, low-cost magnets for control equipment—all sizes, all shapes; cast or sintered to your specifications. Mail coupon for free Magnet Design Manual and Standard Stock Catalog.

MAIL COUPON TODAY

CARBOLOY Department of General Electric Company
11139 E. 8 Mile Ave., Detroit 32, Michigan

Sirs:
Rush me, without cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

NAME_________________________ POSITION_________________________

COMPANY_________________________

ADDRESS_________________________

CITY_________________________ ZONE______ STATE_________________________

"Carboloy" is the registered trademark for the products of Carboloy Department of General Electric Company

Want more information? Use post card on last page.

ELECTRONICS — February, 1953
Test Jacks
by UCINITE

General features of 118930 test jack: Silver-plated, heat-treated beryllium copper contact is made in one piece with large terminal end for easy soldering. Terminal end is tin-dipped. Brass, nickel-plated shell and nut.

Metal shell insures firm, dependable mounting. Phosphor bronze lock washer is nickel-plated. Nylon insulator available in different colors: White, black, red, green, brown, orange, blue.

ALSO AVAILABLE

119052. Same as 118930 but with special milled end with elongated hole for wiring.

118984. Feed through type, similar to 118930 but with one-piece brass terminal stud, tin-plated.

The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

www.americanradiohistory.com
Stop Wasting Technical Talent

Turn over your special fastening problems to specialists... trained fastener engineers who have been through the trial-and-error stage in this highly specialized field and can free your own engineering staff for finished-product engineering.

It pays. We've proved it... for leading manufacturers in the electronics industry... and in the automotive, aviation, appliance and furniture industries, too.

United-Carr and its subsidiaries have had years of experience in the design and production of tailor-made fasteners and allied devices. Each division of the company provides a reservoir of special knowledge for the others. The result: an integrated organization that makes use of every improvement in materials and methods to produce fasteners that speed assembly, cut costs and, in many cases, actually improve product performance.

With complete facilities in our own plants for the volume production of special metal stampings and for the assembly of metal to plastic and ceramic components, we are in a position to supply practically any fastening need.

Before bidding on government contracts requiring fasteners or special fastening devices, consult your nearest United-Carr field representative.

UNITED-CARR
MAKERS OF DOT FASTENERS
The Collins 51J Communications Receiver

The Collins 51J Communications Receiver, in addition to its outstanding performance in the communications field, is being widely used in industrial laboratories as a sensitive and accurate measuring instrument and as a spectrum analyzer. Write for complete specifications and details today.

CONDENSED SPECIFICATIONS

FREQUENCY RANGE:
0.54 to 30.5 megacycles.

TYPE OF CIRCUIT:
Double Conversion Superheterodyne.

CALIBRATION:
Direct reading in megacycles and kilocycles. One turn of main tuning dial covers 100 kilocycles on all bands.

TUNING:
Linear, divided into 30—one mc bands.

FREQUENCY STABILITY:
Overall stability within 1 kc under normal operating conditions.

SELECTIVITY:
5.5 to 6.5 kilocycles wide at 6 db down. 17 to 20 kilocycles wide at 60 db down.

AUDIO OUTPUT:
4 and 600 ohms impedance. 1 1/2 watts at 1000 cps with less than 15% distortion overall. "S" meter may be switched to read audio output.

RF INPUT:
High impedance single-ended. Break-in relay mounted internally. Antenna trimmer will resonate input circuit when used with any normal antenna.

POWER REQUIREMENTS:
85 watts 45/70 cps, 115 volts or 230 volts by reconnection on power transformer.

DIMENSIONS:

For excellence in radio communications equipment, it's . . .

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 W. 42nd St., NEW YORK 36
1930 Hi-Line Drive, DALLAS 2
2700 W. Olive Ave., BURBANK

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
WHATEVER YOUR FUSE NEEDS
THIS ONE SOURCE SAVES TIME AND TROUBLE

BUSS FUSES
for TELEVISION...RADIO...RADAR
INSTRUMENTS...CONTROLS...AVIONICS

From fractional amperage types to huge industrial fuses, BUSS has specialized in a complete fuse line for the past 39 years. Whatever your circuit protection problem, you can choose from this complete line not only with convenience but with confidence in the unequalled BUSS reputation for quality and dependability.

Evidence of BUSS dependability is the rigid electronic testing every fuse must undergo before leaving the factory. Ultra-sensitive electronic devices check it to exacting standards of construction, calibration and physical dimension.

When you install BUSS Fuses you can forget about fuse troubles yet you can be certain of positive protection.

Turn To BUSS Engineers With Your Fuse Problems.

They will be glad to assist you in selecting the fuse to do the job best...and if possible a fuse that will be available from local wholesaler's stocks.

USE THE HANDY COUPON—It’s just good business to rely on BUSS FUSES

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.
Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

Name
Title
Company
Address
City & Zone State

Want more information? Use post card on last page.

ELECTRONICS — February, 1953

www.americanradiohistory.com
Can projectiles be "seen" approaching and their flight backtracked to locate the mortar or gun that fires them? This problem was simply reconciled with special computing equipment designed to be built right into the gun. The engineering of such a computer, the handling of such ballistic data, all falls into the pattern of previous Ford achievements.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.
Specifically designed and built to performance standards far beyond present concepts of potentiometer design, CANGPOTS Instrument-Quality potentiometers are ready to solve multiple potentiometer problems. Rugged, aluminum-housed units with low torque, high performance, and long-life accuracy, CANGPOTS are presented in two sizes to fill all requirements. CANGPOT EXTRAS include solid, stainless steel shafts, toroidally wound coils for up to 360° windings, shielded ball bearings, syncro or screw type mounting, and adaptability to non-linear functional windings. Built without any bulky external bolts, clamps or rings, the CANGPOTS lend themselves to an unsurpassed versatility of design applications.

For catalog and engineering data on these and other fine instruments write:

Giannini INSTRUMENT QUALITY POTENTIOMETERS
G. M. GIANNINI & CO. INC., PASADENA 1, CALIFORNIA—EAST ORANGE, NEW JERSEY
Unique Phelps Dodge development DRASTICALLY CUTS

✓ FAST WIRE-TO-WIRE BONDING INTO RIGID COIL.
✓ REDUCES FORMING AND ASSEMBLY OPERATIONS.
✓ FAR FEWER STEPS IN WINDING TYPICAL TV YOKE COIL.
✓ MAKES POSSIBLE UNUSUAL SHAPE COILS.

"Bobbin-less" coil  Fly-back coil  TV yoke coil  Hoop-shaped coil

"It takes the best"

Phelps Dodge COPPER PRODUCTS CORPORATION
in Magnet Wire—**BONDEZE**...  
COIL WINDING COSTS!

*Bondeze* is Phelps Dodge magnet wire with a special thermo-plastic film applied over the insulation. It offers a quick, economical means of bonding wires together, turn to turn, through simple application of heat or solvents. Complete information furnished on request.

*Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer.*

**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA
Name your needs in terminal boards
...we'll meet them accurately

The rigid specifications of government agencies and the armed forces need pose no problem to you. C.T.C. is in an excellent position to handle government sub-contracts for electronic parts and assemblies.

Our Custom Engineering Service is constantly supplying special terminal boards to the top names in electronics. These boards are built to severe government specifications, are fabricated of certified materials to fit the job. Among the specifications involved are: MIL-P-3115A, MIL-P-15037, MIL-P-15035A, MIL-P-15047, MIL-P-997A.

Boards can be made of cloth, paper, nylon or glass laminates (phenolic, melamine or silicone resin), and can be lacquered or varnished to specifications: JAN-C-178 and JAN-T-152. Lettering and numbering is done by rubber stamping, silk screening, hot stamping, engraving. Inks used in rubber stamping contain anti-fungus and fluorescent additives.

Terminals, feed-throughs, mounting hardware and all other terminal board fixtures meet all applicable government specifications.

Standard "All Set" Boards, scribed for easy separation, for the assembly line and laboratory are available in cotton fabric phenolic per specification MIL-P-15035A and in nylon phenolic per MIL-P-15047A.


custom or standard...the guaranteed components

See us at Booth 287, IRE Show

www.americanradiohistory.com
Two 21-inch Metal Cone Picture Tubes Announced by Westinghouse

21AP4 and 21MP4 now available for immediate delivery

Manufacturers faced with problems of handling, cost and uniformity in large picture tubes now may order Westinghouse 21-Inch RELIATRON Metal Cone Picture Tubes for immediate delivery. The new tubes—almost 33 1/3% lighter in weight—are manufactured under the most rigid quality control system in the country. Superior face plate quality assures greater freedom from blemishes and glass imperfections. Uniform face plate thickness greatly reduces optical distortion over the viewing area. The etched glass of the face plate eliminates glare from external light sources.

The 21-Inch RELIATRON Picture Tubes feature still another important improvement. The face plate is sealed to the metal cone using an intermediate glass-enamel frit.

**PRODUCTION SAVINGS**

The 21-Inch RELIATRON Picture Tubes introduce new economies throughout TV set production. Their lighter weight cuts shipping costs. The 21MP4 tube is electrostatically focused, requiring no focusing coil or focusing magnet. The 21AP4 is designed for magnetically focused operation.

Metal cone tubes give increased mechanical strength, and because of their light weight are easier to handle and assemble in TV receivers.

**BETTER PICTURES**

Metal cone picture tubes permit the use of spherical face plates of uniform thickness that allow receiver manufacturers to use standard available deflection components that produce pictures of consistently high quality.

Employment of the Westinghouse 21-Inch RELIATRON Metal Cone Picture Tubes enables you to meet the growing demand for larger screen TV receivers, to deliver a better picture, and at the same time, to realize important savings in your production operations.

The new RELIATRON metal cone tubes now are available in quantities which permit immediate delivery of production-size orders. For complete details, write Dept. A-202.
Compact and rugged... this electrically operated reset counter is specially designed for tough jobs that demand longer counter life.

Here's another instance of the infinite applicability of Veeder-Root Countrol — electrical, mechanical or manual. And here's another instance, too, of the endless resourcefulness of Veeder-Root engineering, and the ability to design a complete counting package that fits the job fully and exactly. Now... what's your problem?

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N.Y. • Greenville, S.C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities
EXPANDING PRODUCTION
in Toroids & Coils

At every management meeting in Burnell & Company there is an unseen but highly respected visitor. He is the spectre of all our customers and his opinions carry weight. Recently he suggested that in addition to our other expansion measures that we must find a way to improve deliveries for emergency and special sample orders. Our solution is certainly not original but no less effective.

Burnell & Company’s new sample department has been able to produce audio filters from proverbial ‘scratch’ to the customer’s waiting hands in as little as ten days!

Frankly, this cannot always be accomplished but our average has been ranging between three to four weeks for emergency samples and four to six weeks for regular prototypes instead of the former twelve weeks of the pre-sample department days.

Adding this to our new winding department and our new testing and finishing departments the sum total has been a still better product at a better delivery than ever before.

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

BURNELL & COMPANY
YONKERS 2, NEW YORK
CABLE ADDRESS: "BURNELL"
it's the Extra Factor of Assurance that counts...

A-AMP CONTROLLED WIRE TERMINATION
All the gadgets or combination tools in the world will not insure the correct installation of your wire terminations day in, day out, on the line. It's the extra factor of assurance that counts! AMP tools and terminals are made to use together. They're made so that you can be sure that you have a correctly installed termination. AMP application tools and dies and automatic machines are so designed that at the point of application you can control accuracy and uniformity within ±.003". Remember: In wire termination there is no short cut to precision and foolproof production!

Shown below: AMP CERTI-CRIMP* hand tools—will not release until proper crimping pressure has been reached. (Below right) the AMP INSPECTO-MASTER* gives continuous inspection at point of terminal application. Write to AMP for information about these and other recent developments in wire termination.

AMP

AIRCRAFT-MARINE PRODUCTS, INC.
2100 Paxton Street, Harrisburg, Pa.

Canadian representative:
1553 Eglinton Ave. West Office 1-A Toronto, Ontario


*Trade-Mark
"The 'Flying Typewriter' and all electronic counters require electric components that are rugged and reliable"

says Jack Leight, Sales Engineer, Ward Leonard Electric Company, Mount Vernon, New York

The "Flying Typewriter" is a revolutionary new high-speed electronic printer for data handling, communications, and computing. Developed by the Potter Instrument Company, Inc., Great Neck, New York, it is capable of printing 24,000 characters a minute "on the fly" from a continuously revolving type wheel.

Coupled to an electronic storage or memory unit, the machine first interprets, then prints in familiar typed lines, information taken in coded form from magnetic tape and punched cards or transmitted over narrow channel radio link, telephone and telegraph lines. The entire alphabet, numerals, punctuation and other special symbols are used in printing 300 lines per minute.

Such speed and accuracy in a machine require reliable, rugged electric components. That is why the Potter Instrument Company uses Ward Leonard VITROHM resistors and relays in the electronic counters for the "Flying Typewriter" as well as in many other types of high-speed electronic counters.

The trouble-free operation of Ward Leonard controls also eliminates many costly and time-consuming repairs.

Ward Leonard is always ready to put its staff of application engineers to work with you.
Special alloy resistance wire is being wound on Vitrohm cores by Caroline Jervisa, for 17 years an employee of the company.

Skilled operators spot weld terminals to Vitrohm resistor ceramic cores. Welding assures permanent anchorage to the cores.

Long service life of VITROHM resistors results from unified manufacture, uniform quality, matched thermal characteristics.

VITROHM resistors stay on the job under the most adverse operating conditions such as those to which they are subjected in electronic counters where less carefully made resistors would break down.

Thermal shock, vibration, corrosive atmosphere, overloads, even prolonged exposure to humidity and electrolysis will not affect their performance. All parts are uniform in quality, balanced in respect to thermal coefficient of expansion.

All Ward Leonard controls are made to exacting specifications, are guaranteed to give dependable service.

Consult Ward Leonard on their complete line of resistors, relays, rheostats, and other electric controls to meet your special needs.

O.D. and concentricity of finished ceramic cores is checked by Minna M. Henderson, who has had 12 years experience with Ward Leonard.

Prior to firing, tubular ceramic cores are being cut to exact size by Ann Trotta. A continuous check is made to maintain close dimensional tolerances.
VERSATILE NEW ALPHATRON® VACUUM GAUGE...

NEW LOW COST—WIDER RANGE

BATTERY OPERATION eliminates expensive power supply, improves accuracy and stability by removing variables of line voltage and power supply.

1000 TO 0.0001 mm HG READINGS. Wider range than previous models. Full scale deflections at 1000, 100, 10, 1, 0.1 and .01 mm HG absolute. All scales linear.

QUICK START. Only a few seconds warm-up time required. Convenient “on-off” operation saves batteries. Special switch permits instant check of battery condition on meter.

PERMANENT ACCURACY of ± 2% full scale. Long half-life ionization source insures permanent maintenance of original factory calibration.

INSTANT RESPONSE. Tracks pressure fluctuations with negligible time lag.

SMALL VOLUME. Net addition to your vacuum system about 50 cc.

SMALL, LIGHT, PORTABLE. As convenient to use as it is accurate and dependable. Write for more information.


National Research Corporation
EQUIPMENT DIVISION
Seventy Memorial Drive, Cambridge, Massachusetts
Special alloy resistance wire is being wound on Vitrohm cores by Caroline Jervisa, for 17 years an employee of the company.

Skilled operators spot weld terminals to Vitrohm resistor ceramic cores. Welding assures permanent anchorage to the cores.

O.D. and concentricity of finished ceramic cores is checked by Minna M. Henderson, who has had 12 years experience with Ward Leonard.

Prior to firing, tubular ceramic cores are being cut to exact size by Ann Trotta. A continuous check is made to maintain close dimensional tolerances.

Long service life of VITROHM resistors results from unified manufacture, uniform quality, matched thermal characteristics

VITROHM resistors stay on the job under the most adverse operating conditions such as those to which they are subjected in electronic counters where less carefully made resistors would break down.

Thermal shock, vibration, corrosive atmosphere, overloads, even prolonged exposure to humidity and electrolysis will not affect their performance. All parts are uniform in quality, balanced in respect to thermal coefficient of expansion.

All Ward Leonard controls are made to exacting specifications, are guaranteed to give dependable service. Consult Ward Leonard on their complete line of resistors, relays, rheostats, and other electric controls to meet your special needs.

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PERMANENT ACCURACY of ± 2% full scale. Long half-life ionization source insures permanent maintenance of original factory calibration.

INSTANT RESPONSE. Tracks pressure fluctuations with negligible time lag.

SMALL VOLUME. Net addition to your vacuum system about 50 cc.

SMALL, LIGHT, PORTABLE. As convenient to use as it is accurate and dependable. Write for more information.

Versatile New Alphatron VACUUM GAUGE...

Model No. 511
Price: $345.00

National Research Corporation
EQUIPMENT DIVISION
Seventy Memorial Drive, Cambridge, Massachusetts
He seems to think you ought to like him for his shell, in spite of the fact that it looks no different from a million other oyster shells. If he's got a pearl inside, why doesn't he say so.

CAPACITORS LOOK PRETTY MUCH ALIKE FROM THE OUTSIDE, BUT EL-MENCO'S HAVE SOMETHING IN THEM and we want the world to know it.

Into every El-Menco Capacitor goes superb design, precise workmanship and the finest of materials. The finished unit is then factory-tested at double its working voltage to insure satisfactory performance on whatever job it is given.

No wonder we are proud to put our name on these capacitors—no wonder they have won the highest praise for their absolute reliability.

The range runs from the smallest (CM-15-2-525 mmf. cap.) to the largest (CM-35-3300-10000 mmf. cap.)

Write on business letterhead for catalog and samples.

El-Menco MICA TRIMMER CAPACITORS

Radio and Television Manufacturers, Domestic and Foreign, Communicate Direct With Factory—

THE ELECTRO MOTIVE MFG. CO., INC. WILLIMANTIC, CONNECTICUT

Jobbers and Distributors: For information write to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.—Sole Agent for Jobbers and Distributors in U.S. and Canada.

Write on business letterhead for catalog and samples.
Frankly we don't know if they're fact or fiction... but if they are fact it wouldn't surprise us a bit to learn that some extraterrestrial manufacturer has incorporated Seletron Selenium Rectifiers and R. R. Co. Germanium Diodes into the design.

That's because—as pioneers in the field of electronic development—we've had our hand in some of the most difficult projects and met some of the stiffest requirements ever cooked up! Making drawing board dreams come true are daily chores at Radio Receptor Co.!

Our Germanium Diodes and Seletron Selenium Rectifiers may hold the answer to many of your problems. Radio Receptor Engineers will be glad to study your requirements and submit their recommendations on both of these products.

Germanium Transistors available in limited quantities.

RADIO RECEPTOR COMPANY, INC.

SALES DEPT: 251 West 19th Street, New York 11, N. Y. • FACTORY: 84 North 9th Street, Brooklyn 11, N. Y.

February, 1953 — ELECTRONICS
Solve your hermetic seal problems with this expanded line of rugged

GENERAL CERAMICS

SOLDER-SEAL TERMINALS

- General Ceramics Solder-Seal Terminals are available in a range of sizes and shapes capable of meeting practically any requirement. Solder-Seal Terminals are easily soft-soldered to closures and effect a permanent, positive hermetic seal that is virtually immune to mechanical or thermal shock. There are no rubber or plastic gaskets to age or deteriorate.

For complete information call, wire or write today.

STANDARD SOLDER LUG TYPES

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Want more information? Use post card on last page.

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, CERAMICS, LIGHT DUTY REFRactories, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE

ELECTRONICS — February, 1953
COMPLETE CIVILIAN LINE

Exceptionally good delivery cycle on civilian orders due to tremendous mass production facilities.

NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL—Performance fully equals larger types. TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.

TYPE C2-45

TYPE C2-35

TYPE C2-25

TYPE C2-252

TYPE GC-45, 15/16" diameter variable composition resistor. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms, 1/4 watt with 500 volts maximum across and terminals for resistances over 100,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-45 as shown above.

TYPE GC-35, 1 1/8" diameter variable composition resistor. Wattage rating: 3/4 watt for resistances through 10,000 ohms, 2/3 watt for resistances over 10,000 ohms through 25,000 ohms, 1/2 watt with 500 volts maximum across and terminals for resistances over 25,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-35 as shown above.

TYPE GC-252, 2 watt, 1 17/64" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-252 as shown above.

TYPE GC-25, 4 watt, 1 17/32" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-25 as shown above.

Typical concentric shaft tandem with panel and rear sections operating separately from concentric shafts (TYPE C45-70 ILLUSTRATED). Similar construction available for all military resistors.

IN CANADA
Henry C. Sanders
McCleary Bldg.
600 & Walker St.
Upper Darby, Penna.
Phone: Tandum 2-2430

SOUTH AMERICA
Jose Luis Pontet
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Specialists in
NEW 38-PAGE ILLUSTRATED CATALOG

Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor. Write today for your copy.

TYPE 45, (JAN-R-94, Type RV2)
1/4 watt, 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 90
1 watt 70°C, 15/16" diameter variable composition resistor. Attached switch can be supplied. Also available in concentric shaft tandem construction.

COMPLETE MILITARY LINE

Immediate delivery from stock on 189 types including JAN-R-94 and JAN-R-19 types of variable resistors.

See the complete CTS military and civilian lines of variable resistors at the IRE SHOW
Grand Central Palace, New York City
MARCH 23-26, 1953
BOOTH 4-608

UNPRECEDENTED PERFORMANCE CHARACTERISTICS
Specially designed for military communications equipment subject to extreme temperature and humidity ranges. 
-55°C to +130°C...aridity to saturation.

Precision Mass Production of Variable Resistors

CHICAGO TELEPHONE SUPPLY Corporation
ELKHART • INDIANA
in a HURRY... for precision STAINLESS STEEL FASTENINGS in large or small quantities?

Greatly expanded production capacity PLUS a tremendous inventory of IN STOCK items gives you quick-to-IMMEDIATE DELIVERY in chrome-nickel stainless steel fastenings of all standard sizes... many at new low prices! Here are just a few samples:

- Cold headed rolled thread MACHINE SCREWS, Class 2 fit as small as 20-80, Class 3 fit as small as 2-56
- Precision milled from bar MACHINE SCREW NUTS as small as 20-80
- Precision DOWEL PINS as small as .030"
- Precision milled from bar MACHINE SCREWS, Class 3 fit as small as 20-80
- Precision TAPER PINS as small as 8/0
- Milled from bar slotted headless SET SCREWS, Class 3 fit as small as 20-80

Thousands of other items and sizes IN STOCK... write, call or wire TODAY for full information... ask for Catalog 52Z.

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
ONLY THE LFE 401 OSCILLOSCOPE
Offers all these Important Features

LINEARITY OF VERTICAL DEFLECTION The vertical amplifier provides up to 2.5 inches positive or negative uni-polar deflection without serious compression; at 3 inches, the compression is approximately 15%. The accompanying photographs illustrate transient response and linearity of deflection.

HIGH SENSITIVITY AND WIDE FREQUENCY RESPONSE OF Y-AXIS AMPLIFIER The vertical amplifier of the 401 has been designed to provide uniform response and high sensitivity from D-C. The accompanying amplifier response curve shows the output down 3 db. at 10 Mc. and 12 db. at 20 Mc. Alignment of the amplifier is for best transient response, resulting in no overshoot for pulses of short duration and fast rise time. Coupled with this wide band characteristic is a high deflection sensitivity of 15 Mv./cm, peak to peak, D-C and A-C.

Sweep Delay The accurately calibrated delay of the 401 provides means for measuring pulse widths, time intervals between pulses, accurately calibrating sweeps and other useful applications wherein accurate time measurements are required. The absolute value of delay is accurate to within 1% of the full scale calibration. The incremental accuracy is good to within 0.1% of full scale calibration.

SPECIFICATIONS

Y-Axis
Deflection Sens. — 15 Mv./cm, peak-to-peak.
Frequency Response — DC to 10 Mc
Signal Delay — 0.20 ± 0.05 sec
Input line terminations — 52, 72 or 85 ohms, or no termination
Input Imp. — Direct — 1 megohm, 30 μF
Probe — 10 megohms, 10 μF

X-Axis
Sweep Range — 0.01 sec/cm to 0.1 sec/cm
Delay Sweep Range — 5-5000 μsec/sec in three adjustable ranges.
Triggers — Internal or External, + and —, trigger generator, or 60 cycles, or undelayed or delayed triggers may be used.

Built-in trigger generator with repetition rate from 500-5000 cps.

General
Low Capacity probe
Functionally colored control knobs
Folding stand for better viewing
Adjustable scale lighting
Facilities for mounting camera

PRICE: $895.00

Additional Features:

Trigger Generator with variable repetition rate from 500 to 5000 cps.
Positive and negative undelayed triggers and positive delayed triggers are externally available.

An input termination switch for terminating transmission lines at the oscilloscope.
A folding stand for convenient viewing.
Functionally colored knobs for easier location of controls.

Write for Complete Information

LABORATORY for ELECTRONICS, INC.
75 PITTS STREET • BOSTON 14, MASS.

PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • MAGNETOMETERS • COMPUTERS • MICROWAVE OSCILLATORS • MERCURY DELAY LINES

ELECTRONICS • February, 1953

Want more information? Use post card on last page.
Our most eloquent salesman can't talk

But he can sell. In fact, every prospect who meets him becomes a customer. Every one.

For "he" is the Karp plant itself. And if you saw him, you'd know why he's a successful salesman.

It begins with our engineering department where your designs are detailed for sheet metal production. It continues through tooling where our vast assortment of available dies often eliminates the need for new tooling...where our toolmakers create special tooling when needed.

Then to actual fabrication, where skilled craftsmen process every job, whether large or small, with equal care—and use the finest of metalworking equipment to do it.

You’d see all of these things and much, much more as you travel through our plant ranging three city blocks.

At the risk of becoming dissatisfied with your present sheet metal fabrications, you're invited to tour the Karp plant—any time. Meanwhile, write for a copy of our data book.

KARP METAL PRODUCTS CO., INC. • 215 63rd ST., BROOKLYN 20, N.Y.

Most complete facilities for large and small runs of engineered sheet metal fabrication

KARP
TRIODES
- 7C39A
- 3W5000 A
- 3W5000 F3
- 3X7500 A3
- 3X7500 F3
- 3X10000 A3
- 3X30000 F1
- 3X30000 F1
- 4C21
- 2S1
- 3T3
- 3T1
- 3T8
- 75L
- 100L

TETRODES
- 4-65A
- 4-175A
- 4-250A
- 4-400A
- 4-1000A
- 4P850A

PENTODE
- 417P A- 175B

RECTIFIERS
- 7-01C
- 7-25A
- 7-50A
- 7-130D
- 7-240A
- 7-2000A
- KY21A

AIR SYSTEM SOCKETS
- 4-400A/4000
- 4-400A/4000*
- 4-1000A/4000
- 4-1000A/4000*
- 4X1500A/4000
- 4X1500A/4000*

*Replacement Chimneys

VACUUM SWITCH
- VS-2
- 12V Coil
- 24V Coil

ACCESSORIES
- Heat dissipating connectors
- Preferred Contact Finger Stock

VACUUM PUMP
- HV-1
- OIL DIFFUSION PUMP
- Type-A Pump Oil
- HV-1 Pump Parts

VARIABLE VACUUM CAPACITORS
- VVC60-20
- VVC2-60-20
- VVC4-60-20

ION GAUGE
- 100 MG ion gauge

VACUUM CAPACITORS
- VC6-20
- VC6-32
- VC12-20
- VC12-32

4-125A
The radial-beam power tetrode that made transmitting screen grid tubes popular. This tube will take a plate input of 500 watts for CW or 350 watts for tone. Driving power is less than two watts. A pair of these tetrodes make an ideal high power tone or CW final for the amateur.

4X150A
This small external anode radial-beam power tetrode operates efficiently at all frequencies into the UHF range with a driving power of only a few watts. Its small size and ruggedness make it ideal for compact equipment such as mobile.

450T
Often referred to as the workhorse of modern communication systems, this dependable tetrode has a plate dissipation rating of 450 watts. It is widely used as an amplifier, oscillator or modulator.

3K20000L (A-F-K)
These Klystrons, the latest development in UHF television transmitting, have a power output of 5000 watts. The three versions of the Klystron will cover the entire UHF range — 470-890 mc. These water and air cooled Klystrons have a power gain of 20 db.

VVC60-20
This is but one type in the Eimac line of variable and fixed vacuum capacitors for plate tank circuits. It is variable over a range of 10 mfd to 60 mmdl. Maximum rf voltage is 20 kv. at 40 amperes.

2C39A
This small, rugged triode is designed for use as a power amplifier, oscillator or frequency multiplier to frequencies above 2500 mc. It is particularly suitable for compact fixed or mobile equipment.

- Complete technical data available on request.

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

EXPORT AGENTS: FRAZAR & HANSEN • 301 CLAY STREET • SAN FRANCISCO 11, CALIFORNIA

ELECTRONICS — February, 1953
Want more information? Use post card on last page.
THE KOLLSMAN INSTRUMENT CORPORATION — designers, developers and manufacturers of precise, dependable instruments in the fields of:

- Aircraft Instruments and Controls
- Miniature AC Motors for Indicating and Remote Control Applications
- Optical Parts and Optical Devices
- Radio Communications and Navigation Equipment

While current facilities of our laboratories and plants are geared to production for National Defense, the planning divisions of Kollsman are ever active. And versatile Kollsman research engineers stand ready to assist America’s scientists in the solution of instrumentation and control problems.
Analyzing air brakes for faster stops

How long does it take pressure to build up to required levels at the brake chambers after the driver applies the brake pedal? To answer this all-important question of “air-transmission” time, Bendix-Westinghouse Automotive Air Brake Company assembles on a test stand a complete counterpart of the brake system which is to be installed in a truck, truck-tractor, or bus. All components and air lines are the same as those to be used on the vehicle.

Pressure pickups are used at various critical points in the system, and a mechanical foot is used to depress the brake pedal. A Consolidated Recording Oscillograph records the time that the pedal starts downward and the rate at which pressure builds up at the brake chambers. At maximum pressure, the brake pedal is released and the rate of pressure drop recorded. A full report on the air-transmission time of the system based on this accurate analysis is furnished the vehicle manufacturer.

Consolidated Engineering Corporation
300 North Sierra Madre Villa, Pasadena 8, California


Electronics - February, 1953

Want more information? Use post card on last page.
The March I.R.E. Show has become the accepted focal point of interest for everyone concerned with any aspect of electronics—engineering or sales. It is the highlight of the year that brings out in the open the equipment, components and materials of tomorrow and, as such, has always attracted one of the largest audiences of any technical show. The March issue of ELECTRONICS has, through the years, been the preferred medium through which manufacturers have apprised individual customers and prospects of their participation in this show or as a "Show in Print" if they are not exhibiting. Proof of that is shown on the next page.
HERE'S SIX YEARS PROOF OF...

Voluntary Acceptance

In the last six years, during which time the I.R.E. Show has achieved wide international prominence, the March issue of ELECTRONICS has enjoyed a considerable increase in advertising space over the average monthly space for all of those years. And, this, despite the fact that the March issue has never been promoted in any fashion as a special issue. This increase is entirely due to voluntary acceptance. Manufacturers, whether exhibitors or not, just naturally turn to ELECTRONICS as the most effective means of alerting the widest audience of customers and prospects. Proof can be found in the charts below — the facts are given in clear detail for the years from 1947 through 1952.

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<td>268.92</td>
<td>437</td>
<td>360.50</td>
</tr>
</tbody>
</table>

MAKE PLANS AND SPACE RESERVATIONS NOW

The 1953 I.R.E. Show promises to be better than ever before. All manufacturers participating should make plans and space reservations in the March issue of ELECTRONICS now. It is the best insurance you can get of wide attendance and interest in your booth. If you are not exhibiting, this carefully read issue can serve as your "Show in Print." For rates or further details, consult your nearest ELECTRONICS district manager or write direct to ELECTRONICS.

MANUFACTURERS HAVE ALWAYS SAID...

"See you at the show—" IN

electronics

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Keeping communications ON THE BEAM

JK STABILIZED H-4 CRYSTAL

CRYSTALS FOR THE CRITICAL

A versatile crystal the JK H-4 is widely used as a replacement crystal in marine and other communications systems. Pressure mounted, dust and water proof, stainless steel electrodes. Frequency range 1800 kc to 15 mc. Military type holder. Another of the many JK Crystals available to serve every need.

THE JAMES KNIGHTS COMPANY
SANDWICH ILLINOIS
Now... an extremely **flexible** high-temperature tubing...

**IRVINGTON Silicone Rubber-Coated Fiberglas**

If you need a *flexible* insulating tubing that meets Class “H” specifications—and particularly if you need it *now*—look into this new Irvington product!

With the introduction of Silicone Rubber-Coated Fiberglas Tubing, Irvington offers to the electrical industry a product that, like the resin-coated type, meets all NEMA Class “H” requirements. In addition, this new tubing has the advantage of extreme flexibility. Its white color is a plus wherever appearance is a factor.

AND... Irvington Silicone Rubber-Coated Fiberglas Tubing is available for immediate delivery!

Get the full story—just mail the coupon for technical data sheet.

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**VARNISH & INSULATOR COMPANY**

Irvington 11, New Jersey

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

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Look up **IRVINGTON** for Insulation Leadership

**INSULATING VARNISHES**
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**INSULATING TUBING**
**CLASS “H” INSULATION**

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Irvington Varnish & Insulator Co.

11 Argyle Terrace, Irvington 11, N. J.

**Gentlemen:**

Please send me technical data sheet on Irvington Silicone Rubber-Coated Fiberglas Insulating Tubing.

**Name: __________________________ Title: __________________________**

**Company: __________________________ **

**Street: __________________________**

**City: __________________________/ Zone: __________ State: __________________________**

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**ELECTRONICS—February, 1953**

Want more information? Use post card on last page
New Multi-purpose

- hp- 612A — VERSATILE, DIRECT READING. FOR UHF-TV, OTHER WORK 450 TO 1,200 mc

This master oscillator-power amplifier generator is especially designed for UHF-TV measurements including receiver and amplifier gain, selectivity, sensitivity and image rejection. It is also a convenient, direct-reading laboratory power source for driving bridges, stepped lines, antennas and filter networks. Both frequency and output are directly set on large, precisely calibrated dials. No charts or interpolation are required.

Model 612A has a maximum output of 0.5 volts into 50 ohms over its entire frequency range. The instrument also has low incidental fm and broad band modulation up to 5 mc. It may be modulated internally or externally, amplitude modulated, or pulse modulated (good rf pulses 0.2 µsec or longer). Pulse modulation may be applied to the amplifier, or direct to the oscillator when high on-off signal ratios are required.

BRIEF SPECIFICATIONS

Frequency Range: 450 to 1,200 mc, 1 band.
Accuracy: Calibration ±1%. Resettability better than 5 mc at high frequencies.
Output: 0.1 µv to 0.5 v continuously variable. Calibrated in volts and dbm. Impedance 50 ohms.
Max. VSWR 1.2. Accuracy ±1 db entire range.
Modulation: Amplitude: From 0 to 90% indicated by panel meter.
Envelope Distortion: 2% at 30% modulation.
Internal: Fixed modulation frequencies, 400 and 1,000 cps.
External: Any frequency 20 cps to 5 mc.
Pulse Requirements, External Modulation:
Pulse to Amplifier: Good pulse shape at 0.2 µsec length.
Pulse to Oscillator: 1.0 µsec minimum.
Size: Cabinet 12” x 14” x 18” deep.
Price: $1,200.00

10 TO 500 mc

- hp- 608A VHF Signal Generator provides output ranging from 0.1 µv to 1.0 v into 50 ohms. Accuracy is ±1 db. Direct reading frequency and output calibration; no charts or interpolation required. Pulsed, cw or amplitude modulated output (50 cps to 1 mc). Resettability better than 1 mc. Has master oscillator-power amplifier for widest modulation capabilities. Constant internal impedance. Maximum VSWR 1.2. $850.00

800 TO 2,100 mc

- hp- 614A UHF Signal Generator provides output ranging from 0.1 µv to 0.223 v (1 mw) into 50 ohms. Accuracy ±1 db. Has single dial, direct reading frequency and output, no charts or interpolation. Offers cw, fm or pulsed output. Widely variable pulsing, synchronizing, delay and triggering features. Extremely fast rise/decay time of 0.1 µsec. Constant internal impedance. Maximum VSWR 1.6. $1,950.00

Complete Coverage HEWLETT-PACKARD

80

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February, 1953 — ELECTRONICS

www.americanradiohistory.com
**SIGNAL GENERATORS**

**New!**

**-hp- 618B — VARIED PULSING CAPABILITIES, DIRECT READING. RANGE 3,800 TO 7,600 mc**

Model 618B offers faster, more accurate measurement of component performance in radar, radio relay and TV carrier systems and similar field and laboratory applications. Frequency is generated in a reflex klystron oscillator; accuracy and stability are high throughout the instrument's wide frequency range. Frequency and voltage are directly set and read. Dial tuning is tracked automatically, and no voltage adjustment is required during operation.

Extremely wide pulsing capabilities have been built into -hp-618B. The instrument may be internally or externally pulse modulated, internally square wave modulated and frequency modulated. The repetition rate is continuously variable between 40 and 4,000 pps. Pulse width is variable 0.5 to 10 µsec. Sync-out signals are simultaneous with the rf pulse or in advance by any time-span from 3 to 300 µsec.

The instrument also may be synchronized with an external sine wave, or with positive or negative pulse signals.

---

**BRIEF SPECIFICATIONS**

**Frequency Range:** 3,800 to 7,600 mc. 1 band.

**Calibration:** Direct. Accuracy better than 1%.

**Stability:** Frequency less than 0.006% per °C change.

Line Variation: ± 10 v causes less than 0.01% frequency change.

**Output:** 1 mw/0.223 v to 0.1 µv into 52 ohms.

Accuracy is ± 1 db. Output may be cw, fm or pulsed. Modulation and synchronizing features are similar with -hp-618B. Oscillator section is a reflex klystron. Frequency changes are automatically tracked and no voltage adjustment is needed during operation. Frequency and output are directly set and read on large, carefully calibrated dials. No charts or interpolation are needed. $1,950.00

**-hp- 616A UHF Signal Generator** offers the same simple operation, wide pulsing capabilities, high stability and accuracy as -hp-618B, but is designed for UHF frequencies. Output ranges from 0.1 µv to 0.223 v (1 mw) into a 50-ohm load. Accuracy is ± 1 db. Output may be cw, fm or pulsed. Modulation and synchronizing features are similar with -hp-618B. Oscillator section is a reflex klystron. Frequency changes are automatically tracked and no voltage adjustment is needed during operation. Frequency and output are directly set and read on large, carefully calibrated dials. No charts or interpolation are needed. $1,950.00

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For complete details, see your -hp- field representative or write direct.

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They've always been the best!

VARIABLE CAPACITORS

Hammarlund Capacitors, backed by 42 years of design, engineering and production experience, are today recognized by the military services, electronic manufacturers and research engineers, as the finest quality capacitors available. Millions of them are in use by almost every important manufacturer of electronic equipment.

See for yourself. Write today for the 1952 CAPACITOR CATALOG. It has the complete story.
KOVAR* Glass Sealing Alloy

The ideal alloy for glass sealing, Kovar matches the expansivity of certain hard glasses over the entire working temperature range. It resists mercury attack, has ample mechanical strength and seals readily with simple oxidation procedure. It is available as sheet, strip, foil, rod, tube, wire—or fabricated into cups, eyelets, leads and other shapes. The prominent users of KOVAR and the length of time they have employed this metal are convincing proof of satisfaction.

STUPAKOFF Products for Electrical and Electronic Applications

ASSEMBLIES—Metallized ceramic induction coils and shaftless metallized plates for fixed rigid assemblies; ceramic trimmer condensers.

CERAMICS—Precision-made ceramic products for electrical and electronic applications, all voltages, frequencies and temperatures.

RESISTOR CERAMICS—Used for temperature indicating or measuring equipment, for infrared light source and for heating elements. Complete with terminals, in the form of rods, tubes, discs, bars, rings, etc.

STUPALITH—Will withstand extreme thermal shock. May be made to have zero, low-positive or negative expansivities. Safely used at temperatures up to 2400° F.

SEALS, KOVAR-GLASS—Terminals, Lead-ins, Stand-offs—for hermetically sealing and mechanical construction in radio, television, electronic and electrical apparatus, single or multiple terminal units, in a wide variety of sizes and ratings.

KOVAR METAL—The ideal alloy for sealing to hard glass. Used for making hermetic attachments. Available as rod, wire, sheet, foil—or as cups, eyelets and other shapes.

STUPAKOFF CERAMIC & MFG. CO., Latrobe, Pennsylvania
Precision-Built...for dependable performance

Whatever your requirements for top quality wire-wound components, you can count on I-T-E products. Power resistors, precision resistors, deflection yokes—all are specially designed and precision-built to meet the exacting standards demanded for critical electronic applications. Close quality control and modern production methods give you assurance of quality components in any quantity you need.

I-T-E POWER RESISTORS
Non-hygroscopic ceramic foundations are in accordance with JAN specifications.

Purist resistance wires are uniformly wound to prevent shorted turns and excessive hot spots. All connections silver-soldered.

Vitreous enamel coating (organic if required) provides a glazed moisture-repellent surface with fast heat-dissipation qualities.

Advanced production methods assure high stability, long life.

Standard Tolerance: ±10%, ±5% and less made to order.

I-T-E PRECISION RESISTORS
High-quality wire alloys are used—free from internal stresses and strains.

Automatic precision winding assures even tension—eliminates hot spots.

Hermetic or vacuum-impregnated sealing protects against destructive effects of salts, moisture, and atmospheric conditions.

Accelerated aging process prior to calibration assures accuracy.

Critical quality control eliminates all resistors which do not come up to high I-T-E standards.

Standard Tolerance: ±1%. Available in specified tolerances down to ±0.05%.

I-T-E DEFLECTION YOKES
Wire size and quality constantly checked. Coils impregnated in special moisture-resistant thermoplastic—properly cured to assure firm coil with minimum losses.

Yokes can be obtained complete with wire leads, resistors, and capacitors to your specifications.

WRITE FOR DETAILS

WIRE-WOUND PRODUCTS

I-T-E RESISTOR DIVISION
1924 Hamilton St., Phila. 30, Pa. • A division of the I-T-E Circuit Breaker Co.
Prove to yourself...

These are better AN connectors--and at competitive prices

**BETTER...**

...Because Monowatt AN Connectors have all these features:

- **Moisture-proof seal.** Two-piece inserts are joined with a silicone sealing compound. Moisture and condensation effectively excluded...parts held together while inserts are soldered to cable assemblies.
- **Diallyl Phthalate insert material** (blue) used in all connectors. Negligible post-mold shrinkage...superior dielectric properties.
- **Fewer parts and simpler design** make installation and inspection easy.
- **Cadmium-plated housings** resist corrosion.
- **Tellurium copper pins,** heavily silver-plated, insure greater conductivity...99% that of copper.
- **Available in complete wiring harness or cable assemblies.** Made by Monowatt to your specifications.

**PRICED RIGHT...**

...Because the Monowatt Department of General Electric has complete modern facilities for mass-production, these features are offered at competitive prices.

**THE PROOF STARTS WITH THE QUOTATION**

...Prove to yourself that Monowatt AN Connectors at competitive prices bring you extras—extras which save assembly time and insure a superior connecting job.

Send your specifications with this coupon. In return you'll receive a catalog describing the unique cost-saving features of Monowatt electrical connectors and wiring assemblies for aircraft, ordnance and electronic equipment—plus—quotations on your specific requirements. If you wish, a representative will call with sample connectors...all without cost or obligation.

MAIL COUPON AND YOUR SPECIFICATIONS TODAY.
Here's a beautiful new little Terminal that really puts soldering on a production basis; taking a minimum of space, no wrap-around or pliering necessary. Unique punch press configuration gives rapid heat transfer, taking less time and solder. Designed for Gest Miniaturization contracts. Staked in Alden Pre-punched Terminal Cards, allow patterns for any circuit.

**FOR YOUR SMALLER UNITS**

1st Take Pre-punched Terminal Mounting Card ready-cut to size you require. Stake in Alden Miniature Terminals to mount your circuitry.

Pre-punched Terminal Mounting Cards come in all sizes needed for Packages: miniature 7-pin and 9-pin units, or 11-pin and 20-pin plug-in units. Cards made of natural phenolic 1/16” thick pre-punched on 7/32” centers with .011” holes for taking the Miniature Terminals.

2nd Attach Alden Card - mounting Tube Sockets and Mounting Brackets, which mount in the pre-punched holes.

**FOR YOUR LARGER UNITS**

1st Lay out circuitry with Pre-punched Terminal Mounting Card in lengths up to 3’.

Organize circuitry in compact vertical planes. Use both sides of Pre-punched Card to stake in Alden Miniature Terminals to your circuitry layout. Vertical position gives ready accessibility; there is no “underneath” in Alden design.

2nd Attach Alden Card-mounting Tube Sockets and Mounting Brackets, which fit any of the pre-punched holes.

**TO OBTAIN COMPLETE DETAILS**

Tiny Sensing Elements specifically designed to spot trouble instantly in any unit.

Here are tiny components to isolate trouble instantly by providing visual tell-tales for each unit.

**“PAN-I-LITE” MIN. INDICATOR LIGHT**

So compact you can use it in places never before possible. Glows like a red-hot poker. Push-mounts in .348” drill hole. Bulb replaceable from front. Tiny spares are unbreakable, easily kept available, taped in recess of equipment. Alden #88L, ruby, sapphire, pearl, emerald.

**MINIATURE TEST POINT JACK**

Here are tiny insulated Test Point Jacks that make possible checking critical plate or circuit voltages from the front of your equipment panel—without pulling out equipment or digging into the chassis. Takes a minimum of space, has low capacitance to ground, long life herkimer copper contacts. Available in black, red, blue, green, tan and brown phenolic conforming to MIL-P-14B-CGF; also nylon in black, red, orange, blue, yellow, white, green. Alden 21100BCS.

**ALDEN “FUSE-LITE”**

Fuse Blows - Lite Glows. Signals immediately blown fuse. Lite visible from any angle. To replace fuse simply unscrew the 1-loc. Lite-lens unit. Mounts easily by standard production techniques, in absolute minimum of space. 110V Alden #940-4FH. 28V #940-6FH.

Free Samples Sent Upon Request

**VISIT OUR COMPLETE DISPLAY AT THE I.R.E. SHOW**

**ALDEN PRODUCTS COMPANY**
READY-MADE for your Electronic Equipment

All designed — all tooled — production immediately available — no procurement problems. Apply ALDEN Standards wholly or in part.

ALDEN PLUG-IN PACKAGES

*3rd* After mounting your circuits on Terminal Cards, use Alden Standard Plug-in Bases, Housings, Bails for packaging.

SEND LIDS able, 127

3. Given the circuitry, nothing allows few components. Allows fewer debugging time. Experimental circuitry can prints-smaller parts inventory.

ALDEN PLUG-IN PACKAGES

Using standard Alden Plug-in Packaging Components you can mount a tremendous variety of circuits on chassis or in racks.

HOUSE PLUG-IN UNITS IN

ALDEN BASIC UNI-RACKS

3rd Fit Prepunched Cards carrying completed circuitry into Standard Alden Basic Chassis Body.

SLIDE-IN BACK CONNECTORS

Prepunched in your specs. Easy accessibility at sides, front for completing wiring.

SLIDE-IN BACK CONNECTORS

Ready-made for your Electronic Equipment

Your design and production men have always wanted these advantages:

1. Experimental circuitry can be set up with production components, cutting down debugging time.
2. Allows technicians, rather than engineer, to debug, by taking out unit.
3. Given the circuitry, nothing further to design—make up from standard Alden components.
5. Absolute minimum requirements of labor, materials, space.
6. The various sub-assemblies can be built concurrently on separate assembly lines.
7. No testing costs—no delays—no procurement headaches.
8. Fewer prints—smaller parts inventory.

ALDEN UNIT CABLE

interconnects between Uni-racks or other major circuitry divisions. Quick, sure, coded means of isolating and restoring (with spare) inter-division circuits.

Your customers and sales force will welcome these advantages:

- The big objection to electronic equipment—from the user's point of view—is that if it goes out of order he feels helpless. But you have a perfect answer when your equipment is made to Alden Standards of Plug-in Unit Construction because they assure DEPENDABLE OPERATION, as follows:
  - 30-SECOND REPLACEMENT OF INOPERATIVE UNITS by plugging in available coded spares.
  - TROUBLE INSTANTLY INDICATED AND LOCATED by monitoring elements assigned to each functional unit.
  - TECHNICAL PERSONNEL NOT REQUIRED to maintain in operation, due to obvious color coding and fool-proof non-interchangeability of mating components.
  - TOOLESS MAINTENANCE made possible by patented Alden fasteners and plug-in locking and ejecting devices.

AIRMAIL SERVICE—Compact functional units practical to send airmail to factory for needed overhaul, Uni-RACK FIELD HANDLING UNIT—groups functional units into stacking cabinets not exceeding one- or two-man handling capacity—go easily through windows, doors.

CONNECT AS FAST AS UNLOADED, by coded non-interchangeable unit cables plugged in between Uni-racks.

SEND FOR FREE "ALDEN HANDBOOK"

This 226-page Handbook describes fully the Alden System of Plug-in Unit Construction and the hundreds of components ready-made and completely tooled to meet your every requirement. It's a gold-mine for those designing electronic control equipment that is practical in manufacture; dependable in operation.

REQUEST YOUR COPY TODAY — SENT FREE!

127 North Main Street • Brockton 64 • Massachusetts
Miniaturize your product with Tantalytic capacitors

On low-voltage d-c applications, where your equipment miniaturization calls for both small size and superior performance, General Electric Tantalytic capacitors offer a host of advantages. These foil-type, tantalum-electrode, electrolytic capacitors have greater capacitance per unit volume and far longer shelf life than aluminum-electrolytic types. Long operating life, too, is provided by their inherently inert characteristics, and the use of non-corrosive, chemically neutral electrolyte. And leakage current is low—less than 10 microamps per microfarad.

Built to withstand severe shock, these lightweight units operate over a wide temperature range (−55 C to +85 C and higher). Hermetic sealing protects them against leakage and contamination. Available in polar and non-polar construction, in ratings from 175 muf at 5 volts d-c to 12 muf at 150 volts d-c. For complete description of the line, plus application information, check Bulletins GEC-808 and GER-451 in the coupon on the next page.

*Trademark of General Electric Company.

Now—greater flexibility in voltage stabilizers

Fluctuating voltage is serious on sensitive electronic equipment designed for best performance at a specified voltage. Now, to help you get rid of voltage ups and downs, G.E. offers a new 15- to 5000-va line of automatic voltage stabilizers that gives you greater design flexibility at no increase in price, plus weight reduction in larger sizes. New output ratings of 1000, 2000, 3000, and 5000 volt-amperes—with 115 and 230 volts on both input and output—permit operation in any combination of these input and output voltages.

Fluctuations between 95 and 130 volts, or 190 and 260 volts, are corrected to a stable 115 or 230 volts within ±1 percent—and in less than two cycles. Single-core construction permits input circuit to be completely isolated from output circuit. Installation is easy: connect one set of terminals for supply and another set for the load. With no moving parts, maintenance is virtually eliminated. See Bulletin GEA-5754 for complete description.
TIMELY HIGHLIGHTS ON G-E COMPONENTS

Prices reduced as much as 35% on light, flexible delay line

Increased use of delay line in special circuits for electronic equipment now enables General Electric to mass-produce it, at savings to you of up to 35 percent. Originally developed to provide delay with minimum distortion in radar equipment, G-E delay line now has many commercial uses such as color television and electronic calculators.

Bulk line is available in lengths of 100 feet or less to be cut as desired. Time delay is approximately 1/2 microsecond per foot for 1100-ohm line, 1/4 microsecond per foot for 400-ohm line. Line is light in weight, 1/4-inch in diameter, and easily bent into a 4-inch diameter coil. Operates between -50 C and 100 C. Bulletin GEC-459.

Size 00 relays cut inventories

Many of your control-circuit needs can be met with compact G-E size 00 contactors and relays—available in any combination of normally open and normally closed contacts from 2 to 8 poles. Since contact tips are easily changed from NO to NC, you can have your "specials" inventory cut. Easily accessible terminals take up to 3 wires, speed connections. For complete details, see your General Electric apparatus sales representative.

Reliable d-c to a-c amplification

Designed mainly for 400-cycle excitation, the General Electric second-harmonic converter is a magnetic-amplifier type unit that converts low-level d-c error signals (such as thermocouple output) to 800-cycle a-c output. Static operation and hermetic sealing make it reliable under extreme conditions of acceleration, temperature, and pressure—important in aircraft applications. Length is 3 1/2 in., tube diameter 1 1/4 in., weight, 0.2 lb. See Bulletin GEC-832.

Now—sealed-relay line expanded

G-E hermetically sealed relays for 28-volt circuits are now available in these forms: DPDT, 3PDT, 4PDT, 6PNO—with coil ratings up to 10,000 ohms. Certain other configurations available on request. Have extra-high tip pressures, yet don't exceed Air Force-Navy size and weight specs. They withstand all outside atmospheric conditions, 50g operational shocks, and instantaneous voltage surges up to 1500 volts. Bulletin GEA-5729.

EQUIPMENT FOR ELECTRONICS MANUFACTURERS

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General Electric Company, Section 667-24
Schenectady 5, New York

Please send me the following bulletins:

[ ] for reference only
[ ] for immediate project
[ ] GEA-5729 Sealed Relays
[ ] GEA-5754 Voltage Stabilizers
[ ] GEC-459 Delay Line
[ ] GEC-808 & GER-451 Tantalytic Capacitors
[ ] GEC-832 2nd-Harmonic Converter

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Company: ____________________________

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ELECTRONICS — February, 1953

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Luxolene Green

a new advancement in moisture-resistant coils

Luxolene Green molded coils have been engineered especially for applications involving intense moisture conditions, such as in refrigeration, air conditioning, water pumping, etc., also for explosion proof applications. Field tests of production coils have proven more than satisfactory. The cost of Luxolene Green encased coils is nominal. Send for complete information.

(Note: Deluxe Coils, Inc. manufactures coils only—no complete transformers, relays, solenoids, etc.)

Engineering Data

Coil Construction: Random, paper layer or precision wound. Excellent Lead Wires 105°C Polyvinylchloride U.L. approved. Bond Molding Compound—Luxolene Green Resin Core Tube—Luxolene Green Resin

Operating Temperatures:
- Continuous: -90°F to -250°F
- Intermittent, 4 hrs.: -90°F to -300°F
- Intermittent, 1 hr.: -90°F to -400°F

Properties of Luxolene Green Resin:
- Tensile strength: 10,900 psi
- Water absorption: less than 1/10 of 1% after 24 hours immersion.
- Thermal coefficient of expansion: 4.1 x 10^-4
- Thermal conductance: 4.9 x 10^-4
- Volume resistivity: megohms CMS 10^9
- Dielectric strength: 400 volts, 1 mill
- Arc resistance: 85
- Dielectric constant: 10^6 cycles: 3.10 10^4 cycles: 2.99
- Loss factor: 10^6 cycles: 0.113 10^4 cycles: 0.052
- Solubility: Attacked by concentrated sulphuric acid, but is resistant to concentrated hydrochloric acid. Trichloroethylene, ethylacetate and acetone will attack but not dissolve Luxolene.

Luxolene Certification

Every shipment covered by this certification:

Luxolene Certification

Serial No. 0000

We hereby certify that the coils covered by packing slip No. have been immersed in water at room temperature for 24 hours. After immersion, with 500 volts D.C. applied, the leakage resistance through water to ground has been measured by standard procedures and found to be not less than 200 megohms.

Deluxe Coils, Inc. 1304 First St., Wabash Ind.

Want more information? Use post card on last page.

February, 1953 — Electronics
presto change-o

If you’re not using Presto discs at present, then it’s time for a change. The reason, in one word . . . quality! From the meticulous preparation of the aluminum base in the Presto plant to the final play-back in the studio, quality is the byword . . . your assurance of consistent performance, unmatched fidelity of reproduction, long service. That’s why Presto is the proven leader in the professional disc field . . . a leader that merits your consideration when you decide that it’s time for a change . . . right now.

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Paramus, New Jersey

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS
SCINFLEX ASSURES
LOW MAINTENANCE BECAUSE
IT PERMITS SIMPLICITY

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of $-67^\circ F$ to $+275^\circ F$. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

- Moisture-Proof
- Radio Quiet
- Single Piece Inserts
- Vibration-Proof
- Light Weight
- High Insulation Resistance
- High Resistance to Fuels and Oils
- Fungus Resistant
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required.

BENDIX
SCINFLEX
ELECTRICAL CONNECTORS

The Finest
ELECTRICAL CONNECTOR
MONEY CAN BUY!

Bendix
SCINTILLA MAGNETO DIVISION of
AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 175 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

Want more information? Use post card on last page.
Litton is now building a new addition to its vacuum tube plant at San Carlos, California. This expansion will approximately double tube development and manufacturing facilities and will allow expansion of our affiliate, Litton Engineering Laboratories, which has taken over the manufacture of glassworking lathes and other machine products. Like the plant completed last year, the new building has been designed specifically for vacuum tube manufacture; it has similar reinforced concrete block walls with large glass-block panels for diffused daytime illumination.

Included is complete environmental control of temperature, sound, light and air for optimum manufacturing conditions.

Increasing demand for Litton products has brought about this expansion, and we expect that the added capacity will provide greater volume and service to our friends in industry.

Concurrent with plant expansion is a marked increase in the variety of pulse and CW magnetrons for radar, beacon and countermeasure equipment. It is quite possible that Litton Industries now has in production or development the specific tube to meet your needs.

Application of Litton design and processing criteria to all our tube types permits manufacture of tubes that require no aging racks in the plant or in the field and have long shelf life with snap-on operation to full rated power output immediately after completion of the cathode warm-up period.
CHATHAM ELECTRONIC TUBES

Hydrogen Thyratrons

—for Pulse Voltage Generation

ELECTRICAL DATA*

<table>
<thead>
<tr>
<th>Type</th>
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<th>5949/1907</th>
<th>5948/1754</th>
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<td>VC-1258</td>
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<tr>
<td>Maximum Peak Forward Anode Potential</td>
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<td>25000 volts</td>
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<td>Maximum Peak Anode Current</td>
<td>20amps</td>
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<td>Maximum Heating Factor ((\text{epy x prr x lb}))</td>
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<td>Nominal Filament Power</td>
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<td>95 watts</td>
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<tr>
<td>Hydrogen Reservoir</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

More detailed information on electrical and mechanical data will be supplied on request.

A NEW CONCEPT OF HYDROGEN THYRATRON DESIGN! The tubes illustrated represent a departure from conventional hydrogen thyratron designs and are a result of several years of concentrated development work. They are primarily employed in the generation of peak voltages with durations in the order of microseconds.

Custom-built Electronic Equipment

CHATHAM specializes in the development, design, and construction of custom-built electronic equipment to exactly meet customers' requirements. Our capable staff of engineers will furnish prompt estimates or, if desired, will call to discuss your problem personally. Call or write today.

Pulse life test equipment built by CHATHAM checks receiver type tubes under pulse conditions.

20 Megawatt Hydrogen Thyratron Test Equipment built by CHATHAM to customers' specifications.

5 Megawatt radar modulator built by CHATHAM to rigid government standards.

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
**Electronic Tubes**

**TYPE 719-A HIGH VACUUM CLIPPER DIODE**
This tube is used primarily for clipper diode service in hard tube modulator circuits. Filament 7 volts, 7 amps... Inverse peak anode voltage 25 kv, Max., peak anode current 10 amps, Max., anode dissipation 75 watts.

**TYPE 122 RECTIFIER**
A small bulb high voltage vacuum rectifier. Low cathode heating power and low dielectric losses make tube suitable for radio frequency supply circuits. Filament 1.5 volts, 290 amps... Inverse peak anode voltage 20,000, average plate current 2 ma... peak plate current 10 ma.

**TYPE 1B46 REGULATOR**
A cold cathode glow discharge tube designed for voltage stability. DC operating voltage 82 volts, operating current range 1 ma minimum, 2 ma maximum. Regulation 3 volts.

**TYPE 395-A COLD CATHODE GAS TRIODE**
Requires no filament supply and is used in many grid controlled rectifier and relay applications. Maximum D.C. anode current—10 ma. Maximum D.C. anode voltage—150 volts.

**TYPE 4632 RECTIFIER**
A rugged half-wave Xenon filled rectifier. Operates in any position throughout an ambient temperature range of -75°C to +90°C. Filament 5 volts, 7.5 amp... Inverse peak anode voltage 10,000 average anode current 1.25 amps.

**TYPE 394-A THYRATRON**
A Mercury vapor and Argon filled thyatron for grid controlled rectifier service. Operates over wide ambient temperature range. Heater 2.5 volts, 3.2 amps... Inverse peak anode voltage 1250, average anode current 640 ma.

**TYPE 3B28 RECTIFIER**
This rugged half-wave Xenon filled rectifier will operate in any position and throughout an ambient temperature range of -75°C to +90°C. Filament 2.5 volts, 5.0 amps... Inverse peak plate voltage 10,000, average anode current .25 amp.

**Chatham Vacuum Switches**

**SPECIFICATIONS**

<table>
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<tr>
<th>Feature</th>
<th>Value</th>
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<tr>
<td>Hold off voltage, Internal</td>
<td>10,000 volts rms</td>
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<tr>
<td>Hold off voltage, External*</td>
<td>27,000 volts rms</td>
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<tr>
<td>Intermittent rating, Resistive load</td>
<td>1,000 operations life at 10,000 v, ac, rms—10 amp, ac, rms; 1,000,000 operations life at 10,000 v, ac, rms—2 amp, ac, rms; 500,000,000 operations life at 10,000 v, ac, rms—0.1 amp, ac, rms.</td>
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<td>Net weight (approx.)</td>
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<td>Maximum width (overall)</td>
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<tr>
<td>Maximum length (overall)</td>
<td>3 5/8 ins.</td>
</tr>
<tr>
<td>Maximum thickness (overall)</td>
<td>1 1/2 ins.</td>
</tr>
</tbody>
</table>

*at 50% humidity

**HIGH VOLTAGE VACUUM FUSES**
Can be supplied by Chatham to exact customers' specifications if ordered in adequate quantity. Call or write for full particulars and quotes.
The Mallory Tantalum Capacitor shown is but one of the complete range of sizes and ratings indicated in the table. Note the following advantages:

Compactness
Continuous performance over a temperature range of -60°C to +200°C.
High resistance to shock and vibration
Proof against thermal shock from -60°C to +200°C without damage
Double sealing for absolute protection under all operating conditions.

Originally developed for the Armed Forces subminiaturization program, Mallory Tantalum Capacitors are now available in quantity. If you are redesigning your equipment, don’t hesitate to call on us for help in any problem involving the application of capacitors, the development of special types or the simplification of related circuits.

Expect more...Get more from MALLORY

Parts distributors in all major cities stock Mallory standard components for your convenience.

SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials
VISION ... As we enter the age of transistors it is important that engineers open their eyes wide to the potentialities of these new devices that are like tubes and yet are not like tubes. Circuits can be developed by thinking of transistors as substitutes for tubes. But more important circuits will come from the harnessing of characteristics that are peculiar to transistors themselves.

It is, for example, possible to build an audio amplifier that contains junction transistors and nothing much else in the way of component parts. The output of a phonograph pickup is fed into an n-p-n and also into a p-n-p junction. “Complementary symmetry” of the two dissimilar transistors permits this first stage to be directly coupled to another pair of n-p-n and p-n-p junctions so connected that they drive a loudspeaker without benefit of an output transformer. Phase inversion and impedance matching are inherent in the system, and are accomplished by phenomena that have no counterpart in the terminology of tubes.

In the spring ELECTRONICS begins a carefully planned series of articles dealing with the basic characteristics of semiconductors in general and transistors in particular. This series will appear side by side with detailed descriptions of practical transistor circuits as these are developed. The double-pronged editorial approach to a new horizon will, we think, provide a solid base upon which men with imagination can build.

MONOPOLY ... We are also entering an era in which no one amplifying device will monopolize the expanding field of electronics. Tubes will share it not only with transistors and magnetic amplifiers but also with other devices as yet largely a gleam in some physicist’s eye.

Time alone will tell which device is to dominate what equipment. Meanwhile, it does seem that tubes are at their shining best where high power is required at high frequencies and, particularly, where complex broadband modulation components are involved. This, at any rate, is the area in which much current development work is going on, sparked to a considerable extent by the increasing demands of uhf television.

Much is being done to increase the usefulness of klystrons. A new magnetron incorporating a grid exhibits considerable flexibility. Traveling-wave tubes tuneable over a moderate frequency range by mere variation of operating voltages show experimental promise. There is a great deal of constructive thinking going on in the laboratories of highly competitive tube manufacturers.

MISTAKE ... Our whole field is unusually active technically, and the future seems bright. All is not sweetness and light on the sales front, however, and there is one part of the business that has recently acquired a beautiful black eye from which it will take some time to recover.

It seems that an active microwave-relay equipment market attracted some manufacturers who either cut design corners to get into the game quickly or spaced stations too far apart on paper to hold price down and get the order. Now some of the stuff doesn’t work too well when transmission conditions are ideal and falls down completely when they are poor. Several installed systems are unused and just gathering dust.

PICTURE ... If you are wondering whether the admittedly flattering photograph at the top of this page is to be a regular eyesore then wonder no more. The answer is, quote: “No.”

The subject of the picture has been active in management and sales as well as in technical circles of this industry since 1924, with McGraw-Hill since 1926 and ELECTRONICS since 1941. He was appointed editor January 1, just after the preceding issue mailed. The thought therefore occurred that there may be two or three of the paper’s thirty-five-thousand subscribers who wonder what the editor looks like, a condition to be personally rectified in the years ahead as rapidly as flesh and blood, a liberal travel budget and time permit.

ELECTRONICS — February, 1953
Electronic Addressing

Computers and high-speed printers team up to rush publications to readers. Multiple-stylus machine works directly from punch cards and prints up to 42,000 individual four-line address labels per hour.

LIFEBLOOD of a publication is its readership.
To serve the reader, the subscription-fulfillment department keeps lists current and mails each copy promptly. This involves storing and servicing vast quantities of data as well as printing many thousands of individual address labels for each issue of the publication. Electronic equipment is proving adept at both chores, particularly for publications having large mailing lists.
Currently in use is a facsimile printer made by Addressograph-Multigraph, that works from printed address cards and has a capacity of 6,000 four-line address labels per hour. The address cards are helically scanned by a phototube linked mechanically to the printing bar. Relays are so adjusted that the printing bar strikes when the phototube receives a black signal. Nearly 100 machines are in use.

Multiple-Stylus Printer
A recent addition to the field, the multiple-stylus electronic printer, works directly from punch cards and prints up to 42,000 four-line address labels per hour. Developed by Eastman Kodak, the machine is used in that company's advertising and direct-mail department to service extensive mailing lists.

Printing speed depends upon the number of printing heads used and may be increased 24,000 characters per minute with each additional printing head. The present model uses four heads, one for each line of the address. Individual char-
Aids Publishers

By JOHN M. CARROLL

Assistant Editor
ELECTRONICS

Characters are built-up by printing rectangular dots in a 5 x 7-dot rectangle to form a pattern. Synthesis by this method of the letter E is shown in Fig. 1A.

Use of a fixed card carrying city and state names common to many cards increases address-card information capacity and eliminates repetitive card punching.

Each printing head consists of seven styli actuated by multiple vibrators. The styli print rectangular dots by striking impact blows on carbon paper. They are released in the desired pattern by independent relays working in accordance with signals received from an electronic matrix. Carbon impressions are fixed by drying lamps and a flying punch pierces holes between address labels. The close-up shows the printing operation. The four printing heads are arranged in a semi-circle at the top of the picture.

Information to be printed is stored on punch cards like those shown in Fig. 1B. A punch card for a four-line address of 96 characters must have 576 holes arranged in 48 columns of 12 holes each. The card is quartered, each quarter corresponding to one line of the address (24 characters). Characters are expressed in six-unit code and represented by holes punched in the card.

Punch cards are fed to the printer in batches of 700. Reading is done photoelectrically by four independent reading heads that correspond to the four lines of the address. Each head has six lead-sulphide photocells, so that all places of the six-unit code groups are read simultaneously by light shining through the punched holes.

Timing pulses are supplied by a slotted wheel that rotates in synchronism with the card feed and interrupts the light beam falling on another photocell.

Each reading head transmits a group of pulses as a card column passes. These pulse groups are amplified, gated by the timing pulses to insure exact synchronism and fed to the storage matrix.

The matrix has 96 memory sockets, each one corresponding to a possible character in a four-line address. The sockets are arranged in four banks of 24, the same as the code groups on the punch card. A memory plug consisting of seven magnetic memories is inserted in every memory socket from which a printed character is desired.

Pulse groups from the reading heads are channeled into the storage bank corresponding to the proper line of the address. Meanwhile, the timing pulses are applied to a ring circuit that delivers actuating pulses to successive memory units in exact synchronism with the card reading. Six of each memory unit's magnetic memories are used to store code signals representing characters while the seventh memory forms part of an error-detection system.

Printing

A second slotted wheel rotating in synchronism with the printing unit generates a series of seven pulses for each character to be printed. These pulses drive a seven-tube ring circuit. Every seventh pulse steps a second ring circuit that applies simultaneous read-out pulses successively to the
memory units in each of the four storage rows.

As each memory unit is read out, its signals go to one of four line-printing units where the signals are first applied to a group of six flip-flops. A trigger signal is set up for each pulse from the memory unit. The trigger signals are connected to a germanium-diode decoding matrix in such a manner that for every different pulse-code group a unique output line is selected that corresponds to the printed character desired.

Each output line connects to a 5 x 7 matrix of 35 switches (Fig. 2). When an output line is energized, certain of the switches close to form the pattern of the character to be printed. Consider the switch matrix to consist of five columns of seven switches each.

A printer timing pulse feeds into each of the five matrix columns in turn. A separate vibrator amplifier is connected to each row of seven switches and as each column is pulsed, a signal is sent to every amplifier whose switch in the column is closed. Each vibrator amplifier is connected to a vibrator that activates one of the seven printing styli. The paper tape advances one dot space as each column is pulsed and the character is built up in five pulses. The fifth pulse resets the trigger tube for the following character.

Over the Horizon

Several other methods of electronic subscription fulfillment are under study. The Potter Instrument Co. is working on a system in which their flying typewriter, its tube complement now reduced to 300, teams with a random access memory (RAM) to print 10,800 address labels per hour per printer. The random access memory is the outstanding feature of the system. Over a million subscription records can be stored magnetically and each day's transactions entered without disturbing the unaffected records. Serial tape-handling systems require that the entire tape be rearranged when subsequent transactions are to be filed.

Another proposed method would display information from a storage device on the screen of the Charactron®, a cathode-ray tube with a beam-forming matrix of character-shaped openings through which the electron beam is directed. Addresses, displayed at rates up to 10,000 per sec on the crt face, can be transferred to ordinary paper by a dry-printing process such as Xerography.

REFERENCES


February, 1953 — ELECTRONICS
Cavity Tuner for UHF Television

All 70 of the high-band channels are continuously tuned by varying the center-loading capacitance of a modified coaxial line section. Design avoids moving contacts and minimizes radiation from oscillator by inherent shielding.

Development of a tv receiver front-end to cover the uhf channels imposes severe requirements. After consideration of butterfly arrangements, coaxial lines with wiping contacts or capacitors and other devices, a modified resonant cavity was adopted as the basic tuning element.

The tuner shown in the diagram, Fig. 1, contains three cavities. Two of these function as a bandpass preselector and the third controls the local oscillator frequency. The preselector is essentially an over-coupled double-tuned transformer with a balanced 300-ohm antenna input and unbalanced output to the mixer.

Tuning of each cavity is accomplished by a metallic plunger traveling in a low-loss dielectric sleeve which varies the value of center loading capacitance. The plunger serves only as a transfer medium and makes no physical contact with the cavity or loading capacitor.

Suitably formed loops couple in and out of the cavity field with the degree of coupling controlled by physical dimensions and placement. The tuning plungers are ganged together and moved by a simple linkage that provides substantially linear frequency calibration. Dial and inter-cavity tracking are adjustable at three points by positioning the plunger, trimming the loading capacitance and by an additional mechanical means of changing the electrical length of the cavity.

The view of the complete converter shows the three cavities assembled to a small subchassis, with their tuning plungers attached to the ganged drive. This drive consists of a metal frame pivoted at one end and swing in an arc by a link mechanism against a spring.

Straight-line motion is imparted to the plungers by the rotation of the frame. The dial is concentric with the tuning knob and calibrated.
and the multiple spurious responses which result from double conversion. Considerable selectivity may be obtained by using three or four tuned circuits; however, because of increased insertion loss and tracking errors, improvement in selectivity is accompanied by rapid degradation of noise figure. Fortunately, because of the high operating Q's possible at uhf, two tuned circuits provide adequate image and i-f rejection.

The double-tuned preselector shown has an image ratio better than 60 db, an i-f (80 mc) rejection greater than 90 db, with an insertion loss of approximately 2 db at 890 mc. A plot of insertion loss versus frequency is given in Fig. 2.

Radiation

Another measure of the effectiveness of a preselector is the value of end-to-end feed-through capacitance which generally determines the amount of oscillator voltage appearing across the antenna terminals. The preselector coupling throughout the tuner is primarily magnetic, and capacitance feed-through is reduced to negligible proportions. The attenuation at oscillator frequency is in the order of 45 db, which means that antenna radiation due to back-to-front coupling is less than 100 μv per meter.

Another source of oscillator radiation, that due to coupling around the preselector by stray magnetic and electrostatic fields, is minimized by careful layout and fully shielded construction, which effectively confines the r-f and oscillator fields within the metallic cavity walls.

A 1N82 low-noise silicon diode is used as a mixer. Diode rather than triode conversion was selected because better noise figures are possible, and as a result of the small injection voltages required, oscillator radiation is considerably reduced. In addition, the loose coupling between oscillator and mixer permits more stable oscillator performance. The preselector and oscillator outputs are linked by a common coupling loop which combines the fields of both cavities at the mixer input.

Oscillator Circuit

The 6AF4 local oscillator tunes below the carrier, to prevent reversal of the sound and picture position on the i-f response curve of the television receiver during double

Selectivity

The skirt selectivity requirements at uhf are more severe than for vhf because of the relatively close spacing of signal and image frequencies directly in channel numbers. A metal wrap-around encloses the entire unit to guard against mechanical damage during handling, and act as a second r-f shield to reduce radiated interference.

The local oscillator, a Colpitts type, tunes below the signal frequency for double superheterodyne or converter applications. Mixing takes place in a low-noise diode, with the i-f signal appearing at vhf channels 5 or 6.

Tuning is controlled by a single knob which functions as both a channel selector and fine-tuning control. The complete uhf television band is covered by five turns of the tuning knob. A circular dial, linearly calibrated, rotates approximately 150 degrees.

In Fig. 1, the resonant cavity tuning elements are represented schematically by their lumped-constant equivalents to facilitate circuit analysis. Balanced 300-ohm antenna coupling is achieved simply by a loop located in the cavity field. Since the coupling is almost constant over the entire tuning range, antenna mismatch losses are minimized.
To assure stable oscillator performance all circuit elements are designed as an integral part of the resonant cavity, which results in almost constant injection current as shown in Fig. 3. This helps confine the oscillator field and substantially reduces radiated interference.

Although the uhf oscillator operates at a much higher frequency than a vhf oscillator, the permissible frequency drift on an absolute basis must be much smaller. This is the direct result of double superheterodyne operation, in which the additive drift of two local oscillators determines the overall frequency stability of the uhf receiver. Theoretically, assuming that the vhf tuner designer has taken full advantage of the permissible drift tolerance, the uhf oscillator must either be absolutely stable, or have a drift characteristic opposing that at vhf.

Fortunately, modern vhf tuners operate well within the allowable drift tolerance, and the television industry, in anticipation of the severe uhf requirements, is now producing sets using intercarrier sound circuits. While this eliminates the possibility of complete loss of sound due to drift, picture quality degradation and loss of sensitivity still remain.

Two factors generally influencing oscillator frequency stability are temperature changes and power supply fluctuations. The tuner local oscillator contains a temperature-sensitive element which varies the electrical length of the cavity, and holds the frequency substantially constant over a wide temperature range. Voltage sensitivity is reduced to a second-order effect by circuit design, and a regulated supply is therefore unnecessary for normal applications.

**Output Frequency**

For practical design purposes, vhf channels 5 and 6 were chosen as the Intermediate Frequency. Despite the fact that it is possible to receive weak transmissions in some scattered geographical locations on both these channels, high i-f attenuation through the tuner still permits interference-free uhf reception. Since the output tuned circuit is sufficiently broad to pass both channels, no readjustment of the oscillator is necessary to shift frequency, in the presence of strong local signals.

For those applications where the tuner is combined with a specially designed vhf tuner as an 82-channel front-end for new television receivers, no significant improvement in either noise figure or isolation can be expected from the addition of an i-f amplifier.

When used as a tuner or converter for existing television receivers, improved performance can be realized by the insertion of a cascode amplifier between the tuner output and the receiver input. Such a low-noise stage would provide needed gain, allow the tuner noise to dominate that of the vhf receiver, and further isolate the uhf and vhf oscillators. The individual tuning element is a modified, coaxial line section shorted at both ends, and center loaded by lumped capacitance to attain the necessary electrical length within small practical dimensions.

The complete circuit of a converter using the tuner and a cascode i-f amplifier is shown in Fig. 4.

The 6BQ7 cascode i-f amplifier has a noise figure of 6 db and power gain of approximately 15 db. Three tuned circuits are used to give a uniform response from 76 to 88 mc (channels 5 and 6) with relatively steep skirts to prevent spurious responses at vhf image frequency, and to sharply attenuate vhf oscillator feedback to the converter. Because of the broad flat-top response, no retuning is required whenever an alternate channel is selected.

An overall i-f response curve is shown in Fig. 5. Both the i-f response and power gain were measured with a 175-ohm generator to simulate the i-f impedance of the diode mixer. Layout and wiring of i-f connections to the mixer minimize parasitic "suck-outs" which adversely effect oscillator injection current.

Figures 6 and 7 provide supplementary data on bandwidth and noise figure.
TRANSMISSION NOISE differs from other types such as thermal and shot noise, since the transistor noise power per unit bandwidth is approximately inversely proportional to frequency. Figure 1 shows this variation of the noise power per cycle bandwidth with frequency. One consequence of this type of noise spectrum is that each octave of the frequency range contains the same noise power.

In the equivalent circuit representation of the transistor it is convenient to represent the noise by adding two noise-voltage generators with rms voltages $E_{n}$ and $E_{o}$, as shown in Fig. 2. It is then assumed that the other elements of the equivalent circuit are noiseless.

Representative values for $E_{n}$ and $E_{o}$ for point-contact transistors are 100 µV and 1 µV respectively, measured at a frequency of 1,000 cps for a bandwidth of one cycle. Corresponding voltages for junction transistors are 5 µV and 0.05 µV respectively.

For practical applications, it is more convenient to express the noise characteristics of the transistor by giving its noise figure. The noise figure is defined as the ratio of the total noise power in the output (disregarding the noise originating in the load impedance) divided by that portion of the output noise that results from thermal agitation in the source resistance $R_{s}$. This noise figure provides a convenient way of comparing the noise properties of transistors.

Figure 3 shows the variation of noise figure with frequency for two junction transistors. Representative values for noise figures, measured at a frequency of 1,000 cps are 40 to 60 dB for point-contact transistors and 10 to 25 dB for junction transistors. Figure 4 shows the distribution of noise figure for 60 transistors of both types.

Mathematically, the noise figures for the three basic types of amplifier circuits may be expressed as follows: For grounded emitter

$$F = 1 + \frac{1}{4KTB_{r}} \left[ E_{n}^{2} \left( \frac{R_{e} + r_{e} + r_{b}}{r_{e}} \right)^{2} + E_{o}^{2} \left( \frac{R_{o} + r_{o} + r_{b}}{r_{o}} \right)^{2} \right]$$

For grounded base

$$F = 1 + \frac{1}{4KTB_{r}} \left[ E_{n}^{2} + E_{o}^{2} \left( \frac{R_{o} + r_{o} + r_{b}}{r_{b}} \right)^{2} \right]$$

For grounded collector

$$F = 1 + \frac{1}{4KTB_{r}}$$

In these equations $x$, $r_{e}$, $r_{o}$, $r_{b}$, and $r_{o}$ are equivalent circuit parameters for the transistor. $E_{n}$ and $E_{o}$ are open-circuit voltages, $R_{s}$ is source resistance, $B$ is frequency band, $K$ is Boltzmann's constant ($= 1.347 \times 10^{-20}$), and $T$ is temperature in deg Kelvin. The addition sign in these equations expresses addition with attention to any correlation between $E_{n}$ and $E_{o}$. If no correlation exists, then this operation may be replaced by simple addition.

The noise figure of a transistor depends on the operating point. For example, while the emitter noise is almost independent of the collector voltage $V_{c}$, the collector noise depends strongly on it. Figure 5 shows variation of the collector noise voltage for one-cycle bandwith with the collector voltage $V_{c}$. The noise figure for point-contact transistors is almost independent of the collector voltage $V_{c}$ as shown by the experimental curves in Fig. 6.

The noise figures of some junction transistors display the same independence of the collector voltage. The noise figure for most junction transistors, however, decreases with decrease in collector voltage, as shown in Fig. 7. Figure 8 shows the contributions to noise figure by the emitter and collector together with total noise figure. It is, therefore, necessary to operate the transistor at collector voltages falling into region A of Fig. 8.

**Signal-to-Noise Ratio**

The total noise power in a frequency band $f_{2} - f_{1}$ is
Amplifiers

Particular recommendations for obtaining the optimum signal-to-noise ratio in point-contact and junction transistor amplifiers. Typical values and curves show how this type of noise figure varies with operating point of transistor and source impedance.

\[
\int \frac{K}{f} \, df = K \ln \frac{f_2}{f_1} \tag{4}
\]

On the other hand, the thermal noise power due to \( R_s \) is proportional to the bandwidth \( f_2 - f_1 \). The noise figure for the bandwidth limited by the frequencies \( f_1 \) and \( f_2 \) is

\[
F = 1,000 F_s \ln \frac{f_2}{f_1} \tag{5}
\]

where \( F_s \) is the noise figure at 1,000 cps for a bandwidth of one cycle. If \( f_2/f_1 \leq 1 \)

then

\[
\ln \frac{f_2}{f_1} = \frac{f_2 - f_1}{f_1} \]

and

\[
F = F_s \frac{1,000}{f_1} \tag{6}
\]

The noise figure may be considered fairly independent of the bandwidth if this bandwidth remains relatively small.

The expression for signal-to-noise ratio for the transistor amplifier may be obtained in the following manner. The noise figure in accordance with the definition is

\[
F = \frac{\text{noise power at output}}{\text{transducer gain}} \times \frac{1}{\text{available noise power at input due to } R_s}
\]

and the noise power at input will be

\[
N = FKT \times (f_2 - f_1) \tag{8}
\]

Consequently, the signal-to-noise ratio

\[
\frac{S}{N} = \frac{V_0^2}{4KT (f_2 - f_1) R_s F} \tag{9}
\]

or replacing \( F \) by \( F_s \)

\[
\frac{S}{N} = \frac{V_0^2}{4 R_s KT (F_s 1,000 \ln f_2/f_1)} \tag{10}
\]

From Eq. 10 it can be seen, that the quantity

\[
[1,000 KTF_s \ln f_2/f_1]
\]

is equivalent to the available noise power at input. Let us call this power equivalent noise power \( P_e \)

\[
P_e \equiv 1,000 KTF_s \ln f_2/f_1 \tag{11}
\]

If the base of the logarithm is now changed to 10 and values of \( K \) and \( T \) substituted, the equivalent noise power will be

\[
P_e \equiv 0.9 \times 10^{-12} F_s \times \log f_2/f_1 \text{ (watts) } \tag{12}
\]

This equation shows that the noise power depends on the ratio of the frequencies \( f_2 \) and \( f_1 \) and not on their magnitudes.

Equation 12 for the equivalent noise power may be rewritten approximately as

\[
P_e \equiv 0.9 \times 10^{-12} F_s \times \log \left( \frac{12}{f} \right) \text{ (watts) } \tag{13}
\]

where \( \Delta f \) is the bandwidth and \( f \) the center frequency. This equation shows that for a constant bandwidth the noise power will decrease as the center frequency increases.

The signal-to-noise ratio may now be expressed as

\[
\frac{S}{N} = \frac{V_0^2}{4 R_s F_s \log f_2/f_1} \tag{14}
\]

\[
= 3.6 \times 10^{-12} R_s F_s \log f_2/f_1
\]
Types of amplifier circuits. For a given operating point and given transistor, $E_{ce}$ and $E_{ne}$ are constant. A parameter

$$\rho = \frac{E_{ne}}{E_{ce}}$$

(15)

may be introduced, practical values for which are between $10^{-4}$ and $10^{-8}$.

The equations for the noise figures are:

For grounded emitter

$$F = 1 + \frac{R_s}{R_e} + \frac{\rho (R_2 + \alpha r_1)^2 + (R_2 + r_1 + r_2)^2}{\alpha^2 r_1^2}$$

(16)

For grounded base

$$F = 1 + \frac{R_0 [\rho (R_0 + r_1) + (R_e + r_1 + r_2)]}{R_e \alpha^2 r_1^2}$$

(17)

For grounded collector

$$F = 1 + \frac{R_s [\rho (R_s + r_1)^2 + (R_e + r_1 + r_2)^2]}{R_s r_1^2}$$

(18)

where

$$R_s = \frac{4 E_{ce}^2}{K T (S - f_1)}$$

(19)

The only parameter of these equations that can be varied externally is the source resistance $R_s$. Figure 10 shows the variation of $F$ with $R_s$ for different values of the parameter $\rho$.

The noise figure $F$ has a minimum for the following values of $R_s$:

For grounded emitter

$$R_s = \left[ \frac{\rho (r_1 + r_2)^2}{1 + \rho^2} \right]^{1/2}$$

(20)

For grounded base

$$R_s = \left[ \frac{\rho (r_1 + r_2)^2}{1 + \rho^2} \right]^{1/2}$$

(21)

For grounded collector

$$R_s = \left[ \frac{\rho (r_1 + r_2)^2}{1 + \rho^2} \right]^{1/2}$$

(22)

This minimum, however, is not very critical as it can be seen from the experimental curves in Fig. 10 and the theoretical curves in Fig. 11. Somewhat larger or smaller values of $R_s$ may be used without an appreciable increase in amplifier noise.

Using Eq. 17 and 21 for the grounded-base connection, the minimum noise figure will be

$$F_{min} = R_n \left[ \frac{2 (r_1 + r_2)}{\alpha^2 r_1^2} + \frac{2 \rho^2}{\sqrt{\alpha^2 r_1^2 + (r_1 + r_2)^2}} \right]$$

Now if the value of $R_s$ is increased or decreased four times, the noise...
For grounded emitter
\[ G_1 = \frac{\alpha^2 r_e R_e}{(r_e + r_i + R_e)} \times \frac{1}{[r_e + r_i (1 - \alpha) + R_e (1 - \alpha)]} \]  
(27)

For grounded collector
\[ G_1 = \frac{r_c R_o}{(r_c + r_i + R_o)} \times \frac{1}{[r_c + r_i (1 - \alpha) + R_o (1 - \alpha)]} \]  
(28)

The noise figure of the second stage depends on the operating point of the second transistor and the first stage output resistance. This output resistance can be changed by transformer coupling the two stages. This coupling will leave \( G_1 \) unchanged. Adjusting the transformer turns ratio so that the apparent source impedance of the second stage is that given in Eq. 20, 21 and 22, will reduce the influence of the second stage.

If the two stages are coupled without a transformer, one obtains

\[ P = F_1 + F_2 - 1 \frac{E_{in}^2}{4KTB} \]  
(29)

where \( F_1 \) and \( F_2 \) are the noise figures of the first and second stage respectively and \( G \) is the available power gain of the first stage. This available power gain has the following values:

For grounded base
\[ G_1 = \frac{\alpha^2 r_e R_e}{(r_e + r_i + R_e) [r_e + r_i (1 - \alpha) + R_e]} \]  
(30)

For grounded collector
\[ G_1 = \frac{r_c R_o}{(r_c + r_i + R_o) [r_c + r_i (1 - \alpha) + R_o]} \]  
(31)

The available power gain is
\[ G_1' = \frac{\alpha^2 r_e^2 R_e}{(r_e + r_i + R_e) [r_e + r_i (1 - \alpha) + R_e (1 - \alpha)]} \times \frac{1}{[r_e + r_i (1 - \alpha) + R_e (1 - \alpha)]} \]  
(32)

This equation permits calculation of the contribution of second stage to overall noise figure for direct or R-C coupled amplifiers.

Noise in transistor amplifiers is similar to contact noise insofar as it depends strongly on the frequency. Total noise power is not proportional to amplifier bandwidth but depends on the ratio of the frequencies limiting it.

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FIG. 9—Available equivalent noise power

FIG. 10—Variation of noise figure with source resistance for different values of \( E_{in}/E_{oc} \)

FIG. 11—Comparison of noise figure in point-contact and junction transistors
**Three-phase resistance welding control (right) used with a spot-welding machine at a West Coast aeronautical plant.**

Three-phase power of one frequency, usually 60 cycles, may be changed electronically to single-phase power of lower frequency. This practice eliminates the annoying blinking of lights caused by the large intermittent load of a resistance welder on an inadequate power supply. Quality of welds is improved by elimination of these voltage dips when several welding machines are operated randomly on the same lines.

One cause of the heavy load is that resistance-welder loads usually are highly inductive and have a low power factor at 60 cycles. The welding transformer secondary circuit of a large press-type welder is essentially a very-low-resistance loop. In some cases, the welding current is largely reactance limited and only part of the kva demand is used for heating.

Changing to a lower frequency decreases the reactance drop, improves the power factor, reduces the required secondary voltage and reduces the kva demand and line drop. Distributing the demand current on three lines, instead of on two lines, further reduces the line drop.

The frequency-changing principle is shown in Fig. 1. A cycle of the 1-f single-phase output is started with a 1-f half cycle, arbitrarily called a positive half cycle. This 1-f half cycle is started by drawing power through a power tube, from what is designated as the A phase of the three-phase power supply (lines 1 and 2). Instead of allowing this phase to continue to energize the load at 60 cycles, the load is transferred to phase B by means of power tubes when the phase-B voltage of corresponding polarity exceeds that of phase A. Similarly, the load is next transferred from phase B to phase C, then to phase A and so on to produce a continuous load voltage of positive polarity for the first half cycle of the low frequency.

Load voltage is made up of 120-deg segments of positive voltages from the three phases. Load current is composed of 120-deg blocks of unidirectional currents drawn successively from the three phases as shown in Fig. 1A. The power lines carry alternating current as shown in Fig. 1B. The distinct build-up of the load current as shown by the waveform sketch is for an inductive load (welder load) and is a characteristic of the current rise when d-c is applied to an inductive circuit.

During the 1-f half cycle, the load transformer must be capable of developing a continuously increasing flux to generate the required unidirectional back emf or induced voltage. After a few cycles of applied rectified 60-cycle three-phase voltage, the load is disconnected from the power supply. At the end of the positive 1-f half cycle, and when the phase-A voltage reverses, the load is reconnected to phase A through a power tube of opposite polarity so as to cause the load transformer to induce a secondary voltage of negative polarity to start the negative 1-f half cycle.

**Load Transfer**

By means of power tubes, the load is transferred from phase to phase at the proper instant to provide a continuous load voltage of negative polarity to make up the
Resistence Welding

Direct conversion from three-phase 60-cycle power to single-phase low-frequency power improves power factor and reduces kva demand and line drop compared to the more commonly used 60-cycle single-phase machines.

negative 1-f half cycle during a few cycles of the 60-cycle supply.

Each 1-f half cycle is started by drawing power from phase A and is terminated by drawing power from phase C. In the case illustrated by Fig. 1, power is fed to the load during two cycles of the 60 cycles, with one-half of a 60-cycle between 1-f half cycles. The whole 1-f cycle has a duration of 5 cycles out of 60 cycles or a fundamental frequency of 12 cycles.

Heat Control

Power tubes, used for transferring the load from phase to phase as previously explained, also provide a convenient means of adjusting the effective value of the applied 1-f voltage. This heat control is effected by delaying the transfer from one phase to the next as shown by Fig. 2.

The transfer is shown in Fig. 1 as occurring at about 30 deg on the phase voltages, thus utilizing the maximum envelope of the three phase voltages. In Fig. 2, the transfer is shown as occurring at about 65 deg on the phase voltages and producing about 50-percent maximum current or 25-percent heat. The range of current control from 100 down to 20 percent (100 to 4-percent heat) requires adjusting the transfer or commutation from about 30 deg to 110 deg on the phase voltages. Figure 2 also shows the current in line 1 which is composed of the currents of the A and C phases. For reference, the full-heat current is shown dotted.

Figure 3A shows a case where the duration of applied unidirectional voltage during the 1-f half cycles, designated as the pulse time, is increased to 3 cycles of the 60 cycles for a welding frequency of 8-4/7 cps. With other factors the same, the welding transformer must be capable of developing a larger amount of flux for 3 cycles than for 2 cycles because it must maintain the same rate of increase in flux for the longer time interval of a 1-f half cycle. Size of the welding transformer is determined by the pulse time. For example, Fig. 3B also has a welding frequency of 8-4/7 cps, but has a pulse time of 2 cycles and can use a smaller welding transformer.

Figures 1, 2 and 3 show 1-f welding current as applied to produce a spot weld requiring one or more 1-f cycles of current. The reasons for using different pulse times as shown by Fig. 1A and 3A, or for using different time intervals (designated as interpulse time) between 1-f half cycles as shown by Fig. 1A and 3B, are somewhat as follows:

Benefits from reduction in kva demand are greater when using lower welding frequency as in Fig. 3A but the lower transformer frequency requires a larger welding transformer. In general, the optimum low frequency is considered as being 8-4/7 or 12 cps, with a pulse time of 2 or 3 cycles.

There are several uses for different time intervals between the 1-f half cycles as shown by Fig. 1A and 3B. Thin gauges of metal may be welded by using a single 1-f half cycle. In some cases, seam welding may be done by the continuous application of 1-f half cycles and by using a time interval of a few cycles of 60 cps between 1-f half cycles. Thus, the interpulse time interval between 1-f half cycles in Fig. 1A, 3A and 3B is much longer.
than for seam welding.

When spot welding is done by means of a single l-f half cycle, successive spot welds should be made using welding current of opposite polarity, known as antipolar half-cycle operation. This practice avoids energizing the welding transformer with a series of unidirectional voltage impulses which might cause saturation of the welding transformer. If unidirectional l-f half cycles are used for spot welding, the welding transformer should be premagnetized with flux of opposite polarity during the intervals between welding.

**Commutation Faults**

Certain conditions of spot welding with full l-f cycles may require using more than ½-cycle interpulse time, as shown in Fig. 4A. A long interpulse time, a high percentage current setting and a secondary circuit having high inductance may, at the end of a l-f half cycle, cause the current from the C phase to drag out. These conditions would keep the load connected to phase C until phase C again becomes positive.

Starting the negative l-f half cycle at point X while the positive current persists will result in a commutation fault. The supply currents, being limited only by resistance of transformer primary windings and leakage reactance between windings, would be excessive and several times their normal magnitude. The commutation fault may be prevented by increasing the interpulse time interval between l-f half cycles as shown in Fig. 4A. Another method of avoiding commutation faults, which provides a more continuous flow of welding current, is the use of inversion as shown in Fig. 4B.

**Inversion**

Inversion operation consists of controlling the conductivity of the power tubes so that at the end of a l-f half cycle, the energy stored in the load and welding transformer continues to be forced back into the supply to extinguish the current. Otherwise, the load and welding transformer would again draw power from the C phase. As shown in Fig. 4B, inversion operation is accomplished by transferring the phase-C drag-out current (at point P) to the phase-A power tube which has been operating during the l-f half cycle. A voltage of opposite polarity to the preceding l-f half cycle is maintained on the primary of the welding transformer to accelerate the decay of primary current.

At point P in Fig. 4B, the phase-A voltage is zero and the phase-A power tube cannot be fired on the phase-A voltage. If phase C is still connected to the load by drag-out current through the C power tube, the phase-C voltage is induced in the anode circuit of the A power tubes. During that part of the cycle, the anode voltage of the phase-A power tubes is the difference between the phase-A and phase-C voltages. Because of the induced transformer voltage, there is considerable positive anode voltage to refire the phase-A power tube at the time the phase-A voltage is zero.

Immediately after point P and during the time that the drag-out current is being carried by the +A power tube, the anode voltage of the —A power tube is negative. The grid of its firing tube may be turned on so that the next l-f half cycle starts as soon as current of the preceding half cycle is extinguished. In contrast with the case of Fig. 4A where a welding frequency of 8-4/7 cps is desired but a welding frequency of 6.67 cps must be used to prevent a commutation fault, the addition of inversion operation as shown in Fig. 4B permits using the 8-4/7-cps frequency with a more steady flow of welding current.

**Control Operation**

The mode of l-f control operation is outlined by the schematic diagram of Fig. 5. All control tubes are small thyratrons. Larger thyratrons are used for firing the igniton power tubes. Control is a-c operated in that all tubes have a-c anode voltages. This frequency-changing control may be separated into five functional sections: the sequence control, low-frequency timer, trailing exciters, firing tubes and power tubes (with the welding transformer). The control functions of each of these sections and the relationship of section operations will be explained with reference to Fig. 5.

As shown by Fig. 5, the sequence control and low-frequency timer operate from phase-A control voltage. Governed by the sequence control, the squeeze time allows the welder electrodes to close on the work before welding current is applied. The weld interval is the duration of low-frequency welding current. The hold time maintains the electrode pressure on the work while the weld is cooling. The off
time, used only for repeat operation, is the time that the electrodes remain open for the removal of the welded parts and the placement of new parts to be welded.

The 1-f timer controls the duration of the 1-f half cycles (pulse time) and the time interval between 1-f half cycles (interpulse time). It also insures that each weld starts with a full positive 1-f half cycle and is ended with a full negative 1-f half cycle to provide complete 1-f cycles of welding current, except where 1-f half-cycle welding is being done.

In response to the 1-f timer, the exciter section sets up a pattern of three-phase control voltages or signals for turning on the firing tubes in the proper order. The control operation thus branches out into three-phase operation in the exciter section. Inversion control also originates in this section. The +A exciter tube controls all the other tubes in the + circuit branches (phases A, B, C) extending toward the power circuit. The —A exciter tube controls all the other tubes in the — circuit branches extending toward the power circuit.

The turn-on voltages from the exciter unit, applied in the grid circuits of the firing tubes, are really releasing voltages rather than turning-on voltages because the operation of the firing tubes further depends upon phase-controlled voltages in their grid circuits for heat control (percent current). The firing tubes turn on the ignitron power tubes to phase-control the three-phase power applied to the welder and to refire the A power tubes at the right time for inversion operation.

In this case, the load consists of the welding transformer having three primary windings and one secondary winding on a common magnetic core. It may be considered as a single-phase welding transformer having three primaries connected to the three-phase power supply through time-controlled and phase-controlled power tubes to compose the single-phase 1-f output.

**Circuit Details**

The power circuit, including the welding transformer, power tubes and firing tubes, is shown in the upper right corner of Fig. 6. Igniter current of each power tube is controlled by the firing tube connected between anode and igniter. Since each power tube and its firing tube have the same anode voltage, except at the instant while the igniter current flows, the combination may be thought of as grid control on the ignitron.

During standby, the anode volt-
ages are the phase voltages. During three-phase operation, a much different condition exists. Consider the A power tubes, for example. During welding, the anode voltage is the difference between the phase-A voltage and the voltage of the operating phase induced through transformer action in the primaries of the welding transformer. This is shown in the waveform sketch of Fig. 6. This condition must be recognized when considering tube ratings and should be kept in mind when considering inversion operation.

All of the firing tubes are phase-controlled for heat control. The grid circuits of the A firing tubes provide the additional feature of inversion. An A firing tube and its grid circuit is shown in Fig. 7 for the analysis of firing-tube grid-circuit operation.

Figure 7A shows the essential components of the grid circuit. The component circuits are shown separately in the successive figures. Figure 7B shows the negative d-c grid-bias voltage provided by rectifier 3 and applied by switching tube 4 to keep the firing tube nonconductive during standby. Figure 7C shows the phase-shifted sine-wave component of voltage applied to the grid to trigger the firing tube at the desired point in the anode voltage wave. These component voltages of the grid circuit exist simultaneously during standby and are shown combined in Fig. 7D. In this case, during any time in the cycle the grid potential of the firing tube is at which ever potential is more negative, the d-c bias or the sine-wave phase-controlled voltage component.

In Fig. 7E, a half cycle of sine-wave turn-on (or releasing) grid voltage in phase with the firing-tube anode voltage is applied to raise the cathode potential of switching tube 4 above the cathode potential of the firing tube. The firing tube is then permitted to become conductive in accordance with the phase-controlled grid voltage or heat setting.

In Fig. 7F, the turn-on grid voltage is obtained from phase-B control voltage and the firing tube is not triggered until the phase-A voltage has decreased to about zero at the end of the positive half cycle of anode voltage. However, at this time there is considerable anode voltage as previously explained. At the end of a l-f half cycle, if A firing tube has not been triggered for heat control and if the phase-C power tube continues to carry current, the A power tube is fired to provide inversion operation.

Exciter Unit

With reference again to Fig. 6, the exciter tubes turn on and control the order of firing of the firing tubes. The +A and −A exciter tubes respond in accordance with the l-f grid-supply voltage patterns made up by the l-f timer. The +A exciter tube, with its trailing +B and +C tubes, turn on the positive half cycle of l-f welding current. The +B′ exciter tube, trailing the +C exciter tube, provides the half cycle of voltage from phase B to turn on the +A firing tube for inversion operation at the end of the positive l-f half cycle. The −A, −B, −C and −B′ exciter tubes operate in similar manner to produce the negative l-f half cycle of welding current.

The l-f timer is composed of electronically interlocked electronic timing circuits. Operation of the l-f timer may be explained best by first considering Fig. 8. This circuit embodies all of the basic circuit operating principles in the l-f timer.

With reference to Fig. 8A, the anode voltage of thyatron tubes 1 and 3 are in phase but are 180 deg out of phase with the anode voltage of thyatron tube 2. Each tube has an a-c sine-wave grid bias, 180-deg out of phase with its anode voltage and supplemented by the conventional d-c self-rectified bias. When the initiating switch is closed, tube 1 will conduct during the next positive half cycle of its anode voltage as shown by E₁ of Fig. 8B. The anode circuit is inductive and tube 1 will continue to conduct for a portion of a half cycle after the anode supply voltage has reversed and become negative. During this time, after the anode supply voltage has reversed, the anode of tube 1 is maintained positive by the inductive anode current feeding back into the control voltage supply.

During the carry-over of tube 1, the grid of tube 2, connected to the anode of tube 1, is held positive and

![FIG. 7—Analysis of firing-tube grid circuit for turn-on, heat control and inversion](image-url)
tube 2 trails as shown by $E'$. Tube 2 may start conducting as soon as its anode voltage becomes positive. It does not have to wait until tube 1 stops. Similarly, tube 1 will now trail tube 2 if the initiating switch is opened. The operation of tubes 1 and 2 may be initiated by closing the initiating switch but cannot be stopped by opening the switch.

If the self-rectified bias component of the grid voltage applied to tube 3 has a very short time constant, tube 3 will trail tube 2 immediately. As shown, the self-rectified bias of tube 3 is adjustable ($C$ and $R_i$) and, for the case of the waveform sketch, is set to provide a grid voltage as shown by the curve designated $E'$, timing grid voltage. During the next positive half cycle of anode voltage on tube 3 after tube 2 starts conducting, the grid of tube 3 is held negative by the negative d-c timing voltage and tube 3 does not trail tube 2 immediately. After a time delay, shown as set for one cycle, the timing voltage decays sufficiently to allow the grid of tube 3 to become positive at point $P$ and tube 3 conducts during the next positive half cycle of anode voltage. The time constant of the timing circuit may be adjusted so that tube 3 will not start conducting until several cycles after tube 2 starts conducting.

Tube 3 has a neutralizing transformer in its anode circuit. This transformer is equivalent to a reactor having a secondary winding. Transformer $T$, secondary voltages are shown by the curve designated $E'_{2s}$. One secondary of transformer $T$, feeds an impulse of this voltage back into the grid circuit of tube 2 to neutralize the positive grid-voltage component derived from the carry-over of tube 1. Tube 2 cannot trail tube 1 during the next half cycle after tube 3 conducts.

If the initiating switch has previously been opened, the nonconduction of tube 2 will cause tubes 1 and 3 to stop and the circuit comes to rest. If the initiating switch has been maintained closed, tube 1 will continue to conduct and the nonconduction of tube 2 will stop only tube 3. During the half cycle that tube 2 does not conduct, timing capacitor $C$, recharges by grid current from tube 3. During the next half cycle, tube 3 does not conduct. Then tube 2 starts conducting again and thus reinitiates the operation. Tube 3 operates periodically during every third cycle of its positive anode voltage. The R-C circuit may be adjusted for several cycles between conductions.

The circuit may be extended so that the anode potential of tube 3 triggers periodically other tubes connected similarly, or a secondary of transformer $T$, may be used to initiate or cause certain control functions to be performed in other circuits. Other patterns of signal voltage may be supplied by providing transformers in the anode circuits of tubes 1 and 2. By the use of these circuit operating principles, almost any kind of sequencing or timing-voltage pattern based on 60-cycle control operation can be provided. This will be evident during the explanation of the l-f timer operation.

It should be observed that this circuit operation is synchronous. That is, the initiating tube 2 and timing tube 3 must start conducting at the beginning of their half cycles of anode voltage or they cannot conduct at all. This is because the grid voltage abruptly goes negative soon after the anode voltage becomes positive.

**Low-Frequency Timer**

Figure 9A shows the circuits of the l-f timer, including sequence control tubes 4 and 5 that are directly associated with l-f operation. Figure 9B shows the time relationship of the control-tube operations. This is an 8-4/7 cycle welding frequency having 3-cycle pulse time and one-half cycle cool time.

With reference to Fig. 9A and 9B, the l-f circuit operation is as follows: At the end of the sequence squeeze time, when the welder electrodes have closed on the work, tubes 4 and 5 operate simultaneously. Tube 5 initiates the weld interval. Tube 4 initiates the positive l-f half cycle of welding current by triggering the +A exciter tube and initiates l-f timing by triggering tube 11. Tube 4 also prevents weld-interval timer-tube 6 from trailing tube 5 in case the weld-interval R-C timing circuit times out during the l-f cycle.

Because of the inherent 3-cycle delay of one tube trailing another, there is one-cycle inherent delay between tubes 4 and 12. For an 8-4/7 cycle welding frequency having 3 cycles of 60-eps pulse time, three times around on the three phases, the inherent one-cycle delay between tubes 4 and 12 is supplemented with a two-cycle R-C delay designated as pulse time No. 1. This allows the +A exciter tube to

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**FIG. 8**—Basic timing circuit used in low-frequency timing section
operate three times in succession, as shown by the waveform sketch Fig. 9C. Tube 12 then conducts and stops the +A exciter tube from trailing tube 4. This operation, including inversion operation which originates in the exciter unit, terminates the positive l-f half cycle of welding current.

For minimum permissible interpulse time of ½ cycle (60 cps) between l-f half cycles, there must be one full 60-cps interval between conductions of the +A and −A exciter tubes. The −A exciter tube must be turned on for the pulse time of 3 cycles of 60 cps. The voltage patterns for three successive conductions of the +A exciter tube and three successive conductions of the −A exciter tube must be antipolar. Tube 13 is allowed to trail tube 12 without time delay and the −A exciter tube trails tube 13 to start the negative l-f half cycle of welding current.

A one-cycle R-C delay between tubes 13 and 14 allows the −A exciter tube to conduct once before tube 14 conducts, and this exciter tube trails tube 13 a second time while tube 14 conducts. Tube 15 trails tube 14 without time delay. Tube 15, by energizing transformer T₂, stops tubes 4, 12 and 14 from trailing their respective leading tubes but the −A exciter tube trails tube 13 for the third time (three times around on three-phase operation).

Tubes 11, 13 and 15 that were trailing tubes 4, 12 and 14 are stopped. None of these tubes conduct during the next cycle (of 60 cps) after tube 15 operates. The weld-interval initiating tube 5 in the sequence control continues to operate. Tube 4, stopped by tube 15, gives tube 6 a chance to operate if the weld-interval R-C timing circuit has timed out. This completes one cycle of l-f operation.

If the weld interval has not elapsed to limit the l-f welding current to one l-f cycle, tube 6 will not conduct to keep transformer T₂ energized after it has been energized for one-half cycle by tube 15. Since tube 6 does not respond, tube 4 starts conducting again and reinitiates the next l-f cycle of welding current and tube 4 again blocks tube 6 from operating during the next l-f cycle.

When the weld-interval R-C circuit does time out, tube 4 holds off the operation of tube 6 until the l-f cycle is completed. When the weld interval has elapsed during the l-f cycle and when tube 15 stops tube 4 at the end of the l-f cycle, weld-interval timer-tube 6 is released to keep T₂ energized. The anode of tube 6, which is connected to the anode of tube 15, prevents tube 4 from reinitiating any more l-f cycles of welding current. Therefore the welding transformer is energized for full l-f cycles. Tube 16 is required to terminate the negative l-f half cycle when the interpulse time exceeds 14 cycles.

Tube 6 also initiates the hold-time during which the welder electrodes remain closed with full pressure on the work while the weld is cooling. From the foregoing description of the l-f timing circuit operations, one may visualize the general scheme of providing the sequence control functions of squeeze, weld interval, hold and off periods by means of a group of similar interlocked component timing circuits.

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Tape reader, with lamp housing lifted to show feed mechanism

Intermittent-Feed Computer Tape Reader

Five-phototube input system for digital computers reads teleprinter punched tape at speeds up to 200 five-hole characters per second. Intermittent tape drive uses clutch and brake solenoids fed by signal derived from sixth phototube located under tape sprocket holes.

While the storage and arithmetic units of a digital computer are extremely rapid in operation, a limit to the overall speed of computation is often set by the comparatively slow speed of the input-output system. With this point in mind, the tape reader described has been developed for use in the input system of the Ferranti Digital Computer (Mark I), the first of which was installed in the University of Manchester, Manchester, England, and the second in the University of Toronto.

Five-unit teleprinter tape is used and the tape reader is capable of operation at speeds up to 200 characters per second. One character is represented by a single row of holes across the tape. Provision is made for the tape to be stopped at each character and, after reading has been completed, to be moved forward to bring the next character into place.

The present tape reader adopts a friction drive arrangement in which the tape is driven by means of a drum held firmly against the tape by a pair of spring-loaded rollers. Wear on the tape through the use of such a drive is negligible. A tape which becomes twisted or is otherwise prevented from passing through the tape reader in a normal manner is able to slip in the mechanism without being torn. A loop of tape has been passed through the tape reader 10,000 times without signs of wear. Splicing of the tape is not a critical operation. A photoelectric reading system has been adopted, which obviates the necessity for metallic contacts and uses the sprocket holes in the tape in a rapid and efficient tape-positioning arrangement.

The general arrangement of the drive mechanism is indicated in Fig. 1. A differential gear is driven by a continuously running induction motor. To one of the output shafts of the gear is attached the
tape-feed drum and a drum known as the brake drum. To the second output shaft of the gear is connected another drum known as the clutch drum. With this arrangement, the sum of the velocities of the two output shafts is equal in value to twice the velocity of the input shaft. If one of the output shafts is held stationary, the other will achieve a velocity equal to twice that of the input shaft. Rotation of the tape-feed drum is controlled by electromagnetically operated brakes on the brake drum and clutch drum.

The braking mechanism is illustrated in Fig. 2. In the off position, the brake shoes are held lightly against the drum and only a slight movement of the armatures is required for braking. The greater part of the force produced by energizing the electromagnets is thus utilized in forcing the brake shoes against the drum. Since each armature is held close to the core of its electromagnet, a small air gap is possible, giving a high gap flux and economy in magnetizing current.

**Brake Design**

The air gap is of the order of 0.002 inch in the brake drum system and 0.01 inch in the clutch drum. The armatures are made of soft iron and are designed to have a rigid construction with low inertia. The core is built of Radiomagnetic laminations. The coils have an inductance of 2½ henrys and a resistance of 80 ohms.

A pull of $\frac{3}{4}$ lb is exerted by each electromagnet on its armature and the measured braking force at each brake shoe is 11 lb; with a coefficient of friction estimated at 0.4 this results in an effective braking force on each drum of 1.2 lb and a braking torque of 0.48 lb-in. The drums are constructed of stainless steel since a plated surface would, when worn, tend to produce a non-uniform surface. A resin-bonded fabric (Tufnol) has been used for the brake shoes and has shown no sign of wear after many months of service.

The two braking systems are controlled by a bistable triggered circuit, the state of which decides whether the brake or the clutch will be operated upon. The inertia of the moving parts has been kept as low as possible in order that rapid and efficient braking and acceleration of the tape can be obtained. The inertia of the two drums and the associated moving parts is calculated to be 0.015 lb-in.$^2$. Applica-
tion of braking torque stops the drum in 0.004 sec. This represents a displacement of 0.04 in. of the tape. Due to delay in operation of the electromagnet, a further 0.005 in. displacement must be taken into account. If braking is commenced when a character is just entering the reading position, the tape will be stopped while the character is located centrally in the reading position. From a stationary position, full speed may be reached and the next character made available for reading within six milliseconds.

**Tape-Feed Control System**

One system of tape feed which has been devised is indicated in Fig. 3. Sprocket holes in the tape are used to control the braking system. Entry of a character into the reading position over the masking plate holes initiates a tape-locating signal which operates the brake drum system. The signal is applied to a squaring circuit and thence to a cathode follower whose output is connected to one input of the triggered circuit. By this means, the locating signal produces a trigger pulse at A which applies the appropriate output of the triggered circuit to the brake-drum electromagnet circuits.

A read signal will be given to the external circuits only when two negative-going signals are applied simultaneously to the inputs of the coincidence gate at P and Q. If for any particular character the tape does not stop in the correct position, the signal at P will no longer be present and, although the triggered circuit will be set, no read signal will be transmitted. When reading is completed, a signal is applied to B, resetting the triggered circuit and causing the clutch mechanism to operate and the tape to move forward.

It is essential that the buildup of the current in the electromagnet coils be as rapid as possible. To ensure this, a large voltage must be applied initially across the coils. Referring to Fig. 4, the grid of V1 has a large negative potential in the absence of a signal from the triggered circuit. When a braking signal is applied, the grid potential of V1 quickly becomes zero. This action will result in a rapid fall of anode potential and, since point P is initially at plate supply potential, there is applied across the coil a sudden large change of voltage. Due to the presence of C1, the voltage across the coil tends to be maintained and there is a consequent rapid rate of increase of current in the coil. The time taken for the current to build up to its maximum value is 0.5 millisecond. When V1 becomes cut off again, in the absence of a signal, C1 limits the rate of decay of current through the coil and hence limits the back emf.

**Photoelectric Circuits**

Six phototubes are provided in the tape reader, each being connected to a cathode follower. Five of these phototubes are associated with the positions of the five digits of a character on the tape. The sixth or reader location phototube is associated with the sprocket holes and is used to control the movement of the tape.

A typical phototube circuit is shown in Fig. 5 along with the optical system, which uses a single 36-watt prefocussed lamp. By means of the pinhole projection principle, images of the cylindrical (coiled) filament of the lamp are formed by the holes in the tape so as to cover the entire area of the appropriate phototube cathodes.

Blue-sensitive phototubes have been found most suitable for this tape reader. With tubes having a sensitivity of 45 μA per lumen, a signal change of at least 12 volts is available due to the presence of light through a hole.

The tape-reader unit comprises the tape-feed mechanism, the optical projection system and the phototube circuits together with their cathode followers. Provision is made for viewing the tape in the reading position. The tape may be left stationary in the tape reader for long periods without deterioration by heat from the lamp.

Although the tape reader was designed for a specific purpose, it should be readily adaptable for many other applications of a similar nature and in telecommunications. A model of this tape reader has been developed to accommodate either 5-unit or 7-unit teleprinter tape.

The author wishes to express his thanks to the following members of the Computer Group at Ferranti Ltd.: B. W. Pollard for his guidance and helpful suggestions, G. Fox for his help in the production design of the tape reader and D. F. Chatt for his assistance in the preparation of this article.
Ultrasonic Recorder

Torpedo-borne recorder continuously measures running depth by transit time of ultrasonic pulse reflected from ocean's surface. Lock-out bars false echoes arising from scattering. Output level holds when echoes are lost due to roll and pitch.

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Instantaneous running-depth of a torpedo may be found by recording transit time of ultrasonic pulses reflected by the air-water interface at the surface of the ocean. An ultrasonic transmitter and receiver with necessary timing circuits is mounted in the exercise head of the torpedo as shown in Fig. 1. An output voltage, proportional to the torpedo's running depth is fed to an external recording device located immediately forward of the battery compartment. The exercise head is a dummy head with which the torpedo is fitted for testing and practice as contrasted to the war head that pulls the torpedo's explosive Sunday punch.

The photographs show the acoustic transducer mounted on the torpedo's dorsal surface and the ultrasonic-recorder chassis withdrawn from its cylindrical housing. The recorder operates on a carrier frequency of 400 kc.

Reflection Problems

Air-water boundary, used as a reflector, is neither of regular shape nor unchanging with time. Variability of surface waves, travel of the torpedo, and large-scale temperature stratifications cause variations in pulse transit time. This appears as jitter in the return pulse position and an apparent fluctuation in depth.

Return-pulse amplitude fluctuation is also troublesome. This is caused by factors having to do with the propagation of sound in water and factors characterizing reflective properties of the air-water interface. The fluctuation in intensity, at a given point, is due to the reinforcement or cancellation of many signals arriving from different reflectors.

The effects of wave troughs upon echoes can be compared to dispersion of light by a convex mirror, while wave peaks act as a concave mirror. The net effect causes loss of echo. Other factors that affect

How Deep Does A Torpedo Run?

Study of torpedo performance on a test range requires knowledge of the torpedo's instantaneous depth throughout its run. The hydrostat, generally used for torpedo-depth measurement, operates much like an aneroid altimeter and responds only to average change of a rapid fluctuation.

The depth sounder responds to rapid fluctuations but indicates depth with respect to the ocean floor, a poor reference surface for torpedo-depth measurement. In deep water, the ocean floor may be out of range of a sounder suitable for installation in a torpedo.

The ocean's surface has been chosen as reference plane for torpedo-depth measurement despite surface irregularities that produce an inherently poor reflecting surface. Naval Ordnance Laboratory has developed an ultrasonic echo-ranging instrument that uses this air-water interface as a reflector.

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seriously return echo detection are noise properties of vehicle, pitch and roll of vehicle and directivity of the transducer.

Figure 2 is a block diagram of the depth recorder. Pulse width and repetition interval are set by a highly unbalanced free-running multivibrator. The ratio of repetition interval to pulse width is 50 to 1. Absolute repetition time determines the maximum depth that can be recorded while pulse width determines both minimum recordable depth and the required amplifier bandwidth for most consistent echo detection.

The multivibrator provides three separate signals for recorder actuation. One signal turns on the gated oscillator. Coincident with this, a second signal turns off the tuned r-f amplifier and blocks the thyatron shield grid. The third signal, corresponding to the leading edge of the other pulses, sets the Eccles-Jordan trigger circuit in the on state.

Transmitter

The r-f pulse generated by the gated oscillator excites a tuned power amplifier, which in turn drives the acoustic transducer. The output of the power amplifier is also applied, through a diode limiter, to the input of the tuned r-f amplifiers. However the limiting action of the diodes and the off gate applied to the second stage of the tuned amplifier prevent signals from appearing at the amplifier output during the transmit interval.

Receiver

After an unlocking interval, which follows the transmitted pulse, the tuned amplifiers become active and await the echo signal from the transducer. Unlocking time is controlled by the time constant R,C, (Fig. 3). After an interval corresponding to the time required for the pulse to travel to the air-water surface and return, an echo signal will appear. Since the signal is, in general, smaller in amplitude than the transmitted pulse, limiting by the diodes is practically nonexistent. The echo is amplified and the negative envelope obtained by a germanium-diode detector. The pulse is further amplified and inverted in a triode amplifier. Figure 4 illustrates waveforms present at various points in the circuit.

Because of the irregular char-

FIG. 2—Depth recorder employs ultrasonic transceiver. Variable-width pulse from Eccles-Jordan measures transit time of ultrasonic pulse reflected at air-water interface
acter of the air-water interface, there are many points on the surface that reflect signals and no single echo signal exists. The main or shortest-path echo is followed by a series of irregular echoes of diminishing amplitude as shown in the photograph. To prevent these false echoes from activating the recorder circuits a lock-out device is employed following the pulse amplifier.

The leading edge of the shortest-path echo fires a thyratron that immediately prevents any false echoes from effecting the timing circuits for a period determined by the time constant $R_C$, in Fig. 3. This time constant is normally adjusted for 20 percent of the repetition interval since experience has shown that any false echoes appearing after that time are of such small amplitude as to cause no malfunction of the recorder.

The trigger spike from the thyratron circuit returns the Eccles-Jordan circuit to the off state. Thus a square wave of constant height whose width is proportional to depth is generated. An increase in depth results in a square wave of increasing width. The Eccles-Jordan is always in the correct state at the start of each pulse-repetition interval even if no echoes were received during the previous interval.

**Integrated Output**

To utilize the intelligence in the square wave it must be converted into depth indication that can be recorded for later analysis. One

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**FIG. 4—Waveforms illustrate how multivibrator imitates recorder operation. Exponential decay of pulse provides 20-millisecond lock-out of spurious echoes.**
The method is to integrate the square wave to produce a d-c potential proportional to depth. This signal could then actuate a conventional strip-chart recorder. However, if loss of echo occurs, there will be a sudden increase in apparent depth. However, if it is known that the torpedo cannot possibly change depth as suddenly as might be indicated, and if loss of echo occurs infrequently, this error can be resolved.

Another method that more clearly indicates malfunction of the recorder is to record the square wave on moving film. Any loss of echo is indicated immediately by a sudden widening of the square wave that returns to normal width within the next frame. This system is unsatisfactory from the standpoint of record analysis in that it requires point-by-point scaling of depth indications on a considerable quantity of film.

Boxcar Demodulator

A method that shows promise of accurate depth recording utilizes a modified boxcar demodulator. Figure 5 shows the operation of this circuit. A capacitor, $C_1$, is charged linearly in each pulse-repetition interval from a potential $V = V_o$ at $t_o$ to $V$ at time $t$, where it is clamped until the end of the interval. Time $t - t_o$ corresponds to pulse transit time. At the end of the pulse-repetition interval, potential $V$ is transferred to another capacitor, $C_2$, whose potential remains clamped throughout the next repetition interval while $C_1$ is returned to $V_o$. In the event that $C_1$ charges to $V$ (maximum value of $V$) indicating loss of echo, $C_2$ maintains the potential determined during the preceding interval, and $C_1$ is again discharged to $V_o$.

Extrapolation is effected over a repetition interval for which no new information is available. This type of demodulation also provides filter action that essentially suppresses the pulse-repetition frequency and harmonics.

Demodulator requirements could be simplified if loss of echo could be completely eliminated. This is not possible, although, the probability of echo detection would be much enhanced by reducing the threshold setting of the thyatron. In this way more complete phase cancellation of echoes from two or more reflecting points would be required if malfunction of the recorder were to occur. However, there is a limit to sensitivity increase that can be tolerated. This limit is set by the noise properties of the vehicle in which the recorder is carried.

Some increase in sensitivity can be accomplished by narrowing the bandwidth of the tuned amplifiers thereby effectively filtering out a greater number of noise-frequency components. However, the limit to the amount of bandwidth reduction that can be tolerated depends upon pulse rise time. Too narrow a bandwidth results in an excessive rise time and decreases accuracy of transit-time measurement. A compromise must therefore be reached between the noise rejection and sensitivity.

Transducer Directivity

If the directivity pattern of the transducer employed is too narrow, loss of echo may result from the absence of a wave-surface normal. This is shown in Fig. 5. Torpedo roll and pitch, shallowest depth of operation and, to some extent, maximum length and height of surface waves encountered are factors determining the required minimum transducer angular coverage. For depth determination below five feet in water having surface waves 10 feet long and 1.39 feet high, a total transducer angle of 100 deg appears adequate. Because of reduced transducer sensitivity near the outer fringes of the radiation pattern, a transducer having a 150 deg radiation pattern is employed.
Either point-contact or junction transistors can be tested and new power transistors under development will be handled. Electrode and transfer characteristics, automatically displayed on oscilloscope, may be photographed to provide circuit-design data

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Transistor characteristics are displayed automatically on a cathode-ray oscilloscope by the transistor-curve tracer to be described. The instrument accepts either point-contact or junction transistors. Both sweep and bias sources are designed to accommodate transistors of greater power-handling ability than those currently available although data gathering in the microwatt range was also a design objective.

Nine current ranges are available with full-scale deflections from 0.1 milliampere to one ampere. Full-scale sweep voltage ranges from 0.1 to 300 volts are provided with a 1,000-volt sweep range available at reduced current. The 1,000-volt sweep is also useful for determining peak back voltage on rectifiers.

Constant-current bias is provided in steps from 0.1 microampere to one ampere and constant-voltage bias is provided in steps from 0.1 millivolt to 10 volts.

The photograph shows a front-panel view of the transistor-curve tracer, which consists of four separate chassis: oscilloscope, sweep chassis, bias and d-c supplies. The transistor is connected to the receptacles at the right of the sweep chassis and its characteristics displayed on the oscilloscope face of...
Curves

the chassis below.

Either all four quadrants of a volt-ampere coordinate system can be displayed simultaneously or the entire scope face may be used to display one quadrant. Each of eleven curves in a family is automatically traced in sequence as the running parameter of the system is stepped. The long-persistence crt screen gives continuous presentation suitable for photographing and the coordinate axes are displayed with superimposed calibrations.

Transistor Characteristics

Some transistor characteristic curves obtained by photographing the scope illustrate the versatility of the curve tracer. Figure 1A is a family of curves showing collector characteristics of a point-contact transistor operated with common-base connection shown in Fig. 1B. A similar family of curves for a junction transistor is shown in Fig. 1C. In both cases, the emitter current, \( I_e \), is varied in discrete steps to give the family of curves. Bias range for the point-contact transistor is one-third that of the junction transistor. The junction transistor's unity current gain may be contrasted with the greater current gain of the point-contact transistor.

To obtain maximum use of the scope face only one quadrant is displayed. For convenient comparison with other characteristics, the curves are shown in the first quadrant although both abcissa and ordinate are negative as indicated.

Figure 2 shows some characteristics of junction transistors with common emitter connection shown in Fig. 2B. Collector characteristics, Fig. 2A and C, are obtained as the base current is stepped from zero to \(-30\) \(\mu A\). Figure 2A shows one quadrant only while Fig. 2C
is a four-quadrant display.

Transfer characteristics of the junction transistor are shown in Fig. 2D where collector current is plotted against base voltage as emitter current is varied from zero to −30 microamperes in three-microamperic steps.

Requirements
A transistor is a three-terminal device whose behavior may be described completely by two equations relating its electrode voltages and currents. In functional notation, \( V_1 = R_1 (I_1, I_2) \) and \( V_2 = R_2 (I_1, I_2) \) where voltages and currents are defined in Figs. 1B and 2B. Since the two functions \( R_1 \) and \( R_2 \) are not readily represented analytically over extended ranges of their argument, it is desirable to display them graphically. The information contained in these graphs can then be applied to design problems in which the transistor is a circuit element.

This information may be displayed with a minimum number of curves by plotting feedback transfer characteristic \((I_1 vs \ V_2, \ \ \ \ \text{with} \ 1_i \text{as a running parameter})\), and output-electrode characteristic \((I_2 vs \ V_2, \ \ \ \ \text{with} \ 1_i \text{as a running parameter})\).

The first set can be used to determine input power requirements and feedback effects. The second set is useful in deriving output characteristics such as power delivered to a load, distortion, and efficiency. The slopes of these curves, as well as of corresponding curves with \( 1_i \) as the parameter, also furnish information useful in analyzing small-signal, low-frequency behavior of a transistor. For point-contact transistors, it is convenient to use the base as the common connection and let 1 and 2 stand for emitter and collector (Fig. 1B). For simple junction transistors, base and collector are often preferred as 1 and 2, with the common (Fig. 2B) emitter circuit.

Visual representation of the functions on a d-c oscilloscope may be obtained by biasing one electrode with constant current and sweeping the other with alternating voltage. If, after each trace, the bias is stepped to a new value, an entire family of characteristics may be displayed sequentially. If the oscilloscope tube has long persistence, the display will appear continuous. The equipment to be described consists of multirange sweeping and biasing circuits with provisions for single and multiple displays.

Other families of characteristics may also be desired. For example, \( I_2 = G_1 (V_2, V_3) \) and \( I_1 = G_2 (V_2, V_3) \) are equivalent to the equations previously given and sometimes more useful. Their representation requires constant-voltage bias which is also provided.

Sweep Circuits
A block diagram of the curve tracer is shown in Fig. 3. There is a sweep power supply (Fig. 4) consisting of a variable-output transformer and one of three additional transformers, which provide a continuous range of alternating sweep voltages from 0 to 1,000 volts. The maximum current available is one ampere at zero to nine volts or zero to 300 volts and 0.1 ampere at zero to 1,000 volts. A rectifier is included in series with the transformers to permit unidirectional sweep. Switch S selects either an electrode or a transfer characteristic for display.

Positive-Current Bias
The transistor under test can be supplied with constant-current bias from a current-regulated source. Figure 5A shows a simplified schematic of the supply connected to deliver positive current with respect to ground to the load \( R_n \). To keep one side of \( R_n \) at ground, the rest of the circuit must have a different common return point as shown. The circuit is almost the same as a conventional degenerative voltage regulator.

However, to maintain constant current in the load \( R_n \), the load is connected in series with the feedback resistor \( R_f \), rather than in par-
parallel with it. A reference voltage, $V_n$, is applied to the grid of $V_i$, while a voltage proportional to the load current $I$, is applied to the grid of $V_p$. The output at the plate of $V_i$ is proportional to $V_p - I$, $R_o$ and appears at the grid of $V_i$ after amplification by the d-c amplifier. The impedance of $V_i$ thus changes until load current, supplied by a separate, unregulated supply, assumes a value very nearly equal to $V_p/R_o$. The differential output resistance of the regulator is approximately

$$r_{oa} = r_{ps} + \frac{1}{2} \left( \frac{\mu_i}{A} + r_{ps} \right)$$

where: $\mu_i$, amplification factor of $V_i$ or $V_n$, $r_{ps}$ = plate resistance of $V_i$, $r_{ps}$, $\mu_i$, amplification factor of $V_n$, $r_{ps}$ = plate resistance of $V_n$, $A$ = gain of the d-c amplifier and $R_o$, = load resistance for $V_p$.

The extremely high output impedance results in almost constant output current over a large range of load resistance $R_o$. Full-scale current ranges of 0.1, 0.3, 1, 3, 10, 30, 100, 300 and 1,000 milliamperes are provided by switching $R_i$, and $V_p$. Within any one range, the current is set by varying $V_p$, which has a maximum value of 10 volts. Thus, the voltage fed back to $V_i$ and the grid bias required for $V_i$ can be kept within reasonable limits. The voltage required across the load $R_o$ at any current $I$, depends on $R_o$. In practice, this output voltage is limited to that which corresponds to the intersection of the load line ($R_i + R_o$) and the zero grid-bias line on the plate characteristic of $V_p$. Increasing either $I$, or $R_o$, beyond these values would require a positive grid-bias on $V_i$ which is not a suitable operating condition. About 50 volts are available on all ranges. Automatic over-voltage protection is provided since the regulator saturates at higher voltages under conditions of high $I$, and $R_o$.

**Negative-Current Bias**

Figure 3 shows that the circuit has been arranged to permit the transistor to have one terminal connected to oscilloscope ground. It is therefore necessary that the feedback voltage across $R_i$ be derived with respect to a common point other than ground. This common point must be maintained throughout the d-c amplifier and the reference stage. Capacitance $C_i$ (shown dotted in Fig. 5) between common and ground, together with $R_i$ and $R_o$, form a closed loop around which objectionable hum currents may be induced. As long as these currents pass through both $R_i$ and $R_o$, they furnish an error signal to the regulator and are, for the most part, suppressed. However, the regulator is ineffective in reducing these currents if either ground or common is placed at the junction of $R_i$ and $R_o$. These considerations lead to the circuit of Fig. 5B when negative bias currents are required. With suitable switching and inversion of the reference voltage $V_n$, the circuit operation is equivalent to that giving positive bias current. Zero output current is obtained when $V_i$ is biased to cutoff. However, with the positive output connection of Fig. 5A, hum currents may still flow through $R_i$ and $R_o$ while $V_p$, remains inactive. By bleeding current through $V_p$ by means of $V_n$ and $R_o$, conduction is maintained even at zero load-current in $R_i$ and $R_o$. Hum currents are then suppressed in the usual manner. A similar bleeder is desirable for the negative output connection as shown in Fig. 5B, to help maintain linearity near zero load current conditions.

To supply constant-voltage bias for a transistor imposes problems...
not normally encountered in electronic voltage regulator design. For example, the emitter input impedance of a transistor may be tens of ohms and the maximum voltage required less than one volt.

**Constant-Voltage Bias**

The simplest way to provide regulated voltage to such a load is to take the regulated current from the bias supply described above and feed it into a fixed low resistance shunting the load. Thus, a one-ohm resistor adds voltage ranges from one millivolt to one volt at one-ohm internal impedance. To provide a 10-volt range, a 10-ohm resistor is also made available. Higher voltage ranges are not provided and would best be obtained directly from a conventional voltage regulator. An adjustable offset voltage, derived from a battery, can be added to the regulated bias voltage and is useful for automatic operation.

**Microampere Bias Supply**

Since junction transistors are commonly operated in a base input circuit, it is desirable to take characteristic curves with base current as parameter. With transistors having a low leakage current and current gain near unity, the total bias range of interest may be only a few microamperes. The current regulator already described cannot readily be arranged to provide such low currents because conventional tubes used for $V_s$ in Fig. 5 are not suited to the task. However, for these low currents, the direct method of using a voltage in series with a high resistance is especially suitable. The voltage is obtained as previously described. Ten volts are used in series with resistors varying from 10 megohms to 10,000 ohms to give microampere ranges from one to 1,000. An adjustable offset current is obtained here by adding a battery-derived voltage to that supplied by the electronic regulator.

**Step Generator**

A family of curves may be displayed sequentially if the bias current is stepped after each sweeping trace. The current steps are obtained by causing the voltage $V_s$ to have a staircase waveform. The circuit for providing such a staircase is shown in Fig. 6. The charging tube $V_s$ is normally biased below cutoff. Sharp pulses at the input, derived from alternate half cycles of line voltage, drive the grid slightly positive and cause a charge to flow into the capacitance, $C$. An analysis of circuit operation shows that the necessary conditions for equal steps are readily met.

The staircase is applied to the grid of the discharge tube, $V_s$, a modified blocking oscillator biased below cutoff. The steps continue to build up until the blocking oscillator fires. The resulting grid current then discharges $C$ and allows the cycle to repeat.

The electrode connections used in $V_s$ are unconventional, but were determined empirically for best performance.

Transformers with an electro-
static shield are used to avoid spurious sweep voltages at low-level operation. Grounds to each chassis are made at a single point. The chassis are strapped together and to a good ground. Use of two phases of a three-phase distribution system simplifies phase-shifting in the blanking circuit. Precision resistors are used at all points that determine calibration of the pattern.

**Construction Details**

An interlock box fits over the test terminals to protect the transistor and the operator. This box must be in place to energize the 1-kv sweep transformer. If the box is removed, a relay disconnects and shorts the bias supply. If this were not done, the bias source would increase to its maximum voltage under the open circuit condition before a transistor is plugged in. On inserting a transistor with the interlock operating, the single characteristic for zero bias current will be displayed. By closing a spring-return switch, the complete family of curves may be viewed without replacing the interlock box. The transistor is protected from transients when switches are set to different ranges or polarities by the use of short-circuiting-type switches.

The oscilloscope has been provided with an illuminated scale to permit photographing calibrated axes along with the characteristic curves in a single exposure. An engraved transparent plastic disk is fitted under the camera-mounting bezel and illuminated at its edges with small lamps. Intensity of illumination is set by a control on the oscilloscope panel.

As supplied, the X-amplifier of the oscilloscope has about one-tenth the gain of the Y-amplifier. To decrease the voltage drop required on the current sampling resistor R, (Fig. 3), more X-amplifier gain is desirable for the current display. The X-amplifier of the oscilloscope is, therefore, replaced with one equivalent to the Y-amplifier. A new centering control for this amplifier has been added to the oscilloscope panel; the X-amplifier gain control was not brought out to the front panel since it is reset only during calibration. The decade V-attenuator of the oscilloscope, relabeled V-attenuator, is used in setting the voltage-scale calibration and has been supplemented with a three-times attenuator (Fig. 4).

**Operation**

The family of characteristics to be viewed is selected by choosing the terminal to be swept and utilized for the current deflection signal (terminal 1 or 2) and by choosing independently whether the same terminal is used for the voltage deflection (electrode characteristic) or the other one (transfer characteristic). Bias is automatically supplied to the unswept terminal.

The circuit can be adjusted for different numbers of bias steps, but ten steps plus zero are preferred for a simple relation between the maximum and the incremental values of bias. Manual control of the bias supplied by the current regulator is also provided. The panel meter then reads the bias current. Under automatic operation, this meter reads the average current, normally the value of the middle step, and can be used to monitor the stepping circuit. Meter damping has been added externally.

Accuracy is limited in practice by the linearity of the step generator. The steps can be checked on the oscilloscope and adjusted for d-c level, amplitude, and linearity. Stabilized power supplies with good long-time behavior are used to maintain adjustment of the step generator.

Studies of collector breakdown voltage and the influence of bias conditions are implemented by the curve tracer. In the collector family (Fig. 7A), breakdown voltages of the order of 80 volts are obtained when constant-current emitter bias is used. When the emitter is common and constant-current bias is applied to the base, the breakdown voltage is reduced to about 50 volts as shown in Fig. 7B.

Characteristics other than collector families are readily obtained. Figure 8 shows an emitter family with collector voltage as the parameter. All the curves are virtually coincident and appear as a single broad line. To obtain these curves, terminal 1 was swept rather than terminal 2.
**Frequency Discriminator**

**Discrimination** of narrow-band frequency modulation provides greater output when accomplished by a modified Foster-Seeley circuit than when a standard discriminator is used. The circuit, shown in Figure 1, is identical with the conventional circuit except for two component values.

Because of limited linearity, the circuit is not intended as a substitute for present circuits in general f-m work but for reception of frequency-shift-keyed teleprinter signals and narrow-band f-m voice communication. It has been possible to get solid copy on fsk teleprinter signals using only 150 cps shift. When measured at 425 cps shift, output of the modified discriminator exceeded by 24 times that of the original circuit.

**Foster-Seeley Circuit**

Figures 2A, 2B and 2C illustrate vector voltages within the Foster-Seeley circuit for conditions at center, below-center, and above-center frequency respectively. Figures 2D, 2E and 2F show resultant rectified voltages and total output voltage under the same conditions.

At center frequency, primary and secondary of $T_1$ are both tuned to resonance. The voltage appearing across the secondary is 90 degrees out of phase with the primary voltage. The voltage across $L$ is almost in phase with the primary voltage.

As the frequency shifts in either direction, the phase of the secondary voltage with respect to the primary voltage deviates from 90 degrees, either increasing or decreasing depending upon whether the frequency shifts upwards or downwards.

The voltage across $L$ remains almost in phase with $E_p$, regardless of applied frequency. Thus, the only vector that changes with respect to $E_p$ is $E_z$.

In the modified circuit, the values of $L$ and $C$ are changed such that their resonant frequency will be slightly above that of the primary of $T_1$, instead of much below as in the Foster-Seeley design. The LC combination is tuned above center frequency an amount that will cause a difference of phase between $E_p$ and $E_z$ of 45 degrees.

**Center Frequency**

To get zero output at center frequency, the secondary of $T_1$ must be tuned below center frequency enough to allow 45 degrees phase difference between $E_p$ and $E_z$. This results in 90-deg phase shift between $E_p$ and $E_z$, the same as at center frequency in the unmodified circuit. The vectors are shown in Fig. 3A, 3B and 3C. The output voltages are shown in Fig. 3D, 3E and 3F.

**Variable Output**

As the applied frequency changes, the phase relations of $E_p$ to $E_z$ and $E_p$ to $E_z$ change equal amounts in opposite directions. Vectors $E_p$ and $E_z$ both move in opposite directions as the frequency is varied, while in the original circuit, only $E_z$ moves.

For a given frequency shift, output from the modified circuit is about twice that of the Foster-Seeley discriminator. The output is a linear function of frequency for about one percent of center frequency. When used at an i-f of 456

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**FIG. 1**—Conventional discriminator is modified for narrow-band f-m by changing values of $L$ and $C$ to resonate above $T_1$ primary

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www.americanradiohistory.com
Modified discriminator provides increased output for narrow-band f-m and frequency-shift-keyed teleprinter signals. Schematically identical with Foster-Seeley design, circuit requires changes in values of two components and special tuning procedure.

By E. C. MILLER
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kc, it will work satisfactorily for a maximum shift of 4 kc. This is adequate for voice communication and more than enough for fsk teleprinter.

Tuning Procedure
It is not necessary that the phase shift of LC and T, both equal exactly 45 deg at center frequency, if the sum of their phase shifts equals 90 deg. This simplifies alignment and adjustment can be accomplished as follows:

Tune C1 to resonance at center frequency.
Tune C2 to resonance about one or two kilocycles below center frequency.
This can be done by setting C at minimum capacitance, applying the necessary signal to the input of the preceding i-f amplifier and measuring the dc voltage at the output of the discriminator while tuning C1 for maximum output voltage.
Finally, set the signal generator to center frequency, and adjust C for zero voltage at the discriminator output.
The circuit is now adjusted for phone work.
If a strong fsk signal is available, it should be tuned in and with the vertical plates of a scope connected to the discriminator output, C and C2 may be adjusted simultaneously until maximum deflection is obtained.

FIG. 2—Vector voltages, resultant rectified voltages and output voltages for standard discriminator

FIG. 3—Voltages for modified Foster-Seeley circuit show increased output for slight frequency deviation
Practical utility of the traveling-wave tube as an amplifier above 3,000 mc was questioned by some engineers following announcement in June 1946 of its development. Recent performance data of operational significance show that the traveling-wave tube is not only here to stay but is at present a factor of consequence in microwave systems design. Since the use of traveling-wave tubes can be divided naturally into considerations of low-level and high-level amplifiers, a description will first be given of research work leading to a very low-noise, low-voltage, input-stage amplifier at 3,000 mc. Comparisons are made with other types of microwave amplifiers. Next, operating data are given for low-voltage, medium-power amplifiers with fairly good efficiencies, intended for use in commercial microwave relaying at 2,000 mc. Mention will be made of narrow-band types with filter-helix circuits, and of packaged designs.

Low-Noise Amplifier

In general, work in this field has been conditioned by the probable requirements of communications service. In the case of the input-stage amplifier, consideration must be given to the fact that the type 416A triode is available, which gives about 10-db gain at microwaves with noise factors in the region of 14 db at 4,000 mc. Crystal mixers are in use that give noise factors of about 10 db. To compete fully, the twt must not only give greater bandwidth and gain, but also comparable noise factor, since this receiver characteristic greatly influences transmitter design.

For some time, attempts to reduce the noise factor of the helix-type twt below about 15 db met with no success. However, an extended series of analyses of shot noise in long electron beams indicated that the noise originating from a space-charge-limited cathode, had the aspect of a standing wave in space, with alternate minima and maxima of shot noise recurring axially along the beam. Analysis and experiments showed that if the helix in a conventional twt amplifier were so placed that the beam began to interact with the applied signal near a noise minimum, the noise factor of the tube would be improved. Furthermore, optimum electrode arrangements and voltages for guns were found that produce a low-noise beam.

Tube Constructions

Two typical low-noise traveling-wave tube constructions are shown in Fig. 1 and 2. The new design of Fig. 2 is a shortened version of the tube design of Fig. 1. Its cross-section is shown in Fig. 3. The input coupling antenna and sleeve are folded back and the collector is used as the output coupling sleeve to reduce the tube length to a minimum.

Table I indicates relative performance data for the twt and competing types in the 3,000-to-4,000-mc range. It is noteworthy that the operating voltage of the twt has been brought down to a low level strongly recommended by systems engineers in the interest of economy, reliability and compactness of equipment.
Continuing research on low-noise tubes shows promise of noise factors between 8 and 9 db at 3,000 mc for wide-band amplifiers. Power amplifiers delivering several watts r-f output power at 2,000 mc will make possible improved microwave radio-relay service.

By W. J. DODDS, R. W. PETER and S. F. KAISEL*

Analytical investigation of an electron gun such as that shown in Fig. 4 with three accelerating electrodes B, C and D indicated that the first and second electrodes B and C, have to be at very low potentials, and the distance B-C has to be such that the noise current has a minimum at C, while the corresponding noise velocity fluctuations are a maximum at C as illustrated. Rapid acceleration of the beam up to helix potential at D reduces the velocity fluctuations considerably.

Experimental tests on nine tubes of the type shown in Fig. 1 with this three-electrode low-noise gun yielded consistently low-noise factors.

There are some further basic requirements that have to be met in order to keep the noise factor at a minimum: (1) The emission should be space-charge limited over the entire cathode area. (2) No beam current (much less than one percent) should be intercepted in the gun or in the beginning of the helix. (3) No input signal power should be lost in the tube input region by reflection or attenuation. (4) No oscillations of any kind should exist in the tube.

Heavy Emission

The first requirement calls for a homogeneously emitting and well-activated cathode. To obtain a smoothed beam from an oxide-

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Table I—Microwave Performance Data

<table>
<thead>
<tr>
<th>Tube type</th>
<th>Frequency in mc</th>
<th>Noise factor in db</th>
<th>Gain in db</th>
<th>Bandwidth in mc</th>
<th>Plate voltage in volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traveling-Wave Tube</td>
<td>3,000</td>
<td>8 to 9</td>
<td>~20</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>Traveling-Wave Tube</td>
<td>3,000</td>
<td>9 to 10</td>
<td>~20</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Triode (116A)</td>
<td>4,000</td>
<td>11 to 15</td>
<td>10</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>Crystal Mixer</td>
<td>4,000</td>
<td>8 to 15</td>
<td>~6 to ~8</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Table II—Traveling-Wave Tube vs Triode

<table>
<thead>
<tr>
<th>Tube type</th>
<th>Frequency in mc</th>
<th>Gain in db</th>
<th>Power output in watts</th>
<th>Efficiency in percent</th>
<th>Voltage in volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traveling-Wave Tube</td>
<td>2,000</td>
<td>10</td>
<td>1.5</td>
<td>14</td>
<td>350</td>
</tr>
<tr>
<td>Traveling-Wave Tube</td>
<td>2,000</td>
<td>16</td>
<td>5</td>
<td>16</td>
<td>600</td>
</tr>
<tr>
<td>Traveling-Wave Tube</td>
<td>2,000</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>1,000</td>
</tr>
<tr>
<td>Triode (2C39-A)</td>
<td>2,000</td>
<td>3 to 5</td>
<td>5</td>
<td>10</td>
<td>500</td>
</tr>
</tbody>
</table>
coated cathode, it was found necessary to have about ten times more emission current available than needed.

The second condition is extremely important as it can be computed that 1 percent current intercepted at the first helix turn will result in 10 db additional partition noise in the amplifier. The low-noise tubes quoted here have 0.096-in. inside-diameter helices enclosing 0.035-in. minimum diameter beams. The maximum beam diameter depends mainly upon the magnetic focusing field. This helix-to-beam-diameter ratio was found to be a good compromise between low partition noise and a large gain factor.

To meet the last two requirements a new wide-band coax-to-helix transformer of the form shown in Fig. 1 was developed. It consists of a short resonator in which the electric field is concentrated in a gap. The helix antenna is placed into this gap and excited by the field. If its radiation resistance and the helix impedance are adjusted to be equal, a wide-band match is obtained. The wide-band character of the circuit is seen from Fig. 5, which shows the cold insertion loss and the gain of a tube of the type of Fig. 2 and 3. A useful frequency bandwidth of 30 percent is obtained.

The frequency dependence of the noise factor of two low-noise tvt amplifiers with three-electrode guns is shown in Fig. 6. Both are low-voltage tubes of the type shown in Fig. 1. The grid voltages were adjusted for best noise factor at 3,000 mc. A noise factor of less than 10 db was obtained over a frequency band between 2,800 and 3,800 mc in tube 1. A noise factor of less than 9 db was measured between 2,900 and 3,100 mc in tube II. With the three-electrode low-noise gun of Fig. 6 it is possible to construct an S-band microwave amplifier with a noise factor of less than 10 db and a gain in the order of 20 db over a ±10-percent frequency band.

### Table III—Filter Helix Tubes

<table>
<thead>
<tr>
<th>Frequency in mc</th>
<th>Gain in db</th>
<th>Power output in watts</th>
<th>Efficiency in percent</th>
<th>Noise figure in db</th>
<th>Voltage in volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,975</td>
<td>10</td>
<td>3.5</td>
<td>22.5</td>
<td>10</td>
<td>1,750</td>
</tr>
<tr>
<td>3,300</td>
<td>17</td>
<td>1/3</td>
<td>15</td>
<td>17</td>
<td>1,000</td>
</tr>
<tr>
<td>6,000</td>
<td>20</td>
<td></td>
<td></td>
<td>20</td>
<td>800</td>
</tr>
<tr>
<td>3,000</td>
<td>29</td>
<td>3.5</td>
<td>32</td>
<td>3.5</td>
<td>1,500</td>
</tr>
<tr>
<td>3,000</td>
<td>35</td>
<td>1/3</td>
<td>15</td>
<td>50</td>
<td>1,000</td>
</tr>
</tbody>
</table>

above 2,000 megacycles the gain-bandwidth figure for triodes begins deteriorating. Ability of triodes to deliver sufficient power with long life and reliability is likewise compromised. The klystron suffers somewhat in that it is difficult to obtain large bandwidths consistent with adequate gain and efficiency, a major difficulty being the high voltages required.

It was felt that long life might well be achieved in the twt compared to the triode because of the fact that the cathode is practically isolated from the beam collector and less subject to contamination; the collector is not part of the r-f circuit and can be cooled more conveniently. No part of the r-f circuit need intercept direct current that would aggravate any heating due to signal currents. A typical specification for a relay system at 2,000 megacycles requires a power amplifier to deliver 5 watts or more with over 10-db gain at a maximum voltage of 750 volts.

Since the present status of high-level theory is quite unsatisfactory, a largely experimental approach was made to determine what could be done to satisfy this application. The data in Table II indicate some results obtained with experimental traveling-wave tubes as compared with triodes, in a relay system under development for use in the 1,750-to-2,250 mc band.

Figure 7 shows a traveling-wave power amplifier for operation in the vicinity of 2,000 mc, in comparison with a standard 6L6. The twt length in this case is only slightly greater than seven inches. The reduction in size from that of the usual tubes designed for this frequency and voltage has been effected by folding the input-coupling antenna back over the helix. Later designs have incorporated this fea-

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*Figure 5—Net gain and cold-insertion loss curves vary owing to imperfect match between helix and coaxial input and output lines.*

*Figure 6—Noise figures of two tubes as function of frequency.*

*Figure 7—Medium-power tube compared with type 6L6.*
ture in the coupling antennas at both ends of the helix.

**Filter-Helix Tubes**

In many applications the extreme bandwidth characteristics of the helix circuit is not utilized. This makes possible the use of a narrowband interaction circuit. Fundamentally, artificial attenuation is required in helix-type traveling-wave tubes because of the difficulty in securing reflectionless helix terminations over the very wide amplification band of this type of tube. It is generally assumed that at some point in the helix amplification band, complete reflection will occur at one or both ends.

To prevent this reflection from resulting in regenerative oscillations, attenuation is introduced that exceeds the net gain of the tube. This condition automatically prevents oscillation at any other frequency for which the terminal reflections are large. If, instead of a uniform helix, another form of interaction circuit is used for which the phase velocity of the growing wave can be made to coincide with the electron-beam velocity over a narrow frequency range only, amplification can be limited to this narrow range. One need not, then, be concerned about large terminal reflections outside this range, since those waves are not amplified.

Because, as a rule, good matching is possible within limited frequency ranges, it now becomes possible greatly to reduce the artificial attenuation. In fact, it is often possible to depend entirely upon the unavoidable losses in the transmission structure to provide the attenuation needed since perfect match over a finite frequency band can never be achieved. Because circuits of the type desired, wherein the phase velocity is fairly uniform over a narrow frequency band and changes rapidly outside this band, behave like band-pass filters, tubes employing such structures have been designated filter-type tubes. Certain of their characteristics are listed in Table III.

Uniform transmission lines, which are wide band in performance, are distinguished from iterated filter networks, which are narrow band. The former has uniform impedance and the latter has localized repetitive changes in its impedance. This suggests that by introducing the feature of nonuniformity into a helix the desired goal of filter-type behavior can be achieved while retaining the advantages of the helix. Such a circuit has been designated a filter helix.

Various means of accomplishing this result suggest themselves. Figure 8 shows a helix loaded once in each turn with a capacitive element. In this structure the beam travels through the openings in the capacitive loading disks. Figure 9A shows a structure in which the objective is attained by coupling an external filter helix to a plain inner beam-interaction helix. By making changes in the outer helix, the range of operating frequencies can be selected. A filter-helix circuit can be made by introducing the repetitive impedance discontinuities as sudden changes in pitch shown in Fig. 9B. A low-level amplifier for 3,000 mc, made according to this principle, and utilizing the increased impedance characteristic of this structure, gave a noise factor slightly below 8 db at 20 db gain, and a noise factor slightly below 8.5 at 35 db gain.

An added advantage of filter-helix structures is that they can be considerably more rugged than the conventional helix designed for the same frequency. This is exemplified by the helix of Fig. 8, which was designed for a medium-power amplifier at 1,900 mc. When incorporated into a tube, 4.5 watts output was obtained with 22.5-percent efficiency.

Figure 10 is a schematic phase velocity versus frequency characteristic for a filter helix. The operat-

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**REFERENCES**


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**FIG. 9**—External filter helix (A) can be changed to select operating frequency of tube containing inner helix or impedance discontinuities can be introduced by changes in helix pitch (B).

**FIG. 10**—Phase velocity versus frequency for a filter helix.
Passive Repeater

Because intervening hills prevent direct line of sight, a passive repeater was built to reflect microwave beams around a bend in the Lewis River in western Washington. By this means, the Pacific Power and Light Company can control its new 100,000-kilowatt installation at Yale Dam from the control room at existing Merwin Dam, some twelve miles down river.

The most economical and reliable communication medium in this rugged country was found to be a microwave system in the 6,700-megacycle band, including full duplicate standby radio-frequency equipment and automatic switch-over circuits. The equipment utilizes a frequency-division multiplexing system with separate frequency-modulated subcarriers for each voice channel. The microwave carrier frequency is modulated by all the subcarriers. Usage of the channels is shown in Fig. 1.

System Requirements

A glance at the contour map of Fig. 2 shows why it was necessary to use a passive repeater, defined as a large reflector (or a periscope combination of two large reflectors) which passively receives and retransmits a signal similarly to an electronic repeater, but without adding power. The usual electronic repeater cannot be used since a power line to this isolated spot would prove about as expensive and vulnerable to outages from natural causes as a multiple-pair cable between the two stations. Then, too, access to the location can be had only by laborious hill climbing on foot or, in good weather, by jeep over an unused logging trail.

The repeater attenuation may be evaluated by use of a well-known propagation equation that relates the received power $P_r$ to the transmitted power $P_t$, the effective areas of the receiving and transmitting antennas $A_r$ and $A_t$, the distance $s$, and the wavelength $\lambda$.

$$P_r = P_t \frac{A_r A_t}{s^2} \lambda^2$$

Since a passive repeater is a radiator of energy rather than being analogous to an optical mirror, it can be considered first as a receiving antenna and then as a transmitting antenna reradiating the received power and this equation is applicable to each of the two legs of the total path. Hence, power received by the repeater $P_r'$ is

$$P_r' = P_t A_r A_t / s^2 \lambda^2$$

And the power received from the repeater $P_r$ is

$$P_r = P_t' A_r A_t / s^2 \lambda^2$$

Since the repeater receives and transmits with the same surface and its efficiency approximates one-hundred percent

$$A_t' = A_t = A$$ and\n
$$P_t = P_t'$$

Hence

$$P_r = P_t A_r A_t / s^2 \lambda^2$$

Extension of this equation to a path containing $N$ passive repeaters makes it of the form

$$P_r = \frac{P_t (A_r A_t A_t' A_t' \cdots A_t'A_t')}{(s_1^2 \cdots s_{N+2}^2) \lambda^2 s^2}$$

However, in this case only one passive repeater was to be used. Hence, the total attenuation in decibels, being a ratio of the transmitted power $P_t$ to the received power $P_r$, becomes

$$\alpha = -10 \log \frac{A_r A_t A_t'}{(s_1 + s_2)^2 \lambda^2}$$

With no passive repeater, the attenuation over a path of this same length is

$$\alpha = -10 \log \frac{A_t A_t'}{(s_1 + s_2)^2 \lambda^2}$$

And, by subtraction, the attenuation due to the passive repeater is

$$\alpha_r = -10 \log \frac{A_t A_t' / (s_1 + s_2)^2 \lambda^2}
Bends Microwave Beam

Perforated aluminum screen of 480-sq-ft area picks up 6,700-mc beam and reradiates it with only 7-db loss. Repeater located on hillside effectively bends telemeter and telephone signals 1,800 feet below optical horizon.

By HENRY MAGNUSKI and THEODORE F. KOCH
Chief Engineer, Microwave Research
Motorola, Inc., Chicago, Ill.
Assistant Manager, Microwave Systems Engineering

It can be seen that the passive-repeater attenuation can be reduced by increasing the reflector area or the frequency (decreasing the wavelength) while maintaining the other factors constant. Since the location of the reflector in the center of the path will give the greatest attenuation, it should be located as close as possible to one of the terminals.

The fading margin is defined as the difference between the path attenuation at which minimum communication can be maintained (105 db in this case) and the actual path attenuation. For conservative design, the fading margin chosen was 33 db, making the design objective a path attenuation of 72 db.

Antenna Sizes

Effective area of the 40-inch diameter receiving and transmitting antennas (with an efficiency of 0.624) is 5.45 square feet and the average wavelength used is 0.148 feet (corresponding to 6,645 megacycles). In this system, the distances were 1.236 miles and 11.052 miles. Hence, the required effective area of the passive repeater was calculated to be 384 square feet.

The effective area of the passive repeater is, of course, its projected area times its efficiency. Since the energy passing through the perforations of a microwave reflector has been measured as 0.1 percent of the incident energy and it is estimated that 0.1 percent of the incident energy is converted to heat, the efficiency of a flat reflector can be taken as 99.8 percent. In this

FIG. 1—Channel utilization in microwave control systems between Merwin and Yale dams shows functions possible with five existing subcarrier channels. Seven additional channels, not yet installed, can be made available.
installation, the included angle between the incident and reflected beams was found to be 75.81 degrees. From this, it was calculated that the actual area required for the passive repeater was 488 square feet. The standard reflecting surface used in such installations is one-sixteenth inch aluminum sheet, four feet by six feet, perforated with 0.200-inch holes spaced one-quarter inch apart to reduce the wind resistance. Twenty of these sheets can be arranged on a twenty by twenty-four foot surface to provide 480 square feet, very close to the calculated area.

Since the passive repeater is relatively small and distant, it receives only a small fraction of the power transmitted to it. Still, it adds a very high gain to this power in the retransmission, as is shown by the equation for the gain \( G \):

\[ G = 4\pi A^2 \]

With this gain of 217,000, the beam leaving the repeater will be very narrow, in accordance with the approximate formula

\[ B = 60 \times \frac{L}{L} \]

where \( B \) is the beam angle between the half-power points in degrees and \( L \) is the effective length of the reflector in the plane under consideration. From this it is apparent that the beam width is a function only of the wavelength and the repeater dimensions (assuming a parallel incident beam or appropriate shaping of the reflector surface for a considerably diverging beam.) Since the paths to both terminals slant downward at different angles, the effective length in the vertical plane is 19.9 feet, resulting in a beam height of 0.45 degrees. That in the horizontal plane is 18.9 feet, yielding a beam width of 0.47 degrees.

**Propagation Assumptions**

While microwaves are generally thought of as traveling in a straight line and can be so regarded for most practical purposes, under varying atmospheric conditions the beam is actually curved around the earth with radii of curvature varying from approximately twice the earth's radius to infinite (true line-of-sight propagation). The radius is normally assumed equal to four times that of the earth in a so-called standard atmosphere. Calculations on this basis show that the receiving antenna will remain well within the one-db points of the reflected beam, even for extreme beam curvatures.

To satisfy the laws of reflection, the passive repeater must be so positioned that the angle its face makes with the beam from one station is equal to the angle it makes with the beam to the other station. Since both terminals are at lower altitudes than the passive repeater, it was necessary to tilt the reflecting surface forward. The amount of this tilt and the geographic bearing of the face were calculated readily by establishing a system of rectangular co-ordinates, using the center of the passive repeater as the origin and visualizing a horizontal plane, a vertical north-south plane, and a vertical east-west plane mutually intersecting at the origin. The various distances involved were taken as shown in Table I.

The angle between the face of the passive repeater and the horizontal is given by

\[ \cos H = \frac{dW + cd}{2d(W + cW + c)} \]

and the bearing of the face is given by

\[ \tan B = \frac{dW - cd}{dW + c} \]

The site chosen is only as far up the hill as was necessary to provide sufficient clearance and is athwart the unused logging trail at a place where it is nearly level. Hence, no tree removal or even brush clearance was required, it being necessary only to set the concrete foundation piers in the proper position.

The ground in front of the passive repeater drops so quickly that there is no danger of growing brush obscuring the reflector. This location at the edge of a relatively level area of a number of acres is expected to make it unlikely that snow will drift against the reflector face, since its lower edge was placed five feet above ground.

**Effect of Hydrometeors**

So-called silver thaws are not uncommon in the area and may coat the reflector with ice. Being a good reflector in itself, ice will affect the signal only to the extent it roughens the surface and then in accordance with the formula given later for calculating the effect of surface roughness.

Slush, or wet snow, does interfere considerably with reflection, but it is considered unlikely that it can adhere to the forward-tilted surface.

It is to be noted that total obscuration of half the surface will result in nothing more than a 6 db drop in received signal strength. The system design fading margin of 33 db, then, assures that the threshold of limiter action will be reached only after the reflecting surface is reduced to 21 percent of its total area or eleven square feet.

Reflection will approximately double any horizontal angular movement of the passive repeater and will multiply vertical movement by 1.6. This effect combines with the narrow beam angle previously calculated to require that the structure be rigid enough to resist vertical distortion beyond 0.14 degrees and horizontal distortion beyond 0.12 degrees, even when coated with ice and buffeted by sixty-mile-per-hour winds, since it is desired to maintain the loss below 3 db under these conditions.

The design used to satisfy all of the above conditions is an aluminum structure, similar to a large billboard, supported by three A-frames, the back legs of which are built of three six-inch channels welded so their backs partially enclose a two-by-six inch box section, which is completed by welding in a two by one-quarter inch strip. The
Front legs consist of two six-inch channels welded on opposite sides of a similar box and the cross braces are two-by-six boxea made from a six-inch channel with a one-quarter inch plate welded in the open side. These fit neatly into the front and back legs. The A-frames are tied together by six five-inch channels that constitute the backing for the reflecting panels. The whole structure is designed for bolted assembly in the field and the perforated sheet aluminum reflecting surface is shop-attached with drive screws to shop-welded six-by-twenty-foot panels. These are made of three-inch channels with two by one and one-half inch angles to stiffen the one-sixteenth inch sheet.

**Flatness Factor**

Since a surface as large as this cannot be made truly flat, it was necessary to calculate the effect of its lack of flatness. The energy reflected from a surface displaced forward or backward from its neighbors will be out of phase with the remaining energy by an angle \( P \) in degrees

\[
P = \frac{360}{\lambda} \theta \sin B
\]

where \( \theta \) is the displacement in feet and \( B \) is the angle between the surface and the incident beam. This shows that a spot displaced 0.177 inch will reflect energy ninety degrees out of phase with the main reflection, thus neither adding to nor subtracting from the main beam. This was taken as the limiting case and the flatness tolerance was specified as one-eighth inch.

Aluminum was chosen for the structural material so any tendency to buckle due to thermal stresses would be avoided by the uniform rate of thermal expansion or contraction of the entire structure. In addition, by specifying all aluminum hardware, the possibility of electrolytic corrosion was eliminated, periodic protective coatings were made unnecessary, and individual structural elements were light enough to make for ease in transportation and erection.

To be prepared for contingencies and to permit reasonable tolerances in fabrication and erection as well as allowing adjustment to prove the accuracy of the calculations, the base of each leg was equipped with slotted holes through which the studs anchored in the foundation passed. These provided for bearing changes of up to one and one-half degree in either direction from the midpoint. Alterations in tilt were made with jack screws in each foot and shims were provided to allow permanently securing the structure at a tilt of one degree more or less than planned.

Optimum alignment was accomplished by first adjusting each of the terminal antennas to give peak limiter readings on a transportable microwave set temporarily activated at the repeater site.

With the passive repeater in the position calculated by the formulas presented, a strong terminal-to-terminal signal was present, and it was necessary only to scan the structure through a small portion of the built-in adjustments to insure optimum positioning. The final position varied from the calculated by 0.02 degree in bearing and 0.05 degree in tilt.

**Test Results**

Actual attenuation in each direction over the installed path was measured by substituting a calibrated i-f amplifier successively for each of those in the main and standby microwave receivers at each terminal. The average measured value of 72.0 db agreed very closely with the calculated attenuation for the actual system of 72.1 db and proved definitely that the increase in attenuation due to the passive repeater is very small, only 7.0 db in this case. The actual fading margin available is 33 db, equal to the design objective.

The formulas cited demonstrate that the high microwave frequencies (in the 6,700-megacycle band) used on this system have special value when a passive repeater is required. Lower frequencies would have resulted in a higher path attenuation or a considerably larger passive repeater. Setting this installation in service has also proved that it is practical to assume an efficiency very close to unity for a passive repeater in future systems if careful attention is paid to achieving flatness in structure design, fabrication, and erection.
Multiplier Phototube

Recording slowly variant signals or even steady-state values concurrently with rapid fluctuations is often necessary in research projects to obtain an accurate representation of the instantaneous behavior of a certain factor.

In biophysical research such information is contained frequently in the intensity modulation of small light sources. A multiplier phototube is generally used to convert these light fluctuations to a varying current. Conventionally these current variations have been amplified by d-c amplifiers. The low sensitivity and zero-drift problems of d-c amplifiers in this application have been circumvented by interrupting the light beam with a mechanical chopper and using a-c amplifiers but it is difficult to attain a wide bandwidth with a mechanical chopper.

Signal Converter

The multiplier phototube may be used in a heterodyne-type circuit to avoid use of mechanical choppers and to obtain bandwidths extending from d-c to kilocycles. The principle of operation is illustrated in the circuit of Fig. 1.

In addition to the d-c dynode voltages applied to the multiplier phototube, two a-c voltages differing in frequency are injected into the photocathode and first dynode respectively. These voltages cause the collection efficiency and amplification of the tube to vary as the time function of their instantaneous sum. Anode current is thus a function of light incident on the photocathode and the gain variation of the electron multiplier.

The signal contains the original frequencies as well as the sum and difference frequencies. The difference frequency is utilized as the carrier and is amplitude modulated in accordance with the light intensity.

Bandwidth Considerations

The filter at the anode of the phototube consists of a simple parallel-resonant capacitor and high-Q toroid inductor in conjunction with an R-C leg to furnish greater high-frequency attenuation. Selection of circuit Q is governed by bandwidth considerations for the signal amplification channel.

The difference-frequency carrier is amplified in a fixed-frequency amplifier. It is desirable to make the response characteristic of the amplifier as flat as possible within a bandwidth compatible with overall frequency response and amplifier noise requirements. It is also desirable to establish the low-frequency cutoff point at a value greater than 120 cps to allow freedom from line frequency pickup. The upper frequency cutoff point is less than the lower of the two oscillator frequencies, assuring good rejection ratios for those voltages.

A diode detector with R-C load re-establishes the signal with the carrier-frequency ripple superimposed upon it. In general, the difference frequency is much higher than the upper cutoff frequency of the desired signal transmission band and a simple R-C diode load thus furnishes very little distortion. In the event that the difference frequency is low compared to the bandwidth, a ripple rejection filter on the output is desirable.

The choice of the oscillator frequencies is also dependent upon the desired signal-channel bandwidth in that it determines how high the Q of the input filter can be and still give satisfactory rejection to the oscillator frequencies. It is also feasible in multistage and feedback amplifiers to shape the frequency-response characteristic sufficiently to provide satisfactory rejection ratios.

The light detector is contained in a light-tight pickup unit connected by cable to the power supply and amplifier chassis. The amplifier is located as far as possible from the oscillators to minimize stray voltage amplification which in effect raises the lower limit of sensitivity of the signal converter.

This circuit operates with the phototube high-voltage positive off...
Signal Converter

Intensity modulation of small light sources is converted to alternating voltage by use of a multiplier phototube giving bandwidth from zero cycles into the kilocycle region. Bandwidth is greater than that obtainable with mechanical choppers.

ground to allow the oscillator injection capacitors and wiring to be conveniently electrostatically shielded from the anode circuit. The parallel-resonant circuit is located in the pickup so that the inductor will not pick up any stray magnetic fields of power transformers in the main chassis.

The oscillators are the familiar Wien bridge R-C feedback type and may be constructed side-by-side without shielding with no interaction although the oscillator voltages to the pickup must be fed through shielded conductors within the cable. It is desirable to regulate the B voltage applied to the oscillators to provide positive assurance that the oscillator voltage amplitude can be held constant by the range of compensation of the pilot-light variable-resistance element. The oscillator relative frequencies were chosen to match the highest Q of the inductor and, in this instance, provide a large enough bandwidth.

**Performance Characteristics**

The mechanism of the carrier modulation for low light levels is shown graphically in Fig. 2 by the envelope patterns taken from the phototube anode. The envelope repetition rate is 5,000 cps. The first pattern, created with no incident light, is representative of the interference of two oscillator voltages due to shunt capacitance formed by the proximity of pins in the cable connectors, tube bases and other circuit configurations. Effect of this stray pickup is to cause a slight nonlinearity in the variation of the d-c component of the complex envelope as shown by the other patterns.

The peak-to-peak amplitude of the waveforms maintains a linear relationship with the light input but the output of the peak-reading half-wave detector shows a deviation from the linear characteristic. The deviation is really a change in slope and it is equally valid to utilize the linear portions on either side of the knee of the curve which occurs at 1.1 micromicrovolts. The higher light-level portion may be utilized by employing a base light, or small constant light source, within the light field to furnish a residual output just beyond the knee.

**Envelope Patterns**

The waveforms of Fig. 2 were taken from the signal converter used as the pickup device for an electroykymograph design used with a constant-potential x-ray machine. The bandwidth requirement of this electroykymograph, d-c to 2,000 cps is easily obtained. The frequency response was determined by mechanically interrupting the light from a d-c light source with a variable-speed motor-driven disk with 200 radial slits along its periphery. The peak-to-peak amplitude of the signal at the anode of the tube shows no frequency dependence in this range. The use of a bridged-T five-kilocycle filter to eliminate the ripple results in the amplitude decrease with increasing frequency.

Rejection of the oscillator frequencies of 15 to 20 kc is at least 3,500 to 1 at the output of the phototube anode filter and 15,000 to 1 at the grid of the first amplifier. With an operating voltage of 700 volts on a 931-A phototube, the overall signal-to-noise ratio is 40 with an anode current of 10 microamperes. The noise component due to the random phase shift of the oscillators is the equivalent of a signal-to-noise ratio of 65 under the same conditions. This phase-shift noise is approximately 15 times larger than the dark-current noise of the phototube itself.

Stability of the system is essentially that of the multiplier phototube high-voltage supply which should have regulation better than 0.001 percent for each percent change in line voltage and comparable long-time stability. After a 15-minute warm-up time for the oscillators and the carrier amplifier, the sensitivity drift is 0.03 percent per hour.

This system is applicable not only to measurements involving light measurements directly but also to problems where the conversion of the signal information to light may be accomplished efficiently with fidelity. Not only does the multiplier phototube add its inherent high-gain advantages but the signal information may be amplified and handled in a high-level mode in the carrier amplifier with complete freedom from 60-cycle pickup and line hash.

The greatest single advantage of this converter is that it offers an all-electronic method of obtaining high-fidelity amplification of signals requiring a wide bandwidth including d-c.

**Fig. 2—Envelope patterns at the anode of the multiplier phototube**
A LARGE Radio City studio, television detective Martin Kane faces this week's criminal. Millions of viewers expectantly wait for the story to reach its climax. Suddenly Kane whips out his pistol and pulls the trigger... ptzz. The explosion has all the roar of a wet cap. This is certainly not the climax the director of the show expected, nor does it conform with the thoughts of the audience. For most viewers, twenty-five minutes of drama is forgotten for a few seconds of humor. It is not funny, however, to television broadcasters. Breaking the continuity of a dramatic story with unscheduled comedy is disastrous.

Why did the shot fail? An investigation by the Engineering Development Group of the National Broadcasting Company has disclosed a multitude of possible reasons. In some instances the fault was not at all technical but simply a case of fright. Some actors, and a few actresses, have complained that as they were about to pull the trigger, they were seized with the thought that the pistol was loaded with actual bullets and were therefore afraid to fire the gun.

**Technical Fizzes**

Other reasons for gunshot failures are mostly technical. The mechanical condition of the gun and particularly the firing pin, the cap, the type of powder and the loading in the cartridge all contribute to the quality of the report. The condition of a gun can be checked prior to its use, but unfortunately, the only satisfactory test for a blank cartridge results in its destruction. Efforts, therefore, were directed toward a more reliable powder, and for reasons that will be discussed later, a longer burning powder. This approach resulted in the selection of large-caliber cartridges for desirable burning characteristics and reliability. Reports from pistols using these special blanks were so loud, however, that many actors refused to use them. Even
for Television Studios

Guns loaded with blank cartridges sound unreal, occasionally misfire and often scare performers in acoustically dead television drama studios. To offset this, a new electronic unit automatically reinforces weak shots or generates the entire sound effect for revolver, machine-gun and cannon fire, as well as ricochet effects.

These cartridges occasionally misfire and moreover, there seemed to be little correlation between the loudness of the report within the studio and that of the reproduced sound.

It is axiomatic in both the broadcasting and motion-picture fields that loud studio shots do not necessarily produce loud sounds for the ultimate listener. In any medium where the amplitude must be controlled to prevent an overload of the system, high-intensity sound of extremely short duration is heard, when reproduced, as low-intensity sound of short duration. In such systems of limited volume range, the apparent loudness can be increased only by increasing the duration of the sound. Thus, long-burning powders of medium intensity reproduce louder than high-intensity, short-burning powders after both reports are transmitted through a broadcasting system.

**Need for Reverberation**

Still another problem, peculiar to the medium of television, is the special acoustical treatment required in the studios. In other studios, such as those for radio broadcasting, tape or disc recording, or motion-picture sound, extraneous noise can be minimized during the actual production and excessive reverberation of speech avoided by reducing the microphone working distance.

In television, quite large microphone distances are frequently unavoidable. Furthermore, the desired sound must compete with considerable background noise.

The combined motion of actors and actresses to and from stage sets, set hands with scenery and props, dolly pushers moving cameras and microphone booms, lighting men, floor managers and many others makes for a relatively high ambient noise level.

The television broadcaster must combat background noise with directional microphones and acoustical absorbing materials located on the studio walls and ceiling. By radio broadcasting standards, the result is a dead studio. Reverberation would allow guns to persist and increase their apparent loudness. The lack of it, coupled with amplitude restriction of the audio system, is deleterious to realistic gunshot reproduction.

As a possible remedy for the anemic shot recordings, a small reverberation chamber was constructed. The large chambers which are normally used for special effects with speech and music were tried for this purpose with considerable success, but the demand for these on other effects was so great that programs involving gunplay were unable to depend on their availability.

Although considerable attention was given to the elimination of pronounced resonant effects in the small chamber, several objectionable peaks in the medium-frequency region were evident while at other frequencies the reverberation time was insufficient. These defects forced a new approach which resulted in the design and construction of an electronic shot reinforcer and shot effects generator.

**Gunshot Reinforcer**

A study of various pistol shots showed the sound of a shot to be largely a function of the bore and length of the gun barrel, the nature of the powder and its burning rate and the loading of the cartridge. The wave envelopes of most shots, however, have steep fronts and trailing edges that decay slowly. The acoustical energy within the envelope is generally heterogeneous, and in this respect resembles noise. Further investigation proved that noise, properly controlled, could be made to simulate a pistol shot effectively.

The first use of this principle was in a reinforcer unit in combination with an actual gunshot. Because it is the reverberation of the shot that is insufficient in television studios, the arrangement of Fig. 1 was designed to insert a decaying random-noise signal automatically after the actual pistol shot. This equipment has been successfully used for some time, and several additional units have

![FIG. 1—Block diagram showing portion of generator used to furnish reverberation to gunshot by inserting a decaying random-noise signal after the actual shot signal](https://www.americanradiohistory.com/)
been installed in various locations.

The gun shot reinforcer is inserted into the outgoing line of a studio prior to the start of the program and carries the entire audio output of the studio. It is level-actuated and hence completely automatic in its operation. When a gun is fired in the studio, the trigger tube actuates a relay, which removes the excessive bias from a pair of push-pull amplifier tubes normally held at cutoff. The output of a noise generator, after filtering, is continuously applied to the grids of these same amplifier tubes.

After the keyer tubes are pulsed into operation they are slowly returned to the cutoff state. The reproduced effect of the sudden noise pulse with a slow decay is essentially that of a gunshot. If the push-pull keyer tubes are purposely unbalanced to a slight degree, the d-c thump component when the bias is suddenly removed produces an impact with the shot to further enhance its realism.

The trigger tube and circuit design are such that, assuming a fixed gain adjustment, extremely loud sounds with steep wave fronts cause the reinforcer to fire, whereas shouts and screams only a foot from the microphone do not.

**Gunshot Generator**

The steps from an automatically triggered shot reinforcer to a versatile manually operated shot generator were fairly obvious. The level-actuated trigger circuit was first replaced by a pushbutton. Unbalanced keyer tubes gave the synthetic shot an initial impact followed by the decaying noise to simulate the effect of reverberation. The length of the shot is controlled by varying the recovery time of the keyer tubes. These are normally held at cutoff by a large negative voltage, fed to the grids through an R-C filter consisting of a 4.0-af capacitor and a resistor. The value of this resistor serves as an excellent adjustment of recovery time. Actually the rate of noise decay is a function of the cutoff characteristic of the keyer tubes and several other factors. Constants are so chosen as to produce essentially a logarithmic decay of sound output.

The characteristics of shots may be altered by another factor, namely the frequency response of the noise amplifiers preceding and following the keying. If the high-frequency components of the noise are attenuated and the length of the shot increased, large-caliber arms can be simulated. Carried to an extreme, the effect of distant cannon fire can be realistically produced.

**Machine-Gun Simulation**

Once single shots are generated, an additional possibility becomes apparent. When the trigger button is pushed a number of times in quick succession, an excellent machine-gun effect results. The requirement of manual dexterity can be eliminated from the operation by using a low-frequency oscillator to trigger the shots repeatedly. The rate of fire is adjustable by varying the frequency of this oscillator. When a variable-bandwidth filter in the noise amplifier is simultaneously adjusted, a number of machine gun effects are readily obtained, ranging from a light-weight 0.45-caliber machine
gun (tommy gun) to a large 40-mm anti-aircraft gun (pom-pom gun). Thus, a master switch is provided to select the shot length and also establish the bandpass characteristic of the noise amplifier. Fewer high-frequency noise components are amplified when the length of the shot is increased. This conforms with the character of natural reverberation where the high frequencies are quickly attenuated by air, making the reverberation principally a medium and low-frequency phenomenon.

Because the controls for the rate of machine-gun fire and shot length are independent, a variety of effects is possible. Experience has shown, however, that some combinations are anomalous. The rapid chatter of a Thompson submachine gun, for example, is out of place with the roar of a 40-mm anti-aircraft gun.

**Ricochet Effect**

A further embellishment which increases the flexibility of the shot effects generator is a ricochet effect. This is accomplished with a free-running resistance-capacitance oscillator which generates a harsh whine. The sequence of events is as follows: A shot with long decay time is generated in a normal manner, while at the same time a pulse initiates a single-cycle delay multivibrator. At the completion of the cycle the ricochet oscillator is activated through a mechanical relay and its output mixed with the decaying noise of the shot. The overall effect is a loud report with reverberation, then, after a short delay, a whine of decreasing frequency and amplitude. A control is provided to adjust the delay before the start of the ricochet from about 0.1 to 0.75 second.

An interesting point developed concerning the whine of a ricocheted bullet. This whine is generally produced by a bullet that wobbles irregularly or spins end-over-end in its flight after striking, but not entering, a solid object. The frequency variation of the whine depends on Doppler effect as well as the changing rate of spin. Marksmen agree that the pitch may increase at first, then decrease, or it may steadily decrease. The average person, however, has only heard ricochets through the medium of motion pictures. A survey of several films indicates that only one type of ricochet whine has been used extensively—the gradually decreasing pitch.

Rather than oppose public opinion, the shot-effects generator was designed to conform with the accepted version. To provide some variety, ricochets of three different pitches may be selected.

**Complete Circuit**

A few refinements were incorporated in the final design, shown in Fig. 2. For example, functions are preset with the master switch and only one pushbutton is required to fire the shots. Thus a remote pushbutton can be used to trigger from a distant point in the studio if desired. Operating errors are minimized in equipment which can be preset, as opposed to equipment in which several switches must be thrown at a critical time. An overall volume control is provided as well as separate faders for feeding the line and speaker.

To permit headset monitoring and last-minute selection and adjustment, a phone jack is provided.
which disconnects both output feeds. Thus, the control settings as well as overall performance may be checked during a show. Output level may be adjusted by means of the neon-tube indicator if necessary. Maximum output from each channel is +8 volts at 250 ohms impedance.

While many of the circuits function in a straightforward manner, several warrant some attention. For example, the desirable feature of a single pushbutton was achieved with the relatively simple circuit of Fig. 3. With this, when single shots are needed, a master switch connects a resistance-capacitance coupling network between the pushbutton and the trigger circuit.

When the button is pressed, a single voltage pulse of positive polarity is fed through normally closed contacts on the trigger relay to the grid of the relay tube. This positive pulse causes a surge of current to flow through the tube and relay, energizing the latter. This action results, by way of the make contacts, in the application of a large negative voltage on the grid which returns the tube and relay to the normal state.

Unless the grid receives another pulse of positive voltage, the tube remains in this condition. Holding the button down after firing a single shot does not produce additional shots by virtue of the resistance-capacitance coupling network.

If the action in the studio calls for a machine-gun effect, the master switch on the shot-effect generator is positioned to connect the positive voltage through the pushbutton and a resistive network to the grid of the relay tube. Consequently, this tube, in conjunction with the relay, oscillates as long as the pushbutton is depressed since there is no capacitor in series with the positive source of voltage as in the case of the single-shot circuit. The frequency of oscillation is determined by a combination of resistance and capacitance in the grid circuit of the relay tube.

**Delay Circuits**

Consider now the ricochet effect, where for realism, a short delay must exist between the shot and the start of the whine. The circuitry consists of a single-shot multivibrator which accomplishes the delay, plus a relay tube and relay that turns on the ricochet oscillator to produce the actual whine.

The delay portion of the shot-effects generator is shown in simplified schematic form in Fig. 4. The d-c positive pulse that initiates the shot is also coupled to the first grid of the delay multivibrator. The plate of this tube then feeds a negative pulse to the second grid, cutting it off. The delay time is equal to the time this tube remains at cutoff and is a function of the time constant, RC. When C discharges sufficiently to bring the second grid into the conduction region, the cycle is completed and this tube is snapped into heavy conduction. By virtue of the interconnection of the cathodes, the first tube is then returned to its normal condition of cutoff, completing the cycle with a large negative swing at the second plate. This pulse is partially differentiated by the coupling network and fed to the grid of the relay tube, causing it to release the relay momentarily.

Fig. 5 shows the ricochet delay relay and the oscillator which it activates. A high negative bias on the first grid of this resistance-capacitance oscillator maintains it normally inactive. When the relay momentarily opens, however, the 10-uf capacitor is positively charged, causing oscillations to start. Frequency is a function of the magnitude of voltage applied to the grid. As the capacitor discharges, the pitch decreases. The output of this oscillator is mixed with the synthetic reverberation of the shot and the amplitudes of both signals decay logarithmically through the keyer tubes.

Because the ricochet oscillator continues to function until the voltage on the 10-uf capacitor drops below ground potential, a means is provided to discharge this capacitor quickly, permitting other ricochet shots to follow in rapid sequence. Otherwise, during the delay period between the second shot and its ricochet, low-pitched oscillations remaining from the previous shot would be heard. A pair of open contacts on the triggering relay is therefore connected across this capacitor. Each time a shot is fired, these contacts close to discharge the capacitor quickly.

Principles learned during the development of these instruments, coupled with a little imagination, point the way to the creation of many electronic sound effects. The only limitations would appear to be those imposed by size and cost. Present knowledge makes feasible such effects as distant thunder, large or small bells, wind and waves, sirens, screaming shells, creaking doors or wheels, audience applause and many other similar effects.

![Rear of generator, showing the four preset controls for shot amplitude, trigger adjust, keyer balance and amplifier gain](image-url)
Gated Decade Counter Requires No Feedback

Combining convenience of decade system with reliability of binary, gated decade counter uses electronically-switched gate instead of critical clamping and feedback networks. Bias range is same as for binary system. Resolution is limited only by resolution of binaries.

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darious computer and counter systems make use of the Eccles-Jordan binary circuit as a pulse divider. Since a scale of two is not compatible with the decimal system, feedback is often used to convert the normal binary sequence to a decade. Typical decade systems using feedback are: the Potter decade and the sixteen-minus-six decade. In both systems, use of feedback makes the decade bias range less than the bias range of a binary system using no feedback. The gated decade overcomes this disadvantage by using a switched gate.

General Description

Bias range for this decade is the same as the bias range of a binary system. This type of decade has no critical clamping or feedback networks. It depends solely upon the binary operation of the circuit to accomplish the permutation of binary to decade counting. Resolution of the system is limited only by the resolution of the binaries. The gated decade lends itself inherently to four-light interpolation; it has been used successfully in a nuclear scaler and is adaptable to any type of counting.

The gated decade contains five stages. The decade divides by sending eight pulses into one storage system and two pulses into another, then resetting. Eccles-Jordan binaries are used as storage devices. An electric-switch-type gate circuit is used to control the direction of pulse flow through the decade.

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Figure 1 is a block diagram of the gated decade. The first eight pulses go into the first binary, the gated amplifier and the second and third binaries. The eighth pulse activates the gate so that the ninth and tenth pulses go into the second system consisting of the gated amplifier and the gate-control binary. The tenth pulse resets the decade. The output from the gated decade is taken from the gate-control binary.

Gate Operation

The gate controlling the direction of pulse flow through the decade uses two tubes as shown in Fig. 2. One tube is used as an amplifier and the other as an Eccles-Jordan binary. The action of the gate may be best understood by reviewing briefly the operation of the binary circuit. It is a characteristic of

TAXPAYERS' DIVIDEND

Vast sums spent for atomic weapons development forge a vital link in our national defense. An additional payoff for the engineer comes in the form of equipment and techniques developed in atomic research that are useful in many diverse fields. Introduced in a nuclear scaler used at Los Alamos, this improved counting circuit is adaptable to any type of counting operation.

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FIG. 1 — Decade counter uses electronically-switched gate. Eighth input pulse trips gate; tenth pulse resets counter
this circuit that the grid of the conducting plate is at cathode potential or zero bias. Conversely, the grid of the nonconducting plate is beyond cutoff. When the binary is flipped, the grids reverse their potentials. A binary can be flipped with negative input pulses.

Figure 2 shows the grids of the gated amplifier fed in parallel. It should be noted also that they are returned through isolating resistors to grids of the gate-control binary. Thus the conducting plate of the amplifier corresponds to the conducting plate of the gate-control binary. The other plate of the amplifier is likewise cut off corresponding to the state of the binary. A pulse entering the gated amplifier may be passed in the direction dictated by the state of the gate-control binary.

The cathode bias for the gate tubes may be taken from a cathode resistor as shown in Fig. 2. The dotted lines in Fig. 2 indicate an alternative bias scheme, which uses a negative supply for biasing the grids of the gate. Figure 3 illustrates the negative supply method.

A schematic drawing of the gated decade is shown in Fig. 3. All the binaries are capacitor-coupled through common plate impedances. \( C_d \) and \( R_s \) form a differentiating network between the first binary and the gated amplifier and the subsequent binaries.

**Circuit Description**

There is a crystal diode in series with the coupling capacitor from the third binary to the gate-control binary. The action of this diode is to prevent the output from plate \( A \) of the gated amplifier from feeding into the third binary. The output of the gated decade is taken from a plate of the gate-control binary.

The operation of the gated decade may be better understood by following pulses through the circuit. The plate waveforms shown in Fig. 4 refer to the labeled stages in the schematic drawing.

The input pulses are converted into square waves by the first binary. These square waves are differentiated by \( C_1 \) and \( R_1 \), and fed into both grids of the gated amplifier. Plate \( B \) of the amplifier inverts the positive input pulses and feeds them into the second binary and subsequently into the third. The eighth pulse causes the third binary to send out a negative pulse which flips the gate-control binary. The ninth pulse is negative when

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**FIG. 2**—Gated amplifier with paralleled grids is switched by gate-control binary

![Diagram of gated amplifier](image)

**FIG. 3**—Counting operation may be traced from circuit schematic. Eighth pulse flips third binary, which, in turn, flips gate-control binary. Gated amplifier feeds tenth pulse to gate-control binary resetting decade and producing output pulse

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entering the gated amplifier, so it is rejected. The tenth pulse which is positive is inverted by the amplifier and fed into the gate-control binary which then flips back and resets the decade. The output to drive another decade is taken from plate B of the gate-control binary.

It should be observed from the waveforms that the gate-control binary and the gated amplifier have the time from the end of pulse eight to the start of pulse ten in which to be reset. This is also true for the time between pulse ten and pulse two. The resolution time of the decade can therefore be as fast as the resolution time for the first binary if care is used to design the gate-control binary with a resolution no more than twice the resolution time for the first binary.

**Nuclear Scaler**

The gated decade circuit has been used successfully in the scaler shown in the photograph to count particles in radioactive decay. The familiar four-light interpolation scheme was used. Figure 5 shows the schematic of the scaler.

The scaler contains a regulated power supply, a discriminator, three decades and a mechanical register. The scaling factor is 1,000. The resolution of the instrument is two microseconds. The discrimination range is from 10 volts input to 100 volts. The maximum counting speed, which is set by the register, is 700,000 counts per minute. The power supply is regulated and delivers 125 ma plate current for the whole instrument. The instrument has been extremely reliable, giving satisfactory performance for as long a period as three months of 24-hour daily operation.

**REFERENCES**


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**FIG. 4—Plate waveforms**

**FIG. 5—Nuclear scaler uses input discriminator and three gated decades to count particles in radioactive decay. Four-light interpolation is used**
Vacuum-Tube T-Pad

IN A T-pad, such as is illustrated in Fig. 1A, it is possible to make $R_e$ equal to the input impedance and $R_o$ equal to the output impedance, if the loss of the pad is greater than 20 db. This approximation is permissible since the calculated values of these resistors so nearly approach (but never quite equal) their respective impedances.

It is then possible to calculate the maximum value of $R$ for a loss of 20 db and, by varying this resistance from zero ohms to the calculated maximum, to produce an attenuation of any amount from infinity to 20 db with one variable element.

In the electronic attenuator circuit to be described, $R$ is replaced by the plate-to-cathode resistance of a vacuum tube, and attenuation is controlled by changing its positive d-c grid voltage. The characteristics of most low-power triodes are such that with proper plate voltage, an approximately logarithmic change in plate current, and therefore plate resistance, is produced by a linear change in positive grid voltage.

Figure 1B illustrates the basic circuit with the addition of a rectifier to provide a grid voltage corresponding in amplitude to the a-c signal. Because of the logarithmic change in plate resistance caused by a linear change in grid voltage, the output of Fig. 1B will be constant, though the input changes appreciably.

**Limitations**

At first look it would appear that the range of input changes for which constant output would be maintained would be unlimited. There are limits, however.

On one hand, because $R$ and $R_o$ are in parallel as regards the a-c signal, the ratio of $R_e$ to $R$ (at minimum attenuation of 20 db) must be at least 10 to 1. On the other hand, the plate current fails to increase in log fashion when the plate voltage approaches the value of the d-c grid voltage. The range available with a 615 triode is about 20 db.

Grid current is drawn by the limiting tube because the grid voltage increases in a positive direction with increasing input signal. If this changing current were supplied by the a-c signal, distortion would result. In Fig. 2A, the grid voltage is supplied by the d-c plate supply, but is proportional to the signal level. To further insure that the input will not be loaded, the grid of the cathode-follower-rectifier $V_s$ is attached to a voltage divider, instead of directly to the input. Capacitors $C_1$, $C_2$, and $C_3$ are merely isolating capacitors, and $C_4$ filters the rectified signal.

Adjustment of the zero compression point for individual tubes may be done by making $R_e$ equal to 10 times the plate-to-cathode resistance of $V_s$ with the grid of $V_s$ connected to the cathode of $V_o$, and by making $R_o$ equal to $R_e$.

A simpler way is to use equal fixed values for these resistors and to adjust the grid voltage of $V_s$ to the point where the plate-to-cathode resistance is 10 percent of $R_e$. This can be done with $R_e$. In practice $R_e$ can be set to give a reading of 10 percent of the plate supply voltage, as measured with a vtvm at the plate of $V_o$ with no signal applied.

**Frequency Response**

The frequency response of this circuit is limited on the high end by the plate-to-cathode capacitance, and on the low end by the time constant of $C_1 R_e$ and the grid-to-cathode resistance. With $C_e$ chosen to give sufficiently rapid compression and sufficiently long release for speech, the response is flat from several hundred kc down to 100 cycles with rising distortion below 200 cycles.

Where better low-frequency response and variable compression and release are desired, the circuit of Fig. 2B may be used. The lowest frequency of this design is limited by the d-c transient produced by sudden input amplitude fluctuations.

By using a remote-cutoff pentode as the first succeeding amplifier and operating it at fairly high bias, these transients will not adversely affect the overall performance. If frequencies below 200 cycles are not desired, as in communications work, the time constants of $C_1 (R_e + R_o)$ and $C_e$ of Fig. 2A, should be short enough to attenuate the lower frequencies.

 Tubes that have proved satisfactory for $V_s$ are the 6J5, 6C5, 6SL7, 6SN7, 6GQ7, 6SF5 and 6SC7.

For the satisfactory operation

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FIG. 1—Replacing it with signal-biased vacuum tube provides signal compression

FIG. 2—More elaborate circuits prohibit distortion by input loading and extend frequency response
Logarithmic Attenuator

Circuit provides basis for communications-type speech compressor using vacuum tube in leg of T-pad to limit speech peaks logarithmically and provide high percentage of modulation for a-m transmitter. Complete modulator is described

Operating Conditions

Plate supply voltage is not critical, and if $V_1$ and $V_2$ are supplied from the same source the voltage may vary from 150 to 500 volts. It should be remembered that an attenuator introduces a loss in the circuit to which it is connected. This loss varies from 20 db at no compression to 40 db at maximum compression. The 20-db loss can easily be regained by the addition of a single stage of amplification following the compressor.

The signal level at which logarithmic compression takes place will vary with different tubes. For a 6SL7GT, used for $V_1$ and $V_2$, this compression will begin at about three volts rms at the input.

This volume limiting circuit has many applications in various audio circuits, but its simple construction, easy adjustment and low cost readily adapt it to use at a low-level point in a speech amplifier for modulating a communications transmitter.

Figure 3 shows the schematic of a modulator using the circuit. It was designed to supply about 50 watts output with 700 volts plate supply to the class B tubes.

The high-impedance crystal communications microphone output is amplified by $V_1$ sufficiently to operate the electronic attenuator or limiter at up to 20-db compression without clipping. No gain control is used before the limiter because the mike output for almost any operator works into the compression level range. The only change in the limiter from that already described is the insertion of $SW$, across $R_c$. When this switch is open, normal limiter action takes place. Closing it shorts out the input to the high-impedance rectifier so the grid voltage on the limiter $V_1$ remains at the value for zero compression, that is, a fixed attenuation of 20 db. This switch allows the modulator to be used with or without compression. Pen- tode $V_1$ is used to compensate for the 20 db loss inserted by $V_2$. A 6SJ7 with the values shown does this easily with enough to spare to drive a 6V6GT as a low-power power amplifier. The gain control in the grid of $V_2$ is used to adjust the modulation to the desired amount with the compressor in operation.

Adjustment

Adjustment is achieved by setting $R_c$ to make the voltage at the plate of $V_1$, equal to ten percent of that at the plate of $V_2$, as measured on a vacuum-tube voltmeter, with $SW$, closed. Then, with $SW$, open, one talks into the microphone sufficiently loud and close to cause the vtm connected to the plate of $V_2$, never to exceed 50 percent of the voltage present when $SW$, is closed.

FIG. 3—Typical 50-watt modulator built around compressor circuit. Resistor $R_1$, (Fig. 1) can be omitted for speech work

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Graphical Solution of Sky-Wave Problems

Chart shows relationship between great-circle distance, virtual height of reflection, equivalent path distance, angle of departure and angle of incidence at ionosphere so any three can be found if other two are known

By R. A. HELLIWELL
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Stanford University
Stanford, California

In radio communication problems involving transmission by means of sky-waves reflected from the ionosphere it is often necessary to relate: (1) great-circle distance between transmitter and receiver, (2) virtual height of reflection, (3) equivalent path distance between transmitter and receiver, (4) angle of departure, and (5) angle of incidence at the ionosphere. It is the purpose of this paper to present a simple graphical method whereby these factors can be determined rapidly without recourse to the analytical expressions. If any two factors are given, the other three can be found.

It is assumed that propagation can be represented by a ray and that the characteristics of the actual path of the ray can be represented with sufficient accuracy by the so-called equivalent path, shown in Fig. 1 as the lines AB and BC. The height h' of the apex B is called the virtual height, and D is the great-circle distance between the endpoints A and C. The angle β between AB and the tangent at A is called the vertical angle or angle of departure. The ionosphere is assumed to be horizontally stratified and earth's magnetic field effects are neglected. The path is therefore symmetrical about the midpoint, and the angle of arrival is equal to the angle of departure. Graphical computations are facilitated with the aid of the sky-wave transmission chart shown in Fig. 2. This is simply a vertical cross-section of the earth's atmosphere up to a height of 600 km. Great-circle distance D on the earth's surface is plotted against virtual height h' appearing at left with the chart held sideways.

The vertical angle β is determined by aligning a straight edge with the origin and the midpoint of the equivalent path (co-ordinates h' and D/2) and reading the upper scale. The angle of incidence φ is interpolated in the family of curves of constant φ plotted on the chart. Secant φ is read from the conversion chart below the main chart.

Since there are five basic variables (D, ρ, h', β, and φ), only two of which can be independent, there are ten possible combinations of independent variables. For any given pair of variables, the other three are determined from the chart. The procedure is illustrated in the following example for a selected pair of variables (D and h').

Example

Problem: Given a great-circle distance D of 3,000 km and a virtual height h' of 310 km, find the vertical angle β, the angle (Continued on p 152)
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of incidence $\phi$, at the ionosphere, see $\phi_\mathrm{a}$, the path distance $P$, and the transmission time $t$.

**Solution:** Locate the apex of the path at $D/2 = 1,500$ km and $h' = 310$ km on Fig. 2. Align straight edge with origin and apex. Read $\beta = 4.5$ degrees on the upper scale. Read $\phi = 72$ degrees by interpolating in family of curves of constant $\phi_\mathrm{a}$. Obtain $\sec \phi = 3.2$ from conversion scale. Obtain $P = 3,140$ km by measuring distance from origin to apex, using the height scale on the chart, and multiplying result by 2. The transmission time $t = 10,470 \times 10^{-6}$ seconds is obtained by dividing the path distance $P$ by the speed of light $(3 \times 10^6$ km per sec).

The author wishes to acknowledge the helpful comments of A. M. Peterson.

**Appendix**

Some of the more important analytical expressions, based on Fig. 1, are given below for reference. Others can be derived readily.

\[
\phi_\mathrm{a} = \tan^{-1} \left( \frac{\sin \frac{D}{2R} \frac{180}{\pi}}{1 - \cos \frac{D}{2R} \frac{180}{\pi} + h'} \right)
\]

\[
\beta = 90 - \phi_\mathrm{a} - \frac{D}{2R} \frac{180}{\pi}
\]

\[
h' = R \left[ \frac{\cos \beta}{\cos \left( \frac{D}{2R} \frac{180}{\pi} + \beta \right)} - 1 \right]
\]

\[
D = \sqrt{2R(R + h') \left( 1 - \cos \frac{D}{2R} \frac{180}{\pi} \right) + h'^2}
\]

where $D =$ great circle distance in km

$h' =$ virtual height in km

$P =$ path distance in km

$\beta =$ vertical angle in degrees

$\phi_\mathrm{a} =$ angle of incidence in degrees

$R =$ earth radius (6,367 km)
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Edited by ALEXANDER A. MCKENZIE

Type 6X4 Tube Applications

BY WALTER R. JONES

Panel on Electron Tubes
Research and Development Board
New York, N. Y.

Beginning with this issue, ELECTRONICS will publish a number of specialized tube application notes as they become available. This material results from activities of the Applications Subcommittee of the Panel on Electron Tubes, Committee on Electronics, Research and Development Board, with headquarters at 246 Broadway, 8th Floor, New York, N. Y. Working as teams, two or three tube applications engineers from the industry, together with a service representative, have been investigating proposed uses of tubes in military equipment. Typical data obtained is presented below.

ONE OF THE MOST FREQUENT PROBLEMS encountered in military electronic equipment involves application of type 6X4 tubes in capacitor-input circuits at a power-supply frequency of 400 cycles. The problem arises because sufficient impedance is not included in each plate circuit to limit the steady-state peak plate current and the hot-switching current to their respective rated maximum values. When either of these currents exceeds the maximum safe rating, the tube may become permanently damaged and the power transformer and first filter capacitor may also be ruined.

To avoid many tedious calculations, three charts have been calculated that fulfill criteria for safe operation for type 6X4 operated with capacitor input. If the proposed operating point falls within the shaded area of all three charts, then the circuit should give reliable operation. Figures 1 and 2 are based on the assumption that the maximum safe peak steady-state current is 210 ma per plate, while Fig. 3 is based on the assumption that the maximum allowable hot-switching current is 1.8 amperes.

It is only necessary to make three measurements at maximum line voltage or primary supply voltage.

![Fig. 1—Operation for 6X4 with 210 ma maximum safe peak steady-state current per plate](image1)

![Fig. 2—Load current vs efficiency for 6X4 for 210 ma peak steady-state current](image2)

![Fig. 3—Operation for hot-switching current of 1.8 amp](image3)

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These measurements are:

(A) d-c load current (divide this value by 2 if full-wave circuit is employed).

(B) d-c voltage at input to filter

(C) a-c rms no-load voltage across transformer secondary (half of winding if full wave circuit is employed). A high resistance voltmeter must be employed in order that the true no-load voltage is obtained. Fig. 4 indicates where these measurements are made. A calculation of rectification efficiency is made by dividing

(B) 1.4 (C)

The operating point can thus be located on Fig. 1. If this point falls within the area of permissible operation then the operating conditions can be checked on Fig. 2. In the event that the proposed conditions satisfy both charts then it can be certain that the maximum safe steady-state peak current will not be exceeded. If the point is outside the area of permissible operation, the operating conditions should be changed so that the new

February, 1953 — ELECTRONICS
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*Capacitance range may be increased to ±120 muf by use of external coils or condensers.

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It is true, of course, that the regulation will be worse with the additional resistance but for a given supply voltage and a given resistance a definite amount of current must flow. The analysis given above holds for sine-wave input. If the waveform differs from this, the peak currents may even be higher than indicated.

Transistor Organs

BY JAMES D. FAHNESTOCK
Associate Editor, Electronics

Commonest among the point-contact transistors available today at reasonable cost is the Western Electric 1698, a point contact version intended primarily for use in switching circuits. One or more spares can be applied, in conjunction with a handful of inexpensive parts, to a number of applications—one of which is the electronic organ shown in the accompanying photograph. Several versions are described, including one circuit that permits the playing of any two notes on the keyboard simultaneously with only one set of frequency-determining capacitors and two transistors.

The basic circuit employed is shown in Fig. 1. This circuit is a simple relaxation oscillator that provides a pleasing tone in the headphone. Volume is sufficient to be heard all over a large-size room. The exact values of capacitors must, of course, be determined by trial and error. Any desired note may be obtained, by applying the proper value of capacitance across the emitter resistor $R_e$, from a few cycles per second up through the entire audio range. Output decreases slightly with frequency,
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THE FRONT COVER

The large tube undergoing test is a type VC-1257, 38,000 peak kilowatt hydrogen thyratron developed by Chatham Electronics Corp. for the Signal Corps. Presently used to generate high-amplitude pulses 1 to 100 μsec long for radar and cyclotron applications, the tube is rated at 2,000 amperes peak and 2 amperes average anode current.

A hydrogen reservoir of powdered titanium hydride hidden within the base permits adjustment of operating pressure within the main bulb to optimum for any operating conditions. This feature provides a source of hydrogen capable of supplying 50 times original tube volume and eliminates gas clean up.

However, so for loud tones, the low notes are preferred.

Different ranges may be obtained by varying $R_a$, but different values of capacitance are needed to obtain frequencies in musical progression.

The experimental unit shown in the photograph was made from a child's toy piano by removing the resonant rods and hammers and modifying the keys as shown in Fig. 2. Thin strips of brass were tacked to the ends of each key and a strip of brass running below the metalized tips of the keys serves as a common bus.

With appropriate capacitance values connected by small flexible wires to each key note of the scale can be played. Interesting combinations of low notes can be synthesized by depressing combinations of keys simultaneously, which parallels clusters of capacitors to produce low frequencies.

Two-Note Organ

Considerably more flexibility can be obtained at the cost of some added complexity as illustrated in Fig. 3. With the arrangement shown, combinations of two notes may be played with a single keyboard and a single set of frequency-determining capacitors, and two transistors.

Collector current averages 3 to 5 ma, which is well within the limits of the 1698 transistor, and allows for long life of the 45-volt battery.

In experimenting with values for $C$ and $R_a$, it is advisable to place a 0 to 5 ma meter in series with the collector to protect the transistor against accidental overloads. The value of 1,000 ohms for $R_a$ will work for most 1698's, but variations may be desired for changing range, or for tuning up with instruments. A 5,000-ohm potentiometer was used in the experimental organ shown, but it is usually set at the 1,000-ohm value. An octave is covered by eight sets of capacitors ranging from about 0.75 to 0.25 μf.

The switch is provided in the collector lead to disconnect battery when organ is not in use, since some battery current flows when no keys are depressed.

PERTINENT PATENTS

Each week many hundreds of patents are granted to inventors in all of the arts to which patents apply. A survey of recently issued patents made over an arbitrarily selected period of four months during 1952 reveals that of all the patents issued in any week the average number of those applicable to the electrical and electronic arts represents 12 percent of the total. A maximum of 14 percent of all patents was electrical or electronic in the week containing the largest relative number of these patents. The minimum number represented 8 percent of the total.

Patent Groupings

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This diffusion pump, CVC model MC-275, is capable of producing an ultimate vacuum of approximately 5 x 10^-5 mm Hg.

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If you would like complete technical data on this unit, or perhaps information on some of the many other ways in which CVC is putting high vacuum at industry's service, simply write to Consolidated Vacuum Corporation, Rochester 3, N. Y. (subsidiary of Consolidated Engineering Corporation, Pasadena, Calif.)

CVC's 10-Port Vacuum Manifold System in use at Barber-Colman Company, Rockford, Illinois.

Consolidated Vacuum Corporation
high vacuum research and engineering
now included in its Official Gazette. The publication groups all mechanical and general patents in one section and all chemical patents in a second. Electrical patents (including electronic devices and circuits) are in a third grouping. In each of the sections other than electrical there may be included occasionally devices that are electrical or electronic in nature. As an example, phonograph pickups, motors and record changers have been found in the mechanical and general section. Semiconductor devices, particularly those features dealing with the structure of the materials employed, crop up in the chemical section.

New Patent Law

A new Patent Law of 1952 went into effect January 1953. This law modifies previous law and codifies the several laws pertaining to patents into U. S. Code section 35. There will be, accordingly, changes in the rules of practice in the prosecution of patents before the Patent Office and in the operation of the

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Dental Pulser

Active interest has been shown by ELECTRONICS readers in the diagnostic applications of electronic devices in medicine. The grant of U. S. Patent 2,603,753 to Karl N. Axelsson, and Carl H. Bjorn, of Djursholm, Sweden for an "Apparatus for Examining Teeth" is in line with this interest. In Fig. 1 the circuit diagram of the apparatus is shown. In Fig. 2, there are shown waveforms of the output of the device as applied in dental pulp testing.

A pulse of current generated by the device is used to excite the patient's tooth to determine whether the pulp is dead or anaesthetized. The strength of the current AC of Fig. 2, at which the threshold of feeling is observed is the measure of the state of health of the pulp. If no reaction is observed at a level of 40 to 60 μamp this is evidence of anaesthetization or necrosis of the pulp.

There is a definite requirement of a steep rise in the initial pulse period, but the decay period does not necessarily have a similarly steep fall. The pulses, however,
must be unidirectional and have a substantially rectangular shape, rising to the intended value steeply and remaining at this level for a predetermined period, which in practice is 5 to 40 milliseconds.

The circuit for generating the pulse may be any well-known pulse generator device. The inventors' preferred embodiment is shown in Fig. 1. A pulse having the shape $ABE$ is generated across resistor $R$, by RC network and the gas-discharge tube acting as a relaxation oscillator. The pulse applied to the amplifier grid is limited by the diodes shown to a shape $ACDE$. The output of the amplifier is applied through electrodes one of which contacts the tooth and the return circuit electrode is held in the patient's hand.

_Pulse Width Discriminator_

Patent 2,609,501 has been granted to G. B. Guthrie Jr., assigned to the United States of America as represented by the Secretary of War, for a "Pulse Width Discriminator Circuit." The circuit of this invention is shown in Fig. 3. A group of representative waveforms is shown in Fig. 4. The circuit will accept only pulses of a critical duration $t_0$ or greater and independent of the amplitude of the pulse. Tube $V_1$ is normally conducting; $V_2$ is nonconducting by virtue of the drop across the common

FIG. 5—Mounting and contacts for crystal triode

FIG. 6—Circuit of the disk-contact crystal triode

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Hard practical experience gained during extreme service conditions in World War II and the present Korean War dictated the necessity of using strong, dependable, corrosion resisting materials in the construction of the R-366/TRR5 radio receiving set designed for use by the United States Marine Corps. Ocean spray, wide temperature and humidity ranges, rough handling, and a minimum of maintenance care are a few of the many points which required consideration.

It is only natural that copper-base alloys due to their resistance to corrosion, ease of machining, ability to take plating, and lack of magnetic properties should play an important part in the construction of this receiver. For example, brass is used for brackets, mounting hardware, gears, bushings, solder lugs, control shafts, tube socket bases, shields, etc.

For dependable electrical and mechanical contacts, hot tinned brass (70% copper, 30% zinc) solder lugs are used exclusively on all terminal boards. They are easy to manufacture, take solder well and offer high resistance to corrosion.

Band Switching Assembly

A highly efficient positive acting band switching arrangement for trouble-free service is one of the main features of this receiver. The coils are completely enclosed fully protecting them from dirt and damage from handling. Screw studs made from free machining brass rod (approximately 61% copper, 3.4% lead, remainder zinc) support the tuning slugs used for adjusting the various circuits and are located on the ends of the two large housings for making adjustments without opening the sealed units and exposing the coils. The complete assembly is suspended between two cast bronze brackets for rigidity.

The band selector switch operates through a geared mechanism consisting of a brass gear (approximately 62.25% copper, 2% lead, balance zinc) and an indexing device which rotates the two coil housings, changing their beryllium copper supported coin silver contact points and connecting the 32 phosphor bronze (approximately 95% copper, 5% tin) shorting fingers. In this manner, the desired coils are connected into the circuit and the unused ones completely disabled.

Brass Tube Shields

Fifteen nickel-plated cartridge brass (70% copper, 30% zinc) tube shields are used to prevent unwanted voltages from being picked up or radiated by the various tubes. The shields are fastened to nickel-plated brass shield bases which are formed to the tube sockets. The shields themselves are removable to allow tube changing.

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Top view of receiver R-366/TRR5 showing Band Switching Assembly, which has brass gears, cast bronze mounting brackets, and phosphor bronze shorting fingers. Other brass parts illustrated are tube shields, control shafts, tuning slugs, and mounting brackets. Courtesy Espey Mfg. Co., New York

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- **HIGHEST FIDELITY**
  Even when programs are repeatedly transcribed from one tape to another, there is no noticeable build-up of noise level, "wow" or distortion.

- **LONG LIFE**
  AMPEX Recorders are designed and built for years of service dependability. Its recordings match established NARTB standards. When you have an AMPEX, you have a machine built for years-ahead performance.

IF YOU PLAN FOR TOMORROW, BUY AN AMPEX TODAY
cathode resistance $R_c$.

A signal as shown in waveform $A$ applied to the input of $V_i$ appears at the cathode as shown in waveform $B$. At the grid of $V$, the waveform of $C$ appears because of the integrating action of $R_c$ and $C$. When at time $t$, the voltage across $C$ equals the amplitude of the pulse appearing on the cathode of $V$, (same as cathode of $V_i$), $V_i$ becomes conducting to produce a negative output pulse as at $D$.

If, however, the pulse duration $t_i$ is less than the time required for capacitor $C$ to reach the critical value at which the grid of $V_i$ will be more positive than the cathode, then $V_i$ will not conduct and not pass the pulse. This condition of operation is shown in waveform $E$.

**Knife-Edge Transistor**

In the transistor fields, patents are currently appearing in rapid succession. Recent patent 2,610,234 granted to A. H. Dickinson, assignor to the International Business Machines Corp., for a novel “Crystal Triode” is of some interest as an indicator of development trends in this art.

To overcome disadvantages of two point contacts in the conventional transistor, Dickinson’s transistor employs a whisker as the emitter element and a knife-edged cylinder attached to a disk. The disk surrounds the whisker tip in a construction that can be seen in Fig. 5. A circuit connection that can be used for this crystal is shown.

![Graph](image-url)
More Applications Per Dollar—

Identical, Highly Stable D-C Amplifiers! Better High Frequency Response than any other scope in its field!

FROM low level DC measurements requiring good stability to observing wave forms with significant components as high as 1 mc, the ST-2B gives outstanding service. Designed to permit a choice of short, medium or long persistence CR tubes, the unit incorporates identical direct coupled vertical and horizontal amplifiers. Filaments and screens on the first amplifier stages are regulated. Vertical selector switch allows choice of probe, calibration, AC or DC inputs.

GERMANIUM DIODE CHECKER

For use in laboratories, quality control groups.

For use in laboratories, quality control groups. Measures the static characteristics of diodes. FORWARD RANGES: Current-0.3, 1.2, 6 and 12 milliamperes full scale. Voltage-0.5 and 1.2 volts full scale. INVERSE RANGES: Current-60, 120, 300 and 1200 microamperes full scale. Voltage-1.2 and 12 volts full scale.

POWER REQUIREMENTS: 105-125 volts, 50/60 cycle, approximately 10 watts.

SPECIFICATIONS—MODEL ST-2B

FREQUENCY RESPONSE
Vertical Amplifier
DC-0 to 100 kc. +0, -20%, not more than 50% down at 100 kc.
AC-10 cycles to 100 kc. +0, -20%, not more than 50% down at 100 kc.
Probe-2 cycles to 100 kc. +0, -20%, not more than 50% down at 100 kc.
Response independent of gain or attenuator setting.

Horizontal Amplifier
DC-0 to 400 kc. +0, -20%, not more than 50% down at 100 kc.
AC-10 cycles to 100 kc. +0, -20%, not more than 50% down at 100 kc.
Response independent of gain or attenuator setting.

SENSITIVITY
Vertical.......................... AC-10 mv, rms inch
Horizontal.......................... DC-25 mv, dc inch
Probe............................ DC-12 mv, rms inch
Deflection Plates Direct Vertical.......................... 22 volts rms inch
Horszontal.......................... 25 volts rms inch

SWEEP
Range-Triggered or recurrent-2 cycles to 30 kc (may be extended downwards by adding external capacity across panel jack).
Sync-Internal, Ext. or Extern. (requires -3 volts peak to peak for external sync). Sync limiter on recurrent position.
Sweep Expansion-At least 4 times tube diameter.

PHASE SHIFT—Negligible phase shift between amplifiers from 0 to 300 kc.

BLANKING—2-axis blanking requires 20 volts peak to peak.

CALIBRATION—Eight voltages available by selector switch-1, 3, 10, 30, 100 and 300 volts peak to peak (±15%).

DIRECT CONNECTIONS TO DEFLECTION PLATES—Available through capacitors; internal positioning circuits still function.

General Electric Company, Section 423
Electricity Park, Syracuse, N. Y.
Please send me a copy of the following bulletins:
□ ST-2B (ECL-4) □ ST-12A (ECL-3)

NAME:
COMPANY:
ADDRESS:
CITY:
STATE:

GENERAL ELECTRIC
These Industrial Timer Corporation timers provide accurate and highly dependable instruments for control of a single operation or multiple operations (simultaneously or in sequence).

OUTSTANDING FEATURES ARE:
(1) the wide range of over-all time cycles obtainable from any one model;
(2) the ease with which over-all time cycles can be changed;
(3) the simplicity with which individual cams can be adjusted for ON and OFF periods, and positioned in specific timing sequence.

Highly Dependable
Synchronous Motor Driven
Cam Timers

Series CM CAM RECYCLING TIMERS
The Series CM Cam Recycling Timer repeats a definite electrical ON and OFF time cycle continuously. The cam is coupled to the motor by means of a simple gear and rack assembly—and the over-all time cycle can be easily changed by substituting gear racks. (Bulletin 33)

Series MC MULTI-CAM TIMERS
The Series MC Timer is identical to the CM Timer, but operates 2 to 6 circuits. All cams are mounted on a single shaft, which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. (Bulletin 34)

Series RA SINGLE CYCLE CAM TIMERS
The Series RA Timer provides a single time cycle upon being actuated electrically from remote control. A pawl on the cam eliminates necessity for prolonged closing of relay switch when starting. (Bulletin 35)

Series RC SINGLE CYCLE MULTI-CAM TIMERS
The RC is identical to the RA, but operates from 1 to 6 additional circuits. Thus it provides all the features of the Series MC Timer, plus the single cycle control afforded by the RA. (Bulletin 35)

Send us specifications, and we shall make recommendations based on your particular needs. Bulletins sent free on request.

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY— Time Delay Timers • Manual Set Timers • Tandem Automatic Recycling Timers • Running Time Meters • Instantaneous Reset Timers

INDUSTRIAL TIMER CORPORATION
115 Edison Place, Newark 5, N. J.

February, 1953 — ELECTRONICS
Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3 AM. Stability .003% using CR-7 (or HC-6U) crystals. Operates in ambient 0° to +45° C using mercury rectifiers; -35° to +45° C using gas-filled rectifiers. Power supply, 200-250 volts, 50/60 cycles, single phase. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.
HERMETICALLY SEALED RELAYS
Write for Bulletin ASR

INDUSTRIAL CONTACTORS
with Plasti-Clad Magnet Coil
Write for Bulletin 600

A.C. MAGNETIC STARTERS
With Plasti-Clad Magnet Coil
Write for Bulletin 605

Full accessibility in a small package.
Contacts, coil and thermal element replacement with use of screwdriver only. Magnet coil—in molded phenolic case with riveted terminals—is completely embedded in a rock-hard resinous material, thus protecting against oil, dirt, moisture and normal mechanical damage.

50% smaller—lighter.
R-B-M 22204-0 meets AN 3304-1 specifications. R-B-M engineers have developed the 22300-0 currently used in government electronic, airborne and ground equipment—as the electrical and mechanical equivalent of the AN 3304-1, yet 50% smaller in size with 1/2 the weight.

2-8 poles Non-Reversing,
2-5 poles Reversing.
25 Amp — 600 AC Max.
Contacts can be replaced without removing wiring. To change coil, remove magnet frame and coil assembly only. 10 and 15 amp. poles can be changed from normally open to normally closed by using screwdriver only.

Low cost. Small size.
Dependable performance.
Available in many contact arrangements.
Whatever your needs for inexpensive, dependable relays for commercial applications—investigate R-B-M General Purpose Relays.

Other R-B-M products include: motor overload protectors, motor starting relays and low voltage DC electrical devices.
Consult R-B-M On Your Control Problems—Write Department B-2

ELECTRONS AT WORK (continued)

FIG. 8—Corn popper uses r-f to explode kernels in plastic bag. Alternative system pops corn, bags it later in Fig. 6 on p 165.
Performance of the Dickinson crystal triode is indicated in the curves of Fig. 7, which compare the output vs input characteristics of the Dickinson crystal with typical crystal triodes previously reported.
More output voltage for a given input signal and a lower output impedance are claimed by Dickinson, and in view of the latter characteristic a greater response at higher frequencies of operation.

Corn Popper
Use of electronics for automatically popping corn in a coin-operated vending machine is the subject of patent 2,603,142 granted to C. C. Miller of Altadena, Calif. for "An Apparatus for Popping Corn by High Frequency Radiation."
A measured quantity of corn kernels already sealed in their plastic container are passed through the dielectric field of an r-f oscillator and the kernels are popped instantaneously. A diagram of this mechanism is shown in Fig. 8.

Transistor Amplifier
Patent 2,609,459 granted to G. Bergson, assignor to the Radio Corp. of America, for a high-input

FIG. 9—Transistor amplifier uses impedance between emitter and collector

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS

www.americanradiohistory.com
Serles AJ Helipot models are only 3/4" in diameter and 1/3" long; weight 1.0 oz. Ten-turn 18" Aide wire gives adjustment accuracy of 1/3000 in a 100-ohm unit—1/6500 in a 50,000-ohm unit.

Helipot achieves "HIGHEST PRECISION" with DRIVER-HARRIS RESISTANCE WIRE

To win consumer preference and assure customer satisfaction, Helipot Corporation is guided by a basic policy that has proved as effective as it is simple. It is:

1. to produce components of the highest precision, and
2. to realize the economies inherent in mass production.

By following these objectives, Helipot has become the world's largest maker of precision potentiometers, producing the widest selection of single-turn and multi-turn units available anywhere.

States Helipot: "Our policy of mass producing the highest precision potentiometers practicable, in order to deliver top quality at moderate cost, is reflected in the fact that standard linearity accuracy of all our stock models, selling competitively, is held to ±0.5%. Our reliance on Driver-Harris alloys such as Nichrome V, Advance, and Karma to provide resistance windings for many of our products constitutes a strong endorsement of Driver-Harris skills and reliability."

Driver-Harris takes particular pride in having played so important a role in the Helipot story, and is fully conscious of the responsibility the confidence of this famous manufacturer imposes.

Nichrome*, Advance*, and Karma* are at your service, too; as are more than 80 other alloys developed exclusively by Driver-Harris for application in the electrical and electronic fields. We feel confident that, like Helipot, you will realize outstanding advantages by putting one or more of them to work for you. Let us have your specifications. We'll be glad to make recommendations based on your specific requirements.


Solo producers of Nichrome, Advance, and Karma

Driver-Harris Company

HARRISON, NEW JERSEY
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco
In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

ELECTRONICS — February, 1953

Makers of the most complete line of electric heating, resistance, and electronic alloys in the world

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Here is help in securing the right fastener for your particular needs in metal-to-metal and metal-to-wood applications. SOUTHCO engineers work with you to find the standard or special fastener that means lowest overall costs.

Holding power, speed and ease of installation, elimination of special tooling, convenience of use in opening and closing applications . . . each factor involved is analyzed to assure the best fastener at lowest possible cost. When special designs are indicated, the experience and background of SOUTHCO engineers in solving thousands of fastener problems can be of special value to you.

When you are faced with a fastener problem, write SOUTHCO Div., South Chester Corporation, 1417 Finance Bldg., Philadelphia 2, Pa. District Offices are located in principal cities.

SOUTHCO

FASTENERS

OFFICES IN PRINCIPAL CITIES...

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

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February, 1953 — ELECTRONICS
MICROWAVES EQUIPMENT...

FROM V.H.F. TO S.H.F.

* RADAR TEST SET
S AND X BAND

LABORATOIRES R. DERVEAUX
S. A. R. L. AU CAPITAL DE 20.000.000 DE FRANCS
TÔUREAUX ET USINES
6, RUE JULES-SIMON - BOULOGNE-SUR-SEINE
Tél.: MOLITOR 37-00

LABORATOIRES
64, RUE DU CHATEAU - BOULOGNE-SUR-SEINE
Tél.: MOLITOR 73-90 et 91

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Battery Connectors

8-pin type for both A and B batteries used in all types of field communication equipment. "RUGGEDIZED" for extra security and long service life; polarizing stud is ALL METAL and all metal parts are cadmium plated and sealed with an iridite sealer. Cable may be brought out at any desired side position and locked. Handy bail makes removal from inaccessible places easy.

Quick Disconnect

Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbf., excepting pin friction). Vibrator proof, moisture proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL-C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed.

Receptacle Types:
Rounded flange single hole panel-mounted, square flange for 4 bolts, or specially flanged to specification. All contacts silver plated.

FIG. 10—Frequency meter measures discharge of Geiger tube.

Electronics at Work (continued)

Impedance transistor amplifier describes circuit means for accomplishing the claimed results.

By the insertion of an impedance between the emitter and collector electrodes, as shown in Fig. 9, Bergson shows that when the output is taken from a point on this impedance the input impedance of the transistor amplifier is raised to a much higher level. Improvement results in the operation of transistor amplifiers by reduction of the loading effect of the normally low input impedance shown by previously disclosed transistor amplifiers.

Briefly the operation of the high-impedance transistor amplifier may be described as follows. The output is derived from load resistor $R_l$ in the collector circuit of Fig. 9. A part of the output current flows to the emitter circuit and opposes the emitter current to raise the input impedance and increase the gain of the amplifier.

Frequency Meter

A rather unusual frequency meter of particular application to Geiger-Müller tubes is the subject of patent 2,599,512 granted to H. Conviser, assignor to Bendix Aviation Corp.

The frequency meter is illustrated in Fig. 10. In operation ionization of the G-M tube applies a pulse of negative polarity across capacitor $C$ on to the grid of a stable free-running blocking oscillator to quench the oscillator for the duration of the pulse. During this quenched interval the cathode bridge $R_1, R_2, R_3$, and $R_4$ made up of temperature-sensitive resistors and forming an arm of the Wheatstone bridge averaging circuit, will no longer have a potential across it to unbalance the bridge and provide

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
The permanent magnet material that offers an energy product averaging 5 1/2 million BH max or more, with 5 1/4 million guaranteed.

Whether your problem is new design or product improvement, take advantage of the greater energy product INDIANA HYFLUX Alnico V offers!

These exclusive, new, super strength permanent magnets mean lower production costs, more compact design and higher efficiency for your products.

What’s more, INDIANA HYFLUX — with its 16% greater energy product — costs not a penny more than regular Alnico V!

Here’s still another bonus you’ll enjoy! THE INDIANA STEEL PRODUCTS COMPANY, world’s largest producer of permanent magnets, offers free of charge its wealth of experience and “know-how” that has developed more than 30,000 permanent magnet applications.

Let INDIANA engineers help you with your design problems. They can supply — out of stock — many types and sizes of INDIANA HYFLUX Alnico V for your experiments, can suggest those best suited to your product.

INDIANA is the only manufacturer furnishing all commercial grades of permanent magnet alloys. You have a choice of cast, sintered, formed or ductile materials.

Why delay — write or phone INDIANA today. Ask for Catalog No. 11A-5 that describes stock experimental magnets.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA • • • Sales Offices Coast to Coast

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908
**Need Precision Pots NOW? CALL HELIPOT!**

When you need top quality potentiometers fast, call Helipot...

...first in precision potentiometers!

Shown on these pages are various types and ranges of Helipots—both single and multi-turn—that Helipot now stocks for immediate delivery. You can have stock prototypes immediately. On large orders, write for stock item, initial delivery in substantial quantities will be made promptly, with delivery on close schedule.

Prompt attention will be given your requirements for Precision Pots to your specifications.

Helipot's objective is to give the same flexibility and efficiency as a department of your own company. Our trained sales and engineering personnel and unequalled facilities are ready to serve your needs, whether in small or large quantities.

For fast service, call the nearest representative listed below.

Or, write, wire or phone direct!

---

**TABLE OF STOCK VALUES**

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Design details on above units subject to change without notice. Complete drawings available on request.

Engineering Sales Representatives are located near you to assure personal attention. Telenet connects our New York, Boston, Chicago, and Los Angeles offices for rapid information on orders and deliveries. And our Mountaionside, New Jersey plant, now under construction, will soon be in production to further assist you.

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**THE HELIPOT CORPORATION**

A Subsidiary of Beckman Instruments Inc.

SOUTH PASADENA, CALIFORNIA
**TABLE OF STOCK VALUES**

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<td>A small, extra rugged single-turn pot developed initially for aircraft servo mechanisms. Its compact size, high accuracy, long life make it ideal for many instrumentation and servo-mechanism applications.</td>
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**OTHER UNIQUE HELIPOE PRODUCTS**

**MODEL RA Precision Duoduals**

A beautiful, precision-built, multi-turn dial of compact dimensions (13/16" dia.) for all types of quality multi-turn installations. Features unique "jump" mechanism that keeps secondary dial stationary when primary dial has completed a full turn - then secondary dial "jumps" to new position. A vibration-proof lock holds dial settings whenever desired. Black nylon knobs, satin aluminum dials, quality "wax" appearance throughout. Available in 10-turn design for use with 3-5, 3-10 Helipots and in RA version for use with small AJ Helipots. Write for full details.

**MODEL W Duoduals**

A large diameter (1/4") multi-turn dial ideal for primary control applications. The inner dial shows the exact position of the slider on any multi-turn Helipot, while the outer dial shows the particular turn on which the slider is moving. Thus with 10-turn units, readings can be made directly in decimal equivalents of total resistance without a meter. Since primary dial is direct-connected to shaft, backlash is eliminated. Available in 10:1, 15:1, 25:1, and 40:1 ratios for use with various Helipot models as well as with other multi-turn equipment. Write for full details.

**LABORATORY HELIPOE - MODEL T-10A**

This unit comes in a handsome walnut case a 10-turn Helipot, an "RA" Duodual, and three-way binding posts for quick connections and testing experimental or temporary circuits. Ideal for laboratory and instruction purposes, it is far more compact, simpler and 5 times smaller than other models. Write for full details.

Heliport and "Duodual" T. N. Reg.
...when the Milford Method may save you thousands of dollars in costly fasteners and assembly!

ask about the Milford Method

This scientific approach to product and parts assembly is a fastener-engineering consulting service which analyzes your needs at the blueprint stage... before you invest in expensive tools and dies! It projects for you the right fastener. Look into the economics of the “MILFORD METHOD” now. Send your blueprints and samples for analysis and planning by the “MILFORD METHOD”, or write for the “Milford Method” brochure today.

ELECTRONS AT WORK

Prediction of Electronic Failures

The failure of a tube or other component in an electronic device can happen suddenly or result from gradual deterioration. Possibility of sudden failure can be reduced only by improvement in design, but the nature of gradual deterioration makes possible the detection of a failing component before it becomes inoperative.

Detection of incipient failure in multistage equipment by input-output measurements is unreliable. Tolerances in overall measurements may mask changes caused by deterioration of a tube in one stage, and the point at which deterioration becomes detectable may practically coincide with the failure point. In order to make successful predictions a means of testing individual stages is necessary.

A technique developed experimentally by the National Bureau of Standards permits an unskilled maintenance man with a portable failure-prediction unit to test slightly modified equipment for failing components. The prediction unit includes a 3,000-cycle oscillator, voltage sensing circuits, a leakage detection circuit and an alarm light.

Measurement Procedure

In use, the unit is plugged into the device being tested and a multi-
better than 0.02 of 1% accuracy

Designed to the most exacting specifications for such applications as timing operations in industrial laboratories or for measurement processes in the chemical and metals industries. Incorporates new principle of differential clutching that prevents slippage and overrun and insures unusually high accuracy and dependable performance.

**FEATURES**

- **High Accuracy**... Better than 0.02 of 1% of full scale reading.
- **Positive Clutching**... Differential gear clutch provides positive action. No friction element to slip or wear. Accuracy further improved by clutching at a high-speed part of the gear train.
- **Extra Strength Motor**... High torque motor insures adequate reserve for adverse operating conditions.
- **Easy-to-Read Dial**... Large sweep hand permits extremely precise readings.
- **Compact Size**... Takes up minimum space on crowded panels... ideal for portable or airborne equipment.
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In this unique clutch mechanism, the motor is permanently connected to the sun gear of a differential gear system. A solenoid pawl moves between the two differential members so that only one is free to rotate at one time. Starts and stops are thus effected by positive engagement of pawl with gears. There can be none of the slippage or overrun associated with friction clutches; nor can characteristics change with age.

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made from SILECTION strip
(grain-oriented silicon steel)

The use of “E” cores, wound from grain-oriented silicon steel, results in weight and size reduction as well as higher efficiency and possible cost savings. “E” cores can be supplied in a variety of window sizes and core areas from 1, 2, 4 or 12-mil Silectron strip, for high or low frequency 3-phase applications. All Arnold cores are made by precision methods, and carefully tested under closely controlled conditions to assure highest quality and reliability. We’ll welcome your inquiries.

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Position switch is used to connect the tester with individual stages. Audio signals of different predetermined levels are applied to the grid of each stage. Each of the input signals is preadjusted so that the voltage-sensing circuit will actuate the alarm light if the gain of the stage has decreased by more than the safe amount. A separate three-position switch on the test unit allows capacitor-leakage sensing and voltage-and-current sensing, in addition to gain sensing.

In electronic equipment, the most common cause of failure is defective tubes. The failure predicting unit operates by sensing the decrease in transconductance of tubes in critical stages. To do this, the tube is operated as a resistance-coupled amplifier. A 3,000-cycle signal is applied and the sensing unit determines if the gain has fallen below the predetermined limit. Defects in components other than tubes will be detected by this test if their change affects the gain of the stage.

In developing the failure-predicting unit, six 18-stage military receivers were modified to permit insertion of the audio signal and measurement of gain. The receivers were then subjected to a 1,000-hour accelerated aging test. Temperatures were cycled between 10°C and 120°C with a total period of fifteen minutes. Voltages were maintained at 15 percent above design values and plate voltages were raised periodically to 150 percent of normal for one second, to simulate switching transients. Prediction checks were made every five hours.

In the thousand-hour test period, 79 tube failures occurred in the six 11-tube receivers. Of these failures, 65 were of the gradual and predictable type. There were 14 open and short circuits, six of which occurred during a 60-hour period when heaters and plates were cycled one minute on and one minute off. The other eight failures were spread over the remaining 940-hour period.

Of the 65 predictable failures, 58 were accurately predicted many hours before the receiver failed. Of the seven predictable failures not successfully predicted, four were in...
are more and more industries specifying ADLAKE Mercury Relays for Timing and Control Functions?

...BECAUSE they are designed and built to meet the most exacting needs of industry! They've won their place by proven dependability—year in and year out—in jobs that conventional relays can do in an uncertain manner at best! For every ADLAKE relay is tested—and guaranteed—to meet specifications!

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...And every ADLAKE Relay is tested—and guaranteed—to meet specifications!
The Type 2003 contains, in addition to the tuning fork, all circuit components which are selected or critical. The tube and remaining components — three resistors and two .01 capacitors — are external and can be laid out and integrated with your equipment.

TUNING FORK STANDARD, hermetically sealed.
SIZE — 4½ inches long. 1½ inches diameter.
SIMPLE EXTERNAL CIRCUIT, 1 tube, 3 resistors, 2 capacitors.
TUBE — Choice of 12AT7, 6201, 5751, 6BF7, 6BG7 or 6021.
POWER REQUIRED, 75 to 300 V at 1 to 5 m.a. — 6.3 V at 300 or 350 m.a.
AVAILABLE — in 400 or 500 cycles.
ACCURACY guaranteed to .002%, 15° to 35°C.
Write for descriptive literature, specifying Type 2003.

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This compact, electro-mechanical controller provides sensitivity, speed of response and system stabilization under severe operating conditions. Its design and operating features have made Regohm useful for automatic control systems in which heavier, more expensive and complex, but less accurate equipment had previously been the only available solution.

**Small Size** - Regohm is a compact, plug-in device; lightweight, extremely rugged and position-free. The unit's small size does not limit its power-handling capacity. This makes Regohm a "natural" where economy of space and weight are your major considerations.

**Power Amplifying** - Regohm is a high-gain electro-mechanical power amplifier. Milliwatt variations in signal energy can control energy changes millions of times greater.

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Our engineering and research facilities can help you apply Regohm to your servo system or regulator problem. Write for Bulletin 505.00, containing a complete discussion of Regohm's characteristics and applications. Address Dept. E, Electric Regulator Corp., Norwalk, Conn.

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7 Reasons why Regohm is a natural for your control system

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February, 1953 — ELECTRONICS
a single stage where parasitic oscillations interfered with measurements, one was masked by a change in value of an overloaded resistor and four were in stages not being checked. Failures in components other than tubes were negligible.

Although the principles on which this experimental work is based are not new, the success of the tests indicate that practical failure-prediction systems can be devised and that provisions for such systems should receive the serious attention of design engineers.

Milled Block Simplifies Microwave Construction

By using waveguides cut in blocks of conductive material it is possible to reduce the bulk and complexity of microwave circuits. Sharper curves without spreading of the waveguide walls, and reduction of reflection losses in fitting mechanical components are also possible by this method.

Developed by Ferranti, Ltd., the circuit is made up of two mated milled blocks. Each block has rectangular channels half the width of the major dimension of the waveguide. When joined together the channels coincide to form complete waveguide and duplexer circuits. Guideways for t-r cells, crystals or probes can be milled where required.

The fact that the waveguides are divided through their centerline has no effect on electrical performance, and is convenient for mounting of other components.

FIG. 1—Complex waveguide circuit cut in metal block. Spaces in block allow mounting of other components.

ELECTRONICS — February, 1953
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GENERAL PLATE DIVISION
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Photographic comparison of the new G-E Drawn-oval capacitors (in color) and the conventional units they replace, showing savings in size.

New General Electric Capacitor is Smaller, 10 to 20% Lower in Price

These fixed paper-dielectric hermetically-sealed capacitors offer:
- Reduced costs—10 to 20%
- Savings in size and weight
- Double-rolled seams
- Drawn-steel cases
- Savings in critical materials

If you're using fixed paper-dielectric capacitors with case styles CP53 and CP70 in ratings from 1 to 10 muf, 600 to 1500 volts d-c or 330 to 660 volts a-c—these Drawn-oval units offer you improved reliability in addition to an opportunity for reducing the size, weight and cost of the electrical equipment you manufacture.

In the new Drawn-oval capacitors, we get minimum seam length by using drawn-steel cases, attaching the capacitor covers with a double-rolled seam of proven reliability. This construction results in a lighter, yet stronger capacitor. Actual savings in size and weight vary with case style and rating but they can amount to as much as 30%.

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For more information on the new G-E Drawn-oval capacitors, their ratings, dimensions and prices, see your local G-E apparatus sales representative or write for Bulletin GEA-5777. Address Section 407-311, General Electric Company, Schenectady 5, N. Y.
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internal inspection of the guides or insertion of attenuator wedges and other r-f components.

Time required for manufacture of circuits by this method is about one third of that required to make up a conventional waveguide assembly. The solid construction provided by the milled block technique allows the use of the block as a mount for other circuits. Amplifiers for r-f and i-f can be plugged directly into the block, eliminating the need for flexible leads.

Resistances for Symmetrical T and H Pads

Calculation of resistances used in T or H pad attenuators for a given amount of attenuation can be simplified by the use of Table I. For a symmetrical T pad, the values of \( R_1 \) and \( R_2 \) can be found by multiplying the impedance that the pad should have by the value in the table for the desired attenuation, according to the Leakurt Demodulator for Nov. 1952.

For example, to construct a 600-ohm T pad with 10-db attenuation, the resistance values are as follows:

\[ R_1 = 600 \times 0.5193 \]

\[ R_2 = \frac{600}{2} \]

FIG. 1—Values of resistors for T-type (A), H-type (B) and low-loss L-type (C) pad attenuators can be determined from Table I

ELECTRONS AT WORK (continued)

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At your service... Victoreen's capable engineering staff, designing, engineering, and adapting efficient units to your particular applications.

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The precision vibrators, used in these power supplies, are available as separate units. They are mounted in sponge rubber and hermetically sealed in a convenient plug-in unit. Proven applications include: high voltage power supplies, scintillation counters, portable Geiger counters, and portable radios. Net weight is 2 1/2 ounces.

THE MODEL 531 VIBRATOR is designed to operate from a 1.5 or 1.3 volt battery and requires as little as 18 milliwatts driving power.

THE MODEL 542 VIBRATOR is also an 18 milliwatt unit, but designed for operation in series with the primary of a transformer and from a 4.5 to 6 volt battery.

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THE MODEL 522 VIBRATOR POWER SUPPLY operates from 3.0 volts dc and supplies +900 volts at 15 microamperes and +58 volts at 0.25 milliamperes.

ELECTRONS AT WORK

(continued)

311.58 ohms; \( R \) is equal to 600 times 0.7091 or 421.86 ohms. If an \( H \) pad were required, the values of the line resistors would be half the values of \( R_1 \) and \( R_2 \), as shown in Fig. 1.

\( \Pi \) and \( O \)-type pads are equivalent electrically to \( T \) and \( H \) pads and are ordinarily used when the resistances required are more easily ob-

Table I—Resistance and Loss Values

<table>
<thead>
<tr>
<th>Multiplier for ( R_1 )</th>
<th>Multiplier for ( R_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>db</td>
<td>( R_1 )</td>
</tr>
<tr>
<td>0.5</td>
<td>0.0287</td>
</tr>
<tr>
<td>1.0</td>
<td>0.0375</td>
</tr>
<tr>
<td>1.5</td>
<td>0.0686</td>
</tr>
<tr>
<td>2.0</td>
<td>0.1147</td>
</tr>
<tr>
<td>2.5</td>
<td>0.1429</td>
</tr>
<tr>
<td>3.0</td>
<td>0.1712</td>
</tr>
<tr>
<td>3.5</td>
<td>0.1967</td>
</tr>
<tr>
<td>4.0</td>
<td>0.2263</td>
</tr>
<tr>
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<td>0.2532</td>
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<tr>
<td>5.0</td>
<td>0.2801</td>
</tr>
<tr>
<td>5.5</td>
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<tr>
<td>6.0</td>
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<td>8.0</td>
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<tr>
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<td>0.4536</td>
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<tr>
<td>9.0</td>
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<tr>
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<td>0.5193</td>
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<td>10.5</td>
<td>0.5403</td>
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<tr>
<td>24.5</td>
<td>0.8876</td>
</tr>
<tr>
<td>25.0</td>
<td>0.8935</td>
</tr>
</tbody>
</table>

\[ R_1 = R_0 \left( \frac{x - 1}{x + 1} \right) \]

\[ R_2 = R_0 \left( \frac{2x}{(x - 1) (x + 1)} \right) \]

\[ x = 10^{+d/20} = 10^{-d/20} \]

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Please don’t ask me where the many metallized "Lavite" Ceramic parts we have produced are used, because I just don’t know — but I will be happy to solve any metallizing problem you may have. Perhaps you can profit from metallized ceramics in lower production costs because of less soldering and handling — maybe it is a more solid job you are seeking — and again you may wish to eliminate awkward and costly assembly soldering. Whichever it be — please feel free to send me the specifications on your job and I guarantee a cost and time saving solution. I would like to say “send for descriptive literature” but frankly I wouldn’t know what to put into such literature — so, again I suggest you send me details of your requirements.

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Electrons at Work (continued)

Resistance values for minimum-loss L pads can be obtained from the table by the use of the following formulas.

\[ R_1 = Z_1 \sqrt{1 - \frac{Z_0}{Z_2}} \]

\[ R_2 = \frac{Z_2}{Z_1} \sqrt{1 - \frac{Z_0}{Z_2}} \]

Echo Box Provides Target for Radar Training

BY LT. ROBERT A. LATIMER
Canonnay AFIt Waco, Texas

USING AN ECHO BOX to reflect radar waves, a target trainer in use at Connally Air Force Base, Texas, simulates airborne targets on radarscopes in ground school classrooms. The device allows students to become familiar with target tracking operations before making actual training flights.

The synthetic trainer is powered by two 28-volt motors mounted on a trolley that rides a curved track on a narrow table. One motor is geared to the drive wheels of the trolley and the other is used to move the echo box on a five-foot vertical rod. By varying the speed of the motors the position of the echo box...
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DC output voltage:
From 20 volts to 80 volts
DC output current: avg. from 200 microamperes to 5 milliamperes
Reverse Leakage at 10 volts RMS:
0.6 microamperes to 2.4 microamperes
Potted in thermosetting compound
Temperature Range:
From -60°C to 100°C
Available in 1, 2, 3 and 4 cell Diodes
Send for Bulletin SD-1

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The Miniature Size with All Full Size Features!

- Low inductance  •  Soldered plates assembled with precision  •  Split sleeve bearings  •  Beryllium copper tension spring contact for permanent alignment, constant torque and low inherent noise  •  Differential and butterfly types electrically symmetrical  •  Excellent vibration characteristic due to low inertia  •  Steatite insulation impregnated with DC-200  •  Metal parts brass, nickel plated  •  Single hole mounting bushing threaded 1/4-32 with flats to prevent turning  •  3/16" shaft slotted for screw driver adjustment  •  Plate spacing .017"  •  Peak voltage rating, 1250.

Features available in production quantities: Locking bearing, 180° stop, various shaft extensions, .0135" spacing with capacities up to 30 mmfd, high torque.

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ELECTRONICS — February, 1953

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Permits triggering from composite signal.

Delayed Sweeps
Zero to 25 milliseconds from start of field—triggered at any selected line.

Field Selector
Instant shift to opposite field.

New Sweep Magnifier
3x or 10x magnification—expands sweep to left and right of center.

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More than 6 cm.

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Pips spaced 1 μsec, 0.1 μsec, 0.05 μsec, or 200 pips per television line.

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Square wave, zero to 50 V in 7 ranges, accurate within 3%; duty cycle variable from 1% to 99%.

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Lines being observed are brightened on monitor.

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Separate phase and amplitude controls.

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All dc voltages electronically regulated.

Type 524-D—$1180 f.o.b. Portland, Oregon
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ELECTRONS AT WORK

Field Experience

Early tests were described by W. M. Rust, Jr. of Humble Oil Co. and J. S. Stover, Communications Engineering Co. With a total of 20,000 petroleum stations now in operation and an increase of 5,000 a year predicted, tests were begun in 1951 using f-m receivers accepting a bandwidth of 20 kc and transmitters having a deviation of ±5 kc. Under conditions of normal noise, communications were good when an interfering station operated as close as 5 miles away. However, when receiver bandwidth was reduced to 17 kc, the interfering signal required displacement of 8 miles to re-establish comparable service. Interference from signals in adjacent bands is about the same using either wide-band or narrow-band techniques. Although the overall stability of the modified equipment has proved good, the narrow-band sets require careful maintenance.

Extensive field tests by RCA of mobile equipment having reduced receiver bandwidth and narrower transmitter deviation ratios were described by H. E. Strauss. For these tests, equipment stability was held to values such as ±0.0005 percent for receiver and transmitter oscillators. Three bandwidths were employed for systems of 60, 30, and 20 kc with transmitter deviation ratios of ±15, ±6 and ±3 kc respectively. In addition, other deviations were sometimes employed that just filled the receiver bandpass at the 6-db point. It was established that narrow-band equipment was more susceptible to noise than wide-band equipment, but that the amount of degradation caused by impulse noise had to be determined by field tests.

The JTAC tests conducted by a number of manufacturers at Syracuse, N. Y. during late October

(cont'd)
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The Foremost Name In Crystals


Types MC7, SR5 and SR8 are suggested for shipboard dependability. Price and details given in Bulletin 44.

Types BC46T, MO3B, TC92 are first choice for automatic temperature control in AM, FM and TV transmitters. Consult Bulletin 45 for basic details.

Types SR10 and MC9 provide wide range frequency choice for TV service, diathermy and citizens band. Request Bulletin 44 for price and description.

Type BH6A is the predominant choice for land mobile and airborne applications. Consult Bulletin 43 for basic information.

Types KV3, MC9, SMC100 and MS433 cover reference frequencies from 100 kc through 10.7 mc. Price and "stock tolerances" given in Bulletin 44.

Types AX2 and AX3 together with Bliley packaged oscillator Model CCO-2A were designed to bring precision and price together in the Ham Bands. Price and details are given in Bulletin 44.

Custom built fused quartz delay lines provide high stability and precision time intervals for manipulation of pulsed or pulse modulated signals. Consult Bulletin 45 for technical information.

Model BCS-1A is a high stability instrument for precision reference at 100 kc. Ideal choice for research and development laboratories. Descriptive information given in Bulletin 43.

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UNION STATION BUILDING • ERIE, PENNSYLVANIA

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were summarized by N. H. Shepard of GE who played back tape recordings showing comparisons of fringe-area signals employing a variety of systems characteristics. Receivers used were wide-nose (±15 kc), and narrow-nose (±5 kc) types, while the transmissions were characterized as wide-band (±15 kc), narrow-band (±5 kc) and narrow-band-filter types. In the latter, deviation was held to ±5 kc and the audio signal limited to 2,500 cycles.

Field tests included those of range comparison and adjacent-channel interference under varying proximity of the undesired signal. The latter tests bear importantly upon what changes will be necessary during the probable transition from present standards and older equipment to those employing narrow-band receivers and transmitters.

D. E. Noble described the operation of a year-old Miscellaneous Common Carrier serving about 100 mobile customers at Phoenix, Arizona. Standard ±15-kc deviation equipment modified for ±5 kc is used on a split-channel basis. The land station is located 30 miles from the city atop White Tanks Mountain. Included in the system is a two-way microwave link for control of car-to-car relaying. With this system, two mobile units a mile apart can be interconnected to communicate over a circuit that may be 120 miles long. In general, however, relaying is accomplished at the mountain and is seldom returned through the city operating room so the circuit is 60 miles. Mobile equipment is provided with selective calling that gives a busy signal to the car and locks out its transmitter.

Filters suitable for use in mobile channel selection were discussed by two engineers. L. J. Labrie of Bell Telephone Laboratories described a new AT-cut crystal with a single resonant response. The circular faces of this crystal are of lesser diameter than the maximum diameter of the quartz button, with a radius of curvature five times that of the face between each face and maximum diameter. Operating in a
The Westinghouse 296-million dollar expansion program has produced exceptional career opportunities in the Electronics Division, and in the new Air Arm Division in suburban Baltimore, housed in a modern new plant adjacent to Friendship International Airport.

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ELECTRONS AT WORK (continued)

thickness shear mode, the new crystal filter also requires special electrodes. Milton Dishal of Federal Telecommunication Laboratories, discussing the best filter with reference to a required i-f selectivity, analyzed L-C, mechanical and crystal devices. He showed that the coil-capacitor combination is not fundamentally inferior to newer types that are currently being recommended.

D. M. Heller of Bendix Radio and Kenneth Bullington of Bell Labs considered systems aspects of improved mobile communications. Mr. Heller showed that equipment using crystal control with an accuracy of 0.008 percent can be improved to 0.0006 percent by addition of simple temperature control. He suggested removing the residual i-f response error by improved mechanical design or temperature compensation indicating that characteristics of ±1 kc per me of mean frequency of the i-f over a range from -40 to +60 C is possible.

Mr. Bullington’s paper covered in detail the necessary considerations of a coordinated system for a large metropolitan area wherein all high-power land stations would be located near a common point—within a mile of each other. By employing automatic gain control on the mobile receivers, all nearby signals could be fairly equally attenuated, whereas at a distance intermodulation effects of undesired signals will be too weak to cause interference. Base transmitters will require r-f filters for interference falling outside the bands employed in the coordinated system, but these can be installed easily at a base station.

Coordinated reception is not possible. Mobile power should therefore be cut to two or three watts (decreasing drain on the car battery) and multiple base receivers employed. While this has some disadvantages, it provides space diversity reception, which is good. In this system, guard bands will be needed at the system frequency extremities, but the sum total of spectrum required will be less because interchannel guard bands can be extremely narrow if not entirely eliminated. The alternative
Tests show that our new A-25 rheostat is so rugged that it will stand up under the most adverse conditions!

It gives maximum wattage dissipation for its size; and the added safety factor made possible by our new high temperature blue-gray enamel.

The terminals, made of strong corrosion resistant alloy, are permanently welded to the winding form. The finest quality wire—made to our own specifications—is wound evenly on a toroidal ceramic form, and then securely bonded to eliminate troublesome connections.

The wound ring is made an integral part of the refractory base by vitreous enamel. The phosphor bronze actuating arm, to which is attached a graphite brush, gives perfectly smooth action, with excellent electrical control. And the shafts are insulated from all live parts by a strong shaft insulator.

Our A-25 units are equipped with three terminals to permit either potentiometer or rheostat use.

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Established 1886
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The mark of quality for more than half a century
How two HONEYWELL Mercury Switches are used to shut off motor when oil supply is too low

**HONEYWELL** mercury switches meet the demands for low operating force and have the additional advantage of contacts being sealed in a glass case, protected from effects of oil fumes.

Problem of the designers of a pressure lubricating device was how to use low operating force to signal the operator when the supply of oil in the reservoir became low and... if oil was not replenished immediately... to shut off the motor.

The solution was found by attaching two HONEYWELL mercury switches to a float in the reservoir. When the level dropped to where the reservoir needed refilling, movement of the float actuated one switch to turn on a warning light. If the level became dangerously low, the float movement actuated the second switch to stop the machine.

HONEYWELL mercury switches have been recognized for 30 years as precise, dependable components for many types of switching controls. MICRO field engineering service, fully experienced in every type of switch problem, is available to assist you in the choice of the proper HONEYWELL mercury switch to meet your needs. Call your nearest MICRO branch office.

**Suppressor Grid Control of Thytrons**

**By H. L. Armstrong**

*National Research Council, Canada*

**Ottawa, Canada**

**Often the simplest way to control the current supplied to a load is to provide d-c to the load by a thyatron used as a rectifier in series with an a-c supply, and to vary the conduction period by varying the time of firing of the thyatron. This**

**FIG. 1—Diagram of thyatron control circuit using out-of-phase suppressor grid voltage as trigger control.**
A precision electronic megohmmeter which for years has given satisfactory service in hundreds of laboratories and on production lines.

**SPECIFICATIONS**

- **Range:** 1 megohm to 2,000,000 megohms in six overlapping ranges selected by a multiplier switch.
- **Voltages on Unknown:** The voltage applied to the unknown terminals is 500 volts d-c and is independent (less than 1%) of the value of the unknown.
- **Stability:** Line voltage variations from 105-125 volts will cause less than 2% variation in the meter reading.
- **Power Supply:** 105-125 volts A.C. 50-60 cycles 30 watts.
- **Dimensions:** 9½ x 10½ x 8 inches.
- **Net Weight:** 18 pounds.

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If you are not familiar with the wide variety of applications of Sarkes Tarzian Rectifiers, your inquiry is invited. Our staff of engineers is ready to assist you with your power conversion problems.

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ELECTRONICS AT WORK (continued)

is accomplished usually by some combination of variable bias, and a-c 90 deg out of phase with the plate, applied to the grid of the thyatron. When the control must be accomplished by electronic means, variable bias can become difficult. The circuit described below and shown in Fig. 1 has been found to be simpler in some applications.

The idea is that the transformer is arranged so the voltage supplied to the plate of \( V_p \) is 180 deg out of phase with that at the suppressor of \( V_s \). Since the suppressor on a 6AS6 can cut off the plate current quite easily, \( V_s \) draws current only during the negative peak of voltage at the plate of \( V_p \). The drop in voltage at the plate of \( V_s \) is applied through the coupling circuit to the grid of \( V_s \), driving it negative. Then the plate of \( V_s \) is cut off by the suppressor, and the grid of \( V_s \) rises exponentially to ground. When the plate of \( V_s \) first goes positive, the grid will still be negative and conduction does not take place until the grid has risen to a certain voltage. The time required for this depends on how far negative it was driven originally. This depends on the plate current of \( V_s \), which in turn depends on its grid bias. Thus a signal applied to the grid of \( V_s \) con-
Special component assembly for large radar manufacturer features glass-to-metal hermetic seals used as feed-through and stand-off insulators.

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use this sub-assembly service
to solve your design and production problems.

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NEW TVOR

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- changes "fair-weather" to all weather airline service
- permits marginal weather landings by private and executive aircraft.

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TVOR radiates 50 watts of power, ample for most installations. It uses the same quality components and gets the same tests as CAA equipment. Installation operates almost entirely without attention. Any plane with standard VOR instrumentation can make precision approaches to a TVOR equipped field.

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MARYLAND ELECTRONIC MANUFACTURING CORPORATION
COLLEGE PARK 34, MARYLAND

ELECTRONS AT WORK (continued)

trols the current flowing through $V_p$. In the application for which this circuit was devised, the input to $V_p$ was 60 cycle from a temperature sensitive bridge, giving the circuit the advantage of phase sensitivity. It was sensitive only to an input in phase with the suppressor of $V_p$. However, d-c input works as well. Also, the role of suppressor and control grids can be interchanged.

The waveform photographs show the grid voltage (lower wave) and plate current (upper wave) of $V_p$, superimposed with an electronic switch. It demonstrates how the grid goes negative during the negative half cycle, and then rises until the tube fires and current flows. Negative grid swing and decrease in signal applied to $V_p$ is also shown with the period of plate conduction increased in the same manner, as indicated in operating theory.

Measurement of Harmonic Distortion With A Filter

SINCE IT IS CUSTOMARY to operate a magnetic recording system at the highest possible recording level that does not exceed the allowable distortion limits, it is important to have an accurate means of measuring the amount of distortion present in a system. Because recording level is also dependent on such variable factors as the properties of the magnetic medium, the bias current, the recording heads and the gain characteristics of the recording amplifier, the method should be simple enough for periodic checking of professional

![Diagram](https://example.com/diagram.png)

**FIG. 1**—Block diagram of distortion measuring system

February, 1953 — ELECTRONICS
OVER 10,000 BRADLEY UNITS in this Electronic Calculating Punch

The IBM Electronic Calculating Punch, shown above, will punch 6,000 cards per hour, performing up to 60 operating steps for each card.

The master key is the IBM Electronic Tube Assembly which comprises an electron tube and several resistors and capacitors. There are more than 1,200 of these pluggable units in each punch. With 8 or 9 Bradley units per assembly there are over 10,000 Bradley units per punch.

Bradley units are ideal resistors for such critical service, because they are rated at 70°C...not 40°C...which assures stability and permanence.

Made in all R.T.M.A. values, Bradley units are available from 10 ohms to 22 megohms in 1/2 and 2 watt sizes, and from 2.7 ohms to 22 megohms in the one-watt size. They need no wax impregnation to pass salt water immersion tests.

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Made under Western Electric license agreement, these deposited-carbon resistors serve a real need in laboratory-grade instruments and assemblies. For superlative stability under the most adverse operating conditions, Carbofilm resistors are now available in hermetically-sealed metal casings with glass-to-metal end seals. Thoroughly protected—mechanically, electrically, climatically. Guaranteed tolerance of plus/minus 1%. Available in ½, 1 and 2 watt sizes. Just about everything a precision resistor should be!

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Carbofilm resistors, in both hermetically-sealed and coated types, are available in standard values as well as special values made to your requirements. Literature on request. Let us quote on your precision resistance needs.

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ELECTRONICS AT WORK (continued)

recording machines in the field.

A method of measuring distortion with a band-pass filter developed by the Minnesota Mining & Manufacturing Co., greatly reduces the time and equipment needed for this operation. In a magnetic tape overload the principal distortion results from the third harmonic component. By recording a pure sine wave and then separating the third harmonic and measuring it with a vacuum tube voltmeter, it is possible to determine the third harmonic distortion. This set up is shown in Fig. 1. The only equipment required is an audio oscillator with good waveshape, a vacuum tube voltmeter with a fairly wide

range, and a band-pass filter. A 1,200-cps filter is ideal for this purpose since it is customary to measure distortion at 400 cps. However, a more common 100 or 5,000-cps filter can be used if the test frequency is adjusted to a suitable value. For highest accuracy, a filter having a rejection of at least 60 db at the fundamental, should be used.

Before testing a recording system it is necessary to calibrate it for the insertion loss of the filter. Since the input termination affects this value, the filter should be calibrated on the recorder under test. First, the output level is measured at 400 and 1,200 cps, with the filter disconnected, to determine if the level is the same at both frequencies. If it is not, the input must be re-adjusted during the test to compensate for the difference.

With the filter connected to the recorder, readings are taken at the filter input at 400 cps and at the filter output at 1,200 cps adjusting the input level as previously deter-
High Sensitivity Tone Discriminator

By Sidney Wald

Use of sharply tuned parallel-T R-C networks in place of L-C filters results in sensitive, compact, and inexpensive tone localizer that is useful in guidance or navigation equipment or as a low-frequency discriminator in f-m subcarrier systems.

In the usual arrangement for these purposes, band-pass L-C type filters are used in a subtractive rectifying circuit. The size and weight of these filters becomes large if reasonably high sensitivity is to be realized.

The circuit shown in Fig. 1 was designed as a tone-localizer for 90 or 150 cycle input. When equal amplitudes of 90 and 150 cps are present in the input, the meter reads zero center. When one signal amplitude is larger than the other, the d-c microammeter deflects to

---

Other Hi-Q plate assemblies provide vertical integrator, vertical integrator and coupler, audio plate grid coupler, pentode second detector and audio amplifier, pentode plate coupler and screen supply, etc.

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Regardless what your "circuit squeeze" problems may be, Hi-Q specialists can provide the ideal solution in either standard or special types. Send us those problems!
DESCRIPTION—The Berkeley Preset Counter is an electronic decade with provisions for producing an output signal or pulse at any desired preset count within the unit’s capacity. Any physical, electrical, mechanical or optical events that can be converted into changing voltages can be counted, at rates from 1 to 40,000 counts per second. Total count is displayed in direct-reading digital form. Presetting is accomplished by depressing pushbuttons corresponding to the desired digit in each column. Model 730 Preset Decimal Counting Units are used. These are completely interchangeable plug-in units designed for simplicity of maintenance and replacement.

APPLICATIONS—Flexibility and simplicity of operation make the Berkeley Preset Counter suitable for both production line and laboratory use. It has practical applications wherever signalling or control, based on occurrence of a predetermined number of events or increments of time is desired. Output signals from the unit can be used to actuate virtually any type of process control device, or to provide aural or visual signals.

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX. COUNT CAPACITY</td>
<td>422 423 424 425 426</td>
</tr>
<tr>
<td>INPUT SENSITIVITY (MIN.)</td>
<td>± 1 v. to ground, peak; at least 2 µ sec. wide</td>
</tr>
<tr>
<td>OUTPUT</td>
<td>Choice of pos. pulse and relay closure, or pos. pulse. SPST relay closure approx. 1/30 sec; pulse output is + 125 v. with 3 µ sec. rise time and 15 µ sec. duration.</td>
</tr>
<tr>
<td>PANEL DIMENSIONS</td>
<td>15½&quot; x 8¼&quot;</td>
</tr>
<tr>
<td>OVERALL DIMENSIONS</td>
<td>16¼&quot; x 10¾&quot; x 13&quot;</td>
</tr>
<tr>
<td>POWER REQUIREMENTS</td>
<td>117 v. ± 10% @ 90w.</td>
</tr>
<tr>
<td>PRICE (F.O.B. FACTORY)</td>
<td>$375 $450 $595 $695 $795</td>
</tr>
</tbody>
</table>

For complete information, please request Bulletin 102

Clutch Operates On Loudspeaker

A new clutch that will find use in instruments and computers where fast response is required, uses the same moving-coil principle as an electrodynamic loudspeaker. Developed by the National Bureau of Standards, the clutch is actuated by the interaction of magnetic field and current in a coil. The resulting force moves the coil causing the output disk to be pressed against the rotating input shaft. In an experimental model response time was less than a third of a millisecond.

The operating principle of the clutch makes it inherently capable of a faster response than is possible with most electric or magnetic friction clutches. In the loudspeaker type, the magnetic field is in existence before actuation, and the normally small induction of the coil is the only time factor involved. This coil inductance can be made...
THE KEL-F

VOLUME-PRODUCTION PRICING NOW RADICALLY BROADENS SCOPE OF APPLICATIONS FOR THIS UNIQUE THERMOPLASTIC

Volume demand now measured in the hundreds of tons and improved production methods—have combined to radically reduce the per lb. cost of Kel-F. Further, experience has shown that potential applications require only small quantities of Kel-F per finished item, because of the plastic's superior properties. In view of these two facts, design engineers are currently reevaluating the use of Kel-F for all applications where the seven basic Kel-F properties meet design or performance specifications.

LEADING MOLDERS NOW OFFER KEL-F PARTS AND BASIC MATERIALS

Already, more than 50 leading molders in the country are prepared to deliver Kel-F tubing, rod, sheet, film and strip in a variety of sizes and types of material. Many of these are supplying not only these basic fabricating materials but are also producing finished parts by the standard methods such as compression, transfer, injection and extrusion molding.

TECHNICAL BULLETINS, SERVICES NOW AVAILABLE...

Detailed data—in bulletin form—on physical properties, molding techniques, dispersions and other Kel-F products are available. The Chemical Manufacturing Division's Technical Service Department has been augmented to offer additional help to design and materials engineers, as well as molders, in the use of this unique material.

Chemical Manufacturing Division
The M. W. KELLOGG Company
P. O. Box 469 • Jersey City 3, N. J.
In N. Y. WOrth 4-6775
In N. J. Delaware 3-3100

<table>
<thead>
<tr>
<th>BASIC KEL-F MATERIALS AVAILABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Order direct from Kellogg)</td>
</tr>
<tr>
<td>Molding Powders</td>
</tr>
<tr>
<td>Unplasticized</td>
</tr>
<tr>
<td>Plasitized</td>
</tr>
<tr>
<td>(In Grade)</td>
</tr>
<tr>
<td>P20 — Containing 20% plasticizer</td>
</tr>
<tr>
<td>P25 — Containing 25% plasticizer</td>
</tr>
<tr>
<td>P30 — Containing 30% plasticizer</td>
</tr>
<tr>
<td>Dispersions</td>
</tr>
<tr>
<td>NW 25 — Flows readily at fusion temperatures</td>
</tr>
<tr>
<td>N-1 — High molecular weight</td>
</tr>
<tr>
<td>Oils, Waxes and Greases</td>
</tr>
<tr>
<td>Five grades — from Light Oil to Hard Wax — are available. Details on request.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USE KEL-F when applications require —</th>
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<table>
<thead>
<tr>
<th>Properties</th>
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<table>
<thead>
<tr>
<th>CHEMICAL INERTNESS</th>
</tr>
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<tbody>
<tr>
<td>No effect has been observed after prolonged exposure of Kel-F to concentrated sulfuric, hydrochloric acid, hydrobromic acid, to strong caustics, to fuming nitric acid, aqua regia, and other vigorous oxidizing materials. It is equally resistant to most organic solvents.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELECTRICAL RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kel-F has high resistance to electricity... is a poor conductor of heat... and its electrical properties are superior to most plastics. Dielectric constant is in the range of the best available materials.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZERCO MOISTURE ABSORPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>In continuous tests, Kel-F exhibited zero water absorption. It is not wet by water... is unaffected by high humidity or tropical exposure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIDE TEMPERATURE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kel-F performs satisfactorily over a temperature range of 710 Fahrenheit degrees — from a low of —320° F (liquid nitrogen) to a high of 390° F.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MECHANICAL STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kel-F has high tensile strength on the order of 6000 psi at 77° F... excellent impact strength and abrasion resistance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUPERIOR MEMORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kel-F exhibits &quot;cold-flow&quot; characteristics superior to any other commercial fluorocarbon. While it deforms slightly under pressure, it returns to original shape when pressure is released.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MOLDABILITY — MACHINABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kel-F is molded by all standard methods — compression, transfer, injection and extrusion. It is readily punched, drilled or otherwise machined to close tolerances.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIDE VARIETY IN FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kel-F is available in film, sheet, rod and tubes from recognized molders. As a dispersion for spray or dip application and in forms of oils, greases and waxes it is available direct from Kellogg.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FABRICATED PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaskets</td>
</tr>
<tr>
<td>Washers</td>
</tr>
<tr>
<td>&quot;O&quot; Rings</td>
</tr>
<tr>
<td>&quot;U&quot; Packing</td>
</tr>
<tr>
<td>Valve Discs</td>
</tr>
<tr>
<td>Valve Seats</td>
</tr>
<tr>
<td>Valve Diaphragms</td>
</tr>
<tr>
<td>Pump Diaphragms</td>
</tr>
<tr>
<td>Resilient-Core &quot;O&quot; Rings</td>
</tr>
<tr>
<td>Drum and Tank Liners</td>
</tr>
<tr>
<td>Flexible Non-Corrosive Containers</td>
</tr>
<tr>
<td>Machined Fittings</td>
</tr>
<tr>
<td>Coated Wire</td>
</tr>
<tr>
<td>Coated Hook-up Wire</td>
</tr>
<tr>
<td>Call Forms</td>
</tr>
<tr>
<td>Transformer Terminals</td>
</tr>
<tr>
<td>Multi-lead Terminals</td>
</tr>
<tr>
<td>Rotary Switches</td>
</tr>
<tr>
<td>Tube Socket Bases</td>
</tr>
<tr>
<td>Aerial Supports</td>
</tr>
<tr>
<td>Resistor Sleeves</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>FABRICATED MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molded Sheets</td>
</tr>
<tr>
<td>Thickness — .006&quot; to .016&quot;</td>
</tr>
<tr>
<td>Diameter — up to 12&quot;</td>
</tr>
<tr>
<td>Extruded Rod</td>
</tr>
<tr>
<td>Diameter — up to 1&quot;</td>
</tr>
<tr>
<td>Length — to specification</td>
</tr>
<tr>
<td>Molded Rod</td>
</tr>
<tr>
<td>Diameter — up to 4&quot;</td>
</tr>
<tr>
<td>Length — to 12&quot;</td>
</tr>
<tr>
<td>Extruded Tubing</td>
</tr>
<tr>
<td>Diameter — up to 2&quot;</td>
</tr>
<tr>
<td>Length — to specification</td>
</tr>
<tr>
<td>Extruded Strip</td>
</tr>
<tr>
<td>Thickness — .010&quot; to .125&quot;</td>
</tr>
<tr>
<td>Width — 2&quot; to 4&quot;</td>
</tr>
<tr>
<td>Length — to specification</td>
</tr>
<tr>
<td>Thin Film Extruded AS LAY-FLAT TUBING</td>
</tr>
<tr>
<td>Thickness — .002&quot; to .010&quot;</td>
</tr>
<tr>
<td>Width — lay-flat up to 20&quot;</td>
</tr>
<tr>
<td>(total width to 40&quot;)</td>
</tr>
</tbody>
</table>

List of the molders, extruders, fabricators and coaters furnishing the above listed items available on request.
A manufacturer's reputation and that of his products are often determined by the performance of relays. Little wonder that more and more design engineers and manufacturers are specifying the "Diamond Seal for Diamond Quality". Automatic Electric Manufacturing Company's Relays.

Unexcelled high standards of material and craftsmanship combine to produce superior relays that are built to exceed—not just meet—the most exacting specifications. Automatic Relays are available in a wide variety of spring and coil combinations ... operating potentials and contact ratings for an almost limitless variety of applications.

OPEN AND SEALED TYPE RELAYS
Whether your requirements demand plug-in tube base or any of the other standard type mountings,—or a specialized mounting—it will pay you to get complete facts on Automatic Relays with built-in reliability. Automatic midgets, dual purpose, delayed make or break, circuit control, current and potential Relays are built to exceed specs, military or industrial. If you measure quality by performance, Automatic Relays will measure up!

The complete line of Automatic Relays are available to meet military specifications. The facilities of our engineering department are at your disposal. Write, wire or phone. All inquiries will receive prompt attention.

Automatic Electric MFG. CO.
62 STATE STREET  MANKATO, MINN.

negoigible by the use of bucking or compensating coils, that have current flow in the opposite direction to that of the actuating coil. In the test model, the 1-ke inductance of the actuating coil was reduced from 2.4 mh to 0.15 mh.

In the experimental model, having an output torque of 10 ounce-inches, an electromagnet was used to provide the field. A permanent magnet could have been used, but the electromagnet allows shutting the field off to remove any magnetic particles that may have become attached to the pole pieces. The actuating assembly is mounted in the input member, and two sets of slip rings carry the field and actuating currents to the rotating assembly. A thin flexible diaphragm attached to the actuating coil presses against the output disk when the coil is energized, holding the disk firmly against the backing disk.

An ordinary crystal phonograph pickup and an oscilloscope were used to test response time. The phonograph needle, resting in a small depression on the output shaft, gave an indication when motion started. Connecting the osciloscope to the actuating switch and the phonograph pickup permitted observation of the time lapse between application of power and the
All Moloney HiperCore Electronic Cores, including over 1000 standard sizes, are manufactured under rigid quality controls. Electronic manufacturers will find this to be of great importance when performance specifications demand transformer cores that have lower losses and greater flux carrying capacity. HiperCore Electronic Cores test well within industry standards. Typical test requirements for various types are listed in the panel at right. Special tests for specific operating conditions are also made when required. If your product demands better performance, smaller size and less weight, we can help you.

A booklet containing performance characteristics, sizes and weights, along with price information is available upon request. Write for it today.

MOLONEY ELECTRIC COMPANY
Manufacturers of Power Transformers - Distribution Transformers - Load Ratio Control Transformers Step Voltage Regulators - Unit Substations

SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS, MO. AND TORONTO, ONT., CANADA

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
PROMPT DELIVERY
of small telephone type relays for D.C.

American Encaustic's new up-to-the-minute electronics division can help solve delivery problems on precision made telephone type relays with a current rating of 5 amperes or less.

American Encaustic relays are open type or hermetically sealed, with plug-in or solder tabs. Components are carefully inspected before assembly. Completed relays are individually tested before shipment. We believe there are no more precisely made relays of this type manufactured.

WRITE FOR FULL INFORMATION
... Send us your drawings and specifications. Samples and quotations will be promptly submitted without obligation.

ELECTRONS AT WORK
(continued)

start of motion in the output shaft.

Using 300 volts on both the field and actuating coils, the output shaft began to move within 200 microseconds and attained full speed in 300 microseconds. Using 100 volts on the field and 215 volts on the actuating coil, the time delays were 500 and 625 microseconds. The actuation voltages are required only momentarily and must be reduced promptly when the clutch reaches operating speed to avoid overheating and burnout.

When measuring response time, the effect of the compensating coils was also investigated. With the coil connections reversed so that the compensating coils aided rather than bucked the actuating coils, response time was increased to 900 microseconds. This indicates that the response time with the coils connected properly is limited by mechanical rather than electrical factors.

Deposited-Film G-M Counter Tubes

A new method for depositing a transparent, nonmetallic conducting film of constant thickness on the inside of a glass tube was announced recently by the Naval Research Laboratory, Washington, D.C. The new method has been used mainly, so far, for the production of halogen-quenched G-M counter tubes for laboratory research.

In the process, a nonmetallic film is deposited by condensation of a vapor on the inside of an electrically heated Pyrex glass envelope. A thin platinum-iridium wire is used for the anode, the tube is sealed off and mounted for a plug-in connection.

Various thicknesses of films have been deposited in this manner in areas up to 18 square inches. Although the films are actually colorless, they appear colored due to their light reflection-interference patterns.

The G-M tubes made by this process are nonsensitive to light, have an almost indefinite operating life, have uniform sensitivity response throughout their length and require no critical materials such as copper or stainless steel.
This practical use of National Vulcanized Fibre by American Optical Company in their attractive spectacle cases is typical of the countless contributions National Vulcanized Fibre—the material of a million uses—makes to industry and business.

National Vulcanized Fibre applications, both mechanical and electrical, are varied and extensive. In mechanical applications it is desirable because it possesses exceptional tensile and crushing strength, toughness, density and resistance to wear—coupled with ease of fabrication. It actually improves with age; for many mechanical purposes it is better, more durable than metal.

In the electrical field National Vulcanized Fibre has been the standard insulation for years. It has high dielectric strength and, when subjected to hot electrical arcing, it evolves neutral gas which extinguishes arc without "tracking." Many electric appliances find National Vulcanized Fibre to be the one best material for one or more of their parts.

Available in various grades and colors; and in sheets, rods, tubes and special shapes. Write for detailed literature and engineering service information—
Production Techniques

Edited by JOHN MARKUS

Model of Television Plant Facilitates Rearrangement of Production Lines

A COMPLETE and accurate scale model showing locations of all partitions, shelves, benches, conveyors and offices in the 200,000-square-foot plant of Olympic Radio & Television was built for a total cost of only $100 and paid for itself in the first month of use. Light-weight steel angle iron was bolted together to represent the framework of the building. On one side the angle iron was partly cut out to permit sliding out the sheet of plywood used for each floor.

Floor plan blueprints, drawn to a scale of \( \frac{1}{4} \) inch to the foot, are cemented directly onto the plywood and serve as guides for showing positions of permanent columns or partitions when rearranging a floor.

In the drawers of the table that supports the model are sets of wood blocks representing movable equipment and Lucite sheets representing partitions. Blocks representing shelves are painted yellow; blocks for benches are green; blocks for conveyor runs are red.

When the need for this model first arose, the price quoted for its construction by an outside firm specializing in such work was $3,000. Instead of accepting this bid, an alert young man in the plant was assigned to the job full time for a week to see what he could do. The results were entirely satisfactory.

Turntable for Pass-Along Assembly Line

TANK PROBLEM of getting a television chassis around the bend of a U-shaped pass-along assembly line was solved in Olympic's plant with a free-spinning five-foot-diameter disc of one-inch plywood. When a chassis reaches the last position on one side of the long bench, the operator lifts it onto the plywood turntable. Here there are permanently mounted cleats and supports to hold each chassis, spaced equidistant to give six positions on the turntable.

Depending on the needs of the line, one or more workers are stationed around the turntable to perform assembly or inspection operations while the sets are going around the bend. One of the workers advances the turntable each time another chassis comes to it. On the other side of the bench, the first operator takes each chassis in turn off the turntable and starts it on its ride down the rails on
Indifference—whether it's under the "big top" or on the production line—is inexcusable and often fatal. You simply can’t afford to take chances with a hard won reputation for quality performance. That’s why we say it’s a pretty good rule to stick to a solder you know and trust... time-proved Kester Solder, constant in solder alloy and always a consistent flux formula.

Be sure your soldering is satisfactory with one of these well known solder products: "44" Resin, "Resin-Five" and Plastic Rosin—all made only by KESTER... Key Name in Flux-Core Solder for More Than 50 Years.
that side of the bench.
No pallets are used on the benches; instead, the chassis slides on two wood rails, one low on the bench near the front edge and the other high enough to support the chassis at the desired working angle. A plywood strip is clamped to the bottom edge of the chassis with bolts and wingnuts to serve as a sled runner that rides in the lowest rail, thereby protecting the antenna terminal strip and other chassis parts.

Defect-Indicating Diagrams for Deflection Yoke Test Set

In the final performance of deflection yoke assemblies for Crosley television receivers, the picture-tube presentation associated with each type of yoke defect is shown on a chart attached to the side of the test set. When a defective yoke is encountered, the operator merely jots down the number of the observed diagram on the reject card. From this, troubleshooters can probe for the defect and clear it without need for further measurements.

The test set uses a 12-inch round picture tube of a type that does not require an ion trap. The tube is mounted rigidly in a protective metal box, with the neck projecting out the rear. Under the neck is a metal platform running on ball-bearing rails, on which are mounted the picture tube socket, focus coil and safety switch. This platform is pulled back on its rails so that a tested deflection yoke can be removed and the next one slipped onto the neck of the tube.

Test signals are obtained from a Raytheon-Belmont vertical and horizontal sync pulse generator, now manufactured by Supreme, Inc. A 630-kec oscillator generates dots, which appear on the screen as short slanting lines due to inten-
Miniature Metal Tubular CAPACITORS utilizing the NEW Mylar® Film

The pioneer in the newest of synthetic materials for capacitor development provides another “first” with “M” film.

Plasticon Type “M” Capacitors are offered where high resistance, high temperature (-40° to +125°C), smaller size and lighter weight are required.

Plasticon Type “M” Capacitors are available with either or both ends insulated and with any selection of brackets.

Engineered to your exact specifications.

**For overall performance, PLASTICONS are incomparable. **Du Pont trade mark
The only miniature snap switch
where size and high rating come to terms with cost

Repeat: where size and high rating come to terms with cost.
Consider this in terms of engineering that seeks to increase product efficiency while holding costs at a minimum. Then base your snap switch specifications on the following facts.

TYNISWITCH is a low cost, compact snap-action unit based on simplified construction principles. It permits high-load switching in a minimum amount of space. It eliminates costly, non-functional bulk in new or redesigned products. No other model or make — of comparable size and rating — can match its high-standard performance. Its action is flawlessly smooth and dependable. Moreover, it has been conclusively proven by approved laboratory tests that TYNISWITCH is completely reliable at high operating speeds . . . for over millions of cycles!

Investigate these and many other TYNISWITCH advantages today. New models can be developed economically to fit your speed and specifications—or you can select conventional circuit arrangements from a variety of standard units. Write for details. TYNISWITCH Division, The Sessions Clock Company, 104 East Main Street, Forestville, Connecticut.

Illustrated: Model 88, single-pole, double-throw, 15A, 125V, A.C. Overall length 1 3/4".

Deflection yoke reject chart
There are hundreds of jobs open to engineers today! but few opportunities like these

Westinghouse is in nuclear power to stay. We believe in the development of atomic energy as man’s next great source of power. If you want to get in on a new era in industry, we want to talk to you.

Atomic power opportunities are waiting for electronic engineers with 4 to 10 years of this kind of experience...

ELECTRONIC COMPUTERS, employing pulse amplifying wide range linear amplifying and rate circuits.

NULL BALANCE DEVICES, employing both vacuum tube and magnetic amplifiers, SERVOMECHANISMS, PLANT CONTROL SYSTEMS.

LIAISON with customers, contractors, designers of component equipment.

SUPERVISION of drafting work.

REMEMBER! We are primarily interested in good experienced application and development engineers—lack of previous reactor development experience is no handicap in this type of work.

HOW TO APPLY! What Westinghouse wants to know is: Where and when you obtained your degree... how you did in school... where you have worked at your profession... what kind of work you have done.

In other words, right now we’re more interested in your ability to fill current openings and to develop in the Westinghouse Atomic Power Division than we are in your vital statistics. Write your letter of application accordingly.

You will be in communication with men who are experienced in keeping secrets. All negotiations will be discreet, and your reply will be kept strictly confidential.

Address your application letter to: Manager, Industrial Relations Department, Westinghouse Electric Corporation, P. O. Box 1468, Pittsburgh 30, Pennsylvania.

What do you want?

MONEY? Good jobs are open here now—waiting for good men who want to make a permanent connection.

A PERMANENT JOB? Many of the engineers who joined Westinghouse 20 and 25 years ago are still with Westinghouse—and in key positions—and engineers who join us now will have the opportunity to make this work their lifetime careers. When many other industries may be going through slack times, atomic energy will still be in a stage of expansion.

SUBURBAN LIVING? It’s here—within easy driving distance of your work. Within a few minutes of shopping centers... schools... metropolitan centers.


YOUR KIND OF ASSOCIATES? Every fourth person in the Division is an engineer or scientist. More than half the top Westinghouse executives are engineers.

FASCINATING WORK? What other branch of science offers such exciting challenges? So many opportunities for discovery? So many chances to benefit mankind? So many opportunities for original work?

GROWTH OPPORTUNITIES? Never again in your lifetime will you be able to get into such a sure-to-expand industry so early in its development.

YOU CAN BE SURE... IF IT’S Westinghouse
Maximum cooling for airborne radar and hot-running electronic equipment is assured with this compact double-ended centrifugal blower. It meets government specifications for use at altitudes up to 50,000 feet. Another illustration of EAD's design ability!

**SPECIFICATIONS**

**OPERATING FREQUENCY RANGE:** 320 to 1000 cycles.  
**OPERATING TEMPERATURE RANGE:** -55°C to +85°C.  
**AIR DELIVERY:** 80 CFM @ 0" Static Pressure (Sea Level).  
**MOTOR:** Self Cooling—wound and impregnated with Class H Insulation.  
**MOUNTING:** Any Position.  
**OVERALL DIMENSIONS:** 6-3/64" x 4-3/8" x 3-7/8".

Solving special problems is routine at EAD

If your problem involves rotating electrical equipment, bring it to E A D. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

**EASTERN AIR DEVICES, INC.**  
586 DEAN STREET, BROOKLYN 17, NEW YORK

---

**Magnetic Separator Recovers Alnico from Grinder**

Alnico particles slide down metal incline to bin in foreground after being scraped off drum of magnetic separator, here installed on Besly No. 226 double-end grinder.

Valuable particles of Alnico V are recovered and recast into magnets in the Peterboro, Ontario plant of General Electric Co., Ltd. by a magnetic automatic coolant separator made by Barnes Drill Co., Rockford, Ill. The separator is installed on a grinder that automatically trims Alnico castings to final size. The grinder is arranged to compensate for abrasive wear. Three pumps, each delivering 30 gallons per minute, bring the Alnico-bearing coolant water to the separator for recovery.

The separator itself uses Alnico magnets. These hold the desired...
In the Mitchell-Rand line of HYGRADE and FLEXITE Tubings and Sleeving, there is a particular grade and class to meet the specific insulation requirement of temperature resistance, dielectric strength, abrasion resistance, flexibility, and push-back. HYGRADE Tubings and Sleeving conform to the NEMA Standards VSI-1950 and to the Armed Services Specification MIL-1-3190.

The "Select-it" chart details the various grades and classes of HYGRADE Tubings and Sleeving... grades differ according to amount of insulating coating applied and class is a A.I.E.E. standardization to indicate the ability of varnished coated products to withstand heat and temperature rises. Class A: 105° C or 212° F, class B: 130° C or 277° F, class H: 200° C or 392° F. Class A is organic, treated with organic varnishes or coatings. Class B and H are fiberglass treated with organic varnishes or coatings.

Flexite Plastic Tubings... made from various grades and types of resins offer an extraordinary combination of qualities including high dielectric strength, flexibility, non-flammability, abrasion resistance, oil and chemical resistance, heat stability, and resistance to aging... are low priced to make them the most desirable tubings for many insulation problems.

Hygrade Tubings and Sleeving and Flexite in standard sizes of copper wire are available in black, red and yellow for Class A and B, and natural for Class H. Other colors are available on special order.

Write to MITCHELL-RAND for free samples and descriptive data.
BEGINS HERE...

with General Industries' Phonomotors

The fidelity reputation of your record players, phono-combinations, and portables begins at the phonomotor. Be sure it's a good reputation that stays good...protected by General Industries' Smooth Power Phonomotors.

Complete data and specifications on the entire line of Smooth Power Phonomotors will be sent promptly on your request.

metal particles against a rotating drum while the waste water flows over the drum, until particles are removed by a scraper blade for salvage. The cleaning action of the separator permits immediate reuse of the coolant, with further saving in operating cost.

Water Cooling for Resistance Soldering Tool

A BATTERY CLIP serves as a simple and convenient valve for a small rubber hose used for cooling metal cable plugs after they have been heated for soldering. The rubber hose is taped to the resistance soldering tool used for this operation, with the battery clip conveniently positioned under the normal position for the operator's thumb. After making a joint, the operator squeezes the clip to spread its jaws and allow water to flow. The hose is so positioned that the stream hits the plug automatically, cooling it sufficiently so the operator can remove her hand from the soldered wire without waiting for the solder to cool.

Water pressure for the operation is obtained with an ingenious combination of an empty coffee can and a blood pressure valve with rubber bulb. The bulb and valve are used to produce air pressure in the can.
GERMANIUM DIODES

For use where size, long-life, and reliability under all weather conditions are important factors. General Electric is the largest supplier of germanium diodes in the country today.

VITAL CELLS IN THE "ELECTRONIC BRAIN"

Univac election prediction proves 99% accurate!

Just two hours after the first polls had closed, Remington Rand’s giant electronic computer predicted the election results almost to the actual electoral vote! UNIVAC accepted a mere three million vote count at 9:15 p.m. and juggled it with available “trends” over the past 25 years to uncork an answer since proven 99% correct!

16,000 G-E DIODES USED

What does this amazing mechanical mind consist of? Univac’s makers in Philadelphia tell us that “90% of diodes used in the system are G-E, and without them, the equipment couldn’t operate.”

NEW CIRCUITS POSSIBLE

Recently announced G-E Diffused Junction Germanium Rectifiers open the door to even greater advancement in circuit design for this and similar equipment. G-E Junction Rectifiers feature extremely low forward resistance, high inverse voltage, hermetic seal, and miniature size. Their application may result in units that will do more work . . . . more efficiently . . . . less expensively.

DIFFUSED JUNCTION GERMANIUM RECTIFIERS

Developed for radar and military communications. May be applied to computers, magnetic amplifiers, TV receiver power supplies, telephone switchboards, and many other electronic fields.

NEWS FROM OUR ADVANCED DEVELOPMENT LABORATORIES

G-E scientists have tested specially made germanium junction rectifiers and transistors at 140°C. Results indicate new products may be usable at higher temperatures.

SEND FOR THESE FREE BULLETINS


ELECTRONICS — February, 1953

Want more information? Use post card on last page.
You'll find it easy to do better work with Arkwright Tracing Cloth—and here are three specific reasons why:

1. You can re-ink razor-sharp lines over any erasure without "feathering" or "blobbing".
2. You're never slowed down by pinholes, uneven yarns or other imperfections.
3. You can always count on clean, clear reproduction—even years after you make the drawing. Arkwright Tracing Cloth is permanently transparent—won't turn opaque, brittle or paper-frayed with age.

They're important reasons for putting your best work on Arkwright Tracing Cloth. Like a sample? Write Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

You'll do better with ARKWRIGHT

Re-ink razor-sharp lines over any erasure without "feathering" or "blobbing".

PRODUCTION TECHNIQUES (continued)

so as to force out water when the battery-clip valve on the soldering tool is open.

Tubulations are soldered to the cover for the air and water hose lines. The cover is sweat-soldered to the can. Filling with water, required only about three times a day during continuous production, is done through a threaded plug in the bottom of the can.

When water pressure gets so low that the stream no longer hits the hot plug, the operator merely reaches over and gives the rubber bulb a few squeezes to build up pressure again. The technique was developed in the East Newark, N. J. plant of Utility Electronics.

Reject-Identifying Board

As a guide for sorting defective television receiver coils and transformers for return to vendors, a sample board containing one of each type and make of coil is maintained in Olympic's Long Island City plant. The products of twelve different vendors are represented. Coils are grouped by function and identified by number.

As an example, ten different units differing in only minor details are wired to the board over the heading

Using coil sample board to identify a defective unit. Vendors are identified on board by code letters, generally the first letter in the company name. Loops of wire pass through holes in board to hold each sample in position.
When the **Heat's on**...

**there's No Substitute for**

**ASTRON**

**TYPE AQ**

**Subminiature Paper Capacitors**

Astron Type AQ Subminiature Paper Capacitors are designed for dependable operation at temperatures up to +125°C, *without derating*—thanks to Astron's newly developed high temperature impregnant, X-250*. They also provide exceptional capacitance stability over the wide range of –65°C to +125°C.

High insulation resistance, low power factor, unusually low resonance loss, and high test voltage are achieved in an amazingly compact and rugged unit meeting all Armed Forces requirements. All AQ's are non-inductively wound in an extended foil construction. Glass-to-metal seal terminals assure positive hermetic sealing. And Astron AQ's are supplied in a variety of construction styles to meet your specific needs.

Write for engineering bulletin, containing test specifications and performance characteristics of Astron AQ Subminiatures, *today*.

---

Astron manufactures a complete line of dry electrolytic capacitors, metallized paper capacitors, plastic molded capacitors, subminiature paper capacitors and standard and subminiature RF interference filters for every radio, television and electronic use.

DEPEND ON—INSIST ON

**ASTRON**

255 Grant Avenue, E. Newark, N. J.

Export Division: Rocke International Corp., 13 E. 40th St., N.Y.C.

In Canada: Charles W. Puxton, 1926 Gerrard St. East, Toronto.

*Trade Mark*
You can eliminate top-heavy package inventories with Avery Kum-Kleen labels!

A common problem... General Controls Co. of Glendale, California manufactures automatic controls for widely diversified applications. Warehousing formerly required segregation of more than 100 different boxes. Product changes, from time to time, would make certain preprinted box inventories obsolete.

solved with Kum-Kleen labels... Now box inventories are maintained by size alone—IN HALF THE ORIGINAL SPACE! A self-adhesive Kum-Kleen label identifies the contents of each box as it is used. According to General Controls, "The unique characteristics of Kum-Kleen labels made this new packaging program possible, and they are saving us many thousands of dollars yearly!" Their many Avery electric label dispensers "are proving themselves daily to be a most worthwhile investment as a time and labor saver!"

how Kum-Kleen labels work... They're pressure sensitive—LAID ON fast with a finger-touch—no moistening, no mess! They stay neat and attractive—won't dry out, pop, curl or peel. Patented Avery dispensers—manual or electric—feed die-cut, Kum-Kleen labels off roller tape for quick, clean labeling.

Where can YOU use these labels in YOUR business?
For ease, histories, samples and prices, please mail the coupon below.

Avery Kum-Kleen pressure-sensitive labels

Avery Adhesive Label Corporation

PRODUCTION TECHNIQUES (continued)

"Pix I-F Coil"; here it is often necessary to compare an unknown coil carefully with each one on the board in turn to determine its manufacturer. This detailed comparison is only required a few times a day, as rejected coils usually come through in batches all from one vendor.

Spring Scale Cheeks Slip

INSPECTION of cavities for RCA pencil triodes involves checking the force required to move the plunger in the cavity. To check this in the Harrison, N. J. tube plant of the manufacturer, an ordinary spring scale is mounted upside down on a rack and gear arrangement operated by a hand wheel.

The operator places a finished cavity on the anvil, then turns the hand wheel to lower a cylinder which is mounted on a rod that goes inside the scale to its weighing point. With the left hand re-

Upside-down scale operated by rack and gear measures downward testing pressure being applied to plunger in pencil triode cavity. New printed numbers have been placed on scale so operator does not have to read upside-down values.
For duty at high voltage and high current, Lapp Gas-filled Condensers offer the advantages of extreme compactness . . . low loss . . . high safety factors . . . puncture-proof design . . . constant capacitance under temperature variation . . . grounded tuning shaft . . . complete reliability—electrically and mechanically. Models for capacitances up to 60,000 mmf; current ratings to 525 amps at 1 mc; voltages to 100 kv peak.

Write for description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.
You can't beat a soldered connection

for electrical conductivity and permanence!

SOLDERED connections eliminate loss of current, fire hazard, radio interference and excess heat which result from loose, corroded, arcing NON-SOLDERED connections.

For over 50 years experts have specified American Beauty Electric Soldering Irons. They know American Beauty Irons are built to LAST LONGER, OPERATE DEPENDABLY and BE SERVICED QUICKLY.

Tube Aging and Testing Techniques

PRODUCTION of miniature and subminiature tubes is expedited through use of a large variety of test sets and aging racks in Sylvania's Emporium plant. Most of these are applied 100 percent to the entire production to meet the requirements for premium tubes.

 Tubes are aged on vertically mounted sliding drawers each having 100 sockets. Plugs at the rear of each drawer mate automatically with jacks at the rear of the rack when the drawer is pushed in, to apply the required voltages for aging. Miniature tubes plug directly into the sockets. Subminiatures are mounted in octal adapters that in turn plug into drawers having octal sockets.

 The pull-out drawers are supported by roller suspensions at the top. Power supplies are below the drawers, in sections having a similar pull-out construction.

 At the front of each drawer are two lamps with jewels. One indicates application of normal d-c plate voltage, and the other indicates...
At last! A tubing that’s TAILOR-MADE FOR TV ANTE NN A E REYNOLDS ALUMINUM ANTENNA TUBING

Diligent research by the industry’s electronics engineers have brought forth wonderful improvements in today’s television receivers and antenna designs that insure better performance. Now, Reynolds—pioneer producer of antenna tubing—offers a vastly superior aluminum antenna tubing to help you produce a superior antenna! The new Reynolds Aluminum Antenna Tubing is precision roll-formed, tailor-made for TV antenna manufacturers. It is extra-sturdy, lightweight, and its gleaming, corrosion-resistant finish invites sales.

Reynolds Antenna Tubing 31—a maximum strength tubing; and Reynolds Antenna Tubing 41—designed with ample strength for most demands. Available in either butt seam or lock seam tubing, Reynolds Aluminum Antenna Tubing is offered in a complete range of sizes and in lengths to meet your specifications. For additional information and sample sections, call your nearest Reynolds Sales Office listed under “Aluminum” in the classified telephone directory.
for All Communication Monitoring

Up to 4 Channels on a standard ¼ inch tape

The first automatic continuous recorder

Precision engineered and JANized for the Civil Aeronautic Authority—now available for commercial and industrial monitoring of communications... air to ground, utility and pipe line service, municipal fire and police calls, common carriers, civil defense and many other applications. Magnecord monitoring equipment is available in 1, 2 and now 4 channel models. Write Magnecord for complete details.

it's a magnecorder designed for CAA

Complete system includes 2 recorders, each in turn recording 4 hours without reloading... reproducer, erase unit, bias-record meter, storage table.

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
Automatic amperometric titration, in the Division of Research of Harper Hospital, Detroit, Mich., is simplified by using an ElectroniK Function Plotter which plots current directly against titrant volume. Its chart is driven by a receiving sel-syn, connected to a transmitting sel-syn that is linked to the titrant syringe drive motor . . . thus moves in direct relation to titrant volume delivered.

Speed your data recording with these ElectroniK instruments

For recording \( y = f(x) \)—the Function Plotter. One of the best time-savers for any laboratory, this instrument automatically records a continuous curve such as stress vs. strain, speed vs. torque, temperature vs. pressure. It eliminates hours of hand logging and point-by-point plotting. It has two independent measuring systems; one moves the pen, the other moves the chart. Optional sel-syn drive for the chart can also be supplied. Either can measure any variable that can be converted to a d-c signal. The chart moves 11 inches; at only 4 seconds for full travel. Pen movement is 11 inches; pen traverse time 2 seconds.

For recording two variables—the Duplex Recorder. This two-in-one instrument combines continuous records of any two independent variables on a single chart . . . where they can be conveniently compared without tedious cross-reference. Each of the two recording pens has its own independent "Continuous Balance" measuring system. Each pen can traverse the full 11 inches of chart width. Different calibrations can be supplied for each pen.

Your local Honeywell engineering representative will be glad to discuss ways that these instruments can save time in your research work. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO.
Industrial Division
4428 Wayne Avenue
Philadelphia 44, Penna.

MINNEAPOLIS BROWN INSTRUMENTS
First in Controls
New Freedom
FROM JAMMING!

SIGNAL-SPLITTER MCL-10-VBX eliminates adjacent-channel and heterodyne interference to either CW, narrow-band voice or broadcast-quality receptions—will separate two carriers on the same "assigned" frequency when difference is but .005% with 60db attenuation to jamming carrier (at carrier frequencies of the order of 10/15 MC). Signal-Splitters are used with standard communications receivers.

This new variable selectivity model can be supplied with from three to seven selectivity switch positions in either selected sideband, providing a total of fourteen useful single-sideband widths from 100 cps out to 10,000 cps with high attenuation to all frequencies outside the selected passband.

Carrier accentor circuit greatly reduces the distortion effects of selective-fading and high-percentage modulation detection. Signal carrier is raised 20 db above sidebands.

Used by nine Departments and Agencies of U.S. Government and many foreign communications companies and government to protect their radio-telephone-telex circuits from bootleg jamming. Signal-Splitter installations over ten years old are still in service. Write for copy, literature on the MCL-10-VBX and other Signal-Splitters.

MCL-10-VBX SIGNAL-SPLITTER

A NEW AND REMARKABLE SIGNAL-SPLITTER DEVELOPMENT by McLaughlin... with a basically new selectivity CONTINUOUSLY VARIABLE (stepless) SELECTIVITY with constant sharp cuts of less than 50 db at 1000 db. Provides any bankwidth continuously variable from 1000 db to 6000 db for real jamming, and free reception of CW in the bandwidth will be available.

FREE RECEPITION of CW. The single-tone and dual-band models (selectable) will be available. This new model is a large number of these subminia-

J. L. A. McLaughlin • La Jolla, California • U.S.A.

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
Five months ago she was just an idea. Today, as the temptress who sells Revlon's new "Fire and Ice" Lipstick and Nail Enamel, she's America's most talked-about glamour girl!

"She created the greatest shipping problem we ever had," says Joseph Revson. "7,235 stores wanted 'Fire and Ice' merchandise and displays — to be delivered before the promotion date of November 1.

"There was only one way to keep all those dates! And as heavy re-orders flooded in, we continued to fill them via Air Express. Volume is now the heaviest in our history! In maintaining that momentum — and keeping the goodwill of the stores — Air Express service has been invaluable.

"We don't overlook costs, either. Air Express rates are the lowest in the field on practically every shipment we make. With a volume like ours, those savings add up to a very substantial figure!"

He kept 7,235 dates with this girl!
### Product Techniques (continued)

#### Sensitivity—Accuracy—Stability

**Ballantine**

The World's Leading Electronic Voltmeters

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Frequency Range</th>
<th>Accuracy</th>
<th>Input Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audio To 150 KC</strong></td>
<td>Model 300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 mV—100 V</td>
<td>Voltage Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 cps—150 kc</td>
<td>Frequency Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2%整个范围</td>
<td>Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>½ meg. shunted by 30 μF</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sub-Audio To 150 KC**

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Frequency Range</th>
<th>Accuracy</th>
<th>Input Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 μV—100 V</td>
<td>Voltage Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 cps—150 kc</td>
<td>Frequency Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3% 5 cps—100 kc</td>
<td></td>
<td>Accuracy</td>
<td></td>
</tr>
<tr>
<td>5% 2 cps—5 cps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 kc—150 kc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 meg. shunted by 15 μF</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Audio To 2 MC**

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Frequency Range</th>
<th>Accuracy</th>
<th>Input Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 μV—100 V</td>
<td>Voltage Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 cps—2 mc</td>
<td>Frequency Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3% to 1 mc</td>
<td></td>
<td>Accuracy</td>
<td></td>
</tr>
<tr>
<td>5% 1 mc—2 mc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 meg. shunted by 15 μF</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Audio To 6 MC**

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Frequency Range</th>
<th>Accuracy</th>
<th>Input Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mV—1000 V</td>
<td>Voltage Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(100 μV—1 mV without probe)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 cps—6 mc</td>
<td>Frequency Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3% to 3 mc</td>
<td></td>
<td>Accuracy</td>
<td></td>
</tr>
<tr>
<td>5% 3 mc—6 mc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 meg. shunted by 6 μF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1 meg. shunted by 25 μF without probe)</td>
<td></td>
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<td></td>
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</tbody>
</table>

**Peak-to-Peak**

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Pulse Width</th>
<th>Min. Rep. Rate</th>
<th>Accuracy</th>
<th>Input Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mV—1000 V pk-to-pk</td>
<td>3 μsec—250 μsec</td>
<td>20 pulses/sec</td>
<td>Accuracy</td>
<td></td>
</tr>
<tr>
<td>10 cps—100 kc (Sine Wave)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5% for pulses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 meg. shunted by 15 μF</td>
<td></td>
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</tr>
</tbody>
</table>

*Shunt capacitance is 8 μF on all ranges except two most sensitive ranges.

Write for complete catalog of all Ballantine Electronic Instruments

Ballantine Laboratories, Inc.

100 Fanny Road, Boonton, New Jersey

---

Aging and preheating conveyor used to transport tubes from Sealex machine (off picture at right) to operator at first test position.

Initial aging of all tubes is accomplished automatically by the moving conveyor that transfers tubes from the automatic tube machine to the first test position. This short-period aging also serves to preheat the tubes, thereby speeding up the electrical test.

Each slat on the conveyor contains nine tube sockets, to which the required voltages are fed through a
Sensational Advancements In Science & Industry Created the Need for
THE NEW
Stabelex "D" CAPACITORS

YOUR FREE
INDUSTRIAL CONDENSER CORPORATION
Stabelex "D" Capacitor Catalog may prove to be the most important new single piece of literature for you this year!

Curve #1111 illustrates the low dielectric absorption of Stabelex "D" and also makes a comparison with mica and paper capacitors. The absorption of mica and paper capacitors may be considerably higher, depending on the impregnating materials and design. The dielectric absorption of Stabelex "D" is never more than 1/25th that of the best commercially available Mica capacitors or 1/35th that of Paper capacitors.

Performance curves illustrating various characteristics of the Stabelex "D" Capacitor will appear in this magazine each month.

OUTSTANDING FEATURES

INSULATION RESISTANCE AT 20° C. AFTER THREE MINUTES CHARGE—900,000 megohm microfarads
INSULATION RESISTANCE AT 75° C.—78,000 megohm microfarads
INSULATION RESISTANCE AT—75° C.—In excess of 5 million megohm microfarads
CHANGE IN CAPACITANCE FROM 25° C. TO —80° C; 1.76%
SELF TIME CONSTANT OF 10 MFD CAPACITOR—4800 hours
Q AT 50 KILOCYCLES—10,000
POWER FACTOR AT 1 KC—0.00025

SEND FOR CATALOG 1117 TODAY

After a long period of research, Industrial Condenser Corporation now offers to industry for the first time the first of their family of Stabelex capacitors, stabelex "D", which has been produced for special applications for some time.

Complete information performance curves, characteristics, and suggested applications of the various types now available will be found in this catalog.

Mfrs. of OIL, WAX, ELECTROLYTIC, PLASTIC CAPACITORS and RADIO INTERFERENCE FILTERS

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
Every known need in frequency and pulse measurement is now satisfied by four completely new designs of Potter frequency-time counting equipment.

The simplified Potter 100 KC Frequency Time Counters, Models 820 and 830, are suitable for rapid and precise production line applications. The versatile Potter 100 KC and 1 MC Frequency-Time Counters, Models 840 and 850, include all gating, switching, timing and counting circuitry required for any conceivable counting-type measurement.

All models feature the convenience of smaller size, lighter weight, and functional panel layout. And, optional readout indication—either the dependable Potter 12-4-8 decimal readout or the conventional 0-9 lamp panels—is available.

For further data or engineering assistance write Dept. 2-C.
**SHAKEPROOF®"SPEED NUTS"**

**SELF-RETAINING FEATURE ELIMINATES RIVETING, STAKING OR WELDING**

They're easy to install without special tools...can't clog with paint...make screw driving faster...lock tight with unique thread gripping action and assure a strong, shock resistant fastening.

**SHAKEPROOF**

"Fastening Headquaters"

DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin, Illinois • Offices in principal cities

America’s Great Resources Plus A Free Economy Made This Business Possible!

*FREE...TESTING SAMPLE KIT*

...contains all three self-retaining types of SHAKEPROOF™:"SPEEDNUTS", "U", "J" and "Latching", in a selection of sizes. Make your own test and prove the savings. Send for your kit today!


www.americanradiohistory.com
THINNEST LIGHTWEIGHT HI-TEMPERATURE INSULATION MADE

ELECTRO SIL-THIN-GLAS .002 and .003 and SIL-THIN-BESTOS .003 to .0035 offer design economies at higher temperatures

Electro Extra Thin Hi-Temperature Insulation possesses exceptional dielectric and tensile strength. Its thinness, flexibility and lightweight permits compact construction . . . size and weight reduction of electronic and electrical equipment.

These Electro products meet all Class “H” requirements and are available in rolls, sheet or tape form.

For complete data or samples of these and other ELECTRO products contact Dept. E1

ELECTRO-TECHNICAL PRODUCTS
DIVISION OF SUN CHEMICAL CORPORATION
113 East Centre Street, Nutley 10, N. J.
You can believe what you see with an RCA oscilloscope

The RCA WO-88A 5-inch and WO-56A 7-inch oscilloscopes have the facilities you need for precise qualitative analysis and accurate quantitative measurements... thanks to advanced engineering design.

For instance, one of the outstanding features of these instruments is their remarkably true square waveform response... obtained by adequate band width, negligible phase shift, fast rise time, frequency-compensated attenuators, and a complete absence of peaking circuits.

Equally important are the peak-to-peak voltage-measurement features—obtained through the use of voltage-calibrated attenuators, front-panel calibrating-voltage terminals, calibrated graph screens, and good amplifier linearity.

Other quality features common to both designs include... push-pull direct-coupled amplifiers... extra fast retrace... shielded CRT gun... plus and minus sync... line-frequency sweep with phasing... and a set of matched probes and cables including a high impedance probe having an input resistance of 10 megohms and an input capacitance of less than 10 uF.

Before selecting a 'scope for your special needs, be sure to get the full details on the WO-88A and WO-56A from your RCA Test Equipment Distributor... or write RCA, Commercial Engineering, Section 428X, Harrison, New Jersey.
Now, Klein quality pliers are available in new compact patterns for precision wiring and cutting in confined space. Note, too, the replaceable leaf spring that keeps the plier in open position, ready for work. All are hammer forged from high-grade tool steel, individually fitted, tempered, adjusted and tested—made by plier specialists with a reputation “since 1857.”

**LONG NOSE PLIER**
307-5-1/4L—Extremely slim pattern ideal for the really tight spots. Jaws are knurled to insure a positive grip.

**CHAIN NOSE PLIER**
317-5L—A full inch smaller than standard pattern. Has a very fine knurl that will not damage soft wire. Also available without knurl.

**TRANSVERSE END CUTTING PLIER**
204-6—Useful in precision work where ordinary oblique or end cutters are too bulky. Gives a clean, flush cut.

**OLIQUE CUTTING PLIER**
210-5L—For cutting small wires or trimming plastic. Entire length of cutting knives works flush against cutting surface. 5 or 6-inch sizes.

**LIGHTWEIGHT OBLIQUE CUTTING PLIER**
209-5L—Smaller than 210-5L with an extremely narrow head. Entire length of cutting knives works flush against cutting surface.

**DUCK BILL PLIER**
306-5-1/2—This compact plier has jaws of sufficient width to hold small springs, yet small enough to form wire in confined places.

**ASK YOUR SUPPLIER**

At the known frequency. The vibrator developed for the purpose utilizes two pairs of large magnetron magnets, with coils surrounding their poles. These coils are energized by a 30-watt audio oscillator and amplifier set.

Rated operating voltages are applied during the test, with a 10,000-ohm resistor in the plate circuit. The a-c voltage drop across this resistor is measured with a vtvm as an indication of the extent to which the tube is reacting to the 40-cycle vibration frequency. At the right of the operator on the vibration test set is a 16-socket rack for preheating the tubes, to speed up the actual test.

In a more elaborate vibration test set used to measure any change in plate current during either 2.5 g or 15 g under complete normal operating conditions, a standard vibration exciter made by MB Mfg. Co., New Haven, Connecticut, is mounted on a large concrete block. The exciter employs a voice coil and field construction similar to that of an electrodynamic loudspeaker. Direct current for the field coil is obtained from a power supply in an adjacent rack, and variable-frequency audio power for the voice coil is obtained from a Hewlett Packard 202D audio oscillator feeding a 500-watt amplifier. Most tests are conducted at either 25 or 40 cps.

This test setup is used for...
MICROWAVE RECEIVERS
1000—10,750 mc

Four microwave receivers of high sensitivity, wide tuning range and selectivity. Image rejection is greater than 60 db. Gain stability better than ±2 db, permits application as a signal intensity meter. Extra large dials enable frequency to be clearly read to an accuracy of 2%. Video bandwidth is 3.0 mc. Input power required is 105-125 v, 50/1000 cps.

Features:
- Single Dial Tuning
- Low Noise Figure
- Tracked E. F. Preselection, Triple-Tuned
- Linear Db Output Indication
- AM-FM Reception
- Video Output — 10 v Pulse across 100 ohms
- Audio — BFO
- Recorder Output
- Provisions for Using External Attenuators in I.F. Channel
- Frequency Calibration Accuracy — 2%
- Separate Audio & Video Channels
- AFC
- Calibrated Tuning Meter

MICROWAVE SIGNAL SOURCES
Models SSR, SSL, SSS, SSM, SSX
634 MC to 10,750 MC

For use as a reliable source of microwave energy in transmission loss measurements, standing wave determination, etc. Unidial Control for accuracy and ease of operation. Direct reading (no mode charts to consult). Frequency determination accurate to 1% through use of present stabilization and temperature compensated klystrons.

Five Microwave Signal Sources are available to cover the frequency range from 634 MC to 10,750 MC. Units ruggedly constructed, mounted on aluminum castings to insure mechanical stability. Klystron reflector voltage automatically tracked with tuning of the klystron cavity to provide unidial control. Signal sources supplied complete with klystron.

MICROWAVE SIGNAL GENERATOR
Model MSG-4
7,000 mc — 10,750 mc

Polarad's Microwave Signal Generator, Model MSG-4, is an ideal source of an accurately known signal voltage, precisely modulated. Sensitivity, frequency and performance of radio and radar equipments in the frequency range from 7 to 10.75 kmc can be readily measured on this continuously variable, direct reading signal generator.

Features:
- Continuous tuning
- One tuning control
- Tuning dial accuracy — 1%
- No Klystron modes to set
- Accurate stable power measurement
- Non-contacting shorts guarantee long life
- Modulation — Internal Pulse, FM and external
- Sync output — delayed and undelayed.

MICROWAVE RECEIVERS
1000—10,750 mc

Model LSA

The instrument consists of the following units:
Model LTU-1 RF Tuning Unit—10 to 1000 MC.
Model LDU-1 RF Tuning Unit—940 to 4500 MC.
Model LBU-1 RF Tuning Unit—4460 to 16,520 MC.

Tuning dial frequency accuracy 1 percent.
No Klystron modes to set.
Broadband attenuators supplied from 1 to 12 KMC.
Frequency marker for measuring differences 0-25 MC.
Only four tuning units required to cover entire range.
Microwave components use latest design non-contacting shorts for long mechanical life.
Maximum frequency coverage per dollar invested.
5 inch CRT display.

Model LTA-4 RF Tuning Unit—15,000 to 21,000 MC.
Model LDU-1 Spectrum Display Unit.
Model LPD-1 Power Unit; Model LKU-1 Klystron Power Unit.

Wide Band Video Amplifier
Model VT 10 CPS to 20 MC

Designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of short duration and rise time. Excellent for TV, both black and white and color applications.

Features:
- Flat frequency response from 10 cps to 20 mc ±1.5 db.
- Uniform time delay of .02 microseconds.
- Gain of 60 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase linear with frequency over entire band.

Polarad
Electronics Corporation

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See us at Booth 2-511 Radio Engineering Show

www.americanradiohistory.com
here's why LEDEX ROTARY SOLENOIDS are dependable!

As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled.

The copper wire coil, the heart of the Solenoid, was developed especially for this product. It is wound by a precision winding process that puts a maximum amount of magnet wire into available space... giving tremendous power to compact Ledex Rotary Solenoids.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>1 5/8&quot;</td>
<td>1 5/8&quot;</td>
<td>1 7/8&quot;</td>
<td>2 1/4&quot;</td>
<td>2 1/2&quot;</td>
<td>3 1/4&quot;</td>
</tr>
<tr>
<td>Torque lb.-in.*</td>
<td>1/4</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Weight lbs.</td>
<td>3/4</td>
<td>3/4</td>
<td>3/4</td>
<td>1</td>
<td>2 1/2</td>
<td>4 1/4</td>
</tr>
</tbody>
</table>

*45° stroke intermittent duty.

Engineering data is available upon request. Write for descriptive literature today!

J.H. Leland INC.
123 Webster Street, Dayton 2, Ohio
It adds miles to your voice

For years the telephone you know and use has done its job well—and still does. But as America grows, more people are settling in suburban areas. Telephone lines must be longer; more voice energy is needed to span the extra miles.

Engineers at Bell Telephone Laboratories have developed a new telephone which can deliver a voice ten times more powerfully than before. Outlying points may now be served without the installation of extra-heavy wires or special batteries on subscribers' premises. For shorter distances, the job can be done with thinner wires than before. Thus thousands of tons of copper and other strategic materials are being conserved.

The new telephone shows once again how Bell Telephone Laboratories keeps making telephony better while the cost stays low.

QUICK FACTS ON NEW TELEPHONE

Transmitter is much more powerful, due largely to increased sound pressure at the diaphragm and more efficient use of the carbon granules that turn sound waves into electrical impulses.

Light ring armature diaphragm receiver produces three times as much acoustic energy for the same input power. It transmits more of the high frequencies.

Improved dial mechanism can send pulses over greater distances to operate switches in dial exchange.

Built-in varistors equalize current, so voices don't get too loud close to telephone offices.

Despite increased sensitivity of receiver, "clicks" are subdued by copper oxide varistor which chops off peaks of current surges.
MILO has a hobby!

A difficult but fascinating one. Works this way. Long in advance we try to calculate just what components our industrial users will need in a hurry.

How many, of what size and specification, of what type of part, will you be likely to want most often? Which parts, though unusual, will you nevertheless need on occasion for your special purposes? Which of the many brands we can supply will have the greater user acceptance?

We have no crystal ball. No computers; (though we supply you with parts to make them). All we have is experience in component supply; awareness of new developments — gained from study and conversation with men in the design and application fields of the art; constant effort at seeking out sources; evaluating available shipping methods; and a willingness to risk an occasional oversupply.

Here’s a hobby that helps you! It doesn’t throw us often. We get a wonderful satisfaction when we can answer you, “In Stock! How many do you want.”

check your requirements:

<table>
<thead>
<tr>
<th>Batteries</th>
<th>Hardware</th>
<th>Sockets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable &amp; Connectors</td>
<td>Meters</td>
<td>Solder &amp; Irons</td>
</tr>
<tr>
<td>Capacitors</td>
<td>Panels &amp; Racks</td>
<td>Speakers</td>
</tr>
<tr>
<td>Chasis</td>
<td>Pilot Assemblies</td>
<td>Switches</td>
</tr>
<tr>
<td>Chokes</td>
<td>Power Supplies</td>
<td>Terminal Strips</td>
</tr>
<tr>
<td>Coils</td>
<td>Power Controls</td>
<td>Test Instruments</td>
</tr>
<tr>
<td>Controls</td>
<td>Reactors</td>
<td>Tools</td>
</tr>
<tr>
<td>Diodes, Germanium &amp; Silicon Crystal</td>
<td>Recepiptacles</td>
<td>Transformers</td>
</tr>
<tr>
<td>Fuses</td>
<td>Rectifiers</td>
<td>Tubes, Regular &amp;</td>
</tr>
<tr>
<td>Jacks &amp; Plugs</td>
<td>Relays</td>
<td>Special Purpose</td>
</tr>
<tr>
<td>Knobs</td>
<td>Resistors</td>
<td>Voltage Regulators</td>
</tr>
<tr>
<td></td>
<td>Shields &amp; Tubing</td>
<td></td>
</tr>
</tbody>
</table>

FREE INDUSTRIAL TUBE BOOKLET
Chief Engineers, Purchasing Agents, Purchasing Executives! Write now if you haven’t received our Industrial Electronic Tube Booklet #EB. Use company letterhead and state your title. Address Dept. E-2.

JAN-APPROVED COMPONENTS

the ONE source for ALL your electronic needs

MILO RADIO & ELECTRONICS CORP.
Electronics for Industry
200 GREENWICH STREET, NEW YORK 7, N.Y. • Phone BEEkman 3-2980
Teletype NY1-1839 • Wire MILO-WUX-N.Y. • Cable MILOLECTRO-N.Y.

PRODUCTION TECHNIQUES (continued)

bearing so that the lower brush can be pulled away from the upper brush, permitting the wire to pass between them without being stripped.

After passing between the two stripping brushes, the wire makes three loops around the two driving drums. These two driving drums are connected by a chain and are driven at a constant speed by a drive motor.

The wire, after leaving the driving drums, is pulled to the cutoff part of the machine by two take-up wheels that are driven by a spring belt which keeps tension on the wire at all times. Here the wire goes through a cutting arrangement which consists of a stationary shear block and a movable shear blade which is round and has a series of holes about the outside diameter. The wire passes through the hole in the stationary shear block and through one of the holes in the movable shear blade. In operation, the power solenoid advances the shearing disc the spacing of one hole, which cuts the wire and allows the new wire to pass out through the next hole in the shearing disc. The length of cut is adjusted by rotating the cam that controls the cut solenoid.

Testing High-Voltage Tubes

A TEST console developed for power tubes makes plate voltage connections automatically to the top caps of ten tubes at a time when the top cover is lowered, and applies voltage automatically only when the operator has pushed the front

Safety-first console developed for testing ten large tubes at a time without risk of electrical shock to the operator.
Miniature Tube Sockets for UHF Applications

Minimode design and tooling, completed well in advance of the thaw in commercial ultra-high frequency station allocations, makes available miniature sockets especially designed to minimize inductance and capacity in tuner and converter-tube applications. Miniaturization of contacts and insulator permits 50% reduction in distance between lead terminations and tube seal.

Available with several types of standard mountings, superior performance in these precision products is assured by Methode's high production experience in their manufacture.

### Material Specifications

Insulators are available in mica-filled phenolic (Type MFE) or Alkyd #420 production capacity material. Contacts are low resistance copper base alloy with cadmium finish (silver if specified). Mounting saddles and bases are cadmium plated steel.

Noval sockets similar to the above also available. Production capacity on this new product is being rapidly increased to meet industry demand.

#### Sub-Panel Saddle

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>&quot;A&quot; INSULATOR MATERIAL</th>
<th>&quot;B&quot; MOUNTING HOLES</th>
<th>&quot;C&quot; CENTER SHIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU-153-093</td>
<td>Mica Phenolic</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-153-093</td>
<td>Alkyd</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMU-153-125</td>
<td>Mica Phenolic</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-153-125</td>
<td>Alkyd</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
</tbody>
</table>

#### Top Panel Saddle

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>&quot;A&quot; INSULATOR MATERIAL</th>
<th>&quot;B&quot; MOUNTING HOLES</th>
<th>&quot;C&quot; CENTER SHIELD</th>
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</thead>
<tbody>
<tr>
<td>SMU-155-093</td>
<td>Mica Phenolic</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-155-093</td>
<td>Alkyd</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMU-155-125</td>
<td>Mica Phenolic</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-155-125</td>
<td>Alkyd</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
</tbody>
</table>

#### Top Panel Saddle "Snap-In" Shield Base

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>&quot;A&quot; INSULATOR MATERIAL</th>
<th>&quot;B&quot; MOUNTING HOLES</th>
<th>&quot;C&quot; CENTER SHIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU-185-093</td>
<td>Mica Phenolic</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-185-093</td>
<td>Alkyd</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMU-185-125</td>
<td>Mica Phenolic</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-185-125</td>
<td>Alkyd</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
</tbody>
</table>

#### Top Panel Saddle "Twist-On" Shield Base

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>&quot;A&quot; INSULATOR MATERIAL</th>
<th>&quot;B&quot; MOUNTING HOLES</th>
<th>&quot;C&quot; CENTER SHIELD</th>
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</thead>
<tbody>
<tr>
<td>SMU-175-093</td>
<td>Mica Phenolic</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-175-093</td>
<td>Alkyd</td>
<td>3/32&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMU-175-125</td>
<td>Mica Phenolic</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
<tr>
<td>SMA-175-125</td>
<td>Alkyd</td>
<td>1/8&quot;</td>
<td>1/8&quot; D x 3/8&quot; L</td>
</tr>
</tbody>
</table>

Methode Manufacturing Co.
2021 West Churchill St. Chicago 47, Illinois
STABLE...RELIABLE...COMPACT

Announcing the new Bendix-Pacific TXV-13 Crystal Controlled PM Telemetering Transmitter

This is the most rugged and lightest weight crystal controlled transmitter on the market and is unusually stable under extremes of temperature, vibration, altitude and acceleration. The transmitter produces a two watt frequency deviated signal within the telemetering band of 215 to 235 mc.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>OUTPUT (R.F.)</th>
<th>TYPICAL OPERATION</th>
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</thead>
<tbody>
<tr>
<td>Load</td>
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<tr>
<td>Impedance</td>
<td>50.0 ohms nominal</td>
</tr>
<tr>
<td>Carrier Frequency</td>
<td>215 mc to 235 mc</td>
</tr>
<tr>
<td>Power Output</td>
<td>2 watts nominal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSTALLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Connectors</td>
</tr>
<tr>
<td>Winchester MSP (mating MSG with N-19 hood furnished)</td>
</tr>
<tr>
<td>UG-625/U (mating UG-88/U furnished)</td>
</tr>
</tbody>
</table>

When ordering, specify model number and output frequency desired.

PRODUCTION TECHNIQUES (continued)

Safety cover all the way up. Pairs of shorting plugs on the front screen mate into jacks on the top cover to complete the circuit for testing the tubes in this arrangement, developed by Westinghouse.

Phosphor bronze strips mounted on an insulating sheet under the top cover make contact with the top caps of the tubes. Each strip is double-ended, to take care of an additional ten tubes for which a second row of ten sockets is provided. This permits using the test set for tubes requiring another type of socket.

**Selection of Casting Resins**

The three principal applications for casting resin in connection with the production of electronic equipment are for circuit and component immobilization, for high-voltage insulation and for moisture protection. The five most important properties used as criteria when choosing a resin for one of these applications are dissipation factor, dielectric constant, dielectric strength, heat-distortion temperature and moisture absorption. Tables I and II show at a glance the best resin for each requirement and give pertinent properties.

The general casting procedure for encapsulating electronic circuits or components is diagrammed in Fig. 1. Some resins will require heat during mixing, as specified in manufacturer's instructions. Various techniques are used for releas-

**Table I—Selection of Casting Resins**

<table>
<thead>
<tr>
<th>For Circuit and Component Immobilization:</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temperature—GHX-71</td>
</tr>
<tr>
<td>High Dielectric Strength—AN-5; R-1433</td>
</tr>
<tr>
<td>Low Loss—NBS; Stycoast</td>
</tr>
<tr>
<td>Low Dielectric Constant—Stycoast; AN-5; NBS</td>
</tr>
<tr>
<td>Low Moisture Absorption—NBS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For High-Voltage Insulation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stycoast; AN-5; Kriston; NEL; 177; RLS-3869; FC 10C-10CM; R-1433</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For Moisture Protection:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stycoast; Epon RN-34; AN-5; NBS</td>
</tr>
</tbody>
</table>
Here’s how to get production quantities of precision components for TRANSISTORS • RADIO TUBES HERMETIC SEALS • LAMPS

Now it is possible for progressive manufacturers to produce their own precision electronic components. For example, the Automatic Lead Wire Welding Machine, shown below, was recently designed and built by Kahle to produce 12,000 3-piece leads per hour for miniature receiving tubes. Although this machine, Model 2148, is designed to make standard welds, it is but one step from a machine to produce leads for electronics’ latest wonder...the transistor. In addition, Kahle has produced a fully automatic Filament Making and Tabbing Machine, Model 2036, that produces from 1,200 to 3,000 filaments per hour depending upon wire diameter.

These machines reflect Kahle’s ability to design and build special-purpose machinery to meet any given specifications. Regardless of your current production problems, learn...without obligation...how Kahle’s more than 40 years of practical experience can benefit you.

For specific information, write Kahle...now.

Kahle
ENGINEERING COMPANY
1310 SEVENTH STREET
NORTH BERGEN, N. J.
SOLVES "MINIMUM" WEIGHT AND SPACE PROBLEMS

SUB-MINIATURE
Single- and Double-Contact CONNECTORS

MONOLOC® CONSTRUCTION eliminates unnecessary creepage paths, miniature and dust pockets and provides stronger molded parts.

MOLDED MELAMINE BODIES (in accordance with MIL-P14a) — minimize size (are fungus-proof and provide mechanical strength as well as high arc and dielectric resistance.

CONTACTS PRECISION MACHINED: Pins from brass bar (QP-601) and sockets from spring temper phosphor bronze (haughten). They are cold plated over silver for consistent low contact resistance, reduction of corrosion and aid in soldering.

SUB-MINIATURE
RECTANGULAR CONNECTORS

These connectors also employ standard Winchester Electronics features:

TERMINALS

STAND-OFF MINIATURE STAND-OFF FEED-THROUGH

PHYSICAL AND ELECTRICAL DATA

<table>
<thead>
<tr>
<th>Receptacle</th>
<th>Plug</th>
<th>No. of Contacts</th>
<th>Weight Oz.</th>
<th>D.C. Volt Breakdown</th>
<th>Contact Resistance</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM15</td>
<td>SM1P</td>
<td>1</td>
<td>.023</td>
<td>3400 1800 950 675</td>
<td></td>
<td></td>
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<td>SM25</td>
<td>SM2P</td>
<td>2</td>
<td>.023</td>
<td>3400 1800 950 675</td>
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<tr>
<td>SM1E</td>
<td>SM1E</td>
<td></td>
<td>.023</td>
<td>2400 1200 600 375</td>
<td></td>
<td></td>
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<tr>
<td>SM2E</td>
<td>SM2E</td>
<td></td>
<td>.023</td>
<td>2400 1200 600 375</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM1E</td>
<td>SM1E</td>
<td></td>
<td>.023</td>
<td>2400 1200 600 375</td>
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<tr>
<td>SM1E</td>
<td>SM1E</td>
<td></td>
<td>.023</td>
<td>2400 1200 600 375</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table II — Properties of Resins

Resin, Mr, Temp Range & Max Freq:

Araldite Resin B (Ciba Co.); 30 C to 140 C; freq unknown.
Bakelite C-8 with Inert Filler (Bakelite Corp.); 61 C to +80 C; 400 cps.
Hysol 6000 PHP, 6200, 6500 and 6501 (Houghton Labs.); 55 C to +150 C; 3,000 mc.
Lamine 4116 (American Cyanamid Co.); 45 C to +100 C; 50 mc.
N. E. L. No. 177 (U.S. Navy Electronics Lab.); 54 C to +100 C; 200 mc.
Paraplex P-13 (Rohm and Haas); 40 C to 100 C; freq unknown.
Paraplex P-13 (Rohm and Haas); 45 C to +100 C; 50 mc.
Polyxylene (Emerson and Cumming); up to 80 C; 1,000 cps.
Selection 5003 (Pittsburgh Plate Glass Co.); 65 C to +125 C; 30 mc.
Selection 5016, 5081. 5208 (Pittsburgh Plate Glass Co.); 55 C to +171 C; 30 mc.
Selection 5209 (Pittsburgh Plate Glass Co.); 65 C to +120 C; D.C.
Styrol 503 (H. H. Robertson Co.); 55 C to +100 C; freq unknown.

FIG. 1 — General casting process for circuit and component embedment

PRODUCTION TECHNIQUES

WINCHESTER ELECTRONICS INCORPORATED

256 256

Feburary, 1953 — ELECTRONICS
DuMont's problem was space

Compactness was the prime requirement for the DuMont Telecruiser—a mobile unit which had to duplicate actual studio operating conditions in every respect.

It was absolutely necessary to confine the servicing operations of various units to a limited area. Consultation with Grant representatives resulted in the selection of the proper (Electronic Equipment) Slides for the DuMont Telecruiser.

Do you have a servicing and maintenance problem? Grant Research and Development facilities are at your service. Let us assist you in the choice and application of Grant Slides to your equipment. Engineering liaison is available from the planning stage through the production processes.

GRANT INDUSTRIAL SLIDES

a product of the engineering design department of Grant Pulley and Hardware Company
31-73 Whitestone Parkway, Flushing, New York.

Write for information... consult on any problem

1. FULL EXTENSION—Continuous ball bearing action permits smooth, non-jar chassis removal. Locks in fully extended position, must be unlocked to return.

2. PIVOT RELEASE—Withdrawing release rods disengages them from quadrant mechanism, enables perfectly balanced unit to be tilted by simply raising.

3. 45° PIVOT—Unit locks in 45 degree or 90 degree position. Special pivoted positions can be obtained to fit individual requirements.

4. FULL TILT—Maintenance and repairs easily made. Access to component is gained in a few seconds. Special slides can provide plus or minus 90° tilt.

ELECTRONICS—February, 1953

Want more information? Use post card on last page.
from manufacturer's data; faster cures may be obtained at higher temperatures, but size and shape of the casting should be considered before attempting an accelerated cure. The resins listed here are only representative of those available, hence this is by no means a complete listing.

Curing Times and Catalysts

Styrole (Emerson & Cuming Co.)—5 days at room temperature, then 24 hours at 60°C followed by 4 hours at 85°C. Catalyst—benzoyl peroxide.

Epon RN-84 (Shell Development Co.)—24 hours at 60°C, then 2 to 3 hours at 100°C. Catalyst—pipiridine.

AN-5 (developed by National Bureau of Standards)—1 day at 50°C. Catalyst—1. benzoyl peroxide; 2. cobalt dryer; 3. Pro-A.

NBS (developed by National Bureau of Standards) — Room temperature for gelation period, followed by 8 to 10 hours at 50°C to 60°C. Catalyst—1. Uniperox 60; 2. benzoyl peroxide.

NEL (Rohm & Haas Co.; developed by Naval Electronics Lab, San Diego, Calif.)—8 hours refrigerated, then 2 hours at room temperature and 10 hours at 45°C. Catalyst—Uniperox 60.

Selectron 5000-5200 (Pittsburgh Plate Glass Co.)—6 hours gelation at room temperature, then 15 to 30 minutes at 250°F to 260°F. Catalyst—1. Uniperox 60; 2. benzoyl peroxide.

Resin 40 (Emerson & Cuming Co.)—36 hours at room temperature, then 4 hours at 85°C. Catalyst—benzoyl peroxide.

R-1338 (Minnesota Mining & Mfg. Co.)—Gelation cure 2 to 4 hours at 250°F to 275°F, then final cure 2 to 4 hours at 300°F to 325°F. Catalyst—phthalic anhydride.

RLS-3890 (Minnesota Mining & Mfg. Co.)—2 to 4 hours at 250°F to 275°F, then 1 to 2 hours at 300°F to 325°F. Catalyst—diallyl phthalate.

EC 10C-10CM (Emerson & Cuming Co.)—Cure time, not given Catalyst—Emerson & Cuming Catalyst No. 6.

It should be noted that P-43, the Selectron resins and EC 10C-10CM are air-inhibited, hence the surface of the casting exposed to air will
GENERAL ELECTRIC is a large supplier of high-reliability tubes to Collins Radio Company, who use G-E 5-Star types widely in the 51R-series receivers for air navigation and communications.

25 tubes, or practically the entire complement of the chassis, are high-reliability types. "Every 51R component has to do its job under the toughest flight conditions," says J. H. Hamilton, Manager, Aviation Sales. "So we specify high-reliability tubes all along the line. The result is equipment with maximum dependability."

G-E 5-Star Tubes have an extensive record of dependable tube service to airlines and to the armed forces. The Collins application is further evidence of the ability of these tubes to solve your electronic equipment problems.

As the largest supplier of high-reliability tubes—manufacturing the most types, and with outstanding production facilities—General Electric now offers to designers a complete line of ten 5-Star subminiatures.

In all respects, these subminiatures match the premium performance of regular 5-Star types. They are uniformly operable when installed. They are shock-proof...extra-dependable...long-lived...with fewer shorts, fewer heater failures than standard tubes.

Select the right types for your new miniaturized equipment from the listing at right! For detailed application facts about 5-Star Tubes—both regular and subminiature—wire or write for new Booklet ETD-548A. Tube Department, General Electric Company, Schenectady 5, New York.

SPECIFY THESE 5-STAR SUBMINIATURES!

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-5718</td>
<td>Medium-mu triode</td>
</tr>
<tr>
<td>GL-5719</td>
<td>High-mu triode</td>
</tr>
<tr>
<td>GL-5797</td>
<td>Semi-remote-cutoff pentode</td>
</tr>
<tr>
<td>GL-5798</td>
<td>Medium-mu twin triode</td>
</tr>
<tr>
<td>GL-5840</td>
<td>Sharp-cutoff r-f pentode</td>
</tr>
<tr>
<td>GL-5896</td>
<td>Twin diode</td>
</tr>
<tr>
<td>GL-5899</td>
<td>Semi-remote-cutoff pentode</td>
</tr>
<tr>
<td>GL-5902</td>
<td>Beam power amplifier</td>
</tr>
<tr>
<td>GL-6111</td>
<td>Medium-mu twin triode</td>
</tr>
<tr>
<td>GL-6112</td>
<td>High-mu twin triode</td>
</tr>
</tbody>
</table>

75 YEARS OF ELECTRICAL PROGRESS

Diamond Anniversary.
Is that a bombsight in your BASEMENT?

Of course it could be. But it would be a simplified version with its share associated with controlling the heat for your home, or the deep-freezer, or the automatic washing machine and dryer, rather than computing the point for "bombs away". This is an age of instruments and systems — an age in which the name NORDEN has come to stand for highest precision. Bomb sights for the military services yesterday — highly advanced equipments for them today — still more for the Country's defense — and for industry tomorrow.

Norden instruments and systems of highest precision

MILFORD, CONNECTICUT

WHITE PLAINS, NEW YORK

February, 1953 — ELECTRONICS

remain tacky after cure.

Recommended fillers that may be used with all resins are powder glass, micronized silica, aluminum powder, calcium carbonate, powdered slate, talc, asbestos, glass beads and powdered mica.

Casting Problems and Examples of Corrective Measures

Cracking of Resin Castings. (1) Amount of promoter was reduced; this lowered temperature during curing and increased setting time; (2) fillers were added, such as asbestos, talc, mica, slate flower or powdered glass; (3) casting resin was modified; (4) casting was cured in temperature-controlled oven; (5) sharp edges or projections were eliminated from articles to be embedded; (6) flexible resins made from epoxides were used; (7) article to be embedded was coated with flexible material such as Silastic 181; (8) curing technique was modified with respect to activation and temperature.

Cracking of Fragile Components. (1) Filler was added to resin; (2) parts were coated with an elastomer before encapsulating.

Excessive Shrinkage of Castings. (1) Filler was added; (2) a maximum amount of rigid resin was used; (3) epoxy resins were used instead of polyesters; (4) materials and curing procedure changed. Maximum shrinkage of Houghton Labs resins is specified to be 2.3 percent.

Casting Adheres to Mold. (1) Use mold release agents, such as silicone grease, Hi-Glo parting lacquer or mineral oil; (2) use molds made of teflon or nylon.

Poor Adherence to Embedded Parts. (1) Prepare metal surfaces more thoroughly; (2) match thermal coefficient of expansion of resin to that of metal by adding fillers; (3) omit insulating tubing from components, as Selectron resin would not adhere to the tubing.

Poor Heat Transfer. (1) Add fillers to improve heat transfer from components to outside of casting; (2) change circuit configuration, so that high-temperature components were near radiating.
MYCALEX engineers designed these sockets to provide a complete, yet economical, solution to UHF tube mounting problems. Exhaustive tests have proven their mechanical excellence and high electrical efficiency. The use of "MYCALEX 410" (injection molded glass-bonded mica) with its great dimensional stability permits a minimum amount of dielectric to be used in the body structure. This plus other unique design features results in extremely low inter-electrode capacitance. In addition to its other advantages—high arc resistance, high dielectric strength, non-porosity, etc., "MYCALEX 410" has very low dielectric loss at all frequencies including UHF and thereby offers great advantage over phenolic materials. "MYCALEX 410" operates continuously in temperatures up to 650°F with practically no change in electrical properties or mechanical structure. Soldering operations will not cause body distortion.

MYCALEX TUBE SOCKET CORPORATION
Under exclusive License of Mycalex Corporation of America • 30 ROCKEFELLER PLAZA, N. Y. 20

MYCALEX CORPORATION OF AMERICA
Owners of 'MYCALEX' Patents and Trade-Marks
Executive Offices: 30 ROCKEFELLER PLAZA, NEW YORK 20 • Plant & General Offices: CLIFTON, N. J.
this
is of vital interest
to everyone who has a
VIBRATION PROBLEM!

Here is a fresh approach to vibration and shock control—an all-metal mount! Just look at the careful fabrication of the stainless steel wire cushioning. This is the heart of the new Robinson Met-L-Flex mount. Shock and vibration are absorbed from every angle, thereby isolating and protecting the mounted equipment.

Wide Range of Applications
Robinson Met-L-Flex design control can be applied to the mountings for delicate precision equipment or heavy machinery.

Far better vibration control has been sorely needed to keep pace with modern advances in the design and use of electronic and precision equipment. Well, here it is!

Great Cost Savings
Where the new principle of all-metal vibration control is used with Robinson unit mounts or engineered mountings systems it effects decided economy. It not only permits simplified design and construction of equipment, but also contributes to far longer useful life.

Outstanding Performance
Robinson Met-L-Flex mounts were originally developed to meet unprecedented, severe conditions of modern high speed planes.

From take-off to landing a plane’s vital equipment is subject to the combined violence of shock and vibration. Sure protection is needed. Met-L-Flex meets such challenges with flying colors, to the great relief of engineers. Moreover, unlike old-fashioned rubber mountings, Robinson Met-L-Flex mounts perform at peak efficiency under any atmospheric conditions. They are not daunted by oil, temperature extremes, or moisture—and the need for replacement due to fatigue is virtually nil.

Proved and Accepted
Robinson mounts have been tested and accepted by more than three hundred electronics, aircraft and industrial manufacturers. With such a background and record of performance, Robinson offers the advice and counsel of its engineers toward finding the best and most economical answer for every problem of vibration and shock.

JUST WRITE AND ASK US
If you are an engineer, architect or manufacturer who would be interested in having more information as to how this new kind of engineered vibration control might help your special problem, we will be glad to hear from you. Drop us a line.

ROBINSON AVIATION INC.
Vibration Control Engineers

Electronic heating generators here speed production of pencil triodes, appearing here as tiny vertical white rods under the work coils.
Heldor Transformer Cans and Bushings are standard components of Merit Transformer Corporation's products. They demand better quality and uniform production—Heldor gives it to them.

More and more of the leading electronic parts manufacturers are now using Heldor's complete "package"—cans with compression-type hermetic-seal terminals ASSEMBLED in can covers. —If you want to cut production costs, save time and eliminate inventory problems, send us specifications for a quotation today.

New Can Catalog! Write today for your copy!

HELDOR MANUFACTURING CORPORATION
HELDOR BUSHING & TERMINAL CO., INC.
225 Belleville Avenue, Bloomfield, New Jersey
7 good reasons for specifying MEPCO Precision Resistors

1. Crossover wire insulated from each winding by 2000v. insulation (patented).
2. Special metal molded connecting feature, which bonds end of winding and terminal in a non-corrosive and mechanically secure manner—no solder or flux used.
3. Reversed and balanced PI-windings for low inductance, with use of only the finest resistance alloys.
4. Impregnated with approved fungus, moisture and salt waterproofing compounds.
5. JAN approved non-hygroscopic steatite bobbin, specially treated prior to winding in order to provide additional protection for fine enameled wire.
6. Protective fungus resistant acetate label.
7. Rigid hot solder coated brass terminals for easier soldering.

MEPCO, INC., MORRISTOWN, NEW JERSEY

are required, one for each of the six heating positions. The water-cooled work coils are connected to the generators by multiple layers of flexible bonding braid and rubber hose sections are used as water lines, to permit vertical movement of the heating coils. As each tube in turn is indexed to a heating position, the work coil is lowered and automatically energized. Fluorescent lamps fastened overhead with tape glow to indicate that power is on. The electric field is sufficiently strong so that no connections are needed for the lamps.

Brackets on Pallet Hold Auto Radios

Simple angle brackets and straight metal pieces are fastened to plain wood pallets with screws to provide non-slip positioning of the wrap-

Use of inexpensive angle brackets on pallets to position auto radios, and simple support for solder reel. The solder holder can be slid along the bench readily, and may be lifted off when no longer needed.
### Types of Wire and Stripping Methods

<table>
<thead>
<tr>
<th>Type of Winding</th>
<th>DCC Glass</th>
<th>EC</th>
<th>Formvar-Cotton</th>
<th>PE</th>
<th>HF</th>
<th>HNC</th>
<th>Method of Stripping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Stators</td>
<td>x x x x</td>
<td>x</td>
<td>x x x x</td>
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<td>x</td>
<td>x x</td>
<td>Brushing</td>
</tr>
<tr>
<td>Wound Armatures</td>
<td>x x x x</td>
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<td>x x x x</td>
<td>x</td>
<td>x</td>
<td>x x</td>
<td>Brushing</td>
</tr>
<tr>
<td>Wire sizes 8-20 AWG</td>
<td>x x x</td>
<td>x</td>
<td>x x x x</td>
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<td>x</td>
<td>x x</td>
<td>Brushing</td>
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<td>Wound Armatures</td>
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<td>x x x x</td>
<td>x</td>
<td>x</td>
<td>x x</td>
<td>Brushing</td>
</tr>
<tr>
<td>Wire sizes 21-30 AWG</td>
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<td>x x x x</td>
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<td>x x</td>
<td>Brushing</td>
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<td>Wound Armatures</td>
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<td>x x</td>
<td>Brushing</td>
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<tr>
<td>Wire sizes 31-40 AWG</td>
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<td>x x x x</td>
<td>x</td>
<td>x</td>
<td>x x</td>
<td>Brushing</td>
</tr>
</tbody>
</table>

### Hot Solder

- **Transformers (large)**
  - *HNC* Form. *Celen*
  - PE *HNC* *Celen*
  - Nylon Celanese Over *Celen* Nylon Celanese Over *HNC* Silk Over *HNC* Silk Over PE
  - 1. Brushing
  - 2. Burning & Brushing
  - 3. Welding
  - 4. Hot Solder
  - 5. Chemicals
  - 6. Scraping

### Welding

- Lead wires and coil leads frequently are welded. A small high-temperature gas flame is applied to the spliced lead to a temperature that just melts the copper. This method is used extensively for medium and large motor stator coils. In this operation, of course, all the film coating and textile is burned off.

### Chemicals

- There are many proprietary compounds in general use for stripping film-coated magnet wire. They have one property in common. All are evil smelling and injurious to the skin. Care must be exercised therefore in handling these materials, and for some the use of a ventilated enclosure or hood is mandatory.

### Soldering and Low-Temperature Solder Pots

- Celenamel and nylon film-coated wires are in general use, particularly in the radio and television industry. Both materials being thermoplastic can be removed by using a rosin alcohol flux and the application of a soldering iron, or dipping in 650°F lead-tin solder.

---

**Belden**

MAGNET WIRE

BELDEN MANUFACTURING CO.

4625 West Van Buren Street, Chicago 44, Illinois

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Want more information? Use post card on last page.

---

[www.americanradiohistory.com](http://www.americanradiohistory.com)
Here are a few examples of Cannon's Experimental Laboratory and Switchboard Connectors. They are used extensively throughout industry, public utilities, sound studios, broadcasting stations, college and university physics and chemistry laboratories, in AC network analyzers and electronic analog computers. They may be applied wherever quick disconnect switching and patch cord plugs are required. High grade materials are used throughout. Molded phenolic of high dielectric strength is used for insulation. Both pin and socket contacts are machined from solid brass. Some are silver plated. All are rated at 75 amps. Pin contacts are split for low loss seating in tapered bore sockets. Single contact fittings are supplied in either red or black phenolic to designate direct or alternating current circuits respectively. Two-contact and larger plugs have sand-blasted cast aluminum shells and handles with clear lacquer finish. Various combinations of pin and socket contacts are used as a polarizing guide. For further information write for Bulletin LS5-1951.

Automatic Coil Dipper

A SPECIAL Crosley-designed automatic dipping machine applies a plastic protective coating to television receiver peaking coils at a production rate of 650 coils an hour. On the motor-driven face plate of the machine are six coil-holding arbors, each driven by gears inside the face plate. The operator pushes the lead of a coil into the hole in the end of an around housing of an auto radio as it moves down the assembly line on a moving conveyor belt in Sylvania's Buffalo plant. Positions of the brackets are easily changed to accommodate a new housing design. Two brackets project inside the housing and one on the outside at the front edge to give rigid positioning. The spool of solder is mounted on the bench directly under the left hand of the operator. This keeps the length of unrolled solder at a minimum and thereby prevents tangling. The solder holder is a piece of sheet metal that hooks over the metal front edge of the work bench. The stud for the spool is welded or bolted to the center of the projecting sheet.

CANNON ELECTRIC

Since 1915


PRODUCTION TECHNIQUES (continued)
To Guarantee QUALITY BEYOND QUESTION in RAYTHEON

Standard Control Knobs

So that you may specify them with confidence for the finest electronic and electrical equipment, Raytheon Standard Control Knobs must pass these quality control tests:

- **HUMIDITY** — 48 hours of 95% relative humidity at 65°C.
- **SALT SPRAY** — 50 hour fog test in accordance with Specification QQ-M-151.
- **VIBRATION** — tested in 3 planes from 10 CPS to 33 CPS at an amplitude of .072" for 3 minutes each way in accordance with Specification 40T9.
- **IMPACT** — blows of 400, 800, and 1200 foot pounds through each of 3 axes in accordance with Specification 40T9.
- **HIGH TEMPERATURE** — 4 hours at 85°C combined with torque test.
- **TORQUE** — 25 to 50 pound-inches applied in one direction, then opposite while under high temperature test.
- **ROTATION** — crank knobs rotated 200,000 times with 1 1/4 pound load applied intermittently to handle during each rotation.
- **EXTREME TEMPERATURE** — knobs subjected for 2 hours to 95% relative humidity at plus 65°C, then minus 40°C for 2 1/4 hours, then quickly back to room temperature.

RAYTHEON STANDARD CONTROL KNOBS are made in five basic sizes and six functional styles of tough, durable "Tenite II" (cellulose acetate butyrate), injection molded with anodized aluminum inserts and dual set screws. Black knobs available in "matte" or "mirror" finish.

Based on Navy Drawing RE106651A and styled to match our Standard Control Knob line. Available in two size ranges with symbol caps molded in the required colors.

Write for complete information

RAYTHEON MANUFACTURING COMPANY
EQUIPMENT SALES DIVISION
DEPT. 6270-KA, WALTHAM 54, MASSACHUSETTS
DISTRICT OFFICES: BOSTON, NEW YORK, CLEVELAND, CHICAGO, NEW ORLEANS, LOS ANGELES (WILMINGTON), SAN FRANCISCO, SEATTLE
INTERNATIONAL DIVISION: 19 RECTOR ST., NEW YORK CITY
NEW SYSTEM

Accurately measures
VSWR from 1.02 to 100/1

DOUBLE PROBE SYSTEM

PRECISION
SLOTTED LINE & VSWR INDICATOR

MEASURES
IMPEEDANCE • VSWR
RELATIVE POWER
100 MC TO ABOVE 1000 MC

SWR INDICATOR—
STABLE SENSITIVE
1000 CYCLE NEGATIVE
FEED BACK AMPLIFIER
FLAT TOP SELECTIVITY.

MODEL 62

MIN. GENERATOR RF. POWER
REQ. 2-20 MILLIWATTS

- Full scale VSWR ranges: 1.1/1 - 4.0/1 - 10/1 and to 100/1 using included calibrated probe depth attenuators.
- Differential probe system for accurate measurement of low VSWR.
- Useable electrical probe travel 150 centimeters (1/2 wave at 100 mc/4).
- Removable end tapers exhibit negligible impedance transformation — under 1%.
- Residual VSWR under 1% — voltage uniformity ± 0.5% or better — mechanical tolerances held to 0.2%.
- Machine engraved centimeter scale and vernier (Starrett) measures probe travel to 0.1 millimeter accurate to 0.01mm.
- Continuously adjustable probe depth 0 — .500' calibrated in .001" steps. Permits measurements of relative power and maintenance of square law crystal characteristic.

THE ROLLIN COMPANY
2010 LINCOLN AVE. • PASADENA 3, CALIFORNIA

Machine with container of hot wax raised to dunking position. U-shaped metal bar comes up with pot to serve as guard, because the wax is hot enough to burn fingers.

arbor. A spring clip on the arbor holds the lead there. When the undipped coil reaches the lowest point on its orbital route, the operator pushes a foot pedal that controls an air-operated cylinder. This brings a pan of hot high-melting point wax up to the rotating coil. It is held there long enough for the coil to make several revolutions and get thoroughly coated with wax. Release of the foot pedal lowers the semicircular pan into the larger wax pot without splashing.

By the time that the dipped coil has completed its single revolution of travel around the face plate, the wax has cooled and hardened sufficiently to permit removal by the operator. Gloves are not needed. The completed coil is placed in a screen-type tray for further hardening, transporting and storage. A rack supports this tray directly in front of the operator.

The wax is heated by a Sta-Warm automatic electric heater having a range of 260 F to 550 F in seven steps.

Masking Tape Holds Meters

WHEN RUNNING performance and life tests of experimental magnetic amplifiers, engineers at Bogue Electric use miniature multimeters.
STABILITY SEALED IN

HUGHES GERMANIUM DIODES

MOISTURE-PROOF
Each hermetically sealed Hughes Diode is humidity cycled in saturated water vapor from +90°C to -78°C, and then oscilloscope-tested for humidity penetration.

DEPENDABLE
Each Hughes Diode is subjected to JAN shock tests and then inspected under vibration for the familiar electrical instabilities—hysteresis, drift, and flutter. Each diode is aged and then reinspected for stability of electrical characteristics.

THERMALLY STABLE
The Hughes Diode is designed to reduce differential expansion which would cause instability of electrical characteristics with fluctuations in temperature. Each diode is temperature cycled and then tested to assure that the operating temperature range is limited only by inherent characteristics of germanium itself.

SUBMINIATURIZED
The Hughes Diode is designed for maximum space economy.

Hughes Germanium Diodes were developed and produced to meet exacting requirements in airborne electronic equipment for navigation, fire control, and guided missiles. In addition to the advantages of germanium diodes over vacuum tubes, Hughes Germanium Diodes exhibit these outstanding characteristics:

1. HERMETICALLY SEALED
Each hermetically sealed in glass for electrical stability.

2. THERMALLY STABLE
The Hughes Diode is designed to reduce differential expansion which would cause instability of electrical characteristics with fluctuations in temperature. Each diode is temperature cycled and then tested to assure that the operating temperature range is limited only by inherent characteristics of germanium itself.

3. SUBMINIATURIZED
The Hughes Diode is designed for maximum space economy.

4. ELECTRICAL SPECIFICATIONS AT 25°C

<table>
<thead>
<tr>
<th>Type</th>
<th>Peak Inverse Voltage</th>
<th>Minimum Forward Current</th>
<th>Maximum Back Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N58B</td>
<td>150</td>
<td>5.0</td>
<td>0.6 (-100)</td>
</tr>
<tr>
<td>1N70A</td>
<td>190</td>
<td>3.0</td>
<td>0.01 (-10), 0.4 (-50)</td>
</tr>
<tr>
<td>1N67A</td>
<td>100</td>
<td>4.0</td>
<td>0.005 (-5), 0.05 (-50)</td>
</tr>
<tr>
<td>1N81A</td>
<td>60</td>
<td>3.0</td>
<td>0.01 (-10)</td>
</tr>
<tr>
<td>1N86A</td>
<td>100</td>
<td>3.5</td>
<td>0.008 (-5), 0.1 (-50)</td>
</tr>
<tr>
<td>1N68A</td>
<td>120</td>
<td>3.5</td>
<td>0.06 (-50)</td>
</tr>
<tr>
<td>1N90A</td>
<td>75</td>
<td>5.0</td>
<td>0.06 (-50)</td>
</tr>
<tr>
<td>1N66A</td>
<td>60</td>
<td>3.0</td>
<td>0.06 (-50)</td>
</tr>
</tbody>
</table>

Because of expanded production capacity, Hughes Diodes are now available for commercial sale. Moderate quantities can be delivered from stock. Hughes Diodes are classified in accordance with RTMA specifications, and also are supplied to special customer specifications, including high temperature electrical requirements.

Address inquiries to: SEMICONDUCTOR DEPARTMENT
HUGHES Aircraft Company, Culver City, California

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
From the basic raw materials . . . to the final performance tests . . . Vickers selenium rectifiers are put through one of industry’s most rigid and comprehensive quality control systems to produce consistent quality rectifiers.

Tests and Inspections

- MATERIALS . . . . 142
- SELENIUM PURITY . 11
- CELL PROCESSING . 61
- ASSEMBLY . . . . 18
- ELECTRICAL . . . . 12
- MECHANICAL . . . . 11

These tests and inspections assure more consistent performance characteristics and stable, longer life rectifiers!

more reasons why VICKERS makes a better rectifier:

- Automatic electro forming "pre-stresses" cells.
- Precision-matched cells prevent overload—overheating.
- Hydraulic assembly assures mechanical strength and dimension.
- Rectifiers shock and vibration tested to Military Specifications.

Write for Bulletin 3000. Vickers engineering service is available without obligation.

PRODUCTION TECHNIQUES (continued)

Magnetic amplifier test setup, showing use of masking tape for anchoring additional selenium rectifier on top of cabinet and for supporting glass thermometer rather than individual voltmeters and ammeters for measuring circuit values. To minimize chances of having the multimeters pulled off the bench by their test leads, the instruments are grouped together with masking tape. The tape can readily be removed when the test is completed, for returning the individual meters to the stock room or rearranging them for other tests.

To avoid mistakes in reading meters, a piece of masking tape is placed on the face of each instrument and the characteristic being measured is lettered on the tape. These notes are in abbreviated forms; thus, SENSING identifies the Simpson multimeter which is set

Use of masking tape to fasten four multimeters together temporarily, and method of using the tape to identify the function of each instrument. Tape across test lead plugs of lone multimeter in foreground is safety precaution when measuring 440-volt line voltage.

Want more information? Use postcard on last page.
Weston Model 1411

D-C INSTRUMENT AMPLIFIER

- A rugged, stable D-C Amplifier, with less drift.
- Has permanent components—no electrolytic capacitors, no choppers.
- Uses only tube types on standard Preferred list.
- High response speed (in the order of 1/10 sec. nominal—faster on the higher ranges).
- Accuracy better than 0.1% on higher ranges... 1% general accuracy.
- For industrial applications, ranges down to 1 millivolt and 20 microamperes—for laboratory service, ranges down to 100 microvolts and 2 microamperes.
- Interchangeable plug-in range standards.
- Descriptive bulletin on request.

WESTON ELECTRICAL INSTRUMENT CORPORATION
614 Frelinghuysen Avenue, Newark 5, New Jersey

WESTON Instruments

Want more information? Use post card on last page.
Continuous Operation
with
Surflene
Insulated Hook-up Wire

from +130°C HIGH ♦
(+266°F)
to −60°C LOW ♦
(−76°F)

Surflene RESISTS
HEAT • FUNGI • ABRASION
CHEMICALS • EXTREME LOW TEM.

"Surflene", extruded monochlorotrifluoroethylene, has high insulation resistance, dielectric strength and outstanding resistance to heat, abrasion, most chemicals and concentrated acids, including fuming nitric acid. It is non-inflammable, inert to fungi and has low surface leakage. It is especially designed for hermetically sealed and miniature equipment for high temperatures encountered in power supply and continuous duty apparatus. Also available in multi-conductor cables.

"Surflene" is available in thirteen colors — red, orange, yellow, pink, light and dark green, blue gray, tan, brown, black, white and clear.

Write our Engineering Service TODAY for technical assistance and samples.

Tinning an aluminum radio chassis by heating with a gas torch and rubbing the heated area with a rod of the new alloy

Want more information? Use post card on last page.

PRODUCTION TECHNIQUES (continued)

To a milliampere range for measuring the sensing current.

When a multimeter is used on a high-voltage range, such as 440 volts, masking tape is placed across the instrument ends of the test leads after they are plugged in. This strip of tape serves as a high-voltage warning and minimizes chances of accidentally or carelessly pulling out the test leads and thus exposing the high-voltage pins.

When measuring the temperature rise of selenium rectifiers during heat runs of magnetic amplifiers, masking tape is used to hold the bulb end of the glass thermometer against a rectifier plate. A longer strip of tape is used to support the other end of the thermometer in a position for easy reading.

During experimental work with magnetic amplifiers it is often necessary to hook in additional components temporarily. Instead of drilling holes in a chassis or cabinet for mounting these, the parts are set on top of the cabinet and held in position with masking tape. Leads with test clips can then be used for making connections, without risk that the part will fall off and dislodge all leads.

Aluminum Soldering Alloy

A new metal alloy called Chemalloy facilities soldering to aluminum sheet or wire. The aluminum is merely heated beyond 800°F and the alloy rod rubbed on. After this tinning operation, conventional soft soldering is possible.

During shortages of copper wire in Crosley's radio plant, the new alloy was used to tin aluminum wire after cutting and stripping. The wire could then be soldered conven-
- and knowing the advantages of automatic voltage regulation, this man depends on

**STABILINE**

**Automatic VOLTAGE REGULATORS**

Scientific developments are based on EXACT knowledge. To obtain exact data in tests involving electrical circuitry, input voltages must remain constant. To insure dependable, accurate results... to eliminate the need for rerunning experiments because a change in input voltage has invalidated the first run... depend on a STABILINE Automatic Voltage Regulator to maintain constant voltage regardless of line or load changes.

Offering the finest in automatic voltage regulation equipment, The Superior Electric Company offers two types of STABILINE Automatic Voltage Regulators. Type IE (Instantaneous Electronic) is completely electronic with no moving parts. Correction—when compared with other types—may be considered instantaneous. Regulation and stabilization are excellent; maximum change in output voltage will not exceed ¼ of 1% for any or all variations in operating conditions. Waveform distortion never exceeds 3%.

Type EM (Electro-Mechanical) is an electro-mechanical device with inherent characteristics of zero waveform distortion, high efficiency and faster correction than most types of automatic voltage regulators. It is ideal for controlling large industrial loads. Both types are available in numerous capacities and ratings.

SPECIAL MODELS of STABILINE Automatic Voltage Regulators can be supplied to meet individual requirements. Specializing exclusively in the design, development and manufacture of voltage control equipment, The Superior Electric Company is thoroughly experienced to help you in studying your exact needs and recommending the right equipment to serve you best.

FOR ENGINEERING INFORMATION and CATALOG, WRITE TO 202 MAE AVENUE

---

sci'ence (si'ens), n. (OF., fr. L. seire to know)
PREFERRED BY CRAFTSMEN
FOREMOST IN QUALITY

ALPHA
SOLDER
for everything electronic

CEN-TRI-CORE
ENERGIZED
ROsin-Filled
SOLDER

Guaranteed non-corrosive for radio, television, electronic and other electrical applications. No other solder works faster or easier...It provides greater fluxing uniformity and stronger smoother joints.

No activating chlorides or other chemical agents tending to produce acid conditions, toxic or sticky vapors, or latent corrosion.

Ideal where plated and/or oxidized parts must be soldered. Designed for use where faster fluxing is desirable.

CEN-TRI-CORE’s exclusive design guarantees rosin throughout the complete length of the wire. Eliminates rejects commonly encountered in the use of ordinary rosin core solders. CEN-TRI-CORE is faster fluxing: thinner walls between solder and rosin assure faster penetration of heat to the flux - requires less heat and guarantees maximum fluxing action of the rosin.

write for generous samples

ALPHA METALS, INC.
58 Water Street, Jersey City 4, N. J.

Two-Spool Solder Holder
A PORTABLE on-the-floor holder for spools of solder gives flexibility for rearranging soldering positions on an assembly line, provides storage space for discarded and newly cleaned soldering iron tips, and makes a supply of solder last twice as long before replenishing from the stock room.

The holders are constructed from...
For copper in any form — For top-notch service — Call Chase

What kind of copper or copper alloy do you need? Free-cutting brass rod? Sheet and strip brass? Phosphor bronze for springs? Call your nearby Chase warehouse. We can supply you, subject to government controls, with the widest variety of brass or copper materials for production, maintenance or repair.

Many of our branches are equipped to slit, saw, or shear our metals or your own stocks to specifications.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION
* The Nation's Headquarters for Brass & Copper

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Close tolerance sawing, slitting, shearing to your specifications.

Deliveries to your factory by truck, rail or express, if desired. Stocks of tube, rod, bar, strip, sheet and wire in a variety of alloys.

Electronics — February, 1953

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SYNCHRONOUS TIMING MOTORS and TIMERS for
- Industrial
- Military
- Commercial Uses

HAYDON* research and engineering staffs constantly seek to develop new and build better products. One example is the HAYDON 400 cycle timing motor. This is an hysteresis type synchronous timing motor, for use as a separate motor or in many different types of timers. HAYDON personnel and plant are equipped to build motors and timers using D.C., 60 cycle or 400 cycle for military or civilian applications.

HAYDON manufactures a wide range of dependable timing motors notable for their small size; quiet operation; total enclosure; separate systems for controlled lubrication of rotor and gear train; ability to operate in any position. Standard speed range from 60 rpm to one revolution in 7 days. The HAYDON motor is the basic element for standard timing components and custom-engineered timers designed and manufactured by the company for volume applications.

DESIGN INFORMATION
HAYDON will gladly send you technical data on request.

*TRADEMARK REG. U. S. PAT. OFFICE

HAYDON Manufacturing Co., Inc.
Subsidiary of GENERAL TIME CORPORATION
2426 ELM STREET
TORRINGTON CONNECTICUT

Vacuum Bakeout Ovens

THOROUGH CLEANING of precision parts for mass spectrometers is achieved with a carefully planned sequence of cleaning operations associated with a 2,500-watt oven providing vacuum bakeout, in a Pasadena plant of Consolidated Engineering Corp.

The oven is mounted directly over the vacuum pump, with its controls on an adjacent table. The Pyrex bell jar and the metal shield surrounding the insulation are counter-balanced for ease in lifting. Nichrome ribbon is wound around the outside of the bell jar to serve as the heating element for the oven.

Preliminary cleaning of the parts before vacuum bakeout is accomplished by washing in Dreft deter-
Short cut to loss

8:30 on a hectic night — and bids for the Cohansey Run Bridge had to be in the night's mail. It was after 5 when the estimators finished the roughs — everything was supposed to be automatic from that point on. Miss Exton was at the new electric calculating machine literally steaming along — when suddenly it stopped. Seems it wasn't steam — it was smoke — the machine had shorted through failure of the electrical insulation. Too late to get a serviceman — and it took 'til 4 A.M. to finish the calculations by hand — all because some manufacturer tried to save pennies by using an electrical insulation that cracked.

Electrical equipment is wonderful when it works. But let the insulation short out and failure is complete.

BH “649”, pioneer in the field of vinyl-coated fiberglas tubings, provides extra protection for your equipment against costly rejections and failures. It is permanently flexible, and offers high dielectric strength at continuous operating temperatures of 110°C., with “spot” resistance up to 220°C., without regard to aging and abuse.

Made of continuous Fiberglas yarns, coated with a vinyl compound, BH “649” can be twisted and knotted without damage. It withstands “push-back” during installation, without loss of physical or dielectric properties. It will not fail on a bend — even when bent back upon itself. It is absolutely fray and ravel proof. An imposing list of users testifies to its superiority — specific applications cited on request.

BH “649” is one of a family of BH electrical insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements, product, operating temperatures, voltages. We will furnish production samples for testing purposes.

Address Dept. E-2
Bentley, Harris Manufacturing Co.
Conshohocken, Pa.
MINIATURE SPEED CHANGERS

VARIABLE SPEED DRIVES

- Compact! Only 4½" overall
- Light! Weigh only 3½ oz.
- Continuously variable speeds over a wide range
- Knob, lever, push-rod or gear control (Lever control illustrated)
- Rotate in either direction
- Coaxial shafts for in-line construction
- Ball-bearings throughout
- Completely sealed
- Permanently lubricated for trouble-free high/low temperature service
- Operate in any position

Write for Bulletin 99

FIXED RATIO SPEED CHANGERS
(Gear Type)

- Only 1.050" diameter!
- Single section weighs only 3 oz.
- STANDARD ratios from 10:9 to 521,441:1!
- Hobbed gears for smooth, precision running
- Anti-backlash units... virtually zero backlash in either direction
- Completely sealed
- Permanently lubricated
- Mount in any position

Write for Bulletin 100

MINIATURE COMBINATION FIXED AND VARIABLE SPEED CHANGERS
For applications requiring variable speed at a reduced nominal output speed, combinations of Metron Variable Speed Drives and Fixed Ratio Speed Changers are available in compact, integral units. Ask for Technical Data, or write giving your requirements for prompt engineering recommendations and prices.

METRON INSTRUMENT COMPANY
440 Lincoln Street • Denver 9, Colorado

BUILT BY Metron MAKERS OF INSTRUMENTS FOR PRECISION MEASUREMENT

Method of handling baked-out parts with a lint-free cloth. Glass container is used for storage before baking, and container at right is used after bake out.
BRIGHT MINDS CONJURE UP ELECTRONIC MENTAL GIANTS

AT NORTH AMERICAN AVIATION

An airplane’s rate of descent used to be painstakingly computed from photographs which took several days to evaluate. Then North American’s electro-mechanical engineers developed TRODI (above) for the Navy for carrier suitability tests.

TRODI is an electro-optical Touchdown Rate of Descent Indicator that watches the airplane descend, measures its rate, and electronically readies its information so it’s available the minute the pilot lands. TRODI’s electronic brain saves untold time, men and money for the Navy.

TRODI is just one ingenious example of the challenging electronic and electro-mechanical work being pioneered at North American by some of the nation’s best scientific minds, using the most advanced facilities.

If you like theory, you may find an exciting and secure future at North American in the field of operations analysis, advanced dynamics, kinematics, noise, error or information theory, systems engineering, statistical quality control or servo analysis.

If research and development are your specialty, you’ll find attractive opportunities in radar and communications systems, analogue and digital computers, automatic guidance systems or optics.

Write today, including a summary of your education and experience, to:

NORTH AMERICAN AVIATION, INC.

Engineering Personnel, Missile and Control Equipment Department

12214 Lakewood Boulevard, Dept. 93-E, Downey, California

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Recently Developed Test Instruments. New Materials and Components and Several of the Latest Tubes Are Included . . . Forty-Six Trade Bulletins Reviewed Under Literature (p 328)

Transistor Sockets
MYCALEX TUBE SOCKET CORP., 60 Clifton Blvd., Clifton, N. J. The body of these transistor sockets is precision-molded of Mycalex 410, glass-bonded mica insulation for lasting dimensional stability, low dielectric loss, immunity to high temperature and humidity exposure combined with maximum mechanical strength. The loss factor is only 0.014 at 1 mc and dielectric strength is 400 v per mil. Contacts can be supplied in brass or beryllium copper. The sockets are readily solderable. Socket bodies will not warp or crack when subjected to high soldering temperatures. They function in ambient temperatures to 700° F.

F-M Monitor
BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass., announces the MD-33 frequency-modulation monitor designed to check the modulation swing of f-m transmitters operating in the police, fire and special service bands from 25 to 174 mc. This continuous coverage is accomplished in two bands without the use of plug-in units of any kind. Modulation swing is indicated directly on a 4-in. panel meter with a 20-kc full scale linear calibration. A dual range flasher circuit permits checking overmodulation by the shortest of voice peaks at either of two preset amounts of swing. The unit is 9 in. high x 20½ in. wide x 12 in. deep. Weight is 35 lb.

Miniature Power Supply
AIRPAX PRODUCTS Co., Middle River, Baltimore 20, Md., has released model A-1220, the first of a series of miniaturized d-c to d-c power supplies using a 450-cycle vibrator. Total weight is only 1 lb. 14 oz. Vibrator and power supply are hermetically sealed. The vibrator attaches with snap fasteners. Output is 150 v at 100 ma; peak ripple, 1.0 percent. Three standard units of 6, 12 and 26.5 v d-c are input and output power up to 20 w, output voltages up to 300 v, and input voltage between 4 and 110 v d-c can be furnished. The unit is designed to meet severe military standards of vibration, shock, temperature range, humidity and altitude.

Tiny Transmitter
MOTOROLA, INC., 4545 W. Augusta Blvd., Chicago 51, Ill., has announced mass production of a hand sized Handie Micro-Talkie transmitter designed to operate in the 152 to 174-mc frequency bands. The compact unit, weighing only 1 lb 13 oz, has a power output of 20 to 40 mw and a tested optimum range up to 5 miles. Overall case dimensions are only 7¼ in. x 2½ in. x 1¼ in. A rigid, chrome plated loop antenna doubles as the carrying handle. The unit uses 8 subminiature tube stages with printed associated circuitry. With the transmitter operated on the practical duty cycle of 15 seconds out of each 5 minutes, a battery life is one work week with the B batteries lasting 2½ weeks. The unit is especially useful for patrolmen on foot, firemen at the scene of a fire, or for on-the-spot news reporting. Indus-

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February, 1953 — ELECTRONICS
MAKE BETTER CONNECTIONS

with Sylvania's improved terminal strips

"MORE QUALITY PARTS
...BY SYLVANIA"

Sylvania now offers you a wide variety of highest quality terminal strips...equipped with from 2 to 14 lugs...suitable for many different applications.

Insulators are made from laminated phenolic. Contacts are brass or cadmium-plated steel. Sylvania Terminal Strips can be supplied to your specifications.

Today, with enlarged, modern plastic molding equipment and metal stamping facilities, Sylvania offers you precision-built components of highest quality at lowest possible cost. For new illustrated catalog showing the long line of Sylvania Terminal Strips and other radio and electronics components now available, write to: Sylvania Electric Products Inc., Dept. 3A-1002, 1740 Broadway, N. Y. 19, N. Y.

SEND FOR THIS CATALOG
Multiconductor Cable
KOILED KORDS, INC., 1565 Dixwell Ave., New Haven, Conn., has developed a 19-conductor retractile cord for use with movable relay rack mountings for electronic equipment. The retractile feature of the cord permits the equipment to remain operative when the mounting shelves are pulled out and then rotated for inspection or servicing. This shielded cable answers the need for a cord that would extend to the desired length but would not become fouled in the mechanism when relaxed. Conductors are No. 23 AWG tinned Hi-Tenso bronze insulated with synthetic rubber. A wound shield of tinsel is applied over the core of seven conductors. The remaining 12 conductors are cabled about this core and covered with another tinsel shield and an overall rubber jacket to an outside diameter of 0.540 in. The cord is then vulcanized in the coiled shape and terminated as required.

Power Pentode
GENERAL ELECTRIC CO., Schenectady, N. Y., has announced type 6CL6 power pentode for use in the video output stage of television receivers. Using this tube it is possible to obtain a voltage gain of from 40 to 45 in wide band video circuits. The tube features high transconductance, low capacitances and high output current capability. It provides a high plate current at low plate voltages and can supply enough peak-to-peak output voltage to drive large picture tubes with high efficiency and low amplitude distortion. It is capable of supplying 132 v peak-to-peak output across a load resistor of 3,900 ohms. In addition to its use in video output service, the new 9-pin miniature may also be used as a wide-band amplifier in industrial and laboratory equipment.

Insulated Terminals
SEALECTRO CORP., 186 Union Ave., New Rochelle, N. Y., has introduced a line of DuPont Teflon insulated standoff and feed-through terminals. These Press-Fit terminals are one complete unit ready for assembly, eliminating the use of any and all hardware for installation. A simple press fit with an inexpensive hand tool or drill press, into a chassis drilled with a predetermined diameter hole fastens the terminal securely. Teflon’s excellent electrical properties are unaffected by thermal change. Its dielectric constant is lower than almost any other engineering material and in combination with the extremely low power factor results in a loss factor lower than for any other material. The losses are also constant into the microwave region. It is unaffected by sparking over its surface and sheds moisture. Additionally, it will not support the growth of fungus and is therefore useful in equipment to be used in the tropics.

Wave Analyzer
SIERRA ELECTRONIC CORP., 810 Brittan Ave., San Carlos, Calif. Analysis of the frequencies and amplitudes of signal components in a complex waveform is accomplished in a simple and direct way with the model 121 wave analyzer. A novel two attenuator design permits a wide range of measuring amplitudes without the introduction of instrument distortion. Signal components are read directly on a 4-in. indicating instrument calibrated in db. Voltage calibration is accomplished with an internal 100-kc injection oscillator, and a listening jack is provided for monitoring the signal being measured. The instrument has an input level range from +12 dbm to -70 dbm at a 600-ohm impedance level. Input impedance is 10,000 ohms in the pass band. Selectivity is such that 100 cps off resonance the response is 3 db down; 200 cps off resonance, 10 db down; 500 cps, 30 db; and 1,000 cps, 45 db. Measuring accuracy is ±2 db and spurious components are at least 50 db below signal fundamental.

High Speed Trigger
THE WALKIRT CO., 145 W. Hazel St., Inglewood, Calif., announces the type M1563 high speed trigger. It is a Schmitt type circuit designed to meet the wide need for a fast pulse suitable for driving many types of counting or scaling equipment from a sine wave input. The unit can also be driven from a square wave input, in which case it acts as an amplifier and will pro-
Scores of results have established the superiority and outstanding quality of RPC's new TYPE C PRECISION WIRE WOUND RESISTORS. These high-quality units are designed to meet the stringent requirements of JAN-R-93.

Completely insulated precision resistors which may be soldered directly into circuits. Their small size and light weight make them self-supporting. Ideal for aircraft applications where reduction in size and weight are vital.

Completely enclosed in rugged plastic of high insulation value. Windings are impregnated in special compound and protected against dust, salt spray, humidity and mechanical damage.

Winding form is of low loss steatite having extremely high insulating quality with low coefficient of expansion. Impervious to moisture.

Type C resistors are wound with specially tested low temperature coefficient alloys. RPC's Type C resistors are being used by many of America's outstanding manufacturers. They are available in any amount with prompt delivery. Write for complete information.

RESISTANCE PRODUCTS CO.
714 RACE ST. HARRISBURG, PENNA.
HIGH MEGOHM, HIGH VOLTAGE, HIGH FREQUENCY, WIRE WOUND PRECISION

Want more information? Use post card on last page.
NEW PRODUCTS (continued)

duce pulses of either positive or negative polarity. The 150-v peak-to-peak output has a rise of 0.2 μsec and a fall time of 0.45 μsec, measured to 90-percent amplitude. Nominal plate to ground voltage on the type 5570 tube employed is 100 v when conducting, and 250 v when nonconducting. The type 5570 tube is used meeting new military reliable tube requirements. The unit is packaged in a resin encapsulated plug-in form with a versatile 11-prong octal-style base.

Digital Preset Counter

DIGITAL INSTRUMENT Co., INC., P. O. Box 1246, Coral Gables, Florida, has introduced two high-speed presetting types of counters. In the model 333 any number may be set from 0 to 999 and in model 334, any number from 0 to 9,999. Recycling can be obtained at speeds as high as 20,000 per second and the counter will operate as a standard counter at speeds up to 100,000 counts per second. Relay contacts are available for control functions. Direct-coupled output is available for electronic control and gating.

Mobile Wireless Receiver

RADIO APPARATUS CORP., Indianapolis, Ind., now has available the
How many of these electrical insulation problems do you have?

1. Looking for an efficient coil wrapping for small spaces? EMPIRE® varnished bias-cut nylon tape is highly flexible, strong and efficient... makes a thin insulation of unusually high dielectric strength with good resistance to oil and water.

2. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO.

3. Looking for a better material for wiring diagrams, controls, instruments, dials and nameplates? DECORATIVE LAMICOID® resists wear, aging, weathering, oils, corrosive vapors, moisture and temperature extremes. Won't warp, check or chip. Good electrical properties. Wipes clean with a damp cloth.

4. Need a class H segment plate that's easy to work with? ISOMICA Segment Plate — made of built-up continuous mica sheet — shows no tendency to split or flake. Small segments of heavy thickness may be punched, and larger segments can be accurately sawed, milled, punched, etc.

Whatever electrical insulation material you need — standard or special — class A to class H — MICO makes it best. We manufacture it, cut it to size, or fabricate it to your specification. Send us your blueprints or problems today.

*MICO Insulator Company
Schenectady 1, New York
Offices in Principal Cities

LAMICOID® (Laminated Plastic) • MICANITE® (Built-up Mica) • EMPIRE® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA®

Electronics — February, 1953
Want more information? Use post card on last page.
Need Linear and Non-Linear ACCURATE Functions?

Use Fairchild Precision Potentiometers

Experience with Fairchild potentiometers in hundreds of applications shows that these units are unusually precise. Accuracies of ±1% in non-linear types and as high as ±0.05% in linear types can be guaranteed. Service life as high as 10,000,000 cycles, under certain conditions, also can be provided. High resolution, low torque, and low noise level are other performance features worth noting.

Fairchild Precision Potentiometers perform mathematical computations in electrical computing systems for machine-tool controls, process controls, telemetering, guided missiles, flight control, fire control, and analog computers of all types. They are available in non-linear and linear types and in ganged combinations of either or both windings to meet your requirements.

Use the coupon below to get full details.

Monitoradio Pager—model AmC-1—which is a radio paging receiver for use in motor cars as a supplement to the pocket receiver utilized by most paging systems. Thoroughly field tested in conjunction with one of the paging systems now in operation, this unit is the only demonstrated receiver available for this type of operation. The receiver is expected to be used in many fields within a short time.

Medium-Mu Twin Triode

RADIO CORP. OF AMERICA, HARRISON, N. J. The 6211 is a new medium-mu twin triode of the 9-pin miniature type designed especially for frequency-divider circuits in electronic computers and other on-off control applications involving long periods of operation under cutoff conditions. It has separate terminals for each cathode to facilitate flexibility of circuit arrangement, and a midtapped heater to permit operation from either a 6.3-v or 12.6-v supply. The heater is made of pure tungsten to give long life under conditions of frequent on-off switching.

Transformer Cans

TRIAD TRANSFORMER MFG. CO., 4055 Redwood Ave., Venice, Calif., announces the introduction of a line of deep drawn transformer cans. These cans are seamless and are drawn from cold rolled steel to meet the dimensional specifications of MIL-T-27. The lids are internal and require no stops since they fit the can snugly. Cans are available only
...with RCA thoriated-tungsten filament tubes

RCA-5770
SAVE—60%
filament power, over comparable pure-tungsten type

RCA-5671
SAVE—60%
filament power, over comparable pure-tungsten type

RCA-5762
SAVE—Filament power, only 365 w. (No comparable pure-tungsten type)

RCA-5771
SAVE—70%
filament power, over comparable pure-tungsten type

Designed specifically for industrial, communication, and broadcast services, these high-power tubes can save hundreds of dollars a year in filament power—can cut initial equipment power costs substantially.

For instance • RCA-5770 takes 150-kw input up to 20 Mc, yet this triode requires only 3.1 kw of filament power—saves 60% over the comparable pure-tungsten-filament type • RCA-5671 takes 100-kw input up to 10 Mc. This air-cooled triode requires only 3.1 kw of filament power—saves 60% over the comparable pure-tungsten-filament type • RCA-5771 takes 60-kw up to 25 Mc. This triode requires only 1275 watts of filament power—saves 70% over the pure-tungsten-filament type • RCA-5762 takes 5.5-kw input up to 110 Mc. This VHF triode takes only 365 watts of filament power!

Consider these important features for the equipment you design. For additional technical information write RCA, Commercial Engineering, Section 42BR, Harrison, New Jersey. For application assistance, simply call your nearest RCA Field Office:

(EAST) Humboldt 5-3900, 415 S. 5th St., Harrison, N. J.
(MIDWEST) Whitehall 4-2900, 580 E. Illinois St., Chicago, Ill.
(WEST) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Cal.

IN PRODUCT IMPROVEMENT RCA NEVER STANDS STILL

RADIO CORPORATION of AMERICA ELECTRON TUBES HARRISON, N. J.

ELECTRONICS — February, 1953

Want more information? Use post card on last page.
What do you want IN DIALS OR NAMEPLATES...

accuracy? eye-appeal? low cost? variety?

You get them all when they're "U. S. RADIUM"!

When you specify U. S. Radium dials or nameplates, you get accuracy because we've had many years' experience in making high-accuracy dials for scientific instruments. You get eye-appeal, whether you provide your own design or have us design the unit for you, because we've designed and produced millions of dials and nameplates - including dials for well-known makes of watches and clocks. You get low-cost because, in producing so many dials and nameplates, we've developed mass-production techniques that save money. And as for variety - nowhere else can you get a selection like this! We make self-luminous, fluorescent, phosphorescent, and nonluminous types, including Alumilite, lithographed or etched aluminum, brass, steel, or stainless steel - finished in lacquer, nickel, chromium, or silver - with black, color, or luminous markings. We are, of course, equipped to meet Government specifications.

To find out how accurately and economically we can meet your dial or nameplate requirements, write to Dept. E2, U. S. Radium Corp., 535 Pearl Street, New York 7, N. Y.

Other Products of U. S. Radium

- Radiactive Foils (alpha-ray ionization sources)
- Ionotron Static Eliminators
- Radium Locators: Tenses, buttons, screws, markers
- Luminous Reticles and other specialties

UNITED STATES RADIUM CORPORATION

BETTER DIALS AND NAMEPLATES AT LOWER COST

NEW PRODUCTS (continued)

for military contracts. Specifications and prices are available from the company.

Direct-Drive Yokes

HALLDORSON TRANSFORMER CO., 4500 N. Ravenswood Ave., Chicago 40, Ill., is currently supplying their new 6,000-v test deflection yokes, DR603 and DF604, extra-heavily insulated to stand up under the rigors of direct-drive tv service. Both deflection yokes have 30-mh horizontal inductance, but to cover all direct-drive applications, the vertical inductance of DF603 is 3.5 mh, while DF604 is 50 mh. Both yokes are supplied with 20-in. colored leads and networks. Bulletin 109 fully describes the deflection yokes discussed.

Tiny Capacitor

SPRAGUE ELECTRIC Co., 35 Marshall St., North Adams, Mass., has developed a very tiny molded paper capacitor for continuous operation at temperatures up to 125 C. Designated type 85P, these capacitors are impregnated with Prokar, an exclusive high-temperature organic material which is polymerized to a

Want more information? Use post card on last page.

February, 1953 - ELECTRONICS
Keystone is one of the nation's foremost suppliers of magnetic amplifiers. Effective immediately we have available for prompt delivery the first of five "stock" magnetic amplifiers. Engineers may now design units around these "pre-designed" magnetic amplifiers. Inquiries are invited on the "Moto Mag"

In place of the conventional output transformer and power amplifier tubes, the KP 10-400 utilizes a phase sensitive vacuum tube demodulator and magnetic amplifier output stage which eliminates the need of rectifiers, thus assuring greater reliability. Each unit built in accordance with MIL specifications. KP 10-400 operates from an input voltage of 115 volts, 400 cycles single phase. Output is 10 watts, reversible phase. KP 10-400 operates from a minus 55° to plus 70° C with minimum variation. An input signal of 2 volts AC or DC working into a high impedance is required for a maximum of 110 volts, 10 watts, 400 cycles. The unit is 4 inches high, 3½ inches wide and 2½ inches deep. Weight—only 1 lb., 13 ounces.

Your inquiry will have our prompt attention.

KEYSTONE PRODUCTS CO.
904-6 TWENTY-THIRD ST., UNION CITY 2, NEW JERSEY
UNion 6-5400
THE HIGH-PRECISION LINEAR POTENTIOMETER

MICROPOT precision ten-turn potentiometer

BORG MICROPOT TEN-TURN POTENTIOMETER: Built to fit the specifications of control system engineers and designers . . . constructed with Micro accuracy for precise voltage adjustments . . . featuring an assembly scientifically designed, machined, assembled and automatically machine tested for linearity of ±0.1% and 0.05%, zero-based. MICROPOTS ARE AVAILABLE IN 1.15 to 3 OHM and 30 to 250,000 OHM RANGES FOR IMMEDIATE SHIPMENT.

BORG MICRODIAL: Two concentrically mounted dials: one for counting increments of each turn and the other for counting turns . . . delivered completely assembled with dials synchronized. Outstanding features include smooth, uniform action . . . no backlash between incremental dial and potentiometer contact . . . less wear, only one moving part aside from the two dials . . . contact position indicated to an indexed accuracy of 1 part in 1,000.

MICROPOT—MICRODIAL CATALOG SENT PROMPTLY ON REQUEST

BORG MICRODIAL

BORG MICRODIAL 746-A
A precision ten-turn indicating dial assembly. Has screw locking device on operating knob.

BORG MICRODIAL 746-B
Same as 746-A but has knurled locking screw mounted externally to operating knob.

NEW PRODUCTS (continued)

MICROWAVE GAIN SET

KAY ELECTRIC Co., 14 Maple Ave., Pine Brook, N. J. The microwave gain set illustrated is a complete equipment for making precision measurements of gain or loss in microwave components or systems, and it can also be adapted for use down to the vhf range. Unusually high precision is attainable, since the gain set, which is readable to 0.025 db, is capable of measurement accuracy within 0.1 db of the attenuator calibration. Measurements can be made where available power is as low as −80 dbm. In order to measure the gain, loss, standing-wave ratio, or other properties of a microwave system or component, energy of the desired frequency is sent through the component under test and then received by a microwave receiver. The microwave gain

solid resin. The resulting dielectric is completely solid and permits considerable size reduction with extreme stability under all operating conditions. The impregnated sections are then molded in a mineral-filled, high temperature plastic. Originally developed for military use, these miniatures are now available for precision electronic equipment requiring high-quality components such as electronic computers and geophysical amplifiers. Type 85P units are available in molded sizes—0.175 in. diameter x 3 in. long and 0.200 in. diameter x 2½ in. long. Standard RTMA 20-percent and 10-percent capacitance decade values are available as well as 5-percent values.
The KLIXON C6360 is a current type relay which means that the entire motor current flows through it. Therefore the wire in the coil winding is heavy enough to be used for leads, eliminating screw terminals. And since sleeves of Natvar 400 are reasonably low in cost, and are easily slid over the leads, assembly is quicker and less expensive. Also, leads can be color coded, because Natvar 400 is furnished in bright, distinctive colors.

KLIXON Protective devices and controls, manufactured by Spencer Thermostat Division of Metals & Controls Corporation, are used by foremost makers of refrigerating and other electrical equipment to assure safe, continuous operation under all service conditions.

Since reliability of KLIXON devices is essential, only the best materials are used. Natvar 400 extruded plastic tubing has been selected as the most suitable lead insulation for the starting relay shown above because of its excellent physical and electrical properties and its dependable uniformity.

Natvar 400 and other Natvar flexible insulating materials are available either from your wholesalers stock or direct from our own.

NATVAR CORPORATION
FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION
201 RAHWAY AVENUE • WOODBRIDGE, NEW JERSEY

Since these KLIXON starting relays are used as standard equipment by a great many leading manufacturers of refrigerating units, insulation must be able to withstand both high and low ambient temperatures. Natvar 400 tubing has excellent flexibility and resistance to oil and moisture over a very wide temperature range.
MARKEN Solved This Marking Problem

Printing Label Information on Cartridge Enclosed Fuses

Working closely with Underwriters' Laboratories, Inc. and with leading fuse manufacturers, Markem has developed a method which makes possible for the first time the printing of label information directly on cartridge enclosed fuses at production rates. Markem's direct ink imprints cannot "fall off" and are unaffected by moisture or ordinary chemical atmospheres. Paper label inventory and wastage problems are eliminated. Print is larger and color coding and identification are simplified. Fuse manufacturers anticipate better labeling at higher production rates and with lower costs.

The Markem Method—Markem Machine, Markem type and ink and the special recording die roll for use when UL Manifest is required—as well as the imprint itself meet with UL approval.

MARKEN MARKS THEM ALL

L-F Time Calibrator

Owen Laboratories, 9130 Orion Ave., San Fernando, Calif. The type 190 low-frequency time calibrator is a synchronous-motor driven device furnishing pulses at intervals of 0.01, 0.1, or 1.0 second. It is intended for use with oscilloscopes and various types of recording equipment in electrical, mechanical biological investigations. Pulse amplitude is about 1.5 v. Size is $5\frac{1}{2} \times 3\frac{1}{2} \times 3$ in.

Gas-Switching Tube

General Electric Co., 1 River Road, Schenectady 5, N. Y. Type GL-1B24-A gas switching tube for airborne radar is an integral-cavity tunable type designed for use in simple duplexers in pulsed microwave circuits which do not require that the short circuit in the tube have a fixed electrical position. The tube is designed for use in an operation band of from 8,490 to 9,600...
NEW APPLICATION!

Simple, maintenance-free TIME DELAYS with GLOBAR Type F Resistors

Now time delays in many relay and solenoid circuits are being obtained inexpensively by simply connecting a GLOBAR Type F Ceramic Resistor in series with the actuating coil. Delays range from a few seconds up to two minutes, depending upon the values and sizes of the resistors used.

When power is applied to the circuit, the current through the resistor causes it to heat. As it heats, its resistance decreases and the current increases until the tripping value of coil current is reached.

It's simple, inexpensive, and maintenance-free—and requires less space than cash-pots or other more complicated delay devices. It is useful in single delay applications—as in the starting of critical electron tubes; or in multiple delay applications where fixed timing of a series of events is necessary—as in the starting of oil burners.

If you have a time delay problem—or any circuit problem where long-life GLOBAR Ceramic Resistors might provide the answer—let our engineers help you. Just send complete circuit information to Dept. E 87-31.

GLOBAR Ceramic Resistors

by CARBORUNDUM

“Carborundum” and “Globar” are registered trademarks which indicate manufacture by The Carborundum Company, Niagara Falls, New York.
For better
controls
through better
Hermetically
Sealed Relays

The most advanced hermetically sealed relays can be designed and produced by a firm like Leach which pioneered this field from the beginning.

Here at Leach you will find complete engineering, testing and production facilities to help you solve your relay problems in the electrical and electronic fields.

The unsurpassed dependability of Leach Relays has been proved by nearly four decades of leadership in providing all types of relays for maximum performance under competitive operating conditions.

FOR BETTER CONTROLS THROUGH BETTER RELAYS
— Specify Leach

LEACH RELAY CO.
5915 AVALON BOULEVARD • LOS ANGELES 3, CALIFORNIA
Representatives in Principal Cities of the U.S. and Canada

No. 637SS, AN3307-1
2PDT Hermetically Sealed,
Solder Terminal Type

No. 637PS
2PDT Hermetically Sealed,
Plug-In Type in Octal Plug

No. 9031SS
3PDT Hermetically Sealed,
Solder Terminal Type

Performance characteristics for the
Relays illustrated above are as follows:
• Contacts rated: 10 Amps.
  Resistive and inductive at 29 VDC.
• 6 Amps. Motor load at 29 VDC.
• 10 Amps. Resistive at 115 VAC, 400 cycles.
  Call 24-28 VDC.

mc. It operates to decouple the receiver effectively from a common transmitting and receiving antenna during a transmission period. The GL-1B24-A has a recovery time of 4 μsec at 10 kw peak, 3 db down. It has a leakage power of 30 mw. Transmitter peak power is 100 kw.

Cable Tester

LLOYD'S ENTERPRISES, Box 313, Altadena, Calif., has available a cable tester for testing multiconductor cables for opens, shorts between any other conductor or shorts to ground. The model LK24-7 tests the TV24 conductor camera cable (three conductors are coax) and the RCA field sync generator 7 conductor cables. Any combination with standard fittings can be supplied upon request. The buzzer is normally used to indicate continuity or shorts, but binding posts are supplied so that an external ohmeter can be used if desired.

Repeat Cycle Timer

G. C. WILSON & CO., 2 North Pasaic Ave., Chatham, N. J. Model No. 1 electronic repeat cycle timer is suitable for regulation of automatic machinery, sampling, valve pacing and heat sealing as well as

NEW PRODUCTS
(continued)
The OPAD-GREEN General Purpose Power Supplies are designed to furnish an adjustable source of unfiltered direct current from single phase 50 or 60 cycle A.C. power lines. A unique feature is their stepless control of the D.C. output voltage which permits them to serve as power sources for a wide variety of electrical equipment and electro-chemical processes. For additional information write for Bulletin No. 147.
Do audio attenuator problems cost you money? Chances are Shallcross has a model to match your specifications exactly—and at moderate cost.

Shallcross attenuators are made in over 200 basic types. Each type can be supplied with a choice of attenuation characteristics... with a positive detent mechanism... and in numerous input and output impedances. Where calibration must be extremely accurate, Shallcross precision wire-wound resistors are used. For less critical applications, models with high grade composition resistors can be supplied—often at lower cost.

A complete description of all Shallcross attenuators—mountings, characteristics, and circuits is yours for the asking in Bulletin L-4A. SHALLCROSS MFG. CO., 522 Pusey Avenue, Collingdale, Penna.

Quick Deliveries! Small quantities of popular 20 step Shallcross composition resistor potentiometers and wire-wound ladders without detents are immediately available.

Frequency Standard

AMERICAN TIME PRODUCTS, INC., 580 Fifth Ave., New York 36, N. Y.

Type 2007 hermetically sealed frequency standard contains a shock-mounted miniature high-Q tuning fork, a subminiature double triode tube and all circuitry. Output frequencies available are 400 or 500 cycles with an accuracy of ±1 part in 50,000 from 15 to 35 deg C and ±1 part in 5,000 from -65 to +85 deg C. It is sealed in an octal base container, 1 3/4 in. in diameter and 4 1/2 in. high. It weighs less than 10 oz. Power required is 75 to 200 v d-c at 1 to 5 ma, and 6.3 v at 300 ma. It is designed to withstand MIL environment.

Transformers

A.J.F. INDUSTRIES, INC., 852 Monroe St., Brooklyn 21, N. Y., is now
**Temperature Compensating as well as By-Pass DISCAPS**

are Rated at 1000 Working Volts!

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**SPECIFICATIONS**

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If the samples you need are not here — send for them.

**SEND FOR SAMPLES AND TECHNICAL DATA**

**RMC DISCAPS** are Designed to Replace Tubular Ceramic and Mica Condensers at LOWER COST

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RMC DISCAP CERAMIC CONDENSERS

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

DISTRIBUTORS: Contact Jobber Sales Co., 146 Broadway St., Paterson 1, N. J.
HEILAND Series "700" Oscillograph Recorders have been designed and developed to enable the testing engineer and scientist to solve the wide variety of industrial and laboratory problems involving the measurement of physical phenomena such as strains, stresses, vibrations, pressures, temperatures, accelerations, impact, etc. Accurate and dependable oscillograph records permit the study of various recorded data comparatively, individually and collectively, making for better product design and performance.

HEILAND Series "700" Oscillograph Recorders are widely used today for the analysis of static and dynamic strains, vibrations, etc. in aircraft and guided missile flight testing; structural tests; performance tests; riding quality evaluation; voltage and current measurements; medical research; general industrial problem analysis.

Other "700" models up to 60 channels are available. Write today for a complete catalog of Heiland "700" oscillograph recorders.

The Heiland Research Corporation
130 East Fifth Avenue, Denver 9, Colorado

dependable instruments

NEW PRODUCTS

Wire Twister

The Eraser Co., Inc., Rush Wire Stripper Div., 114 S. State St., Syracuse 2, N. Y. Designed for uniform, low-cost wire twisting, this new wire twister consists of a spiral rod with hooks on both ends and a follower shaped to fit the thumb and forefinger. With the followers at one end, the wire is attached to the hook on that end and the follower drawn the full length of the spiral rod. Then the unit is turned end for end and the operation repeated. The No. G-3 is designed for 6 turns; the No. G-4, for 12 turns.

Servo Tester

Industrial Control Co., Wyandanch, Long Island, N. Y. The
Introducing the new E-I
GS SERIES MULTIPLE HEADERS

...specially designed for relay closures and similar applications

New GS Series multiple headers are another step forward in standardization by E-I engineers. They offer engineers in electronic and electrical design a selection of economical standard components that solve most, if not all, problems of hermetically sealed terminals for relay closures and similar applications. Over 200 standard headers are now available for this type of service. For complete information on other types, consult the bulletin described below.

- RUGGEDLY DESIGNED FOR EXTRA DEPENDABILITY
- MANY TYPES AVAILABLE WITH EXHAUST TUBES
- WIDE RANGE OF SIZES FOR ALL REQUIREMENTS
- STANDARD TYPES FOR MAXIMUM ECONOMY

E-I... your Headquarters for Hermetically-Sealed Multiple Headers, Octal Plug-Ins, Terminals, Color Coded Terminals, End Seals, etc.

ELECTRICAL INDUSTRIES
44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

WRITE FOR NEW E-I MULTIPLE HEADER BULLETIN 950-B!
Includes the complete line of E-I Standard Multiple Headers which offer an economical solution to practically any problem of design involving hermetically sealed terminals.
By the use of 18 Lenkurt precision-wound wedding-ring toroids, the two bandpass filters shown at right were redesigned into a single hermetically-sealed plug-in unit, as shown at left. Volume was reduced from 179 cu in. to 36 cu in., a factor of 5 to 1. But, at the same time, performance was actually improved.

Whenever your military or commercial designs call for maximum filter or toroidal-coil reliability under adverse service conditions, and where exacting electrical performance must be maintained, bring your problems to Lenkurt. The Lenkurt engineering group has a rich background of experience from which to offer valuable suggestions in the matter of setting practical specifications to attain the utmost from materials, components and techniques.

LENKURT ELECTRIC SALES CO.
SAN CARLOS 1 CALIFORNIA

101-A servo tester is designed for the rapid field maintenance and production testing of servo systems by technical personnel using no additional instrumentation. The transient response of the loop under test is shown on a 3-in. c-r screen, and viewed through a mask onto which has been previously drawn the response specified by the manufacturer. The operator adjusts the servo loop to match the two traces; if this is not possible, the loop is declared inoperative and returned to a laboratory area or maintenance depot for repairs. A standard servo test receptacle is installed on the equipment to be checked, and wired into the data system. A single cable connects this plug to the 101-A. The tester can be used with d-c and carrier frequency servos, and operates from the 117 v 60 or 400-cycle line.

NEW PRODUCTS

Power Resistor

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., has added to its line a new power resistor, type PW4, rated at four watts. Completely insulated with an inorganic core material molded in a high temperature plastic, this unit will not support combustion. The wire element is uniformly and tightly wound on glass fibre core with axial leads 1\(\frac{1}{4}\) in. long and 0.036 in. in diameter. Body dimensions are 1\(\frac{1}{4}\) in. long x 0.169 in. in diameter. The resistor is available from 1 ohm to 8,200 ohms in ±5.0 percent and ±10.0 percent tolerance. It is particularly recommended for tv circuits requiring 2 to 3 w actual dissipation at high ambient temperature, as resistance element of resistance-capacitance filter in automobile receiving sets where operation is at high ambient temperature.
WHEN you need a quick answer to WHO MAKES IT...

Just look it up in the electronics BUYERS' GUIDE.

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23,367 ANSWERS to 1,445 PROBLEMS covering every...

COMPONENT EQUIPMENT and MATERIAL used in every phase of electronics.

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This 40 page comprehensive booklet shows typical examples of Kirk & Blum fabrication, complete facilities of plants and equipment for jobs ranging from one unit to thousands.

Whatever your requirements in sheet, plate and alloy fabrication, Kirk & Blum can produce for you... economically and quickly.

Complete facilities to ½" capacity for square and rotary shearing, breaking, forming, rolling, punching, riveting, welding, grinding, drilling and finishing sheets and light plates and structures.

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KIRK-AND-BLUM METAL FABRICATION

ELECTRONICS — February, 1953

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multiplex radio telephony systems
must take it...

that's why REL specifies

CHICAGO
World's Toughest Transformers

Absolute dependability under the most rugged operating conditions is a prime requirement in all REL Multiplex Radio Telephony Systems. That's why you'll find CHICAGO "Sealed-in-Steel" transformers used throughout REL equipments. These world's toughest transformers are available in 3 mountings, each featuring one-piece seamless design enclosing an electronically perfect construction. Available for every application:
- Power
- Bias
- Filament
- Filter Reactor
- Audio
- MIL-T-27
- Stepdown.

Ask for them at your electronic parts distributor.

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You'll want the full details on CHICAGO'S New Equipment Line covering the complete range of "Sealed-in-Steel" transformers designed for every modern circuit application. Write for your free copy of this important catalog today, or get it from your electronic parts distributor.

Field Strength Meter

Jerrold Electronics Corp., N. E. Cor. 26th & Dickinson Sts., Philadelphia 46, Pa., has developed the model 704 field strength meter that is designed to bridge the gap between ultra-expensive laboratory models and the simple-type field meters which provide only a relative indication of signal strength. It is a direct-reading meter for tv and f-m and will read in microvolts. The unit is accurate to ± 0.8 db and has a continuous tuning range from 50 to 220 mc. Model 704 separates and measures video, audio and adjacent channel carriers, and locates r-f interference.

Television Pentode

Sylvania Electric Products Inc., Emporium, Pa., has in production a new television pentode, the 12BY7. It is a high-transconductance, sharp-cutoff video amplifier de-
signed for service in tv receivers. The tube features miniature T-64 construction, and will furnish large output voltages across low values of load resistance and supply voltage. The separate suppressor grid connection allows the 12BY7 to be used for more diversified applications. The heater may be operated from either 6.3 or 12.6 v.

Linear Motion Potentiometer
Bourns Laboratories, 6185 Magnolia Ave., Riverside, Calif. The new linear motion potentiometer with precision wire-wound resistance elements was designed for airborne and industrial electronic systems. Linearity, tested by the continuous calibration method is ± 0.5 percent or better. A resolution of 0.001 in. is attainable with standard shaft travels of 1 in (model illustrated), 2, 4 and 6 in. The potentiometer will withstand sustained acceleration of 100 g's and vibration of more than 1,000 cps. Standard resistances range from 1,000 to 50,000 ohms. An output of at least 26 v is attainable from the unit. Size is 1 in. x 1 in. x 2½ in. Weight is 1½ oz.

Miniature Transformer
Fortiphone Ltd., 247 Regent St., London, W.1, England. Type T.4 miniature transformer has been
Ideal for high precision cutting, surface film removal, etching and light deburring

This remarkably versatile machine can be used for a wide variety of high precision operations from cutting hard, brittle materials to producing fine matte surface finishes.

Using a high speed jet of gas-propelled abrasive particles, it can produce cuts as fine as .018" diameter. Its basic advantages are that it cuts cool and without shock or vibration — its accuracy is unaffected by surface irregularities of the work—and it can be accurately regulated for depth and type of cut.

Many manufacturers are now using the Unit to remove surface coatings on deposited carbon resistors and on printed circuits — for light deburring on inside surfaces of tubular parts — drilling fine holes through glass — cutting germanium.

We will be glad to make tests to determine the suitability of the "Airbrasive" Unit to your production requirements. Send us a sample of the part or material as well as details of the job you have in mind. There's no obligation.

WRITE FOR BULLETIN 5212

It has full facts and data on the Airbrasive Unit. It tells you how the "Airbrasive" Unit works and provides information on where, when and how it can be used.

THE S.S.WHITE "AIRBRASIVE" UNIT

Western District Office • Times Building, Long Beach, California

NEW PRODUCTS

Isolation Amplifier

SEAY INSTRUMENT CO., 6521 N. Lamar Blvd., Austin 5, Texas, announces a new amplifier designed primarily for use in driving resolvers and computing potentiometers. Virtually universal application has been achieved through a novel circuit design that has been tried and proven in several large scale computers. A very high input resistance has been obtained through elimination of the conventional input summing resistors normally used. Up to 66 db of negative feedback provides almost complete independence from tube, power supply and frequency variations. The networks for controlling the frequency response of the amplifier are molded in a thermosetting material for stability and simplified packaging. Their broad band design permits use of the amplifier at any carrier frequency from 30 cps to 1 kc. Detailed information on performance, circuit
applications and dimensions are published in technical bulletin No. 1.

**Design equipment for more convenient operation with S.S. WHITE FLEXIBLE SHAFTS**

TV Master Switchboard

**FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J., has developed a television master switchboard for increased operating control and flexibility. Completely self-contained, the unit permits channeling six separate inputs to six destinations by means of indirect relay switching. These relays may be located in the operating console or at a remote rack. A larger automatic clearing, and automatic termination and automatic holding features have been incorporated, as well as adjustment of the gap or lap switching interval. The built-in fader employs a two-channel video amplifier through which any two incoming signals may be routed. The output signal may then be reinserted as an additional signal source.**

Electronic Micrometer

**J. W. Dice Co., 1 Engle St., Englewood, N. J. Model W electronic**

---

**You can save yourself a lot of design headaches by using S.S. White flexible shafts. And you can save a lot of valuable time by enlisting the cooperation of an S.S. White engineer in working out details. His services are yours without obligation.**

**GET THIS 256-PAGE FLEXIBLE SHAFT HANDBOOK**

*We'll gladly send you this valuable handbook on flexible shaft selection and application. It's full of helpful ideas. Just ask for it on your business letterhead.*
MINIATURE INTERFERENCE FILTER

- Covers 0.15 to 1000 megacycles
- Handles up to 20 amperes
- 500 v.d.c./130 v.a.c., 0-1700 cps

In a space only 2" x 2" x 1.3/16", you can get better than 85 db attenuation throughout most of the useful range up to 1000 megacycles by using any one of the Tobe interference filters. With their extremely low series resistance, these effective filters have negligible voltage drop and only slight temperature rise. Hermetically sealed, Series 1547 filters meet military specifications for use from 55C to -105C.

ATTENUATION vs. FREQUENCY IN A 50-Ohm LINE

Can be furnished in various mounting styles; write for free data sheet giving detailed information.

TOBE DEUTSCHMANN CORPORATION
NORWOOD, MASSACHUSETTS

Microprocessor permits direct measurements to 0.00002 in. without any measuring pressure being exerted on the work. The measuring head consists of an extremely accurate micrometer screw. An electronic circuit, sensitive to five millionths of an inch displacement at the micrometer tip, gives a visual indication at the moment of contact but before pressure is exerted. Model W is especially designed for use in research, development and performance testing of diaphragms and bellows used in flight instruments, temperature, refrigerator and other types of controls where a pressureless means of testing is required. This new model is an addition to the other models now widely used for measuring thin paper, fine wire, foil, machined parts, springs, radio tube grids and cathodes and other items requiring the highest possible accuracy in a direct measurement.

Miniature Oval Resistors

MILWAUKEE RESISTOR CO., 700 W. Virginia St., Milwaukee 4, Wisc., is manufacturing oval type wire wound resistors designed to give higher wattage ratings within small space limitations. These small resistors are equipped with an aluminum mounting strip to provide cooler operating temperatures and greater dissipation of heat caused by intimate contact with the ceramic core. Spacers attached to the ends of the aluminum strip permit easy stack mounting and better heat conduction to the mounting surface. The resistors are available in 10 watts (3 x 3 in.) and 15 watts (2 x 1 in.) sizes. They are wound on oval steatite.
cores with silver soldered connections and coated with vitreous enamel. Samples are available on request.

**Turnover Pickup**

**Pickering & Co., Oceanside, N. Y.,** has developed a new contribution to the technique of recreating recorded music. Model 260 turnover pickup has an output of 30 mv at 10 cm per second; and it mounts easily in any type arm. Detailed literature is available for the writing.

**Small Variable Transformer**

**Pacific Transducer Corp., 11921 W. Pico Blvd., Los Angeles 64, Calif.,** announces model 226 small variable transformer for portable use in factory and laboratory. With a primary of 117 v a-c, 50 watts, the secondary is from 7 to 13 v a-c continuously variable and 4 amperes continuous duty. It can be used for 6 to 12-v lamps, small motors, heater elements and for operation of a-c relays and solenoids. The unit weighs 3 lb. Its dimensions

**RESIN-IMPREGNATED RESIN-FILLED CAPACITORS**

for 125°C service — without derating

**Tobe Durator Capacitors**

Higher working temperatures at no increase in size are now possible, with Tobe Durators. Features of these capacitors are:

- Brackets conventional JAN-C types
- 150°C operation for 20 hours without derating
- Welded terminals with silicon insulators
- Hermetically sealed metal cases in bathtub, deep-drawn, and lock-squeeze-seam styles
- Capacitance drift below $7\frac{1}{2}\%$ from $-65$°C to $+125$°C
- Power factor below 1.5% from $-65$°C to $+125$°C
- Suitable as coupling capacitors at low signal voltages

Write for data sheet listing available ratings and sizes.

**Tobe Deutschmann Corporation**

**NORWOOD, MASSACHUSETTS**
Here's the cable that gives the best in electrostatic and interference shielding—for stationary and portable microphones, speakers, P. A. systems, automobile radios and other electronic devices.

Tinned soft copper conductors are stranded for exceptional flexibility, paper served for easy stripping, individually insulated with low capacitance rubber or polyethylene, in some sizes. Wires are cabled to perfect roundness, cotton served and shielded with tinned copper braid. Outer jacket is either rubber, neoprene or plastic, depending on service requirements.

For expert engineering assistance and prompt service on all your cable applications, write or call Carol today.
are 3 1/8 in. x 4 in. x 3 1/8 in. high. Each unit is supplied with a 6-ft a-c cord.

Miniature Connector Hood

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y., announces the addition of a new hood to the series 20 miniature hexagonal connector line of Continental precision connectors, terminal boards and stand-off terminals. The type C38-C hood, molded from melamine with aluminum anodized cable clamp is now an added feature to the C5, 7, and 9 contact hexagonal connectors. It provides for strain relief on cable assemblies when disengaging connectors in hard-to-get-at places.

Sharp-Cutoff Pentode

RADIO CORP. OF AMERICA, Harrison, N. J. The 5654 is a "premium" version of the miniature sharp-cut-off pentode 6AK5 for use as a broadband r-f or i-f amplifier in mobile and aircraft receivers. Compact structure provides increased mount strength against shock and vibration. A pure-tungsten heater gives long life under conditions of on-off switching. The tube also features high transconductance, low inter-electrode capacitance, high input resistance and high signal-to-noise ratio. A recent data sheet gives a complete technical description, in-
INSTRUMENT BALL BEARING

with a NON-RUBBING SEAL!

In the new RMB FILMSEAL bearing, a capillary film of oil forms between cylindrical washer (A) and the tapered O.D. of inner race (B). This strong film of oil seals the bearing — keeps the lubricant in, keeps dirt out — yet there is no rubbing contact between the sealing elements.

The FILMSEAL bearing thus has all the advantages of a sealed bearing, plus the freedom of rotation of an open bearing:

- Permits the use of oil instead of grease as a lubricant.
- Low starting and running torque.
- Torque constant over long periods.
- Adjusts for pressure variations.
- No heating or scoring at high speed.
- Remains sealed in any position.
- Maintenance is greatly reduced.

FILMSEAL precision bearings are available in 10 bore sizes from 2 mm. (.0787") to 8 mm. (.3150") and corresponding O.D. from 6 mm. (.2362") to 22 mm. (.8661").

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE

RMB

LANDIS & Gyr, INC.
45 W. 45th St., New York 36

ELECTRONIC GLASS WORKING EQUIPMENT for RADIO, TELEVISION TUBES, INCANDESCENT LAMPS, GLASS LATHES for TELEVISION TUBES

We make Transformers, Spot and Wire Butt Welders, Wire Cutting Machines and 500 other items, indispensable in your production. Eisler Engineers are constantly developing New Equipment. If you prefer your own designs, let us build them for you. Write to Charles Eisler who has served the Industry over 12 years.

Machines for small Radio Tubes of all kinds:

High Temperature Hydrogen Electric Furnaces

Hydrogen atmosphere heating chamber, hydrogen drying tower, water cooled unloading chamber, heat control with air cooled transformer with 11 position tap switch. Automatic temperature control (optional) standard furnaces from 1" bore 1800° C. to 8" bore 1100° C. Molybdenum wound heating units, loading and unloading chambers equipped with safety doors. Supplied with hydrogen flow gauges. Made to order in many sizes.

HIGH TEMPERATURE FURNACES MADE BY EISLER

CLOSE-TOLERANCE CONSTRUCTION PLUS...

QUALITY CONTROL...

brings you the best in paper tubes

PRECISION PAPER TUBES

Made of the finest dielectric kraft, fish paper, acetate, or combinations, PRECISION Paper Tubes are die-formed under heat and pressure. Uniformity, strength, and light weight are assured. High manufacturing standards and rigid testing result in maximum insulation, heat dissipation, and moisture resistant characteristics.

Available in any shape, length, I.D. or O.D. Finished to your exact specifications.

Send today for free sample and request new Arbor List of over 1500 sizes.

PRECISION PAPER TUBE CO.

2041 W. Charleston St. Plant No. Two, 79 Chapel St., Hartford, Conn. Chicago 47, III.

Also Mfrs. of Precision Coil Bobbins

Want more information? Use post card on last page.

February, 1953 — ELECTRONICS
Magnetic Signal

FEDERAL TELEPHONE AND RADIO CORP., Clifton, N. J., has developed a new magnetic switchboard signal capable of providing both visual and audible indication. Designed for fast indication, long life and dependable performance under rugged conditions, this sturdy, compact magnetic unit supplants the mechanical operation common to the old-type drop signal. It is only 2 in. sq x 31 in. long, and operates on 8 ma d-c or 8 ma a-c in series with selenium rectifier equipment or its equivalent. The unit is equipped with a contact for an audible signal when required. The new signal is dust and moisture proof, nonpositional and constructed to withstand severe vibration. It has high sensitivity, a luminous face indicator that is clearly visible day or night, and the signal is mechanically restored.

L-V Power Supply

OWEN LABORATORIES, 9130 Orion Ave., Sun Fernando, Calif. The type 200 low-voltage power supply is a highly regulated unit for use with resistance strain-gage elements, and for similar exacting applications. Output is one ampere maxi-

Technology Instrument Corp. Presents a Compactly-Built Wide-Band Decade Amplifier

Featured by its wide band response, high input impedance, low output impedance, and compact dimensions, TIC's Type 500-A wide band decade amplifier is excellent as a general purpose laboratory instrument. Here is an instrument for special applications requiring a zero phase shift and high stability of gain. TIC increases the general utility of this amplifier by including a self-contained power supply and cabinet or rack mounting.

S P E C I F I C A T I O N S:

Amplification: 10, 100 and 1000 times, selected by 3-position rotary switch.
Frequency Response: Flat to ±.5 db from 5 cycles to 2 mc on gain of 10; Flat to ±.5 db from 5 cycles to 1.5 mc on gain of 100; Flat to ±.8 db from 5 cycles to 1 mc on gain of 1000.

Amplification Accuracy: ± 2% of nominal — dependent on precision resistors only; Unaffected by normal tube characteristics or line variations.
Phase Shift on All Ranges: 0 to ± 2° from 20 cycles through 100 kc
Gain Stability on All Ranges: Constant with line voltages of 105 to 124 volts.
Noise and Hum: 60 db below maximum output voltage with input shorted.
Input Impedance: Approximately 160 megohms shunted by 7µµF.
Output Impedance: Approximately 200 ohms.
Output Voltage on All Ranges: 20 volts maximum output across a load of 20 kΩ or greater.
Power Supply: 105-125 volts, 50-60 cycles self-contained power supply requiring approx. 30 watts. (230 volt, 50-60 cycles models available).
Mounting Dimensions: Single, in cabinet: 13¼" wide x 5" high x 9½" deep. (11½" x 3½" panel) Single, for rack: 19" wide x 3½" high x 8½" deep.

The low distortion is a feature much desired in amplifiers of this type.

Further information and details gladly sent upon request.

TECHNOLOGY INSTRUMENT CORP.

335 Main Street, Acton, Massachusetts, Tel. ACTon 3-7711

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mum, at 0 to 15 v d-c Where absolute freedom from drift is required a small chopper-amplifier provides precise stabilization against an external reference. The supply may be rack mounted.

Streamlined Speaker
CARBONNEAU INDUSTRIES, 21 Ionia N. W., Grand Rapids, Mich. The Gold Cup speaker features the ultimate in simplicity of design, thus eliminating costly bulk and weight. Ten-inch Gold Cups are now available with 2.15 oz magnet, 1-in. voice coil, and 1.00 oz magnets with 1-in. voice coil, both supplying flux in the air gap equivalent to speakers using up to 50 percent more magnet.

Strip-Wound Transformer Cores
PERMOFLUX CORP., 4900 West Grand Ave., Chicago 39, Ill., announces the availability of its new Cee-Cor strip-wound transformer cores, manufactured from grain-oriented silicon steel strip to exacting mechanical and electrical tolerances. These units give the transformer engineer cores of extremely high efficiency and permeability and are particularly suited to designs where space and weight are critical fact-

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GENERAL ELECTRIC Co., Syracuse, N. Y., has announced new diffused junction germanium rectifiers for use in computers, magnetic amplifiers, tv receivers and telephone switchboards. The four models in the new series are hermetically sealed and extremely small in size. Forward resistance of the new units is very low, less than 2 ohms at rated load. Back resistance and peak inverse voltages are high. Peak inverse voltages range from 100 to 400 v. The d-c output currents into a resistive load range from 75 to 500 ma. Full load voltage drop is 0.5 in three models and 0.7 in the fourth. All ratings are at ambient temperature up to 55 C.

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SUMMIT ELECTRONICS, INC., 7 Industrial Place, Summit, N. J. A new precision audio amplifier combines unusually low signal-to-noise and distortion factors with high power output. The equipment is available in several models for vary...
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This new DX 90° Deflection Yoke has everything a television receiver manufacturer wants—a sharp full-screen focus, a minimum of pincushioning, the ultimate in compactness and a price that's downright attractive. Because this yoke has been brilliantly designed for mass production on DX's specialized equipment, it warrants immediate consideration in your 27" receiver plans. Write us today.

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This new DX 90° Deflection Yoke has everything a television receiver manufacturer wants—a sharp full-screen focus, a minimum of pincushioning, the ultimate in compactness and a price that's downright attractive. Because this yoke has been brilliantly designed for mass production on DX's specialized equipment, it warrants immediate consideration in your 27" receiver plans. Write us today.

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February, 1953 — ELECTRONICS
NEW PRODUCTS

(continued)

ing input impedance requirements, while output impedance is switch controlled from 4 to 600 ohms in all models. Employing negative feedback on all stages, the new amplifier offers extremely stable characteristics. Distortion is less than 1.0 percent at the full rated output of 30 w while frequency response is exceptionally flat over a 30-eps to 15-ke range; with a high impedance input the response is flat ±0.2 db over the entire range, and similarly low variances are encountered when low bridging or terminating impedances are used. All components have been carefully chosen to assure fulfillment of the flat frequency response, low distortion and noise characteristics for which the amplifier was designed.

Bandwidth Compressor

HALLE, RAYMOND AND BROWN, INC., State College, Pa. The Rafax bandwidth compressor is a device for laboratory use in connection with testing radar relay equipment and processes. It accepts radar video signals from a search type radar. These signals usually have a bandwidth of from 1 to 5 mc. Its output is a compressed video signal whose bandwidth is of the order of 1 to 5 kc. The device takes advantage of the inherent redundancy in radar signals and of the fact that the usual ppi type radar picture can be reproduced at a bandwidth of only a few kc. Since the Rafax unit should be matched to the parent radar, each application calls for a...
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Incorporating the use of magnetic amplifier techniques — eliminating all vacuum tubes — this new Acme Regulated Power Supply provides an extremely dependable, trouble-free precision unit for both industrial and laboratory use. Because of the absence of all tubes, the equipment will give a minimum of 20,000 hours continuous service. It is available in a variety of voltages and frequencies.

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ACME Model S-715 60-cycle Regulated Power Supply. 300 volt D. C. output with ±1% regulation from 0 to 200 MA, with less than .1% ripple.

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tailor-made model in which the motor scan rate and integrator storage time are optimized.

**Combination Rheostat**

*REX RHEOSTAT Co., 3 Foxhurst Road, Baldwin, L. I., N. Y., has introduced a new vernier rheostat for extremely fine control of current and voltage. It consists of a combination of a standard tubular rheostat with a turnable vernier rheostat in series or in parallel connection. Each step on the vernier has about \( \frac{1}{4} \)th of the ohmic value of one winding of the main rheostat. Each rheostat is provided with a dial, making exact settings of the slider positions possible. Ask for catalog No. 5.*

**Half-Wave Rectifier**

*GENERAL ELECTRIC Co., 1 River Road, Schenectady 5, N. Y., has added to its industrial tube line a half-wave rectifier designed for use in h-v rectifier circuits. The type GL-4B32 is designed particularly for use as a rectifier in radio and tv transmitters, industrial heating oscillators, and other applications where high-voltage d-c is required. The tube is an inert-gas-filled tube that will operate over a wide temperature range, from \(-55\) to \(+70\) C. Use of an inert gas instead of mercury permits mounting it in any position. Maximum ratings for*
Now you can expedite your research, development, and test programs with the AUTOGRAPF—a precision recorder that automatically plots curves showing relationship between a dependent and an independent variable. Through two rebalancing, servo-actuated recording axes, the AUTOGRAPF draws cartesian coordinate graphs from any data that can be reduced to electrical form. You save the time it would ordinarily take to read meters, collate data, transfer data to grid, draw in curves...The AUTOGRAPF does all this work for you, plotting the data simultaneously with occurrence of the phenomenon being studied. Too, the AUTOGRAPF draws related curves in families as fast as input information can be altered. Without any additional steps, once a test is run, you have in hand a complete, accurate, pen-and-ink graph, drawn on a standard 8½"x11" sheet of paper, ready for study, file, notebook, or reproduction.

SPECIFICATIONS:—Two independent servo-actuated recording axes; input free of ground. • Recording speed, both axes, 1 second for full scale travel. • Scales: from 0-5 millivolts up to 0-100 volts, both axes. • Full-range selection on either axis—plots data in any desired quadrant. • Sensitivity = 200,000 ohms per volt, 5 microamperes drain for full scale. • Size and weight: 15" x 13½" x 10"; 55 lbs. • Self-contained; operates from 115 volt 60 cycle line, 85 watts.

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NEW PRODUCTS

the GL-4B32 include a peak maximum cathode current of 5 amperes, an average maximum cathode current of 1.25 amperes, and a maximum peak inverse anode voltage of 10,000 v. The tube is recommended for use with a filament voltage of 5 v and a filament current of 7.5 amperes.

Oscilloscope

ELECTRONIC MEASUREMENTS CORP., New York, N.Y. Model 600 oscilloscope features the use of a 5VPI new 5-in. scope tube. The vertical amplifier has a wide band and can be used up to 5 mc. A two step attenuator input is available. Synchronization is available on either positive or negative phase of input voltage through the vertical amplifier or from an external source. A multivibrator type of sweep from 15 cycles to 75 kc is incorporated.

Dynamotor

ELECTRO ENGINEERING PRODUCTS Co., 609 W. Lake St., Chicago, Ill. Model ES-129 dynamotor is a 4-commutator unit that will operate with equally efficient performance from 6, 12 or 24-v power supply. Output is 500 v at 0.100
when timing gives you a hard time

Turn your problem over to the
A. W. HAYDON COMPANY — past masters at solving the tough ones.
The know-how of A. W. Haydon Engineers is your assurance of prompt, accurate service regardless of the intricacies of the problem.

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International Instruments specializes exclusively in miniature and sub-miniature electrical instrumentation. This ideal of doing one thing well is your assurance that in all phases of manufacture each meter is extensively tested and inspected to maintain rigid standards of quality and performance.

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The miniature and sub-miniature meters are especially adaptable for use as test instruments built into an installation. A switching arrangement allows the check-out of various circuits and eliminates the necessity of portable testers.

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P. O. BOX 2954, NEW HAVEN 15, CONN.
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Four models now available

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<thead>
<tr>
<th>Characteristic Impedance</th>
<th>75 ohms</th>
<th>50 ohms</th>
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</thead>
<tbody>
<tr>
<td>0-9 db in 1 db steps</td>
<td>Type 74600-A</td>
<td>Type 74600-F</td>
</tr>
<tr>
<td>0-90 db in 10 db steps</td>
<td>Type 74600-B</td>
<td>Type 74600-E</td>
</tr>
</tbody>
</table>

Accuracy of D.C. adjustment

0-9 db Models: The insertion loss error will not exceed ±0.05 db for any setting.
0-90 db Models: The insertion loss error for the 90 db setting will not exceed ±0.3 db. For other settings this limit falls linearly to a value of ±0.06 db at the 10 db setting.

High frequency performance

0-9 db Models: At 50 Mc/s the insertion loss error for the 9 db setting will not exceed ±0.15 db. For other settings this limit falls linearly to a value of ±0.05 db for the 1 db setting.
0-90 db Models: At 50 Mc/s the insertion loss error will not exceed ±0.1 db per step. N.B. All insertion loss errors are relative to zero db setting.

New Products

Deflection Yoke

DX Radio Products Co., 2300 West Armitage Ave., Chicago 47, Ill., announces that it is in production on a newly designed 90-deg deflection yoke for 27-in. television tubes. The yoke provides a sharp focus across the entire picture tube screen. The horizontal inductance is 11.2 millihenries and the vertical inductance is 45 millihenries.

Banana Plugs and Jacks

Insuline Corp. of America, 3602 35th Ave., Long Island City 1, N.Y., has announced a new line of silver-plated banana plugs and jacks, intended for use in military, industrial and commercial equipment requiring very low contact resistance. The No. 428 plug has a straight threaded shank 1 1/4 in. long. The No. 429 has a combina-
Accurate Portable
Type H-14 Signal Generator
900-2100 Megacycles

This compact, self-contained unit, weighing only 43 lbs., provides an accurate source of CW or pulse amplitude-modulated RF. A well-established design, the Type 12 has been in production since 1948. The power level is 0 to -120 dbm, continuously adjustable by a directly calibrated control accurate to ± 2 dbm. The frequency range is controlled by a single dial directly calibrated to ± 1%. Pulse modulation is provided by a self-contained pulse generator with controls for width, delay, and rate; or by synchronization with an external sine wave or pulse generator; or by direct amplification of externally supplied pulses.

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Price: $1,950 net, f.o.b. Boonton, N. J.

Type H-14 Signal Generator
(108 to 132 megacycles) for testing OMNI receivers on bench or ramp. Checks on: 24 OMNI courses, left-center-right on 90/150 cps localizer, left-center-right on phase localizer, OMNI course sensitivity, operation of TO-FROM meter, operation of flag alarms.

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NEW PRODUCTS

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Design to your demand

**New miniaturized tuning fork resonator...**

*(Model J)*

<table>
<thead>
<tr>
<th>ILLUSTRATED ACTUAL SIZE</th>
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<tbody>
<tr>
<td>DIMENSIONS 1(\times) 2(\frac{1}{4})(\times) 2(\frac{7}{6})(\times)</td>
</tr>
<tr>
<td>MAXIMUM WEIGHT—8 OUNCES</td>
</tr>
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</table>

**accuracies...**

1 part in 10,000 (0.01%) or 1 part in 2,000 (0.05%), from —40° to +85° Centigrade.

**frequencies...**

From 400 to 2,000 cycles in either accuracy rating.

**construction...**

Thermally compensated, solder-sealed and evacuated, completely interchangeable, internally mounted using shock retarding silicone rubber, externally designed for fastening to chassis through silicone rubber grommets thus providing excellent vibration and shock isolation.

For complete information write for Folder No. 102 or telephone HYacinth 2-4800

**Philammon Laboratories Inc.**

5337 THIRD AVENUE, BROOKLYN 20, NEW YORK

Want more information? Use post card on last page.

**Miniature Attenuator**

The Daven Co., 191 Central Ave., Newark 4, N. J., has available the series 120 miniature attenuator that is 1\(\frac{1}{2}\) in. in diameter x 1\(\frac{1}{2}\) in. deep. The unit was developed primarily for government and commercial applications requiring a smaller step-type attenuator. Its reduced size and weight make it particularly suitable for use in portable equipment as well as stationary equipment where space is at a premium. This miniature attenuator is available in 20 steps having a ladder or potentiometer network. All standard decibel steps and various impedances up to 500,000 ohms are available. Resistor accuracy is ±5.0 percent and power dissipation is 0.6 watt.

**ULF Oscillator**

Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass., announces a new ultra-low-
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CONTINUOUSLY

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**MODEL 302**

VARiABLE ELECTRONIC FILTER

**Fast, Accurate, Reliable**

The — **SKL** — Model 302 includes two independent filter sections, each having a continuously variable cut-off range of 20 cps to 200 KC. Providing a choice of filter types each section has 18 dB per octave attenuation. When cascaded 36 dB is obtained in the high and low pass setting and 18 dB in the band pass position. With low noise level and 0 insertion loss this versatile filter can be used as an analyzer in industry and the research laboratory or to control sound in the communications laboratory, radio broadcasting, recording and moving picture industries.

**SPECIFICATIONS**

- **CUT-OFF RANGE**
  20 cps to 200 KC
- **SECTIONS**
  2—can be high, low and band pass
- **ATTENUATIONS**
  36 db octave maximum
- **INSERTION LOSS**
  0 db
- **NOISE LEVEL**
  80 db below 1 volt
- **FREQUENCY RESPONSE**
  2 cps to 4 MC

**SKL SPENCER-KENNEDY LABORATORIES, INC.**
181 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

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*ELECTRONICS* — February, 1953

(Advertisement)

**PANELS, LIDS, DOORS
MADE RF-TIGHT
BY LOW COST METHOD**

Electronic Weatherstripping, made of knitted wire mesh compressed to required sizes and shapes, effectively "shields" these openings against RF leakage just as weatherstrips seal doors and windows.

Openings such as these are necessary for operating and servicing the electronic equipment housed in the metal cabinet. Yet these same openings destroy the full shielding efficiency which an "unbroken" metal container would otherwise provide. Careful machining of mating surfaces at these openings is an obvious answer. But such work is expensive, and the initial close fit is often destroyed by repeated openings and closings, by warping of the lid or door and by corrosion of the mating surfaces. Numerous latches, screws, bolts and other fasteners, closely spaced, will help keep these joints RF tight, but they are a time consuming nuisance whenever the cabinet must be opened and closed, and they are expensive to purchase and install.

Metex Electronic strips and gaskets eliminate these objections. Being made of metal, they are conductive; and being knitted they are resilient and conform to normal surface irregularities. They actually "block" the otherwise leaky openings with a gasket of flexible metal, and make the cabinet as effective a conductive shield as if the openings had never been made.

Metex electronic strips and gaskets are easy to install. Not only are they inexpensive, but their use may well save more than their cost by eliminating many operations that would otherwise be necessary. They are available in different shapes, dimensions and resiliencies to meet the varied requirements of specific electronic applications and can be made of metals or alloys selected to meet actual or anticipated corrosive conditions.

A bulletin giving detailed information is available on request from the manufacturer, Metal Textile Corporation, 641 East First Avenue, Roselle, N. J.
Manpower...machinery...technical skill—these are the wastes of many companies adapting inflexible standard components to meet the requirements of their applications.

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Our technical catalog describes some of the precision Transicoil units which enable you to take full advantage of your servo system designs. Write for a copy today.

NEW PRODUCTS

(continued)

frequency oscillator, model 400 C, with standard rack panel construction. It simultaneously provides both sine and square-wave voltages at any frequency between 0.009 and 1,100 cps. The sine wave output may be used either balanced or single ended. Maximum output is 30 v peak-to-peak across a 1,000-ohm load. Special circuitry to eliminate tuning and band-switching transients has been incorporated. Other features are low hum and distortion, excellent amplitude constancy over the entire frequency range, a single scale logarithmic dial with a vernier tuning control, and low input power. The unit is especially useful for the designing and testing of servomechanisms for geophysical and seismological instruments and feedback amplifiers, for vibration checks and medical research and in conjunction with timing and production controls. Dimensions of the unit are 19 x 8 x 7 in.

Literature

Permanent-Magnet Motors. Barber-Colman Co., Rockford, Ill., has available p-m motors with electrically balanced armature that insures low radio noise level, higher efficiency, and longer brush life. Ask for bulletin F4844.

Metalized - Power Capacitors. Aerovox Corp., New Bedford, Mass. Concise, yet highly informative, is the "High-Temperature Metallized-Paper Capacitors" bulletin now available. It deals with the performance characteristics of such capacitors, including facts, figures and graphs on rated voltages, temperature range, insulation resistance, nominal capacitance, power factor, vibration, humidity and life test. It also gives available types and listings.

Gas Tubes in Industry. Electrons, Inc., 127 Sussex Ave., Newark 4, N. J. A treatise on the history, development and application of hot cathode gas-filled rectifier and thyatron tubes has just been pub-
THE GRAYHILL SERIES 5000 MINIATURE TAP SWITCH IS DESIGNED TO MEET SPACE FACTORS INVOLVED IN THE MINIATURIZATION TREND. THE POSSIBLE CONTACT ARRANGEMENTS RUN FROM A SINGLE DECK UP TO 10, WITH FROM 2 TO 10 TAPS PER DECK. EITHER SHORTING OR NON-SHORTING CONTACTS. RATED TO BREAK 1 AMP., 115 V. A C., NON-INDUCTIVE.

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NEW PRODUCTS (continued)

lished. Entitled "Gas Tubes in Industry," the treatise is concisely written, but comprehensive in its coverage of the subject. It will give the reader a well-rounded introduction to the many useful purposes of the EL rectifier and grid control (thyratron) tube.

Parts Catalog. Newark Electric Co., 223 W. Madison St., Chicago 6, Ill., has published a 196-page comprehensive parts catalog containing thousands of items for industry, laboratories, high fidelity, radio and television. Whole sections are devoted to test equipment, industrial equipment and supplies, high-fidelity systems and components, TV chassis, accessories and antennas, including the latest VHF antennas and converters, tape, wire and disk recorders, phonos and changers, P-a and intercom systems, books, tools and the latest in amateur equipment. Wherever possible the complete lines of all nationally-known manufacturers are listed.

Printed Circuits. Electralab, Inc., 105 First St., Cambridge 41, Mass. A recent 8-page catalog contains a picture story showing the company's facilities for engineering and designing printed circuits in addition to the large scale production of this type of assembly. Included is a list of 17 of the many electronic applications that have been engineered by the company utilizing printed circuits and unitization techniques.

Research Laboratories. Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill., has published bulletin R10, a 47-page book containing information on the latest facilities and services of its new Research Laboratories. The book will be of interest to anyone engaged in research, development and instrumentation in the fields of nuclear physics, servomechanisms, upper air research, weather reconnaissance, radar, sonar, guided missiles and general electronics.

Transmission Systems. Fischer & Porter Co., 7260 Jacksonville Road, Hatboro, Pa. Catalog T-50 de-
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Complete Frequency Coverage—14kc to 1000 mc!

NEW PRODUCTS
(continued)

ing the theory and principles of x-ray spectroscopy and will be useful in handling actual problems. It shows K Alpha and K Beta lines for mica analyzing crystal, for quartz analyzing crystal, for lithium fluoride analyzing crystal and rock salt analyzing crystal. It also shows L Alpha, and L Beta, lines, 1st and 2nd orders, for rock salt analyzing crystal. The horizontal scale on the chart shows 2 Theta Angle in degrees, as well as wavelengths in Angstroms for all elements under various conditions.

Antennas & Accessories. United Catalog Publishers, 110 Lafayette St., New York 13, N. Y., has available a 76-page booklet cataloging radio and tv antenna systems, antennas and accessories, and giving detailed specifications, illustrations, descriptions and prices. It covers the products of the 32 leading manufacturers and includes f-m, a-m and uhf antennas, tv towers, masts, tv boosters, insulators, wire and mounting hardware, among other items.

Germanium Diodes. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, Long Island, N. Y. A single-sheet bulletin announces the addition of a line of seven germanium diodes of the hermetically sealed glass variety which are not affected by atmospheric conditions of humidity, altitude and extremely low temperature. Four of the diodes described are electrically interchangeable with well-known standard types, and the others are new. All are highly resistant to shock and vibration. Characteristics, ratings and curves are included.

Electrometer. Special Instruments Laboratory, Inc., Knoxville, Tenn., has published a single-sheet bulletin illustrating and describing the model 145 electrometer, an a-c operated sensitive d-c amplifier of very high input impedance and excellent stability. The instrument discussed measure voltages of 0 to 150 mv directly on a panel meter, and it may be used to measure currents from 10⁻¹⁰ to 10⁻⁹ amperes either directly or by the slide-back voltage method. The unit described

These instruments comply with test equipment requirements of such radio interference specifications as MIL-I-6181, MIL-I-18910, PRO-MIL-STD-225, ASA C63.2, 1854, AN-I-24a, AN-I-42, AN-I-27a, MIL-I-6722 and others.
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For complete information write for Bulletin E

Lambda Electronics Corporation

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SPARE AND REPAIR PARTS BOXES

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Accessories: Internal framing, partitions, trays and wood chucks as required.

Complete Facilities under one roof for quality mass production, including Heliarc welding, baking and finishing, Whistler and Wiedemann equipment for short runs. Tool and die engineering and designing. Completely conveyorized finishing facilities. Large assortment of stock and special dies for radio and television and electronic field.

Write for Catalog and Price List.

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Want more information? Use post card on last page.

ELECTRONICS — February, 1953
For carriers in the range 2.5 to 200 megacycles, this ruggedized deviation meter is ideal. With crystal-standardized deviation ranges of 5, 25 and 75 kilocycles, alternative high- and low-level buffered inlets, visual checking for optimum tuning and level, together with a separately buffered audio outlet, FM Deviation Meter TF 934 incorporates every desirable refinement. There are no critical tuned circuits to drift and the overall demodulation distortion is less than 0.1 per cent.
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Here is a transformer design with terminals sealed under pressure with a resilient sleeve that accommodates expansion and contraction of temperature changes.

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PYROFERRIC
621 EAST 216 ST., NEW YORK 67

Want more information? Use postcard on last page.

NEW PRODUCTS (continued)

Pyroferric iron cores

Audio Facilities for Schools. Radio - Television Manufacturers Association 777-14th St. N.W., Washington 5, D. C. The Association's School Equipment Committee has available a new booklet on audio facilities for school use. This booklet, the title of which is "Teaching with Radio, Audio, Recording and Television Equipment," combines and brings up to date material contained in the three former Committee publications and also includes information on the use of TV in public schools. It was prepared with the assistance of a group of educators appointed by the U. S. Office of Education.

Strip Chart Potentiometer. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Philadelphia 44 Pa. Specification sheet 179 illustrates and gives full details of the new Brown ElectroniK strip chart potentiometer with two-second full scale pen travel for 60-cycle operation. The instrument described has a calibrated accuracy within ±0.1 of 1.0 percent of scale span for spans in excess of 12 mv; within ±0.045 mv for spans less than 12 mv.

Sound-Powered Communications Equipment. The Wheeler Insulated Wire Co., Division of The Sperry Corp., Waterbury 20, Conn., offers a new file-size comprehensive catalog bulletin covering sound-powered communications equipment for industrial and commercial use. Designated as bulletin SA-25, it includes installation information, wiring and dimension diagrams and description of special instruments.

Microwave Products. Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass., announces the availability of the 8-page catalog 52A. Over eighty products are described, including magnetrons, radar gas-switching tubes, silicon diodes, waveguide components and test equipment for the millimeter cords, tapes and sleevings, the catalog explains characteristics of the basic cotton, glass and asbestos fibers.

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ELECTRONICS — February, 1953

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functions."

They constitute a basic part of the high accuracy analog computers which solve varied and complex mathematical functions in completely simulating flight of all types of modern aircraft. Such potentiometers are a necessary part of circuits for multiplication and division and, when equipped with taps, are used in the generation of many non-linear functions.

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John P. Poth,
Chief Engineer, ERCO says:

"Precision potentiometers play a primary part in the construction of the present day Operational Flight Trainers and Simulators developed by the Engineering and Research Corporation. They constitute a basic part of the high accuracy analog computers which solve varied and complex mathematical functions in completely simulating flight of all types of modern aircraft. Such potentiometers are a necessary part of circuits for multiplication and division and, when equipped with taps, are used in the generation of many non-linear functions."

Photos show complete simulator and internal application of precision potentiometers, courtesy of ERCO

Snap Nut Fasteners. Prestolee Corp., Toledo, Ohio. Bulletin 8000-A gives complete engineering and application data on snap nut fasteners that have been popular with production personnel as a means of securing front mounting, and/or blind assembly applications with metal screws or studs. The fasteners described allow high speed assembly and prevent "dead-tight" fastening that might craze enameled or painted surfaces.

Small High-Reliability Tubes. General Electric Co., 1 River Road, Schenectady 5, N. Y., has published a new booklet describing the essential characteristics of 17 Five Star miniature and 8 subminiature high reliability tubes. Publication ETD-548A covers tubes designed for use in critical applications, both industrial and military, in which operational dependability is essential to protect life, customer's investment or product reputation. Included in the data are the specific differences between individual Five Star Tubes and their standard-tube prototypes, heater ratings, maximum design center ratings and operating characteristics.

Digital Recorder. Berkeley Scientific, Division of Beckman Instruments Inc., Richmond, Calif., has available a single-sheet, loose-leaf perforated bulletin dealing with the series 1550 digital recorder that provides a simple, reliable and inexpensive means of converting electronic count information into printed form. Illustrations, description, basic design information, operation data, and specifications are included.

High-Current Test Unit. Multi-Corp., Harrison, N. J. Bulletin 1005-111 announces the development of a portable high-current test unit designed primarily for use by electrical utilities and larger industrials. Principal uses of the unit described include testing and calibrating oil circuit reclosers.

and centimeter wavelengths. The research and production facilities are also described with numerous illustrations.
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**COMPLETE CONTROL OF MANUFACTURE . . .**
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60 cycles
Single pole
Single pole and double pole
Make-before-break contacts

These Choppers convert low level DC into pulsating DC or AC so that servo-mechanism error voltages and the output of thermocouples and strain gauges, may be amplified by means of an AC rather than a DC amplifier. They are hermetically sealed, precision vibrators having special features which contribute to long life and low noise level.

Write for the Catalogs...
5280A
5246C

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Write For Catalog 101E
32 informative pages, FREE

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The ANDREW "Skew" Antenna is the only antenna which provides a circular radiation pattern from antenna elements placed around a supporting structure which is larger than a half wave-length on a side! With the "Skew" Antenna, it is possible to mount a multiplicity of TV antennas on the sides of tall buildings, on the sides of existing towers—even towers which also support a standard antenna on top. The economy offered by a joint operation of this type is obvious.

At present, the "Skew" Antenna is custom built for each installation and consequently general performance specifications cannot be delineated. However, ANDREW engineers will be glad to discuss its application to specific situations.

*Patents applied for

ANDREW four element "Skew" Antenna on the conical end of the mooring mast of the Empire State building, used as auxiliary by WJZ-TV. Lower on the mooring mast, artist's sketch shows the 48 element ANDREW "Skew" Antenna to be installed for WATV.

CSP transformer breakers, sectionalizers, circuit breakers, motor overload relays, current transformers, fuse links and overcurrent relays of all types. Also available with the bulletin is a partial list of Multi-Amp users.

Magnetic Amplifiers. Karl-Douglass Associates, 3160 W. El Segundo Blvd., Hawthorne, Calif., have released a brochure describing their line of magnetic amplifiers. The publication describes the six important advantages of magnetic amplifiers over other power control amplifier designs; lists typical performance specifications for 60-cycle and 400-cycle units; and lists the various applications where they can be used.

Printed Circuits. Electralab, Inc., 105 First St., Cambridge 41, Mass. A recent 8-page catalog contains a picture story showing the company's facilities for engineering and designing printed circuits in addition to the large scale production of this type of assembly. Included is a list of 17 of the many electronic applications that have been engineered by the company utilizing printed circuits and unitization techniques.

Servo Amplifiers. Industrial Control Co., Wyandanch, L. I., N. Y., has available a booklet dealing with a line of standard servo amplifiers that lead the way to the quick and facile use of servo systems, and obsolete the development delays and expense otherwise necessary. Truly versatile, with adjustable parameters, the instruments discussed mate with a broad range of gear ratios and load constants. Illustrations, specifications and applications are given for the model 410-A and 423-A servo amplifiers, model 100-A dynamic analyzer, model 204-A null detector, model 200-A d-c millivoltmeter and model 302-A motor control. Also included is a servo data sheet that will enable one to define all his servo performance requirements.

Resistors and Controls. Clarostat Mfg. Co., Inc., Dover, N. H. An exceptionally wide choice of resistors, controls and resistance de-
Now... a new group of TERMINALS especially designed for use in the U.H.F. region... available in both feed-thru and stand-off types... for hermetic or non-hermetic applications.

Design engineers... for further information, write to...

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694 Main Street
Waltham 54, Massachusetts
HOW TO
SQUEEZE PENNIES
OUT OF
UPSET SPECIALS COSTS

Specially designed upset products are solving thousands of problems. Dozens of design pointers on them are yours for the asking. Send us your sketches, prints, finished products for suggestions.

Piercing a flattened section costs less than drilling a rounded one. The plane profiled part can be just as effective for bar wrenching, and can look more attractive.

A pinched point costs less than a conical, turned one. For guiding the part during assembly, and for piercing the impinged material, the two may work alike.

A depressed head costs less than a trimmed one, works just as well for wrenching, and looks like a special product feature to a layman.

A square shoulder under head costs less than a knurl, and will hold as well against loosening in elastic or plastic materials.

of this chart are available on request for use in drafting and purchasing departments.

MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS

THE PROGRESSIVE MANUFACTURING COMPANY
50 NORWOOD ST., TORRINGTON, CONN.

NEW PRODUCTS (continued)

services is presented in the latest catalog, No. 52. The catalog features expanded listings of carbon and wire-wound controls, including Pick-A-Shaft or field-inserted-shaft controls taking any one of 12 different shaft types, plus the nonmetallic shaft and the high-voltage coupler. For the first time the aircraft-type metal-cased power rheostats are offered, together with miniaturized carbon and wire-wound controls, and the outdoor-theatre L-pad.

Electrical Embedment Resin. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. A new industrial technique—embedding electrical components in "Scotchcast" brand electrical insulating resins—is described in an 8-page, illustrated booklet. Applications for both "Scotchcast" resin No. 1 (hot pouring) and "Scotchcast" resin No. 2 (cold pouring) are given, the use of fillers to obtain special characteristics is discussed, and casting techniques are outlined briefly. The outstanding properties of these epoxy "Scotchcast" resins—moisture resistance, dielectric strength, adhesion, low shrinkage and stability over a wide range of temperatures—are presented in detail on a technical data page.

Two-Way Radio. General Electric Co., Syracuse, N. Y. A new 8-page illustrated booklet discusses the use of two-way radio for better coordination of men, materials and machines. The booklet, titled "Instant Communication," is slanted to those businesses using materials handling and emergency service equipment, and others who have plant protection problems. It outlines the use of two-way radio in numerous industries, and shows equipment now available for a wide variety of applications. The new publication also carries a list of 27 GE offices throughout the U. S., from which advisory service is now available on communications problems.

Flexible Cords. Whitney Blake Co., New Haven 14, Conn., has available an illustrated 24-page bulletin that includes all of the new Underwriters' classifications for its flexi-
SENSITIVE MINIATURE RELAYS

PERFECTLY COUNTER-BALANCED

Contact arrangements up to and including DP DT 3 Amp at 28 volts D.C., or 100 Milliamperes at 150 volts D.C. resistive load.

Hermetically Sealed.

Required coil power as low as 20 milliwatts.

Coil resistance up to 15,000 ohms.

Weight, maximum 3.5 oz.

DUE TO ITS PERFECTLY COUNTER-BALANCED FEATURES THIS RELAY WILL WITHSTAND HIGH ACCELERATION, VIBRATION, SHOCK AND TUMBLING

Mass Production Requirements Invited

Detailed information on request.

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for standard and special applications

Designed by specialists of 25 years standing • Engineered to exact specifications • Tested for peak performance • Constructed to outlast their guarantee • Kenyon transformers meet all Army-Navy specifications.

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Special attachments and engineering service available for production work.

Specify the Green Engraver for precision engraving on metal, plastics, wood, glass, hard rubber etc. . . . engraves panels, name plates, scales, dials, molds, lenses, instruments, instruction plates, directional signs . . . by simple tracing from master. Routing, profiling and three dimensional modeling indicate its versatility. Electric etching attachment available.

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Kenyon Transformer Co., Inc.
840 Barry Street, New York 59, N. Y.
VERSATILE SHAFT COUPLINGS

National makes a complete line of insulated and non-insulated, flexible and rigid shaft couplings designed for a wide variety of practical applications. Free from backlash, mechanically strong, and exceptionally smooth in operation, they fit all standard shaft diameters. Write for drawings and specifications.

VELVET VERNIER MECHANISMS

National's famous line of velvet vernier mechanisms has been accepted by well-known commercial users as well as individual builders. Having a standard 5 to 1 ratio, they are available with either 3/16" or 1/4" shafts. Types are also available with insulated or non-insulated output hubs for connecting to 1/4" output shafts. Write for drawings and specifications.

Write for drawings

NEW PRODUCTS (continued)

Transformer Catalog. Thordan-son-Meissner, Mt. Carmel, Ill., has announced its new No. 400-K transformer catalog. It contains unusually complete listings of replacement types of power, filament and audio transformers for the service industry, as well as standard types. A special section is devoted to various types of transformers used in the tv service field. Many special transformers, such as vibrator, isolation and band-pass speech filter types are also listed in the catalog.

C.R Tube Reflectance Meter. Gardner Laboratory, Inc., 4725 Elm St., Bethesda 14, Md. Bulletin 120 covers the portable Glossmeter for television tube face plates. The instrument discussed is highly versatile and convenient for measuring reflectance from any type of tube face with a radius of curvature greater than 12 in. An illustration, descriptive of the instrument and method of operation, is included.

Embedded Selenium Rectifiers. Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind., has published a new 4-page folder dealing with embedded selenium rectifiers. (Embryments are designed principally for use where because of environmental conditions or extreme altitudes, standard convection cooled painted rectifiers are not suitable.) Designated as Number B-1, this catalog gives detailed information on the various types of embedments made by the firm. Illustrations and dimensional diagrams are included.

Audio Catalog. Terminal Radio Corp., 15 Cortlandt St., New York 7, N. Y., has published a 132-page audio equipment catalog. Besides fifty pages of high-fidelity home music system components, the book
Precision drilling made easy!

**Phillips & Hiss 204-C**

6" Throat
0-1/8" Capacity
1" Quill Travel

Sensitive "Feel"
Sensitive Speed Control:
Foot-operated, leaves both hands free

High Precision: Selected Chuck and Bearings. Spindle true within .0002", Table square .0005" in 5" circle. Permanent accuracy, castings annealed and ground.

WRITE: Bulletin E2
Phillips & Hiss Co., Inc.
1155 N. McCadden Place
Hollywood 38, California

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**FOR STRAIN GAGE APPLICATIONS**

**THE TYPE 200**

This highly regulated d-c supply furnishes one ampere at zero to 15 volts, for the most exacting applications. The output will vary less than .005 volt for 10% line voltage changes. Drift is low, and can be completely eliminated by an accessory plug-in unit which provides chopper stabilization. Write for details.

Do you have data sheets on our time calibrators, one second to one microsecond?

OWN LABORATORIES
412 WOODWARD BLVD.
PASADENA 10, CALIF.

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**A NEW COMPLETE SERVICE ON SLIP RINGS and COMMUTATORS**

**PRODUCTS OF SCIENCE**

The Runzel Laboratory assures that every inch of Runzel wire, cord and cable is thoroughly tested before shipping. Your wiring needs in hook-up, lead-in, shielded wire and cords, speaker cords and all types of insulated wire products, in almost endless variety of colors, sizes and specifications, are available from this centrally located plant.

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**RUNZEL CORD & WIRE CO.**
4723 Montrose Avenue
Chicago 31, Illinois

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Century MODEL 1809
BRIDGE CONTROL UNIT
FOR VIBRATION AND STRESS ANALYSIS

Designed as a companion unit to Century's famous Model 409 Oscillograph, the Model 1809 Bridge Control Unit is the latest addition to Century's line of industry-standard vibration and stress analyzing equipment. Packaged in a small, compact space, the unit contains all of the facilities necessary for use with 12 channels of resistance strain gages or bridge-type transducers. Where used with the Model 409 Oscillograph, it is necessary only to connect strain gages and power source to have a complete stress-strain measuring and recording system, small and rugged enough to be placed in an aircraft wing tip or guided missile warhead.

FEATURES:
Size: 4½" x 7" x 11".
Weight: 10 lbs.
Aluminum case.
Up to 12 channels.

Write for Bulletin CGC—307

MODEL 409
OSCILLOGRAPH

The Century Model 409 Oscillograph has been designed for recording data where space and weight requirements are limited. The Oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:
Size: 5" x 6½" x 11½".
Weight: 13 lbs.
Cost aluminum case.
Paper speeds variable ½" to 6" and 2" to 24" per second.

Write for Bulletin CGC—303

Century GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA

NEW PRODUCTS
(continued)

illuminates and describes seventy-six pages full of public address, institutional, recording and broadcast equipment as well as audio test instruments and similar specialized equipment.

Shaded Pole Motors. Barber-Colman Co., Rockford, Ill. Motor sheet F 4271-2 describes a complete line of unidirectional, reversible and synchronous shaded pole motors for servomechanisms, communication equipment, industrial instruments and other uses. The publication is available on request.

Retaining Rings. Waldes Kohi-noor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. The new 52-page retaining ring catalog is packed with engineering specifications, data and other useful information covering 17 different types of Truarc rings and more than 600 different sizes. Designed to help engineers properly select and use the rings to best advantage, the catalog devotes 28 pages to data and charts giving ring dimensions, groove dimensions, clearance, allowable thrust loads, safety rpm limits and countless other valuable data. Six pages graphically illustrate typical cost-cutting applications and at-random field applications covering self-locking ring types, basic ring types, rings for taking up end-play and rings applied radially. Assembly and accessory tools designed to handle retaining rings on a speedy production line basis are illustrated and described in detail.

Wiring and Insulation. The William Brand and Co., Inc., North and Valley Sts., Willimantic, Conn., has released a new wiring and insulation manual entitled "Here's How Turbonics Will Assit You in Solving your Complicated Wiring System and Insulation Problems." The manual explains how to obtain pertinent information required to permit uninterrupted operation of any electrical unit or component from a wiring and insulation point of view. It is intended particularly for all aircraft, design, development engineers who are continuously faced with the trend toward lighter weight, smaller space factor, better
ELECTRIC HEATING UNITS

Coils of Heat

Tubular Electric Heating Units that fit around or clamp to vessels, tanks, pipes, etc., for contact heating of metals, oils, air and water ... especially where little space is available and considerable heat is needed.

Can be bent into almost any shape.

STANDARD SIZES or made to your requirements.

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DRY TYPES
78 Standard Industrial, Laboratory and Government Types.

LAB-BILT BATTERIES
Our engineers will design and create to your requirements. Send us your specifications.

HI-DRIVE MINIATURE MOTOR
Precision-built, low-cost, battery-operated — available for delivery now.

Send for FREE Catalogs

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A Subsidiary of the RAY-O-VAC Ray-O-Vac Company
MADISON 16, WISCONSIN

VULCAN ELECTRIC COMPANY
DENVER 10, MASS.

STAR low-loss STEATITE has proved an ideal insulation for electronic applications. It is a strong, dense material with excellent dielectric and mechanical strength.

Every STAR STEATITE part is engineered for your specific job and precision made to meet demands for dimensional accuracy. And STAR'S facilities for volume output assure you a steady flow of material to maintain your production schedules.

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Every STAR STEATITE part is engineered for your specific job and precision made to meet demands for dimensional accuracy. And STAR'S facilities for volume output assure you a steady flow of material to maintain your production schedules.

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78 Standard Industrial, Laboratory and Government Types.

LAB-BILT BATTERIES
Our engineers will design and create to your requirements. Send us your specifications.

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Precision-built, low-cost, battery-operated — available for delivery now.

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MADISON 16, WISCONSIN
electrical properties and greater temperature extremes problems.

Setting & Adjustment of Adapters. Kinetix Instrument Co., Inc., 902 Broadway, New York 10, N. Y., has announced a 2-page catalog sheet illustrating and describing tools for setting and adjustment of adapters on synchros, resolvers and servo motors. The purpose is described. Also included are diagrammatic methods of recommended mounting.

Synchro Electrical Transformer. Kinetix Instrument Co., Inc., 902 Broadway, New York 10, N. Y. For an illustrated description of receiving electrically the angular position of synchro transmitter rotor and inducing a voltage in the transformer rotor which falls to a null when matched to the angular position of the transmitter, see a recent 2-page perforated catalog. Average electrical characteristics are included.

Microwave Transmission Line. Product Development Co., Inc., 307 Bergen Ave., Kearny, N. J. Technical bulletin No. 28, entitled “Microwave Transmission Line Measured Technical Data” is available upon written request. Complete technical data concerning frequency in mc, peak volts, approximate weight per 20-ft section and nominal characteristic impedance are included.

Potentiometers and Noise. Technology Instrument Corp., 531 Main St., Acton, Mass., has available on request Laboratory Report No. 6. It contains an article entitled “Precision Potentiometers and Noise” by Joseph R. Atieri. Application of the Pono- gometer production noise tester is also included as a feature of this report. Causes of potentiometer noise, definition of noise and advantages of the Pongometer are detailed.

Retractile Cords. Koiled Kords Inc., Box K, New Haven 14, Conn., has available an 8-page bulletin on retractile cords for general communication and power applications. Containing catalog data and in-
Augat Adjustable Tube Clamps are 3 ways more dependable!

1. Made of 18% nickel silver for greater fatigue value, tensile strength and durability.
2. Available in an endless variety for standard and special type tubes.
3. Rigidly tested; meets all requirements of government specifications.

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Metal Crystal Holder Parts
Send sketch or print for quotation.

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ELECTRONICS — February, 1953

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to the

ELECTRICAL
ENGINEER
or
PHYSICIST

with experience in

RADAR
or
ELECTRONICS

Hughes Research and Development Laboratories, one of the nation’s leading electronics organizations, are now creating a number of new openings in an important phase of their operations.

Here is what one of these positions offers you:

THE COMPANY
Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

THE NEW OPENINGS
The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment.

Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

THE TRAINING
On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work.

WHERE YOU WORK
After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California as an instructor or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

YOUR FUTURE
In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

How to apply:

If you are under thirty-five years of age, and if you have an E.E. or Physics degree, write to the Laboratories, giving a resume of your experience. Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

NEW PRODUCTS
(continued)

formation helpful in ordering as well as photographs of actual applications, the bulletin explains how the cords are made, where they are used and the specific features which make their use advantageous.

Metal & Contacts. Metals & Controls Corp., Attleboro, Mass., has an illustrated, 12-page catalog that describes the various composite metals, precious metals, electrical contacts and Truflex metals manufactured by the company. Contents cover some of the unusual composite metals recently developed; information on the platinum-group metals and manganese age-hardening alloys; and two sections dealing with thin-gage rolling and mirror-finish rolling.

Temperature - Humidity Test Chambers. Tenny Engineering, Inc., 26 Avenue B, Newark 5, N. J., announces a new two-color four-page bulletin on its standard line of temperature-humidity test chambers. Chambers covered can simulate temperatures from -100°F to +200°F and relative humidities from 20 to 95 percent. Specifications give data on heaters, humidification, dehumidification, temperature and humidity controllers, compressor equipment, insulation, exterior construction, access door, air circulation, standard equipment and optional equipment. Chamber construction information, performance characteristics and typical applications are given. Interior dimensions and temperature ranges for eight different standard model types are tabularized in a specification section. Included also are 5 pictures showing typical chambers and chamber applications. Ask for bulletin TR.

Direct-Writing Recorders. Sanborn Co., 38 Osborne St., Cambridge 39, Mass. A new booklet that explains the advantages of using the company’s equipment for the study and recording of a wide variety of electrical and mechanical phenomena has been released. It contains 16 pages of pert illustration and pertinent text that describes direct-recording equipment for industrial users.

February, 1953 — ELECTRONICS
FLEXIBLE DELAY LINES

to meet military specifications

Delay .1 to 2 usec.
Tol. ±.05 usec.
2 to 1200 ohms ±15%
Delay lines are hermetically sealed and are of non-nutrient construction.

We invite your inquiries.

RICHARD D. BREW and CO., INC.
106 CONCORD AVE., BELMONT 73, MASS.

Quality Ribbons

MOLYBDENUM TUNGSTEN TANTALUM FORMED PIECES

Your Special Metals Rolled to Thin Sizes & Close Tolerances

YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

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Conform to JAN-C-172A SPECIFICATIONS ... but are actually made to exceed AN-E-19 Drop Test requirements

RUGGED PROTECTION for VITAL EQUIPMENT: Finnflex Mounts isolate vibration and shock from Electronic, Communication, and Control Equipment. They offer unimpaired efficiency from −80° to +250°F. “Selective Action” friction dampening, non-linear steel springs, and other features. Wide range of sizes and load ratings available.

SHOCK MOUNTS for Signal Corps Mobile Equipment and for Naval Fire Control Units.

SPECIAL PROBLEMS: Complete facilities for designing and fabricating Shock and Vibration Mounts to order — regardless of size or weight of equipment mounted.

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Specialists in Vibration Control
335 JACKSON AVENUE, NEW YORK 54, N. Y.

Finnflex—AIRBORNE MOUNTING BASES

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Finnflex—VIBRATION ISOLATORS and SHOCK MOUNTS

any way you look at it....

REON PRECISION WIRE WOUND RESISTORS stay dependable under the most adverse conditions. The resistance changes less than .05% after completion of the MIL-R-93A tests.

The resistor is the heart of your electronic equipment. No other type of resistor has the inherent stability and accuracy of a REON PRECISION WIRE WOUND RESISTOR.

Specification brochure on request.
For delivery information, call Yonkers 5-9850.

REON RESISTOR CORPORATION
117 Stanley Avenue, Yonkers, N. Y.

Want more information? Use post card on last page.
PLANTS AND PEOPLE

Edited by WILLIAM C. ARNOLD

RAC TO Build Manufacturing Plant In Spain

Plans of RCA to build a factory in Spain for the production of 45-rpm phonograph records, record players and eventually TV home receivers were recently announced by F. M. Folsom, president of RCA. The proposed plant is expected to be completed in mid-1953. It is to be erected at a 322,000 sq ft site overlooking Madrid, on the main highway to Barajas Airport and the city of Barcelona. Estimated cost of the new plant is $0.5 million. When in full operation it will employ about 1,000 people.

According to RCA's president, a favorable economic climate for electronic development exists in Spain and the country offers a good ground for investment. He noted that a large amount of building was being done in Spain, largely with Spanish capital and not with U. S. RCA funds.

Arrangements for the project were made in cooperation with Gabriel Soria, president and managing director of Industria Electronica S.A., associate RCA company in Spain. Industria Electronica will share the cost of the plant with RCA. Chairman of the board of the new company is Demetrio Carceller, former Spanish Minister of Industry and Commerce. Another former Spanish cabinet minister, Jose Luis de Arrese, also is a member of the board. He is present a ranking counselor to the Government of Spain.

Mr. Soria, president of the new company, said that when the opportunity arises, Spanish workers would be sent to the U. S. for further training in RCA factories. Although no TV stations now exist in Spain, plans are in progress that will be developed rapidly.

V. K. Zworykin, pioneer researcher in electronics, has been awarded the 1952 Edison Medal by the AIEE "for outstanding contribution to the concept and design of electronic components and systems". The medal was presented at the opening session of the Winter General Meeting of the Institute at the Hotel Statler.

This honor is the latest of many won by Dr. Zworykin, who is vice-president and technical consultant of the RCA Laboratories Division, RCA, Princeton, N. J. He has been associated with RCA since 1929. Others include the Morris Liebmann Memorial Prize of the IRE for pioneer work in television, the Howard N. Potts Medal of the Franklin Institute for contributions to commercial television, the AIEE Lamme Medal for outstanding contribution to the concept and design of the practical use of electricity, the Institute of Radio Engineers' Gold Medal in 1949, and the Edison Medal of the American Institute of Electrical Engineers in 1951.
World's most successful Autochanger

Radio set makers everywhere have acclaimed the Monarch automatic record changer—the brilliant new changer with the exclusive 'Magidisk' auto-selector

- Now 7", 10" and 12" records may be intermixed and played at 33⅓, 45 or 78 r.p.m. with a realism and a purity of tone hitherto impossible
- Simple centralised control provides easy selection of record speed and 'On,' 'Off,' 'Reject'
- New extended frequency range dual stylus crystal pick-up faithfully reproduces the most fragile overtones
- Fine engineering guarantees a lifetime of trouble-free service
- The price is competitive—send for details.

of electronic apparatus basic to modern television, the Poor Richard Club Gold Medal for Achievement, and the Chevalier Cross of the French Legion of Honor in recognition of his contribution to victory in World War II.

The Edison Medal, first awarded in 1909, has been won by such outstanding scientists as Alexander Graham Bell, George Westinghouse, Frank B. Jewett, and Vannevar Bush. The medal was founded by associates and friends of Edison.

MIT Appoints Electronics Lab Research Heads

George G. Harvey, associate professor of physics, and Henry J. Zimmermann, associate professor of electrical engineering, have been appointed associate directors of the Research Laboratory of Electronics at MIT.

CAPTAIN ROUND RECEIVES ARMSTRONG MEDAL

Frank White Elected President of NBC

Frank White, vice-president and general manager of the radio and television networks of NBC, has been elected president and a director of NBC to succeed Joseph H. McConnell.

Mr. McConnell has resigned from NBC to join a company in another industry, and his new position will be announced by that company. It is reported that he will become president of the Colgate-Palmolive-Peet-Co.

Sylvester L. Weaver, Jr., vice-president in charge of the radio and television networks of NBC, was elected vice-chairman of the NBC board of directors, a new position.

John K. Herbert, vice-president in charge of network sales, has been appointed to succeed Mr. Weaver as vice-president in charge of the radio and television networks.

IBM To Build New Electronics Center

International business machines Corp. has announced plans to begin construction of a research center near its Poughkeepsie, N. Y., plant early next spring, to be completed before the end of 1954. The plant, a model of which is shown above, will add 179,000 square feet of floor space to the company's existing laboratory facilities. An estimated 750 employees will work in the building. The research center will provide centralized facilities for the company's widespread electronics research program.

Honeywell Elects Seidel V-P

Glenn E. Seidel has been elected a vice-president of Minneapolis-Honeywell Regulator Company in charge of engineering in the company's Minneapolis plants, Harold W. Sweatt, president, announced recently.

Seidel, a member of Honeywell's engineering organization since 1948, has been director of the company's expanding ordnance division for the past year and a half. Before that he served for a number of years as assistant to W. J. McGoldrick who, as part of his duties as vice-president, has been handling the engineering activities that Seidel will take over.

Outstanding Engineers Honored

The ETA KAPPA NU plaque designating the most outstanding young electrical engineer for 1952 was awarded to John V. N. Granger, 34, of the Stanford Research Institute, Stanford, California. In addition Edward O. Johnson, 33, of RCA Laboratories, Princeton, New Jersey and Gustave W. Staats, 33, of the Allis Chalmers Mfg. Co., Mil...
MICRODOT, pioneer of micro-miniaturization, has completed development of Coaxial Assemblies one-quarter BNC size with savings in weight of 87% to a comparable BNC* assembly...and designed to do a BIGGER job on top of these outstanding size and weight advantages.

COMPARE these characteristics for instrument hook-ups, transistor packaging, computer and airborne components, etc. Here's how big a job a Microdot Coax Assembly can do for you.

**MICRODOT DIVISION**
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For more than 18 years, Eclipse-Pioneer has been a leader in the development and production of high-precision synchros for use in automatic control circuits of aircraft, marine, and other industrial applications. Today, thanks to this long experience and specialization, Eclipse-Pioneer has available a complete line of standard (1.431" dia. X 1.631" lg.) and Pygmy (0.937" dia. X 1.278" lg.) Autosyn synchros of unmatched precision. Furthermore, current production quantities and techniques have reduced cost to a new low. For either present or future requirements, it will pay you to investigate Eclipse-Pioneer high precision at the new low cost.

AVERAGE ELECTRICAL CHARACTERISTICS—AY-200 SERIES

<table>
<thead>
<tr>
<th>Type</th>
<th>Input Voltage (Nominal)</th>
<th>Input Current (Milliamperes)</th>
<th>Input Power (Watts)</th>
<th>Input Impedance (Ohms)</th>
<th>Stator Output Voltage (V)</th>
<th>Rotor Resistance (DC) (Ohms)</th>
<th>Rotor Resistance (AC) (Ohms)</th>
<th>Maximum Error Spreading Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitters</td>
<td>AY201-1 26V, 400-1, 1 ph.</td>
<td>225</td>
<td>2.25</td>
<td>25 +/1115</td>
<td>11.8</td>
<td>9.5</td>
<td>3.5</td>
<td>15</td>
</tr>
<tr>
<td>Transmitters</td>
<td>AY201-4 26V, 400-1, 1 ph.</td>
<td>100</td>
<td>0.45</td>
<td>45 +/1225</td>
<td>11.8</td>
<td>16.0</td>
<td>6.7</td>
<td>20</td>
</tr>
<tr>
<td>Receivers</td>
<td>AY212-1 26V, 400-1, 1 ph.</td>
<td>100</td>
<td>0.45</td>
<td>45 +/1225</td>
<td>11.8</td>
<td>16.0</td>
<td>6.7</td>
<td>45</td>
</tr>
<tr>
<td>Control Transformers</td>
<td>AY201-9 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>42.0</td>
<td>10.8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Control Transformers</td>
<td>AY201-4 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>250.0</td>
<td>6.3</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Receivers</td>
<td>AY211-2 26V, 400-1, 1 ph.</td>
<td>60</td>
<td>0.35</td>
<td>108 +/425</td>
<td>11.8</td>
<td>53.5</td>
<td>12.5</td>
<td>20</td>
</tr>
<tr>
<td>Receivers</td>
<td>AY211-5 1V, 30-1, 1 ph.</td>
<td>3.7</td>
<td>—</td>
<td>240 +/120</td>
<td>0.34</td>
<td>33.0</td>
<td>18.0</td>
<td>40</td>
</tr>
<tr>
<td>Differentials</td>
<td>AY211-3 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>14.0</td>
<td>10.8</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

**Also includes High Frequency Resolvers designed for use up to 100KC (AY211-24).**

AY-500 (PYGMY) SERIES

<table>
<thead>
<tr>
<th>Type</th>
<th>Input Voltage (Nominal)</th>
<th>Input Current (Milliamperes)</th>
<th>Input Power (Watts)</th>
<th>Input Impedance (Ohms)</th>
<th>Stator Output Voltage (V)</th>
<th>Rotor Resistance (DC) (Ohms)</th>
<th>Rotor Resistance (AC) (Ohms)</th>
<th>Maximum Error Spreading Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitters</td>
<td>AY503-4 26V, 400-1, 1 ph.</td>
<td>225</td>
<td>2.2</td>
<td>45 +/100</td>
<td>11.8</td>
<td>25.0</td>
<td>10.5</td>
<td>24</td>
</tr>
<tr>
<td>Transmitters</td>
<td>AY503-5 26V, 400-1, 1 ph.</td>
<td>100</td>
<td>0.45</td>
<td>45 +/100</td>
<td>11.8</td>
<td>23.0</td>
<td>10.5</td>
<td>90</td>
</tr>
<tr>
<td>Receivers</td>
<td>AY503-3 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>170.0</td>
<td>45.0</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Receivers</td>
<td>AY503-3 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>550.0</td>
<td>188.0</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Receivers</td>
<td>AY503-5 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>550.0</td>
<td>188.0</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Receivers</td>
<td>AY503-7 26V, 400-1, 1 ph.</td>
<td>45</td>
<td>0.5</td>
<td>290 +/400</td>
<td>11.8</td>
<td>210.0</td>
<td>42.0</td>
<td>30</td>
</tr>
<tr>
<td>Receivers</td>
<td>AY503-9 26V, 400-1, 1 ph.</td>
<td>9</td>
<td>0.1</td>
<td>900 +/2200</td>
<td>11.8</td>
<td>560.0</td>
<td>165.0</td>
<td>30</td>
</tr>
<tr>
<td>Differentials</td>
<td>AY503-3 From Trans. Autosyn</td>
<td>Dependent Upon Circuit Design</td>
<td></td>
<td></td>
<td>45.0</td>
<td>93.0</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

For detailed information, write to Dept. C.

ECLIPSE-PIONEER DIVISION
TETERBORO, NEW JERSEY
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

PLANTS AND PEOPLE (continued)

waukeen, Wisconsin received honorable mention citations.

Citations presented to the men were as follows:

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Edward O. Johnson

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- Crossfires
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WESTBURY, L. I., N. Y.

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MODEL TO-100

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- Indicator for beating external signal
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- Constant voltage low impedance output
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- Other frequencies available to order

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WITH MOUNTING HOOK FOR USE ON CORDSETS. This model utilizes a steel mounting hook which can be hooked directly on a cordset molded for this purpose.

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Special cord sets of flexible cord, shielded communications wires and multiple conductor cables, equipped with molded rubber or plastic fittings are among the many quality products offered by Whitney Blake.

If standard molds cannot be adapted to individual applications, Whitney Blake is prepared to design and make special molded junctions and other fittings to provide the water and impact resistance, small size, light weight and protection from tampering so important to many of today's applications.

Whitney Blake has over thirty years experience in the cord set field and more than fifty years in producing well built wires. The close control exercised in the production of Whitney Blake cord and cable and the extensive testing facilities make Whitney Blake Cord Sets completely dependable.

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WELL BUILT WIRES SINCE 1899

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PLANTS AND PEOPLE (continued)

honorable mention, Edward O. Johnson."

"By virtue of his outstanding contributions to the design and construction of supercharged hydrogen cooled turbine generators, and his extraordinary participation in the life of his community, Eta Kappa Nu recognizes with honorable mention Gustav W. Staats."

Motorola To Expand Plant

MOTOROLA president Paul V. Galvin announced that his company plans to spend $3 million for a plant expansion program in 1953. A major new plant will be built in Franklin Park, Illinois which will nearly double the production capacity of the electronics firm's television manufacturing facilities. Some 27½ acres of land have been acquired to accommodate the single large structure measuring 833 feet by 325 feet, embracing 278,000 square feet of usable factory space.

Paul V. Galvin

The new facilities will constitute a bulk assembly plant for final assembly, packing, storing and shipping of tv units. The completion of the new plant, with all installations necessary for operation, is anticipated by mid-year.

GE Elects Vice-Presidents

PRESIDENT Ralph J. Cordiner of the General Electric Company announced that general managers of eight operating divisions of the company have been elected vice-
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WARNING

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Among the many new applications of decals for American industry is the tough Meyercord acid, chemical and weather resistant identification of dangerous chemical containers. If you process and ship dangerous chemicals, be sure to ask for full information on this important feature.

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- Transformers
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- Micro Switches
- Photo Electric Equipment
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- Recorders
- Shunts (Electrical)
- Meggers
- Solenoid Valves
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- Multimeters
- Oscilloscopes
- Timers
- and Laboratory Standard Instruments

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ELECTRO-TECH EQUIPMENT CO.

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SANGAMO offers an exceptionally wide choice of subminiature paper capacitors in hermetically sealed metal cans!

There's no need to search for the right miniaturized hermetically sealed paper tubular capacitor for your application... You can choose from Sangamo's full range of capacities and voltages.

You have a choice of two impregnants—Sanowax for 85°C operation and Sangamo's amazing new E-therm for 85°C or 125°C operation. You can choose from two types of element construction—inserted tabs or extended foil... And, you can obtain all these capacitors with either grounded or insulated circuits.

These Sangamo subminiature paper capacitors, Types SA through SM, are sealed in non-magnetic cases, finished with a high tin content alloy. They are hermetically sealed with glass to Kovar, solder-seal terminals.

Complete information is yours in Engineering Bulletin TS-105. Write today.

Zenith Plans Expansion

Directors of Zenith Radio Corporation have authorized new construction that will add more than 300,000 square feet of floor space to the company's main plant at 6001 Dickens Avenue, Chicago, it was announced by Hugh Robertson, executive vice-president.

The new space will be used chiefly to provide additional packing and shipping facilities required for the steadily increasing volume of Zenith's production.

Construction will begin as soon as final drawings are completed, and is scheduled for completion within a year. With this new addition Zenith and subsidiary companies will have total floor space exceeding 1.8 million square feet. Estimated cost of the new addition is $3 million.

Bendix Names Chief Engineers

Albert E. Namey has been promoted to the position of chief engineer of the Test Equipment Design
more LISTENING COMFORT with lightweight TELEX headsets!!

Modern, lightweight, durable... Easily adjustable and built for hard usage, TELEX Headsets give top quality reception without the punishment of extra weight and pressure.

*MONOSET
The modern styling and dependability and superior performance of the TELEX Mono-set have made old fashioned head-phones obsolete. Magnetic.

*DYNASET
New dynamic under-chin TELEX Dyna-set, with more highs and lows of both music and speech, is the delight of radio and TV monitors. Weights only 1.25 oz.

*TWINSET
This lightweight 1.6 oz. TELEX Twinset pipes signal directly into the ear, blocking out background noises and banishing listening fatigue. Magnetic.

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Sensitive TELEX Earset slips onto ear and is preferred by all who use single-phone headsets. Weighs only 1/2 oz. and leaves other ear free for phone calls or conversation.

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High Current Regulated Power Supplies

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Standard Sizes, 350 Series
0-350 V @ 250 ma.
0-350 V @ 1. Amp.
0-350 V @ 2. Amp.
0-350 V @ 3. Amp.

Featuring: Very low output impedance at high power levels; 1% regulation; 5 MV ripple.
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PULSE COUNTER: 7" high, 19" long, 15" deep, weighs 47 lbs. Fits standard electronic rack. Can be constructed to operate at speeds up to 1,000,000 continuous plus or minus pulses per second.
READ-OUT: 11½" high, 9½" wide, 14" deep, weighs 25 lbs. Built on modern adding machine base. Will accumulate and print a full 8 decade keyboard entry in one half second or less.

CLARY
Electronic Pulse Data Recording Combination

This versatile combination consists of the Clary Pulse Counter and the Clary Digital Read-Out Machine. It is already in use by lab and industry for counting, totaling and printing results from a wide variety of applications. It provides standard, decimally correct summations in algebraic form from Electronic Computers, Geiger Counters, Oscillogram Readers, Test Instruments, and other data reduction equipment. When used with the Clary Analogue Converter, the combination can immediately transform an analogue value like a variation in pressure, temperature, stress, voltage, etc., into a printed digital number. You may have a problem to which this combination may be applied. Why not write Clary, giving details? Our engineers will furnish free information and cooperate in a practical application of the scanner and read-out to your problem.

CLARY MULTIPLIER CORPORATION
SAN GABRIEL, CALIFORNIA

Department at the Towson Plant of Bendix Radio, Division of Bendix Aviation Corporation, it was announced recently by A. C. Omberg, Director of Engineering and Research. He will be responsible for the design, production and purchase of all test equipment used by Bendix Radio and also maintain custody of all primary standard equipment and climatic and environmental test equipment.

Norman Caplan has been named to the position of Chief Engineer of the Military Communication and Navigation Engineering Department of the Bendix Radio Division. He will be responsible for the administration of the design and developmental work currently being undertaken in connection with military communication and navigation equipment programs. Prior to this appointment, he occupied the position of Chief Engineer of the Test Equipment Design Department.

Sparks-Withington Names Fisk Chief Engineer

SPARKS-WITHINGTON COMPANY, Jackson, Michigan, announced the appointment of Harry Fisk as chief electronics engineer of the company's Sparton Radio-tv division. He replaces H. H. Knubbe who served Sparton in that capacity for five years.

Formerly Sparton assistant chief electronics engineer, Fisk has been a major factor in Sparton engineering and research for 26 years. In his new post, Fisk will be responsible for all engineering research at
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P.S. We also produce IRN Magnetic Iron powders for the Electronic Core Industry, the Magnetic Tape Recording Industry and others. Write for complete technical information.
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MODEL 704
Direct Reading
FIELD STRENGTH METER
for TV and FM— it will actually read microvolts!

$275.
MODEL 704
with AC power supply

MODEL 704 offers the answer to field signal measurement!
DIRECT READING...
Microvolts and db meter scales
5 microvolts to 3.0 volts
ACCURACY...
± 0.8 db
FREQUENCY RANGE...
Continuous Tuning 50—220 MC
INPUT IMPEDANCE...
72 or 300 ohms
Separates and measures video, audio and adjacent Channel carriers. Locates RF interference.

6 Volt Vibrator Pack available for battery operation.
MODEL 704-6V
Price $24.75
(includes cable)

JERROLD
ELECTRONICS CORPORATION
1451 South 26th St. • Philadelphia 46, Pa.

PLANTS AND PEOPLE
(continued)

Sparton as well as engineering supervision of the company's radio, television and government projects.

Admiral Works On Color TV
ADMIRAL CORP. announced an established research laboratory for color television at Palo Alto, Calif., near the campus of Stanford University. The company has more than 20 engineers working on various phases of color television and other electronic developments. Robert M. Jones is director of research at Palo Alto.

Sylvania Names McClintock
APPOINTMENT of Raymond K. McClintock to the newly created post of manager of new product promotion of Sylvania Electric Products Inc. was announced by B. K. Wickstrum, vice-president and director of sales. From company headquarters in New York City, he will be responsible for fostering the promotion and sale of new products and for exploratory work leading to the consideration of new lines of products by Sylvania.

Magnecord Sets Expansion
ARRANGEMENTS for $300,000 additional capitalization have been completed by Magnecord, Inc., Chicago, manufacturer of professional magnetic tape recording equipment. The funds are to come from Ameri-
**Portable Communication Masts**

Available in . . .

**Standard Military Designs Including**

AB-38/CR, AB-26/CR, AB-54/FR, AB-72, AB-282/GRC

Also in Special Designs to meet particular requirements

- Criton Masts and Antenna Supports are made of Fibre Glass Reinforced Thermosetting Plastic Tubing
- Weight—approx. 1/5 of Steel, 1/2 of Aluminum
- Non-Corrosive—Can't rust, oxidize or mildew
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- Highly shock resistant
- Easy to erect (90 ft. in less than 1 hour)

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**Southern Industries**

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HERMETICALLY SEALED TO MIL-T-27 SPECIFICATIONS

NYT offers a wide variety of transformer types to meet military and civilian specifications, designed and manufactured by specialists in transformer development.

Latest NYT service for customers is a complete test laboratory equipped and approved for on-the-spot MIL-T-27 testing and faster approvals.

PLANTS AND PEOPLE

(continued)

R. J. Sullivan Joins Fairchild

ROBERT J. SULLIVAN has joined the Potentiometer Division of the Fairchild Camera and Instrument Corporation at its Hicksville, N. Y. plant, to act as head of research and development. He was formerly chief of the Potentiometer Research Unit of the Air Force Cambridge Research Center, Cambridge, Mass.

Halliecrafters Names Graver and Wilson

RICHARD A. GRAVER, formerly vice-president and general manager of the Capehart-Farnsworth Corp., Ft. Wayne, Ind., has been appointed vice-president and director of marketing of the Halliecrafters Co.

Mr. Graver's position at Halliecrafters is a new one with more comprehensive duties than those of the former vice-president in charge of sales, Roland J. Sherwood, who recently resigned to form an auto
**A NEW RACK-MOUNTING 5" BASIC SCOPE**

A new 5" rack mounted basic oscilloscope of high quality parts and design.
- Push-Pull input with blanking post.
- Potted power transformer.
- 2,200 volt anode supply for short, medium and long persistence screens.
- Astigmatism control on panel.
- 1/16" lucite safety glass and grating.
- Flanged bezel for scope cameras.
- Mu metal C. R. tube shield.
- Standard 8 1/2" x 19" rack panel in black or grey engraved crackle.

All high quality parts and workmanship are used in this excellent indicating unit. Balanced input signal connections are at rear of C. R. tube with low capacity leads. Furnished with SUP1, SUP7 or SUP11 as requested. Available for immediate delivery.

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ALL SIZES

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Made of TOUGH, DURABLE ETHYL CELLULOSE PLASTIC

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**SHOCKPROOF VACUUM TUBE RETAINERS**

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DL, ST14, S14, ST16, T5½, T6½, MT-1C, ST18, T14, ST126CT-5.

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**JAMES IPPOLITO & CO., INC.**

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ELECTRONICS — February, 1953
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THREADED CORES COST LESS THAN ANY OTHER TYPE OF ADJUSTABLE CORES

1. Reduced cost per core
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5. Hexagonal hole design permits top tuning
6. Saving of critical material

Television, Electronic and Radio set designers are considering the advantages of the Threaded Core. Where Threaded Core substitutions for Insert Cores are indicated as more practicable design, greater economy, stability and better performance have been the result. Part and labor cost reductions can easily be visualized through the elimination of brass screw inserts and simplified assembly.

Threaded Iron Cores are blank-formed with screwdriver slots or hex holes. The blank is then externally threaded on a centerless thread grinder. Your threaded core self-taps itself through the serrated paper coil form.

Threaded core permeability is effected by the type of threads selected. The table illustrates the advantages of selecting finer and shallower threads.

<table>
<thead>
<tr>
<th>Thread Form</th>
<th>Per Cent Change</th>
<th>Diameter Tolerance vs. Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 pitch</td>
<td>.22</td>
<td>0.001 in. ± 4%</td>
</tr>
<tr>
<td>28 pitch</td>
<td>.14</td>
<td>0.002 in. ± 2%</td>
</tr>
<tr>
<td>32 pitch</td>
<td>.13</td>
<td></td>
</tr>
<tr>
<td>28 shallow pitch</td>
<td>-.7</td>
<td></td>
</tr>
<tr>
<td>32 shallow pitch</td>
<td>-.65</td>
<td></td>
</tr>
</tbody>
</table>

The "Q" potential. Threaded Cores having the least permeability drop during threading usually provide the highest "Q" as smaller coils (less copper) are required to achieve the given inductance.

Threaded Core Size and Strength
Greater physical strength is obtained in the Threaded Core with the use of finer threads because of the effective diameter. The ratio of length to diameter shall not be less than 1 1/2 to 1, nor more than 4 to 1, for economical core design. (Standard Diameters: 0.159, 0.181, 0.238, 0.249, 0.304.)

Radio Core Quality Control
All Radio Cores manufactured, are produced with special attention to both mechanical and electrical tolerances resulting in lower incoming inspection and assembly costs on the part of the customer.

---

**PLANTS AND PEOPLE** (continued)

parts manufacturing business of his own.

At Hallicrafters, Mr. Graver will be in complete supervision of all merchandising, marketing and advertising activities of the company. M. Robert Wilson, prominent major appliance sales executive, has been appointed vice-president in charge of sales for Hallicrafters Co.

**IRC Elects Officers**

The board of directors of the International Resistance Company, Philadelphia, elected Ernest Searing chairman of the board of directors. Charles Weyl, formerly executive vice-president, was elected president.

**JFD Completes Plant**

JFD MANUFACTURING COMPANY, INC., has just announced the completion of a new plant that will expand the company's factory space to a total of more than 200,000 square feet. In addition, a 32,000 square foot area recently purchased will be eventually utilized for another factory, according to Julius Finkel, president of JFD.

**Barthel Board Chairman of NEC**

CHRISTOPHER E. BARTHEL, JR., was elected chairman of the board of directors of the National Electronics Conference. Starting his fourth year as a member of the NEC board, Dr. Barthel succeeds Kipling Adams of General Radio Company. During the current year, he was chairman of the publications committee which prepared the proceedings for the organization's eighth annual conference and exhibition in Chicago.

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As Chief Engineer

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Standard equipment includes electric temperature and humidity recording controllers, altitude gauge, mercury manometer, 8-post terminal panel, and pre-set control for maintenance of altitude. Special features may include high-voltage lead-ins, side viewing windows, hand-operated tuning shafts, high wattage dissipation, utility ports up to 6" diameter. Also stainless steel power shafts, special instrumentation, rapid cooling and heating rates, low temperatures to -150°F., altitudes to 120,000 ft. Also custom-size chambers.

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NEERING, 2nd edition
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MENTS, 2nd edition
Henney's RADIO ENGINEERING HANDB-
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**Bogen In New Quarters**

The David Bogen Company, Inc., has completed the removal of its complete plant facilities to new quarters at 29 Ninth Avenue in New York City. The building, which contains a total of 70,000 square feet of area on six floors and basement, will permit expansion of all departments, especially engineering laboratories and production facilities for the company's new products.

**MASCO Appoints Two Executives**

Ralph Aasen has been appointed chief engineer and G. L. Werner has been appointed director of sales of Mark Simpson Mfg. Co., Inc. of Long Island City, New York, it was announced by John A. Van Auken, general manager.

**Stackpole Promotes Five**

Dr. E. J. Shoberg has been appointed manager of carbon research and engineering for the Stackpole Carbon Co., St. Marys, Pa., and Henry M. Dressel will serve as director of research and engineering for the firm's electronic components division.

Other Stackpole appointments also announced by H. S. Conrad,
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This moving coil, permanent magnet relay
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or pressure. The relay uses no condensers,
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are small.

SPST or SPDT contacts are self-locking,
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reduced number of operations. Contacts are
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contacts can be supplied for special applica-
tions.

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release. Delay is adjusted by setting index
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Cat. No. 306-7002, range 0-5 seconds, 0-50
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Cat. No. 705-7003, range 0-10 seconds, 0-150
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vice-president and general manager, include: L. D. Andrews, director of research and engineering on magnetic materials; E. F. Kiefer, director of research and engineering on carbon products; and F. X. Sorg, director of research and engineering on fixed resistors.

Packard-Bell Enlarges Plant
PACKARD-BELL Co., Los Angeles radio-tv manufacturer, is now constructing a new 92,460 sq ft addition to its Los Angeles main plant. Building and equipment together will represent an investment exceeding $750,000.

The addition will have two units, one housing a division for milling and assembling TV cabinets and the other housing the electronics division for government contracts. When this addition is completed, the total facility will contain 250,000 sq ft.

Capehart Names Manufacturing V-P
L. G. HAGGERTY was elected vice-president in charge of manufacturing of the Capehart-Farnsworth Corporation, associate of IT&T, at a meeting of the firm's directors in Chicago.

Arma Advances Walz
ALLEN W. (Skip) WALZ has been advanced by Arma Corporation, subsidiary of American Bosch Corporation, to executive staff assistant to Clifton T. Foss, Arma's vice-president for engineering. His executive position is a newly created one made necessary by the tremendous backlog of orders, now on Arma's books, requiring engineering and development work. The Engineering Division of Arma Corporation now has some 1,700 employees.

Allied Radio Builds $2 Million Building
RAPID progress is being made on a new $2 million building of Allied Radio Corporation, Chicago, national distributor of electronics
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IN OPERATION, the Micro-Microammeter conducts the current to be measured through a very high input resistance — from \(3 \times 10^7\) to \(10^{11}\) ohms. The voltage produced across this resistance charges a vibrating reed capacity modulator, oscillating at 120 cycles per second, which converts the voltage to an alternating signal. After passing through a four-stage amplifier, the signal is converted back to direct current for measurement.

WITHOUT THE PROTECTION of an EDISON thermostat to control the temperature of the input compartment, the precise, 1% reproducibility could be destroyed through variation of the temperature with input resistance or contact potential of the vibrating reed.

EDISON THERMOSTATS feature stability measured in years, control within \(\pm 0.1^\circ\) F and capacity to 115 volts, 8 amperes d.c. or 1000 watts. EDISON temperature control engineers will be glad to work with you on the solution of your ambient protection problems. Just call or write to:

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New NBS Lab Under Way

CONSTRUCTION has begun on a major laboratory of the National Bureau of Standards at Boulder, Colorado. The new building will house the Bureau's Central Radio Propagation Laboratory on a 210-acre site directly south of the city. Complete and modern facilities are to be provided for research on the propagation of radio waves and on the expanded utilization of the radio spectrum now being used for f-m, television, facsimile and radar.

The new building is scheduled for completion in early 1964. By mid-1954 a staff of about 500 will be employed there.

Westinghouse Readies Round-The-World Sub

THREE nuclear power plants of major size are under construction or design at Westinghouse. One, known as Mark II, will be used on the submarine Nautilus for which the keel was laid last July. It will be the first submarine to receive this revolutionary new type of power plant. In the ship, nuclear energy will be put to use for large-scale power utilization for the first time, resulting in an around-the-world submarine.

The second plant is a full-size
working model of a submarine atomic plant, while the third is another nuclear power plant many times larger than those mentioned above. It is planned that this power plant shall be suitable to power major naval vessels such as aircraft carriers.

GE INSTRUCTS SIGNAL CORPS MEN

SERIES of month-long classes is conducted by General Electric to instruct Signal Corps technicians on the installation, operation and maintenance of microwave relay communications equipment. The company is producing the equipment for the Signal Corps at its Syracuse, N. Y. plant. Assisting instructor Gus Kandaris (right rear) is J. N. Craver (left rear), chief radio engineer for the Signal Corps plant engineering agency, who attended the class to further familiarize himself with the equipment.

RTMA Launches Serviceman Program

A PROGRAM designed to improve the technical proficiency and business technique of radio-tv service technicians is being launched by RTMA with the institution of a pilot course in the New York Trade School.

The vocational training program, developed by the RTMA Service Committee under Chairman R. J. Yeranko of The Magnavox Co., has as its immediate objective the upgrading of television service technicians through existing vocational and trade schools. This is to be accomplished through the development and publication of manuals and teaching aids for schools and instructors which would reflect the recommendations of the radio-tv

Micro Bearings Measure Up

... in this high speed aerial camera gearbox

Made by Exact Engineering & Mfg. Co., Oceanside, California, the tiny gear box shown above is used to drive high speed aerial cameras in modern jet aircraft. Very small size and precision quality are required in every bearing for lowest possible friction, accurate positioning of shafts and minimum back lash in the gears. Assurance of long, trouble-free operation is also important, since battle area servicing is always a problem.

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industry and be consistent with the rapidly changing designs and products of the industry.

It is estimated that the radio-tv training program will require an industry subsidy of $80,000 for the first two years. After this period the program is expected to be self-supporting.

Cincinnati IRE Sets
All-TV Conference

SEVENTH Annual Spring Technical Conference of the Cincinnati Section of IRE will be entirely devoted to television. It will be held in Cincinnati on April 18, 1953.

Following is the list of speakers and papers to be delivered: Television and the Bell System, by (speaker undetermined); A High Powered UHF-TV Broadcast System, by F. J. Bias of GE; The Design of TV Receivers Utilizing Non-Synchronous Power, by G. D. Hulst of DuMont; Approach to Mechanized Assembly of Electronic Equipment Applicable to TV Receivers, by L. K. Lee of Stanford Research Institute; The Selection and Amplification of UHF TV signals, by W. Boothroyd and J. Waring of Philco; Transient Considerations in the NTSC Color System, by B. S. Parmet of Motorola; A Four Gun Tube for Color TV Receivers, by J. Renwick and C. Heuer of Zenith; Latest NTSC Color System (Orange Cyan Wide Band), by R. D. Kell and A. C. Schoeder of RCA.

Reps Change Name

THE Representatives of Electronic Products Manufacturers, Inc. is the new name of the reps’ organization formerly known as the Representatives of Radio Parts Manufacturers.

Electronic Parts Show
Allocates Space

A TOTAL of 234 companies have reserved 374 display units for the 1953 Electronic Parts Show to be held May 18-21 at the Conrad Hilton Hotel in Chicago. It is estimated that 10,000 persons will attend the show.

[Image of a new high audio wave form analyzer]

Specifically designed for applications demanding maximum resolution, the LP-1 offers many new possibilities and high speed analysis of sounds, vibrations and electrical wave forms.

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ELECTRONICS — February, 1953

Vacuum Tube Accessories By Eimac — Now Available!

Designed primarily to simplify and increase the efficiency of cooling the most popular Eimac tetrodes. Sockets are supplied with necessary mounting screws, clips, and a pyrex glass chimney. The 4X150 socket, in addition, incorporates a built-in screen to cathode by-pass capacitor.

* Write for new Eimar Catalogue Summary showing Eimac tubes and other accessories.

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<thead>
<tr>
<th>Size (inches)</th>
<th>@ +30°C</th>
<th>@ 0°C</th>
<th>@ -30°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>.140 x .75</td>
<td>45.0 ohms</td>
<td>86 ohms</td>
<td>194 ohms</td>
</tr>
<tr>
<td>.040 x 1.5</td>
<td>12,250 ohms</td>
<td>26,200 ohms</td>
<td>65,340 ohms</td>
</tr>
<tr>
<td>.018 x 1.5</td>
<td>35,000 ohms</td>
<td>82,290 ohms</td>
<td>229,600 ohms</td>
</tr>
</tbody>
</table>

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NEW BOOKS

Advances in Electronics


The remarkable group of books, of which this is the fourth, comprises a series of tutorial articles on subjects chosen annually by a distinguished editorial board. The choice of subjects displays a catholic interest, ranging from the manufacture of cathode-ray tubes to mathematical treatises on electron scattering in solids.

As the preface to the first edition states: "The 'Advances in Electronics' is a yearly publication devoted to the general field of electronics. The term 'Electronics' comprises both physical electronics and engineering electronics; namely the basic physics of charged particles, on the one hand, and the methods and instrumentation for employing such charged particles usefully."

Rather a conservative statement in the light of Dr. Everitt's recent definition!

The articles usually run from 25 to 75 pages, there being seven in this volume:—
1. Electron Scattering in Solids, H. S. W. Massey, F. R. S.
3. Fluctuation Phenomena, Albert van der Ziel.

None of these articles is exactly easy reading since space limitations force the maximum of compression. Naturally the skill with which the selection and compression of material is effected varies from article to article. On the whole the quality is quite high. Mr. Fromm's discussion of the MAD system is particularly likable. On the other hand Mr. Smith's article on computers suffers from too much packing. It
NEW BOOKS (continued)

could have been made much more readable with the increase of only a few pages.

The format of the books is attractive, the type easy to read, and typographical errors are few.

This series forms an excellent source of material for the research worker who wishes to broaden his interest and to keep abreast with advances in related fields.—KNOX McILWAIN, Hazeltine Electronics Corporation, Little Neck, New York.

Applied Electronics Annual 1952


A series of short articles on the applications of electronics to industrial operations, such as in textiles, medical diagnosis, motor control and high-frequency heating, plus articles on germanium, magnetic recording, underwater television and new materials for components. In addition there is a list of trade and technical societies and manufacturers of radio and electronic apparatus and components throughout the world, a list of trade marks and names, wholesalers, importers, etc. interspersed with the text are advertisements of the principal British manufacturers.—K.H.

Principles of Radar


The subject matter of this book is an expansion and reorganization of the earlier editions of the book. The scope can be appreciated by listing of the chapter headings and number of pages devoted to each: Pulsed Radar (54 pp); Timing Circuits (99 pp); Modulators (62 pp); Indicators (62 pp); Synchro and Servomechanisms (61 pp); Receivers (130 pp); Radio Frequency Transmission Lines (77 pp); Waveguides (68 pp); Resonant Lines and Cavities (84 pp); High-Frequency
Triode Oscillators (48 pp); Klystrons and Magnetrons (60 pp); Radio-Frequency Transmitting and Receiving Systems (89 pp); Antennas (64 pp); Propagation (18 pp); and Index (8 pp).

The original purpose of this book was to serve as a text for a course in radar principles for Naval Officers. As such it provided an excellent basis for study to bring electrical engineers who had not had access to the classified war time developments into position to understand the principles of operation of current radar systems. Thus, in addition to specifically radar subjects, much general information is included on subjects such as transmission line and waveguide theory, servomechanisms and high frequency operation of vacuum tubes.

Now that the Navy course is discontinued, there exists some question of the need for this third edition inasmuch as the more general subject matter is at an intermediate level below that normally given to communication engineering students or needed as reference material for engineers working in the field. As a survey text, this third edition is excellently organized, clearly written and well illustrated.


**Photoelectric Tubes**


Another of the interesting and useful Methuen Monographs on Physical Subjects. In this second edition, care is taken to indicate that it deals with phototubes and not with photovoltaic or photoconductive cells. The new edition contains a new chapter on the theory of photoelectric emission, expanded material on multiplier phototubes and new material on image converter tubes.

Like the other monographs in this series, the book is in a handy pocket-size format and the contents are by men of high repute. The chapters cover the history of photo emission, photoelectric cathodes,
matching of light sources and photocathodes, vacuum and gasfilled tubes, multiplier phototubes and applications of all types of light-sensitive tubes.—K. H.

THUMBNAIL REVIEWS


THE CHEMICAL ELEMENTS. By Helen Miles Davis, editor Chemistry Magazine and Science Service, 1719 N Street NW, Washington 6, D. C. 160 pages, 1952, $2.00. Basic information on the 98 elements and particles plus a periodic table plus some hitherto untranslated accounts of the discovery of certain elements.

THE MILITARY ELECTRONIC STUDY. By William C. Urlovic, Pacific Mercury Research Center, Santa Barbara, Calif. 23 pages, 1952, free. For anyone contemplating, or engaged in, research on any subject for the armed forces. The philosophy, technique and pitfalls of setting up an organization, estimating study time and costs, maintaining good relations all round.


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BACKTALK

Smaller Necks

DEAR SIRS:
The memories referred to in Frank Willey's letter in the November 1952 issue of ELECTRONICS (Backtalk, p. 436) brought back others to this writer. Among the various 1/4-inch neck tubes built in those days at General Electric was one for wide-angle deflection. It was of flat face and such short bulb length that it was promptly catalogued as the Squatron. We also successfully built tubes with neck stems of 1/8-inch outside diameter. For my "Museum" I have kept one of these with a 2-inch screen. Its deflection yoke, built for the occasion by S. Hansen, is in a 1/2-inch cube.

C. H. BACHMAN
Department of Physics
Syracuse University
Syracuse, New York

Electronic Embalming

DEAR SIRS:
Your November, 1952 issue of ELECTRONICS (p. 98) carrying the excellent paper by Gale & Burrill on "Electron Beams Sterilize Food and Drugs" once again calls to my mind my earlier contention that Van de Graaf generators with scanned beam output operating at from 2 to 10 million volts could be used for human cadaver preservation — electronic embalming, if you will!

This rather gruesome approach was promulgated by this writer in 1944 while still an engineering student at Ohio State University. Unfortunately, the idea was received rather badly, not for technical reasons but because of the possible social objections to the plan. Practically the plan would be two-fold, destroying the bacteria extant in the tissues of the deceased and curtailing enzymic action which would otherwise permit degeneration of the cadaver tissue.

Embalming is a time-honored science going back thousands of years. Cremation is also an ancient alternate technique. Practiced among the Jews, temporary packing in ice while awaiting burial is the third popular method of han-
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**BACKTALK**

(continued)

**WWV’s Accuracy**

**Dear Sirs:**

IN THE November issue of *Electronics* is an article entitled “Industrial Frequency Standard” by H. W. Klue (p 130), in which a crystal oscillator is not used, a locked oscillator being synchronized with WWV’s received signal. While WWV’s claimed accuracy, as transmitted, is 2 parts in 100 megacycles, their usual accuracy is perhaps twice this, or one part in 10°.

However, due to the Doppler effect, caused by the motion of the ionized reflecting layer in the stratosphere, the accuracy of the received signal is, usually, only about 5 parts in 10°.

This effect has been known for several years. See such articles as:

A Standard of Frequency, *Jour. IEE*, Jul., 1946; High-Precision Frequency and Time Standards, *Proc. IRE*, Jan., 1950; and my own article in the Western Union Technical Review for Apr. 1952. Also in the first footnote of an article by A. W. Warner, in the Sept. 1952 *Proc. IRE*, he states, “There is no known method of communicating a frequency accurate to one part in 10° or better from one place to another hundreds of miles away: ...”

Even land lines, microwave relays, or coaxial cables will have some variable phase shift, although less than the Doppler effect of sky-wave transmission. To see the ef-

---

David Gknsin
New Rochelle, New York
fect of the Doppler effect, an independent standard of high accuracy must be available at the receiving end of the circuit. I think that a correction of the accuracy of this type of standard might be desirable.

L. W. FRANKLIN
Radio Research Division
The Western Union Telegraph Co.
New York, N. Y.

Dowsers

DEAR SIRS:
THE CORRESPONDENT who asked to have his name withheld concerning water dowsers need not be so cautious. There are quite a few scientists of good repute working in this most interesting parapsychics field today on a purely mechanistic and communications theory basis.

There is no withcraft or supernatural effect involved, but some obscure magnetic, electric and infrared senses possessed by abnormally sensitive humans which are similar to the uncanny homing, tracking and migrating senses of some animals. The water dowser’s gifts appear to be related to the magnetic sense of homing pigeons and the infrared smell senses of insects. Endocardiographic readings taken by Prof. S. W. Tromp indicate that nerve potential variations coincide with the magnetic and electric field variations about a dowser’s body and the nerve reflex responses of his arm muscles and the divining rod. Running water is different from still water in that it develops a frictional electric charge which strongly effects a sensitive dowser’s sensory motors. Bioelectrical fields have been measured at distances up to 15 feet from animals and plants.

Professor Tromp found that some dowsers got responses where there were no measurable currents, fields or radiations. This he eventually tracked down to abrupt changes in soil resistivity with geological equipment, according to a personal correspondence letter to the writer. Hence a dowser’s body radiates either an electrical or infrared field and his fantastically sensitive nervous system picks up the tiny reflections from the soil boundary, which may also be a wet-soil bound-

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ary caused by a body of water. For discussions of such biological phenomena, see the papers of Burr, Yeagley, Rhine, Ravitz, Puharich, Rajewsky, Reich, Cazamalli, Miles, Beck, Humphrey et al, and the books on dowsing by Maby, Tromp and Roberts.

The blind little bat, for instance, emits a triple-modulated sonar pulse to clock distance objects by timing the pulse echoes, and close objects by analyzing the a-m and f-m modulation beats, to extract a maximum of information from a restricted bandwidth of 40 to 70 kc, and has applied Shannon's information theory millions of years before man appeared on this earth. A casual study of so-called "psychics" indicates that Mother Nature may be even better an empirical methods engineer in communications than in the bat's little sonar-computer-servo-blind-navigation system.

T. Powell
Great Neck
Long Island, N. Y.

REFERENCE

More On Dowsers

DEAR SIRS:
The author of the unsigned letter on the subject of dowsing and electronics in the Backtalk column of Electronics, December, 1952, (p 398) is perhaps unaware that:

(1) Dowsers are not infallible. For example, H. B. Nichols, in the Scientific Monthly, May, 1951, p 340, states that in New South Wales the dowsing history of several thousands of water wells was recorded by the government, and that the dowsed wells were consistently less successful than the undowsed locations. From this it might appear that chance, or possibly that more rare quality, common sense, could be as effective as dowsing.

(2) Competent geophysicists and geologists are not completely unaware of electronics as applied to water-finding, and the subject has received some attention by C. A. Heiland, "Geophysical Exploration," Prentice-Hall, New York...
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**ELECTRONICS — February, 1953**

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DEAR SIRS:
Is IT NECESSARY that we be bound down to relatively horse-and-buggy tolerances on tube limits as manufactured for the mass market when more and more applications these days are in the atomic-and-jet classification? Rather than gear our precise instrumentation to wide-tolerance vacuum tube limits, it seems to me that it behooves tube manufacturers to work toward narrowing down those limits to keep step with today's progress. Maybe that is impossible to accomplish at the present time, but the feeling persists that at least as much time and expense should be put in that direction as is used to educate the
user to wide tolerances.

The special industrial and ruggedized series is a step in the right direction, except that they add just so much more to the confusion by bearing rows of gallery numbers that bear absolutely no relation to anything—thus very successfully hiding their identity from the user and adding another to the already-too-long list of types to remember.

Even in the mass-produced home market, the use of the wide-tolerance tubes means engineering and servicing headaches.

Why cannot we clean house somewhat on both the ever-growing list of tube types and the thinking to back it up and assure that progress goes forward rather than being tied down to old-fashioned ideas?

PHILIP C. TAIT
Emeryville, California

Calculated Curves

DEAR SIRS:
I was not very happy to see that you had to omit two calculated curves of antenna patterns in my
article, "Skewed Antenna at WJZ-TV" which appeared in the October issue of ELECTRONICS on page 130.

Among engineers it is quite well accepted to measure the success of a project by the correlation of calculated and measured work. In this case the measured patterns differ so much without the calculated results to substantiate these wide differences, there is reason to doubt the propriety of the work in the no-skew case. It is easy to obtain poor curves by an error in circuit arrangement or phasing.

M. W. Scheidorf
Andrew Corporation
Chicago, Illinois

(Editor's Note: In order to show the close correlation between measured and calculated patterns, as requested by the author, we are reprinting the measured patterns below, along with copies of the calculated patterns that were omitted in editing the article.)

NIM

Dear Sirs:

We note in the November, 1952 issue of ELECTRONICS the article "Digital Computer Plays NIM" (p. 155), which brings to mind that The North Electric Manufacturing
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Company built a similar machine in 1940. While it operated on relay principle only, the results were the same.

This machine was designed and built for Westinghouse and was displayed in the 1940 World's Fair in New York. It was also described in the August 1940 issue of Popular Mechanics.

This machine was known as a "Nimatron". We believe the machine is still on display in the Planetarium at Pittsburgh. The photograph shows the front of the machine, with four rows of seven lights and the operating buttons. The queue on the top merely repeated all of the lights in four directions. In the event the player won the game, a small token was delivered in the slot, lower center, front.

There were four counting chains which operated with the lights in each row and compared the powers of two to determine which play was winning. There was also an additional counting chain which kept track of the number of games and set up nine different starting combinations. All starting combina-
tions were arranged so that the player could win if he did not make a mistake. However, once a mistake had been made, the machine took over and would never lose from that point. In cases where the player had a winning combination, the machine made random plays distinguishing one, two or three lights in rotation, the idea of this being to eliminate memorizing previous plays. This arrangement, together with the nine different starting combinations, gave an infinite number of plays, so that a previous winning combination would be very difficult to memorize and retain.

We thought perhaps you might be interested in knowing that this type of machine had been designed and manufactured at least twelve years prior to your publication of a similar machine designed by Maxson Corporation.

Eric Brooke
Chief Engineer, The North Electric Mfg. Corp.,
Galion, Ohio

Zero and Negative

Dear Sirs:

This refers to “Zero Impedance” in the Backtalk department of ELECTRONICS, p 388, May 1953.

Attention of your correspondent and readers is hereby drawn to my article “On Voltage Stabilizer Circuits” in the April, 1942 issue of the Indian Journal of Physics. Certain innovations for obtaining zero or negative internal resistance and others for perfect and more than perfect negative stabilization has been described there. I believe that is the first publication on stabilizer circuits giving satisfactory methods of obtaining readily these unusual performances. In their classic work published in Rev. Sci. Instr. in 1939, Hunt and Hickman have only made an observation (on the basis of a mathematical study of the effect of source resistance on the performance of stabilizers) that zero or negative internal resistance may be shown by a stabilizer having negative stabilization when working off a primary source of high internal resistance.

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Backtalk

Circuit of zero or negative impedance power supply regulator

age although it may be very small in comparison. The very nature of operation of these circuits demand the presence of some control voltage at the grid of $V_g$. This control voltage is furnished by the change in the output voltage $dV_o$ in the usual two-tube circuits. However the necessary control voltage may be easily supplied from the varying input voltage. In that case, no additional change in output voltage will be necessary to provide extra control and in this sense the circuit may be said to give perfect stabilization.

The circuit I developed is shown in the diagram.

The resistance $R_c$ between the cathode of $V_1$ and the negative line in the circuit brings about negative internal resistance in two-valve voltage stabilizer circuits. A simple analysis gives the internal resistance defined by the relation

$$R_c = \left( \frac{kV_1}{4I_1} \right)$$

$$R_c = \left( \frac{1}{\beta G A^2} - R_3 \left( \frac{1}{\beta} - 1 \right) \right)$$

where $G$ is the mutual conductance of $V_1$; $A$, the amplification given by $V_o$ and $\beta = R_c/(R_g + R_c)$

It will be seen that by a suitable choice of the value of $R_c$, one can make the internal resistance zero or negative. A negative value of several hundred ohms is not difficult to attain.

The stabilization factor of the circuit remains practically unaffected by the inclusion of $R_c$ and is approximately given by $S_r = \beta A d$, where $d$ is the amplification factor of $V_o$.

B. M. Banerjee

Institute of Nuclear Physics

Calcutta, India

February, 1953 — ELECTRONICS
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ELECTRONICS — February, 1953
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February, 1953 — ELECTRONICS
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<td>001</td>
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</tr>
<tr>
<td>04</td>
<td>MFD 5000V DC</td>
<td>$17.50</td>
</tr>
<tr>
<td>05</td>
<td>MFD 5000V DC</td>
<td>$16.00</td>
</tr>
<tr>
<td>06</td>
<td>MFD 5000V DC</td>
<td>$14.50</td>
</tr>
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<td>07</td>
<td>MFD 5000V DC</td>
<td>$13.00</td>
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<td>08</td>
<td>MFD 5000V DC</td>
<td>$11.50</td>
</tr>
<tr>
<td>09</td>
<td>MFD 5000V DC</td>
<td>$10.00</td>
</tr>
</tbody>
</table>

RADAR EQUIPMENT

Type SO-1 (10CM) antenna with reflector, antenna, coordinated, antenna motor, etc. New $79.50

Type SO-3 (0.3 CM) Parabolic type with reflector, antenna motor, etc. New $187.50

RADAR ANTENNAS

Provides 4 Types of Presentation:

1. Panoramic
2. Aural
3. Oscillographic
4. Oscilloscopic

TERMS: Rated Concerns Not 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.
ELECTRICAL PRODUCTS

ELECTRONICS

Searchlight Section

Linear Sawtooth Potentiometer

Brand New $5.75

European Equipment

Antennas

Aerial Commander Universal - 23AGo for Switch Micro R-RL2T Switch

Band Switch Contactor CRP-23AGo for Switch Micro R-RL2T Switch

Arkless Switchboard Lamp Receptacles

Shock

Variac

Cathode Ray Shields

Screw-in type cathode ray tubes, contained in aluminum cases and packed in leaded new receivers.

Exceptional variable transformer.

U.

Laboratory Type

Complete with technical manual and full set of spare parts.

Model ARG-1 Radar with Radarola. 80-111 Makeup units. Pulse Tester units for SBS Radios.

Radar Crystal units - 231/2 inch, Long. 305 ft. whips. 2400 K.V.A.

BRAND NEW

S.B. Radar Accessory Control Panes.

S.B. Transmitter-Receiver units.


Relay

G.E. Battery Charger

Charges 54 cell battery at from 1 to 10 amperes rate.

Input 115V, 60 cycles 180 cycles. The model 61000016 Copper Oxide battery charger consists of a transformer, a secondary rectifier, a copper oxide rectifying element, a ventilating fan, control circuits and auxiliary equipment necessary for proper operation. Transformer tapped for various output voltage. Eight secondary tags for adjusting charging rate. Built into metal cabinet. Complete with two fans and ducts. New in original packing case. Shipping weight approx. 200 lbs.

Price $255.00

RADAR Repeater Adapters

Navy Type CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard and Navy radar equipment wherein provision is made for operation in some P.T.-I. sets. This adapter provides four video and trigger pulse lines for connecting one or more units to the radar equipment. The model can be used with the following equipment: 115 Volts, 60 cycles A.C. from ship's power supply. It is required for operation. Dimensions are 35 x 3 x 13 in.

Description:

A: Output Video Signal Lines.

B: Output Trigger Lines

C: Wide Angle Chart Switch.

D: Connectors for Repeater Ports.

E: 4 Lines at +5 volts amplitude. 4 Lines at -5 volts amplitude. 4 Lines at +2 volts amplitude. 4 Lines at -2 volts amplitude. Used with H-521, I-520, B-520, I-521, etc. CAT No. 30FMX, 1875 c.p. 60 volts, 115 c.p. 115 volt, 2-way, 5-supplier. 62/4-50 50 75.

24V DC Solenoid

2 lb. pull—1/8" stroke

Price New $1.45 Each

Micro-Switch

S.P.S.T. Normally Closed Brand New S.85 Each

Brand New S.85 Each

ELECTRONICRAFT INC.
27 MILBURN ST. BRONXVILLE B, N. Y.
PHONE: BRONXVILLE 2-0044

Merchandise Guaranteed.

Prices Subject to Change

Electronics — February, 1953

www.americanradiohistory.com
**SEARCHLIGHT SECTION**

**OIL FILLED CONDENSERS**

<table>
<thead>
<tr>
<th>MFD</th>
<th>VMC</th>
<th>Price</th>
<th>MFD</th>
<th>VMC</th>
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<td>550</td>
<td>1.50</td>
<td>600</td>
<td>.49</td>
<td>600</td>
<td>39.95</td>
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<td>25KV</td>
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<tr>
<td>1</td>
<td>550</td>
<td>1.50</td>
<td>600</td>
<td>.49</td>
<td>600</td>
<td>39.95</td>
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<tr>
<td>1</td>
<td>390</td>
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<td>600</td>
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<tr>
<td>1</td>
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<td>.49</td>
<td>600</td>
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<tr>
<td>1</td>
<td>96</td>
<td>1.50</td>
<td>600</td>
<td>.49</td>
<td>600</td>
<td>39.95</td>
<td></td>
<td>25KV</td>
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**COAXIAL CONNECTORS**

**FULL LINE OF JAPAN APPROVED COAXIAL CONNECTORS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
<th>Type</th>
<th>Price</th>
<th>Type</th>
<th>Price</th>
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</thead>
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<tr>
<td>AT-1</td>
<td>$160</td>
<td>AT-6</td>
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<td>AT-2</td>
<td>$160</td>
<td>AT-7</td>
<td>$160</td>
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<td>AT-8</td>
<td>$160</td>
<td>AT-13</td>
<td>$160</td>
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<td>AT-4</td>
<td>$160</td>
<td>AT-9</td>
<td>$160</td>
<td>AT-14</td>
<td>$160</td>
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<tr>
<td>AT-5</td>
<td>$160</td>
<td>AT-10</td>
<td>$160</td>
<td>AT-15</td>
<td>$160</td>
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</table>

**HIGH VOLTAGE TRANSFORMERS**

**ANTENNAS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price Per M Ft.</th>
<th>Type</th>
<th>Price Per M Ft.</th>
<th>Type</th>
<th>Price Per M Ft.</th>
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</thead>
<tbody>
<tr>
<td>RG-11</td>
<td>$5.60</td>
<td>RG-21</td>
<td>$5.60</td>
<td>RG-31</td>
<td>$5.60</td>
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<tr>
<td>RG-12</td>
<td>$5.60</td>
<td>RG-22</td>
<td>$5.60</td>
<td>RG-32</td>
<td>$5.60</td>
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**RELAYS**

**Crystral Diodes**

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<th>Type</th>
<th>Price (each)</th>
<th>Type</th>
<th>Price (each)</th>
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<tr>
<td>IN12</td>
<td>$1.19</td>
<td>IN18</td>
<td>$1.19</td>
</tr>
<tr>
<td>IN21</td>
<td>$1.19</td>
<td>IN22</td>
<td>$1.19</td>
</tr>
</tbody>
</table>

**METERS**

**Sprague Pulse Networks**

- **GENERATORS AND INVERTERS**
- **TEST EQUIPMENT**
- **MISCELLANEOUS EQUIPMENT**
- **PULSE TRANSFORMERS**
- **SPARE PARTS**
- **QUOTATIONS UPON REQUEST**

**ELECTRONIC RESEARCH LABORATORIES**

GUARANTEED BRAND NEW

TUBE SPECIALS

SYNCHROS

ARMY ORDNANCE—NAVY ORDNANCE—COMMERCIAL

TERMS 20% CASH WITH ORDER, Balance C. 0. D. unless noted. All prices net. F. 0. B. our warehouse, Phila., Pa., subject to change without notice.

CABLE ADDRESS - "ELECTRONIC PHILADELPHIA"

ELECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST.

PHILA. 6, PA.

Telephones - MARKET 7-6771 - 2-3

415
Increased business from our ever-expanding list of accounts . . . and a desire to give these customers the utmost in service . . . has prompted us to move our facilities from Paterson to adjacent Hawthorne, N.J. Here we have built twin plants with more than twice the office, service, storage, and shipping space as in our previous quarters.

Our greatly increased capacity now permits us to stock many more items — and in much larger quantity — so that immediate delivery is assured. Every shipment carries our guarantee to meet original manufacturers' specifications.

NEW LOCATION

1086 GOFFLE ROAD
HAWTHORNE, NEW JERSEY
Hawthorne 7-3100
IS ON THE MOVE

SYNCHROS • DC MOTORS • AC MOTORS • INVERTERS
SERVO MOTORS • ACTUATORS • GEAR MOTORS • GENERATORS

GUARANTEED TO MEET ORIGINAL MANUFACTURERS’ SPECIFICATIONS

ELECTRIC PNEUMATIC RAM
Standard Type FQ. 6 inch push-pull cylinder. Operates with any air pressure up to 350 pounds. Control valve is electrically operated with 24 volts D.C. Ideal for remote or automatic control. Stock #SA-370 .. each $12.50

DRAFTING MACHINE
Will save many hours of labor on plans, schematics, drawings, etc. Each arm 18 inches long with full ball-bearing construction. Designed by Brunning for the Navy and modified by Servo-Tek to be equivalent of their standard machine, with chucks to hold standard vertical and horizontal scales. Supplied with one 18 inch Brunning scale. Packed in special fitted wooden box. Stock #SA-375 each ................................................................. $39.50
Additional 12 inch scale for above. Stock #SA-376 .................................................... each $4.85

HIGH H.P. AIRCRAFT MOTORS
All 24-28 volts D.C.
SA-340 Electric Specialty, 7.5 H.P. @ 3800 rpm.
SA-341 Electric Specialty, 1.75 H.P. @ 6000 rpm.
SA-325 Electric Specialty, 25 H.P. @ 3800 rpm.
SA-270 General Electric, 3 H.P. @ 4600 rpm.
SA-199 National Mineral, 1.0 H.P. @ 3800 rpm.
SA-154 General Indus', 125 H.P. @ 8500 rpm.
SA-279 HoFzner Cabot, 3 H.P. @ 3600 rpm.
Prices on request.

400 CYCLE TRANSTAT
115 volts, 400 cycle, single phase input, 75 to 120 volts of 6 amperes max. output. Completely enclosed with AN connector for input and output. Locking device for permanent setting. Stock #SA-368 ................... each $12.95

BENDIX AY-201-3-B
HIGH PRECISION AUTOSYN
For use as transmitter or control transformer in controlled (servo) circuits. Average electrical characteristics: input voltage — nominal excitation, 26 volts, 400 cycles, single-phase; input current — milliamperes, 65; input power — watts, 0.33; input impedance — (stator open) — ohms, 80 + 400; rotor resistance — (DC) — ohms, 42; brush contact resistance — (DC) ohms — 0.5 @ 300 rpm max; stator output voltages — (line to line) 11.8 volts; stator resistance (DC) — ohms, 10.8; phase shift — (rotor to stator) — degrees 5.5; accuracy (against standard) spread — minutes 15 max.

PIONEER 10047-2A SERVO MOTOR
400 cycle, 2 phase low inertia drop cup servo motor. 26 volts fixed phase, 45 volts maximum variable phase. Makes excellent rate generator. Stock #SA-90 ............. each $12.50

208 VOLT AIRCRAFT ACTUATORS
In stock various 208 volt, 3 phase, 400 cycle Actuators, including all the other actuators used with the Northrup Flying Wing. Prices on request.

WRITE FOR LISTING
Prices F.O.B. Hawthorne
Telephone HAwthorne 7-3100

1086 Goffle Road
HAWTHORNE, NEW JERSEY

ELECTRONICS — February, 1953

www.americanradiohistory.com
Buy TOP Radio-Electronic Values!

JAN TUBES

<table>
<thead>
<tr>
<th>Code</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0B3/V990</td>
<td>$ .85</td>
</tr>
<tr>
<td>0C1/V105</td>
<td>$ .85</td>
</tr>
<tr>
<td>3629</td>
<td>GL802R</td>
</tr>
<tr>
<td>6C21</td>
<td>9003</td>
</tr>
<tr>
<td>204A</td>
<td>38P1</td>
</tr>
<tr>
<td>368AS</td>
<td>5FP4</td>
</tr>
<tr>
<td>371B</td>
<td>12G9P</td>
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</table>

FILAMENT TRANSFORMERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMERICAN 5 Volt C.T. 10 Amp. SEC. 250 Volt 50/60 Cycle Primary 25,000 Volt TEST</td>
<td>621A</td>
<td>$1.00</td>
</tr>
<tr>
<td>CHICAGO TRANSFORMER 10 Volt C.T. 6.5 Amp. SEC. 390 Volt 50/60 Cycle PRI. 5000 Volt TEST</td>
<td>6213A</td>
<td>$5.00</td>
</tr>
</tbody>
</table>

TEST SETS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1E-36 FOR SCC $27.75</td>
<td>$35.00</td>
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</table>

POWER TRANSFORMER

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRI. 115 Volt 1 Cycle SEC. 380 Volt 50/60 Amps. Hermetically Sealed 1/10/15 TRC-1</td>
<td>10120A</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

RADIATOR OSCILLATOR APR-5

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sig. Ctr. No. 2C-229A</td>
<td>$2.25</td>
<td></td>
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</table>

HIGH FIDELITY TRANSFORMER

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Double Half Shell</td>
<td>6.5 Volt 1 Cycle 10,000 Max. 6.5 Volt C.T. @ 1.5 Amps.</td>
<td>$1.25</td>
</tr>
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HIGH CURR. TRANSFORMER

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary 115 Volt 60 Cycle</td>
<td>1/25 Vac at 100 Amps.</td>
<td>$5.00</td>
</tr>
</tbody>
</table>

0.01 MFD — 600 Volt MICA CONDENSERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000 Volts 10 Microfarads</td>
<td>$5.50</td>
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</tbody>
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6.3 Volt FILAMENT TRANSFORMERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary 115 Volt 60 Cycle 1600 Insulation 6.3 Volt</td>
<td>$2.65</td>
<td></td>
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</tbody>
</table>

AN/AQ-13 MODULATOR UNIT

<table>
<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal Corps 2JK35/37 W.E. N.S. D.25754.</td>
<td>$125.00 ea.</td>
</tr>
</tbody>
</table>

SYNCHRO CAPACITOR

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 25000</td>
<td>1 Watt 200 OHM Wire Wound Rheostat</td>
<td>$1.50</td>
</tr>
</tbody>
</table>

J-38 KEYS

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal Corps Type J-38 Keys</td>
<td>$85.00</td>
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HIGH VOLTAGE TRANSFORMER

<table>
<thead>
<tr>
<th>Model</th>
<th>Stock No.</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>21,000 Volt 10013A. Half Wave Oil filled. Water Proof.</td>
<td>$300.00</td>
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MICA CAPACITORS

<table>
<thead>
<tr>
<th>Model</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Complete list</td>
<td>$50.00</td>
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G. E. SATURABLE REACTOR

<table>
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<tr>
<th>Model</th>
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</thead>
<tbody>
<tr>
<td>15 KVA 410-210</td>
<td>$100.00</td>
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83-1R COAX CONNECTOR

<table>
<thead>
<tr>
<th>Model</th>
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<tbody>
<tr>
<td>5657A</td>
<td>$50.00</td>
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ELECTRONICS — February, 1953

Radio Surplus Corp.

ANON GAS-DRIVEN GENERATOR

<table>
<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 V-2500 Watt D.C.</td>
<td>$225.00</td>
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GAS DRIVEN LIGHT PLANT

<table>
<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
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<tbody>
<tr>
<td>125 Volt Phase 3KVA 50-60 Cycle</td>
<td>$395.00</td>
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SWITCHBOARD BD74

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<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
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<tbody>
<tr>
<td>RCA and KENRAD</td>
<td>$75.00 ea</td>
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RAYTHEON

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<thead>
<tr>
<th>Model</th>
<th>Price per Unit</th>
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<tbody>
<tr>
<td>Individually Boxed</td>
<td>$85.00 ea</td>
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JAN 826'S

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<tr>
<th>Model</th>
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<tbody>
<tr>
<td>35 each</td>
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10 MFD — 600 VDC

<table>
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<tr>
<th>Model</th>
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<tbody>
<tr>
<td>Sprague No. 22-157 10 MFD. 220 VAC 600 VDC Capacitor with Universal Mounting Ring.</td>
<td>$95.00</td>
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TRANSMITTING MICAS

<table>
<thead>
<tr>
<th>Model</th>
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<tr>
<td>Complete list</td>
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OTHER TYPES AND SIZES AVAILABLE

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<tbody>
<tr>
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BUTTERFLY CONDENSERS

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<thead>
<tr>
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<tbody>
<tr>
<td>9-22 mfd per section</td>
<td>$100.00</td>
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</tbody>
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AN-109A WHIP ANTEenna

<table>
<thead>
<tr>
<th>Model</th>
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<tbody>
<tr>
<td>1275 w/Am, 75 less Oz.</td>
<td>$25.00</td>
</tr>
</tbody>
</table>

TERMS:

Account to be settled on Acceptable references. Others Prepayment of Price in Full. G.O.B. Chileno, and Any Other Warranties Subject to prior sale.

ORDER TODAY!

732 South Sherman Street
Chicago 5, Illinois
Phone: Harrison 7-5923
Will check Frequency and Operation of various X Band equipment such as Radar Magnets, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q of resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Also available of new production TS147/UP and TS239A Synchroscope.

**Other test equipment, used checked out, surplus.**

**TSK1/SE K Band Spectrum Analyzer**
**TS3A/AP Frequency and power meter S Band**
**RF4A/ AP Phantom Target S Band**
**TS10/AP Altimeter Test Set**
**TS12/AP VSWR Test set for X Band**
**TS13/AP X Band Signal Generator**
**TS14/AP Signal Generator**
**TS15/AP Flux Meter**
**TS16/AP Altimeter Test Set**
**TS19/APQ S Calibrator**
**TS35/AP X Band Power and Frequency Meter**
**TS34/AP Western EL Synchroscope**
**TS35/AP X Band Signal Generator**

**TS36/AP X Band Power Meter**
**TS47/APR 40-4000 MC Signal Generator**
**TS59/AP Frequency Meter 400-1000 MC**
**TS100 Scope**
**TS102A/AP Range Calibrator**
**TS108 Power Load**
**TS110/AP S Band Echo Box**
**TS125/AP S Band Power Meter**
**TS126/AP Synchroscope**
**TS147 X Band Signal Generator**
**TS251 Range Calibrator APN9**
**TS270 S Band Echo Box**
**TS174/AP Signal Generator**
**TS175 Signal Generator**

**TS226 Power Meter**
**TS239A Synchroscope**

**MOUNTED QUARTZ CRYSTALS IN FT241A HOLDERS**

**WESTERN ELECTRIC**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
<th>Type</th>
<th>Price</th>
<th>Type</th>
<th>Price</th>
<th>Type</th>
<th>Price</th>
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**MINIMUM ORDER**
25 Dollars

**YOU CAN REACH US ON TWX NY1-3235**

**STELRSUP**

**Special**
Wide Band S Band Signal Generator, 2700-10000 MHz using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated. Frequency measuring cavity, CW or Pulse Modulated, externally or internally.

**Large quantities of quartz crystals mounted and unmounted.**

**Crystal Holders:** FT243, FT1718 others.

**Quartz Crystal Comparators.**

**North American Philips Flourescences Type 80.**

**Large quantity of Polystyrene beaded coaxial Cable.**

**Cables:**

**LIBERTY ELECTRONICS, INC.**
135 Liberty Street New York 6 N.Y.
Phone WHALE 4-4700

SPECIAL

February, 1953 — ELECTRONICS
NEW LOWER LIST PRICES!!

AN CONNECTORS IMMEDIATE SERVICE
3100 A & B AND 3101 A & B SHELLS AVAILABLE
BLACK INSERTS MELAMINE INSERTS
50% OFF LIST 40% OFF LIST

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Shell List Price
Shell Insert

SEARCHLIGHT SECTION

RELIANCE MERCHANDIZING CO.
Arch St. Cor. Croskey
Phila. 3, Pa.
Telephone Rittenhouse 6-4927

ELECTRONICS — February, 1953
When you are in need of specialized men for specialized jobs—from general managers to supervisors—contact them through the SEARCHLIGHT SECTION of McGraw-Hill publications.

The SEARCHLIGHT SECTION (Classified Advertising) is the national market place for those wanting the services of men in technical, engineering and operating capacities in the fields served by these publications.

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ELECTRICAL CONSTRUCTION AND MAINTENANCE
ELECTRICAL MERCHANDISING
ELECTRICAL WORLD

ELECTRONICS
ENGINEERING AND MINING JOURNAL
ENGINEERING NEWS-RECORD
FACTORY MANAGEMENT AND MAINTENANCE
FLEET OWNER
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WELDING ENGINEER

The men you need are the men who read the
SEARCHLIGHT SECTION of
McGRAW-HILL PUBLICATIONS
330 West 42nd St., New York 36, N. Y.
**TELEPHONE TYPE RELAYS**

These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applications is thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e., F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations.

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**FRAMES WITH MICROSWITCH**

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**AMPERITE THERMAL TIME DELAY**

Single Pole Normally Open 2.40 ea.

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**SELENIUM RECTIFIERS**

Full-Wave Bridge Types

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**SHORT TELEPHONE RELAYS**

A1896, CLARE, (10731-1) 12VDC, SPST

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**ULTRA SENSITIVE RELAYS**

KURMAN 6503 - Nominal operating characteristics of 12-100 Ohms.

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<td>60</td>
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**KOVAR GLASS TO METAL SEALS**

HIGH-VOLTAGE FEED THRU

Five types and sizes. Send us your blueprint or sample for our quote. Our prices are a fraction of factory cost.

<table>
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<tr>
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**MU-METAL LAMINATIONS**


Sample Kit, 6 lbs, Sufficient Quantity of Each Size for One Unit—Postpaid in U. S. A. $19.75
Headquarters for
MICROWAVE TEST EQUIPMENT

- the widest assortment, the strongest depth and the most immediate availability of any source on test equipment.

We are pleased to announce March occupancy of new enlarged quarters for Weston Laboratories, Incorporated. This latest expansion provides us with almost 26,000 square feet of space exclusively dedicated to the manufacture of high quality test equipment. May we have the opportunity of quoting on your needs? A partial listing of those pieces of military test equipment which is available follows:

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*OF new manufacture*

BEFORE SELLING YOUR IDLE TEST EQUIPMENT...

...please get our offer

Weston Laboratories
INCORPORATED

WESLAB Tel: Boston: WE 5-4500

February, 1953 — ELECTRONICS
A LEADING SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

INVERTERS
WINCHARGER CORP. PU 16/AP, MG750, input 24 vts. 60 amps. outputs 115 vts., 400 cycle, 6.3 amp., 1 phase.
HOLTZER CABOT, TYPE 149F, input 24 vts. at 36 amps., output 26 vts. at 250 V.A. and 115 vts. at 500 V.A., both 400 cycle, 1 phase.
PIONEER TYPE 12117, input 12 vts., output 26 vts. at 6 V.A., 400 cycle.
PIONEER TYPE 12117, input 24 vts., output 26 vts. at 6 V.A., 400 cycle.
WINCHARGER CORP. PU/7, MG2350 input 24 vts. at 160 amp., output 115 vts. at 21.6 amp., 400 cycle, 1 phase.
GENERAL ELECTRIC, TYPE SD123A, input 24 vts. at 35 amps., output 115 vts. at 485 V.A., 400 cycle, 1 phase.
LELAND, PE 218, input 24 vts. at 90 amps. output 115 vts. at 1.5 K.V.A., 400 cycle, 1 phase.
LELAND, TYPE D.A. input 28 vts. at 12 amp. output 115 vts. at 115 V.A., 400 cycle, 3 phase.

ENGINE HOUR METER
JOHN W. HOBBS, MODEL MI-277 records time up to 1000 hours, and repeats, operates from 20 to 30 volts.

VOLTAGE REGULATOR
LELAND ELEC. CO. TYPE B, CARBON PILE. Input 21 to 30 volts D.C. regulated output 18.25 vts. at 5 amp.
WESTERN ELEC. TYPE BC937B, input 110 to 120 volts 400 cycle. Output variation 0 to 7.2 ohms at 5 to 2.75 amps.
WESTERN ELEC. TRANSTAT, input 115 vts., 400 cycle output adjustable from 92 to 115 vts., rating .5 K.V.A.
AMERICAN TRANS. CO., Transtat input 115 vts., 400 cycle output 72 to 120 vts. or 0 to 45 volts, rating .72 K.V.A.

SYNCHROS
1 F SPECIAL REPEATER 115 vts. 400 cycle.
21JF1 GENERATOR, 115 vts. 400 cycle.
21JF3 GENERATOR, 115 vts. 400 cycle.
21J10 CONTROL TRANSFORMER 57.5 vts. 400 cycle.
21J11 DIFFERENTIAL GEN. 57.5/57.5 vts. 400 cycle.
2G GENERATOR, 115 vts. 60 cycle.
5DG DIFFERENTIAL GEN. 90/90 vts. 60 cycle.
SHCT CONTROL TRAN. 90/55 vts. 60 cycle.
SGCT CONTROL TRAN. 90/55 vts. 60 cycle.
55DG DIFFERENTIAL GEN. 90/90 vts. 400 cycle.

TACHOMETER GENERATOR & INDICATOR
GENERAL ELECTRIC, GEN. TYPE AN5531-1, Pad mounting 3 phase variable frequency output.
GENERAL ELECTRIC, GEN. TYPE AN5531-2, Screw mounting 3 phase variable frequency output.
GENERAL ELECTRIC, IND. BD13AAA, works in conjunction with above generators, range 0 to 3500 RPM.

D. C. ALNICO FIELD MOTOR
DIEHL TYPE FDF23, 27 vts. 10,000 RPM.

GENERAL ELECTRIC
D. C. SELSYNS
BY-P-RAB TRANSMITTER 24 vts.
BY-J1-1- INDICATOR, dial 0 to 360°, 24 vts.

RECTIFIER POWER SUPPLY
HAMMNET ELECTRIC MFG. CO. MODEL 5P5-130. Input voltage 208 or 230 volts, 40 cycle, 3 phase, 21 amps. Output 28 volts at 130 amps. continuous duty, 8 point tap switch, voltmeter ammeter, thermo reset all on front panel.

MISCELLANEOUS
PIONEER MAGNETIC AMPLIFIER ASSEMBLY. Saturable reactor type, designed to supply variable voltage to a servo motor such as CK1, CK2, CK3 or 10047.
SPERRY AS CONTROL UNIT, part No. 644836.
SPERRY AS AZIMUTH FOLLOW-UP AMPLIFIER, part No. 656020.
SPERRY AS DIRECTIONAL GYRO, part No. 656029, 115 vts. 400 cycle, 3 phase.
SPERRY AS PILOT DIRECTION INDICATOR, part No. 645262 contains AY 20.
ALLEN CALCULATOR, TYPE C1, TURN & BANK IND., part No. 21300, 28 vts. D.C.
TYPE C1, AUTO-PILOTATION STICK, part No. G1080A3.
PIONEER GYRO FLUX GATE AMPLIFIER, type 120761-A, 115 vts. 400 cycle.
COMMUNICATIONS EQUIPMENT CO.

**FLEXIBLE COUPLING SHAFTS**
MC 215
(ALL LENGTHS SHOWN IN INCHES)
24 PER IN.

<table>
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<tr>
<th>Item</th>
<th>Price</th>
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<tr>
<td>34</td>
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<td>35</td>
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<tr>
<td>MG 124</td>
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<td>(ALL LENGTHS SHOWN IN INCHES)</td>
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<td>24</td>
<td>135</td>
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**SELENIUM RECTIFIERS—Full-Wave Bridge Types**

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<tr>
<th>Type</th>
<th>Current</th>
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<th>Volts</th>
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<th>Volts</th>
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<td>1 Amp</td>
<td>6.5%</td>
<td>1.35</td>
<td>13.45</td>
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<tr>
<td>2 Amps</td>
<td>2.20</td>
<td>3.40</td>
<td>6.30</td>
<td>10.30</td>
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<tr>
<td>3 Amps</td>
<td>1.85</td>
<td>2.60</td>
<td>5.50</td>
<td>8.50</td>
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<tr>
<td>4 Amps</td>
<td>1.50</td>
<td>2.30</td>
<td>4.40</td>
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<tr>
<td>5 Amps</td>
<td>1.25</td>
<td>2.00</td>
<td>3.40</td>
<td>5.60</td>
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<tr>
<td>6 Amps</td>
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<td>1.65</td>
<td>2.80</td>
<td>4.70</td>
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<tr>
<td>7 Amps</td>
<td>0.75</td>
<td>1.35</td>
<td>2.35</td>
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<tr>
<td>8 Amps</td>
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<td>1.05</td>
<td>1.70</td>
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**POWER TRANSFORMERS**
Comb. Transformers—115V-50-60 c.p. Input

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<tr>
<th>Type</th>
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<tr>
<td>CT-120-505V/60V</td>
<td>1.56</td>
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<tr>
<td>CT-150-505V/60V</td>
<td>1.35</td>
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<tr>
<td>CT-220-506V/60V</td>
<td>1.95</td>
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**MOONLIGHT**

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<tr>
<th>Type</th>
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<tr>
<td>CM-45-2500 V. TEST</td>
<td>$3.95</td>
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**INTERPHONE TRANSFORMER SET**
He use your own interphone. Kit consists of 1-In Bout Transformer, 1 in. or 1/4 in. SPDT Switch, and Output Transformer (Matches 50k, 35k, 700 kohm, 800 kohm, 2800 kohm, 1.200 kohm). 12-48V AC. 1.200 WATTS. 1.200 OHMS. | $1.00 |

**UNIVERSAL SUPPLY KIT**
Delivers 230V @ 50/60 DC. From 110/220VAC DC. Can be connected to 12, 20, 30, or 40 A OM. Blower Set. | $3.95 |

**24 VOLT TRANSFORMERS**
For operating various gear, toy trains, and pets, etc. operation from 115V, 60 cy., 120V, 60 cy., and 24V DC. | $6.95 |

**RECEIVER TRANSFORMERS**

<table>
<thead>
<tr>
<th>Type</th>
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<tbody>
<tr>
<td>Pre-115V 60 Cy.</td>
<td>See: 28V/3.1A, 28V/4.1A</td>
</tr>
<tr>
<td>Pre-115V 60 Cy.</td>
<td>7.3V/4.1A</td>
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**FILTER CHOKES**

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<tbody>
<tr>
<td>Stock Description</td>
<td>Price</td>
</tr>
<tr>
<td>CH-305</td>
<td>$1.00</td>
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</table>

**INTERPHONE AMPLIFIER**
Easily connected to any inter, Communications set for office, home, or factory. | $4.75 |
COMMUNICATIONS EQUIPMENT CO.

PULSE EQUIPMENT

H/Volt Pulse Bulkhead, Feedline, Tube, 100/ V/3000-15,000-50 ohms...

APU-2 PULSE MODULATOR, cathode, 100/ V, 3000-15,000-50 ohms...

APU-4 PULSE MODULATOR, 50 ohms...

APU-5 PULSE MODULATOR, 50 ohms...

APU-16 PULSE MODULATOR, 50 ohms...

MICROENGINE COMPONENTS

S-BAND—3" x 11 1/2" W.G. 10 CM.

DIRECTIONAL COUPLER, Broadband, 20 CM, 300 ohms...

WAVELENGTH Transformer, 300 ohms...

MAGNETRONS

(All Primaries 115V, 400 Cycles)

Stock

Price

302-1073

640V @ 1000V, 5.1/2A, 6/F, 3/4, 3/4A...

72724

2400V @ 1250 MA, 6/2A...

K57564

2000V @ 750 VA, 5/10A...

20411

1500V @ 350 MA, 5/7A...

K59767

750V @ 250 MA, 5/10A...

251-1232

1250V @ 200 MA, 5/3A...

252-1236

1100V @ 150 MA, 5/5A...

322-1234

1000V @ 100 MA, 5/1A...

67213

150V @ 30 MA, 5/1A...

3572

150V @ 30 MA, 5/1A...

27156

125V @ 30 MA, 5/1A...

3582

125V @ 30 MA, 5/1A...

3593

125V @ 30 MA, 5/1A...

2332

125V @ 30 MA, 5/1A...

1563

125V @ 30 MA, 5/1A...

2237

100V @ 30 MA, 5/1A...

5302

100V @ 30 MA, 5/1A...

2739

100V @ 30 MA, 5/1A...

ELECTRONICS — February, 1953

www.americanradiohistory.com
**Searchlight Section**

**Atoll-13 Transceiver**

Dynamic power output, either 14 or 25 V. Shock insulated, remote controlled transceiver. Tunable receiver, range 90-150 M.C. $245.00

**Radarr**

AN/APS-3 APT-1
AN/APS-3 APT-3
AN/APS-4 New M/T73/A
AN/APS-4 New M/T73/A
AN/APS-4 New, Complete M/T73/AAP
ANTENNA LOADING

**PORTABLE RADAR**

Model 20. 12 cm. units with PPI indicator. Max. range 28 miles. 1 kw. output. Overrun from 440 VAC, 60 cps. P.U.R.

**AN/ART-13 Parts**

Part # Item
4349-16 Transmitter
4349-27 Receiver
TR89544S Coaxial Switch
TR46655 6-Pole Ceramic, Variable Cup
Antenna Loading C/C-25

**Gas Engine Power Supply**

14 kw. 110 V. 60 cps. Complete gas engine power source. Complete set, $50.00

**Government, Airlines & Industrial**

Send for FREE Catalogue No. 112 for complete list of Military, Industrial and Avition Electronics.

**Pulse Transformer**

Here are precision made, high quality compact pulse transformers wound on hypereal cores. They are built in all bulk size tube bases and can be adapted to many uses. They are completely irregiment and seasoned.

**Supreme Test Equipment**

Model 46 Test Equipment for Viccel and Set Tester...

**Miscellaneous**

NINE DETECTOR SCH-50 for prospecting, tubing, etc. $27.50

**Equipment Wanted**

To meet government and industrial orders we urgently need all types of new and used Test Equipment, Radars, Receivers, and Transmitters. We pay highest prices. Tell us what you have.

**L. A. Ham Shack Sells for Less**

**WESTON • SANGAMO**

All New • All Old • 21/2 Decades

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
<th>Description</th>
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<td>0-5 Ma</td>
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<tr>
<td>0-10 Ma</td>
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<td>0-200 Ma</td>
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<td>0-500 Ma</td>
<td>$16.00</td>
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**Volts/Ohms/Temp**

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<td>10000</td>
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<td>2500</td>
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<td>100</td>
<td>$2.50</td>
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**Rectifier**

Transmitting equipment to produce high voltage DC. 10,000-150 ampere AC 60 cycle amperage. Up to 11,200 VAC 60 W. Mineral filled voltage 11.5-12 VAC 600-3000 ma. 5,000-20,000 ma.

**L. A. Ham Shack**

1306 Bond St., at Pico. • Los Angeles 15, Calif.
**SUPERIOR VALUES FROM AMERICA'S LARGEST ELECTRICAL CONSTRUCTION, HOUSE,**

**400 CYCLE MG UNITS**


AMERICAN 3 UNIT MG. Consists of 1 HP motor operational at 200 V, 150 V, 240 V, 220 V, and with 240 V, 220 V, and 150 V, 400 cycles. With direct connected equipment. PRICE: $150.

**GENERAL ELECTRIC 500 CYCLE OPERATIONS.** Operate at 250 V. 500 A. PRICE: $1.50.

**WINCHURGER 3-HP MG.** Price: $150.

**PE 100 INVERTERS.** Price: $150.

**HOLLISTER-CABOT MG**. Compact 2 bearing units for low power, 250 V, 240 V, 220 V, and 110 V. PRICE: $150.

**BOGUE THREE PHASE MG SETS.** Consists of 2 1/2 HP motors operational at 220 V, 208 V, 200 V, and 110 V. PRICE: $150.

**LUCAS FALLS INVERTER CHANGERS.** Price: $150.

**50 KVA. 400 CYCLE MG SETS.** Price: $150.

**500 CYCLE MG UNITS.** Price: $150.

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**500 CYCLE MG UNITS.** Price: $150.
SELENIUM RECTIFIER UNITS
HEAVY DUTY—30 VOLT DC OUTPUT.
120/200 V. Three Phase 600 Volt Input.
TYPE 143 w/Transformer & BR. 100 Amp. $49.50
TYPE 143 w/Transform. V. R. & B. 100 A. $49.50
TYPE 143A-11 Rectifier Only. Catalyst 300 Volt. $49.50
TYPE A booster Unit. Catalyst 360 Volt. $48.50

BATTERY CHARGING RESISTOR
PANEL
115 VDC—6.0 ohm 20 Amps Max. Switching High Low & 6S7 Charging rate: 6.2 Volt Cycles
Flux 2A. L. 30 A. 10-12.2 Volt Cycles. 30-45. High
Complete with Cable. Price: $28.00

TRANSFORMERS—100V 60 Cycle Pri.
5 VOLT CT-25A-10,000 V. Inc. OPEN FRAME.
60 A. 5 Volts 9.3 A. $7.55
Sec. 12 V. 8 A. windings gives 12 V. 8 A. $4.15
24 V. 4 A. $1.50
Sec. 24 Volt 1/2 Amp. $1.50
Sec. 24 Volt 4 Amp. $1.50
Sec. 6 30 or 30 Volts 8 Amp $1.05

MOUNTING AND CLAMPS:
FD-154 for BC-154 Receiver $2.50
FD-175 Mounting & Clamp $2.50
MC-140 Lead-In Collar—Fairlead $2.00
MC-324 Waveguide Clamp for Fairlead $3.00
M-225 Rodless & 200 FT. W-400 Antenna Wire $1.50
WT-7 Welding for Transmission Antenna $3.50

CORDS—CABLES
C-501 Cord—7X-15 Grommet $2.50
CD-118 Cord w/PL-68 & BW-141 & 6K-48... $2.00
CD-37C Cord w/PL-68 & BW-141 & 6K-48... $2.50
CD-118 Cord w/PL-68 & BW-141 & 6K-48... $2.50
CD-37C Cord for PL-201 $2.00

PLUGS AND CONNECTORS
PL-118 Plug for 8-1 and 1-2 $1.50
PL-PS-119 Plug for HP-258 $1.50
M-2160 plug adapter for Conn. Set $1.00
M-359 Nightlight coaxial Connector $2.50

ANTENNA EQUIPMENT
MAST BASES—INSULATED:
MP-132 BASE: (as illustrated at left) 1/2" dia. 10' 11/2" insulating. Overall length: 11 5/8". Weight: 2-1/4 lbs. Price: $3.50
M-359 Nightlight coaxial Connector $2.50

MAST SECTIONS For ABOVE BASES
Triangular steel, copper plating, 1/4" thick, in 1 foot sections, shown in type. M-53 can be used to make any length in 2'A sections for any length. Add 10 cents for each foot over 10'.

Larger Diameter Sections: MS-55, 56, 57 $1.25 Each
M-53 Antenna—100-150 MC—Copper $5.95
AN-1014 Antenna—100-150 MC—Copper $3.50
AN-1014 Antenna—100-150 MC—Steel $3.50
AN-1014 Antenna—150-250 MC—Copper $3.50
AN-1014 Antenna—150-250 MC—Steel $3.50
AN-1014 Antenna—250-500 MC—Copper $3.50
AN-1014 Antenna—250-500 MC—Steel $3.50
AN-1018 Whip Steel—6 Ft. Length $1.75
AN-1018 Whip Steel—8 Ft. Length $1.75
AN-1018 Whip Steel—10 Ft. Length $1.75
AT-31/AT-71—COPPER $4.50
AT-31/AT-71—STEEL $6.50
AT-31/AT-71—COPPER—250-500 MC $6.50
AT-31/AT-71—COPPER—150-250 MC $5.95
AT-31/AT-71—STEEL—250-500 MC $6.50
AT-31/AT-71—STEEL—150-250 MC $5.95
AT-31/AT-71—STEEL—100-150 MC $5.95
AT-31/AT-71—COPPER—100-150 MC $5.95
AT-31/AT-71—STEEL—100-150 MC $5.95
AT-31/AT-71—COPPER—50-100 MC $5.95
AT-31/AT-71—STEEL—50-100 MC $5.95
AT-31/AT-71—COPPER—25-50 MC $5.95
AT-31/AT-71—STEEL—25-50 MC $5.95
AT-31/AT-71—COPPER—25-50 MC $5.95
AT-31/AT-71—STEEL—25-50 MC $5.95

MOTOR—GENERATOR:
Army type CCL-2114, 115 VDC—.75 HP—4750 RPM. Generator 10, 21, 50 A. New, $29.95

SPECIAL TUBE BUYS
TUBES
All Types—All Brands—Special Lots
- Manufacturers
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- Exporters
- We invite your inquiries on electronic components of all descriptions!

PREMIER T. V. RADIO SUPPLY
Division of Continental Corp.
3241 W. North Ave. — Chicago 47, Ill.
Aurora 4-5530

February, 1953 — ELECTRONICS

AIRCRAFT ELECTRONICS
ARC—1's, ART—13's, RTA 1 B's, BC348's

WRITE OR CALL FOR BULLETIN

MERRICK ELECTRONICS
166-08 DOUGLAS AVE.
JAMAICA, N. Y.

RE 9-5960

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TCS—Collins mfd. Navy radiotelephones for shipboard and mobile use; complete with all accessories for operation from 12, 24, 110, 220 volts d.c. and 110 or 220 volts a.c.

TDE—Navy or commercial marine transmitters, complete 110 & 220 volts d.c. and a.c.

TBK—Navy high frequency transmitter, 2-20 Mc; 500 watts output. Supplied complete with m/g and starter for d.c. or a.c. operation.

TBM—same transmitter but with speech input equipment to give 350 watts phone.

TBL—Navy all-wave transmitter; 350 watts output; CW and phone. Supplied complete with m/g and starter for d.c. or a.c. operation.

TAJ—Navy intermediate freq. transmitter, 175-550 kc; 500 watts output. Supplied complete with m/g and starter for a.c. or d.c. operation.

SCR-284—the famous mobile and ground station for field use. Large quantity of complete sets available.

MAG—10 cm. portable link transmitter receivers, 6-volt operation.

TEN—2000-5000 kw complete with 220/440 volt, 3 ph. 50-60c power supply—conservatively rated at 1 kw. output.

SCR-510 and 610 in quantity, RADAR BEACONS

AN/CPN-6 3 cm.
AN/CPN-5 10 cm.
TJ and YG for shipboard use

AN/CPN-6 3 cm.
AN/CPN-5 10 cm.

AND TUBES—SPECIAL PURPOSE and TRANSMITTING TYPES

This is a sample listing • Write for other items • UNLISTED PRICES

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<table>
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<tr>
<th>Tube</th>
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<td>381B</td>
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Minimum order $10.00 F.O.B. N.Y.C.

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ELECTRONICS — February, 1953
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AWG 22, stranded copper
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10 Ohm  25 Watt  5000 Ohm  25 Watt  $3.70
15  .35  20000  25  2.60
25  .40  15000  15  1.50
30  .45  10000  10  1.10
45  .60  9000  8  .85
100  1.20  6000  6  .60
150  1.20  6000  5  .50
500  1.40  20000  2  .20
1000  1.80  30000  1  1.60

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3T2-97  3.50  12/14  .25  9000  $8.00
3T2  3.50  12/14  .25  9000  $8.00
3R01  3.00  8/14  .25  9000  $7.00
3C120  .35  9/14  .25  9000  $4.00
3W130A  .35  9/14  .25  9000  $4.00
15M  35  277  .15  9000  $4.00
15N  42  277  .15  9000  $4.00
10S  28  277  .14  9000  $4.00
74-44  35  1200  .08  9000  $1.75
45Mens  35  1200  .08  9000  $1.75
2W03  6.70  1020  .12  9000  $1.00
WL035  4.35  7200  .06  9000  $1.00
731A  .30  9000  .10  9000  $1.00

MDR VDC Each Ten MDR VDC Each Ten
1  1  1000  1000
2  2  2000  2000
3  3  3000  3000
4  4  4000  4000
5  5  5000  5000
6  6  6000  6000

FILLED CONDENSERS
MFD VDC Each Ten MFD VDC Each Ten
1  1  1000  1000
2  2  2000  2000
3  3  3000  3000
4  4  4000  4000
5  5  5000  5000
6  6  6000  6000

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Switch Board Panel 0-200 Amps Westcon $268.00

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all makes
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other makes 2.75/C
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other makes 4.50/C
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any values
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GO-9 100/125 W. IF/RF Ship or Aircraft Transmitter, A1 and A2 Emission. All New with Spares.
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MISCELLANEOUS
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GP-7 Aircraft Transmitters.
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RT-3/ARN-1 Alimeter.
RADIONUCES AN/AMQ-1A to D. New.

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$3.95

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110 v. 60 cycle 1 RPM... $2.85

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220 volts to 115 volts

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110 volts to 230 volts

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8 RPM... $3.90

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One each $15.00

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343
DIRECTRON SELENIUM RECTIFIERS

Buy Direct From M'facturer

Full-Wave Bridge Types

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NEW Selenium Rectifiers Transforms

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<tr>
<td>20 A</td>
<td>1200</td>
<td>1522</td>
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GEAR HEAD MOTORS

GENERAL ELECTRIC—DC motor model M590-
125, 3/4 H. P., 60 RPM, 240-208 VAC, 3A surge and 211/2 A field, reversible. Turns out type correct to match order Part No. T8252461. 60 RPM and one 120 RPM take-offs, controlled by throw-out type clutch. Will-bearing. Base line start ex-

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WHITE-ROGER SERVO MOTORS—24VDC, Torque 100 oz-in., Gear 10:1, Stock item 24H-M590. Guard box on top has limit switches, relay, and selenium rectifier to block AC out of motor. Can be supplied in Models 600-4-5104 or 200-216. Price NEW

DC MOTORS

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Plus SPARE PARTS, Quantity available.
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AN/ARN-7 COMPLETE
BC-260 COMPLETE
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BC-348 RECEIVERS
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Electronics - February, 1953
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Frequency range 80 to 3000 Mc/s.

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ELECTRONICS—February, 1953

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ELECTRONICS - February, 1953

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110 VAC 0-6.3 A
28 VAC 0-3.2 A
Every tube guaranteed
All new parts
$151.00
DC-625 MINE DETECTOR
New Special
$59.95

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All popular gear for land, sea, and air. Write for information.
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100 va.
$94.95

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P.M.U.
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TC-47
TB-18
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DC-500 to 3000
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- Signal Corps type TA-3/FT.
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- $150.00
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- $75.00
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New "SEARCHLIGHT" Advertisements received by February 2nd will appear in the March issue, subject to limitations of space available.

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February, 1953 — ELECTRONICS
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Note: This is only a partial listing of our vast inventory of electronic components.

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- RAYTHEON: UX 7310 A, UX 19006
- WESTINGHOUSE: UX 7310 A, UX 19006
- GENERAL ELECTRIC: 6012-T1, 6012-T2, 6012-T3, 6012-T4
- SPECIAL MOTOR STARTING CONDENSERS 110 Volts, 60 Cycles

- 3276 145-175 mfd 51.02
- 95756 161-200 mfd 1.12
- 3279 162-195 mfd 1.14
- 3289 180-220 mfd 1.37
- 3926 200-240 mfd 1.42
- 3251 218-262 mfd 2.22
- 3915 234-286 mfd 1.64
- 3825 243-270 mfd 1.64
- 3275 243-292 mfd 1.68
- 3242 324-389 mfd 1.83
- 3225 400-680 mfd 2.12
- 3224 485-593 mfd 2.26

**SPECIAL**

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- Wellesley 5-5210-1

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The above listing represents only a small portion of our tremendous tube stock. Since we are unable to list our entire inventory, if your requirements are not listed, write and allow us to quote you accordingly.

Prices subject to change without notice. TERMS: Rated firms net 10 days, Non-rated 25% with order balance COD. Prices FOB Boston. Minimum order $10.00 or 10 of a type.

---

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- General Motors Corp., Delco Radio Div.
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PULSE NETWORKS AND TRANSFORMERS

Table 1. Specifications for Pulse Networks and Transformers

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<th>Model</th>
<th>Description</th>
<th>Rating</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Single-ended, 100kHz</td>
<td>20W</td>
<td>$9.95</td>
</tr>
<tr>
<td>DEF</td>
<td>Differential, 1MHz</td>
<td>50W</td>
<td>$14.95</td>
</tr>
<tr>
<td>GHI</td>
<td>Push-pull, 2MHz</td>
<td>100W</td>
<td>$29.95</td>
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HEAVY DUTY COPPER OXIDE RECTIFIERS

Table 2. Specifications for Heavy Duty Copper Oxide Rectifiers

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Voltage</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>JKL</td>
<td>Single-phase, 250V</td>
<td>30A</td>
<td>$15.95</td>
</tr>
<tr>
<td>MNO</td>
<td>Three-phase, 400V</td>
<td>50A</td>
<td>$29.95</td>
</tr>
<tr>
<td>PQR</td>
<td>Full-wave, 600V</td>
<td>75A</td>
<td>$49.95</td>
</tr>
</tbody>
</table>

HIGH VOLTAGE CAPACITORS

Table 3. Specifications for High Voltage Capacitors

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Voltage</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>ASP</td>
<td>Paper, 1kV</td>
<td>10uF</td>
<td>$4.95</td>
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<tr>
<td>BCD</td>
<td>Ceramic, 2.5kV</td>
<td>0.1uF</td>
<td>$12.95</td>
</tr>
<tr>
<td>DEF</td>
<td>Oil, 5kV</td>
<td>0.01uF</td>
<td>$24.95</td>
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MOTORS AND GENERATORS

Table 4. Specifications for Motors and Generators

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHI</td>
<td>DC, 24V</td>
<td>1HP</td>
<td>$29.95</td>
</tr>
<tr>
<td>JKL</td>
<td>AC, 110V</td>
<td>0.5HP</td>
<td>$19.95</td>
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<tr>
<td>MNO</td>
<td>DC, 48V</td>
<td>2HP</td>
<td>$59.95</td>
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SERVICES FOR SPARES FOR RADAR

Table 5. Specifications for Services for Spares for Radar

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Microwave, 24GHz</td>
<td>$299.95</td>
</tr>
<tr>
<td>DEF</td>
<td>Antenna, 36GHz</td>
<td>$499.95</td>
</tr>
<tr>
<td>GHI</td>
<td>Transmitter, 42GHz</td>
<td>$699.95</td>
</tr>
</tbody>
</table>

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**EXCEPTIONALLY FAST WAY TO CHECK CAPACITOR LEAKAGE**

- Direct measurement of voltage decay.
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Voltage Divider has 100:1 ratio, clips over guard ring of Hi terminal. Thus, dc circuit potentials up to 500 volts, such as the open circuit voltage of this high impedance source, are read directly.

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GRC CAP NUTS
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* Vertical Phase-Reversing Switch.
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* "Z" Axis Modulation terminal for blanking, etc.
* Internal, Plasable, 60 cycle Beam Blanker.
* Sweep Phasing Control. Wide angle bridge circuit.
* Direct H and V plate Connections; all 4 plates.
* Audio Monitoring Phone Jacks.
* High Intensity CRT Patterns through use of adequate high voltage supply with 2X2 rectifier.
* Tube Complement and Circuit - 6CG7 "V" cathode follower, 6C6B "V" amplifier, 6C64 "V" phase inverter. Push-Pull GAU's "V" CR driver, 7N7 "W" amplifier and phase inverter. Push-Pull GAU's "W" CR driver, 7N7 sweep oscillator. 5Y5 and 2X2 rectifiers. VR-150 voltage regulator, 5CH4/6 CH74. 7 Four-Way Lab. Type Input Terminals - Take banana plugs, phone plugs, bare wire or spade lugs.
* Light Shield and Mask removable and rotatable.
* Extra Heavy-Duty Construction and components to assure "Precision" performance.
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* Fully Licensed under W.E. Co. patents.

See this "PRECISION" 5" Oscilloscope in display and available at leading radio equipment distributors.

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