ELECTRONIC DESIGN

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Contents

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Editorial

The Price of Independence

If you were sitting in on the sessions of the 1957 Transistor Circuit Conference, you no doubt got the uneasy feeling that something was left off the program handed to you. You kept seeing new transistor symbols flashed on the screen. Was there a contest for the most original (or different) symbol going on? The program didn't say. If you had come in at the middle of several of the lectures, you might have thought you were at a steam engineers' convention—the slides showed an amazing network of pipes and valves.

Naturally, each symbol had some merits. The old "Bell Labs" job still had it over many—you could recognize the base. Other symbols emphasized either the n- or the p-junction. A Canadian import cleverly arranged the triangle and bar of the rectifier symbol to represent either npn or pnp devices. One big disadvantage of this system was apparent at the conference though. So many diodes were needed to get the desired circuit performance that you couldn't distinguish the transistor for the forest of diodes.

This business of complicated circuits seems to be indirectly influencing the symbol. If a lot of transistors are used, the more or less conventional symbol needs a circle around it to catch your attention. Many such symbols take up a fair amount of paper. Apparently you can draw more easily by using a diodelike symbol.

Some simple symbols work fine for simple basic circuits. They aren't efficient in a complicated circuit. On the other hand, symbols desirable to certain circuit specialists have far fewer advantages for more general usage.

All in all, the major disadvantage of each of the admittedly clever schemes is that the advantages are not as apparent for general usage. General usage refers not only to circuit designers of all specialties, but, to name a few others, draftsmen who have to draw symbols and field repairmen who try to read the circuit.

As for general usage, we are not starting at scratch. The "Bell Labs" symbol, later made more precise by MIL-STD-15A, has been widely used. MIL Standard rules make the symbol reasonably clear and leave a degree of flexibility for external connections. It would seem that, unless the standard were impossible, we should try to use it.

The IRE Subcommittee on Transistor Symbols has been studying this problem for a long time. The result of their efforts will soon be sent to the IRE Standards Group. Many of you will be asked to pass judgement on their proposals. Don't be a die-hard for a pet scheme. Don't be an anarchist. Such independence will continue to cause chaos for the entire industry.—JAL.

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.

130 Million Candlepower Searchlight: This airborne searchlight will be carried aloft through the night skies by Navy submarine-killer planes to illuminate their targets lurking in the water beneath. Developed by the Arma Division of the American Bosch Arma Corp., the light greatly exceeds the power of carbon-arc lamps now being used and also has the advantage of being able to burn continuously, or as long as the supply of carbons is maintained. The arc lamps which the military is currently using can only be turned on for an average of 30 seconds at a time. The Navy will also use the new arc light to aid in night sea rescue operations.

Televised Radar for Air Traffic

Televising a radar picture has proven to be a great help to ground air-controllers in solving the traffic problem over crowded airports. Basically, the system allows the successive sweeps of a radar display to be stored and transmitted by television to the traffic controller. The result is a clear picture of the plane along with its trace; this permits easier identification as well as more information of the plane's course and speed.

The heart of the system is a two-gun cathode-ray tube designed in France by the Compagnie Generale de Telegraphie Sans Fil. One electron beam of this tube writes radar information on an internal storage surface, while the other beam reads this information and converts it to a television signal. The system has been developed and adapted to the problem of air traffic control by Intercontinental Electronic Corp., N.Y., working in conjunction with the CAA Technical Development Center, Ind.

The traffic controller employing the Picture Transformer System has control over the system's degree of memory. He can therefore vary the length of trace which an aircraft leaves across the screen. For easy identification of particular aircraft, the operator can juxtapose code numbers to each aircraft's trace.

The CAA Technical Development Center discovered particular advantage in the bright display which permits viewing in full daylight, such as in the control tower of an airport. Coordination between control centers was pointed out as being greatly simplified, since the system lends itself to conventional microwave transmission.

Televised radar is being used here in a typical air traffic control center. The operator can label the individual plane traces by maneuvering templates on the circular work board. An ionoscope picks up the display and mixes it in with the radar presentation. Scanning this produces a composite TV picture which can be transmitted cross-country by conventional channels.

Engineering Review

Powdered X-Rays

A new "less-than-a-minute" X-ray processing system features a dry, electrostatic system in which the X-ray image is produced by a dry powder on a sensitive metal plate. This permits an image-developing procedure that takes less than 1 minute to complete. There is no need for cumbersome, wet-chemical methods of developing a film in an enclosed darkroom.

The process is known as xeroradiography, to be displayed by the X-Ray Department of General Electric Co. at the Western Metals Exposition from March 25 to 29. The sensitive xeroradiographic plate, once exposed, is merely inserted into a "dusting" chamber, where chalky powder is sprayed against its surface. Where the electrical charge is greatest, the powder clings in greater quantity, converting an invisible electrical image into a visible picture. The image can then be erased and the plate reused, providing what is termed "blackboard" X-ray.

Because it speeds processing so that production is not delayed and because plate re-usability drastically cuts image costs, xeroradiography should be a useful advantage in the industrial inspection of products. Provision is also made for securing a paper copy of the xeroradiographic image, thus providing a permanent record.

Drill Square Holes: Employing the principle of the movement and penetration of a tool caused by ultrasonic sound waves, the square-tipped tool shown can cut holes in a glass block. Acoustica Associates, Inc., Glenwood Landing, L.I., N.Y., is the American distributor of the equipment manufactured in England by Mullard, Ltd.

Authors on Communications Wanted

The WESCON Show, Aug. 20 through 24 in San Francisco, will devote technical sessions to the systems aspect of communication. Subject areas which may be included in the communications systems sessions are: multiplexing and channelizing systems, telephone and telegraph communications, modulation techniques, military communications and data transmission systems.

Authors wishing to present papers in these subject areas should send 100 to 200 word abstracts of their papers together with the complete texts or detailed outlines to:

A. M. Seymour
WESCON Technical Program Committee
Lenkurt Electric Co.
San Carlos, Calif.

by May 1, 1957 for consideration by the Technical Program Committee. Authors will be notified of acceptance by June 1.

This year, for the first time, an IRE-WESCON Convention Record will be published. It will include every paper presented at the convention and will be distributed after the convention.

Engineering Review

RCA Campaign Congo

Word has it that natives of the Belgian Congo were duly impressed by a demonstration of RCA's latest line of radios and tape recorders. An advertising campaign was the cause of the 26,000 mile trek into the jungle, which involved journeying in native war canoes and pacifying the more belligerent segments of the population.

A pocket-sized transistor radio was especially effective in almost causing a riot at the airport in Leopoldville. The RCA safari group was mobbed by a huge crowd of natives, eagerly hunting out the tiny source of the strange sounds.

In other localities of the Dark Continent, radio music proved more soothing to the native ear. The fabled Watusi tribe, warriors reaching a height of seven feet, were particularly impressed by the 7-band Strato-World II model. White hunter Nicobar Jones said that he had "never seen a friendship with the Watusis established so quickly."

RCA reported that reception was good, performance in the high-humidity area excellent, and the sets withstood the 26,000 mile trip extremely well.

National Science Foundation Grants

The National Science Foundation has announced that 345 grants totaling $13,853,350 were awarded during the quarter ending December 31, 1956, for the support of basic research in the sciences, for conferences in support of science, for exchange of scientific information and for training of science teachers. This is the second group of awards to be made during the fiscal year of 1957. Since the beginning of the program in 1951, 3166 such awards have been made totaling almost $49,900,000. The research fields included are anthropology, astronomy, chemistry, biology, physics, earth sciences, engineering sciences, mathematical sciences and socio-physical sciences.

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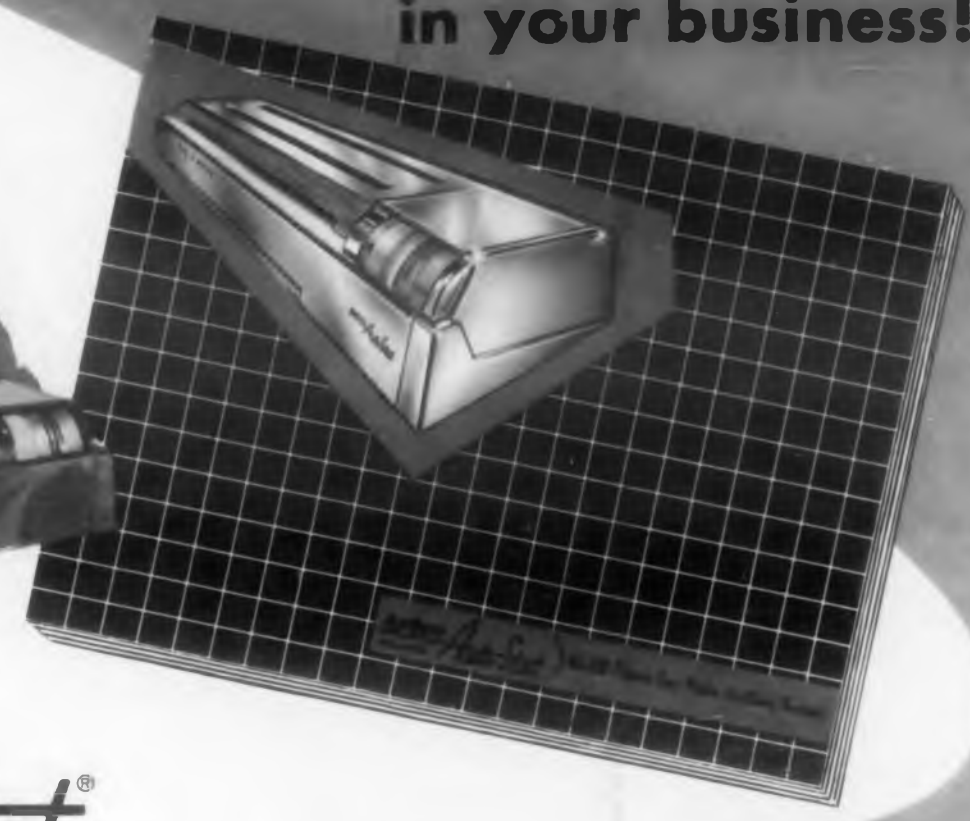

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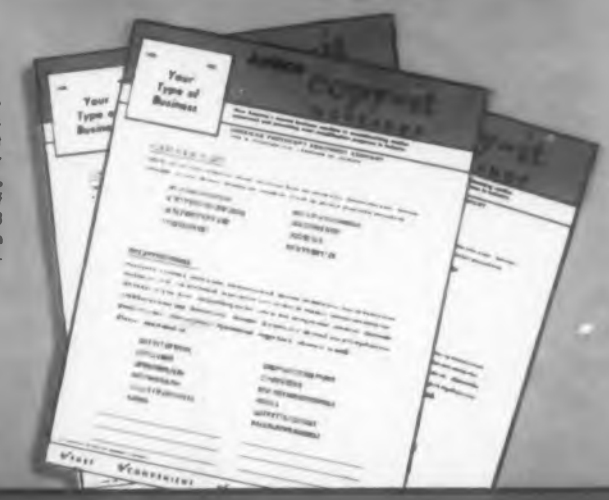

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Engineering Review

Vacuum Techniques Symposium

The Fourth Annual Symposium of High Vacuum Technology will be held in Boston, Mass., Oct. 9, 10 and 11, 1957 at the Hotel Somerset. Sponsored by the Committee on Vacuum Techniques, the meeting is expected to attract attendance by operating people, design and process engineers, and research men whose duties involve the use of high vacuum.

The Committee on Vacuum Techniques is soliciting proposals for papers to be presented at the Boston meeting. Authors with subjects dealing with methods of producing and measuring vacuum, new processes using vacuum, fundamental developments in vacuum technology, and the use of vacuum in research, are invited to contact Committee on Vacuum Techniques, P.O. Box 1282, Boston 9, Mass.

Burnout Testing of Reactors

The importance of burnout testing of reactor fuel elements in the operation of water-cooled nuclear reactors was stressed at the Second Nuclear Engineering and Science Conference. In a pressurized water-cooled reactor, the nuclear fuel elements are a highly concentrated power source and it is possible that the amount of heat released is so high that the water cannot remove the heat as fast as it is generated. This may result in failure of the fuel elements due to excessive temperatures. The condition is known as burnout, which occurs because of a change in the water heat transfer properties, changing nucleate boiling to film boiling.

The purpose of intentional burnouts to destruction or near destruction of the reactor fuel elements is to provide knowledge of the upper limits of power that can be removed from a nuclear reactor. Electricity is used because of the ease and accuracy with which it can be applied and measured.

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CIRCLE 8 ON READER-SERVICE CARD ➤

◄ CIRCLE 7 ON READER-SERVICE CARD

Engineering Review

Digital Computers "Ace" Analogs

J. M. Bridges, Director of Electronics, Office of the Assistant Secretary of Defense, recently told assembled computer manufacturers in Los Angeles that digital computers are destined to replace less reliable analog devices in complex military weapons systems of the future.

He cited seven salient points regarding the design of digital devices.

Because computers are vital to the successful operation of high-speed weapons systems, the utmost in reliability is needed in such devices. One good way to get reliability is to manufacture standard, simple modular digital units which can be combined with little or no change into complex computing systems. Interchange ability of standard modular logic units is desirable.

A trend is definitely developing toward the use of digital computers instead of analog computers as the mainstay of high-speed military weapons systems. Lightning speeds of jet interceptors and guided missiles make it necessary to compute reliably and fast.

Military agencies and the electronics industries must cooperate in standardizing modules for digital computers according to Bridges. This means that interchange of information is necessary between various design groups and industrial concerns.

Cross Fertilization Needed

Success in new digital designs depends on cooperative effort. Technical design teams should not gather together in specialized cliques. But rather there must be a free exchange between electronic weapon designers and geometric intercept people of techniques and information. One of the past troubles in the weapons system development programs, Bridges feels, has been lack of knowledge of geometry of fighting by electronic design groups. How to put a weapon at a particular point in space at a particular time, must be completely understood by the electronic designer if a good weapons system is to be made.

More systems engineering is needed to minimize analog to digital conversions necessary in weapons systems. This means, for example, that radar designers should design new radar equipment with digital output directly so that digital computing machines can take the radar information directly and operate upon it in a digital manner.

Standardize Logic

Careful emphasis is needed in basic logic elements in order to simplify and make more reliable the resulting complex maze of digital equipment. Basic, standard modules of logic equipment are mass-producible. In order to efficiently utilize the

mass production facilities in our nation, it is necessary, said Bridges, for various manufacturers to get together at a high level, early in the design stage to decide upon standard construction techniques and standard circuits.

The military, ideally, would like to have very few basic building blocks capable of being swapped around almost at will to form unlimited minor varieties of computing equipment.

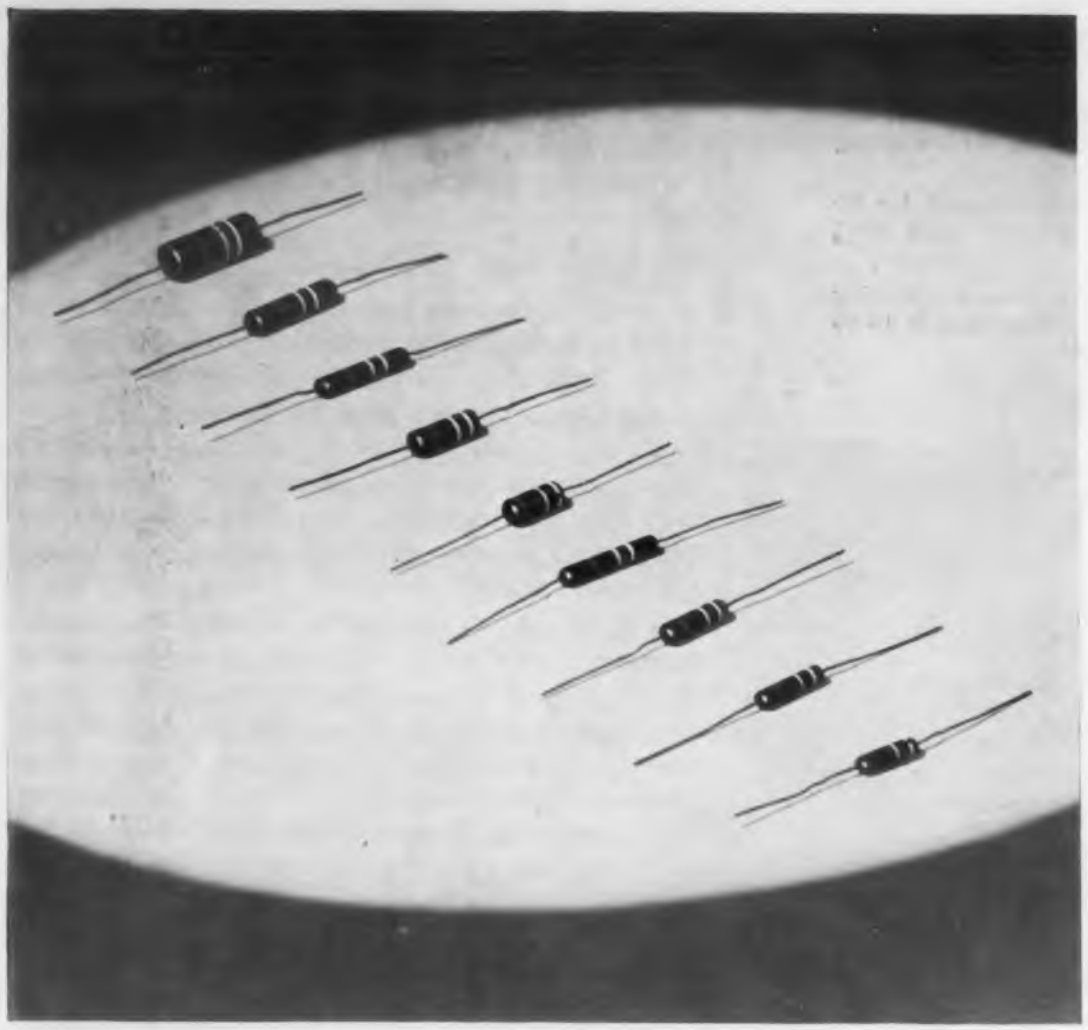
All weapons systems interception problems are basically the same. Minor changes in numbers and minor changes in mathematical operations will make a brand new computing system out of a standard building block type of computer.

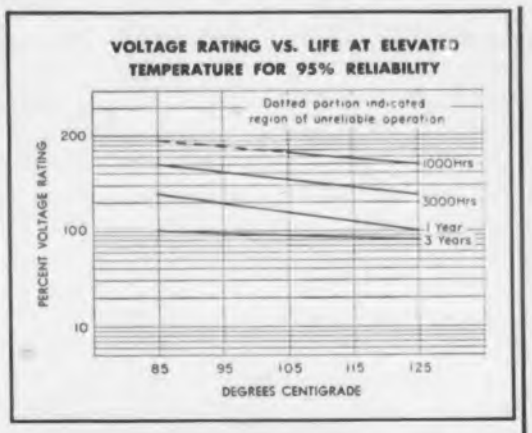
Jet Engine Noise Simulator

A simulator that can imitate the noise vibrations of a jet in flight has been developed by the Kittell-Lacy Corp. of California. Since electrical and mechanical components can be damaged by such high-level noise, it is often necessary to subject these components to the environmental abuse which they will receive when in use. Such testing on the plane itself is either extremely expensive and dangerous or entirely impossible.

The simulator is capable of producing noise ranging from a single sine wave to a combination of all frequencies or white noise. Engineered to specification, installation includes isolation of the test area by a soundproof encloseure. A typical simulator recently installed utilizes James B. Lansing loudspeakers and generates 151 db of noise, in the range between 50 and 10,000 cps, through an opening 8″ x 8″ into a free field condition.

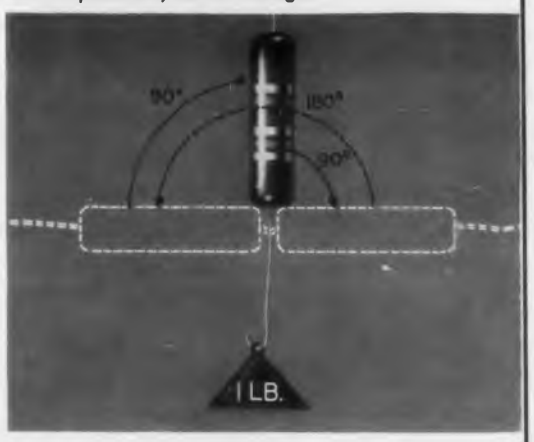
DESIGNER'S





TYPICAL PERFORMANCE CURVES for PVZ capacitors, designed for a minimum of one year's life at 125C operation, rated voltage.

TESTING TRANSISTORS in electronic equipment is one of many uses for the versatile M2 leak detector, shown in background.



HIGH LEAD BEND STRENGTH. Capacitors withstand 1-lb vertical pull test, moving unit 90°, then 180° opposite way, then back 90° to original vertical position.

New General Electric molded PVZ* paper tubular capacitors are moderately priced, operate from −55 C to +125 C

Now available for electronic designers is a new line of General Electric molded PVZ paper tubular capacitors—at moderate prices—for exacting applications in computers, missiles, telephone equipment, and other high-grade military and commercial electronic equipment.

Priced at less than half the cost of comparable metal-clad tubular capacitors, they offer characteristics similar to "K" of MIL-C-25A, and operate from −55 C to +125 C without voltage derating. They are designed for a minimum of one year's life at rated voltage and 125 C operation.

Completely solid after molding, the unit has excellent shock, vibration and moisture-resistance properties because of the high grade case material and controlled molding technique used. The paper tubular capacitor is impregnated with a high temperature organic material which is polymerized into a solid resin. The solid capacitor rolls are in a mineral-filled phenolic plastic case.

In this new line, General Electric PVZ capacitors are available in 100, 200, 300, and 400 volt ratings. Microfarad ratings are, respectively: .00047 to .15 uf at 100 V; .00047 to .1 uf at 200 V; .00047 to .068 uf at 300 V; and .00047 to .022 uf at 400 V. Capacitance ratings are available with ±20%, ±10%, and ±5% tolerances. To cover the various ratings, nine different sizes are offered, ranging from .175 inch diameter by $\frac{5}{8}$ inch long to .375 inch diameter by $1\frac{1}{16}$ inch long.

For more details, check Bulletin GET-2671.

*Trade-mark of General Electric Co.

New leak detector can spot leak rate of one cubic inch of air over 5000-year span

The ultimate in leak sensitivity is now offered by the new General Electric Mass Spectrometer Leak Detector. It can detect a leak rate of 1×10^{-10} standard cc of air per second. At this rate it would take 5000 years for a thimbleful of gas to escape.

Among the many applications for this versatile aid in locating leaks in vacuum and pressure systems—to prove equipment reliability—are the testing of transistors, Klystron tubes, hermetic sealing of components, capacitors, and TV tubes.

Designed for greater reliability and ease of maintenance, the new leak detector makes extensive use of plug-in components—minimizing downtime. For example, the complete spectrometer tube is a single unit that is easily and quickly removed for repair or replacement. All electronics are mounted on three easily removed, plug-in type chassis, according to basic functions.

Unit's simplicity of operation is such that nontechnical personnel can operate it successfully. See Bulletin GEC-336B.

GENERAL ELECTRIC

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DIGEST

GENERAL ELECTRIC COMPONENTS FOR ELECTRONIC MANUFACTURERS

Hermetically sealed germanium and silicon rectifiers now in cooling "packages."

General Electric hermetically sealed germanium and silicon rectifiers are now available in carefully engineered, "cooling packages," either air-cooled or water-cooled designs. This eliminates the need for costly, time-consuming engineering on your part, and provides more efficient rectifier operation. General Electric's 30,000 kilowatts of field experience with germanium rectifier installations brings you these two important features:

1. These assemblies are furnished with matched electrical characteristics so that paralleling reactors or multiple transformer secondaries is not required when it is necessary to operate cells in parallel.

2. Better protection against atmospheric conditions is provided by a true hermetic seal which increases cell uniformity, permits a longer life expectancy, and maintains high rectifier efficiency throughout its life.

Where size and weight requirements are particularly important, General Electric packaged germanium and silicon rectifiers have broad application in efficient, low-cost power conversion equipment. Included among their advantages over other types of metallic rectifiers are increased efficiencies—up to 95%—less heat to be dissipated; exceptionally small size and light weight per watt output, meaning smaller units; excellent voltage regulation; and no aging indicated after five years of operation.

For data on G-E germanium rectifiers, check Bulletins GEA-5773C and GEA-6375..

ACTUAL SIZE OF G-E germanium and silicon rectifier cell, hermetically sealed in ceramic housing, is shown in side view (left) and cutaway (right).

AIR-COOLED type in new "sunburst" fin design provides efficient cooling by conducting heat away from both sides of cell.

WATER-COOLED assembly is mounted on hollow bus bar which serves as conductor for both water and current, providing compact, efficient design.

TYPE ARR-2

TYPE ARR-3

Dependable starting relays eliminate need for voltage adjustments, special mounting brackets

For such applications as starting single-phase motors, particularly where adverse atmospheric conditions exist, General Electric offers two starting relays that are inexpensive, quiet in operation, and easily wired. Both are especially useful where adverse atmospheric conditions exist, or where there is a need for remote control which can be built into an explosion-proof case.

Type ARR-2 current-type accelerating relay, silver-dollar sized, is designed for more than 1,000,000 operations because there are no pivots to wear out, and sturdy plastic case encloses all moving parts. Contact pressure and action are always dependably the same—regardless of line-voltage or motor-performance variations—because contact tips are independent of solenoid plunger.

Easily mounted from any direction, relay eliminates need for special mounting brackets. Readily accessible terminals, available in push-on, screw or lead-type, speed wiring. At 115 volts, relay will make and break 15 amperes; at 230 volts, 7½ amperes. See Handbook Sheet 3286, Page 23.

Type ARR-3 voltage-type relay, requiring no customer adjustments, is accurately calibrated at the factory to pick up at a voltage predetermined by the specific application. Repetitive accuracy is high—change in calibration is less than 5% after 500,000 operations. Molded cover helps protect against dust and water. Relay mounts in any position and adapts to many mounting brackets. Terminals, including two available spares, are easily accessible. For ratings up through 5 hp, relay at 115 volts will break 50 amperes; at 230 volts, 35 amperes. See Handbook Sheet 3286, Page 29.

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- ☐ **GEA-5773C Air cooled germanium rectifiers**
- ☐ **GET-2671 Molded tubular capacitors**
- ☐ **GEC-336B Leak detector**
- ☐ **HB-3286, P. 23 ARR-2 relay**
- ☐ **HB-3286, P. 29 ARR-3 relay.**

For information on other products, contact your nearest G-E Apparatus Sales Office.

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Engineering Review

One In the Air Worth 25 on the Ground

Although missiles take one man out of the air, they depend on a full crew of men to take the place of that one man. The trouble lies mainly in the problem of information feedback from an airborne missile. Despite the present sophistication of feedback systems, they do not equal the performance of a pilot's kinesthetic "feel" of his own plane. The human being's five senses provide a running commentary on a plane's performance which at present far excels the similar attempt of electronics.

Stanley A. Hall, head of the human factors staff of the Lockheed Missile Systems Div., recently remarked on this problem to a group of Air Force physicians. Missiles, he said, present more human problems than do their manned counterparts. To remedy this, Lockheed is taking a new look at the human being as part of a functional system in order to find ways to simplify command systems and improve information feedback from a missile in flight.

Hot Box Detector

The Chesapeake and Ohio Railway is first to put in use an infra-red detector to spot overheated journal boxes on railroad cars. Detector units are located outside and parallel to the rails with infra-red lenses angled up 45 deg at the axle journals of moving railroad cars. The equipment records on tape the temperature of every journal box regardless of the train's speed. When a detector finds a journal box above a certain temperature, it flashes a warning to a signal mechanism and the train is stopped. The equipment also notes the location of the car and the defective journal.

The detector, developed by the Servo Corp. of America, N.Y., contains an infra-red pyrometer with a lens aimed at the passing journal. A magnetic gate opens and closes a shutter that protects the lens and keeps it clean. This gating unit requires no external power source since the wheel flange passing over it gen-

CIRCLE 12 ON READER-SERVICE CARD ➤

Winner of the first power transistor IPS contract awarded by the Signal Corps, Clevite Transistor Products developed the only military-approved power transistor. In the commercial field, its power transistors are approved for the new radios used in nine out of ten makes of 1957 automobiles. Clevite's high-back resistance and fast recovery time glass diodes have won great favor in the computer industry. A new Remington-Rand Univac Computer, for example, utilizes approximately 60,000. Clevite is also the largest single supplier of germanium diodes to the television industry.

Originally a producer of varied types of semiconductors, Clevite Transistor Products now concentrates research and development on a select line of transistors and diodes. The 50 members of the engineering staff — part of an employee group of almost 500 — are concentrating their efforts on the product improvement and quality control of power transistors and high-quality diodes for the more critical applications. Their work is supported by the scientists and engineers of both Clevite Research Center in Cleveland and the German subsidiary Intermetall G.m.b.H. of Dusseldorf, Europe's second largest manufacturer of semiconductors.

Extreme crystal uniformity — the key to high quality semiconductors — has been achieved by the development of a continuous vertical crystal puller in Clevite's Waltham metallurgical laboratories. Quality control is further advanced by a device that simplifies the measurement of thermal resistance in power transistors.

Single crystals of silicon, grown at Clevite Transistor Products Metallurgical Laboratory, demonstrate the unusual uniformity made possible by Clevite's crystal pulling technique.

Automated production of diodes now underway is another indication of Clevite's ability to control quality level and achieve high volume rates. Clevite is itself a large producer of silicon and germanium crystals — a basic advantage in meeting exceptional volume requirements.

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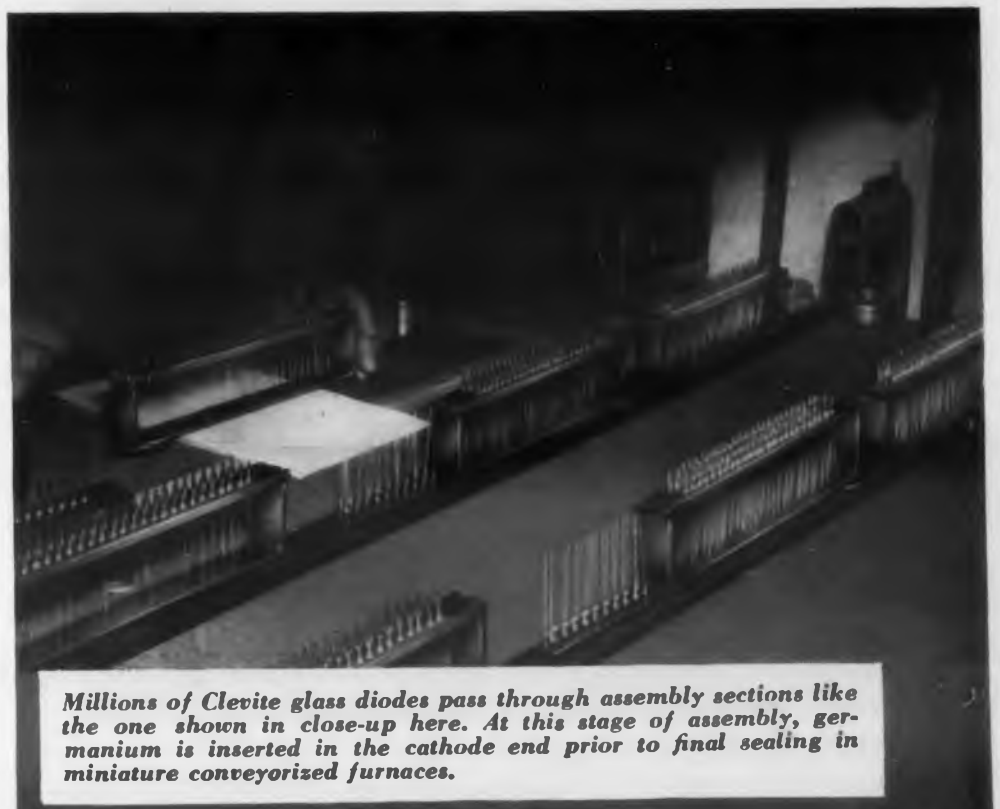
Crystal structures are double-checked in Clevite's Materials and Metallurgy Laboratory by X-Ray and Double Crystal Spectrometer to match crystal quality to specific application requirements.

Thermal resistance measurement equipment, another Clevite development, is used to check temperature drop between the junction and mounting base of power transistors under actual operating conditions. It's one of many specialized testing procedures to control quality and improve performance.



Millions of Clevite glass diodes pass through assembly sections like the one shown in close-up here. At this stage of assembly, germanium is inserted in the cathode end prior to final sealing in miniature conveyorized furnaces.

erates a voltage pulse that operates the shutter. The gating unit is located so the amplifier operates only when the journal is viewed by the detector. Because of this, heat from other sources, such as hot brake shoes, wheel rims and steam lines, does not affect the detector.

Communication System in Asia

The lack of effective communication within the general region of Thailand, Vietnam and Laos has long been a handicap to trade and economic development in this section of Asia. To help this situation, 25 or more engineers from Hycon-Page of Cambridge, Mass., are embarking for Southeast Asia to study the situation. Their purpose will be to draw up complete plans, designs and specifications for a telecommunications network to meet commercial, governmental and military needs.

The cost of the project is estimated at $1,852,000 and is made possible from the President's Fund for Asian Economic Development. This is a $100 million fund available to assist development projects benefiting two or more countries in Asia.

British Know-How Sold to France

One of Britain's leading Geiger counter and electronic tube manufacturers—20th Century Electronics Ltd.—has signed a new 5-year agreement with an important French company, Compagnie Generale de Telegraphie Sans Fil.

Under the agreement the French organization will use 20th Century's designs and patents. Provision is made in the agreement for the training of French engineers and the exchange of know-how.

Over the past seven years 20th Century has signed similar license agreements with the Netherlands, Belgium, Germany, Switzerland and France which have resulted in considerable revenue for the country. Prime interest of the firms who buy these licenses is to make Geiger tubes and multigun cathode ray tubes.

◄ CIRCLE 12 ON READER-SERVICE CARD

Mainly Kudos

Dear Sir:

I would like to get another copy of the Nov. 15 issue. This issue contained several design articles which I wanted to keep for my file. Unfortunately someone else liked the articles so much that they borrowed my copy and neglected to return it.

I would also like to congratulate you on the production of a magazine which contains more design information and better abstracts than any other publication in the field.

You are helping to alleviate the engineer shortage by making it possible for engineers to keep abreast of the latest product developments with the least expenditure of time and effort.

Donald L. Ort
Airborne Computer Department
Litton Industries

Dear Sir:

Reference is made to the (Russian) abstract of the article "Use of Reactance-Tube to Control Frequency of Vacuum-Tube Oscillators" by G. A. Levin and Z. P. Zozhenina, which appears on page 133 of the February 15th issue of ELECTRONIC DESIGN.

This article deals with a fundamental problem in the design of FM (or AM) receivers incorporating Automatic Frequency Control. For this reason, I urge you to publish a translation of the complete article. If this is not possible, can you tell me where such a translation may be obtained.

I would like to take this opportunity to commend you for the excellent job ELECTRONIC DESIGN is doing. I now consider it the most valuable of the publications that I receive.

Eugene H. Kopp
Chief Engineer
Radio Craftsmen, Inc.
Los Angeles, Calif.

▶ Both Mr. Ort's and Mr. Kopp's kind remarks about ELECTRONIC DESIGN came in one Monday's mail. It helps to puff out our chests occasionally.

Letters to the Editor

We do not have *complete* Russian translations available. However, they can be obtained from several sources at a reasonable fee. We have sent Mr. Kopp a list of such sources. Anyone else interested may obtain the list by writing the Editors.

Seeks Special Designs

Dear Sir:

Perhaps you can help me in locating a manufacturer of a DPDT push button switch with a holding coil to keep the button depressed.

I would like to locate, also, a push to turn, snap back out and lock when released, locking device for potentiometer dials.

Please put me on your subscription list for your design magazine. Thank you.

E. L. Shaver, Design Engr.
Ordnance Department
Westinghouse Electric Corp.

▶ We offered Mr. Shaver a suggestion or two that came to mind. However, we are naturally not set up to do a consulting job on such matters. Some of our readers may be able to offer him some suggestions.

Training

Dear Sir:

Thanks for the clipping *(ED Nov. 15, p. 16)* that you sent me . . . The first and third sentence of this represent an accurate report of my comments. The middle sentence deals with a matter that was not even referred to in my talk, and is an invention of someone else. I rather object to the fact that this alien idea is injected in a way that implies I recommended the elimination of the summer vacation, and a 50-week program of study. Experience in the war training programs indicated that intensive study to this extent did not produce a good educational result.

F. E. Terman
Stanford University

▶ We are sorry that our source was inaccurate.

Washington Report

Herbert H. Rosen

RETMA Manpower Report

A survey of the industry's programs in manpower utilization was conducted by RETMA's Industrial Relations Department and Bill Reynolds of the RETMA staff. It has been in the making since last May, and was started at the request of the Assistant Secretary of Defense for Supply and Logistics. A preview of the report was given several weeks ago at its fourth annual conference in Mississippi. At that time, a recitation of industry activities left a tremendous impression on Rep. James C. Davis (D-Ga). He heads up a house subcommittee looking into the manpower problem.

The report also had made an impression on its recipient, Albert Kay, DOD Director of Manpower Supply. Kay told the Board that copies would be distributed to people in the Defense Department and to the President's committees set up also to look into the problem.

But what does the report show? For one, roughly 25 per cent of RETMA members responded to the survey. However, according to those who prepared the report, this represents about 60 per cent of the total number of people in the industry.

Generally, RETMA sought information on three broad classifications: training programs, aid to education, and encouragement of the young to enter engineering and scientific careers. In all, some 21 different manpower practices were disclosed.

The most used practice was the summer employment of students and teachers (68 out of 92). Next was the sponsorship of after-hours, out-of-plant degree training (59 out of 92). The least used practices were summer workshops for teachers and creation of youth science clubs.

In between the most and least practices were the following:

- In-plant training for upgrading.
- Undergraduate and graduate co-ops.
- Donation of exhibit and display materials.
- Staff joining of local community groups.
- Donation of equipment to schools.
- Open houses for community.
- Science encouragement for employees' children.
- Lectures and films for youths.
- Speakers bureau.
- After-hours nondegree training.
- Scholarships.
- Endowments.

Meetings

April 15-17: Symposium on Systems for Information Retrieval

Western Reserve University, Cleveland, Ohio. Sponsored by the School of Library Science of Western Reserve University in conjunction with its center for Documentation and Communication Research. This will be a comprehensive demonstration of systems presently in use for the organization, storage and retrieval of recorded information, together with a symposium on information-handling problems and techniques. Further information may be obtained from Jesse H. Shera, Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

April 16-18: Symposium on Nondestructive Tests Developed in the Field of Nuclear Energy

Morrison Hotel, Chicago, Ill. Sponsored by American Institute of Chemical Engineers, American Nuclear Society, American Society for Testing Materials, and Society for Nondestructive Testing. Information resulting from 15 years research and development in testing applications in the nuclear field will be presented. Papers will be in three categories: reactor materials, completed fuel assemblies, and miscellaneous. For information, write to American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

April 23-25: International Symposium on the Role of Solid State Phenomena in Electrical Circuits

Auditorium of the Engineering Societies Building, New York, N.Y. Sessions will be on basic processes and techniques, semiconductor properties and techniques, magnetic properties, photo-techniques, and a round-table discussion. The discussion topic is: "To What Extent Will the Challenging Needs of the Circuit Designer be Met by New and Unexploited Developments in the Solid State Art?" For information write to the Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N.Y.

April 24-26: Seventh Region IRE Conference

San Diego, Calif. Theme of the meeting is "Electronics in Space." Sessions will be held on electronic aids to air navigation, audio, management, uses of computers, antennas and propagation, nuclear activiation and damage of electronic equipment, electronic devices, electron tubes, microwave, instrumentation, telemetering, data handling and automation, magnetic components, and radio astronomy. For information, write to IRE Seventh Region Conference, U. S. Grant Hotel, San Diego, Calif.

Meetings

April 25-26: Annual Technical Meeting of the Institute of Environmental Engineers

LaSalle Hotel, Chicago, Ill. For information contact the President of EEI, Henry F. Sander, Vapor Hearing Corp., 6420 W. Howard St., Chicago, Ill.

May 1-3: Electronic Components Conference

Hotel Morrison, Chicago, Ill. Sponsored by the AIEE, IRE, RETMA and WCEMA. Papers to be given on high temperature components, radiation effects, component reliability, passive components, active components, instrumentation and measurements, materials development and general component needs. For information write to J. S. Powers, Electronic Components Symposium, 84 E. Randolph St., Chicago 1, Ill.

May 3: Fourth Annual Conference for Engineers and Architects

Ohio State University campus. Sponsored by the College of Engineering.

May 9-10: Symposium on Microwave Ferrites and Related Devices and Applications

Western Union Auditorium, New York City. Program will have reports on advances in microwave ferrite devices and their applications, non-reciprocal propagation in gas media, and microwave solid state devices. There will be two sessions of contributed papers and a round table discussion on design limitations of microwave ferrite devices, high power effects, low frequency limits, high frequency limits, anomalous propagation in ferrite loaded waveguides, below saturation behavior of ferrites, "fast" ferrite devices (depending upon relaxation time), bandwidth problems and material losses. Award for the best paper appearing in the Transations of PGMTT will be given. For information write Samuel Weisbaum, Bell Telephone Labs, Murray Hill, N.J.

May 13-15: National Aero and Navigational Electronics Conference

Dayton, Ohio. Sponsored by Professional Group Aeronautical and Navigational Electronics, Dayton Section. For more information, write John E. Wilkinson, 410 W. First St., Dayton 2, Ohio.

May 13-16: Fifth Annual Semiconductor Symposium of the Electrochemical Society

Statler Hotel, New York City. For more information, write the Electrochemical Society, 216 W. 102, New York, N.Y.

May 16-18: Eighth Annual Conference and Convention, American Institute of Industrial Engineers

New York City, Hotel Statler. For information write to AIIE, P.O. Box 8, Substation 135, The Bronx 53, New York.

June 6-7: First National Symposium on Production Techniques

Hotel Willard, Washington, D. C. Sponsored by the IRE Professional Group on Production Techniques. Discussions will be held on "How to Prepare For and Implement Automation "and "Military Problems in Electronic Automation." Papers will be presented on "Designs for Production." For information, write to IRE, 1 E. 79th St., New York 21, N.Y.

June 10-11: Second RETMA Symposium on Applied Reliability

Syracuse, N.Y., Hotel Syracuse. Symposium emphasizes the practical aspects of achieving reliability. Sessions will be held on mechanical design, selection and use of components, proof of mature design and case histories of reliable and unreliable designs. A panel discussion is planned on industry vs. military responsibility on contract and specification control for reliability. Advance registrations will be handled by the RETMA Engineering Office, Rm. 650, 11 W. 42nd St., New York 36, N.Y.

June 10-14: Fifth Annual Technical Writers' Institute

Rensselaer Polytechnic Institute, Troy, N.Y. Designed for those who supervise technical writing in business, industry and the professions. Sessions on manuals and instruction books, reports, technical promotion, training programs, industrial films and graphic and illustrative aids. For additional information, write Jay R. Gould, Director, Technical Writers' Institute, Rensselaer Polytechnic Institute, Troy, N.Y.

Paper deadlines

May 1: Deadline for papers submitted for the Wescon convention August 20-23 in San Francisco. Send 100-200 word abstracts, together with complete texts or additional detailed summaries, to D. A. Watkins, Technical Program Chairman, Stanford Electronics Laboratories, Stanford University, Stanford, Calif. Authors will be notified of acceptance by June 1.

May 1: Deadline for papers submitted for the April, 1958 convention of the American Society of Tool Engineers. ASTE membership is not required. Each proposal should include an outline of the paper, the author's name, his title and affiliation. Send outlines to L. S. Fletcher, Program Director, American Society of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.

Aug. 1: Deadline for papers proposed for the Oct. 31-Nov. 1 conference of the **Professional Group on Electronic Devices, IRE,** in Washington, D.C. Abstracts should be submitted to the program chairman, W. M. Webster, RCA Semiconductor Div., Somerville, N.J. Subject matter should concern developmental techniques and devices, such as electron tubes and transistors, rather than basic research or circuit applications.

Design Procedures for Semiconductor Regulated Power Supplies

S. Sherr, P. Levy and T. Kwap
General Precision Laboratory Inc.
Pleasantville, N.Y.

IN A previous article,* a number of circuits for all semiconductor power supplies were presented, along with analytic expressions which defined their operation. This article describes design procedures for these circuits, shows several practical circuits designed according to these procedures, and compares calculated and measured performance data on circuits. A heat sink design procedure is included to complete the design.

To simplify the problem, we initially define the design equations for all circuits in terms of three regulation factors, as follows:

$$K_i = \frac{\frac{dE_o}{E_o}}{\frac{dE_i}{E_i}} \tag{1}$$

$$K_L = \frac{\frac{dE_o}{E_o}}{\frac{dR_L}{R_L}} \tag{2}$$

$$K_r = \frac{dE_o}{dE_i} \tag{3}$$

These factors are respectively, the regulation against input voltage variation, the regulation against load variation, and the ripple reduction factor. By means of these three factors we shall describe the operation of the circuits and establish the appropriate figures of merit for determining performance.

Design Procedure for Complementary Transistor Circuit

The basic circuit is shown in Fig. 1. The regulation factors are:

$$K_i = \frac{1}{1 + \beta_1 \frac{E_r}{E_i} \frac{r_{c1}\,(1-\alpha_1)}{R_b}} \tag{4}$$

$$K_L = \frac{1}{1 + \beta_1\,\beta_2 \frac{R_L}{R_b}} \tag{5}$$

$$K_r = K_i \frac{E_o}{E_i} \tag{6}$$

We will now go through the design, based on these equations, of a regulated power supply, which will illustrate the procedures to be followed. We will then present some specific data on the operation of a supply which has been built and tested, and which establishes the validity of the design equations.

Referring to Fig. 1, it is first necessary to select a transistor type for β_2 (β_n designates both the n^{th} transistor and the grounded emitter current gain of this transistor). This selection is determined by the voltage and current requirements for the supply, and will usually limit the choice to only a few types. Once β_2 has been chosen we note that the collector voltages, V_{cb} for transistors β_1 and β_2 are approximately the same. It is desirable to keep this voltage at a minimum, since it contributes heavily to the dissipation requirements of both transistors. This consideration will assist in the ultimate choice of the transistor for β_1. The design now proceeds as follows:

1. Select V_{cb1} and assume V_{be1} at values compatible with the characteristics of transistors likely to be used in this function. Then $V_{cb2} = V_{ec1} = V_{eb1} + V_{bc1}$.

2. Using the appropriate common base characteristics as shown, find the intersection of the V_{cb} and I_c lines at the calculated value of V_{cb2}, and the desired value of I_{c2}. V_{eb2} is specified by this point, and $V_{cc2} = V_{eb2} + V_{be2}$.

3. Using the appropriate common emitter characteristics as shown, find the intersection of the desired value of I_{c2} and the calculated value of V_{ce2}. This point defines the base current, I_{b2} for β_1.

4. The operating point for β_1 is now determined, since $I_{c1} = I_{b2}$, and a transistor may be selected for β_1. Germanium is preferable because it will operate successfully at a low value of V_{cc}, and thus minimize the dissipation requirements.

5. The reference voltage is $E_r = E_o + V_{be1}$ and the input voltage is $E_i = E_o + V_{ec2}$.

6. The peak input ripple must be less than $E_i - E_r$ to avoid cutting off β_2.

The design is now complete, and the regulation factors may be calculated to determine whether the specification requirements are met. A power supply designed according to this procedure, and rated at $E_o = 6.3$ v and $I_L = 2$ amp is shown in Fig. 2. The measured and calculated performance is shown in Table 1 and exhibits good correspondence between the two sets of values. The calculations were based on assuming $\beta_1 = 20$, $\beta_2 = 5$, $r_{c1}\,(1-\alpha) = 5000$ ohms, and $R_L = 3.3$ ohms. Since R_b consists of the total resistance seen by E_r, both external and internal to the transistor, if we let the external resistance go to zero, as is the case here, then $R_b \approx r_b + \beta_{re} = 300$ ohms, which establishes the last value needed for the calculation. A noteworthy feature of this supply is the regulator efficiency of greater than 50% which is unusually high for a supply at this voltage and current level, and makes regulated d-c filament supplies feasible in equipment design.

A circuit for improving the load regulation is shown in Fig. 3. The load regulation factor is

$$K_L = \frac{1}{1 + \frac{\beta_1\,\beta_2\,\beta_3\,R_L}{R_b}} \tag{7}$$

Therefore the load regulation is improved by the factor β_3, but there is no change in the other regula-

*"Design Considerations for Semiconductor-Regulated Power Supplies"—S. Sherr, P. M. Levy, Electronic Design, Vol. 4, No. 14, July 15, 1956.

tion factors. This circuit is a simple extension of the previous circuit, and may be designed by a straightforward application of the same design procedure, if improved load regulation is required. These supplies may be designed over a wide voltage and current range using either the circuits as shown, or the complementary connection, where the npn is the series, and pnp is the shunt transistor.

Series Voltage Regulator (Similar Transistors)

Under certain conditions it may be necessary to use only npn or pnp transistors. For this purpose, the circuit of Fig. 4 may be employed. This circuit will also provide a voltage regulated supply capable of regulation against load and input voltage variations comparable to the complementary circuit. The regulation factors are:

$$K_i = \frac{1}{1 + \dfrac{\beta_1 E_r R_c}{E_i R_b}} \tag{8}$$

$$K_L = \frac{1}{1 + \dfrac{\beta_2 R_L}{R_c} + \dfrac{\beta_1 \beta_2 R_L}{R_b}} \tag{9}$$

$$K_r = K_i \frac{E_o}{E_i}$$

The procedure for the design of this circuit is somewhat different than the preceding one:

1. $E_r \approx E_o$ and $V_{be2} \approx V_{ce1}$. $R_b \approx r_{c1} + \beta_1 r_{b1}$.
2. $I_{c1}\,\text{max} = \dfrac{P_r\,\text{max}}{E_o}$,

where P_r is the maximum allowable dissipation in the reference diode. This establishes several of the parameters for β_1 and simplifies the choice of this transistor.

3. $E_i = E_o + V_{ce2}$ which determines the minimum input voltage. V_{ce2} is determined by the minimum voltage at which β_2 will operate at the required current.
4. $R_c = \dfrac{E_i - E_o}{I_c}$, where $I_c = I_{c1}$ max.
5. The other parameters for β_1 may be calculated by solving the equations for K_i and K_L for β_1 and R_{b1}. This gives:

$$\frac{\beta_1}{R_{b1}} \geq \frac{E_1}{E_r} \cdot \frac{1 - K_i}{R_c K_1} \tag{10}$$

$$\frac{\beta_1}{R_{b1}} \geq \frac{1 - K_L\left(1 + \beta_2 \dfrac{R_L}{R_c}\right)}{\beta_2 R_L K_L} \tag{11}$$

Table I Series Voltage Regulator (Complementary Transistors)

Regulation Against Load

$\frac{\Delta R_L}{R_L}$	$\frac{\Delta E_o}{E_o}$ E_{rb}	$\frac{\Delta E_o}{E_o}$ E_{rz}	K_{Lb}	K_{Lz}	K_L cal
−0.1	8.4×10^{-3}	1.8×10^{-2}	8.4×10^{-2}	1.8×10^{-1}	4.7×10^{-1}

E_{rb} = Battery reference
E_{rz} = Diode reference
K_{Lb} = Load regulation — Battery reference
K_{Lz} = Load regulation — Diode reference

Regulation Against Input Voltage

$\frac{\Delta E_i}{E_i}$	$\frac{\Delta E_o}{E_o}$ E_{rb}	$\frac{\Delta E_o}{E_o}$ E_{rz}	K_{ib}	K_{iz}	K_i cal
+0.1	8.3×10^{-4}	1.6×10^{-3}	8.3×10^{-3}	1.6×10^{-2}	5.3×10^{-3}
−0.1	8.3×10^{-4}	3.2×10^{-3}	8.3×10^{-3}	3.2×10^{-2}	5.3×10^{-3}

K_{ib} = Input regulation — Battery reference
K_{iz} = Input regulation — Diode reference

Ripple Reduction

E_i rms	E_o rms E_{rb}	E_o rms E_{rz}	K_{rb}	K_{rz}	K_r cal
280 mv	2.1 mv	7 mv	7.5×10^{-3}	2.5×10^{-2}	2.8×10^{-3}

K_{rb} = Ripple factor, Battery reference
K_{rz} = Ripple factor, Diode reference

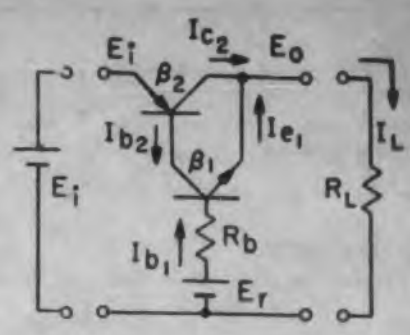


Fig. 1: Series voltage regulator (complementary transistors).

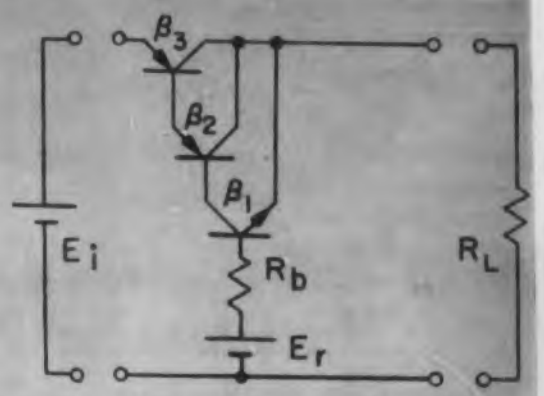


Fig. 3: Series voltage regulator (ascade).

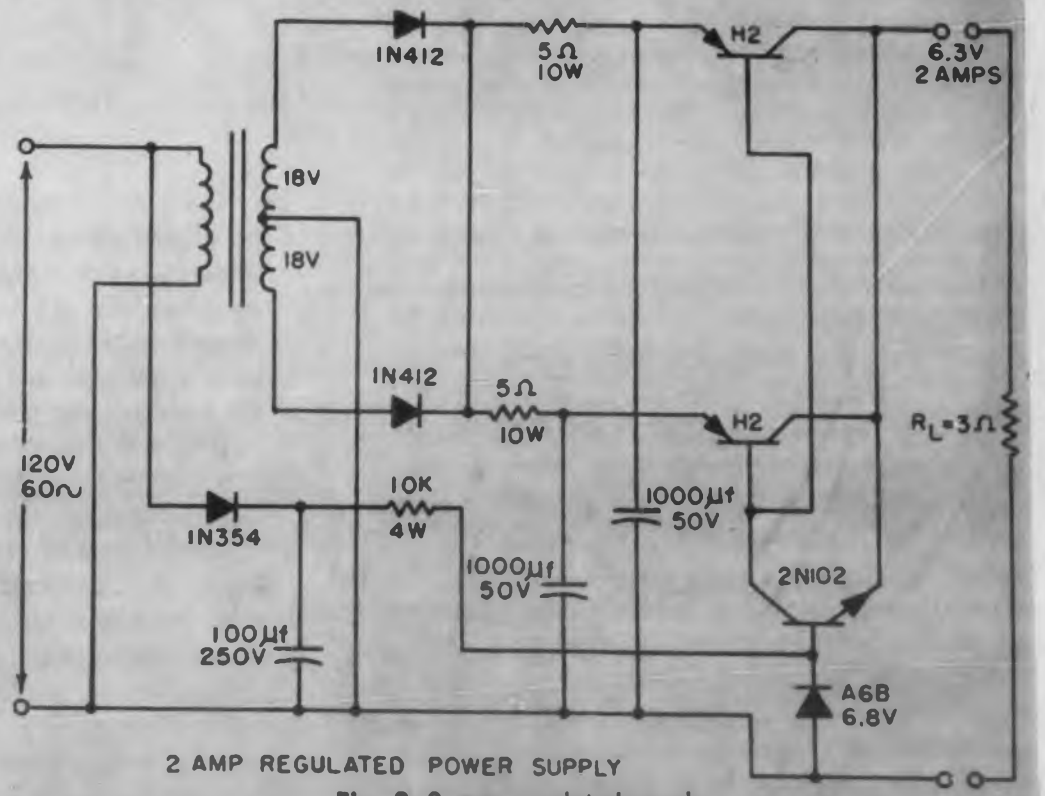


Fig. 2: 2 amp regulated supply.

Table II Series Regulator (Similar Transistors)

Regulation Against Load

$\frac{\Delta R_L}{R_L}$	$\frac{\Delta E_o}{E_o}$ E_{rb}	$\frac{\Delta E_o}{E_o}$ E_{rb}	K_{Lb}	K_{Lz}	K_L cal
+0.1	2×10^{-5}	4.5×10^{-3}	2×10^{-4}	4.5×10^{-3}	6.67×10^{-4}
−0.1	11×10^{-5}	5×10^{-3}	11×10^{-4}	5×10^{-3}	6.67×10^{-4}

Regulation Against Input Voltage

$\frac{\Delta E_i}{E_i}$	$\frac{\Delta E_o}{E_o}$ E_{rb}	$\frac{\Delta E_o}{E_o}$ E_{rz}	K_{ib}	K_{iz}	K_i cal
+0.1	7.8×10^{-4}	1.5×10^{-2}	7.8×10^{-3}	1.5×10^{-2}	5×10^{-3}
−0.1	15.6×10^{-4}	2.7×10^{-2}	15.6×10^{-3}	2.7×10^{-2}	5×10^{-3}

Ripple Reduction

E_i rms	E_o rms with E_{rb}	E_o rms with E_{rz}	K_{rb}	K_{rz}	K_r cal
140 mv	1.0 mv	10 mv	7.1×10^{-3}	7.1×10^{-2}	3.75×10^{-3}

Variation With Temperature

Temp. °C	E_o with E_{BR}	E_o with E_{ER}
30	45.719	45.25
40	45.69	46.1
50	45.67	46.55
60	45.649	46.92
70	45.621	47.5
80	45.598	47.9
90	45.57	48.1
100	45.54	48.25

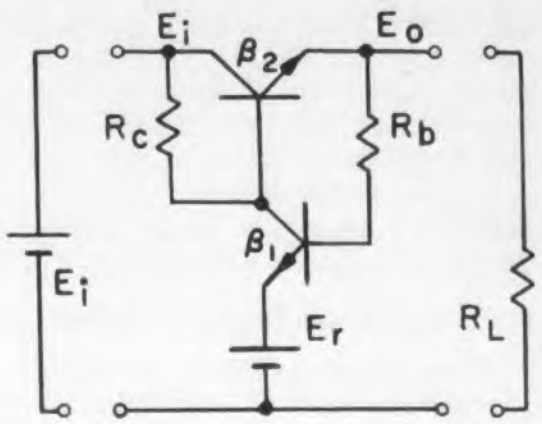


Fig. 4. Series voltage regulator (similar transistors).

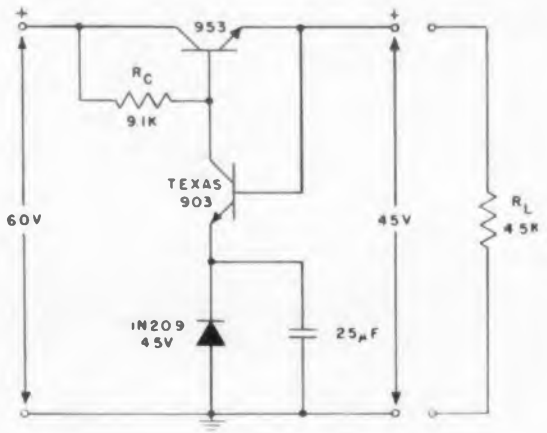


Fig. 5: Complete series voltage regulator (similar transistors) power supply circuit.

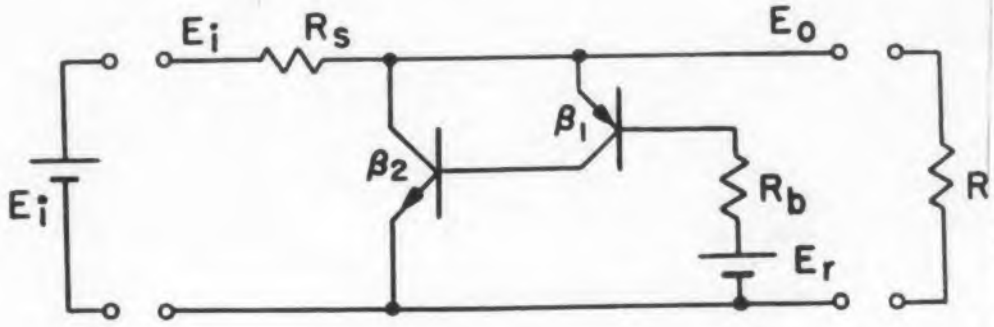


Fig. 7: Shunt cascade voltage regulator (complementary transistors).

Two values of $\frac{\beta_1}{R_{b1}}$ will usually result, and the larger of the two is the controlling one in selecting a transistor type for β_1.

6. Finally the maximum input ripple is calculated from $E_{ir} = \frac{E_{or}}{K_r}$ where E_{ir} and E_{or} are the input and output ripple respectively.

The complete circuit of a power supply designed according to this procedure is shown in Fig. 5. This supply is rated at $E_o = 45$ v and $I_L = 10$ ma. The calculated and measured performance characteristics are shown in Table 2 and again exhibit good correspondence. The entire power supply, exclusive of transformer was packaged on a 2 x 2 in. card. Special mention should be made of the high efficiencies attainable in this circuit with 75 percent not at all unusual. The load regulation of this circuit may also be improved by the addition of a cascaded transistor stage as in the complementary supply. The circuit and equation will not be presented since they are of the same form as above. These circuits can be designed over a voltage and current range similar to that for the previous circuits.

Shunt Voltage Regulator

A third type of circuit is the shunt regulator shown in Fig. 6. This circuit has the advantage of requiring only one transistor to obtain both input voltage and load variation regulation. The applicable factors are:

$$K_i = \frac{1}{1 + \frac{\beta E_r R_s}{E_i R_b}} \tag{12}$$

$$K_L = \frac{1}{1 + \frac{R_L}{R_s} + \frac{\beta R_L}{R_b}} \tag{13}$$

$$K_r = K_i \frac{E_o}{E_i}$$

If a second transistor is cascaded as in Fig. 7, the regulation factors become:

$$K_i = \frac{1}{1 + \frac{\beta_1 \beta_2 E_r R_s}{E_i R_b}} \tag{14}$$

$$K_L = \frac{1}{1 + \frac{\beta_1 \beta_2 R_L}{R_b} + \frac{R_L}{R_s}} \tag{15}$$

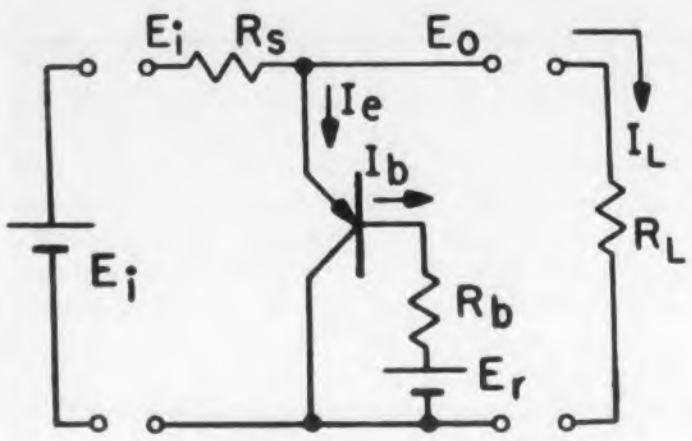


Fig. 6: Shunt voltage regulator.

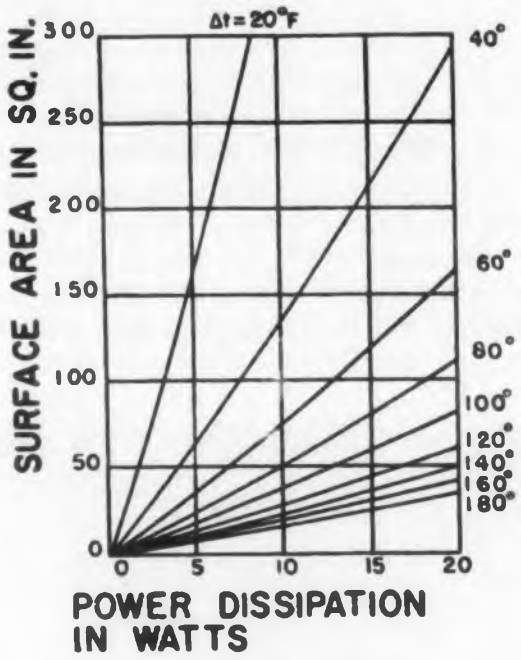


Fig. 8: Graph for heat sink design.

$$K_r = K_i \frac{E_o}{E_i}$$

thus contributing to the improvement of each factor.

Design of Shunt Voltage Regulator

The design procedure for this circuit will be outlined, and though no measured data is available, calculations have been made which indicate the relative advantages of this versus the other circuits. The procedure follows:

1. The current in the transistor must be at least equal to the load current variation expected. Therefore $I_c \geq \Delta I_L$. Similarly, E_o must not exceed the maximum rating for the transistor that is $V_{Ec\ max} \geq E_o$.

2. if K_r is known, then R_s may be directly calculated from:

$$R_s = \frac{1 - K_r}{\frac{K_r}{R_L} + \frac{\beta K_r}{R_b}} \tag{16}$$

Otherwise R_s and E_i must be found by solving the equations for K_r and either K_i or K_L simultaneously.

3. $E_s = E_o + (I_L + I_E)\, R_s$, and $E_r \approx E_o$.

Heat Sink Design

As an example of heat sink design let us employ the case of the heat sink designed for the 6 v 2 amp supply described above. The basic equation is:

$$T_j = T_a + P \sum_{i=1}^{n} R_{ti} \tag{17}$$

where T_j = Transistor junction temperature
T_u = Ambient Temperature
P = Power to be dissipated
$R_{ti} = i^{th}$ thermal resistance in the heat flow circuit
Δt, (See Fig. 8) can be found by rewriting Eq. 17 as:

$$T_j = T_u + P \sum_{i=1}^{n} R_{ti} + \Delta t \tag{18}$$

where $\Delta t = PR_{tn}$.

For the present design, the values of parameter are:
$P = 4$ w
$T_i = 200$ F
$T_a = 140$ F
R_{t1} = Thermal resistance between transistor junction and case $= 6.5°$ F/w
R_{t2} = Thermal resistance between transistor case and mica insulator
R_{t3} = Thermal resistance between mica insulator and heat sink
$R_{t2} + R_{t3} = 2°$ F/w for a 2 mil mica washer
then $200 = 140 + 4\ \ (6.5 + 2 + R_{t4})$
$R_{t4} = 6{:}5°$ F/w and
$\Delta t = R_{t4} \times P = 26$ F

Referring to the graph of Fig. 8, we find that the dissipator area required is 80 square inches or an aluminum area of 40 square inches, since both sides are useful in converting heat.

The various power supplies described above should meet most of the needs raised by the increasing utilization of transistors as well as certain needs which existed but could not be previously satisfied. The design information and procedures necessary to design all of these supplies to specifications have been provided, and should enable the engineer to develop the supplies required to power the transistorized and other equipments which can benefit from these designs. The advantages of small size and weight, high efficiency, low power, and high reliability which are characteristic of transistors are retained in these circuits, with not significant degradation in performance over vacuum tube circuits. The applications are many and the results should be most satisfactory.

A Review of Modulators and Their Requirements

M. H. Zinn
Signal Corps Engineering Laboratories

THE PROBLEMS faced by the equipment engineer who is designing a modulator can be generally divided into three groups of factors—operational, performance, and packaging. The operational factors, or circuit requirements, usually provide a sufficiently severe limitation to dictate the choice of modulator device. This article will review these factors and their relationship to the circuit and to discuss the advantages and limitations of various modulators.

For comparative purposes, let us divide the field of modulator devices into three broad classes: hard-tube modulators, line-type modulators, and passive-element or magnetic-amplifier modulators.

Hard-Tube Modulators. This class covers both high-vacuum pulse amplifiers and self-switching RF tubes. Examples of the latter are grid-pulsed triodes and tetrodes, injection magnetrons, and pulse klystrons. With respect to the switching function alone, the operating and performance characteristics of pulse amplifiers and self-switching generators are similar.

Line-Type Modulators. These are low-impedance switches, used to connect a charged transmission line to a load. The switching device may be a thyratron, an ignitron or pool cathode tube, a cold cathode discharge tube, or a spark device. The gas tubes may use hydrogen, mercury vapor, or inert gases; the ignitron or pool cathode tubes may use simple pools or sponge pools, containing mercury or another low-melting metal. Other variations are, of course, possible.

Passive Modulators. These devices are usually of the inductive type, taking advantage of the large changes in inductance which can be obtained with saturable reactors. In one form of this device, power is delivered to the load from a conventional a-c generator by a progressive decrease in the time duration of energy flow from condenser to condenser along a line. This particular device does not require the use of electron tubes. Hybrid modulators, incorporating tubes may also be employed.

None of these types of device is essentially superior to any other type for every application. For any particular job, one or another may be most suited, depending upon the precise operational factors involved.

Operational Factors and Circuit Requirements of Modulators

Peak Applied Voltage. All pulse modulator devices must be capable of holding off a voltage and the energy corresponding to this voltage until the precise instant at which it is desired to use the energy. The maximum levels which have been used to date in both

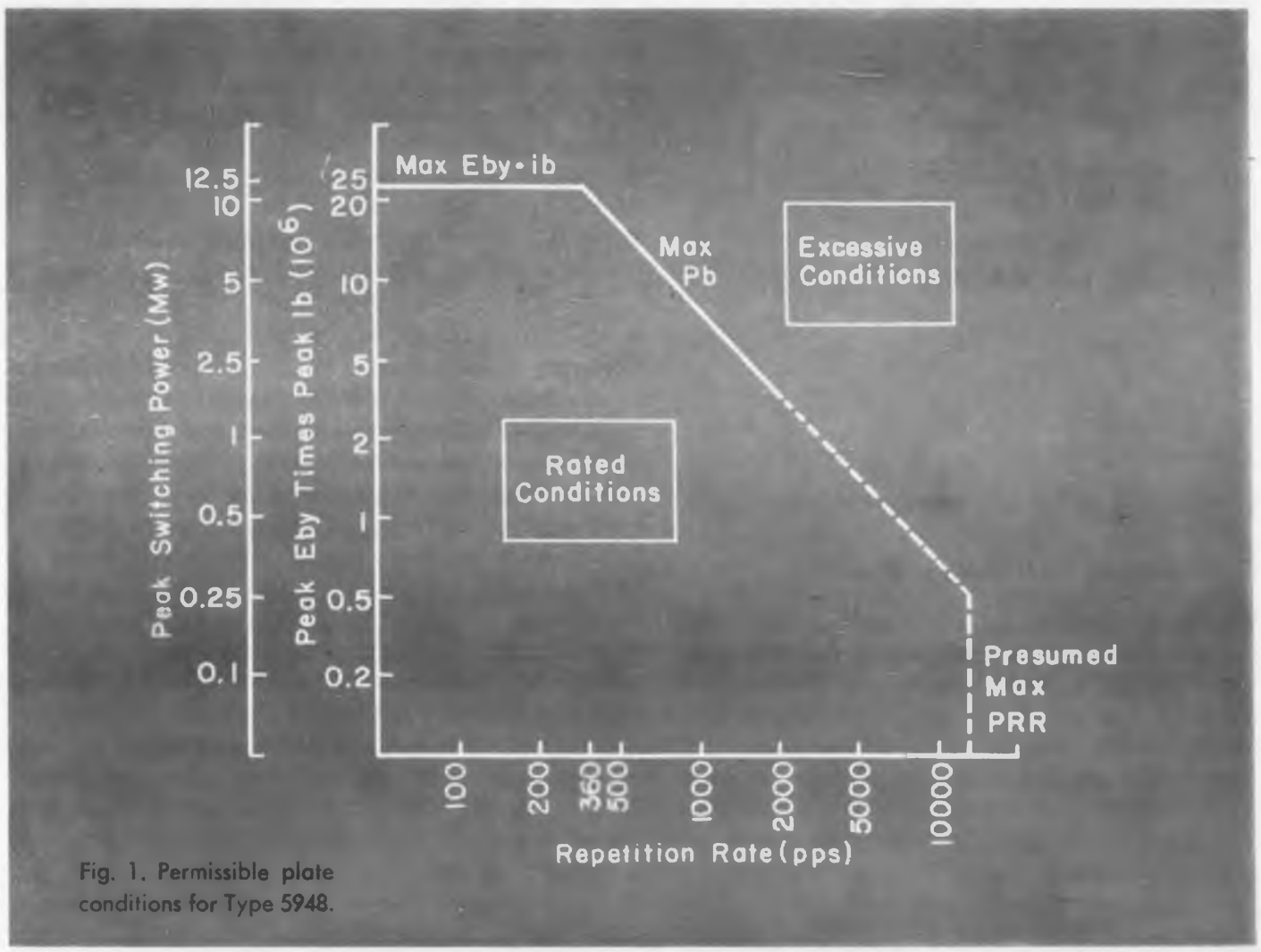


Fig. 1. Permissible plate conditions for Type 5948.

hard-tube and line modulators are of the order of 20 to 40 kv. The limitations in maximum voltage in the two types of devices are somewhat similar in that the internal and external insulators must hold off the peak voltage, and that both types of device may be limited to some extent by field emission problems. The gaseous types must be designed not to break down spontaneously at the desired gas pressure operating level, while the high-vacuum tubes have to be designed so that, even with undesired levels of gas pressure present, there will be no threat of gas arc-covers in the tube. The voltage limitations of passive modulators should be restricted to insulation problems only. If we now consider what we must have in the way of voltage with respect to these three classes of devices, we see that the line modulator and the passive-element modulator do not necessarily need to be designed to operate at high voltages. The only requirement that dictates the use of high voltage is the limitation in available pulse transformers and in the tolerable levels of circuit impedance; that is. if the basic impedance of the network becomes too low then the resistance of connecting elements from the modulator to the pulse transformer may be appreciable portions of the circuit impedance. In the hard-tube modulator, on the other hand, one needs to work at high voltages simply to extend the peak power capabilities of the tube, since anode current is to a great extent limited. The high voltage may be necessary just to draw the desired current, because of the limitations of space charge in the vacuum tube.

Peak Current. The hard-tube modulator is basically limited in its ultimate peak current capabilities. In order to increase the current, either the size of the device or the anode voltage or both must be increased to overcome the limitations of space charge. The only alternative approach is to space the tube elements closely, which leads to fundamental limitations due to undesired thermionic emission by the control elements. The gas-discharge device is a means of effectively obtaining the close spacings required for high currents, without the use of closely spaced tube elements, by means of the formation of a plasma which essentially brings the anode to a point adjacent to the cathode. However, this is done at the sacrifice of the use of the control elements in the tube once current has begun to flow. The size of the thermionic cathode in a thyratron does impose some limitation on the amount of peak current that can be supplied, but this can be minimized to a great extent since one is not restricted in the shape factor of the thyratron cathode as one is in a high-vacuum tube. Cathodes of pool tubes and solid metallic cathodes may be regarded as practically unlimited sources of current, taking into account the impedance considerations mentioned above. The passive-element modulator should be limited with respect to the peak current only by the heat developed in its elements.

Peak Load Power. The modulator device must obviously be capable of delivering the desired packet of energy to the load. This quantity is proportional to the product of peak voltage and peak current. The peak-power rating is not sufficient, however, to judge the capabilities of a modulator device. Consideration must also be given to one or more of the following parameters:

Average power

Peak power x repetition rate (important in line-type devices)

Peak power x pulse duration (may be very important in hard-tube devices)

Average Power. The average power in all types of modulator devices is basically the power dissipated during the switching process. In a vacuum tube the limiting factor is usually found to be the dissipation capability of the control element rather than that of the anode. In this type of device, the product of peak power and pulse duration may be the determining rating, to the extent that at extremely long pulse durations it may be necessary to build a tube capable of operating continuously at the peak-power level desired in order to obtain satisfactory operation, even though the duty factor may be low. A gridless self-switching klystron may be the best solution to this type of problem if one restricts oneself to the use of hard-tube modulators. The gas-discharge device has a basic advantage with respect to average power, since the power lost in the switch is low compared to the total power switched. With respect to the passive-element type, average power may have little meaning although it may be limited by other considerations.

P_b Factor. The breakdown power factor, or P_b factor, is the product of peak voltage, peak current, and repetition rate. The writer feels that this is an extremely important rating and one which has dictated a lot of investigative work, at least in the field of line-type modulators. The P_b factor has been used with the hydrogen thyratron since about 1950 as a semi-empirical, semi-theoretical, but very practical rating. It is approximately equal to twice the product of peak output power and repetition rate in a typical line-type modulator, assuming the load impedance is equal to the impedance of the line. The importance of the P_b factor as a rating can be demonstrated by using the 5948 hydrogen thyratron as an example. This tube has a P_b rating of $9.0 \cdot 10^9$ (volt-ampere-pps). The ratings also permit a peak power level of 12.5 mw at low repetition rates. The existence of the P_b factor limitation, however, only permits a maximum peak switching power at 1000 pps of 4.6 mw. See Fig. 1.

The P_b factor is proportional to the power dissipated in the tube during breakdown. During this period, the voltage across the tube is decreasing while the current is increasing. Their product represents the instantaneous power dissipated in the tube, which may be large compared to that dissipated during the remainder of the pulse. In particular, the power dissipated in the tube during breakdown can be shown as approximately equal to:

$$P = (P_b) \frac{(T_a)^2}{2(T_a+T_c)}$$

where T_a is the voltage-fall time constant of the tube and T_c is the rise time constant of the discharge circuit (independent of the tube). It has been determined that the life of the hydrogen thyratron is inversely proportional to this factor. Purely from the standpoint of dissipation, the factor should be of equal importance (and possibly even greater importance) in other types of low-pressure gas-discharge devices, including mercury-vapor and inert-gas thyratrons. Even though the dissipation factor may be greater in these tubes than in the hydrogen thyratron, the factor may not have as great an effect on life as it has in hydrogen thyratrons, especially those of the non-reservoir type. This is due to an observed effect whereby the operating pressure level in a hydrogen thyratron is an inverse function of the P_b factor. Since the actual tube dissipation is a function of gas pressure, the tube dissipation will increase at a rate greater than linear as the P_b factor is increased.

In spark gaps, the amount of material sputtered varies directly with the P_b factor. In vacuum-tube modulators the factor may or may not have a negligible effect, depending upon the exact circuit conditions. If we set up our circuit so that the per cent current rise time and the duty factor are held constant as the repetition rate is increased, the commutation power in a hard-tube modulator turns out to be independent of repetition rate. If this is not the case, it simply means an additional dissipation required in the anode which may readily be taken care of by proper design of the tube. The power losses in a passive-element modulator are probably directly related to the P_b factor, but the writer has not fully explored this aspect of the problem.

Repetition Rate. In addition to the limitations in the repetition rate due to the P_b factor there are also basic limitations, at least in line-type devices, in repetition rate itself. Such devices are limited in general to repetition rates at which they can be operated without loss of control. Hard-tube modulators obviously are not limited in this respect. Passive-element modulators may or may not be limited in this manner, depending on core design and other similar factors. They are, however, limited to the extent that the frequency at which they must operate is the a-c generator (supplying power to the modulator) frequency, or a multiple thereof.

Average Current and RMS Current. One usually feels that the average current limitation is cathode emission capability, but on further examination this does not always appear to be true. What may be more important to consider is the rms current that the device has to pass, since this determines the amount of heating within the tube, particularly in the cathode. This is especially important if the cathode is an oxide-coated type with a finite coating resistance. On this basis, the passive-element modulator must be considered the least limited of the three general classes of modulator devices with respect to rms current.

Peak Inverse Power. Another factor which is of importance in the line-type modulator, though of lesser importance in other classes, is the peak inverse power that must be dissipated in the switch device. The effect on the circuit of peak inverse voltage remaining on the network in a line modulator can usually be eliminated, as far as the effect on the next pulse is concerned, by the use of clipper tubes. This method may not to any great extent alleviate the amount of power that is dissipated in the switch tube itself by the application of inverse voltage. In devices filled

Maximum Ratings of Typical Hydrogen Thyratrons

Type	Peak Power kw	Avg. Diss. W	Peak Switch kv	Avg. I_b Amp.	Peak I_b Amp.	Pb x 10^9
3C45	50	65	3	0.045	35	0.3
5956/7	350	400	8	0.100	90	2.5
4C35A	350	400	8	0.100	90	2.0
5949	6000	6000	25	0.500	500	6.25
6587	2500	1800	16	0.225	325	3.9
5958/9	150	180	8	0.045	40	1.1
5948	12 Mw	12 kW	25	1.00	1000	9.0
5C22	2500	1600	16	0.20	325	3.2
1257	33 Mw	45 kW	33	2.50	2000	20.0
6130			3	0.045	35	0.3
1258			1	0.050	20	0.1
(*)			25	2.00	1000	40.0

(*) Prototype Ceramic-Metal Tube at E.G.&G.—S.C. Contract.

In general, simultaneous employment of maximum ratings is inadvisable. This table is provided for purposes of comparison. Sufficient data for hard-tube modulators was not available at the time of writing, except from two firms.

with heavy gases the inverse power may be the determining limitation because of excessive anode erosion caused by ion bombardment during the inverse cycle. Anode erosion does occur in the hydrogen thyratron but it rarely is the determining factor in the life of the tube; what one must consider is merely added anode dissipation placed on the tube by the presence of inverse power. It has not yet been possible to establish any definite rating on thyratrons for this characteristic. One may limit the inverse power to some extent by specifying the maximum value of inverse voltage to which the tube may be subjected. In a certain mercury pool switch, a rating was established limiting operation to a specific positive mismatch of the load. The load impedance was deliberately chosen to be higher than the impedance of the network in order to minimize inverse voltage effects, the presence of which quickly causes the death of the tubes. This mismatch, of course, limits the useful power which can be delivered to the load by the switching device.

With respect to passive-element modulators, it would appear that the presence of inverse voltage can be damaging or deleterious in that it would affect operation by causing ringing in the various inductance and capacitance circuits. This may be taken care of by using a clipper device (probably an electron tube).

Pulse Duration. The hard-tube modulator is greatly limited in the pulse duration that it can pass. This may be due, as is the case with oxide-coated cathodes, to the capabilities of the cathodes themselves. In the case of thoriated-tungsten filament tubes, however, the limitation is not in the cathode but in the grid and screen dissipation. The hydrogen thyratron is known not to be limited in pulse duration out to at least 100 μsec, and is believed, on the basis of some very sketchy and meager testing, not to be limited out to approximately 8000 μsec. It is not believed that there is any limitation in the mercury pool type of device with respect to this characteristic.

Fault Control. If we have an r-f generating device which has a tendency to arc during the pulse, the switch tube is occasionally subjected to conditions which are other than normal. In the line-type modulator tube the peak current due to an arcing load is automatically limited to a value of twice the normal operating peak current; such a tube can normally provide this increase in peak current on an intermittent basis. In a hard-tube device, when the load shorts, the peak current rise is restricted only by the switch tube itself. The dissipation in the tube may increase by a large order of magnitude; the switch tube must not only restrict the current, but it must also suffer the consequences of having the voltage across the tube go up. This is believed to be one of the most serious limitations of the hard-tube modulator device.

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The circuit to be stabilized is broken and the Current Governor is inserted in series to maintain a constant predetermined current level. The level may be programmed and modulated.

Versatile Current Stabilizer

THIS INSTRUMENT can be used as a constant current source, an ammeter calibrating reference, a test set for regulated voltage power supplies and for component tests which require programming of the test current. Known as the Current Governor, the unit is basically a two-terminal device, designed for series connection in circuits that require stabilization. By means of high gain feedback, the circuit current is then kept at a constant level over a wide range of voltages and impedances.

Manufactured by North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, N.Y., the Current Governor can be programmed and modulated. Stabilization is maintained at all instantaneous current levels within the 1 to 600 ma current range, the voltage from either end of the instrument to ground not exceeding 3000 v. The modulation selector switch offers a choice of modulation by either internal 60 cycle sine wave or external sinusoidal or complex signals. Frequency limitations in the feedback system are reflected in the 25 to 35 μsec rise time of the current waveform in response to a unit step modulation signal. Amplitude of modulation is continuously variable. 125 v is required for 100 per cent modulation over most of the operating range.

A block diagram of the CG-1 circuitry is shown in Fig. 1. In the absence of modulation, the voltage drop across a resistive sampling network is compared with a reference voltage. Any difference between the two is amplified and applied to the grids of a bank of series tubes, thus stabilizing the circuit loop current by negative feedback. With modulation the drop across the current sampling network is compared to the algebraic sum of the reference voltage and that of the modulator. The stabilized current tracks the modulation signal very closely.

The Current Governor can be used to convert a voltage generator into a constant current source. The voltage generator need not even be regulated in order to furnish a highly stable current. Since the voltage may be supplied at anywhere from zero to 3000 v, the instrument lends itself to testing of devices ranging from low voltage diodes and coils to high voltage magnetrons and other microwave tubes.

In contrast to its application as a power source, the instrument can be regarded as an electronic load, drawing a preset constant current over a wide range of applied voltage (bottom, Fig. 2).

Accuracy of current indication is determined by the 1 per cent resistance tolerance and stability of the entirely passive current sampling network and the reference adjustment, continuously monitored on the front panel meter. The Model CG-1 is designed to mount in either its instrument cabinet or a standard 19 in. relay rack. The cabinet dimensions are 21-3/4 x 11-1/2 x 15 in., and the panel space required in relay rack mounting is 8-3/4 in.

For further information on this current stabilizer turn to the Reader's Service card and circle 22.

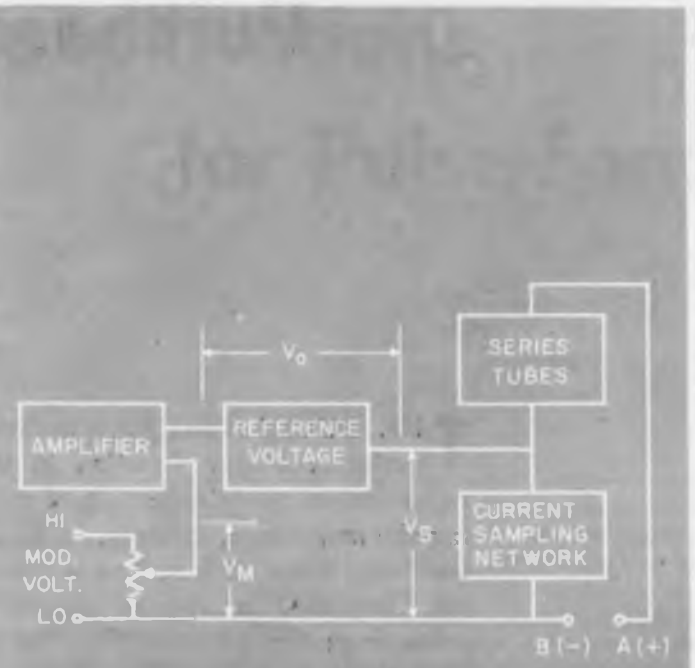


Fig. 1. Current Governor design. In operation, $V_o - (V_s + V_m)$ is made equal to zero when any difference is amplified and fed into the series tubes.

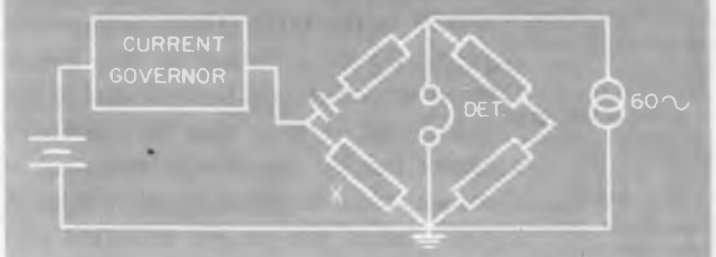


Fig. 2. For ac bridge measurements of components as functions of superimposed dc current, (top) the instrument feeds dc power into impedance X. Used as a test set for regulated voltage power supplies (bottom) the current stabilizer checks the internal dynamic impedance of the supply. Test leads are clipped to terminals C and D, a convenient current produced, and the drop across CD compared with the drop across series resistor R.

Purchase

THE PULSE-FORMING network performs a vital function in the radar system modulator: that of driving the magnetron, klystron, or triode oscillator. Since each system is different, requiring a special repetitive pulse from the network, there is no such thing as a "standard" network. Each PFN must be designed to meet individual equipment requirements.

Owing to its uniqueness, no standards such as those available for capacitors or resistors are possible for this component part; generally a purchase specification must be prepared for each application. While the guide shown in the table (right) is provided primarily as a listing of the salient items which should be included in this document, it may also be used as a check list by the design engineer to insure consideration of all variables involved in the proper selection of a network.

Specifications for Pulse-Forming Networks

Factor	Description
Reference to Commercial Specifications.	This section should list all applicable equipment specifications; those standards which specify the performance required of the finished assembly, and the tests which will be performed to ascertain compliance, e.g.: MIL-E-5400.
Various Types, Sizes, Ratings and Classes Covered.	Pulse-forming network specifications may be prepared so as to cover a family of networks used within the same equipment. The body of the specification should contain all information common to the entire group of networks, individual ratings and requirements of each network being included on properly identified specification sheets which become part of the document.
Use for which the Network is intended.	Details should be provided in this section as to the exact function the network is required to perform, as well as information as to the components to be used in conjunction with the network, e.g.: the PFN will be used to trigger a type XXX magnetron, when used in conjunction with a XXX charging reactor, a XXX pulse transformer, and a XXX thyratron. See Fig. 1.
Kind of Materials and Workmanship.	Information to be included in this section may be drawn directly from the equipment specification, or from a closely allied existing component specification, such as for transformers or capacitors. Note: It is suggested that material and workmanship requirements be in accordance with MIL-C-25 (metal-cased paper dielectric capacitors) in so far as practicable. Since most PFN's are supplied by capacitor manufacturers, these requirements may be readily met with assurance to the buyer that the needed quality control at the vender's plan will be present, without special premium prices.
General Requirements.	Details should be provided as to the environmental conditions to which the network may be subjected without impairing its performance. Such conditions as moisture resistance, temperature and immersion cycling, vibration, thermal and mechanical shock, corrosion, and life should be included in this section. Note: ▲ The requirement portions of the specification are for the purpose of defining quality—"quality" meaning "suitability"—not necessarily the best quality but the right quality. ▲ The most important environmental condition, the figure of merit of the network, is the minimum life requirement. The minimum life of a network refers to the number of hours, under rated conditions and at the maximum operating temperature, that the unit will operate. It may also be specified in terms of the number of duty cycles (the hourly on-off schedule of the network with the prevailing voltage and temperature conditions) of which the network is capable.
Detail Requirements.	Included here (unless covered on individual sheets in the case of purchase specifications dealing with a family of networks) should be details as to: ▲ Physical shape and size, as well as the number of terminals required. ▲ Voltage rating (voltage to which network is charged in kilovolts). ▲ Type and number of meshes including circuit arrangement. The most common type of circuit arrangement used consists of one or more inductance coil sections. Each inductance section with its accompanying capacitor is termed an "E" section. See Fig. 2. ▲ Pulse width (the time interval between the first and last instants at which the instantaneous amplitude reaches a stated fraction of the average pulse amplitude) in microseconds. See Fig. 3. ▲ Rise time (interval between the instants at which the instantaneous amplitude first reaches specified lower and upper amplitude limits) in microseconds. ▲ Permissible per cent ripple (a distortion of an otherwise essentially smooth-topped pulse characterized by an alternate rise and decline of the pulse top). ▲ Pulse repetition rate in pulses per second. ▲ Characteristic impedance of the network in ohms (generally designed to be somewhat more than the equivalent impedance of the lead to aid in deionization of the thyratron).

(Table continued on next page)

Factor	Description
Inspection Information.	Information contained in this section must provide details as to the ways and means of testing deliveries to insure compliance with the general and detail requirements indicated. Note: Care must be exercised to insure that general agreement exists among buyer and supplier as to exactly what each term means, what instrumentation will be used to determine compliance with the given requirements, and the type of load which is to be used to simulate the system. (Generally a pure resistive load, equal in magnitude to the characteristic impedance of the network, is used). Since determination of the pulse parameters is dependent upon the determination of the 100 per cent amplitude reference of the pulse, it is important to mutually agree on the method to be used to find the 100 per cent point. The most popular method for accomplishing this is to draw a horizontal line through the top of the pulse, which cuts the ripple in such a way that the area of the ripple above the line is equal to the area below the line. This line then become the 100 per cent amplitude reference. This method works on all pulses of two or more sections with reasonably square corners. The method for determining the 100 per cent amplitude of a single section having a well-rounded top is arbitrarily to draw a line tangent to the peak; this line becomes the 105 per cent amplitude reference. (The term ripple has no meaning in this case).
Packaging and Piece Marking.	This section of the specification is generally divided between requirements for the packaging and piece marking of the network itself as well as the packaging and piece marking requirements of the shipping container. Notes: ▲ To assist in planned programs of simplification, as well as to reduce the unit cost of the component, standard MIL size capacitor containers should be used to house the network. ▲ In addition to the manufacturer's name or symbol, the network container should be marked with the network coding which exists by general agreement within the industry. This coding, which appears on all networks, gives the pertinent performance data, as well as the rating of the network. This code can best be described by the following example: 10E3-1-500-50P2C 10 = voltage to which network is charged in kilovolts, E = type of meshes (types are A, B, C, D, and E), 3 = number of meshes, 1 = pulse width in microseconds, 500 = pulse repetition rate in pps, 50 = characteristic impedance in ohms, P = type of dielectric (P, paper; A, plastic film; M, mica; T, Teflon), 2 = number of terminals, C = internal choke coil (D, internal de-spiking capacitor; E, external network coil).

Notes and Special Instructions.

For more information about pulse-forming network parameters consult the author's original paper "Pulse-Forming Networks" first published in the Sperry Engineering Review, January-February 1956, and reprinted in the September 1956 IRE Transactions on Component Parts.

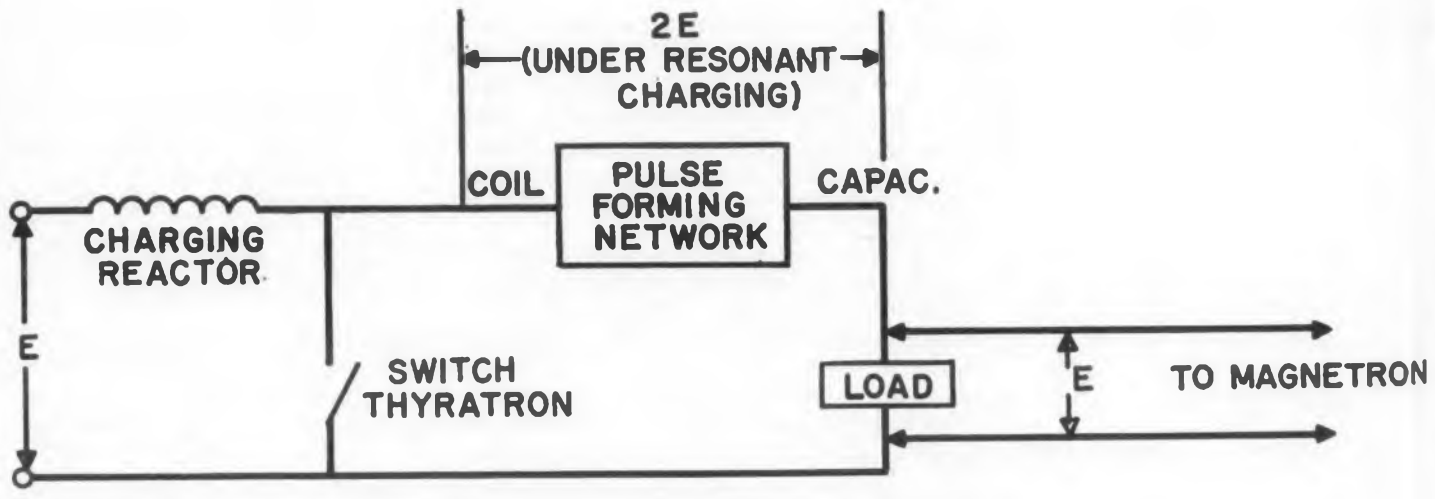


Fig. 1. Typical modulator circuit arrangement, showing the pulse-forming network.

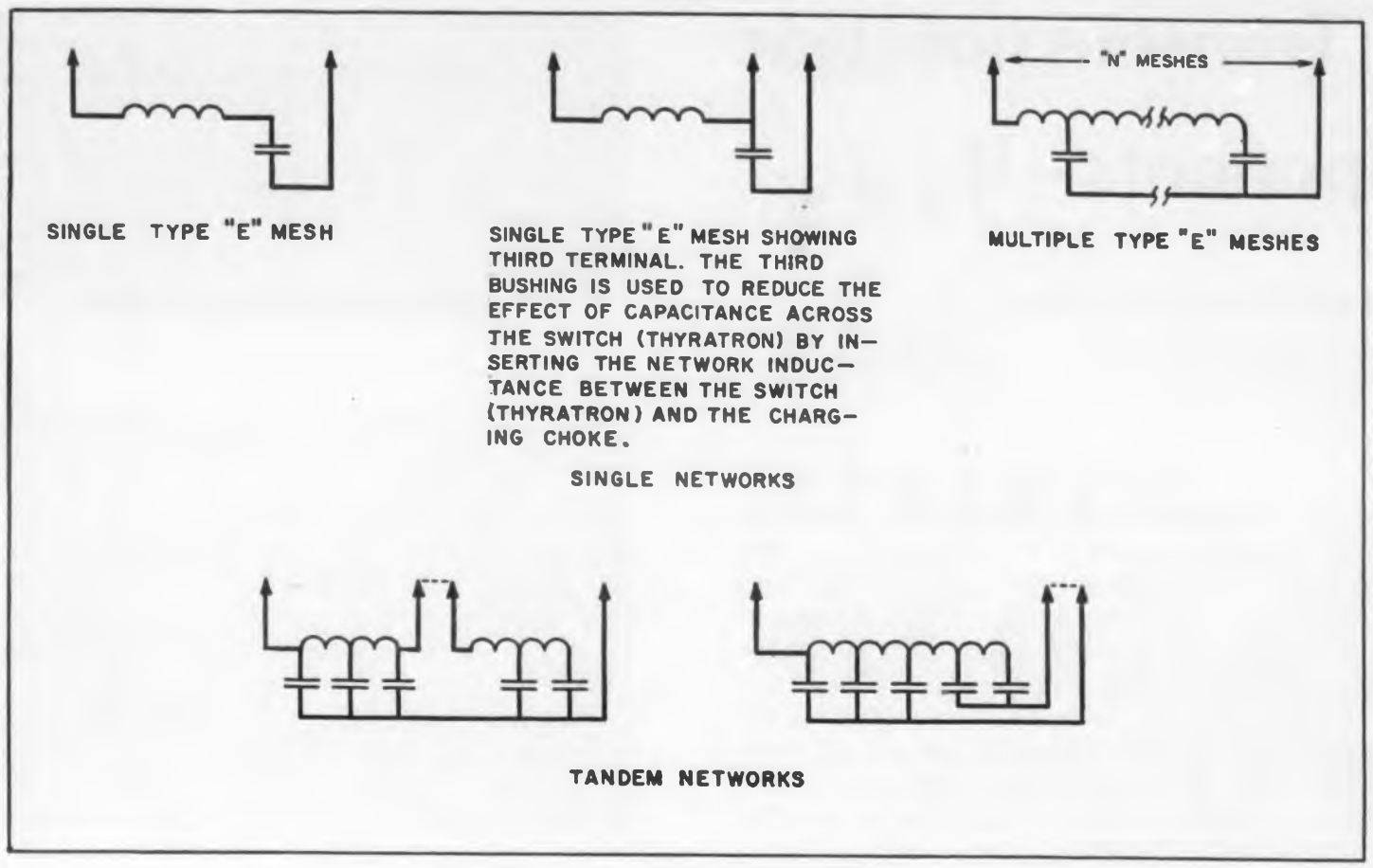


Fig. 2. Graphical symbol representation of single and tandem networks.

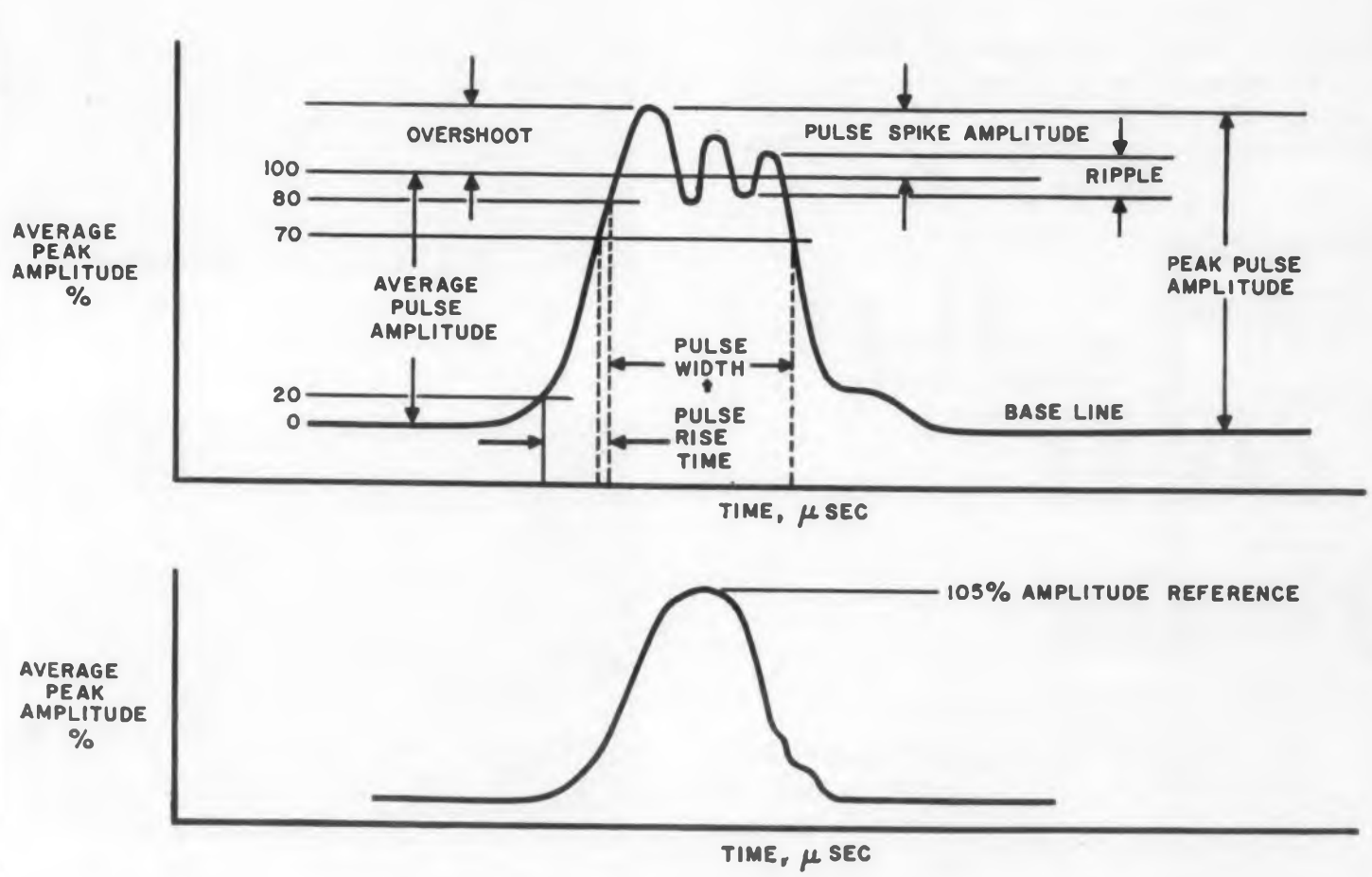
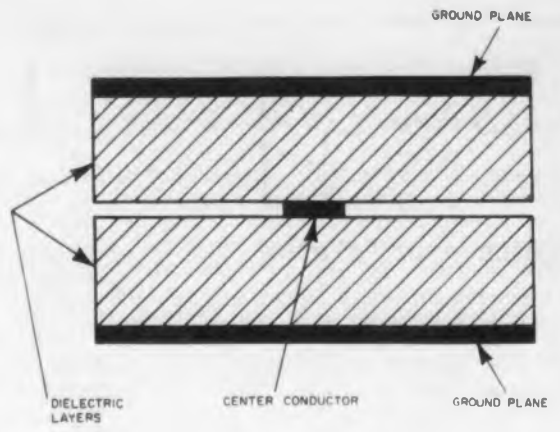


Fig. 3. Recordings of a multiple section (upper) and a single section (lower) pulse showing pulse parameters.

Miniature Strip Transmission Line and Components—II

Eugene N. Torgow and John Griesmsmann

Polytechnic Institute of Brooklyn
Brooklyn, N. Y.



CONSTRUCTION of miniature strip line transmission components is essentially a two dimensional problem. Relatively inexpensive photoetching techniques, used in fabricating strip line components, replace intricate machining operations necessary for waveguide and coaxial structures. In many applications these advantages of miniaturization and cost greatly outweigh the disadvantages of greater dissipation losses and decreased power capacity. This second part of the article describes the design of various strip line components for such applications.

In transmission line structures, the manner in which various elements are connected together becomes an important factor. Stray field effects introduced by the junctions behave, to a first order approximation, as additional circuit elements which must be taken into account. Whenevr possible, it is desirable to take these effects into account in the initial design. Three of the most commonly encountered stray field effects are evaluated in *Fig. 1.* They are: stray shunt capacitance associated with series inductive elements; capacitance associated with the fringing fields of overlap capacitors; and the effect of the junction of two perpendicular lines, such as is encountered at the junction between a series and a shunt arm. The equivalent circuit for the intersecting lines is shown in *Fig. 2.* This circuit is based on one derived by Dr. Arthur Oliner of the Polytechnic Institute of Brooklyn for a "Tee" junction in strip line. To a first order approximation the circuit reduces to two inductances in series with the series (or higher impedance) line.

Low Pass Filters

Low pass filters are extremely well suited for fabrication in strip line. A simple ladder filter such as the constant-k ladder type shown in *Fig. 3*, can be realized in strip line by a sequence of high impedance line sections and open circuited shunt arms less than a quarter wavelength long. The two reactance elements can be designed by use of the equations shown in *Fig. 1.* Lengths of line involved are selected to be less than a quarter wavelength at the highest operating frequency, to insure broadband operation without spurious responses. As the transmission line elements only approximate the lumped element characteristics, it is necessary to design these elements to have exactly the proper reactances at the cut-off frequency of the filter. This is necessary to insure that cut-off of the filter is at the desired frequency. On the basis of this first design the shunt capacitance associated with the series inductive arm, and the series inductance associated with the series arm-shunt arm junction are computed and appropriate corrections made for the design of each element. In order to maintain a good match over the pass band and to have steep rise in insertion loss above the cut-off frequency, m-derived filter sections are commonly employed.

In the distributed circuit, the series inductance is obtained in the same manner as before. The equivalent transmission line structures for a series resonant circuit placed in shunt with the line is a quarter wavelength long open circuited line. Resonant frequency is determined solely by the length of line.

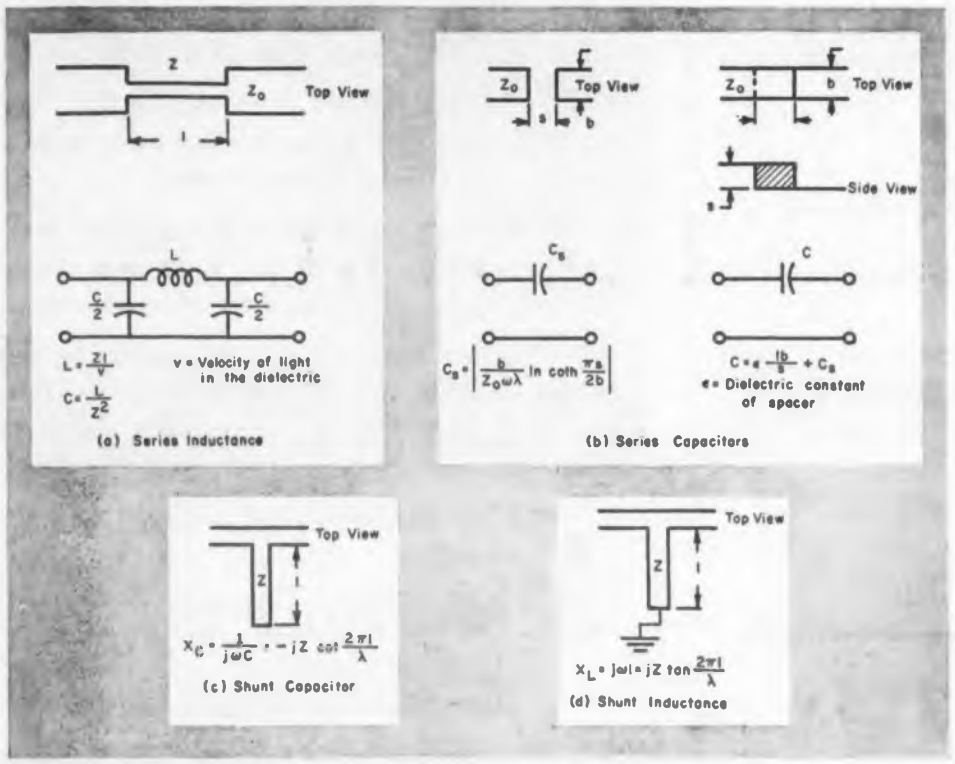


Fig. 1. Center conductor configuration of strip line circuit elements.

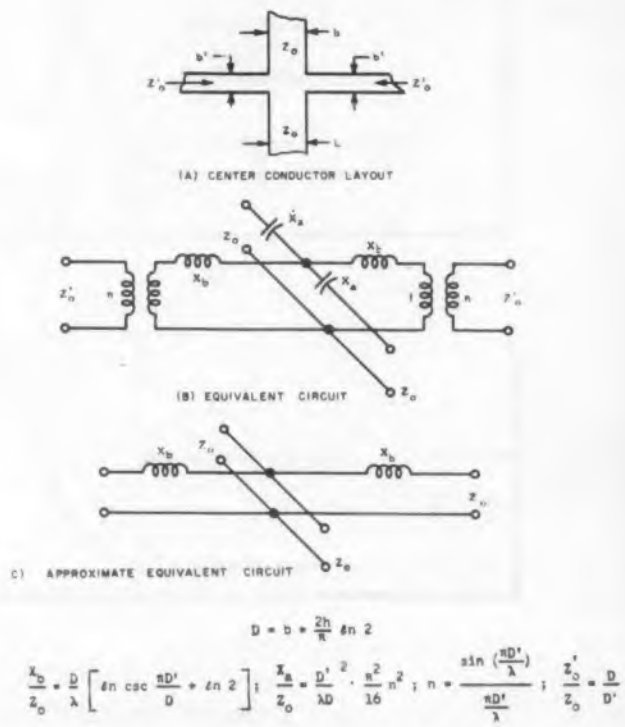


Fig. 2. Discontinuity reactances at junction between series and shunt arms.

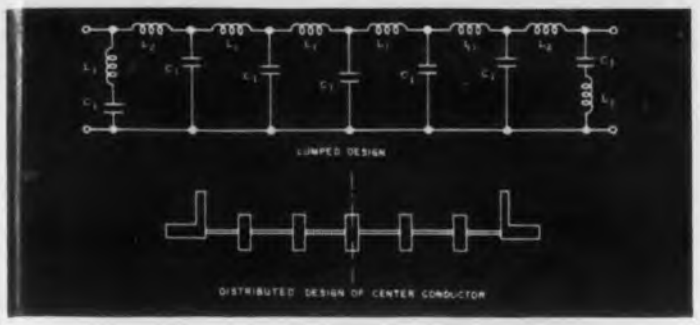


Fig. 3. Five-section constant-k low pass filters with m-derived half-section terminations.

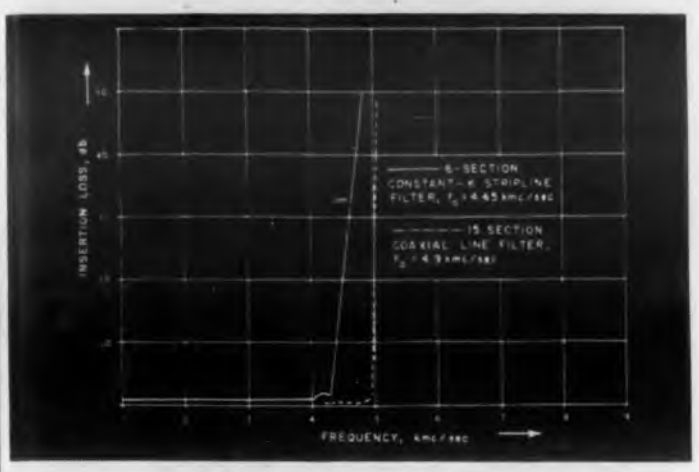


Fig. 4. Comparison of constant-k strip line filter and coaxial line filter for low band pass.

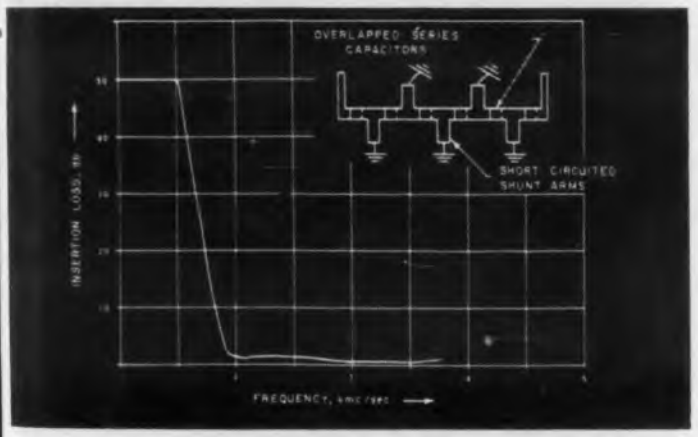


Fig. 5. Measured-performance of high pass filter (insert upper right) using overlap capacitors and short circuited shunt arms.

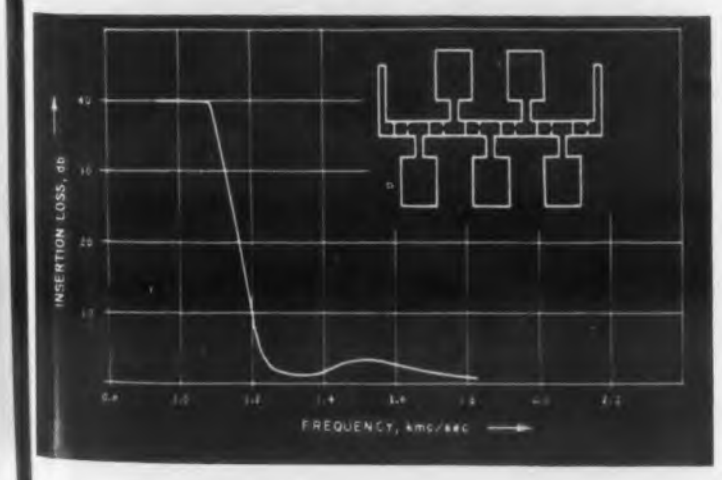


Fig. 6. Measured performance characteristics of a high pass filter (insert upper right) with broadband shunt inductances.

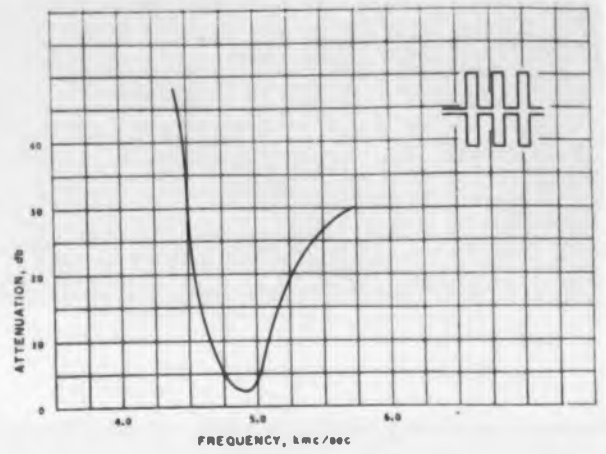


Fig. 7. Three-section band pass filter.

Since the structure only approximates the performance of the lumped element circuit, it is necessary to examine the image impedance of the actual structure over the entire pass band to determine the optimum value for the characteristic impedance of the resonant line.

The measured performance of a filter of the type shown in *Fig. 3* is illustrated in *Fig. 4*. Measured performance of a coaxial line filter of similar design is shown by the dotted curve. Except for a slightly higher insertion loss in the pass band, the strip line filter performance compares quite favorably to the performance of the coaxial filter.

Low pass filters of this type are readily fabricated by photo-etching techniques. From one accurately prepared photographic negative, a large number of identical filters can be manufactured.

High Pass Filters

High pass filters have been fabricated, utilizing series overlap capacitors and short circuited shunt arms to represent series capacitors and shunt inductances respectively. In the case of these circuits, additional fabrication procedures are required, beyond the photo-etching operation, to form the overlap capacitors and the short circuited terminations for the shunt arms. A typical high pass filter center conductor configuration, and the measured performance characteristics of a filter of this type are illustrated in *Fig. 5*.

High pass filters having a similar performance can be obtained by the use of the broadband open circuited inductive structure described earlier. The measured performance characteristics of a filter utilizing these structures is shown in *Fig. 6*. This filter can be fabricated by photo-etching techniques except for the series overlap capacitors. It should be noted, however, that filters of this type may exhibit a spurious pass band at frequencies below the cut-off frequency.

The lumped circuit approximation procedure can also be employed to design narrow bandpass filters and equalizers exhibiting prescribed insertion

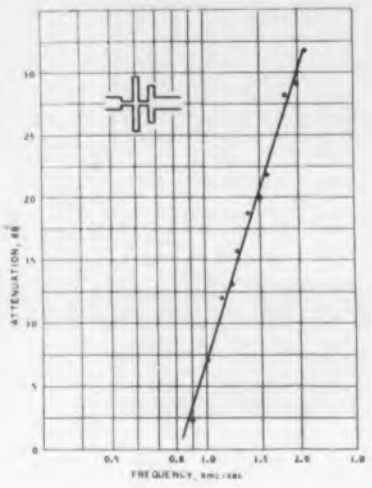


Fig. 8. Measured characteristics of Butterworth type equalizer.

loss characteristics in the rejection band. The performance of typical circuits of these types is illustrated in *Fig. 7* and *Fig. 8*. This technique can also be employed in designing delay lines for lower frequencies and many other applications.

Application Below 1000 Mc

Application of strip line structures to circuit designs at frequencies well below 100 mc appears to be quite feasible. The miniature size and flexible dielectric of the line permit the possibility of manufacturing compact, simple circuits that can be formed into coils or other confined shapes. Thus the bulkiness of waveguide or coaxial systems at low frequencies can be avoided while many of the advantages of transmission line systems over lumped element circuits in the uhf band can be maintained. Two devices have been built that give an example of the compactness which can be achieved by the use of strip line structures. (1) An array containing three low pass filters, four high pass filters and appropriate interconnecting networks, designed to separate the frequency band from 1 to 10 kmc into four equal bandwidth output channels, was fabricated on a flat sheet whose overall dimensions, including a 1/4 in. thick phenolic supporting plate, were 14 in. wide by 16 in. long by 0.293 in. thick. More complex networks could have been formed by stacking additional layers of different circuits, one above the other, without appreciably increasing the total volume. (2) A low-pass filter designed for a cut-off frequency of 1800 mc was formed in a spiral by wrapping it 1-1/2 turns about a 7/8 in. core, to form a tube 3 in. long with a 1 in. diameter. Performance of this filter was virtually unchanged after wrapping. Thus, not only can circuits be compactly packaged, but circuits can also be fabricated to fit into confined spaces in and around other components in a system.

This paper describes work done under the sponsorship of the Rome Air Development Center, Griffiss Air Force Base, Rome, N.Y., on Contract AF-30 (602) —1430. The paper was originally presented at the "1956 Electronic Components Symposium" in Washington, D. C. on May 2, 1956 and is published in the proceedings of that Symposium.

Simplified Coincident Motion Picture Sound Using A Tape Recorder

THE COINCIDENT motion picture sound system described is equally applicable to all film sizes and frame speeds, results in a sound track capable of rendering reasonable fidelity, provides for complete coincidence between the visual and audio records without the need for constant operator supervision, does not involve the reprocessing of the picture film, is relatively inexpensive and technically straightforward, and in addition, provides for a sound track that can be quite satisfactorily produced by the inexperienced operator. This is believed to be the least involved of any method for adding synchronized sound to nonprofessional motion pictures. It should find considerable use in the laboratory for training purposes, etc.

The coincident sound system is best described by reference to Figs. 1 and 2. In Fig. 1, the prime functional units of the recording system are shown. Two sources of sound, *1*. a microphone, and *2*, a phonograph or tape recorder are indicated. It is anticipated that the musical background and sound effects will be either disc or tape recordings, and that the microphone will be used for adding the descriptive dialogue. The recording amplifier *3* is arranged with the proper mixing circuits to permit the operator to select or mix the various sounds to produce the desired effect. The output of the recording amplifier is applied to the No. 1 recording head *4* which produces a magnetic sound track *A* on the tape *6* while the erase head *5* is energized by the supersonic erase and bias frequency in the usual fashion.

The No. 2 head *7* indicated in Fig. 1 is an auxiliary record/playback head so positioned that its pole faces are opposite the normally unused half of tape *B*. During the recording process a 60 cy ac tone at a level of 6.3 v is applied to this auxiliary head, producing a corresponding magnetic recording on the tape. For purposes of illustration, this tone is shown as being obtained from the power connection *9* through a step-down transformer *8*.

Also in Fig. 1, the projector *10* and the synchronous motor *12* are powered from another power line connection *11*.

In practice, the recording amplifier is a normal part of the tape recorder, and the step-down transformer provides power for the cathode heaters of the tubes. The only modification is the addition of the auxiliary head and some sort of a switching means to connect this head to the 6.3 v ac power during the recording process, and to the synchronizing amplifier during playback.

From the foregoing, it is seen that during the recording process the speed of the projector is controlled by the frequency of the power line, a sampling of which is simultaneously recorded on the tape.

The functional parts of the reproducing system are shown in Fig. 2. The various blocks shown are not necessarily separate units. In operation, the magnetic elements of the sound track, *A*, on the tape will produce a voltage output in playback head No. 2, which is amplified by a power amplifier *15* to the proper level to drive the loudspeaker system *16*.

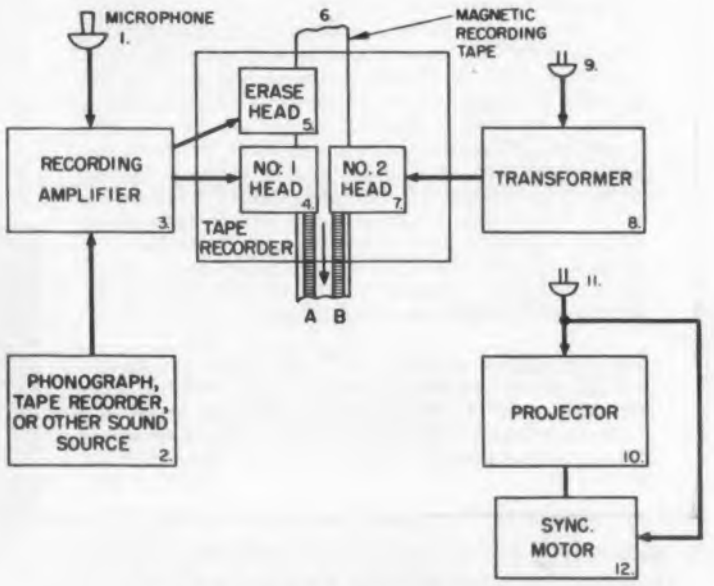


Fig. 1. Prime Functional units of coincidence-sound *recording* system.

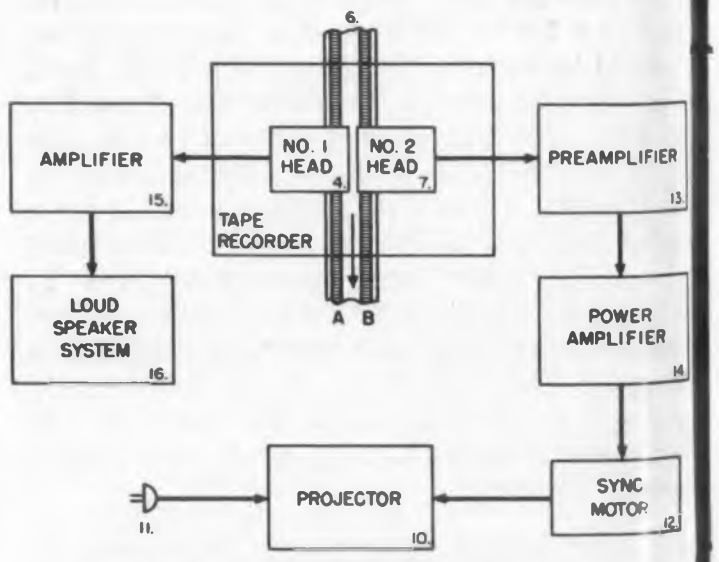


Fig. 2. Functional parts of the *reproducing* system.

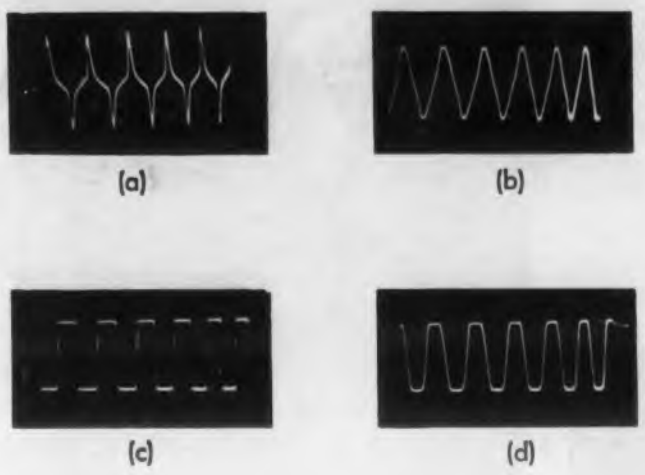


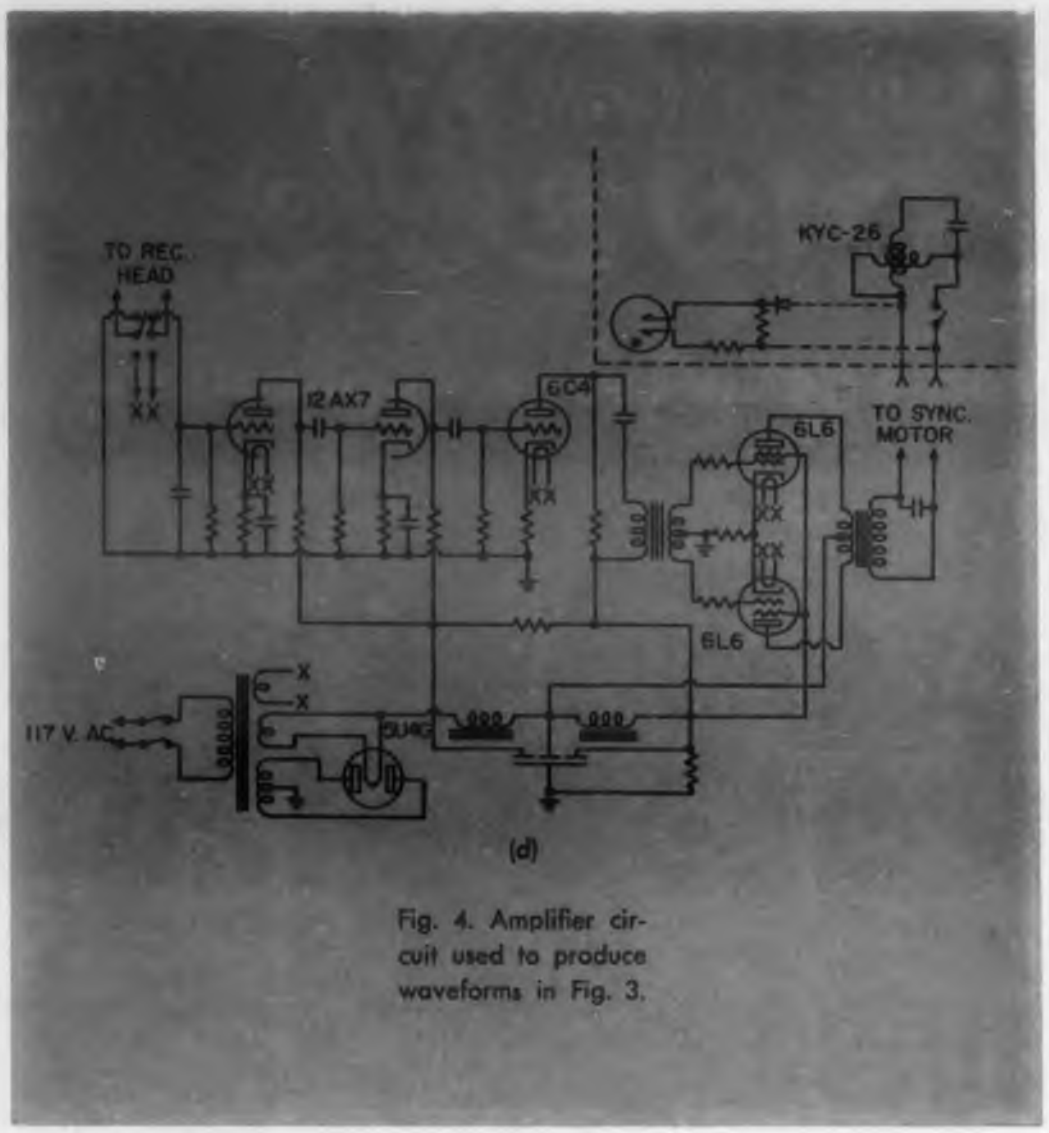
Fig. 3. Output waveforms from the head, on playback. At *a*, without compensation, the spiked waveform occurs. At *b* is the same output with an 8-10 μf capacitance placed across the head output terminals (see text). At *c* is the output where the amplifier incorporates limiting but uses no capacitor. With capacitor, the waveform is shown at *d*.

Simultaneously as the magnetic elements of synchronizing track *B* pass the auxiliary head, a 60 cps ac voltage is produced which is applied to a preamplifier *13* and a power amplifier *14* to control the speed of the projector through the synchronous motor *12*. The power for operating the projector drive motor and for the projection lamp is applied through a standard power connector.

The speed of the projector, which was controlled by the 60 cps power-line frequency during the recording of the sound track, is controlled by the 60-cycle tone derived from the synchronizing track on the tape during playback. Any slight variation in frequency due to tape creep or any other normal change in tape speed will be immediately passed on to the projector, maintaining complete coincidence between the tape and the film. Since any change in tape speed will introduce a corresponding change in film speed, it naturally follows that the coincidence between the audible sound and projected picture will be maintained to the same degree as when recorded.

The exact coincidence between film and sound track presupposes a definite starting point for the tape with respect to the film. This is accomplished by marking the leader of the film with a strip of colored pressure sensitive tape. A bit of splicing tape on the back of the magnetic tape provides a corresponding starting mark for the sound track. When all is in readiness, the projector is started and the film loop watched carefully. When the colored tape flashes around the loop, the tape recorder is started, which controls the speed of the projector through the medium of the synchronizing tone.

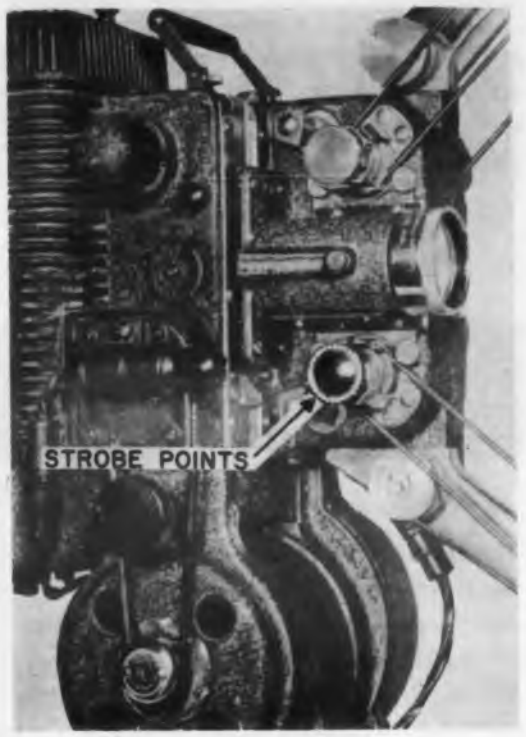
If absolute coincidence is required, as for instance in synchronizing lip sounds with a closeup



(d)

Fig. 4. Amplifier circuit used to produce waveforms in Fig. 3.

(a)



(b)

Fig. 5. *a.* How synchronous motor is mounted on typical projector; *b.* modification of projector to permit strobe monitoring of synchronization.

of a person speaking, it will be necessary to drive the camera with a synchronous motor, and record an ac signal derived from a power source for synchronizing. The camera and the recorder must both be driven from a common ac source, which may be a power line, a mobile converter, or any other suitable source. For most purposes, however, the sound effects may be dubbed in later and while good coincidence between the sound and the action on the film is necessary, absolute coincidence is not required.

A Typical System

The details of the system will vary somewhat, depending upon the type of equipment used. Only one specific system will be described here.

The basic requirements are a standard projector, preferably of the type designed for projecting silent films at 16 frames per second, a tape recorder capable of producing whatever fidelity of sound is desired, an auxiliary amplifier capable of delivering 10 w at 60 cps from the output of a standard tape recording head, a small instrument-type synchronous motor and an auxiliary tape recording head.

The auxiliary recording head is mounted on the tape recorder at any convenient point where the normally unused portion of the tape will be exposed to the field produced by the signal. It is generally possible to slightly modify the tape recorder switch to perform the desired switching functions related to the use of this auxiliary head in the performance of the recording and reproduction functions of the synchronizing tone. It is often even possible to add a preamplifier for the synchronizing tone.

The synchronous motor is mounted on the projector in such a fashion that the film will be projected at 16 frames per second when operated at synchronous speed.

The synchronizing amplifier may be any standard amplifier capable of delivering the required power, or it may be a special amplifier, designed to incorporate amplitude limiting, thereby providing a constant output to the synchronous motor. An amplifier using push-pull 6V6 or 6L6 tubes in the output stage appears to be about right for the job. The output transformer should have a 500 ohm output winding. While this does not exactly match the impedance of the motor, it is a practical value which works satisfactorily. The actual impedance of the motor is about 1000 ohms.

If there are some rather significant stray magnetic fields present in the tape recorder, 60 cps power-line pickup may be present in the auxiliary head, causing a slow beat in the ouput signal. The effect of these stray fields may be nullified by limiting in the synchronizing amplifier. This may be accomplished by any one of several methods, the most simple of which is to introduce poor regulation in the output amplifier stage by the use of a high impedance in the grid circuits. Adjustments of the amplifier should be such that the output to the motor will be between 110 and 130 v with the motor operating normally. The motor represents an inductive load, and a 2.0 μf capacitor across the amplifier output is used for power factor correction. It will also modify the square waveform produced by the limiting action, if limiting is used.

The synchronizing tone is recorded without supersonic bias. The tape is magnetically saturated on each half cycle of the synchronizing tone. This provides for a more constant output of the synchronizing tone and at the same time performs the function of completely erasing any previous recording. The result of this arrangement is a great simplification of the entire system.

On playback, the output voltage from the head is in the form of pulses. The saturated recording method results in alternate blocks or sections of the tape being magnetized as north and south poles. No change in flux occurs except at the point where the polarization changes take place. The output waveform consisting of alternative positive and negative spikes is shown in Fig. 3a. This waveform may be rounded out appreciably by resonating the head at the approximate frequency of the synchronizing tone. A capacitance of 8 to 10 μf across the head is usually sufficient, and produces the waveform shown in Fig. 3b. The output waveform of an amplifier incorporating limiting is shown in Fig. 3c. This waveform, as modified by the power factor correction capacitor, is shown in Fig. 3d, and while it departs appreciably from a sine wave, it has no adverse effect on the operation of the synchronous motor. The amplifier which produced the waveforms in Fig. 3 is shown schematically in Fig. 4.

In operation, it was found that the synchronous motor exerts a far greater control force when acting as a brake than when contributing to the over-all drive power for the projector. The normal projector drive motor is therefore adjusted to operate the projector at a speed slightly in excess of 16 frames per second. The synchronous motor then acts to hold the speed down to precisely 16 frames per second.

One method of mounting the synchronous motor to the projector is shown in Fig. 5a. In this instance, the motor is mounted directly to the projector gear housing, using studs having an offset hole in one end. Rotation of these studs provides a slight lateral movement of the motor for adjusting the gear mesh.

To monitor the projector speed to assure that it is synchronized with the applied synchronizing tone, a strobe system can be used consisting of a small neon lamp and 32 equally spaced holes drilled near the edge of the film takeup sprocket and filled with white paint as shown in Fig. 5b. The neon lamp is excited by the voltage applied to the synchronous motor.

Tape recorders usually have two inputs, one for a microphone and one for a higher level input such as from a phonograph pickup or a radio receiver. If these two inputs can be used simultaneously, or if a mixer is included, a perfect arrangement exists for sound track recording.

Tape recorders designed for recording and reproducing binaural sound require no modification for use in this coincident sound system. The sound track is recorded and reproduced on one channel, while the synchronizing tone is recorded and reproduced on the remaining channel.

Information for this article was obtained from a paper presented by James N. Whitaker, Senior Technical Staff Member, Hughes Aircraft Co., at the Audio Engineering Society West Coast Convention, Los Angeles, Feb. 7, 1957.

Elapsed-Time

THIS ELAPSED-TIME indicator—called a "Chronistor"—is an electro-chemical device that measures the total number of hours of operation of any electrical instrument, appliance or component. Designed to fit into a standard-size 3AG fuse clip, and inexpensive, the Chronistor can be obtained for either 500 or 1000 hours maximum total elapsed time. Other ranges are available on special order, from its manufacturer—Bergen Laboratories, 247 Crooks Ave., Clifton, N. J.

How It Works

The Chronistor is in effect a miniature electroplating bath containing an anode, cathode and electrolyte. When a dc current passes through the electrolyte, metal ions are carried from the anode to the cathode. Since the cross-sectional area of the anode and cathode is known and the plating efficiency is kept near 100 per cent while the current flow is constant, the length of both the cathode and anode will change with time—the anode becoming shorter and the cathode becoming longer. A time scale alongside either the anode or cathode can then be calibrated directly in hours, as shown in the illustration. To achieve proper operation the composition of the electrolyte, the type and heat treatment of the anodes and cathodes must be carefully controlled in manufacture.

The current required to actuate the Chronistor (about 1.0 ma or less) can be obtained from any dc or rectified ac voltage. Greatest accuracy is obtained if this voltage is constant, but for many applications where great accuracy is not essential an unregulated dc is sufficient.

Since the resistance of the Chronistor is very low—a fraction of an ohm—a large value external resistance is necessary between the source of voltage and the Chronistor. This also serves to maintain a constant flow through the Chronistor during use. The minute amount of current required by the unit is provided by the equipment being timed. No auxiliary relays or switches are necessary.

Indicator

Made to fit a standard 3AG fuse holder, this inexpensive elapsed-time indicator weighs only 0.2 oz.

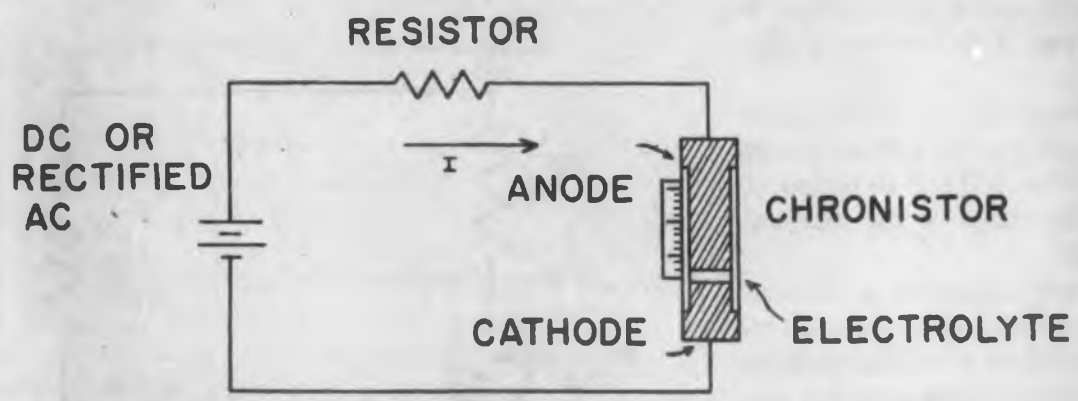
Characteristics

Size of the Chronistor is 1.25 x 0.25 in. in dia. It weighs 0.2 oz. Accuracy of indication is within 5 to 10 per cent when operated from an unregulated power source and very accurate with regulation. Suggested temperature operating range is 40 to 100 F, and best performance is obtained when the unit is mounted vertically.

Applications

The Chronistor can be used to measure the life of TV picture tubes, bearings of motors, life of heater elements, elapsed time of operation of magnetrons, klystrons, transmitting tubes, etc. Suggested general categories of use include the determination of periodic overhaul times, component replacement periods, warranty of instruments or equipment, and life-test timing.

For additional information about this product, fill out the Reader's Service Card and circle 35.



Circuit required for operation of "Chronistor". Minute current required (1.0 ma) is determined almost entirely by external resistance.

High-Efficiency

Crystal Detector Mounts

THESE COAXIAL broadband detector mounts, for frequencies between 500 and 4500 mc provide an improvement in video gain of 2 to 6.5 db over previously available crystal holders. This as much as doubles the range of equipment with which they are used. It reduces the required number of transmitters and/or receivers, with great cost, size and weight savings. Where a certain range of reception is required, the extra sensitivity produced by the improved detector mounts may still permit the use of a crystal video system instead of the heavier, bulkier, and costlier superheterodyne receiver system.

These detector mounts, available from American Electronics Laboratories, Inc., 121 N. 7th St., Philadelphia 6, Pa., are designed as broadband mounts in the region from 500 to 4500 mc in three bands. The upper frequency will be extended to 12 Kmc in two bands, shortly. They are coaxial mounts with type N male input connectors and type BNC output connectors, designed to operate in 50 ohm systems. They have a video short and dc bias return and are designed for 1N23B or MA408A crystals with approximately 30 μa positive bias. An especially low r-f impedance is presented and a high video impedance, resulting in minimum video loss. In the two lower bands, 500-100 mc and 1000-200 mc, the AEL mounts are about 6 db better than the UG-119 A/U over most of the band. In the 2000-4500 mc region, these mounts are better than the best commercial mounts by 3 to 5 db over most of the band.

Applications

Crystal video systems, using these low-loss detector mounts, have extremely useful applications in the reception and detection of microwave radiation:

1. Where wide-open non-frequency scanning is required. This type of system can be used to detect the presence of radar activity, tell the direction of this radar activity, view the shape of the modulation, and trigger an action;

2. Where single-frequency operation is desired but where the greater sensitivity of a superheterodyne receiver is not required; or where the weight, size, and/or cost disadvantages of the superhet system outweight the sensitivity advantages of the superhet system.

For further information about these mounts, turn to the Reader's Service card and circle 37.

Background

A typical crystal video system is shown in Fig. 1 Its equivalent circuit is shown in Fig. 2. The filter will separate signals closely spaced in frequency; or it can be used with band-pass filters in adjacent bands to split the spectrum.

In Fig. 2,

e_{nf} = instantaneous nf voltage induced in the antenna;

R_a = antenna radiation resistance;

C_h = crystal holder capacitance;

s = an element in the detector mount explained below.

In a properly designed detector mount, the nf equivalent circuit is as shown in Fig. 3.

where, R_x = resistive component of crystal impedance

It is assumed that the nf impedance on the video side of the crystal (C_h in parallel with the input impedance of the amplifier) is very small compared to R_x and that the nf impedance at s is very large compared to R_x. For best operation of the system, the reactive component of the crystal impedance should be cancelled out and the remaining resistance matched to the line feeding the detector mount. Usually R_a is matched to 50 ohms and there is a 50 ohm line feeding the detector mount. The detector in its mount should then be matched to 50 ohms.

Fig. 1. Arrangement of units for crystal-video system.

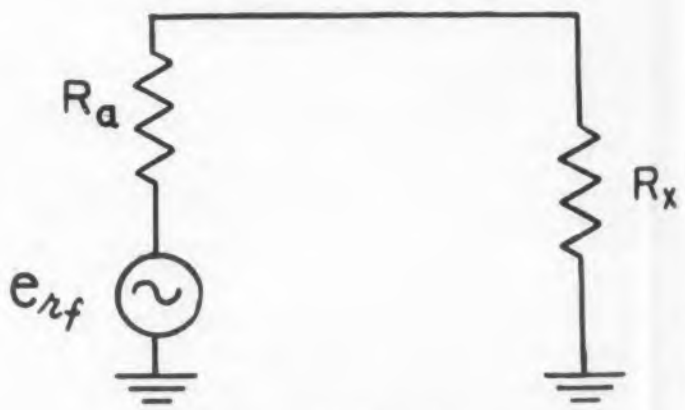


Fig. 3. RF equivalent circuit.

For the equivalent video circuit, the crystal can be replaced by a generator and a series resistance as shown in Fig. 4.

where,

R_L = Load Resistance of the amplifier;

e_v = instantaneous video voltage at input of video amplifier;

R_x = resistive component of crystal impedance;

E_s = rms value of e_s, the nf signal voltage applied to the crystal, and

α = Log Current Slope in the forward direction = $\frac{q}{kT}$.

The current voltage characteristic of the crystal is

$$i = A\left(e^{\alpha e_s} - 1\right) .$$

For best operation, R_L should be must larger than R_x and *s*.

The importance of *s* is evident here; *s* should be a video short and, as stated before, an rf open circuit. The video short would be required if the element feeding the detector has a high video impedance to ground; such an element would be an antenna with a probe transition from waveguide to coaxial cable or a high-pass lumped parameter or coaxial filter. The video return is not required if the detector mount is fed from a ridged waveguide filter with a waveguide-to-coax transition feeding from the top of the ridge.

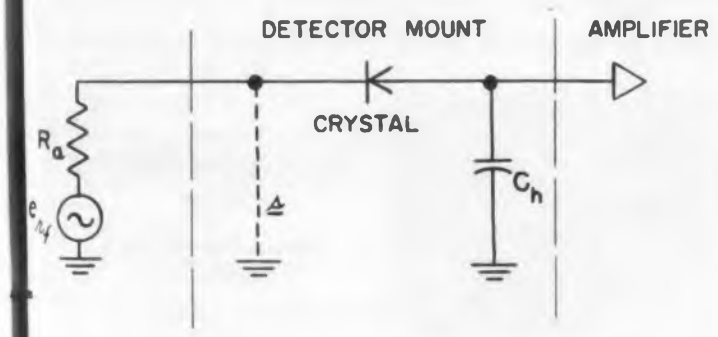


Fig. 2. Equivalent circuit of crystal-video system.

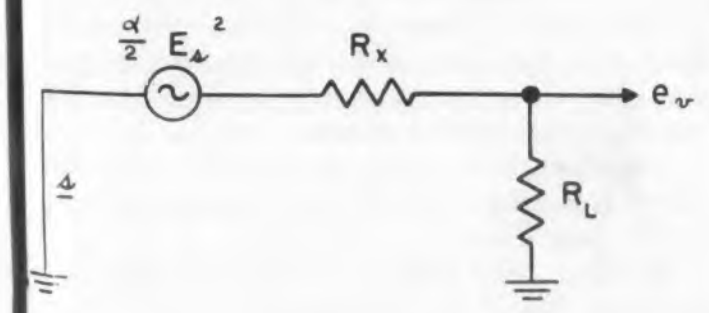


Fig. 4. Video equivalent circuit.

New Products

Ultrasonic Watch Cleaner

Washes, Rinses and Drys

The Model WC-35 is a small, inexpensive complete cleaning machine designed specifically for cleaning watches and small precision parts. It offers washing, rinsing, and hot air drying in a single unit. Equipped with two removable transducer cans, it is also furnished with baskets, basket holders, and an ultrasonic beam disperser.

It consists of a single cabinet into which is built an electronics unit capable of delivering about 35 w of rf power at 1 mc. The top of the cabinet has an opening through which hot air from the electronic circuit is blown to provide a hot air drying facility. The unit will operate satisfactorily with almost any cleaning solvent or with water.

McKenna Laboratories, Dept. ED, 2503 Main St., Santa Monica, Calif.

CIRCLE 40 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Polarization Antenna

High Gain

A 6 ft diam high tolerance aluminum parabolic reflector and a "question-mark" rectangular waveguide fed with a weatherized conical horn, are the major components of this system. A remotely controlled ferrite transducer, located between the feed and the horn, is used to rotate the plane of polarization of the transmitted wave.

The electrical performance characteristics are as follows: frenquency, 16,000 mc ±1 per cent; gain, greater than 45 db; beamwidth in both planes, 0.7 deg ±0.1 deg; front side lobe level, greater than 24 db down; all other side lobes, greater than 30 db down; system insertion loss, less than 1.0 db at any rotation; VSWR with gyrator, less than 1.20:1 over ±1 per cent band, and less than 1.40:1 over ±5 per cent band; polarization angle, ±90 deg rotation with maximum coil current of 40 ma applied to transducer; cross-polarized component, greater than 12 db down from a linearly polarized signal.

Variation of signal strength with rotation of plane of polarization does not exceed 0.5 db peak to peak at a distance of 2000 ft from the antenna located on the axis of the beam.

Diamond Antenna and Microwave Corp., Dept. ED, 7 North Ave., Wakefield, Mass.

CIRCLE 41 ON READER-SERVICE CARD FOR MORE INFORMATION

AN Type Connector

Quick Connect and Disconnect

In order to provide a quick connect and quick disconnect action, an accessory consisting of an adapter and a coupler has been designed for standard AN connectors. The adapter screws over the coupling threads of a standard AN receptacle and contains an external locking groove which receives the formed ends of the coupler latch when fully engaged. The entry of the coupler latch into this groove permits the compression spring to move the coupler sleeve forward, locking the parts securely. A simple straight pull back on the sleeve releases the latch and permits disconnection.

Cannon Electric Co., Dept. ED, P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif.

CIRCLE 42 ON READER-SERVICE CARD FOR MORE INFORMATION

Accelerometer

Fits in 3/8 in. Hole

Accurate vibration measurements to 10,000 cps can be made by mounting the model 2216 accelerometer right in the device being tested, in addition to the usual surface mounting. This subminiature model is 0.635 in. high, provides 5 mv per g sensitivity with a natural frequency of 50,000 cps. Temperature characteristics are flat ±10 per cent —30 F to 230 F. The accelerometer is supplied with adapters for surface mounting on vibration tables or devices being tested, and a matching 3/8 in. tap for mounting within a device under test.

Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.

CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

Microwave Dummy Load

Measures Energy Absorbed

This high-power, L-band, dummy load operates on the heat-exchange principle, measures the heat absorbed by means of a thermopile, and reports the energy level directly in kilowatts. It consists of a four-foot long aluminum wave guide which can be lifted and attached; two molded fiberglass tapered fluid elements centered inside the wave guide, and a remotely located heat exchanger.

Frequency range of the unit is 1150 to 1750 mc. VSWR is less than 1.15. Maximum average power is 1.5 kw, peak pulse power 5000 kw.

WacLine, Inc., Dept. ED, 35 S. St. Clair St., Dayton 2, Ohio.

CIRCLE 44 ON READER-SERVICE CARD FOR MORE INFORMATION

Seven Vacuum Tubes

For TV

Two of these tubes, designated 6AM8A and 6AT8A, have 450 ma heaters with controlled warm-up time and are the series string versions of the 6AM8 and 6AT8. Types 9CL8 and 9U8A are 300 ma versions of the 6CL8 and 6U8 respectively with controlled heater warm-up time for series string operation. Type 3B2 is a glass half-wave, high voltage rectifier. Type 6BY8 is a miniature diode-pentode with a 600 ma heater with controlled warm-up time for series string use. Type 6DT6 is a miniature sharp cut-off pentode.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.

CIRCLE 45 ON READER-SERVICE CARD

Eight-Channel Data Recorder

Logs Analog Computer Output

Designated Model 158-5490, an eight-channel, single-console recording system records the output of analog computers. It is used with its manufacturer's Model 183 Programmer. The programmer starts and stops the recording system, checks initial condition of computer, calibrates each channel for readout of attenuator settings at a later time, and can record solutions over a predetermined length of record.

Sanborn Co., Dept. ED, 195 Mass. Ave., Cambridge 39, Mass.

CIRCLE 46 ON READER-SERVICE CARD

Thermostat Metals

Wide Deflection Range

One of these new metals posseses a useful deflection range of —100 to 700 F, with maximum sensitivity from 0 to 300 F. It has a high deflection rate, high torque, and good strength properties up to 800 F. Electrical resistivity is high and corrosion resistance good.

The other has a wide range of linear deflections between —50 F and 700 F. Its maximum sensitivity is 200 to 600 F. It combines a high deflection rate with a high torque rate.

American Silver Co., Dept. ED, 36-07 Prince St., Flushing 54, N.Y.

CIRCLE 47 ON READER-SERVICE CARD

CIRCLE 48 ON READER-SERVICE CARD ➤

New Products

Stabilized Power Supply

Loads Up To 150 Amp

Highly regulated, these power supplies' dimensions are varied to suit space requirements. Several voltage units can be combined into one frame. The thyratrons used are standard tubes, commercially available. Efficiency is greater than 80 per cent. One knob adjusts the output voltage between 110 per cent and 20 per cent of rated value. Maximum peak to peak ripple is ±0.1 per cent, response time 10 msec and recovery time 20 msec.

Oscillographic recordings have shown that with a dc load of 37 amp a step change in ac line voltage of 7 per cent, from 120 v to 112 v and back to 120, results in an output voltage change of only 0.1 v. A load change of 35 per cent produces an output voltage change of 0.5 v. Steady-state change in output voltage from no load to full load is 0.3 v—less than ±0.1 per cent.

The unit operates from 60 cps ac and can be supplied for dc outputs up to 500 v and up to 150 amp.

Dynamic Controls Co., Dept. ED, 1955 Massachusetts Ave., Cambridge 40, Mass.

CIRCLE 50 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Measuring Device

For Excursions Up To 5000 CPS

Utilizing a light beam, a photomultiplier tube, a cathode ray tube and an oscilloscope, this instrument measures vibrations up to 5000 cps in shake tables, accelerometers, relays, flywheels, cylinders, and rotating shafts. No physical contact is made with the vibrating object. A spot of light on the screen of the CR tube, having an effective diam of 0.0001 in., is focussed by a 100X optical system onto the work. The reflected light beam is received and amplified by the photomultiplier, and the amplified

output is applied to the vertical deflection plates of the CR tube. When the momentary direction of vibration is upward the light spot follows it; when the vibratory motion reverses itself so does the motion of the spot. The oscilloscope spot thus follows exactly the motion of the CR tube spot. Synchronizing the oscilloscope sweep will result in display of the exact waveshape of the motion and all transients and characteristics of the displacement.

Designated Optron, this instrument comes in three models for working ranges from 0.1 in. to 10 in. All models are tripod mounted. and are used in close proximity to the work to be measured. The power supply operates from 105-125 v 50/60 cps.

Optron Corp., Dept. ED, 3526 State St., Santa Barbara, Calif.

CIRCLE 51 ON READER-SERVICE CARD FOR MORE INFORMATION

Static Circuit Relay
For Teleprinters

Intended primarily to replace teleprinter relays with a static circuit that has no moving parts, this relay eliminator package is also useful wherever low-power switching may involve troublesome inductive kicks. It consists of a transistorized switching circuit with silicon diodes and a built-in rectifier, and is powered directly from a 115 v a-c 50/50 cps line. Designated Model 530 Trepac, the device has an almost purely resistive input. It operates with either 20 or 60 ma signal input; its output current is nominally 60 ma and only insignificantly changed by variations in the input current. The Trepac is furnished with mounting for Teletype Model 14 tape printer, Teletype Model 15 page printer, Teletype Model 28 printer; for standard 19 in. relay racks or standard 19 in. cabinets. It will be available in the future with mountings for Olivetti Model T2 teleprinter, Kleinschmidt Model 155 printer and Lorenz Model LO-15 page printer.

Alcor Electronics Corp., Dept. ED, 180 Lafayette St., New York 13, N. Y.

CIRCLE 52 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Brighter TV Phosphors

For Aluminized Tubes

New phosphor blends, designated P-4, have been developed and made available for television picture tubes. They are a light-body color type suited for aluminized tubes, and are the brightest at a given energy level that their manufacturer has produced.

E. I. Du Pont De Nemours & Co., Dept. ED, Photo Products Plant, Towanda, Pa.

CIRCLE 55 ON READER-SERVICE CARD

Cathode Metal

Has Hot Strength

A passive cathode material with increased hot strength, Cathaloy P-51, contains four per cent tungsten. Hot yield strength is approximately 5000 psi at 800 C. Cathaloy P-51 is designed for electronic tubes which require the low rate of barium evolution, minimum sublimation and freedom from interface impedance characteristic of passive cathodes but at the same time must operate under conditions of shock and vibration.

Superior Tube Co., Dept. ED, 1521 Germantown Ave., Norristown, Pa.

CIRCLE 56 ON READER-SERVICE CARD

Double-Diode Tetrode

Drives Output Transistor

A miniature double-diode tetrode intended primarily for use in tube-transistor hybrid automobile radios, has a 9-pin miniature button. Designated 12J8, its intended application is as detector, avc and driver of the output transistor. Since this tube is to be used in automobiles its heater is designed to operate over the 10.0-15.9 range. Heater current is 350 ma; maximum plate voltage 30, typical plate voltage 12.6, transconductance 5400 μmhos, approximate plate resistance 4000 ohms, maximum output power 20 mw.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 57 ON READER-SERVICE CARD

◀ CIRCLE 54 ON READER-SERVICE CARD

New Products

Dielectric Tester

Good Accuracy for Solids and Liquids

The type DK-08 is used to determine the dielectric constant of solid and liquid materials with an accuracy of ±0.1 to 1 per cent, the dielectric loss factor from 10^{-4} to 1 with an accuracy of ±1 to 3 per cent, the permeability and the magnetic loss angle in the range from 300 to 6000 mc. Two signal generators provide continuous and stable frequency setting from 300 to 3000 and from 2000 to 6000 mc.

The unit uses a resonant coaxial cavity to hold test samples, with a detector probe to read the voltage distribution. The sample chamber is housed in a water jacket to permit measurements from −70 to +180 C; no slotted lines are employed. A micrometer spindle with an accuracy of ±0.01 mm is used for frequency setting.

Arka Imports, Dept. ED, 754 Ladera St., Passadena, Calif.

CIRCLE 61 ON READER-SERVICE CARD

Voltage Stabilizer

Plus or Minus 1/2 Per Cent

A transistor-magnetic amplifier regulator that will regulate at 120, 208 or 440 v, over a range of 380 to 420 cps, is available from stock. Designated Magohm Type STR, it is usually supplied with three-phase sensing, but can also be furnished with single-phase sensing. The regulator holds alternator output voltage within ±1/2 per cent for all steady-state load conditions over the entire frequency band covered. Response time is 1/400 second. The four elements of which the regulator is composed—generator, voltage detector, voltage reference and transistor-magnetic amplifier, operate at conservative ratings. Installation is easily made, and components are accessible for adjustment.

Electric Regulator Corp., Dept. ED, Norwalk, Conn.

CIRCLE 62 ON READER-SERVICE CARD

CIRCLE 63 ON READER-SERVICE CARD ➤

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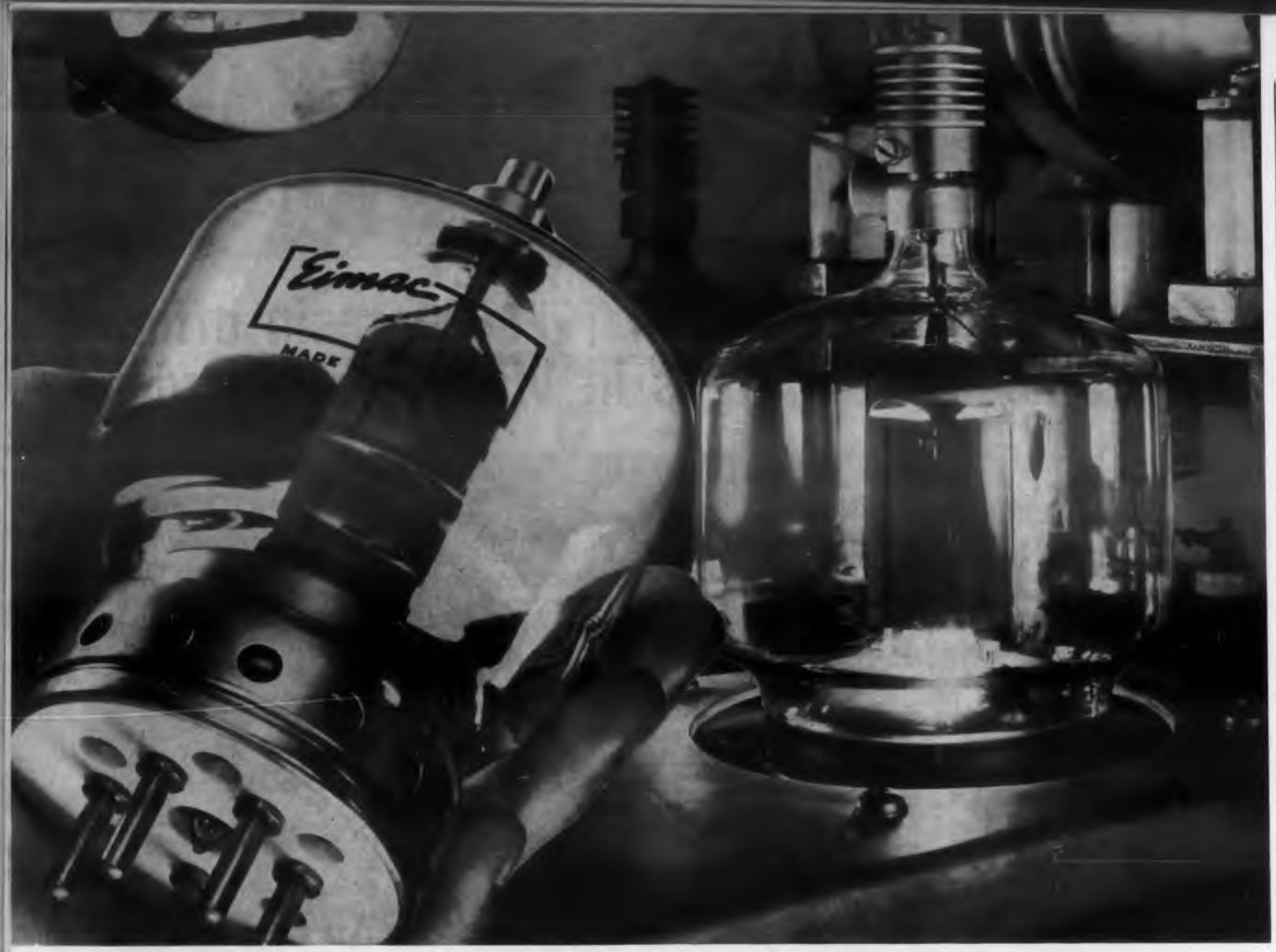
Electric Regulator Corp., Dept. ED, Norwalk, Conn.

CIRCLE 62 ON READER-SERVICE CARD

CIRCLE 63 ON READER-SERVICE CARD ➤



New Products

25-Kvar Capacitor

Reduced in Weight and Size

A 25-kvar capacitor which places less weight on crossarms and poles is now available in all ratings of 4500 v and above. Similar units in ratings below 4500 v will be available soon. Utilizing capacitor papers developed for its maker's 50-kvar units, this device weighs 19 pounds less than its 25-kvar predecessor. Dimensions also have been greatly reduced; cubic volume exclusive of bushings has been cut by more than 25 per cent. The new capacitor complies fully with NEMA standards. It can be substituted for the larger 25-kvar capacitors in all equipment.

General Electric Company, Dept. ED, Schenectady 5, N.Y.

CIRCLE 65 ON READER-SERVICE CARD

Printing Inks for Teflon

Adhere Permanently

A new line of printing inks especially developed for permanent printing on Teflon-insulated wires and cables has the characteristics of Teflon itself. Once printed on Teflon, the inks adhere permanently, are stable at temperatures from −90 C to +250 C, and are inert to all known commercial solvents and chemicals. The ink is available in black in quantities of eight ounces or more; the variety of other colors that have been developed are not at the moment in production but soon will be. Printing on Teflon with these inks is accomplished by the standard, engraved-wheel equipment and technique used for printing on vinyl, with the difference that after leaving the printing equipment the Teflon ink must be cured by passing the printed wire or cable through an oven of 650 F. The curing dwell time is short, and printing and curing can be made one continuous process.

Hitemp Wires, Inc., Dept. ED, 26 Windsor Ave., Mineola, N. Y.

CIRCLE 66 ON READER-SERVICE CARD

◄ CIRCLE 64 ON READER-SERVICE CARD

Delay Cable

Flexible

HH-1600 has a delay of 1.0 μsec/ft, an impedance of 1700 ohms and an insertion loss of 0.3 db for a delay of 1.0 μsec. The operating temperature range is from −40 to +85 C. The delay cable has a diameter of only 0.28 in. and is flexible.

It can be furnished in calibrated lengths as a calibrated delay line with molded vinyl endcaps with delays from a fraction of one to 100 μsec, or as bulk cable.

Columbia Technical Corp., Dept. ED, 61-02 31st Ave., Woodside 77, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

Cold Punching Laminate

For Production Economy

A new cold punching laminate with low moisture absorption, low dielectric loss at high frequencies, and excellent insulation resistance effects production economies in mechanical assembly and in printed circuitry. Identified as Insurok XT-896, the laminate punches clean and sharp at room temperature, eliminating the need for heating before punching and the problem of dimensional changes resulting from heating. Copper-clad, the material has high bond strength and good blister resistance.

The Richardson Co., Dept. ED, 2749 Lake St., Melrose Park, Ill.

CIRCLE 68 ON READER-SERVICE CARD

Miniature Capacitor

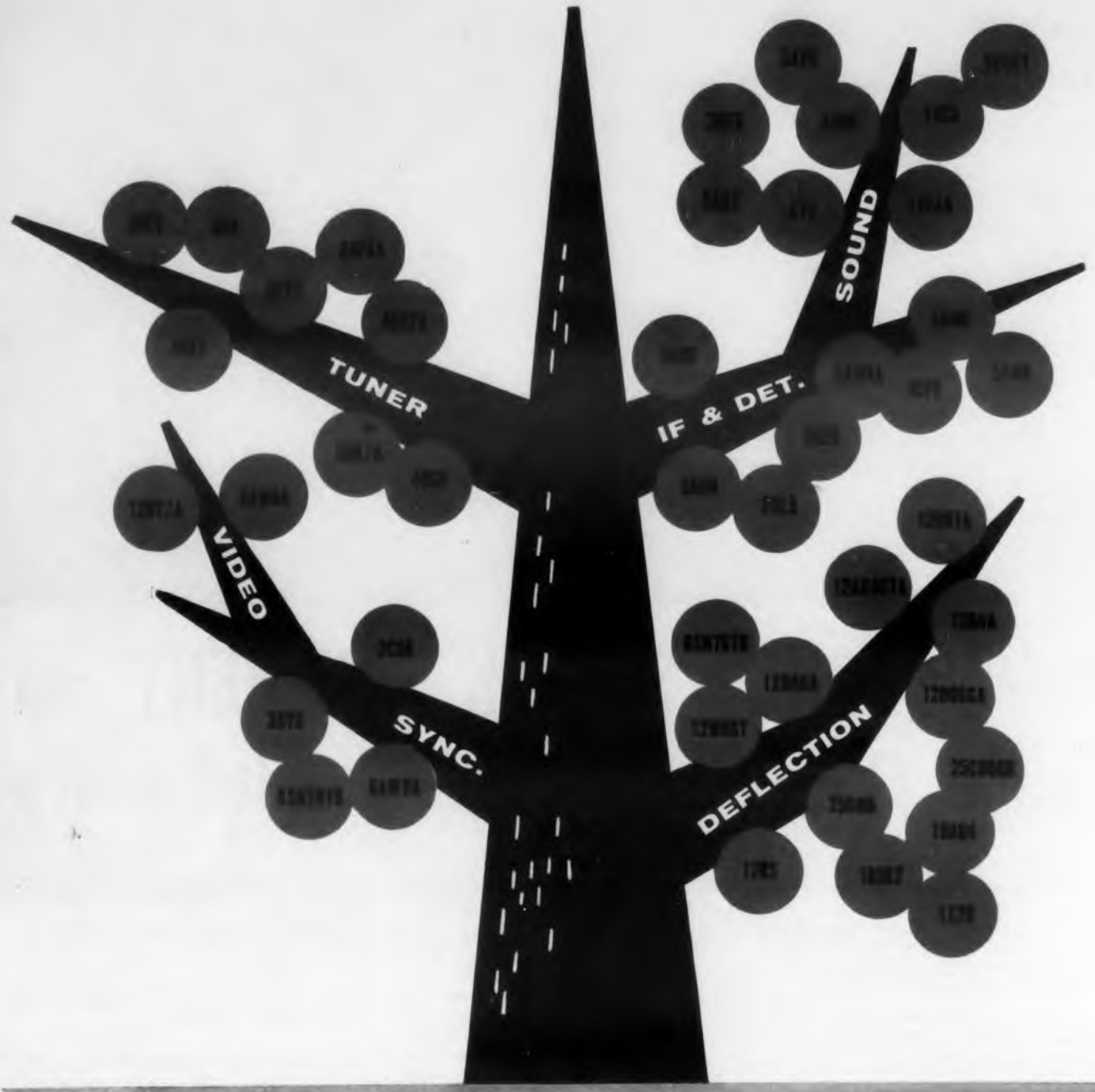
High Ambient

These miniature metalized Teflon capacitors operate at 200 C without derating. With a power factor of 0.0005, and a capacitance change of 1 per cent from −55 to 200 C, these capacitors have an insulation resistance of 10^9 ohms at 200 C. Units are hermetically sealed in metal cans, and are available in ratings of 0.005 to 4 μfd, to 1000 wvdc, and tolerances to one per cent.

Research Labs., Dept. ED, 49-53 Edison Pl., Newark, N.J.

CIRCLE 69 ON READER-SERVICE CARD

CIRCLE 70 ON READER-SERVICE CARD ➤



The first family of 600 ma Series-String TV Tubes

In 1953, Tung-Sol became the leading proponent of 600 ma series heater tubes for TV receivers. This program was made possible through advanced designs in heater and cathode structures that would permit controlled heater warm-up time.

The success of this pioneering led further to the development of series-string tubes for 450 and 300 ma currents. These are designed for sets using smaller numbers of tubes.

In all, nearly one hundred of these types have been introduced, indicating the complete success of the series-string design principle.

Tung-Sol is currently supplying all of the series-string tube types required for replacement service as well as for initial equipment production.

TUNG-SOL®
ELECTRON TUBES

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

The Complete Roster of Tung-Sol Series String Tubes

300 ma

4CY5	6BY8	6DT6	9X8	12BY7A
6AU6A	6CB6A	8BQ7A	10C8	12CT8
6AX7	6CE5	9CL8	12B4A	12SN7GTB
6BU8	6DK6	9U8A	12BH7A	17H3
				18A5

450 ma

3AF4A	4DK6	6CG8A	8AW8A	17A5
3BN4	4DT6	6CL8	8BA8A	17AU5GA
3CY5	5BQ7A	6CM8	8BH8	17AX4GT
4AU6	5BS8	6CQ8	8BN8	17BQ6GTB
4BA6	5BZ7	6CR8	8CG7	17C5
4BC5	6AM8A	6CS8	8CM7	17CA5
4BC6	6AN8A	6J6A	8CN7	17CU5
4BE6	6AQ5A	6T8A	8CS7	17DQ6
4BN6	6AT8A	6U8A	8SN7GTB	17DQ6A
4BU8	6BE8A	6V6GTA	9AU7	17L6GT
4CB6	6BK7B	6X8A	11C5	17R5
4CE5	6BT8	8AU8	13DE7	35CD6GA

600 ma

2AF4	3DT6	5BT8	6BK7B	12C5
2BN4	4BC8	5CG8	6BN8	12CA5
2CY5	4BQ7A	5CL8	6BV8	12CS5
2T4	4BS8	5CM6	6BY8	12CU5
3AU6	4BX8	5CM8	6CG7	12D4
3AL5	4BZ7	5J6	6CS7	12DB5
3AV6	4BZ8	5T8	6SN7GTB	12DQ6
3BA6	4CX7	5U8	10DA7	12DQ6A
3BC5	5AM8	5V6GT	10DE7	12L6GT
3BE6	5AN8	5X8	12AU5GA	12R5
3BN6	5AQ5	6AU8	12AX4GTA	12W6GT
3BU8	5AS8	6AW8	12B3	15A8
3BY6	5AT8	6AW8A	12B4A	19AU4
3BZ6	5AV8	6AX7	12BH7A	19AU4GTA
3CB6	5B8	6BA8	12BK5	19AU4GT
3CE5	5BE8	6BA8A	12BQ6GA	25CD6GA
3CF6	5BK7A	6BH8	12BQ6GT	25CD6GB
3CS6	5BD8	6BJ8	12BY7A	25DN6

Information about these products and special purpose tubes is available upon request to Tung-Sol Commercial Engineering Division.

Tung-Sol Electric Inc., Newark 4, N. J.

Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington N. J.; Melrose Park, Ill; Newark, N. J.; Seattle, Wash.

New Products

Precision DC Amplifier

Completely Transistorized

The amplification ratio of this dc amplifier is variable by means of plug-in "cans" of precision resistors. The unit is chopper-stabilized and the signal passes first through an ac circuit that chops, amplifies, demodulates and filters it; then through a dc amplifier circuit. Power transformers are isolated from ground, so that these amplifiers "float" relative to earth. Noise referred to input is only 3 μv p-p at 0-1 cps; since there are no vacuum tubes there are no microphonics in any service condition. Drift at 25 C is 2 μv in 24 hrs. Power required is 105-125 v, 60 cps.

Beckman Instruments, Inc., Dept. ED, 325 North Muller Ave., Anaheim, Calif.

CIRCLE 73 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo System Motor Generator

For Error Rate Damping

For error rate damping in servo systems for high stability, a new size 10 motor generator has been brought out. It weighs 72 grams. The main phase motor voltage is 26 v at 400 cps, the control phase motor voltage is 0-26. Maximum motor current per phase is 185 ma; motor dc resistance per phase 58 ohms; no load speed 7000 rpm and stall torque 0.33 in.-oz. Generator main phase voltage is 10 v at 400 cps, input power 0.2 watt, output 0.16 v per 1000 rpm. Generator dc resistance per phase is 200 ohms, its max. null 0.005 v. Phase shift at 25 C is ±3 deg. The rotor moment of inertia is 0.60 gm-cm.^{2} Among features of the unit is cast rotor construction.

Clifton Precision Products Co., Inc., Dept. ED, Marple at Broadway, Clifton Heights, Pa.

CIRCLE 74 ON READER-SERVICE CARD FOR MORE INFORMATION

for Teflon* on wire

From advanced know-how and industrial chemistry . . . came "Teflon." Through unique applications of "Teflon" on wire and cable . . . Hitemp Wires, Inc. has opened new horizons for the electronic and electrical industries.

With "Teflon" insulated wire, tubing, multi-conductor cables, lacing cord, tape and sewing thread, miniaturized electronic and electrical components are now possible . . . with the amazing working temperature range of −90°C to +250°C.

"Teflon" insulated products offer this unexcelled combination of properties: low loss factor, low dielectric constant, high volume resistivity, nonflammable, low coefficient of friction, unaffected by moisture, tough . . . yet flexible, and completely inert to all known commercial solvents.

For better products . . . for lower production costs, call the leading specialist in high temperature insulations . . . your nearest Hitemp Wire, Inc. sales engineer.

HITEMP WIRES INC.

26 WINDSOR AVE., MINEOLA, NEW YORK

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Hicksville, New York

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Aeronic Accessory Co
161 Orlando Drive
Binghamton, N. Y.

TEXAS
General Power Equip.
5626 Dyer Street
Dallas 6, Texas

OREGON AND WASHINGTON
Ray Johnston Co.
11009 Evanston Ave.
Seattle, Washington

WASHINGTON, D. C. GOVERNMENT
John W. Houston, Jr
1625 "K" Street, N.W
Washington 6, D. C.

INDIANA
Richard C. Warner
Box 338
South Whitley, Ind.

ILLINOIS, WISCONSIN, IOWA
Caine Sales Agency
3020 N. Cicero Ave.
Chicago 41, Illinois

FLORIDA
Larry Johnson
8163 N. E. 2nd Ave.
Miami, Florida

UPPER N. Y. STATE
Philip L. Kirsh
223 Windemere Rd
Rochester 10, N. Y.

MINNESOTA
Ken Mills
5230 Culver Road
Minneapolis, Minnesota

EXPORT
Hitemp Wires, Inc.
Export Division
Mineola, N. Y.

NEW ENGLAND
Richard Whitehead
Guilford, Connecticut

SAN FRANCISCO
Bill Kolmes & Co
2580 20th Street
San Francisco, Calif

LOS ANGELES AND CENTRAL CALIF.
C. B. Rush & Associates
3757 Wilshire Blvd
Los Angeles 5, Calif.

TULSA, OKLAHOMA
Joseph Turner
P. O. Box 7068
Tulsa, Oklahoma

BIRMINGHAM, ALABAMA
C. H. Emory
P. O. Box 9013
Birmingham 9, Ala.

WRIGHT FIELD
Jack Carney & Assoc.
938 Knott Bldg.
Dayton 2, Ohio

ARK., KAN., MO., NEB.
White Supply Co.
4343 Duncan Ave.
St. Louis, Missouri

S. CALIF. AND ARIZONA
Fred W. Falck Co.
2311 West Burbank Blvd.
Burbank, California

MICHIGAN
Jim Morrow Sales
85 Louise Ave.
Highland Park, Mich.

KENTUCKY AND OHIO
Gallagher Company
15 Ritchie Ave.
Cincinnati, Ohio

NO. CAROLINA, SO. CAROLINA AND TENNESSEE
Larco Engineering, Inc.
123 Brevard Court
Charlotte 1, N. C.

MARYLAND AND DEL.
Sol W. Goodman
32 West Biddle Street
Baltimore 1, Maryland

*DuPont's Trade Name for POLYTETRAFLUOROETHYLENE

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Temperature Measurement System

Full Scale Output of 5 v

This multichannel temperature instrumentation system is designated to operate directly into airborne telemetering and magnetic tape systems. Models are offered in 7, 14 and 20 channel capacity. The TME contains two precision mag-amp type regulated d-c power supplies, series connected with a common neutral, for excitation of the temperature transducers in half bridge circuitry. Balance and attenuation controls are provided for each channel. No vacuum tubes or transistors are employed in its design. Output voltage and impedance characteristics are directly compatible with fm subcarrier and pwm coder input requirements. System stability is within 1 per cent throughout MIL-E5272A environmentals. Dimensions of the 20 channel model are 7 x 4-1/4 x 3 in. Total weight is 5-1/2 lb.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Generator

Variable Delay and Width

A simplified circuitry providing fast rise time pulses at high repetition rates, make the model 2125B pulse generator a reliable instrument for use in laboratory and test applications. Controls for this improved version of the previously available model 2125A provide better resolution, utilizing multiple-decade ranges for pulse spacing, delay and width. Repetition rates from 10 cps to 100 kc, variable advance or delay operation 0 to 100 μsec, variable pulse width from less than 0.1 to 100 μsec and variable amplitude low impedance output are provided. Snap-off top and bottom plates provide quick accessibility.

Electro-Pulse, Inc. Dept. ED, 11861 Teale St., Culver City, Calif.

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

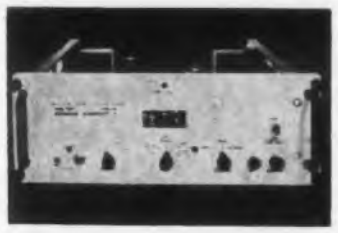
Computer Logic Elements

Compact

These transistor-magnetic core logic elements are part of a line that includes compatible drivers, input units and output units. The transistor-core element consists of one transistor and one encapsulated rectangular hysteresis-loop magnetic core. It can perform logical OR, inhibit and data storage functions. Its components are mounted on a printed circuit board and the entire unit sealed. Solder lugs, printed circuit lugs, plug-in headers or custom-packaging can be provided. The required power supply is 12 v, ±20 per cent; 120 of these units can be mounted in one square foot of panel space and are of indefinitely long life. Two rated operating ranges are available, of 0 to 50,000 and 100,000 bits per second.

Mack Electronics, Dept. ED, 40 Leon St., Boston 15, Mass.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION



Digit-Reading AC-DC Meter

Three-Digit Display

Utilizing a basic 100-mv dc servo system, a digital-reading ac-dc volt-ohmmeter has been made available. Its readings are displayed in numbers 7/16-in. high. Small indicator lights on the instrument point off decimal places, plus and minus lights show whether an indicated quantity is positive or negative, and an off-scale lamp lights when the quantity to be measured exceeds the capacity of the meter. Semi-automatic standardization is provided by an internal Weston type unsaturated standard cell, operated by a push button on the front panel. A Zero-Read-Hold selector either zeros the instrument or holds an instantaneous reading. Full scale response time is approximately five seconds.

The dc voltmeter circuit provides ranges of 0-0.1, 1, 10, 100 and 1000 v. Accuracy is ±0.1 per cent full scale. The ac voltmeter circuit provides ranges of 0-0.1, 1, 10, 100 and 1000 v rms. Accuracies are ±0.5 per cent from 30 cycles to 3 kc and ±1.0 per cent from 3 kc to 20 kc. The ohmmeter circuit ranges are 0-1000, 10,000 and 100,000 ohms, with full scale accuracy of ±0.1 per cent.

Performance Measurements Co., Dept. ED, 5301 W. McNichols Rd., Detroit 35, Mich.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 81 ON READER-SERVICE CARD ➤

RECOGNIZED LEADERSHIP

NEW SERIES 5000 sub-miniature ROTARY SWITCH

NOW PROVIDES **12** CONTACTS
ON EACH SIDE OF EACH DECK
UP TO 3 DOUBLE DECKS

No Increase In Size Over Series 7000

A low-contact resistance switch ideal where small size and peak performance are essential. Available with 1, 2, 3 or 4 poles on each deck and with either shorting or non-shorting contacts. Also available with rotary contact shorting out all positions except one, and all variations to shorting out only two positions. Order a switch today and see for yourself its many advantages. Also available as Spring Return Switch.

MINIATURIZATION HEADQUARTERS

international instruments

Since 1947, GROWING BIGGER making things smaller

ACTUAL SIZE

sub-miniature
SERIES L-5000

LEVER SWITCH

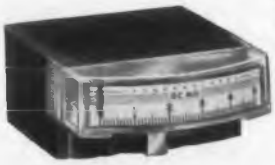
36 POLES
with single throw switch
24 POLES
with double throw switch

Designed for miniaturized or transistorized test equipment, speech in-put systems, intercoms and remote control panels. Also available as Spring Return Lever Switch.

SIDE INDICATORS

For Horizontal or Vertical Mounting

Now Available in 3 SIZES
Models 1145, 1135 and 1120
Pat. Pend



Write INTERNATIONAL INSTRUMENTS for Engineering Data Sheets Describing These Miniature Components

1½" Ruggedized Meters • 1" and 1½" Panel Meters • 1½" VU, DB and Illuminated Meters • Miniature Multitesters • Side Indicators

P.O. BOX 2954, NEW HAVEN 15, CONNECTICUT

Representatives in Principal Cities

Cable: "INTERINST"

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

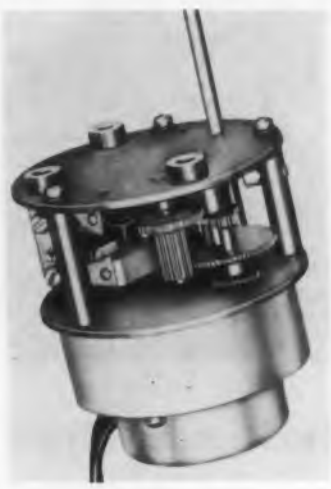
Epoxy-Cast Solenoid

Unlimited Continuous Service

Sold with an unconditional guarantee of limitless continuous service under rated conditions, this solenoid coil assembly is processed with epoxy resin under vacuum, and electronically cured. Designated Kast-Coil, it is waterproof and impervious to corrosive fumes; highly resistant to physical abuse and thermal shock. Kast-Coil can be supplied to operate at specified voltage.

Hays Mfg. Co., Dept. ED, Industrial Sales Div., West 12 St., Erie, Penna.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION



Solenoid Clutch Motor

Starts High Torque Loads

These units consist of a standard Bristol Circle B motor driving one of the inputs of a differential and a solenoid-operated finger stopping or releasing the other input. The output of the differential connects directly to the output shaft. The output shaft is disconnected entirely from the motor gear train when not in use. The full running torque of the Bristol motor may therefore be used to start a load.

The Bristol units are available with clockwise or counterclockwise outputs. Output speeds range from 60 rpm to as low as one revolution per month. The available output torque is limited to the developed torque of the motor used and should not be more than 20 in.-oz for optimum life. All motors and clutches are rated for 115 v, 60 cy applications, in standard units. Other voltages and frequencies can be provided.

Vocaline Co. of America, Inc., Dept. ED, Bristol Motor Div., Old Saybrook, Conn.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

5-Way Binding Post

For Test Prods or Plugs

Available in two models, for either 0.060 test prods or for standard 3/4 in. banana plugs, a new 5-way binding post provides unusual flexibility in making electrical connections. It can be used in the following five ways: plug or prod can be plugged into a jack fitted with a knurled thumb screw; a spade lug can be inserted around the post shaft and clamped; alligator or other clip leads can be fastened to shaft; a wire lead inserted through a hole in the shaft and clamped; or wire lead looped around the shaft and clamped. All metal parts of the binding post have been plated to withstand a 50-hour salt spray test. These posts also pass a 250-hour humidity test at 40 C.

Raytheon Mfg. Co., Dept. ED, Waltham 54, Mass.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

Right Angle Octal Socket

Structural Rigidity

This socket is mounted on a laminate base with a printed circuit supplying the circuitry to the socket and the component. Designated to be incorporated into printed circuits, the octal socket is held rigidly through supplementary buttress ribs. Base material is 3/32 in. XXXP Phenolic (Nema Grade) and the copper pattern is 0.0027 on two sides, offering a current carrying capacity of 15 amp per connection. Both the base material and the copper pattern of the standard sockets can be altered in size and dimension to meet the purchasers' specifications.

Cleveland Metal Specialties Co., Dept. ED, 1783 East 21 St., Cleveland 14, Ohio.

CIRCLE 89 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Proximity Transducer

Counts Small Parts

Operating on a principle similar to that of the military mine detector, a new hollow coil proximity transducer with a detachable cable connection can count in excess of 60,000 small metal objects per minute. Its hollow phenolic table, which can be used as part of either a slide or a chute, comes in 15 sizes, according to the size of part to be counted, from 1/4 in. diam to over 3 in. diam. The liners are replaceable. The device senses aluminum, brass, copper, iron and steel. The phenolic table mounts a sensing coil carrying a high frequency excitation and is cable-connected to a control unit which generates dc voltages, operates relays, actuates counters or controls automatic machinery. The transducer mounts on a rectangular bakelite panel, which may measure either 3-1/2 x 4-1/2 in. or 4-5/8 x 5-3/4 in, depending on the size required. Designated Model 4920-AN Hollow Coil Proximity Pickup.

Electro Products Laboratories, Inc., Dept. ED, 4500 Ravenswood Ave., Chicago 40, Ill.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

Double Clamp Plug

For Easier Soldering

To eliminate the problem of cold solder or flux joints resulting from movement while soldering and poor contact of metals, these plugs include a double clamp or ear arrangement. The lower ear provides a means of clamping the braid of shielded cable under pressure while soldering. The upper clamp can be closed down over the insulating jacket, doubly assuring a firm grip on the cord. This practically eliminates the nuisance of pulled-apart connections. Plugs are of two and three conductor types, with finger diameters of 0.250 in. or 0.206 in.

Richards Electrocraft, Inc., Dept. ED, 3741 N. Kedzie Ave., Chicago, Ill.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Servo Amplifier

1000 W

This servo amplifier features one-cycle response, and provides both reference-phase and control-phase power for a 3/4 hp motor. It allows automatic operation of milling machines and other 60 cy equipment or processes that permit programmed operation. Designated the MB-1000-60, the unit incorporates a Scott-connected transformer and has no toroids. It is used primarily in 220 v, three-phase operation, but will also provide 115 v, single-phase or two-phase operation with simple factory modification. It is installed in an enclosed, wheeled cabinet 20 in. high, 16-1/2 in. deep and 17 in. wide. A 200 w unit having the same basic features as the MB-1000-60, and designated the MB-200, is also available.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION

Versatile DC Supply

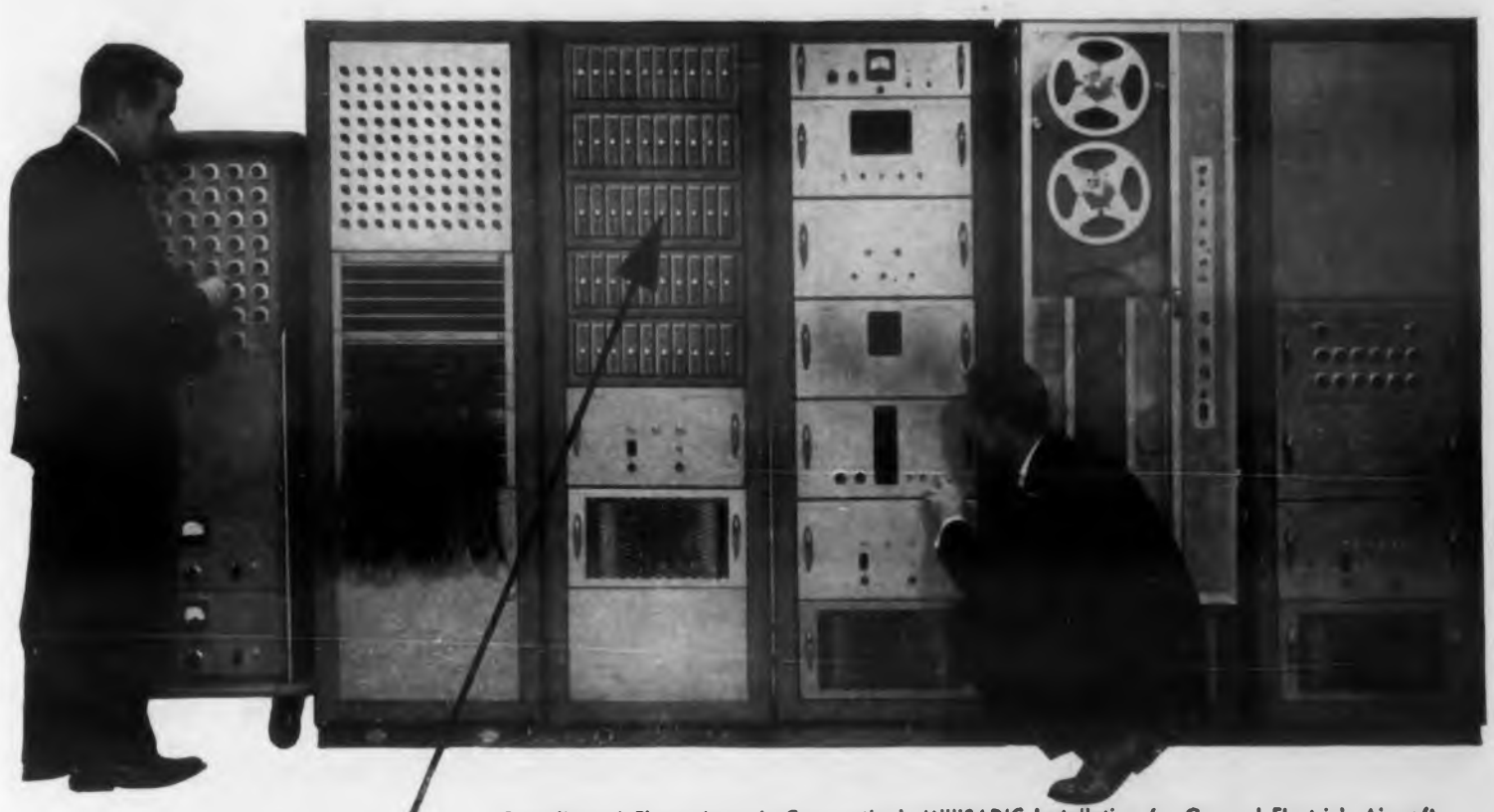
For Rack or Bench

Wherever filtered dc, from 0 to 32 v and 0 to 15 amp, is required this versatile power supply may fill the bill. It can be used in circuit design work in general and transistor circuit design particularly. Designated "NFAR," the unit operates from 115 v 50/60 cps. Its dc output is filtered to a ripple content less than 0.75 per cent at full load. A single control provides continuous variation of voltage output from 0 to 32 v at all current loads from 0 to 15 amp. Its steel panel, 19 in. x 1-1/2 in., is designed for standard rack mounting, but carrying handles also are provided.

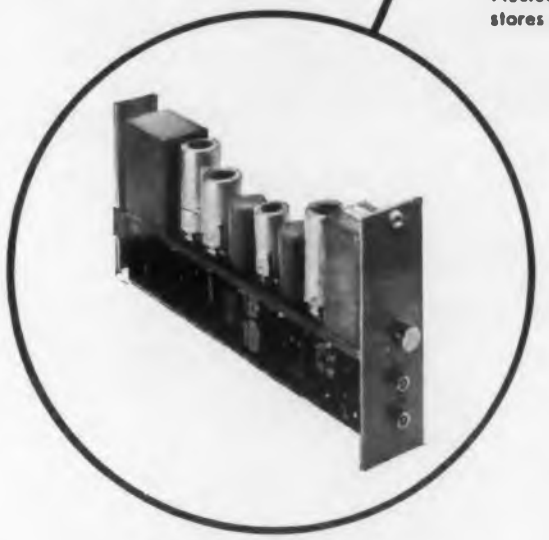
Electro Products Laboratories, Dept. ED, 4500 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION

Honeywell Preamplifiers combine isolated input with accuracy of 1 part in 2,000 in the CEC MilliSADIC



Consolidated Electrodynamic Corporation's MilliSADIC Installation for General Electric's Aircraft Nuclear Propulsion Dept., Cincinnati samples 400 jet engine temperatures per second and stores this information in digital form.



Honeywell Data Handling D-C Amplifier, Model 2HDH-2. This type is used as preamplifiers in the CEC MilliSADIC shown above.

The *isolated input* of the Honeywell Data Handling D-C Amplifiers, Model 2HDH-2 makes them ideally suited as preamplifiers to raise the input signals from thermocouples and strain gauges to the level required by the analog-to-digital conversion system of CEC's MilliSADIC installation at General Electric's Aircraft Nuclear Propulsion Dept., Cincinnati. The low noise level, high degree of linearity and zero and gain stability of these amplifiers provide the accuracy of 1 part in 2,000 required for this application. The exclusive Honeywell Second Harmonic Converter as the input element of these amplifiers provides the bonus features of ultra high common mode rejection and resistance to pick-up.

Honeywell Data Handling D-C Amplifiers, 2HDH Series, are compact plug-in, rack-mounted units specifically designed for use as preamplifiers in data processing systems. These amplifiers are available in the input range, rise time, frequency response or gain specifications required by many data processing systems. Other amplifiers in this series can accept as many as 150 separate D-C signals per second. *Write for Bulletin 2HDH . . .* Minneapolis-Honeywell, Boston Division, Dept. 10, 1400 Soldiers Field Road, Boston 35, Mass.

MINNEAPOLIS **Honeywell** H HONEYWELL

BOSTON DIVISION

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Adjustable Drafting Device

Speeds Drawing to Scale

For use by engineers, draftsmen, designers and technicians, this drafting device facilitates drawing to scale. It can be supplied in either 6-in. or 12-in. lengths and with engineer's scales, mechanical draftsman's scales, or architect's scales. The scales, which are of boxwood, white-edged and beveled, are secured to a swivel quadrant. The swivel can be rotated on a protractor base graduated between 10 and 90 deg. Adjustment is of vernier accuracy, and can be locked by dependable clamping screws.

The two engineer's scales are 1/10 in. to foot and 1/50 in. to foot. The four mechanical draftsman's scales are: half size reading to 32nds, full size reading to 16ths, 50ths of inches and 32nds of inches. The two architect's scales are 1/8 in. to 1/4 in. to foot, and 1/2 in. to 1 in. to foot.

Alvin & Co., Dept. ED, Windsor, Conn.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

Aircraft Power Sensors

Magnetic Amplifier Type

A group of power supply sensors has been developed that can detect over- or under-voltage, over- or under-frequency, and negative phase sequence. Output contacts are provided to light warning indicators, disconnect gyros, remove non-essential loads, or institute whatever other remedial action is indicated. Designed for 400 cps systems, these sensors utilize a basic circuit of toroidal coils, which in turn actuates an output relay. Operation is positive; borderline relay inaction is not possible. The basic units can be supplied with modifications to suit specific requirements; or special units designed for special needs.

Electronic Specialty Co., Dept. ED, 5121 San Fernando Rd., Los Angeles 39, Calif.

CIRCLE 101 ON READER-SERVICE CARD FOR MORE INFORMATION

RF Voltmeter
0.2 to 500 MC

Recommended as a practical replacement for the more expensive tuned amplifier or bolometer type rf indicating instruments this rf voltmeter, designated 91B, covers the range from 0.2 to 500 mc at values between 0.001 v to 3 v. Its zero stability and sensitivity permit extension of its range to detect signal levels as low as 400 μvolts and frequencies up to 1000 mc with some reduction of accuracy. A general purpose probe for high impedance work and a low VSWR 50 ohm probe are included with the instrument. These probes each contain a full wave diode detector which approaches rms response at levels below 0.1 v.

Boonton Electronics Corp., Dept. ED, Morris Plains, N. J.

CIRCLE 102 ON READER-SERVICE CARD FOR MORE INFORMATION

Telescoping Wireway Fittings
Oil Tight

Oil tight telescoping wireway fittings have been designed for use in machinery or buildings where oil and dust are problems. Illustrated is an exploded view of a telescoping section partially assembled into a 1 ft straight section. After adjusting the unit to the proper length, the "O" ring gasket and the two sliding retainer plates are bolted to the end flange of the straight section, forming an oil tight junction. The telescoping section for each of the three wireway sizes is 15-1/2 in. long, and permits adjusting the length of an assembly between 1-1/2 and 13-1/2 in.

Hoffman Engineering Corp., Dept. ED, Anoka, Minn.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

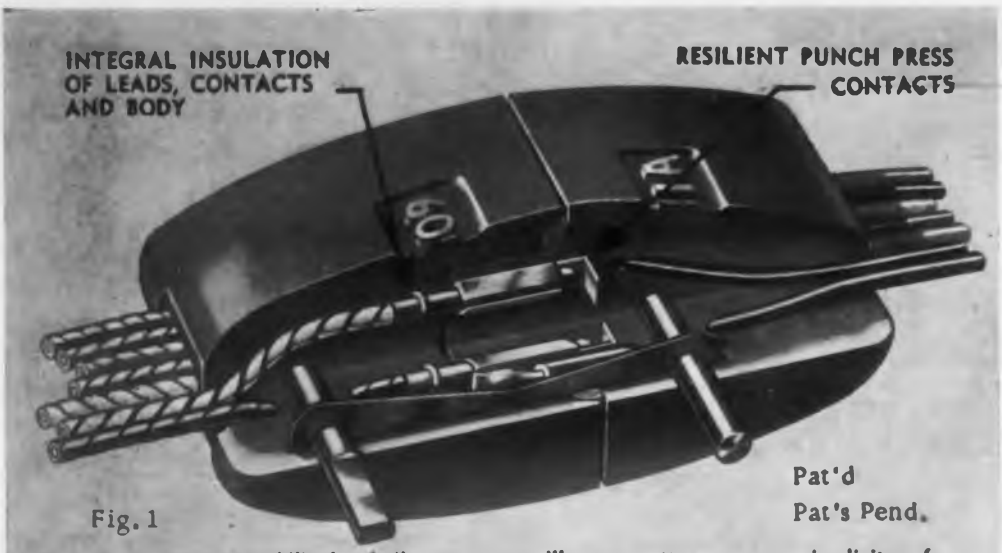


Fig. 1

Multi-contact umbilical missile connector illustrates the extreme simplicity of design made possible by Alden's "IMI" (integrally molded insulation) Technique.

First Major Advance in Connector Reliability Since Potting

UNIT CONNECTORS INTEGRALLY MOLDED ON CABLES RAISE WHOLE LEVEL OF CONNECTOR RELIABILITY

A new approach to connector design—"unitizing"—offers a simple low cost and basic solution to connector problems.

Advantages of Unitized Connectors

"Unitized" connectors are plastic molding of the entire assembly—contacts, leads, even circuit components *—integrally with the insulation forming the connector body itself.*

History

The first approach to connector reliability was through heavy mechanical construction using several dielectric inserts, wire supports, and screw machine parts for contacts and structural members. For high voltage applications it was necessary to provide long leakage paths at wire entries, resulting in connectors of unusual length, bulk and weight. (See Fig. 2.)

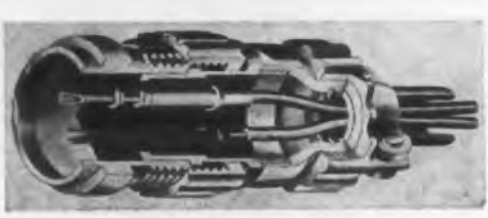


Fig. 2 **Conventional multi-contact connector.**

Potting was the next development. Based on previous mechanical designs, it provided for special sealing compounds to be cast at the rear of the connectors around the wires and solder cups after assembly. An improved moisture seal, somewhat better electrical characteristics and greater overall reliability resulted. Mechanical complexity, weight, and bulk were reduced somewhat.

However, certain disadvantages were inherent in potting; it is messy and tedious. Temperature and humidity must be controlled and time allowed for curing. It is expensive and virtually impossible to put on a fast, efficient production basis.

Most Recent Advance

The recent development of advanced molding techniques and highly specialized production machinery by Alden Products Company has made possible the new **Alden "IMI" (integrally molded insulation) process.** This technique enhances connector reliability because the entire assembly is *unitized.* The connector elements are molded by a single hot shot of insulation into a finished assembly. Using insulation material compatible with the wire insulation effects a homogeneous bond between the wire and connector insulations forming a continuous seal against moisture, contaminants, and leakage. (See Fig. 1.) The insulation material used can be selected for characteristics pertinent to the application.

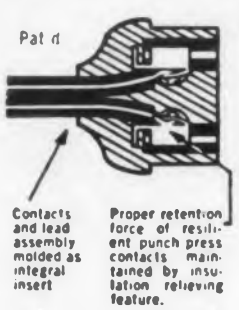


Fig. 3 **Alden "IMI"**

Since the connector parts and lead wires are embedded in the plastic connector body, excellent strain relief is provided for the leads, minimizing wire and solder joint fatigue under vibration and shock. Alden's new patented technique, providing a relieving space around the contacts, permits the use of highly resilient, long-life punch press contacts which eliminate troublesome, inelastic screw machine parts. The result is a compact, lightweight, unitized connector—inherently tough, durable and strong.

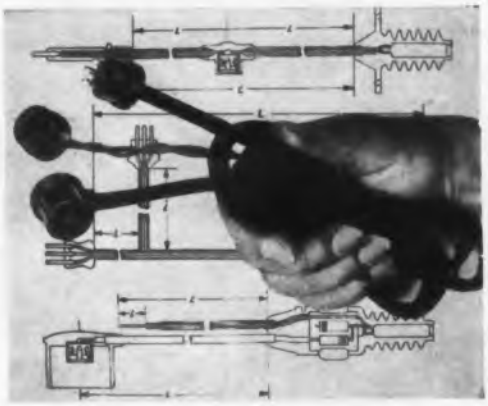
Electrically, advantages are numerous. Contacts are deep-seated in the connector openings and the long leakage path on the rear of the connector

eliminated. Protection against flashover, dust and moisture is provided. Circuit components such as resistors, chokes and capacitors can be molded in, insulated and protected, and located near their operating elements. For high voltage corona suppression, shielding shells can be molded into the insulation.

Alden's "IMI" Technique offers equipment designers greater freedom in connector cabling because of its extreme flexibility. An infinite variety of connectors suitable for any electrical or electronic application becomes possible—limited only by the designer's imagination. Because of their inherent simplicity in design and construction, mass production, with speed, economy and reliability becomes possible for the first time with Alden "IMI" unitized connectors.

Standard Designs Available

Available right now are standard, mass produced Alden "IMI" Connectors that are solving these problems in fixed, mobile, marine and airborne application: Instantly replaceable, molded unit connector and cable assemblies in several insulation types for a variety of uses. Tube caps and high voltage disconnects for commercial and military electronic gear. Umbilical disconnects for missiles, (See Fig. 1).



Alden "IMI' unit molded connector-cable assembly. Fig. 4

Alden Custom Design Service

If you have an urgent need for volume quantities we will work with you to design custom connectors and unit cables to meet your specific requirements. We have the techniques and facilities to move fast from idea to production.

We design and build our molds, giving us close tooling control for quantity and speed. Flexible production planning, combined with tooling techniques and manufacturing know-how assure you of proper timing with your schedules.

To get started quickly, send us your sketches or prints so that we can begin working on proposals immediately. Or, better still, we cordially invite you to visit our plant, bring your connector problems, and sit down with our engineers and see for yourself how we are prepared to help you. **Write, wire or phone** our Connector Engineer, Mr. Malcolm Partridge, today. See us at the IRE Show: Booth 1614 and 1616, March 18-21, Coliseum New York.

ALDEN PRODUCTS CO.
4139 No. Main St.
Brockton, Mass.

RMATION

New Products

Chopper

Needs No Phase-Shift Circuit

The Type 605 chopper is designed so that both the electrical and mechanical phase lags, inherent in choppers, total 180 deg at 400 cps. Thus, the Type 605 can be wired exactly 180 deg out of phase or reversed to be exactly in phase (360 deg out). Coil current is 25 ma; impedance, 190 ohms; resistance, 160 ohms. Phase change is ±10 deg at constant 400 cps under all conditions of use and life. Noise is less than 0.5 mv rms into 1 meg.

Oak Mfg. Co., Dept. ED, 1260 Clybourn Ave., Chicago 10, Ill.

CIRCLE 107 ON READER-SERVICE CARD FOR MORE INFORMATION

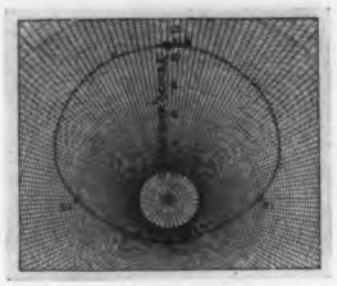
Eddy-Current Damper

Damps Linear, Rotary Forces

Damping torque is developed by transmitting an input force through a precision gear train which rotates a disc across permanent high intensity magnetic fields. The resulting eddy currents produce a damping torque which is directly proportional to the input speed of rotation. Design features include Alnico V permanent magnets, unaffected by time, cycles, or extreme temperature variations up to 1000 F. A complete range of models is available, with damping rates from 50 in. lb/rad/sec to 1250 in. lb/rad/sec.

Lyndon Aircraft Corp., Dept. ED, 140 Clifford St., Newark 5, N.J.

CIRCLE 108 ON READER-SERVICE CARD FOR MORE INFORMATION



More Efficient Antenna
In 450-470 MC Band

For communication systems that require exceptional power in some one direction combined with adequate coverage in all directions an antenna system, designated Type 201, has been developed, which provides a measured gain of 9.1 db in the desired direction as compared with conventional antenna equipment, and gain higher than unity through 360 deg. The Type 201 antenna system consists of three basic components—the base station, a flexible air dielectric cable, designated Ho Heliax, which saves 2 db over conventional cable, and a mobile antenna, designated Type 233 (RG-8). The Type 201 antenna system operates in the 450-470 mc band.

Andrew Corp., Dept. ED, 363 E. 75th St., Chicago 19, Ill.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

Ultrasonic Cleaner
Portable

Besides cleaning delicate mechanisms, this cleaner can also be used in experimental work for emulsions and mixing solutions. The unit shown can operate two cylinder tanks 6-1/2 in. diam x 7 in. deep, or two rectangular tanks 6-1/2 in. wide x 8 in. long x 10 in. deep alternately. The rectangular tank is equipped with a stainless steel basket and drain valve. Output of the generator is 150 w. The cleaning tanks are stainless steel. The transducers are barium titanate and operate at a frequency of 35 to 40 kc for best cleaning results.

The generator has a single oscillator tube and includes a line switch, tuning knob, selector switch, plate switch, and output meter, all mounted in a metal cabinet. The generator and cleaning tanks are connected with a 6 ft coaxial cable.

Labline, Inc., Dept. ED, 3070-82 W. Grand Ave., Chicago 22, Ill.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Frequency Meters
Highly Accurate

Frequency accuracy to within 0.1 per cent for a 120 v ±35 per cent source at a constant ambient temperature is obtained with these PFM meters. A corresponding series has been developed with integral temperature controls which enable the meters to operate at maximum accuracy from −55 to +55 C. Power consumption of the standard models is 1 w, and the temperature controlled meters have intermittent excursions to 20 w. The meters consist of a 3 in. D'Arsonval galvanometer and a case (approximately 2 x 3 x 1.5 in.) containing potted circuit components.

American Machine & Foundry Co., Dept. ED, 1025 N. Royal St., Alexandria, Va.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

UHF Transmitter
375-570 MC

This transmitter consists of an Eimac X-564-B klystron, a modulator unit, three 150 v 5 amp focusing magnet power supplies, a 500 v focus-electrode supply, a 6 v 40 amp klystron filament supply and a 15 kv 0.15 amp power supply. Operating range is 375 to 570 mc. Output power is 15 kv peak at maximum duty cycle of 0.1. Pulse rise and fall time are both less than 1 μsec; pulse length is continuously variable from 4 to 3000 microseconds and repetition rate is continuously variable from 5 to 500 pps. Designation is Model PC 57 transmitter. Operation is from a 240 v, 3-phase, 60 cps source. The unit is completely interlocked.

Levinthal Electronic Products, Inc., Dept. ED, 758 Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Instrumentation Motors
In Four Types

These are ball-bearing mounted machines with precisely ground stainless steel shafts, in varying lengths, diameters and threads, as required and with housings and brackets of high tensile strength heat-treated aluminum. Hysteresis motors come in single and dual speeds, single phase and polyphase, and are recommended for use where load inertia is large compared to that of the motor rotor. Induction motors also come in single and dual speed, single phase and polyphase; they are available in servo types, torque types and others, with special windings, taped windings, and for voltages up to 440, frequencies up to 1600 cps. The ac permanent magnet generators and tachometers supply single phase or polyphase voltages proportional to speed at ranges up to 100 v per 1000 rpm. The single phase and polyphase sine wave generators have a harmonic content of 0.5 of 1 per cent in 2-pole operation at 60 cps, 3600 rmp, and a maximum range of 5 v at 1000 rpm.

Syntorque, Inc., Dept. ED, 601 West 26 St., New York 1, N. Y.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Analyzers
In-Place Balancing

The model 300 and 400 vibration analyzers measure, troubleshoot and balance out vibrations caused by rotating parts and assemblies. The Model 300 is intended primarily for in-place and production balancing, while the Model 400 incorporates features for analyzing or troubleshooting as well as balancing.

Component features of the units include a sensitive, seismically-mounted vibration pickup. At maximum sensitivity, both models have a full-scale displacement range of 0.001 in. Both units operate on 110 ac 50 or 60 cy, 1 phase. The 300 requires 40 w, while the 400 requires 50 w.

International Research and Development Corp., Dept. ED, 797 Thomas Lane, Columbus, Ohio.

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Digital Flow Totalizer

For Turbine Flowmeters

Designed primarily for use with its manufacturer's turbine flowmeters, applicable also to balanced 500-ohm inputs from similar signal sources, this digital flow totalizer continuously displays turbine meter output on a 7-digit register. The register comprises a 5-digit mechanical counter and a 2-digit electronic counter, and can be set to show total pulses, counts or cycles. External reset and gating is controlled manually. Accuracy of the totalizer alone is ± one count; when it is used with its own manufacturer's turbine meter the system accuracy is ±0.5 per cent. Counting rate ranges from 20 to 1000 cps. Nominal power requirement is 50 watts, 115 v 60 cps ac. Dimensions are 6 x 6 x 14 in.; weight 15 lb.

Fischer & Porter Co., Dept. ED, 952 Jacksonville Rd., Hatboro, Pa.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Tester

Portable

Completely self-contained (although a scope may be plugged in if desired) this transistor tester measures grounded emitter current gain, collector saturation current, and input impedance. It embodies its own mercury cell power supply, with a rated battery life of about 1000 hours, and its own 1 kc oscillator. Printed circuitry has been used throughout to conserve weight, which is 3 lb.

Ranges and accuracies are: grounded emitter current gain, 0-200, ±3 per cent; input impedance, 0-10 k ohms, ±10 per cent; collector saturation current, 0-50 uamp, ±2 per cent. Emitter current is 0.5-10 ma. Collector voltage can be selected in steps of 1.5, 3.0, 4.5, 6.0 and 7.5 v.

The Model KT-1 is intended for laboratory use, quality control testing, incoming inspection and general trouble-shooting. It can be adjusted in direct reading calibrations to compensate for temperature variations. Positive meter overload protection has been built in. Dimensions are 5-11/16 in. wide, 5-1/2 in. deep and 10 in. high.

Baird-Atomic, Inc., Dept. ED, 33 University Rd., Cambridge 38, Mass.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION

Interval Timer
45 sec to 6 Days

This timer consists of one or two spdt or spst open blade switches rated at 30 amp, 115 v ac resistive and 1/3 hp at 115 v ac. The permanent magnet synchronous motor drives precision cut cams which actuate the 30 amp switches at full scale intervals, ranging in duration from 45 sec to 6 days. Shorter than 45 sec ranges are available with lower contact ratings. For use on all standard voltages, 60 and 50 cy, and a selection of special voltages.

Cramer Controls, Dept. ED, Centerbrook, Conn.

CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

Reluctance Pickoffs
Transistorized Translator

Variable reluctance electro-mechanical pickoffs can be substituted for potentiometers in aircraft and missile systems without adding much size or weight to the electrical installation by means of this transistorized instrument translator. Its small size and weight make it usable in all types of missiles and aircraft. Various models are available to operate meters, hydraulic valves, recorders, servos and similar equipment. The translators have no moving parts and need no adjustments. They receive power from the system power source, whether ac or dc, and when connected with a suitable a-c sensing transducer they produce a d-c or a-c signal which is proportional to the physical changes sensed by the transducer. A thick-walled anodized aluminum housing and completely potted interior enable the translator to withstand rugged environments without damage.

Crescent Engineering & Research Co., Dept. ED, 5440 North Peck Rd., El Monte, Calif.

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Thermal Time Delay Relay

Ambient Temperature Compensation

Encased in metal, this miniature relay is ambient compensated for normally encountered temperatures. Available in 6.3 v, 26.5 v, and 120 v heaters using approximately 2 w. Normally open or normally closed contacts. This low-priced item will carry a 3 amp load with a timing range from 10 to 90 sec. The seated height of the 7-pin base miniature relay is 1-7/16 in. and is all metal.

O. K. Electronics Corp., Dept. ED, 7 Hunt Place, Nutley 10, N. J.

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

400 cy Power Supplies

Motor-Alternators

A line of compact, 2-bearing, 400 cy motor-alternator sets are especially suited for the production testing of electronic equipment. These units are supplied as a complete package with the static exciter, magnetic amplifier type voltage regulator, voltmeter, and voltage adjusting rheostat. These power supplies feature a mono-coil design, static excitation, magnetic amplifier voltage regulation, permanently lubricated ball bearings, rapid response, ±2 per cent voltage regulation and less than 3 per cent total harmonics.

The output frequency is between 408 and 418 cy from no load to full load. The 2-bearing units may be operated from either 115, 208, 220, 440 or 550 v, 3 phase, 60 cy power. Ratings available with 3 phase outputs from 500 w to 6.25 kva.

The Hertner Electric Co., Dept. ED, 12690 Elmwood Ave. N.W., Cleveland 11, Ohio.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency-Amplitude Analyzer

Reads Wave Components

Frequency-amplitude spectra of random waves and the frequency and amplitude of individual components of a periodic complex wave are analyzed and read out by this instrument. Designated TP-625, it determines and measures wave components in db and per cent of total signal. Results are indicated by a calibrated attenuator as well as on a meter, and outputs are also provided for driving a recorder.

Technical Products Co., Dept. ED, 6670 Lexington Ave., Los Angeles 38, Calif.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

Humidity Chamber

2-Point Programming

An accurate and inexpensive automatically controlled two point programmer and recorder system for a vapor-temperature controlled relative humidity chamber, the Dual Microtrol Controller, has two independent and adjustable control switches mounted to a hydraulic bellows assembly. There are no cams and the two desired conditions—both wet and dry bulb temperatures—are set on the controllers. The on-off dial riders on the timer are set to correspond with time cycle specified in the test; the Dual Microtrol then automatically holds the low condition for the desired number of hours until the timer trips. The timer then transfers control action to the other set of controllers and the humidity cabinet rises to the high condition holding for desired number of hours until timer trips again, transferring control action to initial setting.

Blue M Electric Co., Dept. ED, Blue Island, Ill.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Nonlinear Potentiometers

For Sine-Cosine, Square-Law

Standard sine-cosine potentiometers of this type are available in AIA sizes 30 and 20 with tolerances of ±0.5 per cent peak to peak and ±1.0 per cent peak to peak respectively. Standard square-law potentiometers are available in AIA sizes 30 and 20 with tolerances of ±0.25 per cent and ±0.75 per cent independent conformity respectively. These nonlinear pots meet military specifications.

Ace Electronics Assoc., Inc., Dept. ED, 103 Dover St., Somerville 44, Mass.

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

Custom-Built Ovens

Top-Loading

Gas-electric ovens, designed to be loaded and unloaded from the top either manually or by an overhead hoist, and custom-built as to dimensions, insulation and patterns of air circulation, have been put on the market. The one illustrated here measures 67 x 44 x 38 in., overall; and encloses a working space 36 x 30 x 24 in. This model is electrically heated and is fitted with electric ignition and electronic combustion safety controls. Pilot lights show when blower and heater circuits are energized. Temperature controllers are integrally mounted.

Grieve-Hendry Co., Inc., Dept. ED, 1401 W. Carroll Ave., Chicago 7, Ill.

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

Phenolic Terminal Blocks

With Up To 120 Terminals

Molded of black phenolic plastic, a series of terminal blocks has been made available with up to 120 terminals per block. The terminals are arranged

in rows of 20 and the blocks can be supplied from stock with any number of rows up to six. The terminals are 0.040 in. plated brass, molded into the blocks. The obduracy of the phenolic material and its high polish facilitate removal of any accidental solder flash resulting from wiring operations. The rows of terminals are graduated in length and identified by numbering along the top row. Base dimension is 3 in. x 6-1/16 in.; height depends on the number of rows required. Designation is PJ-106.

Audio Development Co., Dept. ED, 2833 13th Ave., South, Minneapolis, Minn.

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

Plug-in Decade Counter

12,000 Counts Per Minute

For high-speed shop or laboratory counting needs this portable instrument offers a combination of plug-in electronic decade and five-digit mechanical register. It consists of an input amplifier, a pulse shaper, plug-in decade unit and a register; and is capable of counting rates up to 12,000 per minute (200/sec). It responds to pulses of 2.5 v peak, or to ordinary contact closure. Capacity is 999,999 counts, with an accuracy of ± one count. The unit operates on 105-125 v ac, and supplies 90 v accessory dc for operation of photocells, etc. Weight is 7 lb.

Performance Measurements Co., Dept. ED, 15301 W. McNichols Rd., Detroit 35, Mich.

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION

Spectrum Analyzer

Sub-Sonic Through Microwave

Useful for evaluating noise, vibration and other changing phenomena, this flexible instrument is designated Spectral Power Density Analyzer, Model PDA-1. Its function is to analyze automatically the energy distribution of random information of many kinds.

Panoramic Radio Products, Inc., Dept. ED, 10 South Second Avenue, Mount Vernon, N. Y.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Precision Potentiometer

Has Unlimited Phasing

Designated the RL-270B, this line of unlimited phasing potentiometers include these specifications: a 3/8 in. depth per section; continuous service up to 150 C; stainless steel clamps with unlimited phasing range; a larger number of taps, limited only by physical spacing; and reliable performance under high g or vibration conditions. There are three styles of mounting: servo bushing and 3-hole bushing; available in ball or sleeve bearings, shafts as specified. High unit pressure contacts give permanent low resistance tap connections and eliminate linearity distortion.

The Gamewell Co., Dept. ED, Newton Upper Falls 64, Mass.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION

Dipped-Mica Capacitors

Plastic Coated

These plastic-coated dipped-mica capacitors meet applicable RETMA test standards for molded mica capacitors, exceed many of the advantages of the molded mica units, and are smaller in size. Available in a complete range of standard capacitance values, they are recommended for long-life, performance and stability characteristics. Opearting temperature range is −55 to +125 C.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

FM-To-Voltage Converter

62 Filter Bandwidths

This converter operates on any of the 23 standard IRTWG telemetering sub-frequencies, and on a total

of 62 different low-pass filter bandwidths from 11 to 3490 cps. When desired, transistor-powered servo-actuated corrections can be provided for arbitrarily chosen zero and 100 per cent information frequencies. Designated Model FM-108, the converter has accuracy of 0.05 per cent and dynamic accuracy better than 0.2 per cent. The converter is composed of plug-in units on which the actual components are mounted. An all-channel, voltage-controlled oscillator is also available for use with this equipment. The FM-108 converter occupies a standard 19-in. panel 10-1/2 in. high, and weighs 30 lb.

Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed-Wiring Capacitors

Assembly-Line Package

These capacitors, intended for use in printed-wiring assemblies, are packaged for handling on assembly lines. They are of the paper-tubular type, adapted for upright mounting by means of an outer insulating sleeve. The outer lead in every case indicates the outside foil. Provision is made at the capacitor base for free circulation of air. Designation is P-156.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION

Synchronous Motor

Permanent Magnet

The Type 114 synchronous motor has a torque of 30 in.-oz at 1 rpm, a selection of speeds from 60 rpm to 1/2 rpd. Fast start and stop, low input (approximately 3.25 w) and permanent lubrication are designed into this motor. It will operate on all standard ac voltages, 60 and 50 cy. The over-all motor depth dimension is 1-5/16 in.

Cramer Controls Corp., Dept. ED, Centerbrook, Conn.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Teflon Cloth

Pressure Sensitive

The adhesive back, which is protected by a strippable paper, offers a simple and economical method of using Teflon. The anti-stick qualities of Teflon can now be easily applied to guides, slides, chutes, rails, and other equipment hampered by sticking and build-up.

General Plastics Corp., Dept. ED, 165 Third Ave., Paterson, N.J.

CIRCLE 148 ON READER-SERVICE CARD

Contact Cleanser

Less Toxic Than Carbon Tet

A refined grade of 1, 1, 1-Trichloroethane has been made available under the designation Vythene-E. Tests have shown it to be a good cleaner of precious metal contacts used in electronic equipment. Like its parent product, Vythene, Vythene-E is approximately 20 times less toxic than carbon tetrachloride. It is stable to all metals, including aluminum; and has no flash point. Vythene-E is sold in drum quantities. It can be reclaimed successfully by means of its manufacturer's special distilling equipment.

Tect, Inc., Dept. ED, Cortland Ave. and Erie St., Dumont, N.J.

CIRCLE 149 ON READER-SERVICE CARD

Self-Filling Draftsman's Pen

Push-Button Cartridge

A draftsman's pen that fills itself at the touch of a button, with no ink on the outside of the nib, has been made possible by a new cartridge-loading design. The cartridge contains enough ink for 55,000 in. of ruled lines. The draftsman fills the pen by pushing the button with his thumb. When exhausted, the cartridge can be replaced in a matter of seconds. Time is saved and neatness promoted.

Clover House, Dept. ED, Box 1107, Santa Monica, Calif.

CIRCLE 150 ON READER-SERVICE CARD

Telemetering Oscillator

Improved Stability

A subcarrier telemetering oscillator has been designed to give linearity better than 0.5 per cent of full bandwidth over full input range. Stability during variations in filament and plate supply has been increased. A 1 v B+ variation produces less than ±0.5 per cent full bandwidth frequency deviation. A ±5 per cent filament voltage produces less than 1 per cent of full bandwidth deviation. A new plug-in printed circuit filter board permits changing the frequency channel of the basic oscillator without removing it from service. The unit operates on either ac or dc filament voltage, and the input level can be adjusted so as to operate either from −2.5 v to +2.5 v, or from 0 to 5 v.

Dorsett Labs., Inc., Dept. ED, 401 E. Boyd St., Box 862, Norman, Okla.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

Radiation Spectrometer

Alpha, Beta or Gamma

Consisting essentially of a linear pulse amplifier, a pulse height analyzer, a precision ratemeter and a high-voltage power supply this spectrometer, designated Model SR-300, is suited to alpha, beta or gamma spectrometry. The energy-band width ranges from zero to full spectrum. The instrument can be used as a differential or integral spectrum scanner, as a photopeak counter, or as a wide energy-band counter. In addition, being to a large degree independent of pulse duration or shape, it may be used with scintillation detectors utilizing fast or slow phosphors, or with ionization chambers. The Model SR-300 was designed primarily for geophysical measurements, but it is also suited to many other laboratory applications.

Mount Sopris Instrumental Corp., Dept. ED, 1320 Pearl Street, Boulder, Colo.

CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 153 ON READER-SERVICE CARD ➤

New Products

Delay Line with Built-In Oven

Provides Stability

This temperature controlled delay line is supplied to specifications in delay time range 100 to 1000 μsec with stability ±0.01 per cent from 0 to +60 C. Known as type SDL-25T, it is designed for use in commercial memory channel units. Carrier frequency is 10 to 40 mc. Oven heater voltage is 110 v; power, 30 w.

Bliley Electric Co., Dept. ED, Union Station Bldg., Erie, Penna.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

Thyratron Amplifiers

For Power Control Devices

These packaged thyratron amplifiers are offered with tube ratings from 2.5 through 18 amp output current, single phase, 2 phase and 3 phase. They can be connected for back to back, one, two or three half-wave operation and bridge circuits. The units meet all requirements for industrial operation and are designed for vertical panel board mounting.

Hanson-Gorrill-Brian, Inc., Dept. ED, 85 Hazel St., Glen Cove, N.Y.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

Shop and Pocket Magnifier

50X, 0.001-In. Divisions

This 50-power pocket and shop microscope contains a precision, etched-glass reticle which is calibrated for measurements up to 1/10 in. in 0.001-in. divisions, and with which estimates to 0.0005 in. can easily be made. This microscope is intended for direct-reading measurements, for checking precise di-

CIRCLE 58 ON READER-SERVICE CARD ➤

mensions by means of powerful magnification, for inspecting surfaces, threads and small parts, and for general use wherever highly accurate observation is needed. It is no larger than a fountain pen. Construction is sturdy; the reflector at the base of the instrument, which illuminates the object to be examined, is chrome.

Edmund Scientific Co., Dept. ED, Barrington 23, N. J.

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION

High Temperature Coil

Withstands 260 C

Use of 100 per cent Teflon insulation permits efficient coil operation at −68 to +260 C temperatures, continuous duty. Coils are baked out at 300 C under 29-1/2 in. of vacuum, and are nongassing throughout the temperature range. No varnishes, adhesives or other gas-producing materials are used. Moisture absorption of materials used is zero. Coils are resistant to most chemicals, will not react with coil metals, and withstand oxygen attack up to 300 C. These high-temperature units can be wound in subminiature size, using Teflon wire as small as No. 50 AWG. For ultrahigh temperature applications, coils are produced with mica insulation, which, however, is not nongassing.

Tur-Bo Jet Products Co., Inc., Dept. ED, 424 S. San Gabriel Blvd., San Gabriel, Calif.

CIRCLE 158 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire Wound Resistor

"Toothpick" Type

Standard tolerance of these resistors is ±1 per cent; some can be obtained as close as ±0.1 per cent. The smaller resistor, known as type 1288, measures 1 in. long x 1/8 in. diam; its maximum resistance is 100 K, and it dissipates 0.15 w. The type 1289, larger, measures 2 in. in length x 1/8 in. diam. Its maximum resistance is 200 K, and it dissipates 0.20 w. Both are noninductive. These units will pass environmental requirements of MIL-R-93-A, Amendment 3.

The Daven Co., Dept. ED, 530 W. Mt. Pleasant Ave., Livingston, N.J.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 58 ON READER-SERVICE CARD

New Products

Frequency Meter
2350 to 10,500 Mc

The Model 802 Frequency Meter has a Veeder-Root digital counter system for indicating frequency readings. Two cavities are tuned by turning a precision lead screw. The single knob actually tunes both cavities while actuating the counter. The counter reading is referred to a nomograph-type calibration chart. Frequency in megacycles is obtained without calculations at any point in the entire frequency range to the rated accuracy of 0.2 per cent.

Narda Corp., Dept. ED, 160 Herricks Rd., Mineola, N.Y.

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized Inverter
Handles 300 VA

Weighing 5.5 lbs and with a volume of 96 cu in., the CW-1029 has a life expectancy of over 10,000 hours and requires no servicing. It will withstand vibrations of 10 g, between 10 and 2000 cps. Voltage modulation will not exceed 0.25 per cent. The CW-1029 is rated at 300 va to altitudes in excess of 100,000 ft. It is conduction cooled through the mounting base of the unit. Having no tubes, it has zero warm-up time. This unit controls 400 cps to ±0.2 cy, and operates at 60 to 70 per cent efficiency. The harmonic content of the CW-1029 does not exceed 5 per cent of the fundamental.

Electrosolids Corp., Dept. ED, 7436 Varna St., No. Hollywood, Calif.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

Sub-Chassis Power Supplies

Two Similar Models

Two similar sub-chassis power supplies have been made available, differing only in their output voltage ranges. One, designated Model PS-S150, delivers 150 v, 150 ma, dc, and 6.3 v ac 6 amp. The other, Model PS-S300, differs in that it delivers 300 v dc. In both, d-c regulation is 0.5 per cent for 10 per cent lines; 1 per cent for no load to full load. Input is 115 v, 60 cps. Units are designed to be mounted on chassis with four screws, and contain provision for easy adjustment of operating voltage within the limits specified. Construction is rugged.

Reflectone Corp., Dept. ED, Stamford, Conn.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

High Pressure Blower

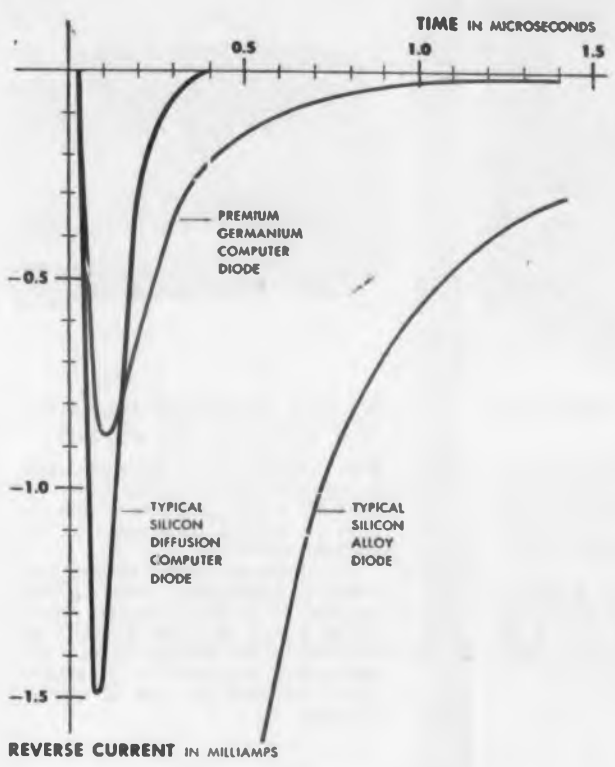
Low Noise

These centrifugal blowers deliver 25 to 350 cfm at a static pressure of 10 to 55 in. water column (2 psi) on suction or pressure. They have 3 to 9 cascaded pressure stages. They have no wearing parts and are direct-coupled to a 1/4 to 2 hp induction motor which is an integral part of the unit. The shaft speed of the Model L blower is 3400 rpm and noise levels are relatively low. The entire assembly runs on 2 ball bearings. Integral air filters and outlet manifolds are available. Motors are wound single or 3-phase and for all standard line voltages.

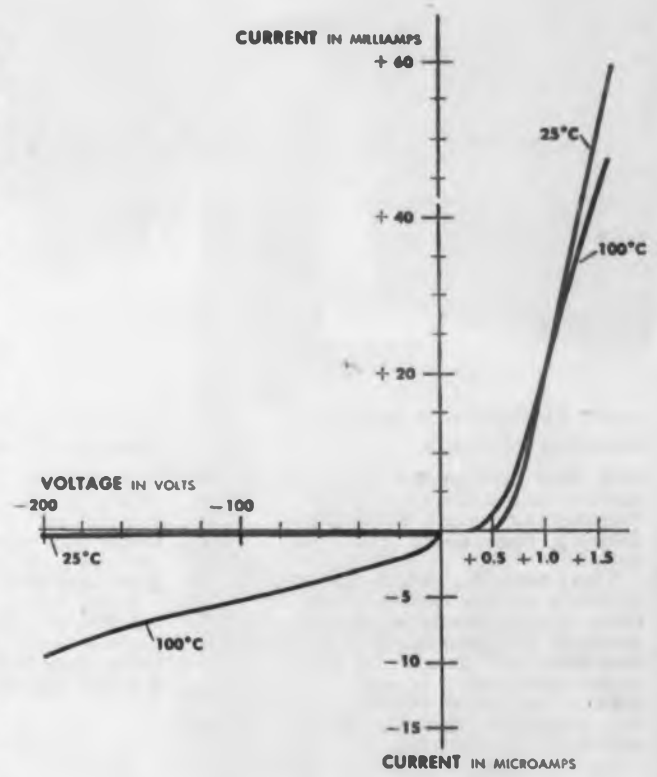
Rotron Mfg. Co., Dept. ED, Schoonmaker Lane, Woodstock, N.Y.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.



COMPARISON OF PULSE RESPONSE OF THREE DIODE TYPES



TYPICAL D-C CHARACTERISTICS OF PSI's SILICON DIFFUSION COMPUTER DIODE

Silicon Diffusion Computer Diode

FOR FAST RECOVERY AND HIGH-TEMPERATURE OPERATION

Research and development work in solid state diffusion at Pacific Semiconductors, Inc. has led to a significantly advanced semiconductor product, the silicon diffusion computer diode described herein. The fast-recovery characteristic of the best germanium computer diodes and the high-temperature operational capability of silicon diodes are combined in one unit. PSI's silicon computer diode will provide performance not heretofore available in circuits requiring fast pulse response at high temperatures.

The silicon computer diode is now being produced at a limited rate by PSI's Manufacturing Department. Sample quantities can be purchased. Write today for product literature.

Production engineering of PSI's silicon computer diode has been conducted in part under Signal Corps. Industrial Preparedness Study Contract No. DA-36-039-SC-70274.

SPECIFICATIONS

RETMA Type 1N643

Forward Current (min. at +1 volt, 25°C)	10 ma
Reverse Current	
(max. at 25°C)	.025 μa (−10vdc)
	1.0 μa (−100vdc)
(max. at 100°C)	5.0 μa (−10vdc)
	15.0 μa (−100vdc)
Reverse Saturation Voltage (min. at 100 μadc, 25°C)	−200 volts
Reverse Recovery (max. time to 200K, 25°C)*	0.30 μsec
Temperature Range	−65°C to +150°C
Maximum Average Rectified Current	40 madc
Maximum 1 μsec pulse, 1% duty factor	2 amps

*Switch from +5 ma to −40 volts, 2300 ± 10% ohm loop resistance.

PSI offers standards of reliability in fusion-sealed germanium and silicon diodes with four basic configurations.

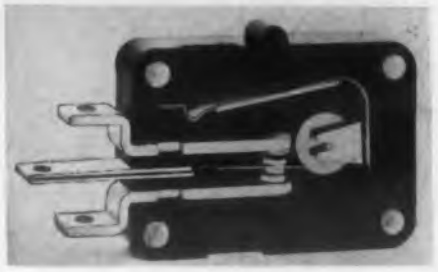
Pacific Semiconductors, Inc.

10451 West Jefferson Boulevard, Culver City, California

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Resonance-Free Snap Switch
Eliminates Undue Arcing



By virtue of a virtually resonance-free mechanism a new sensitive snap switch essentially operates without arcing and without so-called vibratory contact when actuated. The design permits ever increasing pressure immediately before the actual breaking phase. Designated the Cam-Flip switch, Model C, it can make positive, complete, noise-free contact in less than 450 microseconds. It withstands 20 g's of vibration over a frequency range of 10 to 4000 cps. The silver contacts can resist 200,000 actuations at 10 amp; the mechanical life of the switch is 27 million actuations.

C. Torres Engineering Co., Inc., Dept. ED, South Hackensack, N. J.

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION

Voltage Control Unit
For AC Aircraft Tests

A compact voltage control unit for testing ac-operated aircraft equipment and components, this device operates on 115 v, 400 cps single-phase supply and provides a continuously adjustable output from zero to 115 v under maximum load current of 15 amp. Designed to be readily portable, the unit is equipped with a carrying hand, weighs only 12 lb, and is housed in a ventilated enclosure 12 in. wide x 6 in. deep x 7 in. high. Standard instrumentation includes a 3-1/2 in., 21-reed frequency meter accurate to 0.5 per cent and an a-c voltmeter accurate to 2 per cent. A 6-ft rubber-covered input cord is supplied.

Opad Electric Co., Dept. ED, 69 Murray St., New York 7, N. Y.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

Clamp Lining
Teflon and Asbestos

This clamp lining is made by a process which involves molding to shape an asbestos wire-reinforced strip that is impregnated with Teflon. The cushion-like material made by this method combines the high temperature characteristics of asbestos with the electrical, chemical and mechanical properties of Teflon. The Joclamp withstands temperatures ranging from —300 to +500 F. Engine tested, the clamps prove to be impervious to hydraulic fluids, lubricating oils, corrosive fuels and solvents. The material has a coefficient of friction of 0.04, as well as a high degree of resiliency.

Joclin Mfg. Co., Dept. ED, North Haven, Conn.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

Heating Tapes
Fiberglass Insulated

Applied to any shape or type of surface, the heating tapes are quick heating and economical. Two types are offered, Standard and Heavy Insulated. Standard tapes are made of stranded resistance wire covered with two layers of fiberglass insulation knitted into a flat tape form with a connecting lead wire at each end.

Heavy insulated tapes are same as standard tapes with a heavy glass braided covering over the tape for added insulation. They are recommended when used in contact with an electrical conducting surface. All tapes are delivered complete with two feet of heat resistant nickel-clad copper lead wire ready for immediate operation on 110 v ac or dc.

Burrell Corp., Dept. ED, 2223 Fifth Ave., Pittsburgh 19, Pa.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Miniature Clutches
Constant Torque

Maintaining constant torque at any variable rpm, these miniature clutches are designed for use in guided missiles, computers, tracking devices, film rewinders, memory devices, business machines and wherever reliable, compact torque limiting devices may be needed. They are supplied in three types—magnetic, spring beam and multiple disc. They are constructed in five sizes, with ratings from 1 in.-oz to 800 in.-lb. Outside diameters are 3/4 in. to 2-1/4 in., and bore sizes 1/8 in. to 1/2 in.

Radial Metal Products, Inc., Dept. ED, 1044 Linwood St., Brooklyn 8, N. Y.

CIRCLE 174 ON READER-SERVICE CARD FOR MORE INFORMATION

Sound-Measuring Microphones
Read Shock Waves

For measuring high frequency sound pressures such as occur in exhausts from jets or missiles, or in gunfire and explosions, this new line of laboratory microphones can be made to read audio levels in excess of 200 db versus 0.0002 microbars, at frequencies between 20 and 120,000 cps. The microphones are stiffness-controlled over the specified frequency ranges and therefore introduce no phase shift errors to interfere with accurate reproduction of acoustic transients. Their high acoustic impedance provides linear response to extremely high magnitudes, so that the microphones are suited to measurement of conventional sound pressure levels as well as measurement of blasts and shock waves. There are four models, of different frequency ranges and sensitivities, and varying in size from 5-1/2 in. long to 1/2 in. long. Operating temperature range is −40 to +160 F. Accessory equipment, including power supplies, preamplifiers and adapters, is available.

Massa Laboratories, Inc., Dept. ED, 5 Fottler Road, Hingham, Mass.

CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you sent us your subscription renewal form?

Self-Locking Anchor Nut
23 Per Cent Lighter

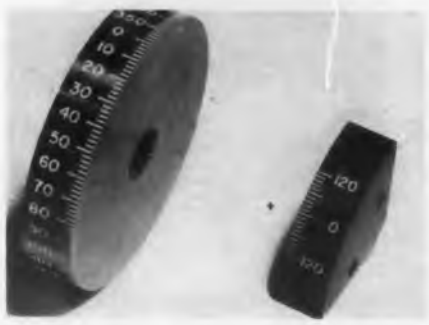
First of a series of redesigned anchor nuts, this unit is interchangeable with, but far lighter than, other designs, including those of its own manufacturer. In some sizes they are 23 per cent lighter. They facilitate use of newly-designed short-thread bolts for additional weight savings. Still further, the design permits the bolt grip to enter the base of the nut, reducing the need for shims.

The self-locking action is positive under severe vibration. The heat-treated threads do not lose their locking ability even after repeated insertions and removals of mating bolts. The nuts, being harder than most mating bolts, will not be damaged by cross-threading. The carbon steel nuts are useful up to 550 F; for higher temperatures or non-magnetic applications a similar line is made in A286 corrosion-resistant steel. Sizes now available are from 8-32 through 3/8 in.-24. Designation is Kaylock 1000.

Kaynar Co., Dept. ED, Box 2001, Terminal Annex, Los Angeles 54, Calif.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

Drum Dial and Vernier Sets
In Four Diameters



These precision engraved Drum Dial and Vernier sets are available in 1-1/2, 2, 2-1/2, and 3 in. diam. A complete set consists of drum dial and a vernier which allow readings within 6 minutes of accuracy. These sets are made of 24ST aluminum are finished black anodized to milspecs.

Standard stock units are engraved in 1 deg. steps, reading from 0 to 360 deg. Type "K1" and "K2" stainless steel hubs are also available for these dials, allowing a wide range of available bore or shaft sizes. PIC Design Corp., Dept. ED, 160 Atlantic Ave., Lynbrook, L.I., N.Y.

CIRCLE 177 ON READER-SERVICE CARD FOR MORE INFORMATION

MICROWAVE PROGRESS

Frequency Measurement Devices

A couple of years back, it seemed to us that there were almost as many frequency measuring devices as frequencies. Anticipating that, sooner or later, some sort of definitive material would be needed, our engineer, Bob Lebowitz, consolidated the scattered, available information into his excellent report, "Frequency Measurement Devices"

This report provides a valuable summary of the various equipment types for measuring frequencies in the 300 to 40,000 mc/s range, and a succinct reference source for their respective design considerations and applications. It covers coaxial and cylindrical cavity wavemeters; crystal oscillator frequency standards; and use of stable reference spectral lines.

Most of the commercial requirements for precision are met by open circuited coaxial and right cylindrical waveguide cavities. Since the $\lambda/4$ and $3/4\ \lambda$ coaxial cavities can be made smaller than right cylindrical waveguide cavities, they are generally preferred for lower microwave frequency measurements. To overcome the critical design problem of contacting the movable plunger without introducing contact resistance in coaxial frequency meters, it has been found more satisfactory to use a non-contacting choke system rather than shorting fingers.

Broadband cavity frequency meters have accuracies that vary between .01 and 1%. For accuracies greater than .001%, low frequency quartz crystal standards are utilized. For microwave applications, multiplying and heterodyning means are required to compare the l.f. frequency oscillator signal with the signal of unknown frequency.

Although we've tried to cover most of the aspects of Bob Lebowitz' report in the preceding paragraphs, space has forced us to omit many of the important details. But, the full report on frequency measurement devices is available to you for the asking. Just request on your company letterhead, "PRD Report Vol. 2 No. 4F".

New Products

Hi/Lo Temp Chamber
For Small Parts

Temperature is automatically controlled within ±2 F in this 5 cu ft all-steel chamber. It drops temperature to −65 F in 5 min, raises it to +400 F in 10 min. Three 2 in. diam instrumentation ports are on the left side. Designed for testing of instruments and components, it has 100 lb dry ice capacity.

Mantec, Inc., Dept. ED, 126 Maryland St., El Segundo, Calif.

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

Timing Motor
1 rpm to 1 rph

The Synchron RHP eliminates the need for extra gears between 1 rpm and 1 rph in intermittent time trains, and it provides a gear train with lifetime lubrication. Speeds of the motor in revolutions per hour are 0.8 to 120.0 at 60 cy 0.8 to 100.0 at 50 cy and 1.0 and 2.0 at 25 cy. It is available with an optional 1-way or 2-way clutch. The above speeds are in addition to 42 other speeds. The motor is available with 4 hole mounting and operates mounted in any desired position. Continuous stalling does not damage the motor coil according to the manufacturer.

Hansen Mfg. Co., Dept. ED, Princeton, Ind.

CIRCLE 181 ON READER-SERVICE CARD FOR MORE INFORMATION

Crystal Unit
Withstands 100 G Shock

With a frequency range of 200-500 kc, the Model ST 70X Crystal Unit meets a shock test of 100 G's. It will withstand vibration of 15 G's, 10-55 cps for 2 hrs, per Mil C 3098B; 5 G's, 5-500 cps for 45 minutes, per MIL E 05272A; and 3 G's, 500-1200 cps per MIL T 5422 (ASC). Storage temperatures are −65 to 135 C1 operable temperature range is −55 to +120 C. Frequency excursion is low as ± 0.001% over any given 30 C temperature range. This crystal has been developed primarily for missile requirements. Bulova Watch Co., Electronics Div. 1, Dept. ED, 40-06 62nd St., Woodside, 77, N.Y.

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Amplifier
Small Size

The Model No. AEC-0-202, single-stage, 400 cps magnetic amplifier is designed to drive a Bu Ord Mark VII Servo Motor or other similar two-phase servo motors up to 6 w ratings. This unit, measuring 4.2 cu in., 1.75 in. diam by 1.75 in. high, is especially useful where space requirements are critical. It is designed to meet MIL-E-5272 environmental specifications and is hermetically sealed. The unit may be operated from a 115 v, 400 cps supply. It has a power gain of more than 300 to 1, output voltage of 60 v max. and a speed of response of approximately 2.5 msec.

American Research & Mfg. Corp., Dept. ED, 920 Halpine Ave., Rockville, Md.

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you sent us your subscription renewal form?

New Products

Revised Drafting Template

Meets Latest Standards

A revised drafting and lettering template, with symbols conforming to the most recent changes in military and industrial standards, has been added to its marker's line of templates. The unit, designated No. 35, carries the symbols shown above. Drawing edges are tapered and finger relief is provided at edges for lifting.

E. F. Twomey Co., Inc., Dept. ED, 728 W. 10th Place, Los Angeles 15, Calif.

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

Neon Indicator Light

Plug-In Replacement

Requiring a mounting hole of 3/8 in. diam, this neon or incandescent plug-in lamp is designed for use in equipment where miniaturization is necessary. Starting voltage of the plug-in neon lamp, which is rated at 1/25 w, is 65 to 85 v. Bulb life exceeds 10,000 hours. Incandescent lamps are available in ratings of 6, 12 to 14, or 24 to 28 v. Lens colors are red, amber or clear for use with the neon lamp, with blue and green added to the list for use with incandescent lamps. Designation of the indicator is the E-lite 1DH.

Eldema Corp., Dept. ED, 9844 Remer St., El Monte, Calif.

CIRCLE 187 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Delay Relays

For Missiles and Jets

Developed for missiles, these miniaturized thermal delay relays are available in standard heater voltages and in most-specified time delays, for either continuous or intermittent application. Normal

ambient range is −65 to +85 C. They have virtually no contact chatter up to 1500 cps at 10 g, no resonance to 500 cps. Rigid construction admits use of high contact pressures. Contacts are rated for 1 amp at 27.5 v dc or 3 amp at 115 v ac. Relays are permanently calibrated before shipment and sealed in metal shields. Their seated height is 2 in., dia 3/4 in. Maximum weight is 1 oz.

Thomas A. Edison Industries, Dept. ED, West Orange, N. J.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

Guided Missile Dynamotor

10-25 Watt Output

This dynamotor, which has an output up to 25 w (depending on duty cycle and cooling) weighs 1 lb and measures 1-1/2 x 1-1/2 x 3 in. Its brush life is 100 hours at 50,000 ft. Under mechanical shock the unit can absorb up to 40 g in any direction; under vibration it can withstand 3 g along three perpendicular axes from 5 to 600 cps. Operating temperature range is −40 to +71 C. Designation is BD 1509 D.

Induction Motors Corp., Dept. ED, 570 Main Street, Westbury, Long Island, N. Y.

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Tubing

Production Cut

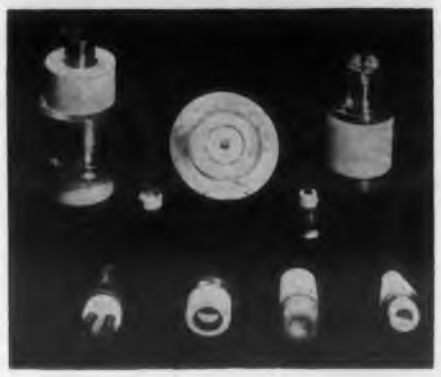
The Teflon spaghetti, tube and rod are production cut without feathers or flattening and to a high degree of accuracy in any length from 1/4 in. up, with a minimum loss in footage.

Pennsylvania Fluorocarbon Co. Inc., Dept. ED, 1115 No. 38th St., Philadelphia 4, Pa.

CIRCLE 190 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Metal Bond Ceramics
Secure to Crushing Point



These ceramics have a bond which will not fail even when ceramic is crushed. They are dimensionally accurate, vacuum and pressure tight, safe for use in soft or hard solder assemblies and are not soluble in soft solders.

The Carborundum Co., Dept. ED, Stupakoff Div., Latrobe, Pa.

CIRCLE 193 ON READER-SERVICE CARD FOR MORE INFORMATION

Low Drift Gyro
Single Degree of Freedom

Model U-105-H1G5 is an improved single degree of freedom gyro. It is a hermetically sealed, integrated unit featuring low drift rate, low harmonics, low quadrature and low noise level.

A dynamically balanced gyroscopic element reduces spin axis distortion. Gimbal design minimizes mutation and close tolerances assure mechanical stability. The high strength solder joints are stable even at elevated temperatures.

Unicorn Inc., Dept. ED, Waterbury, Conn.

CIRCLE 194 ON READER-SERVICE CARD FOR MORE INFORMATION

Accelerometer
With Caging Mechanism

This accelerometer has a caging mechanism that prevents potentiometer wear when the system is not in use. The mechanism is electrically released when the instrument is used. The instrument, Series LA07-0100-1, has an accuracy of 1/2 per cent and

an operating temperature range of —50 to +100 C. Case height is 2.56 in.; diameter, 3.25 at top, 3.36 at bottom. The intsrument can withstand vibration from 10 to 2,000 cps to 10 g.

Ranges are —1 to +4 g, ±5 g, ±10 g; linearity is 0.5 to 1.0 per cent; hysteresis 0.1 to 0.2 per cent; friction 0.1 to 0.4 per cent; natural frequency 18 cps at —1 to +4 g; potentiometer pickoff 500 to 20,000 ohms; resolution to 0.15 per cent.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed Circuit Connector
Independent Mechanical Bond

In the 7000 Series printed circuit varicon connector, contacts are staked directly into printed circuitry, providing independent mechanical bond.

Current rating of these units is 7 amps, and the withstanding voltage (sea level) is 2000 v rms. Contact resistance is 0.002 ohm, while spacing is at 0.100 centers. These connectors are available in 17 contact units.

Elco Corp., Dept. ED, "M" St. below Erie Ave., Philadelphia, Pa.

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

Fasteners
For Unthreaded Studs

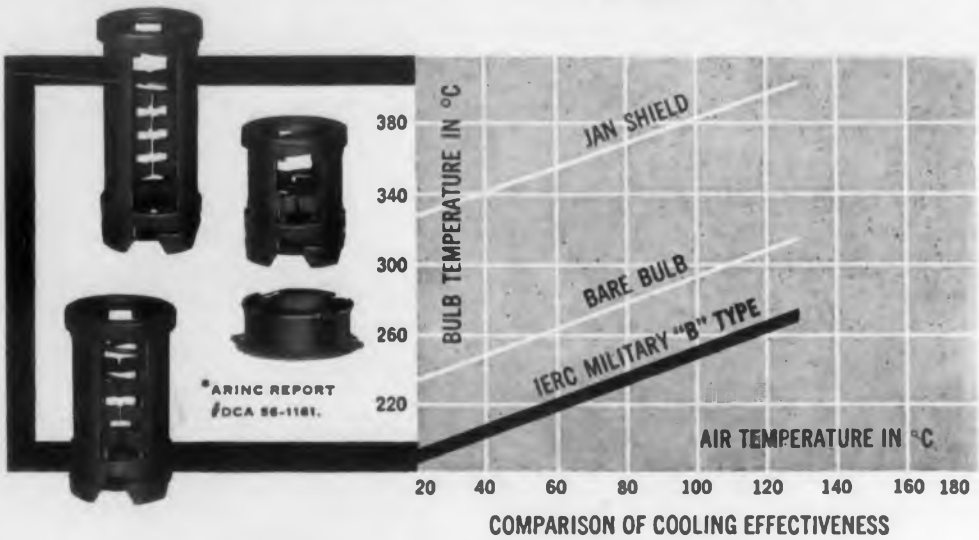
Type H Pushnut fasteners for unthreaded studs of die-cast nameplates, medallions, grilles and ornaments are made of 410 stainless bright hardened steel, for applications requiring a high degree of corrosion-resistance.

The fasteners incorporate four gripping teeth, a long spring arch that compensates for wear on parts, turned up ends that slide smoothly and prevent damage to seating surface, and fast assembly with hand or power tool applicators. Sizes are available for 1/16 in., 3/32 in. and 1/8 in. studs.

The Palnut Co., Dept. ED, Glen Rd., Mountainside, N.J.

CIRCLE 197 ON READER-SERVICE CARD FOR MORE INFORMATION

NOW—increase electron tube life *12 TIMES!



COMPARISON OF COOLING EFFECTIVENESS

Exclusive IERC Tube Cooling Effectiveness Provides Greatly Extended Tube Life And Reliability!

Though electronic engineers know that even the *slightest* tube temperature reduction improves tube life, the greatest success enjoyed in obtaining *extended* tube life has been when IERC Heat-dissipating Tube Shields have been specified and used. Results show that extensive gains in tube life and reliability are easily achieved—that tube operating temperatures are reduced as much as 150°C—that IERC's Military Type "B" shield is the *only effective answer* to obtain these benefits in *your* new equipment. Positive shock and vibration protection plus electrostatic shielding is provided. Graphs show temperature reductions when IERC "B" and "TR" shields are used with 6005 tube operating at full plate dissipation.

PATENTED OR PATS PEND. CROSS-LICENSED WITH NORTH AMERICAN AVIATION, INC.

Retrofit For Maximum Tube Life

No modification is required with IERC "TR" Type Heat-dissipating tube shields! TR's fit easily to existing JAN sockets—greatly extend tube life through excellent cooling and retention against shock and vibration.

Complete IERC literature and Technical Bulletins sent on request. WRITE TODAY!

International
electronic research corporation

145 West Magnolia Boulevard, Burbank, California

CIRCLE 199 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Computer Potentiometer

Ultra-Low Torque

Designated Type 11, a line of miniaturized potentiometers has been made available, essentially for use in computers, which features dimensional interchangeability with other servo components, motors and resolvers. Pictured here are the single and three-gang models, which measure 1.062 in. in diam and are 0.81 and 1.81 in. long, respectively; but individual potentiometer cups are 0.500 in. long and ganged assemblies up to twelve cups can be supplied. These instruments, however, are also available in the dimensions prescribed by Aircraft Industries Association Spec NAS-710. Individual sections are linked to each other by internal clamps. No projections extend outside the case, but clamp screws are accessible from the outside so that each section can be separately rephased.

The metal case provides a high degree of mechanical stability and precision. The shaft is mounted in ABEC class 5 ball bearings. Slip rings are 18 karat gold. Terminals are glass insulated.

Torque normally required is 0.11 ounce-inch per cup but this can be reduced, if necessary, to 0.050 oz-in. per cup. Electrical rotation angle of 360 deg is possible. Standard linearity tolerance is 0.5 per cent but 0.15 per cent can be attained in the higher resistance values; and non-linear types are also available to meet varying requirements. Power dissipation is rated at 1 watt at 80 C; and resistance values range up to 150,000 ohms. The pots can be supplied with a multiplicity of electrical taps, each positioned with an angular accuracy of ± 0.5 deg.

Electro-Mec Laboratory, Inc., Dept. ED, 47-51 33rd St., Long Island City 1, N.Y.

CIRCLE 200 ON READER-SERVICE CARD FOR MORE INFORMATION

Cold Cathode Rectifier

Withstands 35 g

This type CK6763 is a ruggedized cold cathode rectifier of miniature construction with electrical characteristics like those of type CK5517. It will stand a 96 hour 35 g vibration test at 320 cy without change whereas conventional designs are destroyed after only a few hours. The tube will handle 2800 v peak inverse at a rectified current of 12 ma and requires no heater power.

Raytheon Mfg. Co., Dept. ED, 55 Chapel St., Newton 58, Mass.

CIRCLE 201 ON READER-SERVICE CARD FOR MORE INFORMATION

Signal Generator System

Measures, Records, Controls

A non-electric signal generator system measures, indicates, transmits and controls a variety of process variables, such as pressure, differential pressure, flow, liquid level or temperature. Basically, the system is composed of three elements—a signal transmitter (transducer), a power unit (magnetic amplifier) and a null-balance indicating receiver. True null balance (infinite gain at zero frequency) assures a high degree of accuracy. Pressure may be measured by a twisted Bourdon tube, or differential pressure and flow by a bellows; the signal transmitter converts the measured variable into rotation of the shaft of a rotary differential transformer, the output of which is an ac voltage exactly proportional to the variable measured. (Full scale, 12 v.) When measuring temperature the signal transmitter is a temperature-sensitive resistor and the rotary transformer is replaced by a potentiometer.

Norwood Controls, Dept. ED, 934 Washington St., Norwood, Mass.

CIRCLE 203 ON READER-SERVICE CARD FOR MORE INFORMATION

Encapsulating Shells

Simplify Production

By use of a newly-announced line of molded epoxy shells it is now possible to encapsulate electronic components simply by inserting the component in the shell and pouring epoxy casting compound in after it. The resulting encapsulated component is resistive to humidity, temperature variations and corrosive influences. Temporary molds, release agents and patching are not needed. These new molds have been designated "N-Case" shells.

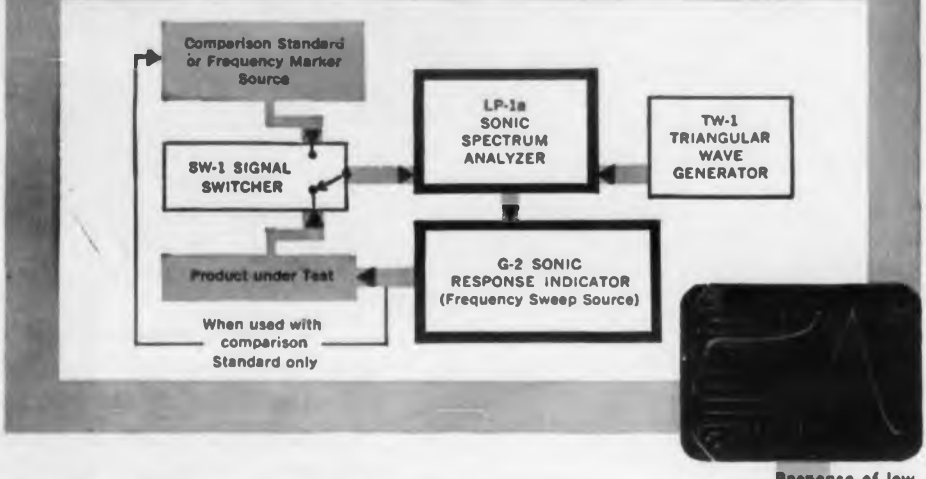
Epoxy Products, Inc., Dept. ED, 137 Coit Street, Irvington, N.J.

CIRCLE 204 ON READER-SERVICE CARD FOR MORE INFORMATION

Panoramic's unique

AUDIO RESPONSE TRACING SYSTEM

- **Shows response to fundamental frequency only**
- **Discriminates against noise and hum**
- **Has virtually unlimited dynamic range**
- **Gives a single line presentation**
- **Features log and linear amplitude scales**
- **Provides direct reading**



Response of low pass filter with trap; log freq. vs. log amp.

Here is a unique frequency response tracing system invaluable for testing audio frequency networks and devices which tend to produce distortion products . . . where hum and noise are present . . . or where measurements through large dynamic ranges must be made. Ideal for acoustic devices, filters (particularly band stop), transmission lines, amplifiers, hearing aids, etc.

The system centers on the Model LP-1a Panoramic Sonic Analyzer and Model G-2 Sonic Response Indicator.

As a slave to the LP-1a, the **Model G-2 Sonic Response Indicator** produces a swept audio frequency which is precisely tracked by the LP-1a as it automatically tunes through the spectrum. When a filter or other device is interposed between the G-2 and the LP-1a, an accurate, directly read, single line response curve of frequency vs. amplitude is presented on the LP-1a screen. The selective characteristic of the LP-1a assures response to fundamental frequency only . . . discriminates against hum . . . minimizes the effect of noise . . . provides virtually unlimited dynamic range. The G-2 has an output voltage range of 50 microvolts to 5 volts through a 10 step 100 db attenuator. Output impedances of 100, 300 and 3000 ohms.

G-2

The swept frequency range of the G-2 is controlled by the **Model LP-1a Panoramic Sonic Analyzer.** Ranges are 4 cps to 20 kc logarithmic or linear segments of 200, 1000 or 5000 cps centered anywhere between 0 to 20 kc. Two amplitude scales on the indicating screen are provided, 20 db linear and 40 db log. Internal scanning rate is 1 cps.

LP-1a

To overcome the problems of time delays and ringing of sharply attenuating networks, the **Model TW-1 Triangular Wave Generator** may be added to the system. The TW-1 produces a continuously variable linear bi-directional time base enabling establishment of the proper scan rate in order to insure presentation of a true response. Range 0.05 cps to 60/sec.

TW-1

And to complete the broad scope of Panoramic's unique audio curve tracing system, **Panoramic's SW-1 Signal Switcher** may be used to present the signal from the device under test alternately with a comparison standard or frequency marker source.

SW-1

Use the LP-1a, too, for vibration and general wave-form analyses!

Result? An exceptional system for **quickly, visually,** and **reliably** checking complex audio equipment and devices. For ultrasonic frequencies (1 kc to 300 kc) ask about Panoramic's SB-7aZ and G-3.

Write, wire, phone TODAY for complete details and catalog sheets.

PANORAMIC
RADIO PRODUCTS, INC.

15 So. Second Ave., Mount Vernon, N. Y. • Phone: Mount Vernon 4-3970

Cables: Panoramic, Mt. Vernon, New York State

CIRCLE 206 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

High Reliability Capacitors

For Miniature Circuitry

Featuring specially anodized, 99.99 per cent pure aluminum foil and carefully compounded electrolytic formulas, two new high reliability electrolytic capacitors are represented as ideal for miniaturized, printed and transistorized circuitry. Rugged, hermetically sealed, these capacitors have extremely low leakage and long idling or shelf life, are small in size, and supply dependable performance over wide temperature ranges. They withstand shock and vibration, surge voltage and momentary overloads without permanent damage. The two designations are EX and EZ; the former has a standard twist prong mounting while the latter is designed for printed circuit mounting.

Astron Corp., Dept. ED, 255 Grant Ave., East Newark, N.J.

CIRCLE 207 ON READER-SERVICE CARD FOR MORE INFORMATION

Acid Resist Lacquer

For Silk Screen Printed Circuits

Formulated for silk screen printing of the circuit design, this lacquer deposits a positive protective coating on the metal or plastic laminate prior to the acid bath operation. It air-dries tackfree in thirty minutes or can be forced air-dried at 160 F for five to ten minutes with the same results. The formulation gives the fastest possible drying time without screen clogging.

The lacquer has high resistance to the acids used in the etching process. Hence, upon complete drying, it gives fully adequate protection to the lacquer-coated surfaces during etching. After etching is concluded, it is easily removed by spraying the printed circuit with warm trichloroethylene or by wiping off with any common lacquer solvent.

Chemical Products Corp., Dept. ED, King Philip Rd., East Providence, R.I.

CIRCLE 208 ON READER-SERVICE CARD FOR MORE INFORMATION

Electro-Chemical Analyzer
Senses Chemical Changes

Changes of relative concentration of specific chemical ingredients in liquid vehicles alter the electrical potential between an inert-metal electrode and a reference electrode. The cell in which these changes occur and are detected thus offers an accurate and convenient means for controlling oxidation-reduction or other processes. Either batch or continuous-flow processes can be controlled. The cell operates at pressures up to 35 psi, and is supplied either alone or with a matching potentiometer.

The cell, designated O-R-P, is offered in a choice of body and electrode materials, to suit the process it is to monitor. It is easily disassembled for inspection and cleaning. Straight-bore design gives an unrestricted flow stream, eliminating deposits or plugging, while large electrodes minimize polarization effects. Reservoir pressure from 2 to 5 psi greater than the static pressure in the cell prevents contamination of the reference electrode.

The matching potentiometer offers continuous rebalancing to a null balance, single or multi-point reading and continuous standardization by comparison with a standard cell. Readings can be recorded on a round chart.

Fischer & Porter Co., Dept. ED, 2000 Jacksonville Road, Hatboro, Penna.

CIRCLE 210 ON READER-SERVICE CARD FOR MORE INFORMATION

Air Dielectric Coax
Low Capacitance

This cable has a nominal capacitance of 10 μμf/ft at 1000 cps, with a nominal over-all diameter of 0.220 in. The conductor is 30 AWG, 7/38 silver plated copperweld. A choice of outer jackets of Teflon, lacquered nylon braid, Teflon or silicone impregnated glass braid are available as standard constructions.

The low attenuation of the 10 μμf cable makes it useful for high frequency, low level applications and as low capacitance probe cable. Capacitance values of less than 10 μμf with somewhat larger over-all diameters are also available on request. Flexibility is pointed to as being a feature of the air dielectric coaxial cable. Among the other physical characteristics of the cable is its solderability, light weight, small size, and ready adaptation to a variety of connectors.

Tensolite Insulated Wire Co., Inc., Dept. ED, 198 Main St., Tarrytown, N.Y.

CIRCLE 211 ON READER-SERVICE CARD FOR MORE INFORMATION

GYROS
for every application

Kearfott Free, Vertical, Rate, Directional and Floated Rate Integrating Gyros and Stable Elements are accurate, rugged and dependable. They are designed to meet the most stringent aircraft and missile requirements. The Kearfott Free Gyro shown was designed specifically for missile applications. It provides airframe attitude information for use in guidance systems. Remote electro-mechanical caging and uncaging is provided.

ACCURATE
RUGGED
DEPENDABLE

Kearfott Free Gyros withstand 60 G shock of .0157 secs. duration, vibration up to 500 CPS at 10 G acceleration. Operating temperature range -20° C to +100° C. Weight 5.5 lbs.

Write today for technical data on Kearfott Gyros.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Kearfott

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KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

CIRCLE 213 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Modulators and Demodulators

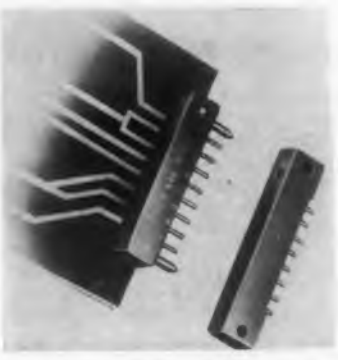
For Analog Studies

Matched circuit packages intended for servo system design, analog computer studies, autopilot syntheses, general 400 cps signal instrumentation and circuit action demonstrators, have been made available. They consist of a modulator, designated Type 703A, and a matched demodulator designated Type 707A, both operating directly from the 400 cps line and both miniaturized. Six of these units will fit interchangeably in a rack panel which is designated 709A.

The 703A has a phase-reversing sinusoidal output; the output of 707A is a dc voltage whose polarity is determined by the phase of the ac signal input. Gain is controlled by a calibrated front-panel ten-turn indicator. Features common to both the modulator and demodulator are one-megohm input impedances, low output impedance, carrier phase set directly by front panel control, low noise, low drift, and transfer gain of unity.

Industrial Control Co., Dept. ED, Wyandanch, L. I., N.Y.

CIRCLE 214 ON READER-SERVICE CARD FOR MORE INFORMATION



Printed Circuit

Right-Angle Pins

Two miniature right-angle pin connectors for dip soldering to printed circuit boards have been made available. One, designated Series 676, has polarizing guide pins and can be supplied with polarizing screw locks. Its mounting studs are threaded. Contact spacing is 0.15 in., and it is available with 19 contacts. The other, designated Series 600-70, is the smallest obtainable for dip soldering to printed circuit boards. Guide pins and threaded mounting studs are provided. Contact spacing is 0.156 in., and the series is available in either 4 or 8 contacts.

DeJur Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 215 ON READER-SERVICE CARD FOR MORE INFORMATION

Quartz Crystal Transducer

Measures Pressure Changes

Measuring rate of pressure changes, this transducer system, designated Model PI-114, reads the electrical current (rate of change of charge) generated in a quartz crystal transducer, amplifies it, and displays it on a standard oscilloscope or recorder. Featuring high sensitivity and fast response (15 microsecond rise time), the instrument is particularly recommended for studying cylinder processes on engines and compressors, for indicating combustion and detonation phenomena in the evaluation of new engines and fuels, and for use with shock tubes, rocket motors, hydraulic systems and pneumatic systems. The stainless steel pickup transducer withstands diesel combustion and other temperatures up to 600 F without special cooling. Constant calibration, independent of temperature, is achieved. An electrical charge placed on the amplifier input will remain for hours or even days. Amplifier range can be switched from 0-1 psi to 0-1000 psi. Rugged and reliable, the instrument makes precision rate or dynamic pressure measurements under the most severe conditions.

Kistler Instrument Corp., Dept. ED, 15 Webster St., North Tonawanda, N.Y.

CIRCLE 218 ON READER-SERVICE CARD FOR MORE INFORMATION

Patching Circuit Components

Diodes, Capacitors, Networks

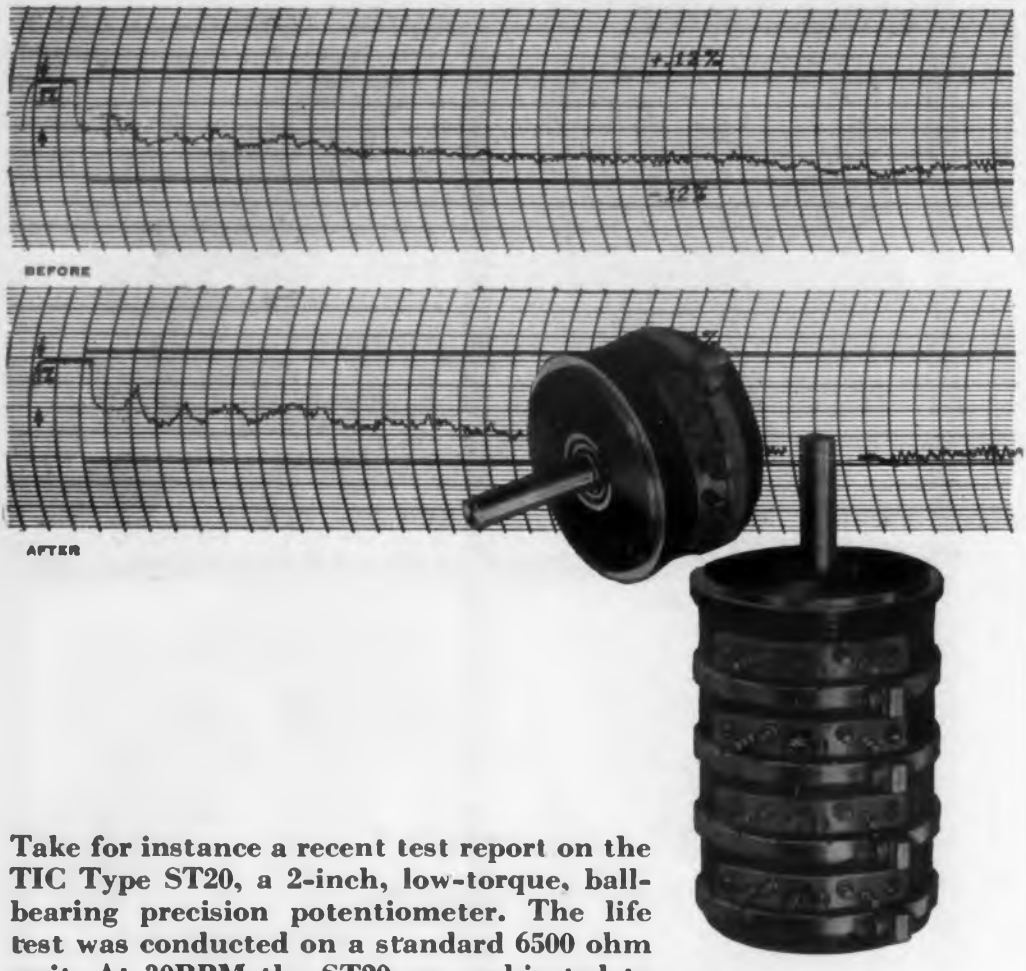
Plug-in component packages can be used to patch an entire program into a computer, telemetering equipment or testing equipment. Diodes, capacitors, RC networks are some of the patch-cord components that can be supplies to specification for this purpose. For example, a precision wire wound resistor may be encapsulated in a package measuring 5/16 in. x 1 in. with one end terminated in an AMP male pin and the other end furnished either as a solder terminal, a female receptacle, or a patching cable. Designated Comp-Plug, these patching packages are especially designed for use with their manufacturer's AMP Shielded Patch Cord Programming System.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn 7, N.Y.

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

LIFE IS NO PROBLEM

WITH TIC® PRECISION POTENTIOMETERS



Take for instance a recent test report on the TIC Type ST20, a 2-inch, low-torque, ball-bearing precision potentiometer. The life test was conducted on a standard 6500 ohm unit. At 30RPM the ST20 was subjected to 700,000 cycles, reversing direction every 30 minutes. The linearity graphs shown above show the before and after of the ST20's independent linearity. *As can be seen, the linearity change is imperceptible.*

Some of the change in linearity after the life cycling can be attributed to change in effective resolution due to contact wear. Other results from the life test indicate less than 100 ohm equivalent noise resistance except for one spot, where it was less than 1000 ohms. The 1000 ohm spot was of such short duration that the linearity recording did not pick it up. Test Summary: The ST20 will perform with only infinitesimal degradation for over 700,000 cycles. If it's long life *at full precision performance*, that you want, specify precision potentiometers by TIC.

TECHNOLOGY INSTRUMENT CORP.

555 Main Street, Acton, Mass. COlonial 3-7711
West Coast Mail Address, Box 3941, No. Hollywood, Calif. POplar 5-8620

CIRCLE 221 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Internal Field Transformer

Doughnut-Shape Design

Conservation of space is the object behind the design of these transformers, which are wound on a toroidal core and encapsulated in epoxy resin. They are called transoids, and meet all applicable military specs. The one shown here is a conventional plate-and-filament transformer; but transoids may be used to replace cased or open type transformers generally. Mounting is accomplished with a single bolt through a central mounting hole. Since the external magnetic field, and therefore magnetic coupling, are negligible, the units may be stacked to conserve space. Terminal lugs, alternating with molded bosses or side barriers, project radially from the disc. The bosses or side barriers perform two functions; they increase the length of surface path between terminals and thus prevent flash-over or current leakage at high altitudes, and they serve also as cooling fins. The transoid in the accompanying illustration has a 115 v single-phase primary; two 6.3 v filament secondaries, one of which is tapped at 5 v, and a 650 v rms center-tapped plate winding. It measures 1-1/2 in. in height x 3-3/4 in. outside diam.

Raytheon Mfg. Co., Dept. ED, 100 River St., Waltham 54, Mass.

CIRCLE 222 ON READER-SERVICE CARD FOR MORE INFORMATION

Sensitive Microwave Silicon Diode

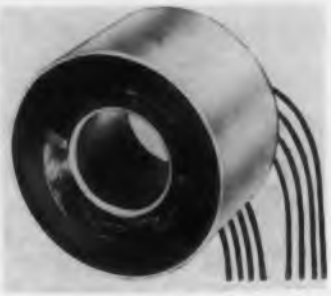
For X-Band Circuitry

A high sensitivity microwave silicon diode, MA-408B, can be used as a low-level detector in X-band video receiver circuitry. The MA-408B video diode minimum figure of merit is 220. Theotretical tangential sensitivity is −53 dbm at 9000 mc for a receiver bandwidth of 10 mc. An average improvement of 4 to 5 db is indicated when the MA-408B replaces IN23C mixer crystals in low-level video circuitry. The new crystal is approximately 2 db more sensitive than the MA-408A. For highest sensitivity performance a dc bias of +50 μamp is recommended. The MA-408B is interchangeable with other cartridge type diodes of the IN23 series.

Microwave Associates, Dept. ED, Burlington, Mass.

CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you sent us your subscription renewal form?



Magnetic Deflection Yoke

Transistor Driven

These miniaturized, epoxy-encapsulated push-pull magnetic yokes fit all standard 7/8 in.-neck-diameter CR tubes, and are available in impedances and winding configurations suited either to vacuum tube or transistor drive circuits, to order. Designated Type Y57-P, the yokes withstand extreme environments; temperature rating is 105 C, max. Circuit flexibility is promoted by use of push-pull windings with separate B plus leads. Residual magnetism is 0.5 per cent, max; radial error 1 per cent, max; angular error 0.5 deg max; deflection angle up to 70 deg; horizontal coil capacity 11 mmf, and vertical coil capacity 15 mmf.

Syntronic Instruments, Inc., Dept. ED, 170 Industrial Road, Addison, Ill.

CIRCLE 226 ON READER-SERVICE CARD FOR MORE INFORMATION

UHF Converters

30 or 60 Mc Output

A series of four UHF converters has been developed which accept input frequencies in the 400-900 mcs range and convert them to ouput frequencies of either 30 or 60 mcs, with a gain of 50 db. Each converter consists of an rf amplifier and a converter unit, which are available separately or completely assembled, with or without a regulated power supply. The units can be remotely operated, if desired. All four converters carry the fundamental designation Model UHC-R. Model UHC-R-4.5 is for inputs between 400 and 525 mcs; Model UHC-R-6 for inputs between 525 and 650 mcs; Model UHC-R-7 for 650 to 775 mcs inputs, and UHC-R-8.2 for 775-900 mcs. All models have input bandwidths of 10 mcs, output bandwidths of 5 mcs. Noise figures range from 5.5 to 8.5 db, increasing with models of greater input frequency. Input impedance is factory-set at 50 or 75 ohms, output impedance also factory-set at 50 or 75 ohms. Converters can also be supplied on request for other frequencies and with bandwidths up to 50 mcs. Power required is 6.3 v ac at 2.0 amp and +200 v regulated dc at 80 ma. Built to be mounted in a standard relay rack, the converter measures 7 in. x 7 in. x 19 in.

Applied Research, Inc., Dept. ED, Flushing, Long Island, N.Y.

CIRCLE 227 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Evaluation
at a glance

CUBIC 504

TRANSISTOR CURVE TRACER

- **EIGHT-CURVE FAMILY PRESENTATION**
- **SINGLE CURVE SELECTIVITY**
- **DUAL INPUTS FOR RAPID MATCHING**
- **FOR PNP & NPN JUNCTION TRANSISTORS**

FULLY TRANSISTORIZED • SELF-POWERED • PORTABLE
(Weighs only five pounds)

A must for circuit design, production test, and receiving inspection, the 504 makes possible immediate visual indication of GAIN, LEAKAGE CURRENT, LINEARITY, BREAKDOWN, COLLECTOR RESISTANCE, and ALL PERFORMANCE ANOMALIES.

CUBIC CORPORATION

5575 KEARNY VILLA ROAD • SAN DIEGO 11, CALIFORNIA

CIRCLE 228 ON READER-SERVICE CARD FOR MORE INFORMATION

EXCEEDED

by these 2 Resinite Sleevings

Just **two** sleevings—one source—can supply **all** your needs for **every** grade of MIL-I-631C vinyl insulation. Resinite EP-69A and Resinite Hi-Heat 105A not only meet every requirement, but far exceed specifications. Simplify ordering, reduce inventory with these two fine Resinite sleevings.

EP-69A for low temperature and general purpose use. Wide working range from —48°C to 90°C. Dielectric to 750 volts/mil. Corrosion, oil, fungus and flame resistant. #20 AWG through 2½" ID. 5 standard colors, others available.

HI-HEAT 105A for high temperature use where outstanding resistance to heat and oils is required. For continuous operation from —21°C through 105°C. 1000 volts/mil average dielectric. Exceptionally high flame, fungus and cut-through resistance. #24 AWG through 2½" ID. 11 standard colors, others available.

Write us your requirements and we'll submit samples and performance data on appropriate sleevings, tapes or lacing cords.

® Resinite

Resinite Department **THE BORDEN COMPANY** Chemical Division
Box 1589, Santa Barbara, California

SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS, ELECTRICAL AND PHARMACEUTICAL FIELDS

CIRCLE 229 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Trimmer Potentiometer

For Extreme Conditions

Available from stock in many standard resistances from 25 ohms to 50K ohms, a trimmer potentiometer designated the 50-M11 has been designed for extreme conditions of heat, humidity, shock and vibration. Although it is only 1/2 in. in diameter, the standard dielectric breakdown on this tiny trimmer is 1000 v rms. Standard insulation resistance to ground at 100 C is 300 megohms. The trimmer dissipates 2 watts at 40 C. Terminals are riveted into the terminal board and tiny #000-120 screws are used to fasten the lead wires to them. Terminals and winding assemblies are encapsulated. Mechanical stops allow a nominal 310 deg rotation; the stops withstand 4 inch-pounds of torque. Accidental drift of the shaft is prevented by a compact and effective shaft lock.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Ave., Chicago 17, Ill.

CIRCLE 230 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Gage

Reads Thickness of Films

The thickness of films of conductive and non-conductive materials can be read by this film gage, designated Type 255-A. It can measure the thickness of films of conductive, non-magnetic material, such as copper, on insulating base material such as glass, phenolics or ceramics. It can also measure the thickness of non-magnetic metal plating such as silver, gold, cadmium, etc., on non-magnetic base metals such as copper, brass or aluminum. Specifically, it can measure the thickness of protective anodic coatings on anodized aluminum or magnesium. Still further, the thickness of such insulating films as organic paints, enamel or porcelain can be measured with this instrument.

Boonton Radio Corp., Dept. ED, Boonton, N.J.

CIRCLE 231 ON READER-SERVICE CARD FOR MORE INFORMATION

Printed Card Receptacles

Double-Row

Double-row printed card receptacles for dip-solder connection to printed circuit boards have been put on the market in a family of cards of different materials and varying number of contacts per row. They are an addition to their maker's line of single-row printed card receptacles. They are for two thicknesses of printed cards, 1/16 in. and 3/32 in., and may have either 6, 10, 15, 18 or 22 contacts per row. Contacts are creep-proof beryllium copper. Available insulating bodies are glass-reinforced Alkyd 440A, mineral-filled Melamine, or Orlon-filled diallyl phthalate, to meet all types of electrical and mechanical requirements. Insulation resistance is over 100,000 ohms, and the receptacles resist 2200 rms ac voltage at sea level, 600 rms ac voltage at 60,000 feet.

U. S. Components, Inc., Dept. ED, 454 East 148th Street, New York 55, N.Y.

CIRCLE 234 ON READER-SERVICE CARD FOR MORE INFORMATION

Directional Couplers

2600 To 75,000 Mc

Designated Series 610, a line of directional couplers has been expanded to cover the entire frequency range between 2600 and 75,000 mc. They are fabricated of two waveguides with a common broad wall. An array of precisely sized and located holes pierces the wall; the number, size and spacing of these holes is governed by the required coupling and directivity. At rated frequency range overall directivity is higher than 40 db. Nominal coupling values are 3, 6, 10 and 20 db, within ±0.4 db; frequency variation of coupling over the rated frequency range is less than ±0.5 db. Main line VSWR is below 1.05 and auxiliary VSWR below 1.20. Their high directivity and uniform coupling with frequency make these couplers particularly useful for measuring VSWR by the incident and reflected power technique; and, since they provide an accurately attentuated sample of main-line power, for power and frequency monitoring, as an accurate and stable attenuation standard, and for injecting local oscillator power into a mixer circuit.

F-R Machine Works, Inc., Dept. ED, 26-12 Borough Pl., Woodside 77, N.Y.

CIRCLE 235 ON READER-SERVICE CARD FOR MORE INFORMATION

Whether it's heat dissipation from minute tubes or a complex problem of RF interference involving special structural parts or design, Metex products offer not only wide range possibilities but an unbroken record of performance *and* approvals. Practically unlimited by either form or material, Metex engineers welcome design problems that require high standards and dependable operation.

Unlike many, Metex products carry the full approval of not only industry specifications but the entire complement of performance specifications set up by the Armed Forces and the Bureau of Ships. Inquiries, together with blueprints, on individual problems of vibration control, heat dissipation and RF shielding are always welcomed. No obligation. Write today for illustrated bulletin.

ELECTRONICS DIVISION

METAL TEXTILE CORP.

ROSELLE, NEW JERSEY

CIRCLE 236 ON READER-SERVICE CARD FOR MORE INFORMATION

Shallcross
BRIDGES

Types 6100 and 6101

Type 6320

Type 638-R

617 Series

Type 6350

ACCURATE dc RESISTANCE MEASUREMENTS

. . . 1 micro-ohm to 10^6 megohms

Among the many bridges manufactured by Shallcross, these six have become virtually "standards" for general-purpose resistance measurements. Each is easy to operate and ruggedly constructed to maintain accuracy and stability in every kind of field and laboratory service. Switch decks are inside the case for minimum maintenance.

Of special interest are the 617 Series Limit Bridges. These provide direct "GO-NO GO" production line resistor testing for any percent tolerance spread from ±0.1% to ±20%.

NEW BULLETIN L-19B contains full specifications for each instrument. For your copy write to: SHALLCROSS MANUFACTURING COMPANY, 526 Pusey Avenue, Collingdale, Pa.

Model Number	Measurement Accuracy	Maximum Setting	Minimum Setting	Circuit	Special Features
6100	±0.1% +0.01Ω (.1Ω to 1.011 MegΩ)	1.011 MegΩ	0.001Ω	Fault Location—Wheatstone	Fault Location by Murray, Varley, Hilborn & Fisher Loop Tests.
6101	±0.1% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	0.001Ω	Wheatstone	Four dial rheostat usable as decade box.
6320	±0.02% +0.01Ω (1Ω to 11.11 MegΩ)	111.11 MegΩ	0.00001Ω	Wheatstone	Most accurate five dial Shallcross bridge for direct resistance measurement.
	±0.05% to ±20% on separate "+" and "—" percent selectors. (1Ω to 10 MegΩ)	11.111 MegΩ	0.0001Ω	Percent Limit	Rapid "GO-NO GO" percent limit testing. Built-in adjustable comparison standard.
638-R	±0.75% or better (.001Ω to 1Ω)	11.11Ω	0.000001Ω	Kelvin	Overlapping Kelvin and Wheatstone ranges selected with single ratio dial.
	±0.2% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	.001Ω	Wheatstone	
6350	±1%, (10Ω to 10 MegΩ) ±2%, (10 MegΩ to 10,000 MegΩ) ±5%, (above 10,000 MegΩ)	1.111 x 10^8 MegΩ	0.01Ω	Wheatstone with d-c Amplifier	Modular construction dual range power supply, null indicator-amplifier, for 115V. 60 cycle operation.
617 Series	±0.1% to ±20% on separate "+" and "—" selectors from a minimum resistance consistent with number of dials in use to the maximum settings.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Percent Limit	For rapid "GO-NO GO" percent limit testing. Hand or foot operated for production testing. All models also usable for direct resistance measurements. Binding post for external d-c power supply.
	†±0.2% +0.01Ω from a minimum consistent with number of dials in use to the maximum setting.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Wheatstone	

† Except 617B and 617J ±0.1% ±0.01Ω. * Except 617G, 0.01Ω.

CIRCLE 237 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Remotely Caged Gyro

For Missiles and Aircraft

This new free gyro with a solenoid-powered caging system is already in use on missile systems and in flight test operations where remote caging and uncaging are essential. It is small and light, having a length of 5-1/2 in., diameter 3 in., and weighing 2-1/2 lb. The caging system has a minimum number of parts, is positive and reliable in operation, and is fitted with cage indicating switches, and with precision potentiometers on both gimbals. The motor can be supplied, optionally, for 115 v 400 cps three-phase, 115 v 400 cps single-phase, or 28 v dc power. Designation is Series FG01-0203-1.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 238 ON READER-SERVICE CARD FOR MORE INFORMATION

Snap-In Production Vise

For Printed-Circuit Assembly

Securely holding printed-circuit and terminal boards during assembly operations, this vise requires no adjustment after it has been set for a particular board size. Slight pressure on the spring-loaded jaw by one edge of a board engages it in the vise; a similar operation disengages it. Positive grip is assured by a tough cork-an-synthetic-rubber compound on both jaws. The pressure exerted by the vise is predetermined and there is no possibility of cracked boards. The vise is mounted with screws to a work bench or on a plywood base. A two-way feature permits adjusting it in whatever position is most convenient for the most efficient production. Vise jaws measure sixteen inches in length and are capable of holding boards up to twenty-four inches or longer; width range is from one to six inches.

Western Electronic Products Co., Dept. ED, 655 Colman St., Altadena, Calif.

CIRCLE 239 ON READER-SERVICE CARD FOR MORE INFORMATION

Self-Aligning Hex Nut

Saves Weight

Misalignment between bolt holes and mounting surfaces in any direction and up to 8 degrees is automatically corrected by a new self-aligning and self-locking hex nut. The nut eliminates the need for spotfacing or using tapered shims in such applications at tapered spar caps, tapered skins, and forgings and castings with draft angles. Designated Kaylock H19000, and designed with a spherical seat and matching lightweight washer, it combines the advantages of low height, full strength and light weight. The two sizes now available are 10-32, weight 0.18 lb per hundred; and 1/4-28, weight 0.31 lb per hundred. Other sizes are in development. The H19000 meets applicable military specs for self-locking nuts.

Kaynar Co., Dept. ED, Los Angeles, Calif.

CIRCLE 241 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Multiplier

Gives Faster Measurements

Used in connection with standard electronic counters this new frequency multiplier gives precise frequency measurements in one-tenth the time normally required. The 100-second time interval normally needed to produce an accuracy of 1 count per 400,000 (0.0025 per cent) is reduced to 10 seconds. Similarly, the 10-second interval needed for 1 count per 40,000 accuracy (0.025 per cent) is cut down to 1 second. Coax leads permit direct insertion into the circuitry of standard precision counters. The frequency multiplier designated Model 4C4K operates on the 390-410 cps band; other models of the same basic design are available for other frequency ranges. Dimensions are 3-1/2 in. x 3-1/2 in. x 19 in. Black or gray baked enamel finish are optional. Special configurations can be supplied on request.

Gyrex Corp., Dept. ED, 1654 Lincoln Blvd., Santa Monica, Calif.

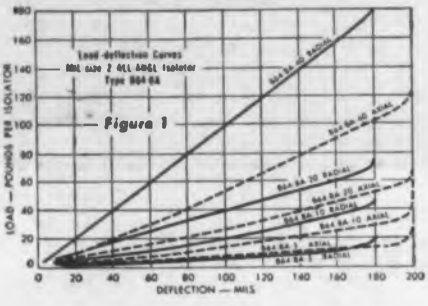
CIRCLE 242 ON READER-SERVICE CARD FOR MORE INFORMATION

How to Meet Tougher Specifications for Shock and Vibration Protection in Jets and Missiles

You've got to design to tougher specifications for combined shock and vibration isolation if you're going to protect the reliability of electronic controls in today's high-performance jets and missiles. Faster accelerations, zero-length launching, and extreme maneuverability combine to impose shock and vibration loads far beyond current MIL specs. *These severe operating conditions must be reduced to a predictable environment suitable for electronic equipment.*

Isolator Requirements

Higher shock inputs require more stiffness in the isolator, to store more energy for a given deflection, so there will be less energy to dissipate if the isolator bottoms. *Higher vibration amplitudes* call for greater clearances and minimum transmissibility at resonance. And vibration protection *under high-g sustained acceleration* demands a combination of these characteristics.



Use of Performance Curves

The characteristics of an isolator having the stiffness necessary for handling the shock and sustained accelerations of jet and missile take-offs is shown by the curves of Figure 1. These curves can be used in choosing the proper isolator for operation under the expected service conditions, since they show both the deflection of isolators under a wide range of loadings and the maximum allowable deflection due to the combination of static load, sustained acceleration, and vibration amplitude.

A transmissibility at resonance well below three — considered exceptionally low — is shown by the curves of Figure 2. The measurements for these curves were made with a 27-pound load supported on four 10-pound isolators, with double-amplitude vibration input of 80 mils. These curves, showing performance for both base and bulkhead mounting, also indicate that the isolator satisfies the need for *consistent operation in every attitude* of flight, launching, and maneuvering.

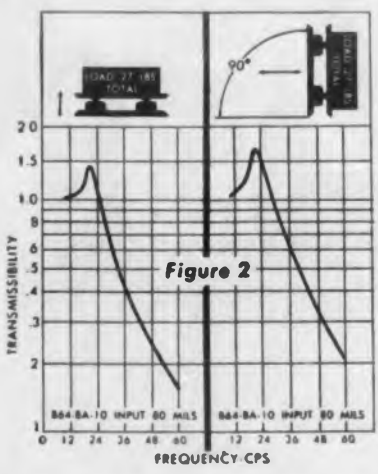


Figure 3 illustrates the construction of the B64 isolator that provides the performance characteristics shown by the curves, yet is dimensionally interchangeable with MIL-size mounts of comparable load ratings.

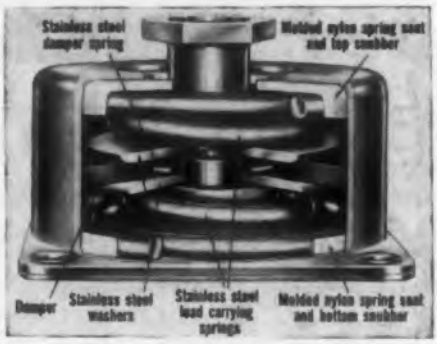


Figure 3

Additional Design Data

Other curves of isolator characteristics, and data on their use in designing *for predictable environment in jets and missiles*, are contained in Barry Bulletin 57-2. This bulletin fully describes the complete line of ALL-ANGL Barrymount isolators in standard MIL sizes. Write today for your free copy.

New Products

Improved Rectifier Mounting Potentiometer

Gives Better Results

Selenium rectifiers derive improved mechanical stability, better moisture resistance and uniformity from a recently-developed method of mounting that features installing them on a prefabricated, insulated molded stud. The improvements are the result of the reduction in number of handling and assembly operations.

Federal Telephone and Radio Company, Dept. ED, Clifton, N.J.

CIRCLE 245 ON READER-SERVICE CARD FOR MORE INFORMATION

Hydraulic Valve

For Short Stroke Applications

Primarily intended for use in control and instrumentation systems a new sub-miniature potentiometer has a stainless steel, flexible pushrod, cast case, glass seal terminals and weighs one ounce. It contains two center-tapped resistance elements of 1000 ohms each, each capable of dissipating 1/2 watt. Accuracy is ±5 per cent, linearity 0.75 per cent, resolution 0.002, electrical travel 0.50 and mechanical travel 0.75. The instrument measures 1.4 x 0.56 x 1.13 in.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 246 ON READER-SERVICE CARD FOR MORE INFORMATION

Embedded Circuitry

Uses Epoxy Resin

Enscapsor is a manufacturer's designation for hermetically sealed electronic circuits, including flip-flops, gating, mixing, triggering, oscillating and smilar stages. Where the circuit embodies a vacuum tube the encapsor is equipped with the appropriate socket and, where required, with a tube shield or clamp. As few as one and as many as 20 components are contained in a single encapsor.

The embedding material is a modified epoxy-alumina casting resin, designated Alcorite. This material is non-toxic, non-corrosive, non-volatile, of low viscosity and opaque. It forms a solid, bubble-free

mass which cures rapidly after addition of the hardening agent and under only slightly elevated temperature. No pressure is needed. Alcorite is available in 12 colors for circuit identification and servicing.

Alcor Electronics Corp., Dept. ED, 180 Lafayette St., New York 13, N. Y.

CIRCLE 249 ON READER-SERVICE CARD FOR MORE INFORMATION

Absorption Meter

Probe Slips Over Tube

This absorption analyzer has a ring type probe, designed to slip over any tube. Used in TV testing, the instrument follows composite video from antenna to CRT, traces sound from IF's to speaker, displays sweep and sync information through progressive stages, and isolates defective circuits by displaying wave forms as they appear in each stage. Because no physical connection is necessary, minimum loading effects are produced and information displayed is extremely accurate.

Kingston Electronic Corp., Dept. ED, 17 Tudor St., Cambridge 39, Mass.

CIRCLE 250 ON READER-SERVICE CARD FOR MORE INFORMATION

Film Insulation Stripper

AWG # 25 to # 50 Wires

Every type of film insulation can be stripped from solid, stranded, or Litz wires with this stripper and wheel. It strips to within 1/8 in. of coils without damaging the coils. It can be very accurately adjusted for highly critical jobs. The stripper employs twin fibreglas wheels with micrometer screw precision adjustment. Types of film insulation handled include enamel, formex, formvar, nylon and teflon. The instrument is sturdy, and precision-built to do a clean, efficient job on highest speed production line basis.

Ideal Industries, Inc., Dept. ED, Sycamore, Ill.

CIRCLE 251 ON READER-SERVICE CARD FOR MORE INFORMATION

REFLECTONE

announces
4 NEW
POWER SUPPLIES

Developed as components for highly specialized custom Reflectone equipment . . . available now for the first time to other engineers in the industry.

MODEL PS-L425

LABORATORY TYPE

ELECTRICAL SPECIFICATIONS

Input:	105-125 v. 50-400 cps
Output:	325-525 VDC, 0-200 ma DC 6.3 v. 10 amp AC
DC Regulation:	0.15% or 0.3 v. (whichever is greater) against line 0.25% or 0.5 v. (whichever is greater) against load
Internal Impedance:	less than 6 ohms
Ripple and Noise:	less than 3 mv rms

Two models available; Model PS-L425 in 325-525 VDC range, Model PS-L225 for 125-325 VDC. Designed for dependable, continuous heavy-duty operation. Protected against external overloads or internal failure. Electronic control; substantially free from noise and hum signals. All transformers and chokes hermetically sealed. Designed for standard 19" relay rack mounting.

MODEL PS-S300

SUB-CHASSIS TYPE

Electronic regulated supplies ideal for normal requirements in research and general industrial applications. Two models available; Model PS-S150 for 150 VDC, Model PS-S300 for 300 VDC. Rugged construction, simple chassis mounting with 4 screws. Easy adjustment for any operating voltage within limits specified.

ELECTRICAL SPECIFICATIONS

Input:	115 volts 60 cps
Output:	300 v. 150 ma DC 6.3 volts 6 amp AC
DC Regulation:	0.5% for ±10% line; 1.0% for no load to full load

Write today for complete information on these new products.

OTHER REFLECTONE PRODUCTS

INTEGRATORS • DIFFERENTIALS • COUPLINGS
PULSE GENERATORS • SIMULATORS • PROCEDURE TRAINERS

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Box No. 1057, Atlanta 1, Georgia

REFLECTONE

THE REFLECTONE CORPORATION • STAMFORD, CONNECTICUT

CIRCLE 252 ON READER-SERVICE CARD FOR MORE INFORMATION

TRANSISTORIZED RADAR PERFORMANCE CHECKER

A child can operate this small, lightweight performance checker of already-installed radar equipment. It is ideally suited to rapid, on the spot, pre-flight testing. Normally, inaccessible apparatus can be checked in less than 60 seconds.

Performance is measured by comparing standard ring-time with echo box ring-time. The echo box is coupled to the radar transmission line at the directional coupler or, with a pick-up horn, to the antenna. The ring-time provides a direct measure of standard performance.

A multivibrator with a variable pulse width is incorporated into the radar checker and set to match the required standard ring-time. The difference, if any, between this ring-time and actual ring-time is automatically related in decibels to standard overall performance.

COMPLETE LINE OF COAXIAL AND WAVEGUIDE INSTRUMENTS INCLUDES:

DIRECTIONAL COUPLERS
TERMINATIONS
FREQUENCY METERS
HORNS
TUNERS
ECHO BOXES
SLOTTED LINES
DETECTOR MOUNTS
ATTENUATORS
STANDARD REFLECTIONS
BOLOMETERS
THERMISTORS

FREE ILLUSTRATED CATALOG
contains much valuable data →

the narda corporation

160 HERRICKS ROAD, MINEOLA, N. Y. • PIONEER 6-4650

COMPLETE INSTRUMENTATION FOR MICROWAVE AND UHF

CIRCLE 254 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Adhesive with Plastics 256

Use of Adhesives with Reinforced Plastics, an 8-page reprint of technical paper is now available in booklet form.

The illustrated booklet, including tables, charts and diagrams, contains data on effect of temperature on tensile shear strengths; physical properties of foamed-in-place plastic "sandwiches"; peel strength of "Kel-F" laminate-to-steel bonds with epoxy room temperature curing adhesives; and bond properties of printed circuit laminates made with various adhesives. Rubber & Asbestos Corp., 225 Belleville Ave., Bloomfield, N.J.

Industrial Rectifiers 257

Components to complete power supplies are described in brochure just released. The illustrated pamphlet gives a complete description of many models of selenium, germanium and silicon rectifiers. American Rectifier Corp., 95 Lafayette St., New York 13, N.Y.

Backward Wave Oscillator 258

A 4-page brochure and a 2-page data sheet have been issued to introduce the VA-161 backward wave oscillator. The mechanical, electrical, and general characteristics of the miniature unit, which operates across the 8.2 to 12.4 kmc band, are listed along with maximum ratings. A general description of the oscillator, its features and applications, is also given. Graphs and a cutaway illustrate the text. Varian Associates, 611 Hansen Way, Palo Alto, Calif.

High Altitude Motor Unit 259

Engineering specifications for the BC 2914F motor unit are presented in a one-page data sheet. Featuring a 4 1/2 in. vane axial blower, the unit is designed especially for high altitude applications. The sheet is illustrated with a dimensional diagram and a performance curve. Induction Motors Corp., 570 Main St., Westbury, N.Y.

Thermostats 260

Engineering data on thermostats is outlined in 8 page brochure now available. It includes a description of sensitive detecting elements used on motors, cycling, fire alarm and sprinkler systems, safety device in electrical appliances on regulating systems, automatically making and breaking circuits and for numerous other electrical and electronic instrument applications. Actual size illustrations, complete specifications and engineering data on all standard models are given. Franklin Dales Co., 180-184 E. Mill St., Akron, Ohio.

Pressure Switch Movie 261

The story of high reliability pressure switches used in the production of aircraft, war missiles, and industrial automation is told in a 20 minute 16 mm color and sound movie, "Switching to Safety." The film portrays the concept, design, testing, manufacture and function of high reliability pressure switches which detect malfunction and move to correct it within thousandths of a second. Ten prints of the film are available for showing. Reservations may be made by writing to any district sales office. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

Rectifier Circuit Slide Rule 262

For computing rectifier and thyratron circuits, a convenient slide rule calculator has been devised. The calculator makes it possible to readily determine design parameters for all of the most frequently used circuits. It may be obtained for a 25¢ handling charge. Electronics, Inc., 127 Sussex Ave., Newark, N.J.

ACTUAL SIZE

first...

MINIATURE CONNECTORS SERIES 20

ACTUAL SIZE

then...

SUB-MINIATURE CONNECTORS SERIES SM-20

...and now Continental Connectors ruggedized micro-miniature connector series mm-22

ACTUAL SIZE

Series MM-22 Ruggedized MICRO-MINIATURE CONNECTOR

Available in 7, 11, 14, 20 26, 29 and 34 Contacts. Series 22 can be supplied with hoods and protective shells.

SERIES MM-22, designed for use in miniaturized equipment requiring extremely rugged and compact components, offers the ultimate in miniaturization without sacrifice of performance. No wiring problems are presented by SERIES MM-22, which uses #22 AWG wire, the standard for larger connector types. This Series surpasses the requirements of MIL specifications.

ELECTRICAL AND MECHANICAL RATINGS

Voltage Breakdown:
At sea level .....1800 Volts RMS
At 60,000 ft. ..... 450 Volts RMS
Current Rating .....3 Amps.
Solder Cup .....#22 AWG Wire
Maximum creepage path between contacts .....1/8"
Minimum air space between contacts .....3/64"
Contacts, center to center .....3/32"
Pin Diameter .....030 inches

you're always sure with **DeJUR** electronic components

progress in SIGHT SOUND SCIENCE

FOR SPECIAL DESIGNS AND TECHNICAL DATA SHEETS ON THESE CONNECTORS WRITE ELECTRONICS SALES DIV., DEJUR-AMSCO CORPORATION, 45-01 NORTHERN BLVD., LONG ISLAND CITY 1, N. Y.

CIRCLE 266 ON READER-SERVICE CARD FOR MORE INFORMATION

Panel Wiring Techniques 268

Raceway techniques for the wiring of electrical and electronic equipment are explained in a booklet of 8 pages. With photographic instructions, Bulletin S-301 outlines methods for simplifying wiring operations from the drafting room to the assembly floor by the use of raceways and precut wires. It points out quick ways of bundling and lacing wires, and of making corners and T's. A complete guide to all available standard raceways is provided with specifications, part numbers and sizes. Stahlin Bros., Inc., 344 Maple St., Belding, Mich.

Electronic Production Facilities 269

Electronic design, development, and production facilities are described in a 6-page brochure. The text outlines the progression of an idea to a working prototype and finally a manufactured product. Shown are a wide range of custom-built electronic controls, research apparatus, and industrial and medical instruments. Nelson Instrument Co., 607 Howard St., Evanston, Ill.

Blowers for Aircraft 270

A number of illustrated bulletins devoted to blowers and blower wheels for cooling aircraft and electronic equipment are available. The descriptive text is amplified with specification tables, graphs, photographs and dimensional diagrams. The bulletins are B-101, B-203, B-303, B-303A and BW-10. Ripley Co., Inc., Middletown, Conn.

High-Frequency Instruments 271

Signal generators, FM monitors and receivers, 1 kc to 250 mc bridges, and a dielectric test set are shown in a recent short form catalog. The 6-page folder contains a photograph, a brief description, and a list of specifications for each model. Marconi Instruments, 44 New St., New York 4, N.Y.

Microwave Catalog 272

More than 700 different standard units of microwave-radar test equipment and component parts are listed in a catalog of 118 pages. Bound with an embossed cover, the catalog features easy-to-read type and many clear illustrations. Douglas Microwave, Inc., 252 E. 3rd St., Mt. Vernon, N.Y.

Resistance Bridges 273

Seven bridges covering d-c resistance measurements from 1 μohm to 1 million megohms to tolerances of ±0.02 per cent are described in Bulletin L-19B. General-purpose Wheatstone bridges for laboratory and field, kelvin- and megohm-Wheatstone bridges for measurements of low or high resistances, and special-purpose per cent-limit bridges are some of the types illustrated. Shallcross Mfg. Co., Collingdale, Pa.

Magnetic Components 274

Catalog 571 contains 48 pages of magnetic and inductive component listings. Audio, power, and pulse transformers; filters and discriminators; toroids; magnetic amplifiers; and ultrasonic components are pictured and described in detail. The 128 graphs show the performance of many units. Complete data on transformers for military and commercial applications are also presented. Illustrations and dimensions are given for all components. Freed Transformer Co., Inc., 1727 Weirfield St., Brooklyn 27, N.Y.

Electrical Insulating Films 275

Four types of polytetrafluoroethylene electrical insulating films and tapes are featured in an illustrated booklet. Prominent in the 4-page brochure is a chart listing the electrical, physical and chemical properties of the tapes and information on methods of applying them. The films described are a fully fused insulation, an unfused film which can be fused in place after application, a film with a pressure sensitive silicone adhesive for positive placement, and a fully fused film treated to provide wetted surfaces for nonslip application. Minnesota Mining & Mfg. Co., 900 Fauquier St., St. Paul 6, Minn.

Copper-Clad Laminate 276

Cirprint, a copper-clad laminate meeting military specification MIL-P-3115B and specifically developed for printed circuits, is introduced in a 4-page brochure. Numbered 755, the folder contains tables of properties and comparative data. Several illustrations are provided. Formica Corp., 4411 Spring Grove Ave., Cincinnati, Ohio.

MARCONI ACCURACY

Model 791C

NEW FM DEVIATION MONITOR

WIDER modulation frequency range is a feature of Marconi Deviation Monitor Model 791C, 50 cps to 35 kc.

HIGHER carrier frequencies are covered, 4 to 540 Mc in 6 ranges.

LONGER life is not claimed. No Marconi Deviation Monitor has yet worn out.

LOWER price, yet still Marconi precision.

Brief Specification

Frequency Range	4 to 540 Mc
Mod. Freq. Range	50 cps to 35 kc
Deviation Ranges	0 to ±5, ±25, ±75, ±125 kc
Accuracy	3%, crystal standardized
Harmonic Distortion	Less than 0.2%
Tubes	6AK5, 6C4, 6CD6, 5718, 6AL5, OB2, 5Z4G

Price $720.00 **Delivery Immediate**

The Marconi range of FM test instruments includes:

- Signal Generator Model 1066/1 10 to 470 Mc
- Signal Generator Model 995A/2 1.5 to 220 Mc
- Signal Generator Model 913 22 to 176 Mc
- Deviation Monitor Model 928 for Telemetering
- Ruggedized Deviation Monitor Model 934 2.5 to 500 Mc
- Eddystone Receiver Model 770R 19 to 165 Mc
- Eddystone Receiver Model 770U 150 to 500 Mc

MARCONI instruments
44 NEW STREET • NEW YORK 4, N. Y.

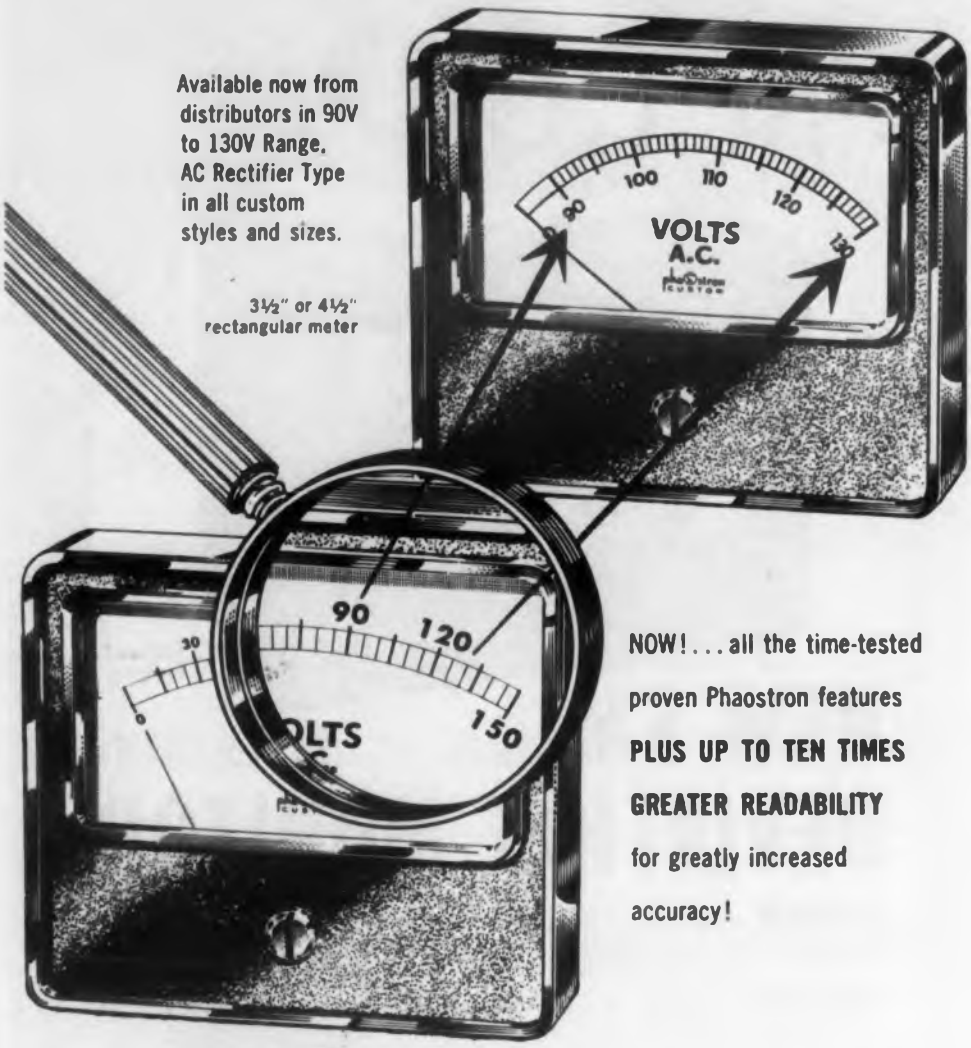
CIRCLE 278 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW PHAOSTRON

EXPANDED SCALE AC Voltmeter

Available now from distributors in 90V to 130V Range, AC Rectifier Type in all custom styles and sizes.

3½" or 4½" rectangular meter



NOW!... all the time-tested proven Phaostron features **PLUS UP TO TEN TIMES GREATER READABILITY** for greatly increased accuracy!

2½" or 3½" square meter

6" rectangular meter

2½" or 3½" round meter

All meters available with illuminated dial on special order

Phaostron has squeezed down that under 90V portion of the scale, where you don't need it, and expanded the section where you need it most – between 90 and 130V. Precisely calibrated 1 volt scale increments provide greater reading accuracy. Wide frequency range – linearity – true rms reading and Phaostron craftsman construction.

Phaostron Custom Panel Meters, with expanded scale, 90V to 130V AC rms, are available in nine types at your Parts Distributor. For special requirements for AC or DC expanded scale meters, write to Product Development Dept. for practical recommendations.

PHAOSTRON

PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 PASADENA AVE., SOUTH PASADENA, CALIF.
CIRCLE 279 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Sound Measurement Instruments 280

Illustrated with more than 60 photographs, a condensed catalog presents a complete line of instruments for sound, strain vibration and acoustical measurements. The 24-page booklet is sectioned for easy reference and describes, in addition to the aforementioned, instruments for stress analysis and production testing. Chart paper and accessories are also covered. The catalog contains a list of representatives and their territories. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Teflon Insulated Hook-Up Wire 281

All the engineering characteristics of a line of Teflon high-temperature insulated hook-up wire are outlined in Catalog T-1. Both extruded and spiral-wrapped insulation types are detailed as to conductor sizes, conductor strands, insulation thickness, voltage rating, outside diameter and stock colors. The 4-page catalog also lists a series of special constructions of this wire available on order. Alpha Wire Corp., 200 Varick St., New York 14, N.Y.

Direct Writing Recording Systems 282

Direct writing recording systems are the subject of a recent 6-page folder. Covered in the pamphlet are a line of oscillographs and amplifiers, a penmotor, and accessories and supplies used with the basic instrumentation. Five oscillograph and six amplifier models are pictured, and more than a dozen are described. The folder also lists application information and design features of many of the instruments covered. Brush Electronics Co., 3405 Perks Ave., Cleveland 14, Ohio.

Potentiometers and Environment 283

Originally presented at the Western Electronics Convention in 1956, "Environmental Effects on Precision Potentiometers" by Albert W. Green and Keith S. Schulz has been reprinted as Technical Paper 762. Based upon data gathered during a 3-year test program, the article is a 9-page discussion of the effects of extreme temperatures, vibration and shock, humidity, altitude and acceleration on precision potentiometers. The effects of increasingly severe environments on performance are described along with the design changes required to attain the desired performance. The booklet is illustrated with photographs, diagrams, and a table which shows the particular potentiometer characteristics affected by each of the environments discussed. The authors describe the design features of a single hypothetical unit which meets specifications evolved from existing customer requests. Helipot Corp., Newport Beach, Calif.

Phenolic Molding Compound 286

The 16274 phenolic molding compound, which meets the requirements of MIL-P-14D, is the subject of a 4-page illustrated pamphlet. Complete physical properties of the compound are listed, and recommended molding equipment, preforming, preheating, mold temperature and curing time are briefly discussed. Finishing operations and shelf life of the material are also treated. Hooker Electrochemical Co., Durez Plastics Div., Walck Rd., No. Tonawanda, N.Y.

Precision Optical Instruments 287

How low-cost precision optical instruments can simplify and speed manufacturing and inspection operations is the topic of a booklet called "Industrial Optical Aids." The text describes an assortment of instruments and suggests ways to use them for faster, lower cost production. Items discussed include magnifiers, microscopes, wide field tubes, macroscopes and comparators. Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N.Y.

D-C Motors 288

Engineering data on 2000 series special-purpose d-c motors are presented in a 1-page design specification sheet. The page is illustrated with a performance curve and engineering drawings. Induction Motors Corp., 570 Main St., Westbury, N.Y.

Teflon Tubing 289

Bulletin T-200 is devoted to Teflon thin-walled tubing. The 2-page data sheet states the principal uses and advantages of the tubing, and lists electrical properties and available sizes in table form. An illustration is provided. Haveg Industries, Inc., 900 Greenbank Rd., Wilmington 8, Del.

Marking Machines 290

A series of 20 2-page leaflets cover a line of general purpose marking machines. Each sheet presents a single model, citing its uses, specifications and operating principle. Each model is amply illustrated with photographs and drawings. Jas. H. Matthews & Co., Inc., 3942 Forbes St., Pittsburgh 13, Pa.

Computer Racks, Consoles & Cabinets

...can breathe

ROTRON Model NF Fan with 6½" diameter propeller is one of 6 similar designs ranging from 3" to 8" in propeller diameter.

ROTRON

- PUSH OR PULL FLOW
- VENTURI RING MOUNTING
- LENGTH: 5-1/16", MAXIMUM DIAMETER OVER VENTURI: 8½"
- WORKS ON ALL STANDARD POWER SUPPLIES
- HORIZONTAL OR VERTICAL MOUNTING
- VIBRATION ELIMINATORS AVAILABLE
- MEETS ALL APPLICABLE GOVERNMENT SPECIFICATIONS

CATALOG SHEETS: 50105-1 & 50105-2

ROTRON MANUFACTURING CO., INC.

WOODSTOCK • NEW YORK

CIRCLE 413 ON READER-SERVICE CARD FOR MORE INFORMATION

WHY SETTLE FOR LESS?

WHEN YOU SPECIFY POWER SUPPLIES

. . . you are entitled to all of the benefits of complete facilities, thoroughly experienced engineers, wide product range, prompt delivery and competitive prices.

WHY SETTLE FOR LESS?

Take a standard DC requirement, anywhere between 6 and 1000 volts. You need a good, reliable standard DC source — you want to be able to install it and forget it. You want it promptly and, since it's a standard item, you want it for a reasonable price.

If you investigate Sorensen's "Nobatron"* group — more than 70 models available "off the shelf" — and look a bit deeper than the electrical and mechanical specs, here's what you'll find:

*Reg. U.S. Pat. Off. (NO BATTERIES — ELECTRONIC CONTROL)

SORENSEN & COMPANY, INC. 375 FAIRFIELD AVE., STAMFORD, CONN.

"The authority on controlled power for research and industry"

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

CIRCLE 291 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Electrolytic Condensers 293

Technical Bulletin No. 53, issued to supersede No. 47, is a two-page presentation of data on a series of high capacity electrolytic condensers. The construction and applications of the units are discussed and their specifications are listed. A table shows the capacity and dimensions of a number of types. The text is illustrated with a graph, diagrams and photographs. The Telegraph Condenser Co., Ltd., Radio Div., N. Acton, London W.3, England.

Electronic Parts Catalog 294

A catalog with 288 pages of electronic parts listings has recently been issued. In it is an 8-page insert for technicians and engineers which contains carrier frequency information on TV channels, transistor performance tables, wire specification information, color codes, decimal equivalent charts and many other tables of data used in electronic work. Radio Distributing Co., 432 S. Carroll St., South Bend, Ind.

Silicone Fluids 295

Prepared to aid designers in evaluating various silicone fluids for specific applications, a 4-page reference brochure describes the physical and electrical characteristics of all leading silicone fluids now commercially available. Data in the Code 3-106 pamphlet are arranged in tabular form and include such standard properties as specific gravity, pour point, thermal conductivity, surface tension, refractive index, dissipation factor, and specific heat. Brief general descriptions of each fluid and general application information are also provided. Dow Corning Corp., Midland, Mich.

High Temperature Alloys 296

The engineering properties and fabrication characteristics of ten high-strength alloys for elevated temperature service are described in detail in a booklet of 20 pages. The technical information presented includes physical constants, mechanical properties at room and high temperatures, heat treatment, forging, cold working, welding and corrosion resistance. Recommended uses are spelled out for each alloy with a comprehensive discussion of how to use stress-rupture and creep data in designing components for high temperature service. The effect of steelmaking practice on forgeability, cold working properties and service behavior is also described. The booklet is illustrated with graphs and photographs. The Carpenter Steel Co., 3114 W. Bern St., Reading, Pa.

Converters and Inverters 298

A catalog sheet and a 7-page technical bulletin have been issued to cover a line of transistorized semiconductor converters and inverters. The catalog sheet lists full technical details and price information for stock model d-c to d-c converters and d-c to a-c inverters. The technical bulletin provides operational characteristics, design data, and technical descriptions for the same units. Electronic Research Assoc., Inc., 67 E. Centre St., Nutley 10, N.J.

Military Cargo Cases 299

Reusable cases built to military specifications and designed to protect vital cargo such as guided missiles, missile components, electronic equipment, and airplane parts during transit and storage are depicted and described in a booklet of 8 pages. The brochure also presents such allied equipment as spare parts cabinets, operator consoles, and general purpose electronic equipment racks. Craig Systems, Inc., Danvers, Mass.

Drafting Room Check List 300

To help pinpoint possible ways to increase drafting productivity, an item-by-item check list is offered. The list enumerates every type of product used in a modern, well-equipped drafting room. It also suggests several specific ways to cut down waste motion, eliminate time-consuming methods, reduce fatigue and save space. Frederick Post Co., 3630 N. Avondale Ave., Chicago 18, Ill.

Flexible Couplings 301

Flexible couplings designed to provide maximum flexibility combined with high torque capacity and zero backlash are listed in a folder of 4 pages. Complete details are given for 1/2, 3/4, 1 and 1-1/2 in. diam models. The bulletin is illustrated with photographs, dimensional diagrams, and graphs for lateral and torsional deflection. Naugler Engineering Inc., 19 Madison Ave., Beverly, Mass.

Pantograph Engraving Machines 302

In Catalog No. 57, a line of pantograph engraving machines and accessory items are described with illustrations. The 12-page booklet also lists a cutter grinder, a name plate edging machine, a sensitive drill press and a hand tapping machine. A separate booklet gives prices for all items listed in the catalog. Mico Instruments Co., 80 Trowbridge St., Cambridge 38, Mass.

Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.

Lockheed F-94C Starfire and the Hughes radar fire control system with which it is equipped.

Hughes has been the leader from the beginning in applying electronic computers to airborne fire control equipment. Today every U.S. Air Force and Canadian continental defense interceptor uses Hughes-developed and Hughes-manufactured systems.

PRODUCT DESIGN at HUGHES

As the intercept problem becomes more and more automatic, additional equipment such as new-type computers, control surface tie-in (CSTI), autopilots, and other units must be integrated into the system. Faster speed and heavier engines dictate more streamlining—and hence less space for electronic gear. The result is even more miniaturization and compact packaging, evolved from special techniques.

This all means that now the product design engineer is more important than ever before. In the Product Design Laboratory he is a vital part of the formal link between the Research and Development activity and the optimum configuration and installation arrangements for the systems "black boxes."

HUGHES *Scientific Staff Relations*

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

CIRCLE 563 ON READER-SERVICE CARD FOR MORE INFORMATION

From LFE's special products division —

...complete line of dependable, low-cost, plug-in scalers- any kind!

from 20 kc/s to 20 mc/s

10 mc/s Decade Scaler

100 kc/s Decade Scaler

Binary Scaler

100 kc/s Preset Decade Scaler

Decade . . binary . . preset? No matter what type scalers you need, contact Laboratory For Electronics . . manufacturers of the industry's most extensive scaler line! Each compact LFE scaler features printed wiring, bright, easy-to-read display. And LFE scalers are low-cost . . each is competitively priced to give you top dependability at lowest cost.

Counting Speeds of Popular Models

(Available with either 8- or 11-pin plugs)

Binary	Decade	Preset
20 mc/s	20 kc/s	20 kc/s
	40 kc/s	40 kc/s
	100 kc/s	100 kc/s
	1 mc/s	
	10 mc/s (exclusive with LFE)	

Features

Decade or Individual Stage Output
Bright Neon Display
Printed Wiring
Low Cost — High Reliability
Standard and Special Purpose Models
Externally Accessible Reset Bus

Decade Scalers Available 9 or Zero Reset

Outstanding Counters Welcome Comparison.

For detailed specifications on standard models, request Bulletin 1700 now. If you have special counting problems, write today to

LABORATORY FOR ELECTRONICS, INC.
75 Pitts Street • Boston 14, Massachusetts

L/E

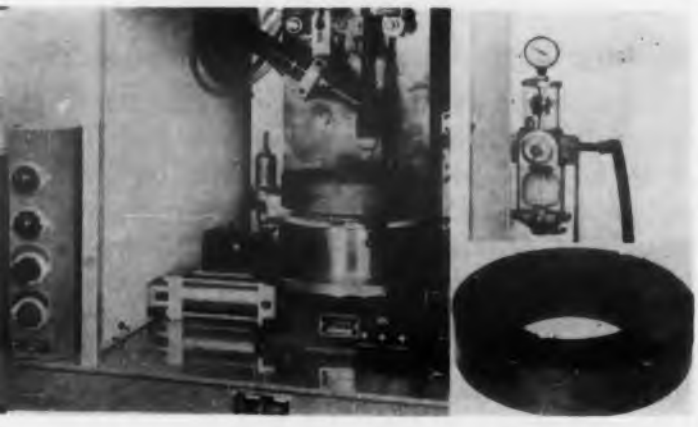
CIRCLE 303 ON READER-SERVICE CARD FOR MORE INFORMATION

Production Products

Designers might find it profitable to redesign their present products, or to conceive of better products, to take advantage of the capabilities of these new production equipments.

Complicated Automatic Welder

For Unskilled Operator



This newly designed automatic welding machine permits an operator with no welding experience to produce finer welds than is possible by hand at a rate substantially greater than can be produced by even the fastest experienced welder. The unit consists of a standard dc welding machine and separate all metal enclosure which houses the torch, indexing table, automatic and regulatory controls. When door of welding enclosure is open, a green light glows indicating that the machine is not in operation and that it is safe to place hands inside. Operator may then secure workpiece onto index table. When door is closed and START button is pushed, red light glows indicating that controls are operating automatically, regulating argon gas, water for cooling the torch, welding current and movement of torch across workpiece. During operation, large viewing glass permits several people to observe welding simultaneously. Should door be opened for any reason during operation, the machine ceases to operate.

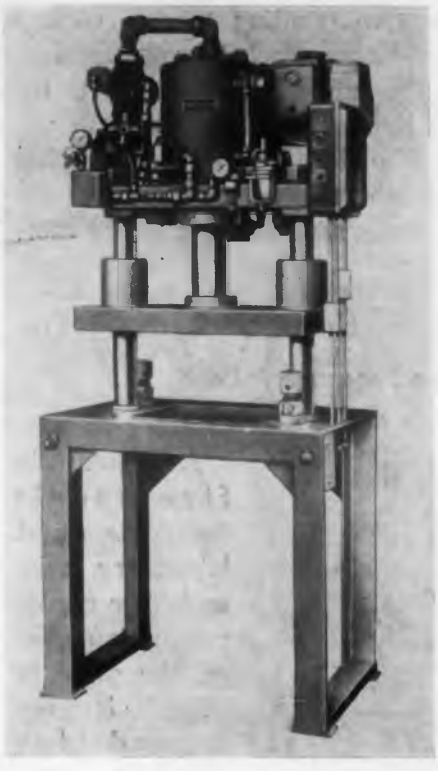
Advantages are: (1) unskilled operator performs welding task especially difficult even for skilled welder, i.e. in the case of core, evenly spaced welds were desirable—torch produced consistent arc and moved at a uniform rate in a straight line producing large quantities of workpieces of equal perfection, (2) welding operation may be viewed by several people simultaneously (3) fully automatic adjustments, controls and operation (4) maximum safety assured operators, passers-by and viewers.

Torch height and other operating controls are quickly adjusted to accommodate wide variety of workpieces of varying diameters and thicknesses.

Automatic Methods, Inc., Dept. ED, 808 W. Grand St., Elizabeth, N.J.

CIRCLE 304 ON READER-SERVICE CARD FOR MORE INFORMATION

20 Ton Hydraulic Trim Press
Requires Only 3 HP Motor



Featuring high speed travel of the ram in both directions, this Mohler Press is designed around the parallel strain rod, guided platen principle. With its special electrical and air controls, and its unique hydraulic circuit, the press is quiet and practically "shock-free" during operation. The 3 hp drive motor is less than half the horsepower usually called for by earlier presses of similar capacity.

Speeds from 0 to 600 in. min. are accomplished through vernier finger tip controls. Stroke is adjustable from 0 to 12 in., with a shut height of 17 in. between platens. Upper platen has an 18 x 24 in. free area. Lower platen has a 15 x 15 in. cut out, which can be eliminated or varied to suit the need. Working area between uprights is 23 in. The press permits broaching, staking, swaging, stamping, shearing, blanking and forming operations.

A E. Bausenbach, Dept. ED, 33 Roetzer St., Buffalo 11, N.Y.

CIRCLE 307 ON READER-SERVICE CARD FOR MORE INFORMATION

Coil Winding Lathe
For Power Transformer

A new coil winding lathe is being introduced in the power transformer manufacturing field which provides fast, uniform tension coil winding, in a range from 8 to 36 in. coil ID.

The new lathe operates with a hydraulic drive, operated by a simple treadle bar control which starts, controls speed and stops the lathe. The expansion-type mandrel can be rotated in either direction. The machine provides a completely vari-

Smallest, most versatile, multiple-circuit rotary switch

Centralab Series 100

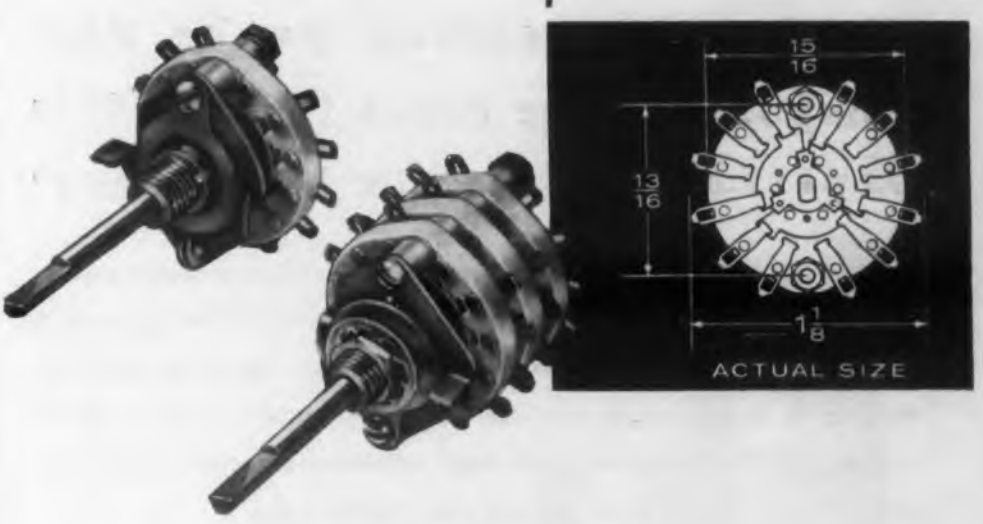
An ultra-small switch that measures less than 1" in diameter — weighs less than an ounce — yet has the electrical rating of larger, heavier switches.

Available up to 12 positions. Make and break, resistance load, .5 ampere at 6 volts d.c.; 100 milliamperes at 110 volts, a.c.; current-carrying capacity, 5 amperes.

Ideal for band switching in subminiature electronic equipment, transistor circuits, aircraft instruments, and guided missiles.

Features not found in phenolic-type switches

Maximum voltage flashover
High Q — Low loss
Minimum inter-circuit capacity
Maximum circuit flexibility



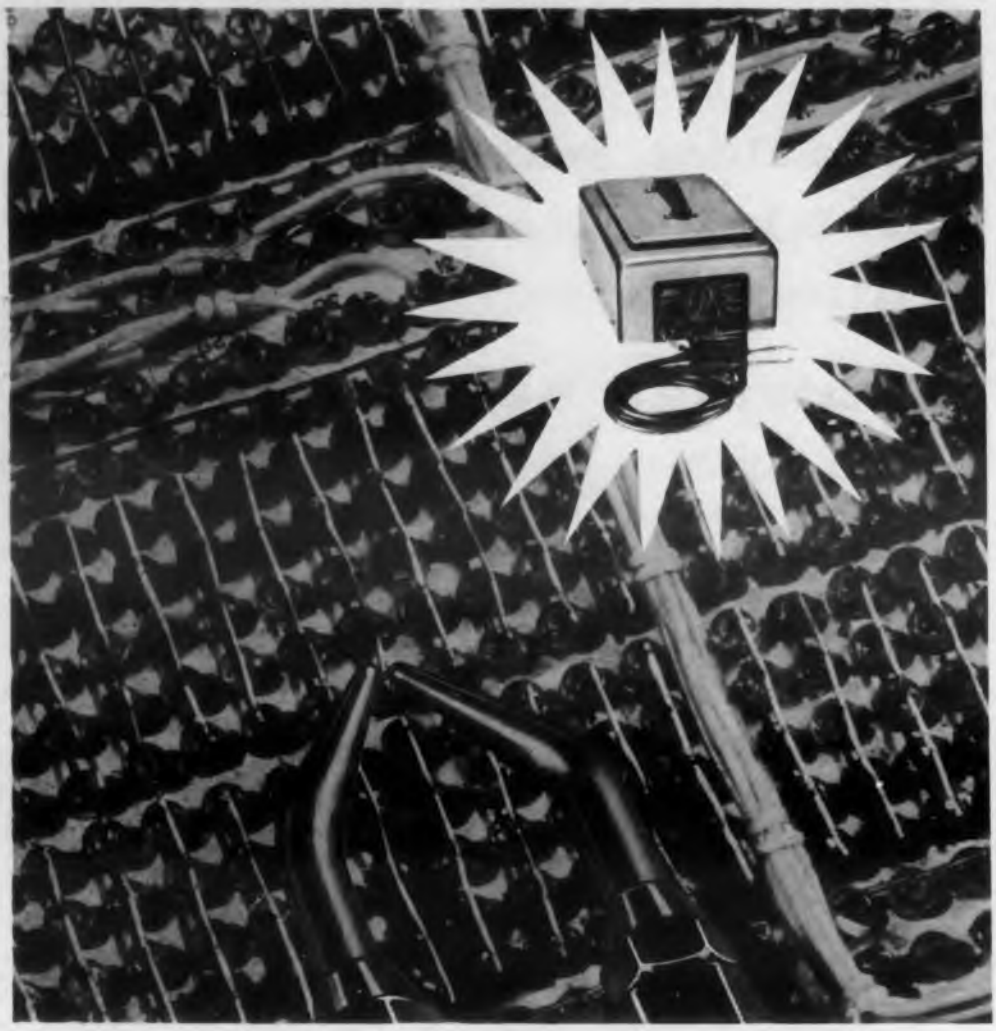
Centralab CRL

A DIVISION OF GLOBE-UNION INC.
960 D E. Keefe Ave.
Milwaukee 1, Wis.
In Canada:
804 Mt. Pleasant Road
Toronto, Ontario

New 36-page Switch Catalog

Provides specifications on the complete line of CRL switches capable of handling power from a kilowatt to a microwatt. Write for this catalog today.

CIRCLE 308 ON READER-SERVICE CARD FOR MORE INFORMATION



Weldmatic welding packs 94.5 components per cubic inch in this experimental matrix by Hughes*

Hughes achieved the unprecedented compactness of this computer matrix by making diode connections *right next to the diode body*... with a Weldmatic stored-energy welder. Note how tweezer handpiece simplifies working in hard-to-reach locations. Weldmatic instantaneous precision welding, which also makes joints more reliable and uniform, may offer advanced solutions to *your* metal-joining problems, too.

**Hughes Aircraft Company — one of many leading users of Weldmatic stored-energy welders*

Weldmatic literature and a full technical report of the Hughes miniaturization techniques referred to above are available on request.

WELDMATIC

DIVISION OF UNITEK CORPORATION

260 North Halstead Avenue • Pasadena, California

sales engineering representatives in principal cities

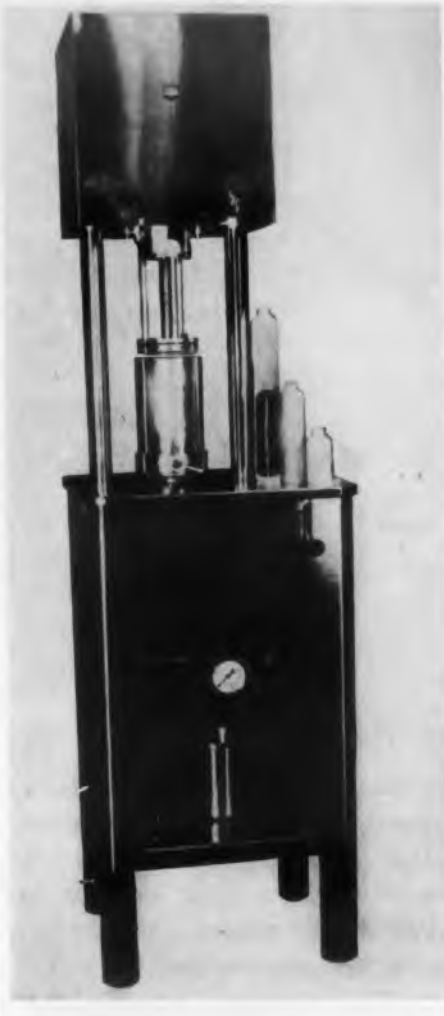
CIRCLE 311 ON READER-SERVICE CARD FOR MORE INFORMATION

able speed, has positive winding tension control and safety braking. The mandrel, interchangeable, swings away from the tailstock and contracts for easy removal of coil by crane pickup.

Mason, Shaver & Rhoades, Inc., Dept. ED, 1235 Fifth Ave., E. McKeesport, Pa.

CIRCLE 309 ON READER-SERVICE CARD FOR MORE INFORMATION

Air-Free Pressure Mixer
For Lab or Production



Available in five models from one quart laboratory mixer to five quarts production mixer, the pressure mixer is designed for blending catalyst and additive materials in a manner which assures that the mix delivered is air free. Any quantity up to a full quart of base material may be mixed in a few mins. and the mix is delivered for use, while still under pressure, into a polyethylene cartridge. Action of mixer is provided by two double acting air cylinders. The lower cylinder first forces entrapped air through an air bleeder and seal at the top of the container, and then holds the container under pressure while the upper cylinder forces a dasher through the material with an involved motion that gives a thorough mix and blend.

A counter registers the dasher cycles assuring positive uniformity of batches. Number of cycles necessary to give thorough mix is determined by experiment or by material manufacturers' recommendation. The cabinet and pots are stainless steel. Pot and dasher readily disassemble for easy cleaning.

Pyles Industries, Inc., Dept. ED, 8926 Second Ave., Detroit 2, Mich.

CIRCLE 310 ON READER-SERVICE CARD FOR MORE INFORMATION

Services for Designers

Applied Magnetics Research

Laboratory Facilities

Bussey Research Laboratories Inc., Rockford, Ill. has announced expanded facilities for serving large and small manufacturers in the electrical, electronic, magnetics, and related fields. Of interest to manufacturers of data processing, computing, and control instruments is the research work undertaken by Bussey in the field of applied magnetics. Preliminary work now completed points to innovations that will eliminate the moving parts and mechanisms employed in current product designs. The benefits from this research is open to a limited number of sponsoring firms. The following suggests the range of potential applications: Sound recording and reproduction—without moving parts; pictorial and other visual recording and reproduction in magnetic replica—without moving parts; recording, storage and reproduction of information either digital or of an analog nature; circuit selection and commutation by magnetic methods, without mechanical switching and relay contacts.

Custom-Formed

Cylindrical Bobbins

A complete line of cylindrical bobbins is now available to fill custom form requirements. They can be made of epoxy resin, nylon, teflon and many other plastics and are custom-formed to any cylindrical shape in diameters of 1/8 in. to 7/8 in. and lengths up to 7 in. There are no molds necessary to the process thus making possible lower costs and quicker delivery.

Illustrated are but a small fraction of the countless possible variations of cylindrically shaped bobbins that can be custom-formed of plastic materials. Blueprints or samples may be sent to Orange Products, Inc., 554 Mitchell St., Orange, N.J.

Have you sent us your subscription renewal form?

XD BODY

new Solar by-pass disc capacitors offer

35%

increased capacity

Solar's new XD body now makes available capacitors meeting RETMA specifications REC-107A with Z5Z characteristics, and having an increase of 35% more capacity per comparable size. This bonus capacity is achieved with no sacrifice in temperature stability or voltage rating.

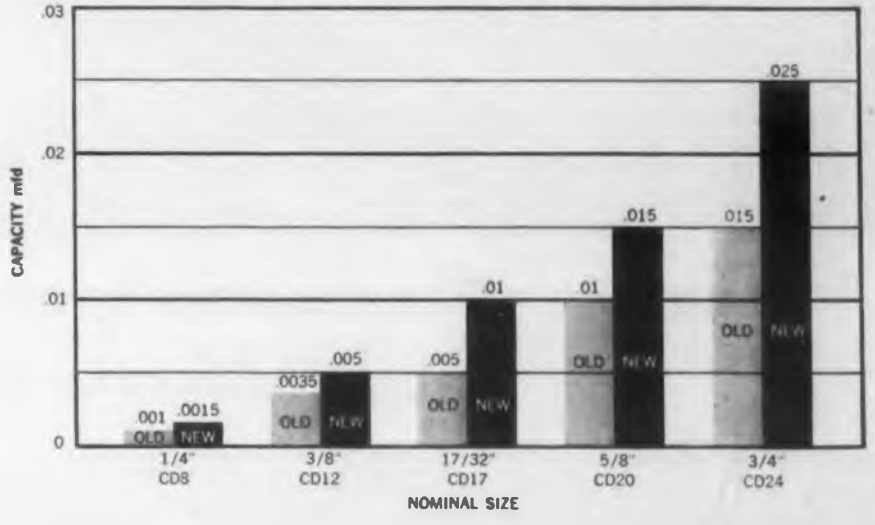
You'll find these units widely useful in miniaturized circuitry. Specify them where you want increased capacity without increased size—or where a smaller size is imperative.

Voltage ratings are conservative. Capacitance change is less than 50% from its value at 25° C. as the temperature varies from +10° C. to +75° C.

SPECIFICATIONS

Capacity	**See chart**
Capacity Tolerance	**GMV**
Working Voltage	**500 VDC**
Test Voltage	**1250 VDC**
Min. Leakage Resistance	**10 K megohms**
Max. Power Factor	**2%**

COMPARATIVE CAPACITY CHART



Write for literature

"QUALITY ALWAYS"

SOLAR MANUFACTURING CORP.
New York, N. Y.

SOLAR

SALES OFFICES: *46th & Seville, Los Angeles 58, Calif.*
4000 W. North Ave., Chicago 39, Ill.

CERAMIC CAPACITORS • PRINTED NETWORKS • PIEZO CERAMICS

CIRCLE 314 ON READER-SERVICE CARD FOR MORE INFORMATION

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication. Full information and an "entry blank" can be obtained by circling 548 on the Reader's Service Card.

Improved Radar Target

Fig. 2. Ecco Reflector based on the Luneberg Lens. Where low weight is important, the unit is mounted using the flange of the enclosing radome instead of the mounting stand shown.

The reflector described here is highly effective as a passive target for radar energy. It has a large cross section which is essentially constant over a wide conical viewing angle, yet it is compact, rugged, light in weight and easily installed. It is broadbanded throughout the microwave frequency range.

Based upon the Luneberg Lens principle, the reflector is essentially a Luneberg Lens with a metal plate at its focus. The Luneberg Lens is a sphere of dielectric material, wherein the dielectric constant varies from 2.0 at its center to 1.0 at the outer surface. Variation of dielectric constant is in accordance with:

$$K = 2 - r^2$$

where K = dielectric constant
r = radius

Energy incident upon the lens is focused to a point; or conversely, it produces a plane wave from a point source. The ray pattern in a Luneberg Lens is shown in Fig. 1. The antenna pattern of a 12 in. dia lens is also shown.

When the lens has a spherically shaped reflective plate at its focus, incident energy upon the lens is focused at the metal plate and reradiated. The energy is sent precisely back in the direction from which it was received. Such a device is the reflector shown in Fig. 2, designed and manufactured by Emerson and Cuming, Inc., 869 Washington St., Canton, Mass. As supplied, it is provided with enclosing radomes and mounting.

The radar or backscattering cross-section of this (Ecco) reflector is given by:

$$\frac{4\pi^2 R^4}{\lambda^2}$$

where, R = radius of the spherical Luneberg Lens which is used
λ = wavelength

The theoretical radar cross-section of several reflectors of different sizes is given in the following table. Measured values of actual reflectors available are within 2 db of theoretical.

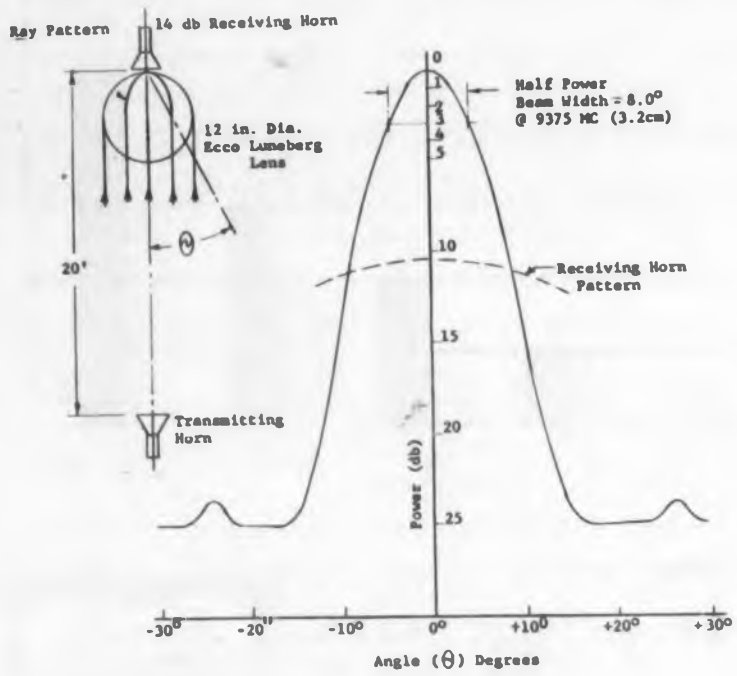
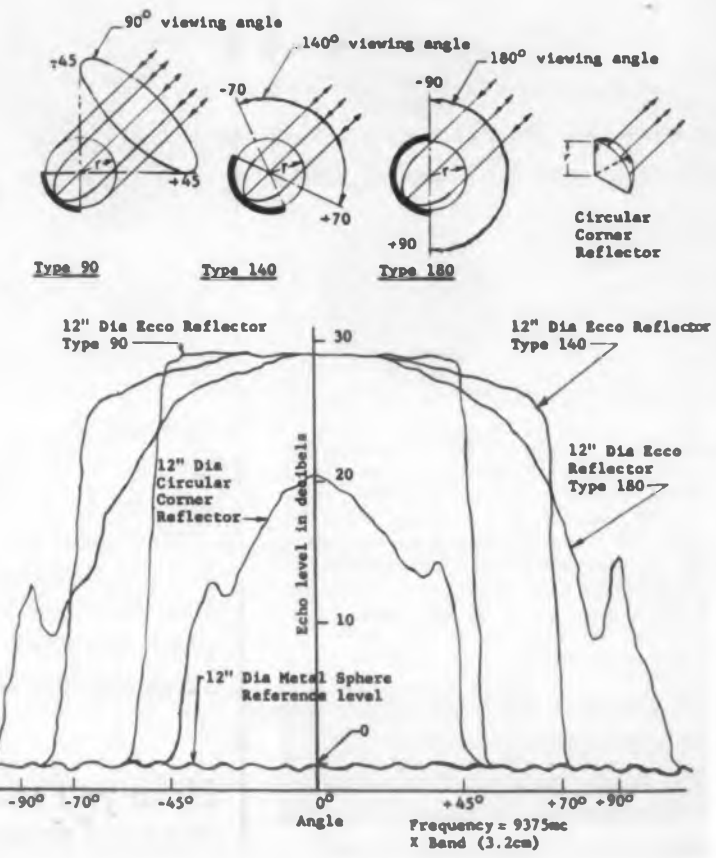


Fig. 1. Antenna pattern of the Luneberg Lens. This lens is a variable-dielectric-constant device of spherical contour which focuses an incident plane electromagnetic energy wave to a point on its surface, or conversely produces a plane wave from a point source.

Fig. 3. Reflectivity data on various Ecco Reflectors. Reference level is a metal sphere. Ecco reflector, corner reflector and metal sphere are all the same radius.



Reflector Characteristics

Reflector Size	Radar Cross-Section			
Nominal Dia—Inches	X Band (3.2 cm) Sq ft	X Band (3.2 cm) Sq Meters	S Band (10 cm) Sq ft	S Band (10 cm) Sq Meters
12	700	66	70	6.6
18	3500	330	360	34
36	56,000	5300	5800	550

For a given diameter, the radar cross-section of the reflector is much greater than that of a corner reflector. This is indicated in Fig. 3. However, the real merit of the Luneberg Lens reflector is in its wide conical viewing angle. The actual extent of this angle is dependent upon the angle subtended by the reflective plate used. Three different types are shown. Type 90 gives a constant return for a full 90 deg conical angle and no return at all other angles. Type 180 gives some return for a full 180 deg conical angle; the 3 db points are ±45 deg. Type 140 is intermediate between the two. Other configurations are possible.

A typical flight test indicates the effectiveness of the unit. A reflector was mounted behind the plexiglas canopy of a Beechcraft Bonanza plane. The plane was flown at altitudes of 5000 to 8000 ft—weather cloudy; ceiling 10,000 ft; visibility 10 miles; temperature 50 F. viewing radar was an LFE SPAR GCA, X-band radar located at the airport.

At first, the plane was sent out to 15 miles and returned toward the airport at 5000 ft elevation. With the reflector exposed to radar, it was clearly visible on the oscilloscope at 15 miles. The plane became visible with the reflector masked at 7 miles.

Next, the plane was sent out to 15 miles, to circle the airport at 5500 ft elevation. With the reflector masked the plane was visible to radar only occasionally, and then poorly. With the reflector exposed, the plane was at all times clearly visible.

Then, the plane was sent out to 25 miles and returned toward the airport at about 8000 ft elevation. The reflector was alternately exposed and masked each 15 seconds. The oscilloscope photos of the plane were readily made at 21 miles with the reflector exposed. At 17 miles, the signal was noticeably increased, but the plane was not visible without the reflector exposed. At 12 miles distance, the plane was at the noise level without the reflector, but showed as a brilliant radar target when the reflector was exposed.

Applications

Some suggested "Reflector" applications are:

- Target for test of radar equipment;
- Airfield runway markers;
- Tow or drone target for aerial gunnery;
- Aircraft echo amplification for in-flight location, control or landing;
- Use by survivors, either on land or sea; or,
- In clusters as a passive beacon for use in radar navigation.

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CIRCLE 561 ON READER-SERVICE CARD FOR MORE INFORMATION

Fig. 1. "Cartridge" of Belleville washers ready for assembly in equipment.

Spring-Washer Cartridge

Pre-assembled stacks of spring washers, which are easier to install and provide high loads with small deflection, have been developed by Associated Spring Corp. of Bristol, Conn. (See Fig. 1) The washers are held together by pins or rivets passing through them at or near their neutral axis (Fig. 2). The assembly forms a "cartridge."

Advantages: The "cartridge" has the advantage that it can be incorporated as a one-piece component in the final machine, and as such is easier to handle and install than loose washers. Assembling of the stacks of washers can be done in jigs or by automatic machinery. The cartridge can be preloaded, so that only a very slight additional compression force is necessary to assemble the unit in the machine. The three-point (or more) loading of the cartridges prevents buckling of the stacks, a common disadvantage that arose with the previous methods of assembly unless the washers were very carefully made with considerable machine work. Furthermore, preassembly of the washers in permanent form precludes the hazard of reassembling them in the wrong sequence in the field, which might happen if individual stacked washers happened to be disassembled.

Possible Applications: Possible electronic applications for these spring-washer cartridges include: 1. As a shock-absorber in vibration-isolation mounts for airborne electronic equipment; 2. Where neces-

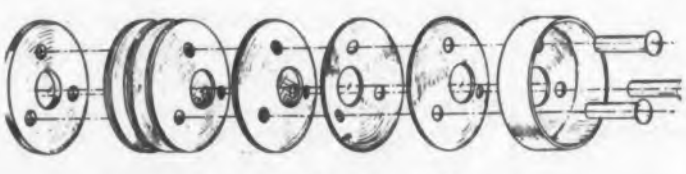

Fig. 2. Exploded view of "cartridge," arranged in series, with one recessed end-plate to allow for the outward travel of the ends of the pins.

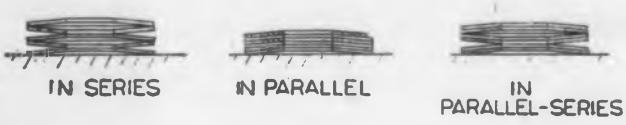

Fig. 3. Three possible methods of stacking Belleville washers in multiple arrays.

sary to exert large amounts of force within a limited range of deflection; 3. Where necessary to exert force at a low rate, i.e., a very small increase in load in proportion to the increase in deflection, such as in clutches for drives; and 4. To maintain reasonably constant pressure in spite of expansion due to temperature variations.

Series and Parallel Stacking. Since the deflection or load obtained from a single washer is relatively small, it is often desirable to stack several washers together. Stacking them in series—that is, with each adjacent spring inverted with respect to its neighbor—increases the deflection in direct proportion to the number of washers in series. Stacking them in parallel—that is, with all the springs parallel in all conditions of stress—increases the load in direct proportion to the number of washers in parallel. The three possible arrangements of stacking are shown in Fig. 3. Assuming that each individual washer in the stack gives 35 pounds of load with 0.025 in. deflection, then: a stack of five washers in series would give 35 pounds of load with 0.125 in. deflection; a stack of six washers in parallel would give 210 pounds of load with 0.025 in. deflection; a stack of six washers paired in parallel and in a series of three would give 70 pounds of load with 0.075 in. deflection; etc.

In certain other applications, it may be desirable to assemble the multiple washers with adjacent springs separated by spacers, to permit them to be deflected beyond the horizontal.

Edge Trim for Sheet Metal

This new thermostat shows how a good-looking extruded plastic edging can be provided on stamped metal products.

The spring-hinged cover—a drawn metal part—would have been too expensive to produce if turned over edges had been required. The problem of providing a smooth edge against which the fingers can rest when opening the cover, and to assure silent closing, was solved by using the extruded shape shown, snap-fitted over the edge. The plastic material has enough natural springiness to grip the metal edge, and the recessed design of the cross-section assures that the edge trim will stay on. The end of the trim is held in place by means of a small metal clip inconspicuously mounted near the hinge part of the cover.

Anchor Plastics Co., Inc. of Long Island City, N.Y., produces the extrusion named Aeroflex.

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CIRCLE 320 ON READER-SERVICE CARD FOR MORE INFORMATION

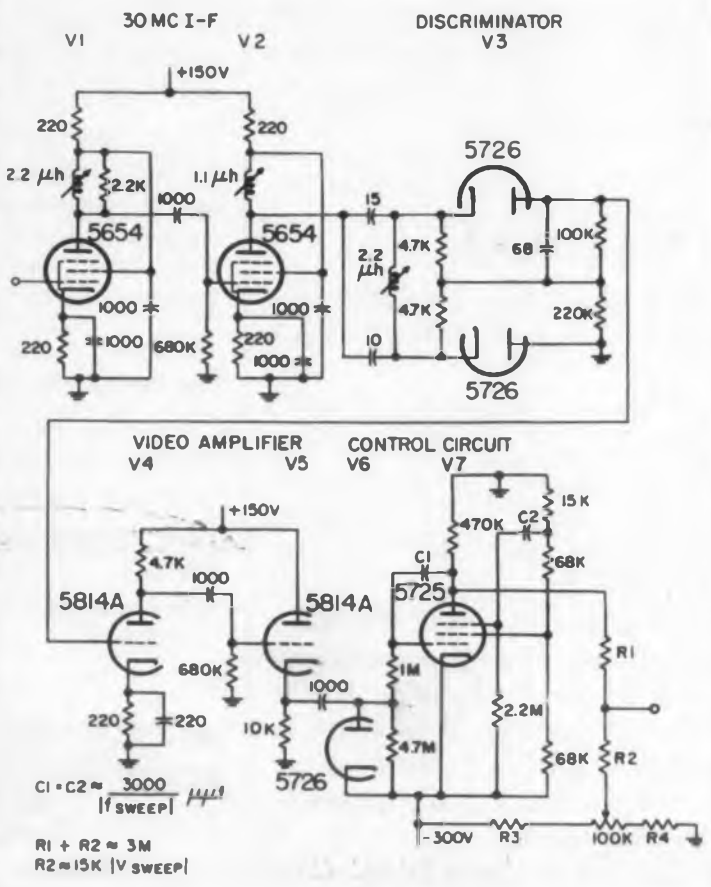
Ideas for Design

Preferred AFC Circuit

The National Bureau of Standards has derived an automatic frequency control (afc) circuit which is applicable wherever a 30-mc intermediate frequency is used with pulse widths between 0.5 and 5.0 μsec.

The portion of the afc system between the mixer and the local oscillator, in a typical radar system, is usually a self-contained sub-assembly and is a logical choice for a preferred circuit. A preliminary study of a number of existing circuits revealed that they are composed of a few basic types. The mixer is followed by IF amplifiers which are usually synchronously tuned; the number of stages varies with the bandwidth requirements. In the majority of cases, Weiss discriminators are used to develop the error signal in preference to the Foster-Seeley circuit. The video amplifiers, used as error amplifiers, vary from single triodes and pentodes to pentode-triode and pentode cathode-follower combinations. The control circuits, which also function as sweep generators, are either of the thyratron or phantastron types with the trend toward the latter.

The performance requirements of these circuits fall within fairly narrow limits. The bandwidth of the IF amplifier and the peak separation of the discriminator are determined by the pulse width of the transmitted signal. Since many radar systems employ both short and long pulses, it was essential



PREFERRED AFC CIRCUIT

to accommodate the range of pulse widths without adjustment. Two IF amplifier stages were required to obtain the necessary gain and bandwidth. While the input signal is constant for a particular system, it varies from 50 to 500 mv among the systems studied, and it is necessary to adjust the gain to suit the input level because of the possibility of responding to crystal harmonics. The gain is adjusted by varying the plate load resistors in the IF and video amplifiers. This is permissible in the former case because the bandwidth requirements are not rigid.

The diode-phantastron control was selected instead of the thyratron for the Preferred Circuit because of its better performance. The sweep rate can be adjusted by selection of the two feedback capacitors, the sweep amplitude by the divider on the output of the phantastron, and the sweep centering by the "Range Set" divider.

The choice of input circuit is properly a part of the mixer design. The IF amplifier and discriminator are designed for the shortest pulse, and no adjusting controls are provided—or required—for bandwidth. The preferred afc circuit will operate at pulse widths between 0.5 and 5 μsec and duty factors between 0.001 and 0.0001. It can be adjusted for input signal levels between 50 and 500 mv. The sweep output is a sawtooth which can be adjusted for rates between 0.1 and 10 cps, amplitudes between 40 and 150 v, and average d-c levels between 0 and −200 v. The values for the eight components necessary to make these adjustments are specified in terms of performance requirements. The result is a circuit which is usable, without sacrifice in performance, in most afc systems operating in pulse systems with 30 mc IF's.

For previously published preferred circuits see: Handbook Preferred Circuits Navy Aeronautical Equipment NAVAER 16-1-519. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., Price, $1.75.

Beryllium Spring Solves Fatigue Problem

Precision compression type beryllium copper springs, manufactured by Instrument Specialties Co., Inc., Little Falls, New Jersey, have solved the problem of fatigue in a sealed thermal control.

Specifications called for springs of high fatigue resistance with nonmagnetic properties. The application, current-type motor starting relays, required springs that would provide long, trouble-free service in controls that were sealed against dirt, oil and atmospheric pressures. Smooth, quiet operation was an additional requisite.

The compression type beryllium copper springs, aside from being non-magnetic, provide extremely high fatigue resistance. They also have the advantage of high conductivity, excellent corrosion resistance, stability at temperature extremes, and reduced space requirements.

Report Briefs

A New Wide-Band Amplifier

This report describes the development of an instantaneous logarithmic amplifier containing nonlinear network elements which provide for the appearance of the logarithm of the input voltage directly at the output. The accuracy of the approximation of the log function is calculated in the report, and the effect of various design parameters is discussed. Construction of an amplifier for measurement of noise potentials is described to illustrate the principles involved. *PB 121485 A New Type Instantaneous Logarithmic Wide-Band Amplifier, G. Epprecht, Bern, Switzerland, OTS, U.S. Dept. of Commerce, Washington 25, D. C., May 1955, 14 pp, $0.50.*

Automatic Control Theory

This paper considers the use of harmonic linearization as applied to the analysis of nonlinear automatic control systems. The approach consists in the replacement of a nonlinear equation by a linear equation. *NACA TM 1406 On the Use of the Harmonic Linearization Method in Automatic Control Theory (K voprosu o primenenii metoda harmonicheskoi linearizatsii v teorii regulirovanya), E. P. Popov, NACA, 1512 H St. NW, Washington 25, D.C., Jan. 1957, 6 pp.*

High-Resolution Potentiometers

Three basic methods are in use today for producing precision potentiometers with resolutions approaching infinity. They are slide-wire, evaporated metal films, and molded plastics. This report discusses each type in terms of its advantages and disadvantages, methods of measurement, and characteristics. *PB 121530 Precision Potentiometers Approaching Infinite Resolutions, M. Bailer and T. T. Crow, Wright Air Development Center, OTS, U.S. Dept. of Commerce, Washington 25, D. C., Feb. 1956, 19 pp, $0.50.*

Bibliography of Government Electronics

This is a bibliography of electronics research reports released to the public in 1956 by the Army, Navy, and Air Force through the Office of Technical Services. OTS is the Government's clearinghouse for reports of Government-financed research of interest to the nation's scientific and industrial public. *PB 121779 Government Electronics Research, A Bibliography of Research Reports Released Through the Office of Technical Services, OTS, U.S. Dept. of Commerce, Washington 25, D. C., Jan. to Dec., 1956, 50 pp, $1.50.*

High Ambient Resistors

This report presents information on the preparation and properties of chromium-nitride and chromium-titanium-nitride resistors in 1 and 1/4 w sizes for operation at temperatures up to 200 C. These resistors are capable of being produced in large quantities. A resistance range of 100 to 500,000 ohms was found to be practical with temperature coefficients of less than ±0.01 per cent/deg C for 1 w chromium-titanium-nitride resistors. The chromium-nitride resistors could be made with resistances from 100 ohms to 6,000,000 ohms with a temperature coefficient of less than ±0.05 per cent/deg C. Detailed information on processing steps and apparatus are presented for producing chromium-titanium-nitride resistors. *PB 121388 Research and Development of Nitrides of Chromium and Chromium Alloys for New Film-Type Resistance Elements, Battelle Memorial Institute, Wright Air Development Center, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Mar. 1956, 56 pp, $1.50.*

Single Crystals for Detectors and Counters

This investigation of the potential use of cadmium and zinc sulfide crystals as infrared detectors and crystal counters provides a source of fundamental research data and an aid to the solution of applied problems. A procedure is given for growing single synthetic crystals with and without controlled impurity additions. The crystals were examined for index of refraction, absorption coefficient, dielectric constant, resistivity, photoconductivity, rectification and photovoltaic effects. Preliminary experiments also were made on the radiation effects from high energy electrons. *PB 121537 The Study of Properties of Single Crystals for Use as Detectors and Crystal Counters, S. J. Czyzak and others, University of Detroit, OTS, U.S. Dept. of Commerce, Washington 25, D.C., Oct. 1955, 42 pp, $1.25.*

Temperature Transducers

This report describes various transducers used for measurement of temperature. Among the transducers discussed are the resistance thermometer, which detects variations of 0.0001 C at room temperature, and the platinum resistance thermometer, which forms the basis for the International Temperature Scale from —190 to 660 C. Others are the electrolytic transducer, the ionized gas transducer, two inductive temperature transducers, thermoelectric transducers, and a noise thermometer which shows promise for measurement over a wide temperature range. *PB 121296 Elements of Instrumentation: II. Temperature Transducers, K. S. Lion and W. L. Harries, MIT, OTS, U.S. Dept. of Commerce, Washington 25, D.C., June 1955, 37 pp, $1.00.*

Patents

Coupling Circuit For Semiconductor Devices
Patent No. 2,747,111. W. R. Koch. (Assigned to Radio Corp. of America)

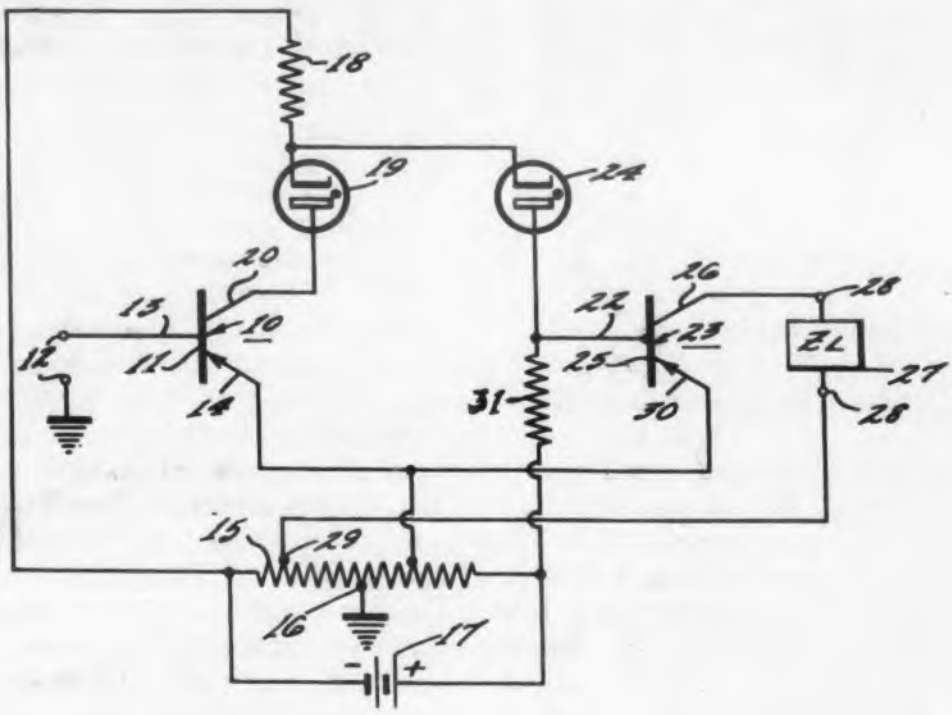
The coupling circuits used between amplifiers to transmit a signal of low frequency or an a-c wave superimposed on a direct current have been confronted with undue distortion. In such amplification circuits, each stage is energized from a source which introduces a problem in connection with voltage drift and insulation. There are circuits which overcome these difficulties in connection with amplifier circuits using vacuum tubes, however, these circuits require high potentials as compared with those used for operation of transistors. The patent describes an effective coupling circuit for transistors.

The circuit illustrated shows two transistors *10* and *23* connected in cascade. The input signal is applied across the terminals *12* in the connection with the base electrode of the first transistor *10*. The output is taken from the terminals *28* in the collective circuit *26* of the second transistor. The necessary potentials which are required for the operation of the transistors are taken from a voltage divider *15*. The poential across the divider is supplied by a potential source or battery *17*. The coupling between the two transistors utilizes rectifiers shown particularly as gaseous discharge diodes *19* and *24* connected in opposed relation between the collector of transistor *10* and base electrode *22* of the second transistor *23*.

Within a certain range, the potential across a diode remains substantially constant. The impedance to an alternating current superimposed on the direct current of the diode within this range of operation is very small at most so that the transmission of an alternating signal is efficiently accomplished. An amplified input signal generated in the emitter circuit *20* of the first transistor including the diode *19* and resistor *18* is applied directly to the base elec-

trode of the second transistor through the discharge tube 24. The gaseous diode 19 is selected to have a lower potential drop across the tube than that of diode 24 so than a 15 v difference in d-c potential exists between the potential applied to the collector 20 and the base electrode 22.

The coupling circuit illustrated here may be used in a flip-flop transistor circuit which has been illustrated in another figure in the patent. This circuit uses a single transistor and a pair of diodes between the emitter and collector electrodes. Another transistor flip-flop circuit is illustrated using a single semi-conductor diode as the coupling element.



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RESISTORS

NEW Sub-miniature Type 128A, .160 dia. x .50 long, 0.1 watts dissipation at 125° C. ambient. Max. resistance: 50 K ohms. Tolerances to 0.05%.

Miniature Type 83, .25 dia. x .75 long, for **MECHANIZED PRODUCTION,** for use in printed wiring assemblies.

The **NEW** Series **"PH"**

The New Series "PH" wire-wound resistors include over 50 types . . . from the sub-miniature (illustrated) to the 4 watt units, 20 megohms. Axial and radial leads and lug types in a wide variety of physical shapes are described in the new Bulletin PH.

Series "PH" resistors are encapsulated in a tough epoxy resin for protection against extreme humidity, mechanical and thermal shock. The plastic is filled with heat-conducting mineral which dissipates heat and equalizes "hot spots" in winding. Sealed-in terminal connections are welded.

SPECIFICATIONS:

MILITARY: Performance characteristics satisfy all requirements of MIL-R-93A.
TEMPERATURE COEFFICIENT: ±0.0022% per degree C.
OPERATING TEMPERATURE: −65° C. to +125° C.
RESISTANCE ACCURACY: Tolerances to 0.05%.
WATTAGE RANGE: From .25 watt to 4.0 watts.
RESISTANCE RANGE: 1.0 ohm to 20 megohms.

Hycor products are manufactured under precise quality control in new air conditioned factory and laboratory facilities.

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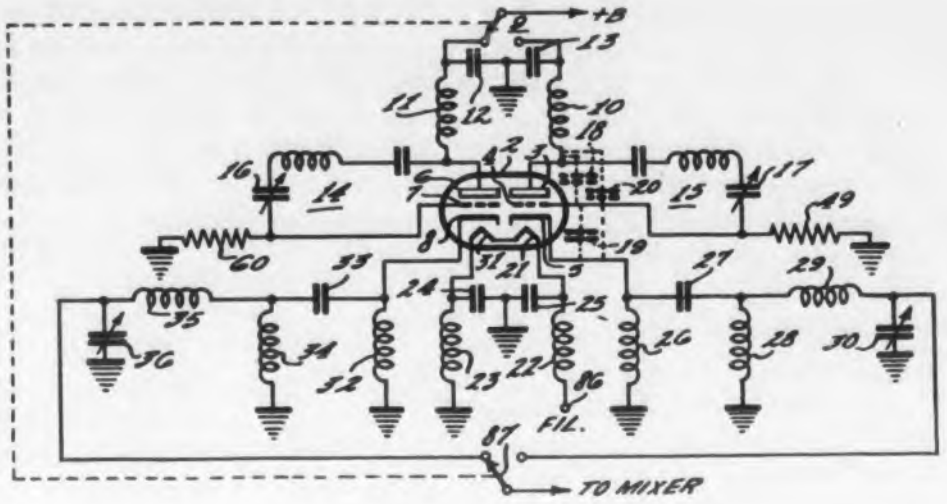

Tunable Oscillator Circuits

Patent No. 2,753,456. Wen Yucan Pan & David J. Carlson. (Assigned to Radio Corp. of America)

With the extension of the ultra-high frequency band up to 890 megacycles to accommodate television channels 14 to 83, it has become necessary to devise a receiver circuit which can receive programs in this extended range. To receive the whole range, a super-heterodyne circuit would have to tune the local oscillator through the entire range. Most vacuum tubes c types presently marketed are incapabl of oscillating at these high frequencie Broadcasting in the extended uhf band wi probably be limited initially to cities an in many localities to one or two channe in this extended range in each city. Th being true, a converter with a loc oscillator using available vacuum tube which oscillator is tuned to the two loc channels would serve to receive the loc programs in the upper range. Simpl

switching from one tuned oscillator circuit to the other would bring in the two stations. The patent describes oscillator circuits having these capabilities and having necessary stability.

The oscillator circuit of the figure uses oscillator circuits which can be tuned through the entire uhf range to select any two desired channels. A simple switching mechanism controls the channel to be received. Each of the two oscillator circuits uses a conventional triode or a double triode as shown. A switch 9 connects the power supply to the anode of either tube. A second switch 87 is ganged with the switch 9 for connection of the output of the oscillator with the receiver mixer. The oscillator circuits include a tank circuit *14* and *15* respectively between anode and control grid which is tuned to a fundamental frequency by the variable capacitor *16* or *17*.

An output circuit is connected in the cathode circuit of each tube and includes inductors and capacitors forming a filter having a high Q to effectively filter out the fundamental frequency. Each output circuit is tuned through a variable capacitor *30* or *36* respectively to one of the harmonic frequencies of the fundamental frequency generated in the tank circuit. With these two oscillator circuits, two channels in the increased range of uhf frequencies can be selected merely by switching from one oscillator circuit to the other. When one oscillator circuit is operating the tube for the other circuit is without anode potential and hence is inoperative. The circuit uses available tubes and components. The patent describes other forms of the circuit illustrated.

Linear Accelerator

Patent No. 2,770,755. (Inventor, M. L. Good, AEC)

This patent relates to a linear accelerator that permits radial focusing of the ions while maintaining phase stability. This is accomplished by having drift tubes which are alternately shortened and lengthened over the relative sizes they would have in a standard machine. The improvement provides a simple, inexpensive way of applying strong focusing techniques to existing accelerators.

DRESSEN-BARNES
Model D3-500B

dual D-B power supply

—*six outputs; close regulation; only 8¾" high*

Output Voltages:
1. Dual 0-300 V.D.C. continuously variable without switching. Outputs are floating—either plus or minus may be grounded. Current: 0-500MA max.
2. Dual bias voltages: —300 V.D.C. fixed. Current: 0-2 MA max.
3. Dual external 6.3 V.A.C. @ 10 amps.

Regulation:
For 300 v. output: 100 MV change NL to FL. For line voltage of 115 V.A.C. ±10%, the voltage change is 0.15%.

Ripple—below 2 MV. RMS for any voltage or load within rating.

Recovery Time—NL to FL: 0.4 milliseconds. FL to NL: 0.1 millisecond. 1 volt max. transient.

This compact unit gives you two 0-300 volt outputs... two bias outputs, and two A.C. outputs. Note the excellent regulation... the low ripple and fast recovery. Unit is a true dual—each half is independent of the other. Only 8¾" high, 19" wide, 17" deep. Request literature on Model D3-500B.

Also available as single unit. Model 3-500B

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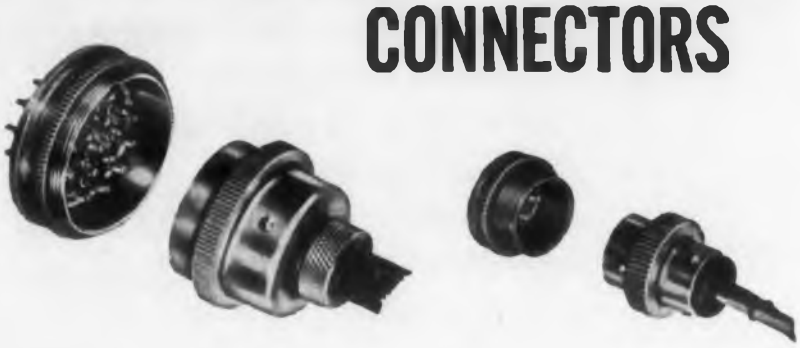
CIRCLE 370 ON READER-SERVICE CARD FOR MORE INFORMATION

A. R. C. CERAMIC INSULATED CONNECTORS



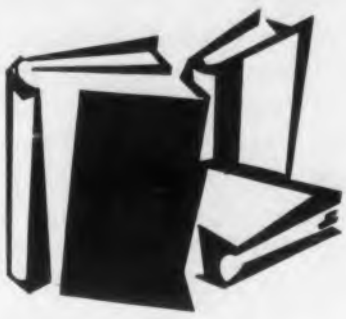
Minimize Leakage, Save Space

We developed this ceramic-insulated connector to obtain performance features we needed in our airborne communications and test equipment. Doubly silicone coated, it is virtually impervious to extremes of moisture, and mechanically stable under heat. Eight contact points per pin make for low contact resistance. Being of small overall dimensions, these connectors are space savers. 2, 3, 4, 6, 8, 12 and 19 contact connectors each are available in three-key keyway combinations to prevent incorrect insertion. Design them into your equipment for extra dependability. Write for details.

Dependable Airborne Electronic Equipment Since 1928

AIRCRAFT RADIO CORPORATION
BOONTON, NEW JERSEY

CIRCLE 371 ON READER-SERVICE CARD FOR MORE INFORMATION



Books

Patent Notes for Engineers

C. D. Tuska, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 192 pages, $4.00.

The purpose of this 7th edition is to acquaint engineers with patent matters. It bridges the gap between the inventor and the patent attorney and gives a clear idea of what patentable inventions are and how to protect them. What the book does is to erect clear warning signals along the path which leads from the conception of an invention in the inventor's mind to his ownership of a patent. Properly heeded, these warnings may constitute the difference between one's acquiring wisdom from bitter experience and his acquiring valuable patent rights.

Case histories and court decisions are frequently quoted for clarifying purposes. There are also many actual patent illustrations, disclosure drawings and sample application forms. Chapters explain how applications are prepared, filed, and acted upon; and what happens when applications of rival inventors are placed in interference.

Since patentable inventions are created by statutes, the nature and practical aspects of statutory invention has been thoroughly covered. The book gives the reader a view of the subject through the experienced eyes of the court.

An Introduction To Cybernetics

W. Ross Ashby. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N.Y., 295 pages, $6.50.

Proceeding from commonplace and well-understood concepts, this book defines cybernetics in terms of elementary algebra. The author is Director of Research, Barnwood House, Gloucester. The book demonstrates how concepts can be developed to lead into such subjects as feedback, stability, regulation, ultrastability, information, coding, noise, and other cybernetic topics. The book first covers the principles of mechanism, treating such matters as its representation by a transformation, what is meant by "stability" and "feedback," the various forms of independence that can exist within a mechanism, and how mechanisms, can be coupled. This section introduces the principles that must be followed when the system is so large and complex (e.g. the brain or society) that it can be treated only statistically, and also explores the system that is not entirely accessible to direct observation—the so-called Black Box Theory. Part II of the book uses the previously developed methods to study what is meant by "information," and how it is coded when passing through a mechanism. Exercises and answers are included for each of the fourteen chapters except the first.

Basic Electrical Engineering

A. E. Fitzgerald and David E. Higginbotham. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y., 540 pages, $7.50.

A revised second edition, this introductory text stresses the scientific, analytical, and physical background of modern electrical engineering. It places approximately equal emphasis on the four main subdivisions of electrical engineering: circuit theory, machinery, industrial electronics and measurements, and feedback-control systems. Starting with simple statements of the elementary electrical principles resulting from classical scientific experiments, the authors then present the fundamental methods of analysis which are of greatest importance in these fields. Numerous examples with complete solutions and a wide variety of tested problems illustrate the principles described.

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Russian Translation

The Regeneration Method in the Design of Transistor Amplifier Stages

J. George Adashko

A CHARACTERISTIC feature of the transistor is that it incorporates internal positive feedback (regeneration) which thus becomes part of any transistor amplifier stage. The positive feedback influences the principal characteristic of the stage, including such important properties as stability (in the sense of self-excitation), gain stability, limiting frequency, etc. By using the concept of the regeneration coefficient it becomes easy not only to explain the behavior of the principal characteristics of the stage, but also to calculate readily its principal parameters.

This article defines the regeneration coefficient as applied to a transistor-amplifier stage and tabulates the regeneration coefficients for different types of circuits; it also indicates another possible application of the theory to the practical design of the circuit.

Transistor Regeneration Coefficient

In the transistor, the collector current is controlled by varying the emitter current. Regardless of the amplifier circuit used, the emitter current can be represented as the sum of two currents, one (i^o_e) representing the signal alone, and the other (i'_e) being the current flowing in the absence of a signal and represented by current generator αi_e in the equivalent circuits (Figs 1 and 2). Thus,

$$i_e = i_{eo} + i'_e$$

The regeneration coefficient is defined as

$$p = \frac{i'_e}{i_e} \qquad (1)$$

To calculate the regeneration coefficient it is necessary to find the current i'_e flowing in the emitter circuit at zero signal.

Table I gives the values of the regeneration coefficient calculated in this manner for the four simplest transistor circuits. The equivalent resistance R_{eq} shown in this table is the resistance shunting the collector capacitance C_k and determines the equivalent value of the time constant of the collector circuit,

$$\tau_{k\,eq} = C_k R_{eq} \qquad (2)$$

Table 2 gives the expressions for the amplification factors and for the input and output resistances of the corresponding stages. In these tables and hereinafter in the text, R_o denotes the resistance of the signal source, R_L the load resistance, and the transistor parameter symbols (α, r_e, r_b, and r_k) are standard. The sign $\|$ denotes that two or several resistances are connected in parallel.

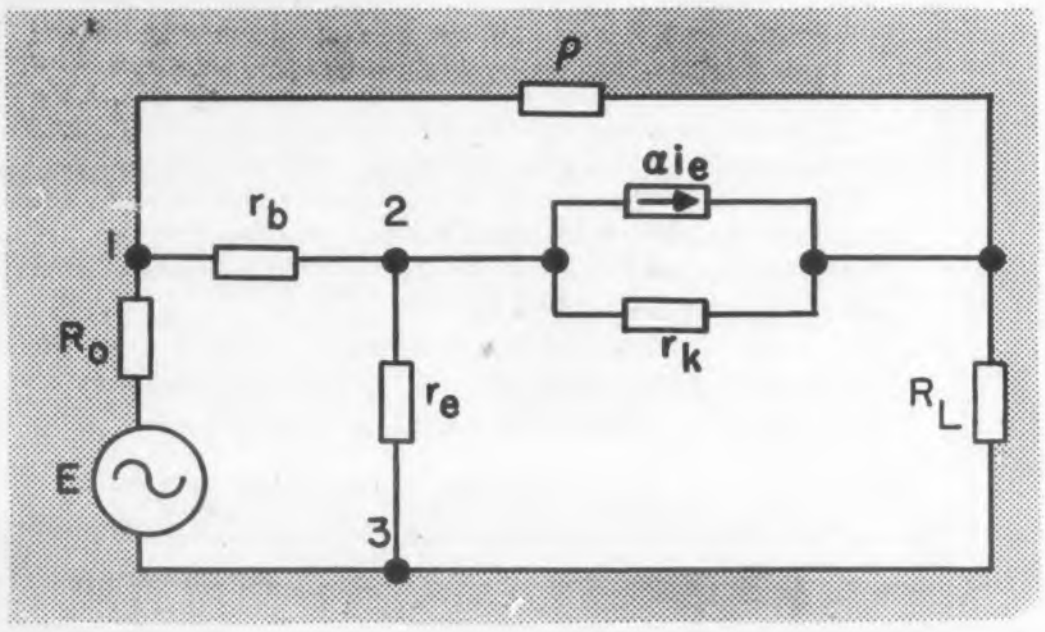

Fig. 1

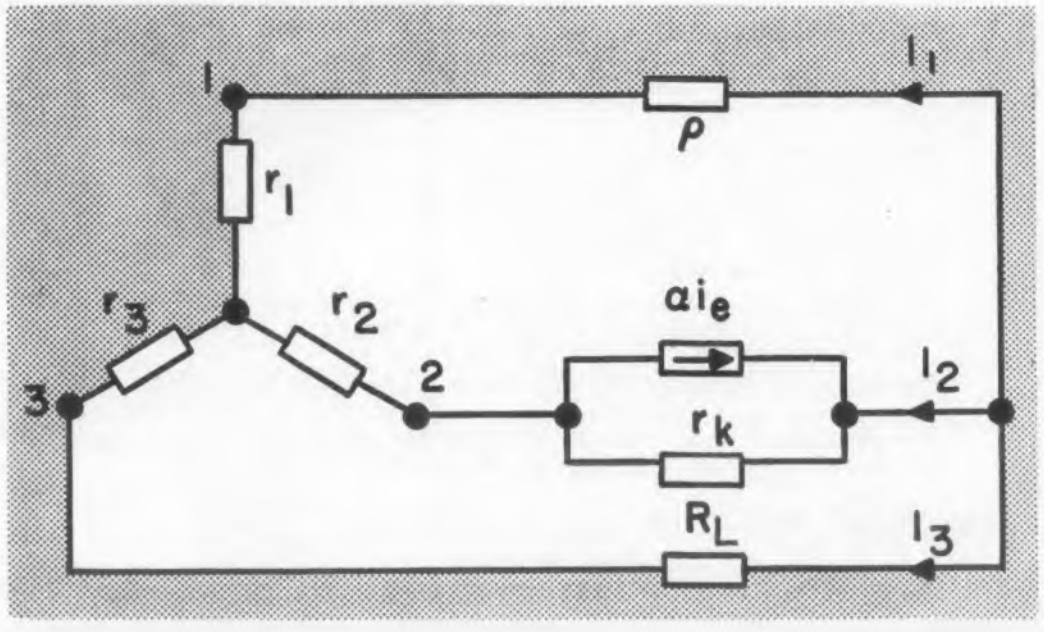

Fig. 2

Table I

Ser. No.	Type of Stage	Regeneration Coefficient p	Equivalent Resistance R_{eq}
1	Common Base	$\dfrac{\alpha_o\, r_b\, r_k}{(R_o + r_e + r_b)\,(r_k + R_L) + r_b\,(R_o + r_e)}$	$R_{eq} = r_k\,(R_L + r)$ $r = [r_b \parallel (R_o + r_e)]$
2	Common Emitter	$\dfrac{\alpha_o\, r_k\,(R_o + r_b)}{(R_o + r_e + r_b)\,(r_k + R_L) + r_e\,(R_e + r_b)}$	$R_{eq} = [r_k \parallel (R_L + r)]$ $r = [r_e \parallel (R_e + r_b)]$
3	Common Collector (Base Input)	$\dfrac{\alpha_o}{1 + \dfrac{(r_e + R_L)\,(R_o + r_k + r_b)}{r_k\,(R_o + r_b)}}$	$R_{eq} = [r_k \parallel (R_o + r_b) \parallel (R_L + r_e)]$
4	Common Collector (Emitter Input)	$\dfrac{\alpha_o}{1 + \dfrac{(r_e + R_o)\,(r_b + r_k + R_L}{r_k\,(r_b + R_L)}}$	$R_{eq} = [r_k \parallel (r_b + R_L) \parallel (r_e + R_o)]$

Table II

Ser. No.	Type of Stage	Amplification Factor K	Input Resistance R_{in}	Output Resistance R_{out}
1	Common Base	$\dfrac{\left(\alpha + \dfrac{r_b}{r_k}\right) R_L}{(R_o + r_e + r_b)\left(1 + \dfrac{R_L}{r_k}\right) - r_b\left(\alpha - \dfrac{r_e + R_o}{r_k}\right)}$	$r_e + r_b - \dfrac{r_b\,(\alpha\, r_k + r_b)}{r_k + r_b + R_L}$	$r_k + r_b - \dfrac{r_b\,(\alpha\, r_k + r_b)}{R_o + r_e + r_b} \approx r_k\,(1-p)$
2	Common Emitter	$\dfrac{\left(\dfrac{r_e}{r_k} - \alpha\right) R_L}{(R_o + r_b)\left(1 - \alpha + \dfrac{r_e + R_L}{r_k}\right) + r_e\left(1 + \dfrac{R_L}{r_k}\right)}$	$r_b + \dfrac{r_e\,(r_k + R_L)}{r_e + r_k\,(1-\alpha) + R_L}$	$r_k + \dfrac{(r_b + R_o)\,(r_c - \alpha\, r_k)}{R_o + r_e + r_b} \approx r_k\,(1-p)$
3	Common Collector (Base Input)	$\dfrac{1}{1 + \dfrac{r_e}{R_L} + \dfrac{r_b + R_o}{R_L}\left[\dfrac{r_e + R_L}{r_k} + 1 - \alpha\right]}$	$r_b + \dfrac{r_k\,(r_e + R_L)}{r_e + r_k\,(1-\alpha) + R_L}$	$r_e + \dfrac{(R_o + r_b)\,(1-\alpha)\,r_k}{R_o + r_b + r_k}$
4	Common Collector (Emitter Input)	$\dfrac{1}{1 + \dfrac{r_b}{R_L} + \dfrac{r_e + R_o}{1-\alpha}\left[\dfrac{1}{r_k} + \dfrac{1}{R_L}\left(1 + \dfrac{r_b}{r_k}\right)\right]}$	$r_e + \dfrac{(R_L + r_b)\,(1-\alpha)\,r_k}{r_k + r_b + R_L}$	$r_b + \dfrac{r_k\,(R_o + r_e)}{R_o + r_e + (1-\alpha)\,r_k + r_e}$

It is interesting to note that the equations of Table 1 show the regeneration coefficient p to be always greater than zero and that it cannot be made negative in single-stage circuits; negative feedback is obtainable only in multi-stage amplifiers.

Frequency and Transient Characteristics

Analysis shows that the frequency and transient characteristics of a transistor stage depend primarily on the inertia of the carriers and on the capacitance of the collector, and to a lesser extent on the load capacitance. In this case the first two factors, taken separately, cause the coefficient to become complex and to diminish with frequency. As a result, the regeneration coefficient also decreases with rising frequency, and the dependence of the amplifier characteristics on the carrier inertia and on the collector capacitance becomes quite pronounced. On the other hand, Table 1 shows readily that the regeneration coefficient is almost independent of the load resistance.

It is easy to show that a transistor stage in which the collector circuit has a time constant given by eq. (2) and values of R_{eq} and p as determined from Table 1 will have a limiting frequency

$$\omega^* = \frac{1 - p}{C_k R_{eq}} \tag{4}$$

(As usual, the limiting frequency means the frequency at which the gain is 3 db below the lf gain.)

The frequency and transient characteristics of the stage are readily expressed in terms of the limiting frequency

$$K = \frac{K_o}{1 + i\frac{\omega}{\omega^*}} \tag{7}$$

$$h(t) = K_o\,[1 - e^{-\omega^* t}] \tag{8}$$

where K_o is the gain of the stage at the center frequency (Table 2).

If the frequency dependence of the circuit is determined not by the collector-circuit capacity, but by the inertia of the carriers, the limiting frequency becomes

$$\omega^* = \frac{1 - p}{\tau_i} \tag{6}$$

and the frequency and transient characteristics are given by the same equations (7) and (8).

Matters become more complicated if both variations are of the same order of magnitude and both must be allowed for. In this case it is easy to derive an approximate equation for the limiting frequency in the form

$$\omega^* \approx \frac{1 - p}{\tau_i + \tau\, K_{eq}}$$

and equations (7) and (8) again become approximately valid.

Single Stage Amplifier with External Feedback

The equations derived above and given in the tables can also be applied to circuits containing external feedback, such as shown in Fig. 1, where the feedback factor is denoted by ρ. Since the regeneration coefficient of the circuit and its time constant are independent of the signal voltage, the circuit of Fig. 1 can be replaced by that of Fig. 2 by a delta-star transformation, whereby

$$r_1 = \frac{r_b R_o}{R}\,;\, r_2 = \frac{r_e r_b}{R}\,;\, r_3 = \frac{r_e R_o}{R}\,;\, R = r_e + r_b + R_o$$

The resistance shunting the current source in the circuit of Fig. 1 is

$$R_{eq} = [r_k \parallel (r_2 + r)]$$

where

$$\tau_e = [(r_1 + \rho) \parallel (r_3 + R_L)]$$

The time constant of the collector circuit, due to the capacitance C_k, is

$$\tau_{k\,eq} = C_k R_{eq}$$

We obtain the regeneration coefficient of the circuit of Fig. 1 in the following manner: The feedback current i'_e through the emitter, due to generator current αi_e, is

$$i'_e = \frac{u_3 - u_2}{r_e}$$

According to the circuit of Fig. 2:

$$u_3 - u_2 = I_3 r_3 - I_2 r_2$$

In addition

$$I_1 (\rho + r_1) = I_3 (r_3 + R_L);\quad -I_2 (r_1 + r_2) = \alpha i_e R_{eq};$$
$$I_1 + I_2 + I_3 = 0$$

Solving these equations simultaneously we obtain the following expression for the regeneration coefficient

$$p = \frac{\alpha R_{eq}}{(r + r_2)\, r_e}\left[r_2 + \frac{r\, r_e}{R_L + r_3}\right] \qquad (13)$$

Knowing the regeneration coefficient p, it is easy to establish the circuit stability, the limiting frequency, and the gain stability

$$\epsilon = \frac{\frac{\Delta K}{K}}{\frac{\Delta \alpha}{\alpha}} \qquad (14)$$

The regeneration coefficient p plays the same role as the coupling factor $K\beta$ in the Nyquist criterion, and the hodograph of the vector p determines the stability of the circuit. (*Abstracted from an article by A. A. Rizkin, Radiotekhnika, No. 5, 1956, pp 56-64.*)

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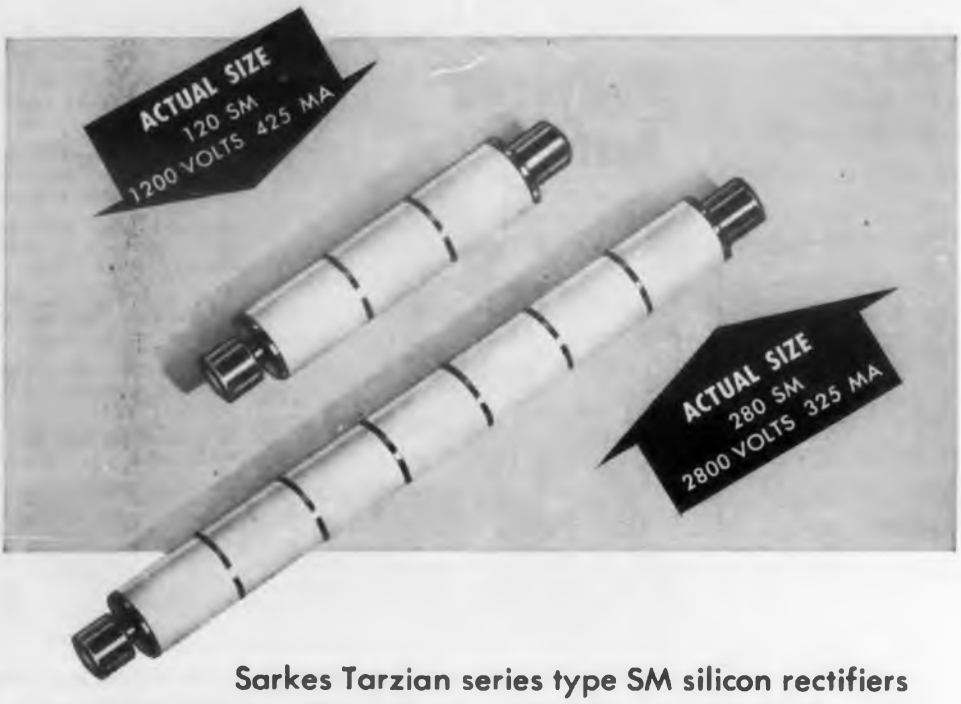

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120SM	1200	840	.425	.212	1.06	.530	4.25	2.12	25.5	12.7	1N1109
160SM	1600	1120	.40	.200	1.00	.500	4.00	2.00	24.0	12.0	1N1110
200SM	2000	1400	.375	.187	.940	.470	3.75	1.87	22.5	11.2	1N1111
240SM	2400	1680	.35	.175	.875	.437	3.50	1.75	21.0	10.5	1N1112
280SM	2800	1960	.325	.162	.812	.405	3.25	1.62	19.5	9.7	1N1113

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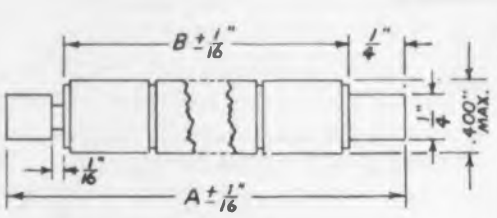

Figure 1

Figure 1		JETEC NO.
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1-15/16"	1-7/16"	1N1109
2-13/32"	1-29/32"	1N1110
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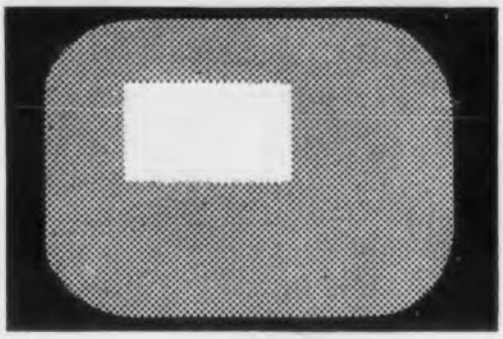
CIRCLE 382 ON READER-SERVICE CARD FOR MORE INFORMATION

Abstract—German



Typical test patterns available from the generator. All shades of gray can be obtained.

Electronic Test

THE USE of an all electronic test image generator makes it possible to generate a video signal which is easily duplicated, adjustable and versatile. The apparatus which is described in this paper generates a video test signal electronically, this picture has continuously variable image contents and constant black-white transition. The measurements for which this generator is suited include:

1. Level-maintenance under conditions of greatly varying average value of the picture.
2. Testing for automatic white-maintenance or black-level control of darkest point on picture.
3. Adjustment of the video amplifiers.
4. Testing and adjustment of the dc restorers.

The video signal (which forms a rectangle) is obtained by mixing an impulse of variable duration which occurs at the vertical repetition rate with an impulse of the horizontal rate. Each of these impulses is generated with a bistable multivibrator as shown in Fig. 1 (*T3/4* forms this multi). The capacitable C_1 controls the time position of the output pulse through the bistable multi formed by the circuits of *T1/2*. The width of the output pulse is ad-

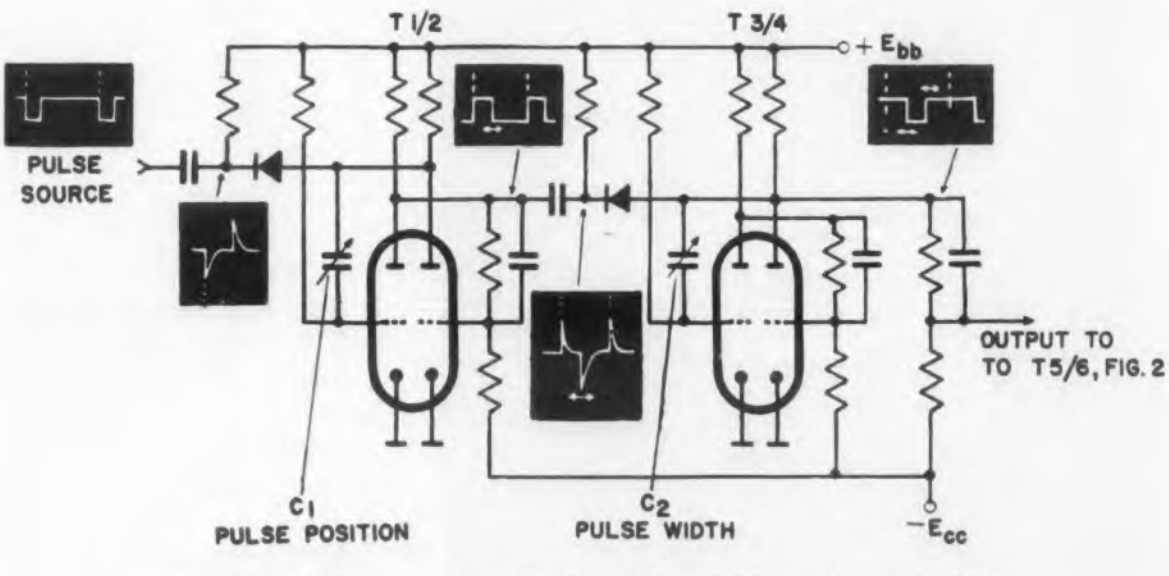


Fig. 1: Circuit for production of pulses with variable position and width.

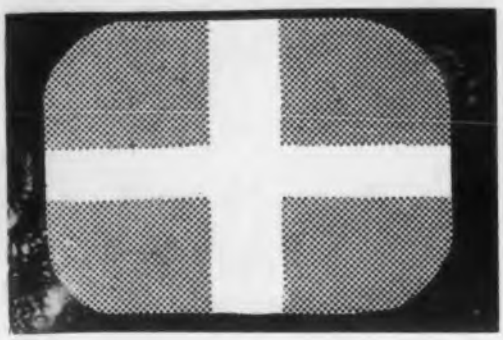


Image Generator

justed with capacitance C_2. While the values differ in the two cases, the circuit of Fig. 1 is used to generate both the vertical and the horizontal pulse.

The pulses generated in the circuits represented by Fig. 1, are fed to the grids of the additive mixer stage formed by *T5/6* in Fig. 2. This stage is coupled to an amplifier *T7/8* by both the RC path for ac and the glow tube coupling for dc. Tube *T9* is in a cathode follower stage, this circuit is followed by a germanium diode, G_1. This diode limits the positive excursions of the signal, adjustable through the resistance (Black-level adjust). In the next stage the blanking pulse is added (if desired). The second Germanium diode, G_2, limits the signal to a fixed value. The pentode stage, *T12*, is so designed that the signal is clipped by the lower part of the tube characteristics so that the "white" potential of the signal is held constant. A synchronizing signal may be added in *T13*. The output tube is coupled to *T13* exactly as *T5/6* is coupled to *T7/8*.

Abstracted From an article by W. Dillenburger and J. Wolf, Electronische Rundschau, *Vol 10, No. 11, Nov. 1956, p 293.*

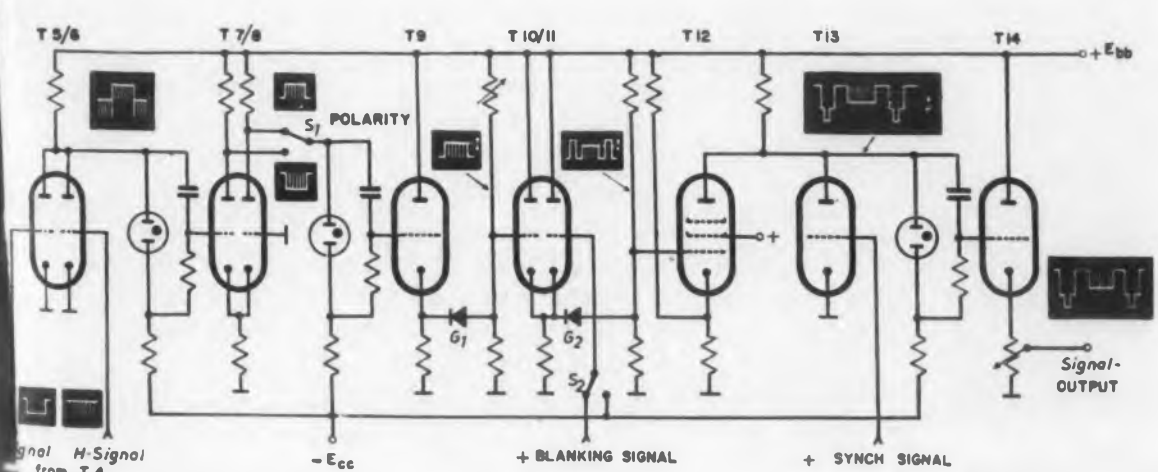


Fig. 2. Schematic of mixer and amplifier.

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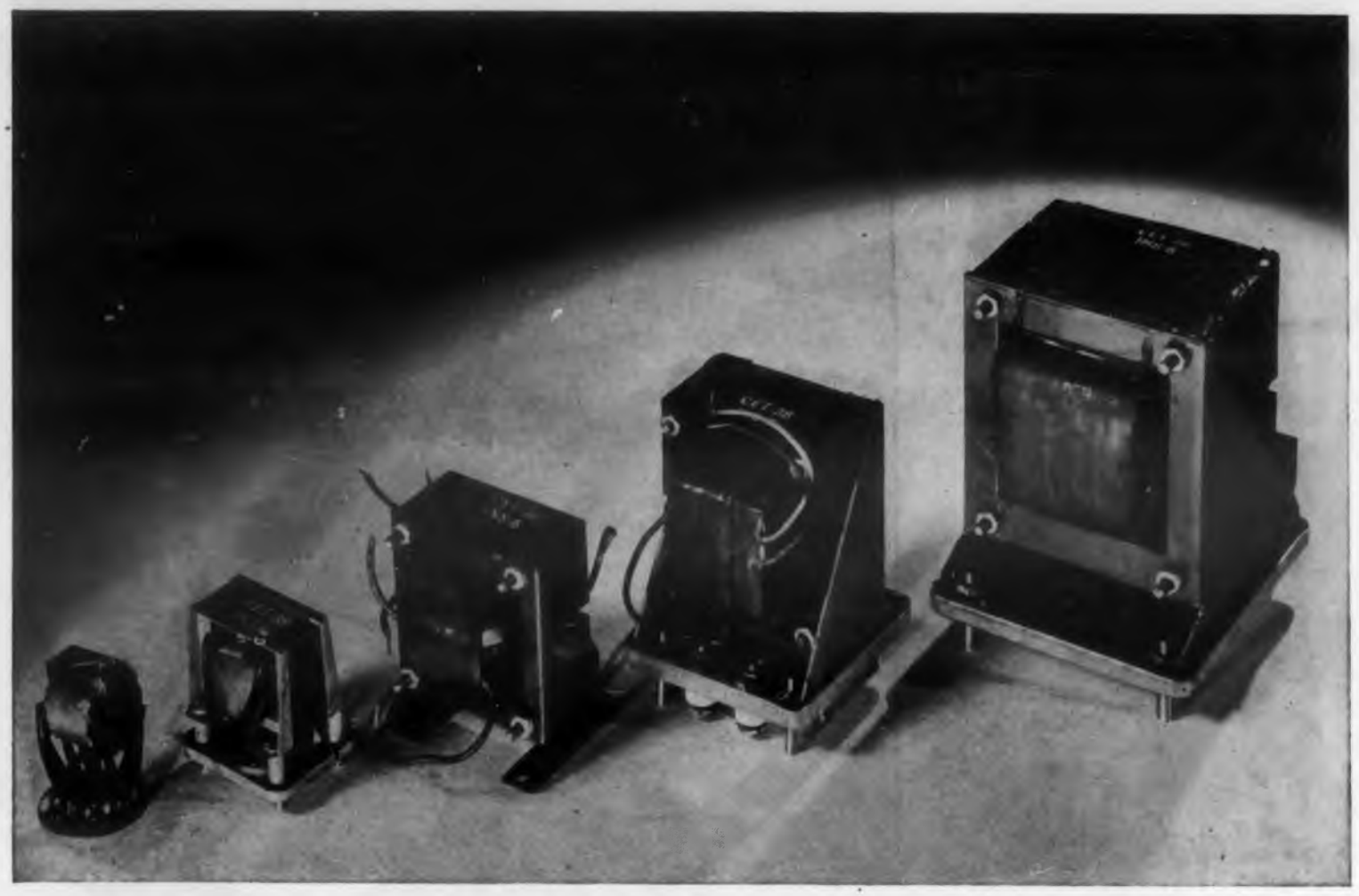

Abstract

Transistor TV

USING presently available transistors, a practical vertical deflection system for 21-in., 90 deg TV picture tubes was designed. The circuit, when tested, was comparable to tube circuits in performance, though some precautions must be observed to minimize collector current drift in the output stage. When smaller picture tubes are used, the situation improves, and stability is more easily obtained at the lower current and power levels.

Electromagnetic deflection was utilized, as this method is particularly adaptable to transistors with their good current handling characteristics. A sawtooth yoke current is required, the magnitude of which is dictated by picture tube anode voltage, deflection angle, and yoke characteristics. For 21-in., 90 deg picture tubes and conventional yokes of about 40 ohm resistance, the required sawtooth current is on the order of 400 to 500 ma peak-to-peak, and such currents may be controlled by available transistors without using transformers.

The circuit is single-ended, direct-coupled and requires permanent magnet centering, since the dc component of the yoke current causes vertical picture decentering amounting to more than half of the total picture height. Small bars of ceramic magnets are placed longitudinally in the window formed by the vertical yoke windings. The circuit uses a power transistor blocking oscillator, shown boxed off in Fig. 1. The oscillator is ac coupled to the common emitter output stage. Frequency control is accomplished by varying base bias resistor R_1. Synchronization of the blocking oscillator is accomplished by coupling a negative trigger pulse into the base through a tertiary winding on the pulse transformer. A linearity correction network is provided in the form of R_3 and C_2—the emitter sawtooth is integrated into a parabola which is fed back to the base through integrating capacitor C_1. The curvature of the parabola compensates for the nonlinear transistor transfer characteristic. The linearity control R_3 controls the amplitude of the parabola and thus the degree of linearity compensation. It should be noted that the linearity control affects the amplitude of the yoke current sawtooth;

TV Deflection System

therefore, readjustment of the amplitude control R_4 is necessary with each linearity adjustment. A bias control R_2 is necessary, as current amplification is not the same for different transistors.

The power consumption of this circuit is 8.5 to 9 w, a substantial improvement over the power consumption of a tube vertical deflection circuit. The linearity of the sawtooth produced was 10 to 15 per cent, measured on a crosshatch pattern. A synchronizing pulse of −0.2 v at the base of the blocking oscillator was required for adequate synchronization. Frequency drift was within the extremes of +5 per cent and −2 per cent for supply voltages between −10 and −35 v. Nominal V_{cc} was −28 v. *Abstracted from Transistorized Television Vertical Deflection System, W. Palmer and G. Schiess, Sylvania Electric Products, Inc., Electronics Div., Woburn, Mass.*

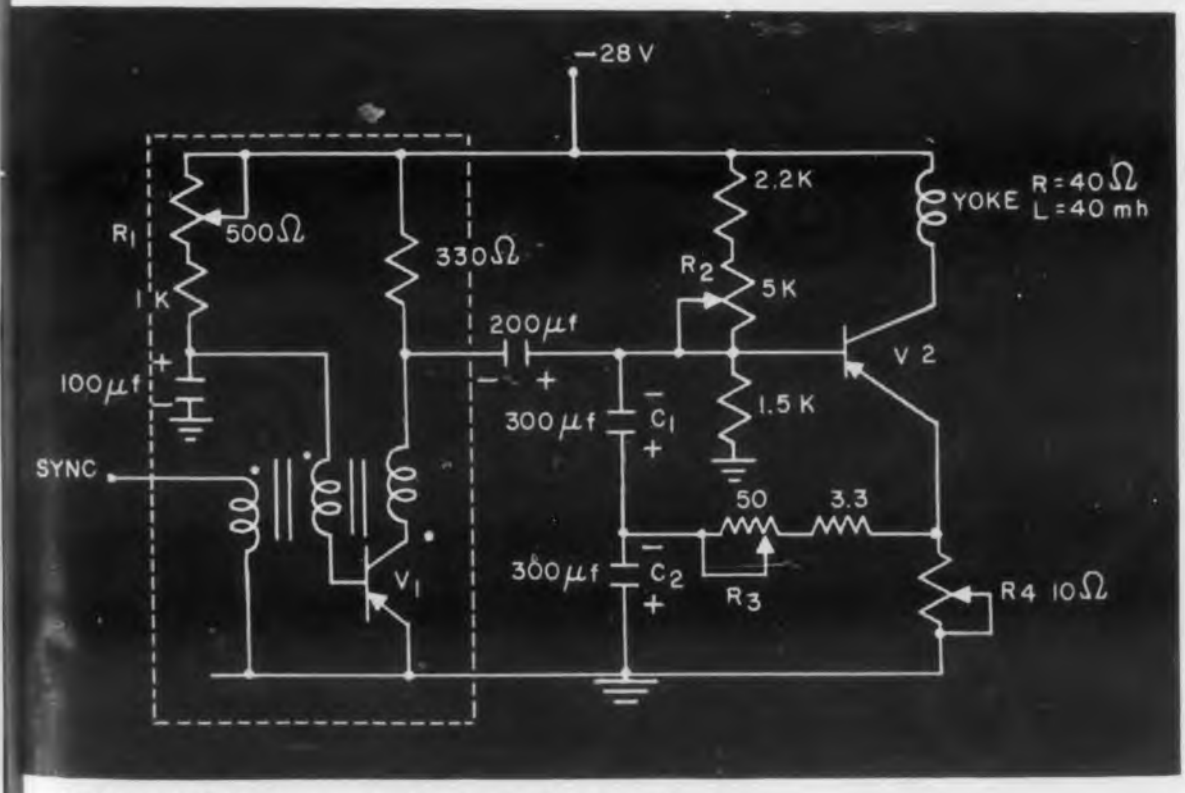

Fig. 1. Vertical deflection section for 21 in., 90 deg deflection. Controls shown are R_1, frequency; R_2, bias of output stage; R_3, linearity; R_4, amplitude. V_1 and V_2 are Type GT900 transistors.

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Abstract

THE PROBLEM of achieving radio communication in tunnels was solved economically by application of the concept of radiation from a continuous transmission line along the tunnel instead of from separate antennas. A study was undertaken in the Pennsylvania Railroad's North River tunnel, some 13,400 feet long. A number of antenna configurations were tried initially, with generally unsatisfactory distance coverage results.

The observed attenuation rate of a transmitted signal was about 18 db per hundred feet. Since this is significantly more than the attenuation expected of a small-diameter coaxial cable, a combination of feeder cable and multiple antennas to obtain tunnel coverage was tried. Due to cable radiation losses, this method also proved unsatisfactory. Although a lower-loss cable of similar construction would probably provide complete coverage, the cost would be higher than could be justified.

The results obtained with the coaxial cable suggested that a two-wire line running the length of the tunnel might provide a means for obtaining the desired continuous coupling to a train's antenna. From the available types of commercial low-loss solid-dielectric two-wire cable, the one selected was similar to, but of heavier construction than, ordinary television twin-lead cable. A 1000-ft length of cable was mounted on the tunnel wall, suspended from the tips of dowel rods thrust behind the tunnel lighting conduit, and with the two conductors mostly in the horizontal plane. The mobile antenna, mounted on the roof of a car or locomotive, was approximately 6 ft from the cable. The relative positions of the antenna and cable are indicated in Fig. 1. It was not possible to locate the cable on the tunnel ceiling, directly over the train antenna, because of the 11,000-v trolley.

Coverage tests were made in which either the output of the base transmitter or the input to the base receiver was attenuated until a definite coverage boundary somewhere along the 1000-ft cable was determined. From the resulting data the effective coverage distance for a transmitter output of +15 dbw was determined to be the equivalent of 6000 ft of cable.

ommunication in Tunnels

t was appreciated that a cable or open-wire line ving more nearly optimum characteristics for this rticular application might be determined by ther experimentation. However, in view of the sfactory results obtained with the experimental ble, and because of its availability and relatively cost, it was decided that such cable, when manently mounted on stand-off insulators on the nel wall, would provide an acceptable answer the tunnel communications problem.

n practical applications, the maximum permissi- cable coverage distance would be reduced to haps 5000 ft to allow for deterioration in radio- performance between service visits. A further all reduction in coverage distance for each cable uld result where a radio set connects to two or re cable branches. This arrangement offers prac- l advantages where a radio set is located at an rmediate point in a tunnel or where more than paralleling tube is involved.

Abstracted from an article by H. S. Winbigler, l Laboratories Record, *Feb. 1957, pp 57-60.*

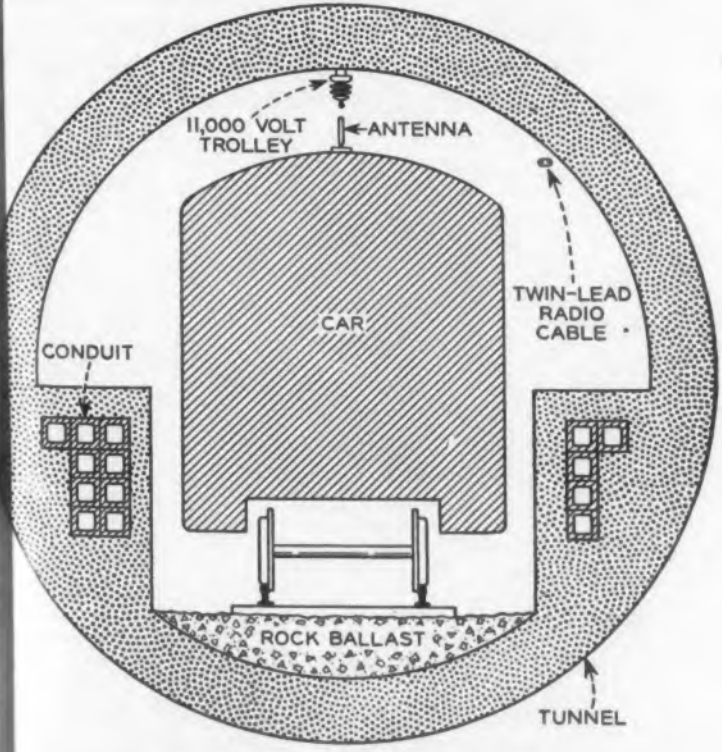


Fig. 1. Cross-section of tunnel showing relation between base-station and mobile-station antennas.

Abstract

Fig. 1. Pierce-type parallel-flow gun used in the 17 to 27 kmc tube. The lower cylinder contains the cathode and focusing electrode, the second cylinder contains the current-control electrode, and the third supports the accelerating electrode which is operated at helix potential.

Backward-Wave Oscillators

TWO BACKWARD-WAVE oscillators have been developed for use as voltage-tunable local oscillators. One operates over the frequency band 17 to 27 kmc, the other at 26.5 to 41 kmc, the voltage tuning ranges being 500 to 2000 v. The circuit element employed in each case is a unifilar tape helix. Power output of the lower frequency tube ranges from about 20 to 100 mw; for the higher frequency tube it is approximately 4 to 10 mw.

These tubes have microwave characteristics which make them suitable for test equipment and local oscillator applications. Reasonably flat power output and voltage tunability over large bandwidths are their principle advantages over klystrons.

In these backward-wave oscillators interaction between the electrons in the beam and the microwave circuit takes place under approximately synchronous conditions. The microwave circuit, however, carries energy in the direction opposite to that of the electron flow. The beam interacts with a space harmonic of the total field whose phase velocity in the direction of the electron flow increases with frequency. Thus for a given electron velocity, synchronous interaction takes place at only one frequency. Since the electron velocity is controlled by the voltage applied to the helix, the frequency of the oscillator may be tuned electronically over a broad range. The rf output from the tube is at the gun-end of the helix, the collector end of which is terminated internally under matched conditions.

A tape helix was chosen for the slow-wave structure. Being axially periodic, it supports an electromagnetic field which can be described by an infinite series of components called space harmonics. The power flow associated with these space harmonics is directed opposite to the phase velocity, giving rise to the term "backward wave."

For best efficiency, a hollow beam electron gun is normally employed in tape-helix backward-wave oscillators, but due to the smallness of the beams required for these tubes, it was decided to use a solid beam. Fig. 1 is a photograph of the gun used.

A detailed view of the helix-to-waveguide transition is shown in Fig. 2. It is seen that a ground plane surrounds the helix external to the glass envelope. The electrical lead from the helix is a tungsten pin, welded to the helix and sealed through the 7052 glass envelope.

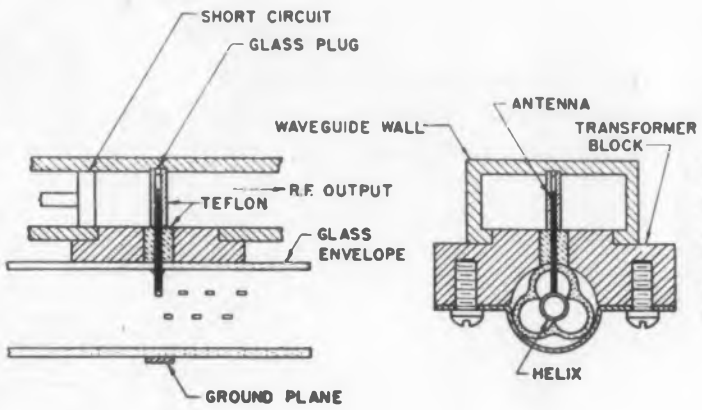


Fig. 2. Helix-to-waveguide transducer arrangement.

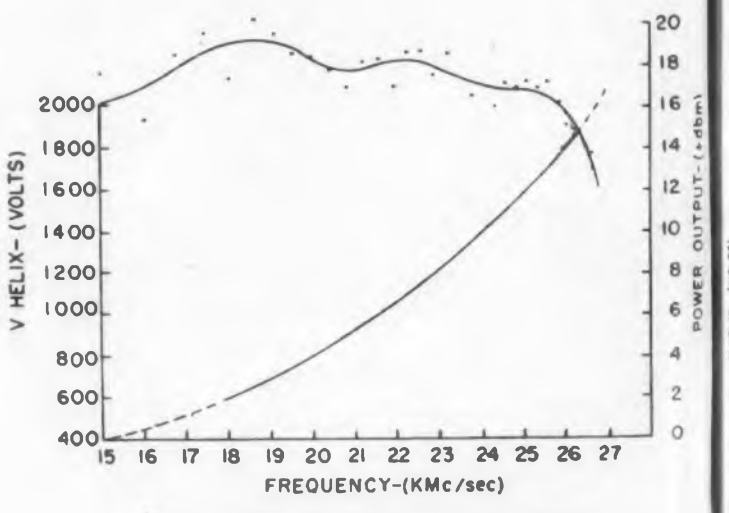


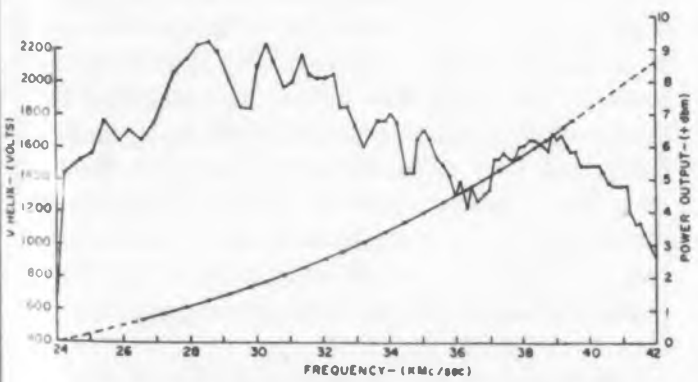
Fig. 3. Helix voltage and power output vs. frequency for the 17 to 27 kmc BWO.

The tubes have an external termination at the collector-end of the helix. This termination is accomplished by effecting a continuation of the helix external to the glass envelope where the dc lead from the helix is brought out.

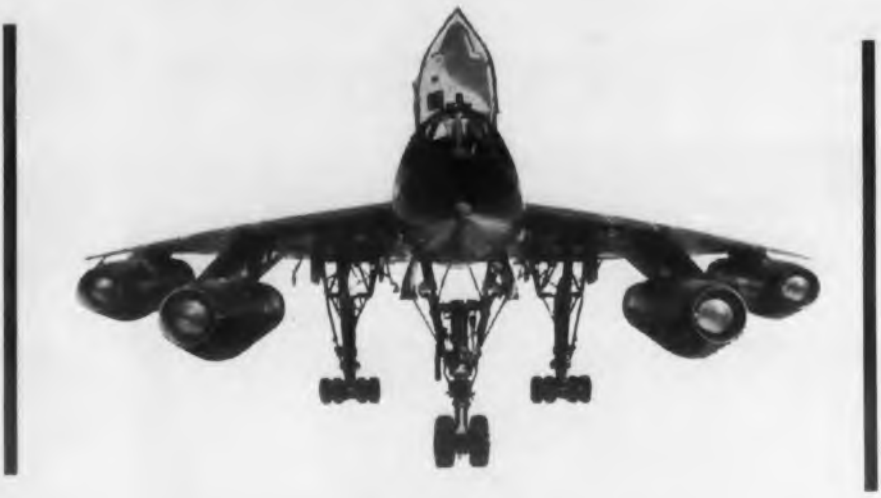
The helix voltage and power output vs frequency curves for the 17 to 27-kmc oscillator are shown in Fig. 3. Considerably more bandwidth is available at the lower frequency end, actually extending to 15 kmc. The tuning and power output curves for the 26.5 to 41 kmc oscillator are shown in Fig. 4. Although the intended tuning range is 26.5 to 41 kmc, a range of 24 to 42 kmc is possible. This tube can be taken as high as 46 kmc with a power output of about 1mw over this extended range.

Inherently a narrow-bandwidth device, and voltage tunable, the backward-wave tube needs no external feedback when used as an oscillator. It is expected more efficient magnetic field structures can be employed. Future tubes should be well suited for use in equipment.

Abstracted from Backward-Wave Oscillators for the 17 to 41 kMc Band, J. A. Noland and R. E. Lepic, The Sylvania Technologist, *Jan. 1957, pp 13-16.*



Fix. 4. Helix voltage and power output vs frequency for the 26.5 to 41 kmc BWO.



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CIRCLE 564 ON READER-SERVICE CARD FOR MORE INFORMATION

Abstract

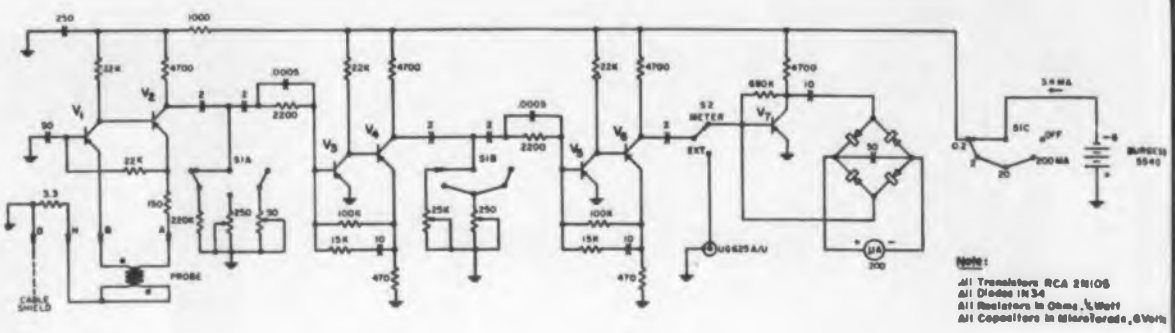


Fig. diag men amm

The Clamp-Type A-C M

A CLAMP-TYPE instrument capable of measuring currents in the microampere range over a wide band of audio frequencies is realized by means of an experimental circuit employing seven transistors. The experimental instrument fits into a conventional sloping-front meter case (for a 3-1/2 in. meter). It is designed around a 0-200 ma dc meter movement for the indicating element. A clamp about the size of a battery clip is used as the probe. By transformer action, an output voltage is induced in the winding on the closed-magnetic circuit of the probe when it is clamped around an ac current-carrying conductor. Even with a reasonable step-up ratio, however, the output from this secondary winding requires amplification before it can be rectified, to be able to actuate the indicating meter. Also, under operating conditions, the secondary output is dependent on frequency. Both of these difficulties are overcome in an interesting way by letting the current gain of the transistor amplifier vary in such a manner that the amplifier signal output current remains substantially independent of frequency over a design center-range of 20 cycles to a little beyond 100 kc. Design equations are given and frequency-response curves of the resulting experimental circuit are shown in the original paper for four full-scale current ranges of 0-200 μa and 0—2/20/200 ma.

The necessity for measuring small values of current additionally introduces two difficulties peculiar to such low-level measurements; namely the non-

Fig. 1 Circuit diagram of experimental ac microammeter.

C Microammeter

linearity of the meter rectifier at small input currents, and noise problems. The methods used for attacking these problems are discussed in detail in the paper. As may be seen in the schematic diagram of Fig. 1, the non-linearity is reduced by driving the rectifier with amplifier *V7*, which provides negative feedback through the rectifier. For obtaining a good signal-to-noise ratio while still keeping the current amplification of the over-all circuit within reasonable limits (around 400), positive current feedback is included by the 3.3 ohm resistor at terminal *H*. These approaches keep the linearity of response within 2 per cent and the noise level around 20 μamp. The need for shielding the instrument, particularly from power-frequency fields, is also discussed in this connection.

The authors' conclusions emphasize the fact that the experimental results confirm the initial theory, with some unforseen results in the higher-than-predicted noise level. Pointing out that the design of the instrument is subject to further development for special uses, particularly at either extreme of its frequency range, they conclude that successful meters of this type may be designed for various frequency ranges and sensitivities, and that such instruments are entirely practical for convenient laboratory use. *Abstracted by S. D. Prensky from* The Clamp-Type Alternating-Current Microammeter. *G. Franklin Montgomery and Carroll Stansbury, in an original paper presented at the AIEE Winter General Meeting Jan. 1957*

Standardizing Modules

Sherman H. Hubelbank

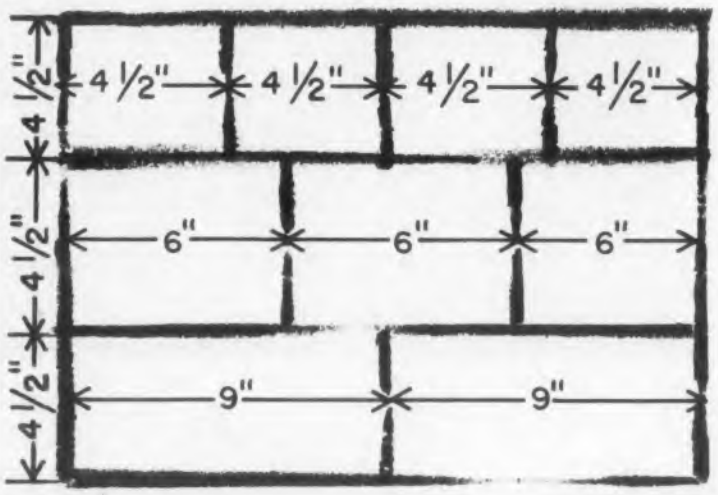
MODULAR construction, an architectual concept for years and long discussed in electronic circles, has at last been officially introduced to electronics, with the approval of spec MIL-E-19600. The guide is entitled "General Specification for Electronic Modules," by the Bureau of Aeronautics, Department of the Navy.

Minimum size and weight, simplicity of operation, and an improvement in performance and reliability are the design objectives of this spec. Equipment circuitry is divided on a functional basis, with each modular unit containing the circuitry of one or more complete functions to facilitate testing and repair. To achieve maximum flexibility, the equipment is divided into as many modular units as is electrically and physically practicable, in keeping with efficient space utilization, and overall equipment reliability.

Broad Goals

The design goals of electronic modules are (1) to provide a "building block" which will allow a flexible overall form factor for the equipment involved; (2) to permit the redesign or modification of an existing equipment in a minimum length of time; (3) to allow the integration of a number of equipments into a system, operating from a common power source, and with a common source of cooling air; and (4) to standardize the module form factor, mounting, and cooling, thereby decreasing engineering time for new design.

Interchangeability is such that any new module for the latest design equipment is interchangeable with the corresponding module for an earlier equipment.



Size

Module size is limited to 4-1/2 in. high, 4-1/2, 6, or 9 in. wide; and any reasonable length in 1/2 in. increments. Thus, the modules can be stacked and packed in many configurations. The actual module width and length is 1/16 in. smaller to provide a 1/16 in. nominal space between modules.

Screwheads and other projections, except power plugs, coax connectors, and mounting screws are within the maximum dimensions specified. The certain exceptions may extend a maximum of 3/4 in. beyond the mounting surface of the module.

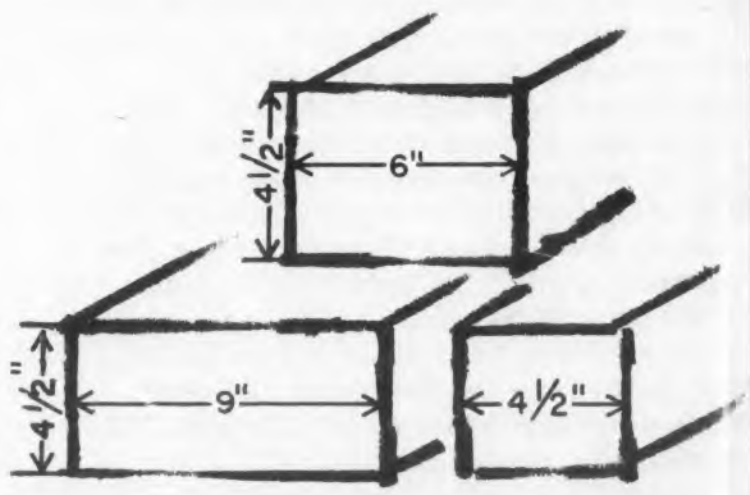
All modules are removable from the top and are mounted with fastening devices terminating in an 10-32NF-2A thread. The nominal centerline of all hold down screws is 0.3 in. from the module dimension limits.

Modular equipment designed to this spec has a reliable operating life of 200 hours minimum without removal for bench servicing.

Types

Four types of modules, according to temperature range of the operating parts, have been classified. They are: Class A, using 85°C parts; Class B, using 100°C parts; Class C, using 125°C parts; and Class D, using 150°C parts. These classifications are the upper temperature ambient in which the parts will work. If the part does not produce heat itself, the ambient is generally considered the same as the surface temperature of the part.

Input power characteristics for modular design are (1) from the aircraft electrical system, 115/200 v constant frequency, 115 v constant frequency (single phase), or 28 v dc; (2) from the equipment



power supply, 26 v ac single phase synchro power, 6.3 v ac filament supply, 130 v ± 1% positive dc regulated, 130, 250, and 400 v ± 10% positive unregulated dc, and 15 and 95 v ±1% regulated negative dc voltage, and 180 v ±10% negative unregulated dc.

Copies of this spec may be obtained from the Commanding Officer, Aviation Supply Depot, Philadelphia 11, Pennsylvania. Attenion: Code ODPT.

Test Methods

MIL-STD-202A, Test Methods for Electronic and Electrical Component Parts, 24 October 1956 . . . Under general test requirements, the working area of environmental chambers is defined in terms of the temperature deviation allowed within this area. The following new test methods have been added: Method 107, Thermal Shock; Method 203, Random Drop; Method 204, High-Frequency Vibration; Method 304. Resistance-Temperature; Method 305, Capacitance at five frequencies; Method 306, Quality Factor Q; and Method 307, Contact Resistance. In addition, the following test methods have been revised: Method 101A, Salt Spray (corrosion); Method 102A, Temperature Cycling; and Method 103A, Humidity (Steady State).

MIL-STD-202A, Test Methods for Electronic and Electrical Component Parts, Proposed Method 205, Shock, Variable Duration, 31 January 1957 . . . The purpose of this proposed test method is to determine the ability of various parts, covering a wide weight range, to withstand shock of variable duration and different degrees of severity. The test apparatus is constructed in three different sizes and designated by the test weight allowable on the elevator of each. This test method reproduces the magnitude-time duration relationship of different kinds of shock pulses by arresting the downward motion of a freely falling elevator in either sand or lead. Shock of this kind simulates the same condition that the parts may be subjected to during field service. In addition, Method 205 specifies those precautions, apparatus, procedures, and calibration curves necessary to get reproducible results. Additional information regarding this proposed test Method may be obtained from the Armed Services Electro-Standards Agency, Fort Monmouth, New Jersey.

Switches

MIL-S-15743 (Ships), Switches, Enclosed, Rotary, Snap Action, Amendment No. 1, 24 August 1956 . . . The requirement that the enclosed switches shall be of a brand which has been tested and which has successfully passed the specified qualification tests has been deleted. The qualification tests table has been deleted and a contract suitability tests table has been substituted.

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Standards and Specs

RETMA Standards

RETMA RS-178, SOLDERABILITY TEST STANDARD, FEBRUARY 1957 . . . A test for solderability of lead wires, terminals, and appropriate hardware which are to be joined by a soft-solder operation involving immersion in molten solder, or the use of hand solder, a bench iron, etc. is established. This standard is not a production procedure for soldering operations. The surface to be tested is immersed in molten solder under clearly defined conditions. The surface is considered solderable, if after removal from the solder and cooled, and examined under adequate light with the unaided eye, it is seen that the area immersed in the pot is completely covered with solder and essentially bright and smooth. The solder must also have uniform adhesion to the lead. This may be checked by inserting a razor blade between the solder and the test sample. If solder can be lifted, it is considered cause for rejection. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y. for 25 cents each.

RETMA RS-177, VIBRATOR POWER TRANSFORMERS, FEBRUARY 1957 . . . Purchase specs and performance specs are established by this standard for dry-type vibrator power transformers which are used in conjunction with vibrator inverters to permit operation of radio receivers from d-c sources, such as automobile batteries. These transformers have one midtapped primary and suitable midtapped secondary windings. They may be equipped with an electrostatic shield between primary and secondary, or have an inverted connection of the halves of the secondary to furnish self-shielding. Copies of this standard may be obtained from the Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y., for 30 cents each.

RETMA RS-159, CHASSIS PICKUP OF VEHICULAR RECEIVERS, FEBRUARY 1957 . . . Vehicular receivers are considered to comply with the principles of good engineering practice if, when installed according to the manufacturer's instructions and using materials supplied by the manufacturer, there is no perceptible chassis pickup with any setting of the user controls. Copies of this standard are available from the Radio-Electronics-Television Manufacturers' Association, 11 West 42nd Street, New York 36, N.Y., for 25 cents per copy.

RETMA RS-179, CLASSIFICATION OF TUBE TESTERS, FEBRUARY 1957 . . . Tube testers are classified into four groups. Group I covers tester in which all available electrodes except cathode are connected together and an a-c voltage applied through a d-c

indicator between the interconnected electrodes and cathode. Group II testers apply separate a-c voltages between grid and cathode and between other elements, individually or collectively, and cathode. A d-c indicator is connected in series with the plate. Group III testers apply separate grid signal and bias voltages, with the indicator responsive to the grid-signal-produced component of the output current. Group IV testers permit quantitative measurements of Gm, or Gm and other tube parameters, as defined by ASA C42-1941. Copies of this standard may be obtained from Radio-Electronics-Television Manufacturers Association, 11 West 42nd Street, New York 36, N.Y., for 25 cents per copy.

Specs on Packing, Marking

BULLETIN No. 56Z, PRESERVATION, PACKAGING, PACKING, AND MARKING FOR SHIPMENT SPECIFICATIONS, 1 SEPTEMBER 1956 . . . This 31-page specification bulletin lists and cross-indexes the approved specs for use as the standard methods for preservation, packing, packaging, and marking of USAF equipment. Specs other than those listed in this bulletin may not be used without prior AF approval. Copies of this bulletin are available from Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.

MIL-M-19590 (SHIPS), MARKING OF ELECTRON TUBES AND CONTAINERS TO INDICATE RADIOACTIVE MATERIAL, 14 AUGUST 1956 . . . The requirements for marking or labeling electron tubes containing intentionally added radioactive isotopes and their containers are established by this spec. A table listing the radioactive isotopes is included.

Transistors

MIL-T-19502A (SHIPS), TRANSISTORS, TYPE 2N117, 9 OCTOBER 1956

Silicon NPN Grown Junction Transistor type 2N117 are covered by this spec. MIL-T-19502 (Ships) is superseded by this spec.

Resistors

RETMA RS-172, FIXED COMPOSITION RESISTORS, DECEMBER 1956

Resistors standardized by this spec are insulated fixed resistors having a composition resistance element capable of full-load operation at ambient temperatures of 40 or 70° C, as applicable. A typical resistor type designation covered by this spec is RRC20GF153M. Copies of this standard may be obtained from the Radio-Electronics-Television Manufacturers Association, 11 W. 42nd St., New York 36, N.Y. for $1.20 each. This standard is a revision of REC-116.

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Standards and Specs

Switches

NEMA KS 1-1957, ENCLOSED SWITCHES . . . Air-break switches which have their current-carrying parts enclosed in metal cases and which are manually operable by means of external handles and enclosed switches with or without provision for plug or cartridge-enclosed fuses are covered in this standard. These switches may be heavy-duty Type HD, normal-duty Type ND, or light-duty Type LD. Information is given concerning safety requirements, temperature rise, enclosures, spacings, voltage and horsepower ratings, tests and markings. Copies of this standard are available from National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N.Y. for $1.00 per copy.

Drawings

MIL-D-5028B (ASG), PREPARATION OF MANUFACTURERS' DRAWINGS AND DATA LISTS FOR PRODUCTION AERONAUTICAL AND ASSOCIATED EQUIPMENT, 20 AUGUST 1956

The preparation of manufacturer's engineering design drawings and related data lists for production aeronautical and associated equipment are covered by this spec. Defined in this spec are the minimum requirements necessary for the preparation of any set of drawings. The requirements of this spec are not mandatory for contractor standard parts, except where specified.

Capacitors

MIL-C-25A, CAPACITORS, FIXED, PAPER-DIELECTRIC, DC (HERMETICALLY SEALED IN METALLIC CASES), SUPPLEMENT 1F, 17 JANUARY 1957 . . . Style CP61 has been cancelled. This style has been replaced by styles CP90 and CP91.

Design

MIL-E-25647 (USAF), GENERAL SPECIFICATION FOR THE DESIGN OF AIRBORNE ELECTRONIC EQUIPMENT, 4 SEPTEMBER 1956

The philosophy of design and the general requirements for the design and the manufacture of airborne electronic and related equipments are covered by this spec. The philosophy of design is particularly applicable during the experimental and developmental phases of design. The primary objective of this spec is to obtain an optimum overall system or equipment design which shall provide the function and performance as specified in the detail requirements. The spec recognizes that many of the factors which influence the choice of a design are not necessarily of a technical nature, and the importance of such factors should be considered on an equal basis with the straight-forward technical factors.

Power Supplies

MIL-P-15736C (SHIPS), POWER SUPPLIES, METALLIC RECTIFIER, NAVAL SHIPBOARD, AMENDMENT 1, 29 OCTOBER 1956

The requirement for periodic tests has been modified as follows, if more than 18 months elapse from the time of the last periodic test until the manufacturer again supplies the specific size, class, and design of equipment, the periodic test, except for shock and vibration, shall be conducted on the equipment of the subsequent contract or order.

Test Equipment

AF BULLETIN 120A, LIST OF MULTIUSE ELECTRICAL AND ELECTRONIC TEST EQUIPMENT, AMENDMENT 1, 26 SEPTEMBER 1956

A new classification under comments has been added. It is "AUTH TAB," meaning that the stock number is used for authorization tabulation only and that when the equipment is ordered another stock number should be used. Also included in this amendment are nine pages of revisions, changes, and additions to the list of test equipment.

Microwave Power Generators

RETMA RS-173, EMERGENCY STAND-BY POWER GENERATORS AND ACCESSORIES FOR MICROWAVE SYSTEMS, DECEMBER 1956

Definitions and minimum requirements for engine-driven generator sets used for providing emergency stand-by power to microwave communication systems are established by this standard. Permanently-installed engine-driven generator sets of not over 25 kw are covered. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 W. 42nd St., New York 36, N.Y. for 40 cents per copy.

Capacitors

RETMA RS-171, HIGH VOLTAGE CERAMIC CAPACITORS, CLASS 2, DECEMBER 1956

Capacitors standardized by this spec are fixed, ceramic dielectric capacitors of a type specifically suited for high voltage power supply filtering. Copies of this standard are available from the Radio-Electronics-Television Manufacturers Association, 11 W. 42nd St., New York 36, N.Y. for 25 cents each.

Noise

MIL-A-8806 (ASG), GENERAL SPECIFICATION FOR ACOUSTICAL NOISE LEVEL IN AIRCRAFT, 25 OCTOBER 1956 . . . The general requirements for the control of acoustical noise in occupied spaces of aircraft, including the acceptable noise levels, and the testing requirements for determining conformance to these levels are established by this spec. Spec MIL-A-18150 (Aer) is superseded by this spec.

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"What do you need for a successful avionics career?"

Your future is brighter at Ryan because of this unique combination of advantages:

SPECIALIZATION—Ryan is far advanced in the use of continuous wave radar techniques in three important fields: global navigation, missile guidance and helicopter hovering. An Automatic Navigator—global in scope and completely self-contained—is in production.

DIVERSIFICATION—Ryan's electronics work involves microwave engineering, advanced electronic circuitry, transistorization, servomechanisms, field engineering, advanced system engineering and electronic production engineering.

SIZE—Ryan is big enough to have complete electronics lab, environmental test and machine shop facilities... yet small enough so you will never feel "lost in the shuffle."

CLIMATE AND SCHOOLS—you will enjoy clear-sky San Diego where *living is unlimited.* You will benefit from graduate electronics engineering courses in San Diego's fine schools, where you can earn up to an MS degree.

Ryan needs all types of Electronics Engineers, Designers, Analysts, Specialists. Invest in your future—act now—write to James Kerns, Engineering Division — Ryan Aeronautical Company, 2708 Harbor Drive, San Diego 12, California.

RYAN AERONAUTICAL COMPANY

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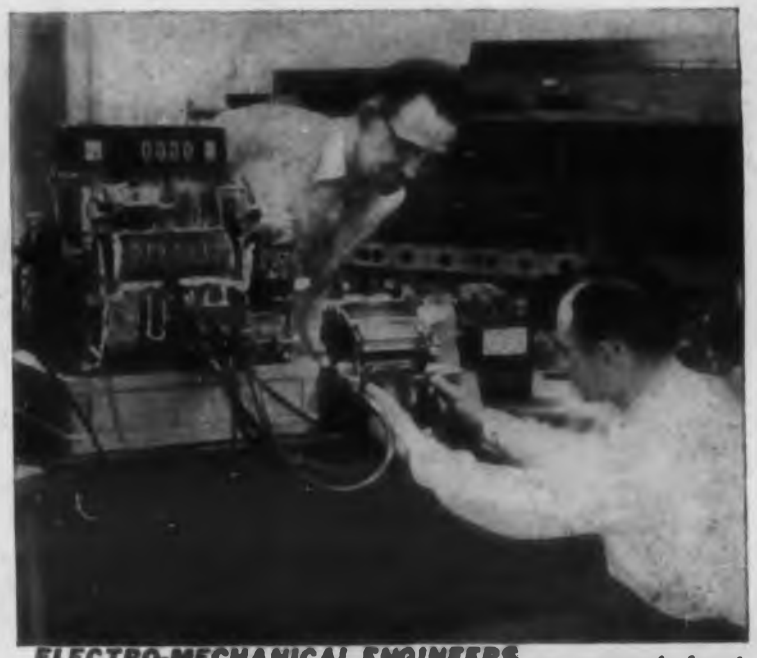
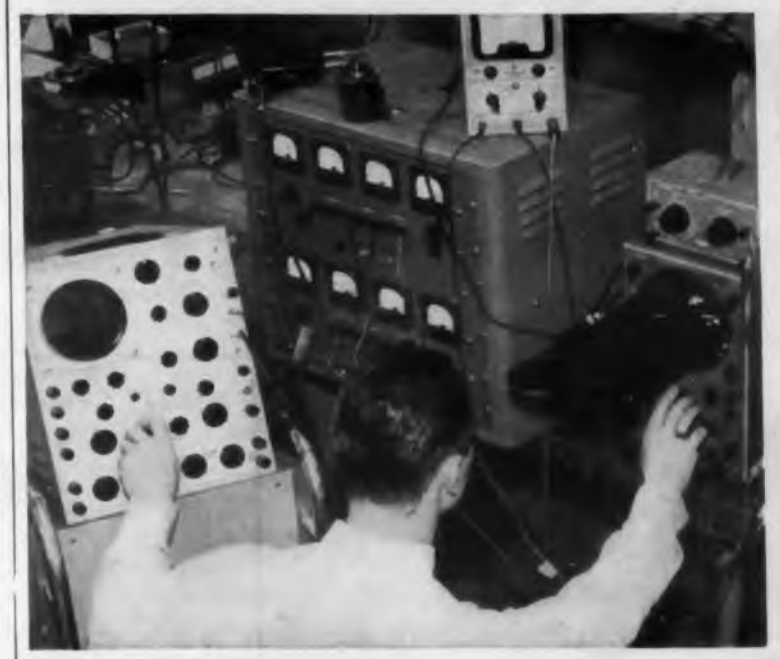
MECHANICAL ENGINEERS are using their skills in the design and development of new mechanisms required for business machines and for those mechanical products which are associated with electronic data processing equipment.



ELECTRO-MECHANICAL ENGINEERS are constantly faced with the problems of capturing information from the various input devices and converting this information into a usable form for subsequent use in data-handling equipment.



ELECTRONIC ENGINEERS enjoy an unparalleled freedom in the development of new types of circuitry and components which are necessary to maintain leadership in the competitive field of record-keeping automation.

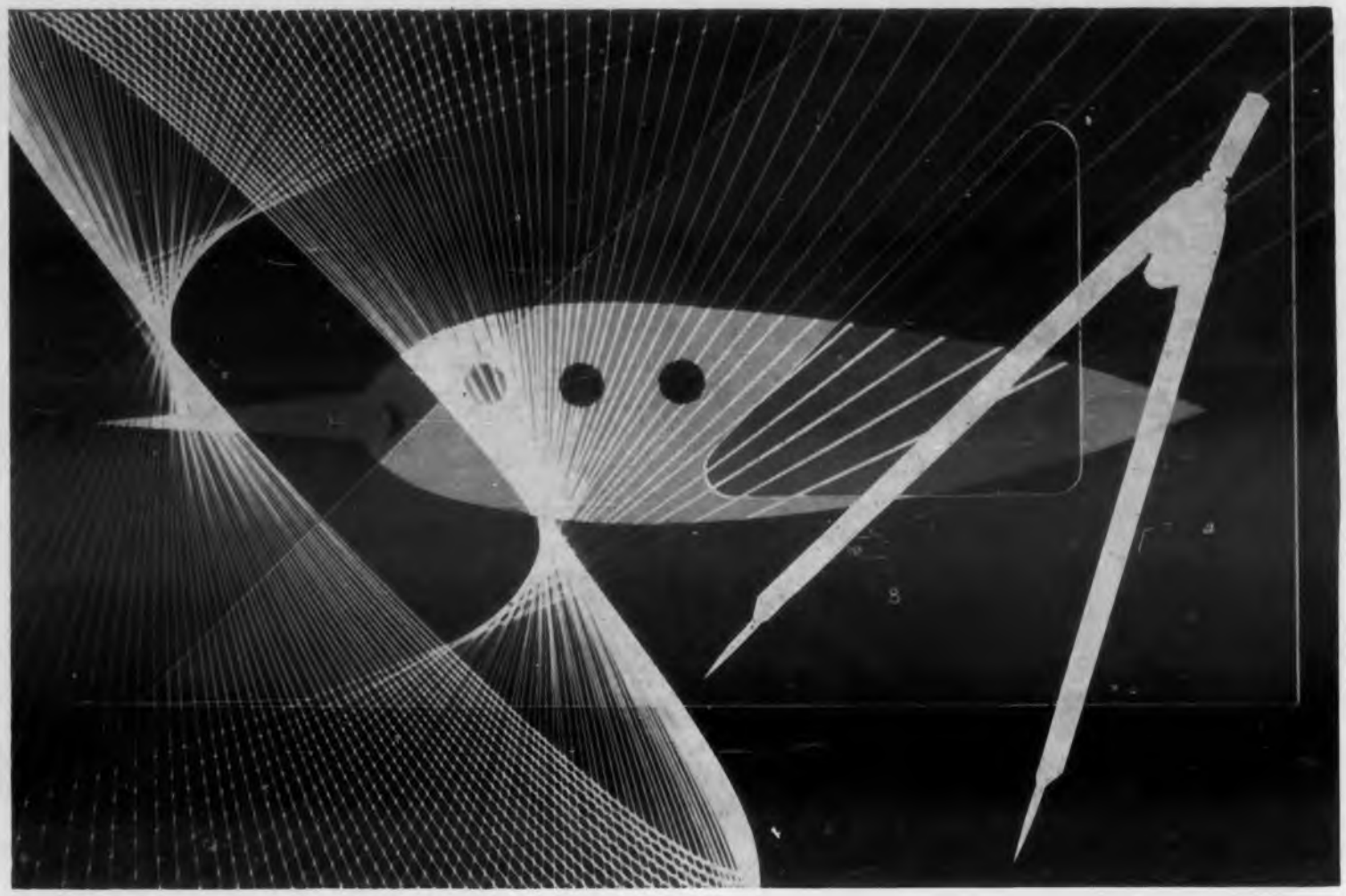
COMPUTER ENGINEERS backed by the company's computer research since 1938 are developing an economical, flexible digital computer to meet the requirements of all record-keeping applications.

HOW TO USE THE HOME REPLY FORM

If you wish to inquire about any of the employment opportunities listed in the "Career Section" simply circle the appropriate Reader Service number in the grey (shaded) area of your Reader Service card. Be sure to include your home (or non-business) address in the space provided at the bottom of the card. In this way, the privacy of your inquiry will be protected while still providing the speed and efficiency of ELECTRONIC DESIGN's Reader Service card system.

Last year ELECTRONIC DESIGN processed more than 60,000 individual reader cards. Now ELECTRONIC DESIGN is first to add a confidential inquiry form—one more step to its speeding communications between reader and advertiser.

ADVERTISING INDEX
APRIL 15, 1957



Creative Engineers:

Work where the breakthroughs are being made in every major field of Electro-Mechanics

As a creative engineer, you belong at the front-line of your field . . . where tomorrow's scientific battles are being won . . . where you can help win them.

For more than a decade, AUTONETICS has been at the forefront of electro-mechanical technology . . . building up the unique stockpile of experience and developing the advanced techniques and tools that can make your professional victories possible at AUTONETICS today.

Just a few specific results of AUTONETICS' pioneering are: the MG-4 Fire Control System for NATO's F-86K Sabre Jet; Flight Control elements for the F-100 Super Sabre; *Numill*, a new magnetic-tape controlled machine-tool system capable of performing complex milling and drilling operations automatically; *Recomp I*, a new portable, high-speed, completely transistorized digital computer; and inertial guidance systems for both airplanes and missiles.

Today, our programs are gathering speed, broadening scope. New engineering methods have been developed to cut lead time. System and component evaluation is being accelerated with automatic checkout equipment. Packaging is being designed and systems micro-minaturized to fit the cramped confines of sleek missiles and jets.

YOUR OPPORTUNITY EXISTS AT EVERY LEVEL of creative engineering from Preliminary to Performance Test—because Autonetics is one of the few companies in the world that can design and quantity-produce complete automatic control systems for both the military and industry.

LET US KNOW what kind of creative engineering interests you (please include highlights of your education and experience). Write today to: Mr. A. N. Benning, Administrative and Professional Personnel, Dept. 358-ED4, AUTONETICS, 9150 E. Imperial Highway, Downey, California.

Autonetics
A Division of North American Aviation, Inc.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

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Assistant Chief Engineer Norman F. Parker joined Autonetics in 1948 after receiving his DSc from the Carnegie Institute of Technology. Dr. Parker has been recognized nationally for his work in Inertial Navigation, and was chosen recently to present a paper on that subject at a NATO conference in Italy.

Jack Wittkopf was Associate Professor of Electrical Engineering at Oregon State for 6 years before he joined Autonetics in 1951. Now Group Leader in computers and electronics, Jack lives with his wife and four children in Autonetic's home town of Downey, California, where his spare time activities include photography and ham radio.

Another RCA first in 110° design

RCA-17BZP4

- Weight—only 10 pounds
- Length—only 12 9/16 inches
- No Ion-Trap Magnet Needed

Scale: 1 square = 1 inch

Pioneer in the development of 110°-deflection picture tubes for compact black-and-wh TV receivers, RCA presents the 17BZP4—the 17-inch-type, rectangular, glass tube designed specifically to meet popular demand for large-screen TV in smaller, lighter-v cabinets. Here is a very short picture tube with a large viewing area of 155 square inches—3 inches shorter than types having the same size faceplate and 90° deflection. Super-aluminizing produces bright, high-contrast pictures that have made RCA pictur tubes famous. The new RCA electron gun of the "straight-type" design *DOES AWAY ENTIRELY WITH THE NEED FOR AN ION-TRAP MAGNET!*

Available in quantity to meet your production schedule, RCA-17BZP4 is another imp addition to RCA's expanding family of 110°-deflection types—including the RCA-21CEP4, the first commercially available 110° tube; a 14-inch developmental typ available for sampling to equipment manufacturers; and a 24-inch type in developmer

For sales information and delivery schedule on RCA 110°-deflection types, call your R Field Representative. For technical data, write RCA Commercial Engineering, Section 18Q2, Harrison, N.J.

RADIO CORPORATION OF AMER

Tube Division — Harrison, New

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NOTE: *RCA can supply you with the horizontal and vertical deflection tubes and components needed for 110°-deflection-angle systems.*

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East: HUmboldt 5-3900
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West: RAymond 3-8361
6355 East Washington Blvd.
Los Angeles 22, Calif.

CIRCLE 410 ON READER-SERVICE CA