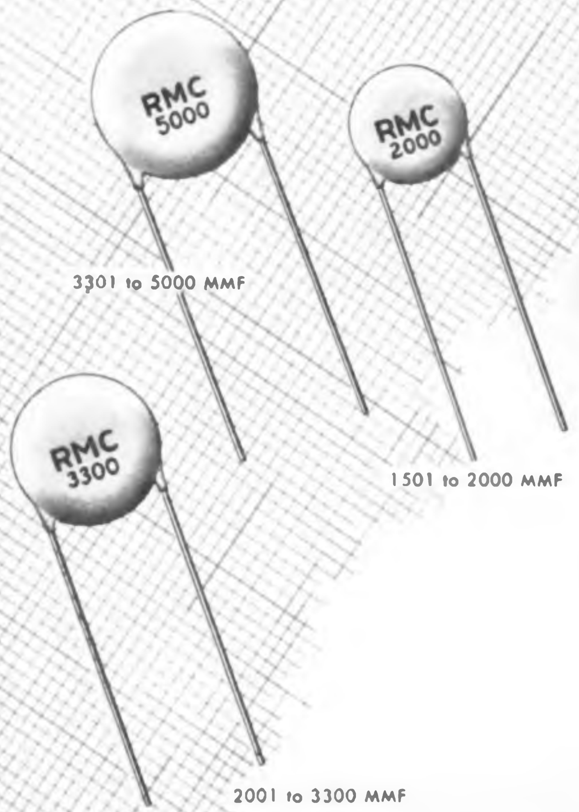
TELE-TECH

& Electronic Industries

ELECTRONIC RECORDING... Vital Tool and Servant

Bibliography of Magnetic Recording 1900-1953
Foreign Electron Tube Techniques
Du Mont's New Tele-Centre

July • 1954 Caldwell-Clements, Inc.

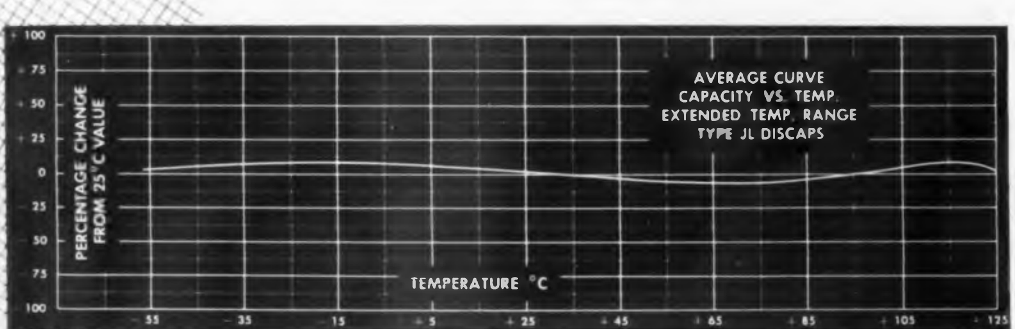


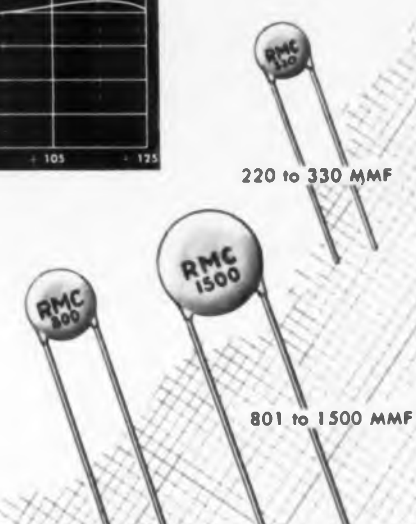
investigate the advantages of Type JL RMC DISCAPS®

More and more of the leading electronics, radio and TV manufacturers are specifying Type JL DISCAPS as the ideal cost saving replacement for paper or general purpose mica capacitors. In addition to a lower initial cost, Type JL DISCAPS feature smaller size and greater mechanical strength to effect additional economies in production assembly.

This series is manufactured in a wide range of capacities and offers exceptional stability over an extended temperature range. The maximum capacity change between −60° C and +125° C is only ±7.5% of capacity at 25° C. Type JL DISCAPS have a standard working voltage of 1000 V.D.C. and are available in tolerances of ±10% or ±20%.

Our engineers are prepared to work with you on problems requiring standard or special types of ceramic capacitors, write today.





POWER FACTOR: 1% max. @ 1 K C (initial)
POWER FACTOR: 2.5% max. @ 1 K C, after humidity
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ± 10% ± 20% at 25° C

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

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TELE-TECH
& Electronic Industries

JULY, 1954

FRONT COVER: ELECTRONIC RECORDING—Symbolic of the wide scope of recording in serving industry, the military, and the public are the six artistic representations of signal sources, typical waveforms, and their recording systems. From top to bottom are: Guided missile telemetering on magnetic tape; audio on disc and tape; industrial control on graphic strip chart; radar on a PPI scope suitable for photographing; TV on motion picture film and magnetic tape; and computer pulses on a magnetic memory drum.

DEPARTMENTS

TELE-TECH & ELECTRONIC INDUSTRIES*, Vol. 13, No. 7. Published monthly by Caldwell-Clements, Inc. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Secretary; M. B. Clements, Treasurer. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., June 9, 1954. 75¢ a copy. Annual Subscription Rates: United States and possessions: $7.00; Canada: $8.00; All Other countries: $10.00. Please give title, position and company connection when subscribing. Copyright by Caldwell-Clements, Inc., 1954. Printed in U.S.A.

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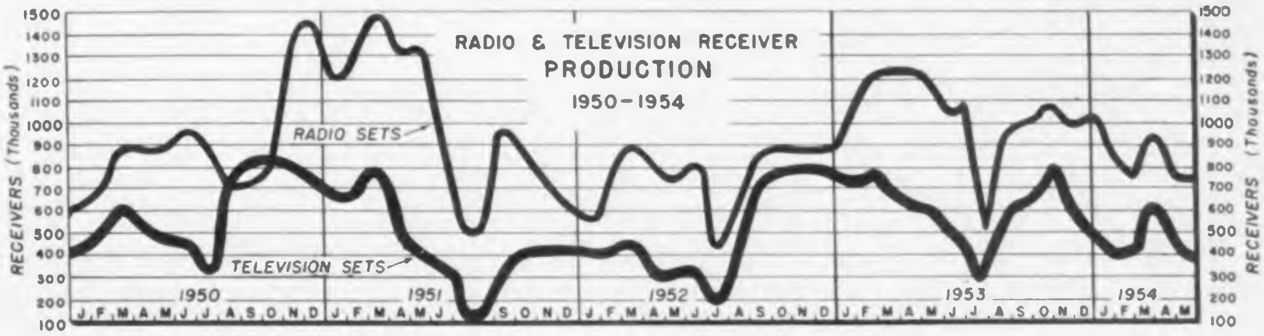
Facts and Figures Round-Up
July, 1954

ELECTRONIC INDUSTRIES TOTALS



Tables at right are from recent study of commercial and military electronic fields by Stanford Research Institute for Hoffman Radio Inc. They represent findings of approximately seven weeks of research. The present market for the electronic industries is considered to be composed of the following three segments: (a) household (b) military (c) commercial—which represents about 12% of total.

TOTAL ELECTRONIC MARKET
ESTIMATED ANNUAL VALUE OF FACTORY SALES
(Millions of Dollars)

End Products	1940	1944	1947	1953	1960
Household Products	$ 300	$ 25	$ 800	$1,675	$ 3,750
Military Equipment	300	4,600	400	3,400	5,000
Commercial Products	25	100	150	425	1,250
Total	$ 625	$4,725	$1,350	$5,500	$10,000
Components[1]	$ 100	$ 900	$ 350	$1,100	$ 2,000

[1] Excluding tubes.

June 19 was FCC's 20th Anniversary. Following is a comparison of radio authorizations of the Commission's first years with those of today:

Class of Service	1/30/35	3/31/54
Marine	2,157	44,598
Aeronautical	678	43,324
Public Safety	298	15,065
Industrial	146	20,599
Land Transportation	0	12,370
Broadcast	623	5,808
Experimental	1,012	544
Common Carrier	565	1,534
Amateur	45,561	118,750
Other	34	782
Sub Total	51,074	263,374
Operators		
Commercial	*30,000	*745,000
Amateur	36,525	116,125
Sub Total	66,525	861,125
Grand Total	117,599	1,124,499

*Estimated

COMMERCIAL ELECTRONICS MARKET
ESTIMATED ANNUAL VALUE OF FACTORY SALES
(Millions of Dollars)

Product	1940	1947	1953	1960
Data Processing Equipment	$ 0	$ 4	$ 25	$ 500
Laboratory and Service Equipment	5	23	100	200
Industrial Control Instruments	3	12	65	150
X-Ray Equipment and Tubes	12	49	60	90
Broadcast Equipment	1	18	60	80
Mobile and Amateur Radio	2	25	35	60
Heating Apparatus	1	4	20	50
Radiation Instruments	0	4	20	50
Industrial Television	0	0	6	40
Microwave Relay	0	2	12	25
Marine Equipment (nonmilitary)	1	5	9	15
Aviation Equipment (nonmilitary)	1	2	7	15
	$26	$148	$429	$1,275

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by the government procurement agencies in May 1954

Actuators	$ 80,423
Amplifiers	1,732,992
Antenna Supports	151,834
Battery Chargers	90,435
Batteries	8,238,018
Bridges	28,946
Cabinet Relay Assys	55,650
Cable	1,477,589
Capacitors	154,672
Circuit Breakers	462,660
Crystal Units	192,458
Components, autopilot	67,182
Controls	1,633,632
Couplers, antenna	41,257
Dummy Loads	91,376
Dynamotors	75,375
Exciters	33,020
Generators	7,971,183

Indicators	492,526
Headphones, radio test	148,970
Leads, electric	123,693
Meters	605,197
Mixer, cavity tuned	33,285
Motors	423,951
Oscillators, test	34,175
Potentiometers	41,745
Power Units, auxiliary	277,244
Probe, r-f	34,680
Radars	13,861,998
Radio Compasses	557,116
Radiosondes	27,288
Receivers, double synchros	137,570
Recorder-Reproducers	116,529
Relays, solenoid	31,033
Resistors	81,996

Slotted Lines	73,432
Switch Assys	62,036
Switchboards	101,640
Switches	100,207
Synchros	131,029
Tape, magnetic	44,998
Target Drones	6,427,688
Target Indicator Equipment	100,000
Teletypewriter Sets	70,000
Terminal Boards	45,096
Test Sets	179,010
Testers	793,765
Transformers	972,544
Transmitters	1,921,703
Tubes, electron	2,514,751
TV Equipment, underwater	211,895
Voltage Regulators	57,805

agreed conclusively - - -

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DU MONT COLOR MULTI-SCANNER

Here is the one system that puts you years ahead . . . whether for monochrome or color. The Du Mont Color Multi-Scanner permits you to be ready for the day you start color broadcasting, and at the same time provides a means of monochrome-film, slide and opaque pickup surpassing all other systems in quality of performance, operating economies and dependability. Yes, sir . . . anyway you look at it . . . you're years ahead with the Du Mont Color Multi-Scanner — the **only** continuous-motion scanner now being delivered commercially!

16 mm. COLOR FILM

. . . FOR COLOR

Permits the average television station to prepare for color now, without the large investment required in specialized color equipment. The cost of the system may be amortized over both current monochrome broadcasting operations and future color operations.

The Color Multi-Scanner eliminates registration and other technical problems inherent in triple pick-up tube camera designs. The single scanning tube along with the unparalleled sensitivity of the Du Mont Multiplier Phototube results in a color signal source far surpassing that of other systems.

COLOR TRANSPARENCIES

. . . FOR MONOCHROME

The Color Multi-Scanner can go right to work on monochrome transmission. Utilization of the same equipment provides fine quality black and white reproduction. At the flick of a switch—your choice of color or monochrome—it's as simple as that!

The Color Multi-Scanner is basically the same as the famous Monochrome Multi-Scanner with the exception of a light-splitting mirror system and additional unitized channel amplifiers. All operational advantages and economies have been retained.

16 mm. FILM MONOCHROME

MONOCHROME TRANSPARENCIES

. . . AND OTHER DU MONT COLOR EQUIPMENT

Incorporated in the Du Mont Color Multi-Scanner and available as a separate unit for improving other color signal sources, the Du Mont Color Masking Amplifier adds new realism to color signals. It permits compensation for dye and filter deficiencies and adds new qualities to any color setup.

Get details on the complete line of Du Mont color transmitting accessories. As always . . . in color or monochrome . . . it's Du Mont to be first with the finest!

MONOCHROME OPAQUES

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MANUFACTURING

—Electronic equipment, communications, broadcasting, microwave relay, instrumentation, telemetering, computing.
—Military equipment including radar, sonar, guided missiles, fire controls.
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—Fixed, mobile and airborne communications in commercial, municipal, aviation and government services.
—Broadcasting, video and audio recording, records, audio and sound systems, motion picture production.
—Military, civilian and scientific electronic computing and control systems.
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Published annually as an integral section of TELE-TECH in June

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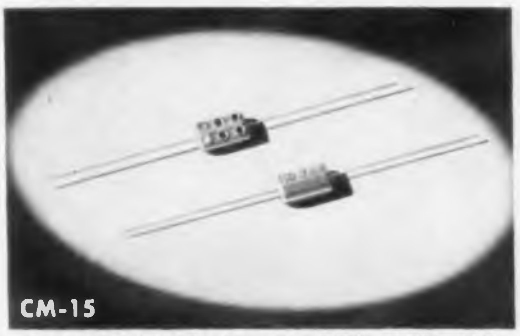
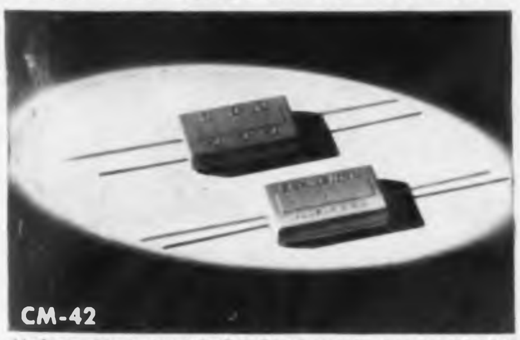


Smallest Molded Mica Capacitors 9/32" x 1/2" x 3/16"



Made to Meet All MIL-C-5 Requirements. Largest Molded Mica Capacitors of Wire Terminal Type. 13/16" x 1-1/2" x 5/16"

Jobbers and Distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y. — large stocks on hand — spot shipments for immediate delivery. Sole Agent for Jobbers and Distributors in U. S. and Canada.

When the mighty giants of the air lift their massive wings to fly, a thousand and more "tremendous trifles" instantly go to work in harmonious unison to give life and power. It is the perfection of these "trifles" that makes possible the magnificent performance of today's luxurious air liners.

The EL MENCO Capacitor—CM-15—is one of these "tremendous trifles" that plays such a vital part in the efficient operation of aircraft communication.

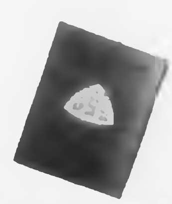
EL MENCO IS THE ONE OUT OF MANY CHOSEN FIRST

Superiority of manufacture and dependability of performance make EL MENCO first choice on the specification sheet . . . because EL MENCO Capacitors are factory-tested at *double their working voltage* — they are *guaranteed stable* under the most adverse conditions. Whether you use our *high* capacity CM-42 (10-25,000 mmf) or our midget *low* capacity CM-15 (2-525 mmf) you have guaranteed assurance of job-tested, job-rated capacitors — tremendous trifles of perfection so vital to the magnificent performance of YOUR product.

ELECTRO MOTIVE is now supplying special silvered mica films for the electronic and communication industries — just send us your specifications.

WRITE FOR FREE SAMPLES AND CATALOG ON YOUR FIRM'S LETTERHEAD

El-Menco



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

As We Go To Press...

TV Receiver Developments

A survey of recent progress in TV receivers shows considerable activity in the field interwoven with extreme caution regarding color. DuMont reports that its 19-in. color picture tube will be available for use in receivers by the fall of this year. This "Chroma-Sync Teletron" produces a 185-sq. in. picture, is of the shadow mask type, and has the phosphors applied directly on the curved faceplate. Pilot production of 15-in. color sets selling for $995 has been announced by Stromberg-Carlson. The company reports plans for 19-in. sets in the fall, as does Andrea Radio.

Improvements of black-and-white sets are noted by Raytheon, which is producing a compact 7-in. vertical chassis receiver, with controls located on top of the set. Admiral's new line features a 21-in 90° deflection picture tube providing a 270-sq. in. picture, which incorporates printed circuits. A new short 21-in. rectangular black-and-white tube, the 21ATP4, has been announced by Sylvania. Deflection angle is 90°, and overall length is only 20⅜ in.

Airborne Radar

A new airborne radar—RDR-1—designed by Bendix Aviation Corp. for commercial airliners employs a new technique of PPI "scope" presentation—Iso-Echo contours—integrated into the equipment which operates on X-band (3.2 cm.). It enables a pilot to see instantly the position, intensity, and extent of a storm. RDR-1 with a nose-mounted, gyro-stabilized antenna utilizes a pencil beam which will scan an angle up to 120° to either side of an aircraft's heading, depending upon the configuration of the plane's leading edges. Maximum range of the radar sweep is 150 miles. Range markers provide calibration at 5, 10 and 25 mile intervals respectively. While designed primarily for weather purposes and as a storm-warning device, RDR-1 has provisions for ground beacon navigation and terrain radar mapping.

New Computer For Industry

The introduction of IBM's new type '702' electronic data processing machines was hailed by Thomas J. Watson, IBM president, as "the biggest step toward automation in accounting procedures since the introduction of alphabetical punched card machines."

Basic unit of the new system is the central Arithmetical and Logical Unit, which is capable of performing more than 10,000,000 operations in an hour. The data to be processed and the instructions for processing are stored in a bank of cathode-ray "memory" tubes and a magnetic drum unit. The results of the computations are recorded on reels of magnetic tape, each having a capacity of 5,000,000 characters. Recording is achieved at a rate of approximately 15,000 letters or numbers per second.

Data on the tape are transcribed into punched cards and printed cards by the appropriate equipment —Card Punch or Line Printer machines.

Control over all units is maintained from the operator's Control Console.

The units are connected by cable and the sequence of operations can be varied by merely changing the connections.

The needs of the individual office or operation will dictate which of these machines will be needed and an exhaustive study of the office procedure will first be undertaken before the equipment is ordered.

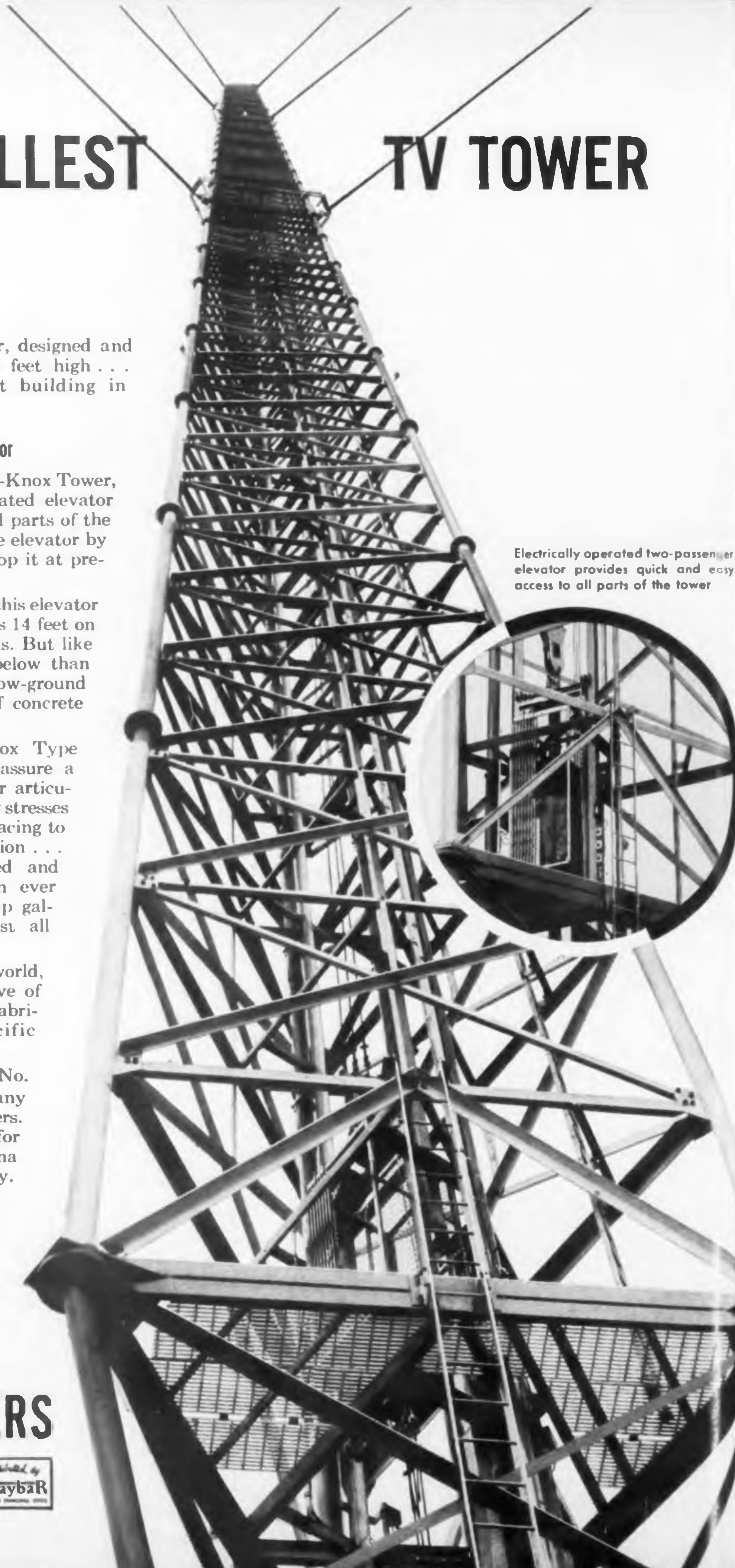
Partial view of the IBM '702' electronic data processing machine. Control over the entire system is maintained from the operator's console in foreground. Arrangement of units is varied to fit particular applications. Prime users of this equipment will be insurance companies and manufacturing industries

Tubes for "Series string" TV Operation

Development of a new line of 20 electron receiving tubes which operate with their heaters connected in a single "series string" circuit has been announced by the RCA Tube Div. The tubes make possible the elimination of such components as heater transformers in TV receivers. The new tubes are intended for 600 ma series operation and are reported to include an improved design which enables all heaters in the tube string to reach operating temperature uniformly, thereby minimizing heating burnouts caused by non-uniform heating characteristics.

MORE NEWS on page 14

WORLD'S TALLEST TV TOWER



This tremendous Blaw-Knox tower, designed and fabricated for WHIO-TV, is 1104 feet high . . . five times taller than the highest building in Dayton, Ohio.

Tower equipped with two-passenger elevator

Gliding up and down inside the Blaw-Knox Tower, the two-passenger, electrically operated elevator provides quick and easy access to all parts of the tower. A man in the cab operates the elevator by push button control . . . and can stop it at predetermined levels.

To support both the antenna and this elevator the sturdy triangular tower measures 14 feet on each side and weighs 600,000 pounds. But like an iceberg, there is more weight below than above the surface. For the below-ground pyramid base is 220 cubic yards of concrete weighing 832,700 pounds.

Some features of the Blaw-Knox Type TG-4 Tower construction, which assure a sturdy structure, are the pivoted or articulated base to avoid excessive bending stresses . . . double laced structural angle bracing to provide extra strong rigid construction . . . guys that are factory pre-stressed and proof tested to load greater than ever required in service . . . and hot-dip galvanized coating to protect against all weather conditions.

This tallest TV tower in the world, complete with elevator, is indicative of how we are prepared to design and fabricate towers to meet your specific conditions.

Write for your copy of Bulletin No. 2417 for more information on the many types of Blaw-Knox Antenna Towers. Or, send us your specifications for height of tower and type of antenna for prompt service on your inquiry.

Electrically operated two-passenger elevator provides quick and easy access to all parts of the tower

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for AM • FM • TV • radar
microwave • communications

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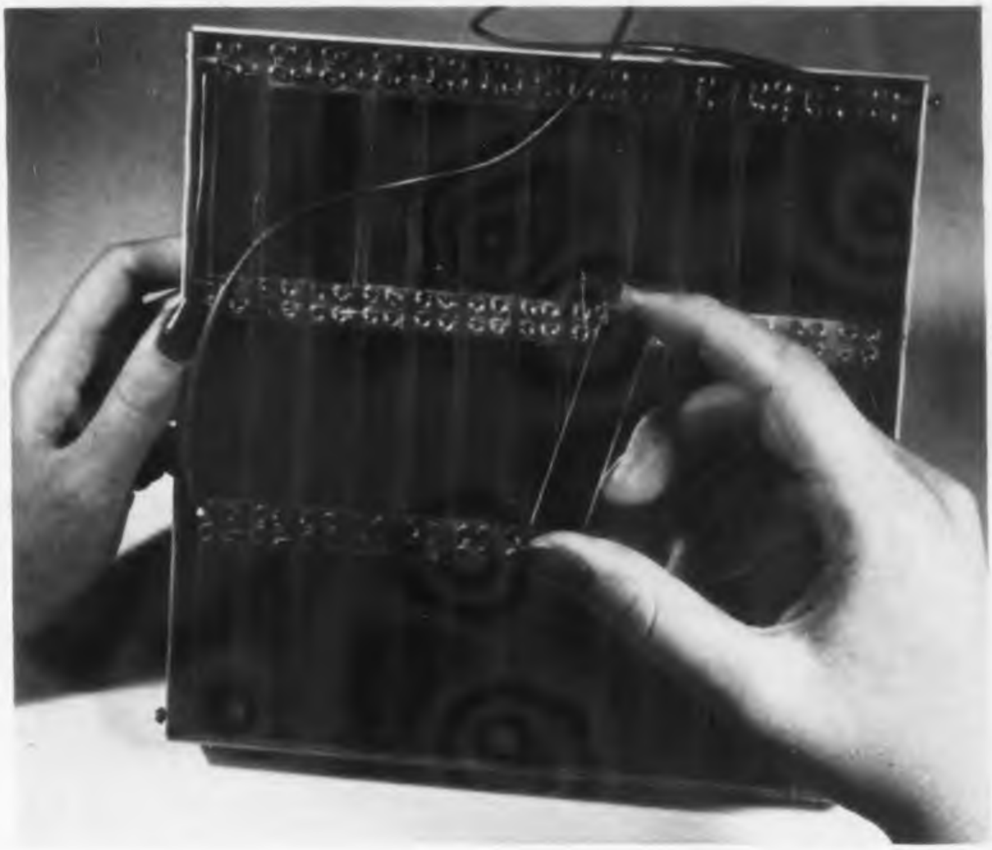
For product information, use inquiry card on last page.

The Bell Solar Battery. A square yard of the small silicon wafers turns sunshine into 50 watts of electricity. The battery's 6% efficiency approaches that of gasoline and steam engines and will be increased. Theoretically the battery will never wear out. It is still in the early experimental stage.



Bell Solar Battery

Bell Laboratories scientists have created the Bell Solar Battery. It marks a big step forward in converting the sun's energy directly and efficiently into usable amounts of electricity. It is made of highly purified silicon, which comes from sand, one of the commonest materials on earth.

The battery grew out of the same long-range research at Bell Laboratories that created the transistor—a pea-sized amplifier originally made of the semiconductor germanium. Research into semiconductors pointed to silicon as a solar energy converter. Transistor-inspired techniques developed a silicon wafer with unique properties.

The silicon wafers can turn sunlight into electricity to operate low-power mobile telephones, and charge storage batteries in remote places for rural telephone service. These are but two of the many applications foreseen for telephony.

Thus, again fundamental research at Bell Telephone Laboratories paves the way for still better low-cost telephone service.

Inventors of the Bell Solar Battery, left to right, G. L. Pearson, D. M. Chapin and C. S. Fuller – checking silicon wafers on which a layer of boron less than 1/10,000 of an inch thick has been deposited. The boron forms a "p-n junction" in the silicon. Action of light on junction excites current flow.

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As We Go to Press . . . .

Low Bridge Tug

A tugboat that ducks its masthead when passing under a low bridge was recently rebuilt for the Moran Towing and Transportation Co. The vessel, one of the strangest ever seen in New York harbor, has been equipped with a "Mariners Pathfinder" Model 1500 radar, built by Raytheon. When passing under a low bridge, the tug's wheelhouse—occupants and all—retracts like a turtle pulling in its neck. The upright mast tilts backward until it lies horizontally above the deck. Once clear of the obstruction, the vessel's air and oil hydraulic ram rig extends the telescoping wheelhouse again, pushing it seven feet upward in one minute, and erecting the mast. Throughout this maneuver, radar unit remains intact and operative.

Tugboat lowers mast to duck under low bridges. The vessel's radar transmitter and receiver is built entirely within the vessel's antenna housing

COLOR SCANNER

New General Electric color slide and film scanner is examined by C. Graydon Lloyd (l) GE manager of engineering for Commercial Equipment, and Richard E. Putnam, development engineer

COMING EVENTS

July 6-9—International Conference on Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England

July 8-12—Convention British Institution of Radio Engineers, Christ Church, Oxford, England.

July 13-15—Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif.

July 13-14—Western Plant Maintenance Conference. Ambassador Hotel, Los Angeles, Calif.

July 21-28—3rd International Crystallographic Congress, at the Sorbonne, Paris, France.

Aug. 25-27—Western Electronic Show and Convention. Los Angeles and San Francisco IRE sections and WCEMA sponsored. (Show) Pan-Pacific Auditorium, Los Angeles. (Convention Hq.) Ambassador Hotel, Los Angeles, Calif.

September—First International Scientific Radio Union, Amsterdam, Holland.

Sept. 1-16—Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

Sept. 5-9—International Frankfort Fair, Frankfort, Germany.

Sept. 13-24—International Instrument Congress and Exposition. Commercial Museum and Convention Hall, Philadelphia, Pa.

Sept. 15-17—IRE-MIT Symposium on the Information Theory, co-sponsored by the AIEE and URSI, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 15-21—ISA First International Instrument Exposition, Convention Hall, Philadelphia, Pa.

Sept. 16-18—Joint Electron Tube Engineering Council General Conference, Chalfont-Haddon Hall, Atlantic City, N. J.

Sept. 28-30—1954 National Packaging and Materials Handling Competition, sponsored by the Soc. of Industrial Packaging and Materials Handling Engineers. Chicago Coliseum, Chicago, Ill.

Sept. 30-Oct. 2—High Fidelity Show, International Sight and Sound Exposition, Inc., Palmer House, Chicago.

Oct. 4-6—Tenth Annual National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 11-15—AIEE Fall General Meeting, Morrison Hotel, Chicago, Ill.

Oct. 13-17.—1954 Annual Convention, Audio Engineering Society. Hotel New Yorker, N. Y.

Oct. 18-20—RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

Oct. 18-22—42nd National Safety Congress and Exposition. Conrad Hilton, Congress, Morrison and La Salle Hotels, Chicago, Ill.

Oct. 27-30—30th National Convention of the National Assoc of Education Broadcasters. Hotel Biltmore, New York.

Nov. 4-5—East Coast Conference on Airborne and Navigational Electronics, sponsored by the Baltimore section of IRE and IRE Professional Group on Aeronautical and Navigational Electronics. Sheraton-Belvedere Hotel, Baltimore, Md.

Nov. 10-11—AIEE Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

Nov. 10-12—18th Annual Time and Motion Study and Management Clinic, sponsored by the Industrial Manage-Society. Sherman Hotel, Chicago, Ill.

Nov. 12-13—National Symposium on Quality Control Methods in Electronics, sponsored by the Professional Group on Quality Control of IRE and Electronic Technical Comm. of the American Soc. for Quality Control. Hotel Statler, New York.

Nov. 18-19—6th Annual Electronics Conference, sponsored by the Kansas City Section of IRE, Hotel President, Kansas City, Mo.

Nov. 29-Dec. 4—First International Automation Exposition. 242nd Coast Artillery Armory, New York, N. Y.

ACM: Assoc. for Computing Machines.
AES: Audio Engineering Society.
AIEE: American Institute of Electrical Engineers.
IRE: Institute of Radio Engineers.
ISA: Instrument Society of America.
NACE: National Assoc. Corrosion Engineers.
NARTB: National Assoc. of Radio and TV Broadcasters.
RETMA: Radio-Electronics-TV Manufacturers Assoc.
WCEMA: West Coast Electronics Manufacturer's Association
WESCON: Western Electronics Show & Convention.

No Relief for UHF

The industry-supported amendment to H.R. 8300 proposed by Senator Edwin Johnson, which would have removed the excise tax on UHF receiving equipment, has been turned down by the Senate Finance Committee. The tax relief would have provided UHF-TV sets at prices comparable to VHF-only sets, thereby encouraging a wider audience for economically pressed UHF broadcasters.

New Tape Firm

Technical Tape Corp., West 177 St. & Harlem River, Morris Heights 53, N.Y., manufacturers of plastic and adhesive products, is now producing magnetic recording tape. The tape will be marketed through the company's magnetic Products Div. under the name "Encore."

MORE NEWS on page 24

we're prepared

NOW to supply you

in quantity with

Midland FREQUENCY CONTROL CRYSTALS for Color Television

↑ CRYSTAL CONTROLLED REACTANCE TUBE OSCILLATOR FOR COLOR SYNCHRONIZATION

To obtain the maximum advantage of Crystal Control in a reactance tube oscillator combination, the Midland Engineering staff has developed a crystal controlled Reactance Tube Oscillator Circuit for color synchronization.

The unit is Custom engineered to provide an inexpensive complete circuit and to take full advantage of the crystal characteristics to give optimum performance.

This is available to the television industry in sub-assembly form.

Midland was far in advance in the development and perfecting of frequency control crystals and circuits for color TV. Experimental production started in 1952.

Midland has met the exacting requirements of color television with a crystal of complete reliability. An early and thoroughly sound solution to each new challenge is in keeping with the Midland background of having served the communications field with millions of crystals that perform dependably under the most severe conditions.

Midland's unequalled experience, critical quality control at every stage of production, and expanded plant capacity assure you dependable, fast crystal supply—in any quantity—to meet your exact specifications.

Whatever your Crystal need, conventional or specialized, When it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.
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WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

For product information, use inquiry card on last page.

Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

WAD 5238

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"MAGNETIC MATERIALS CATALOG"

General information on all Arnold magnetic materials: permanent magnets, tape-wound and powder cores, types "C" and "E" cut cores, etc.

"ARNOLD SILECTRON CORES"

52 pages of valuable data covering a complete range of core shapes, sizes, tape gauges, etc.

ADDRESS DEPT. T

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

This is just another of Arnold's facilities for better service on magnetic materials of all description. ● Let us supply *your* requirements.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES ... New York: 350 Fifth Ave.

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Power supplies will meet the toughest requirements of battery operated equipment if experienced engineering goes into the selection of each element . . . vibrator, transformer, and buffer capacitor . . . so that electrical characteristics are balanced to give maximum vibrator performance.

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EXPERIENCE gained through years of working with leading manufacturers on a broad variety of vibrator applications.

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Big things are happening at Lockheed.
That's why:

Lockheed in California increases engineering staff

Diversification at Lockheed is again resulting in more and better careers for engineers.

Already 11 models are in production – huge luxury airliners, transports, trainers, bombers, radar search planes.

Now Lockheed has new aircraft of the future coming up – the XF-104, a lightweight jet fighter; the XFV-1, a vertical rising plane; the Universal Trainer, a versatile new jet fighter-trainer. In addition, continuing development on the Super Constellation and other classified activities require a larger staff.

These new development projects offer engineers outstanding opportunity for achievement and promotion. To engineers who seek that opportunity, Lockheed offers:

1. **Increased pay** rates now in effect
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Lockheed invites inquiries from Engineers who seek opportunity for achievement. Coupon below is for your convenience.

Lockheed has career openings for:

Servomechanisms and Autopilot Research Engineers

with a degree in Electrical Engineering and experience in research and testing of servomechanisms and autopilots.

Aircraft Design Engineers

for structural, mechanical or hydraulic design. To qualify, you need an engineering degree and experience in above or related fields.

Aerodynamicists

with a degree in Aeronautical Engineering and experience in sonic and supersonic performance and stability control.

Thermodynamicists

with a degree in Aeronautical or Mechanical Engineering and extensive experience in aircraft thermodynamics.

Aircraft Maintenance Design Engineers

for expert advisory guidance in maintenance design aspects. To qualify, you need extensive aircraft maintenance design experience, military or commercial. This position commands a high salary.

Electro-Mechanical Design Engineers

for important research and development on servomechanisms, autopilots and flight simulation. To qualify you need a degree in Electrical Engineering and at least two years' experience.

Electrical Design Engineers

with a degree in Mechanical or Electrical Engineering and experience in 1) aircraft circuit development and electrical design or 2) experience in design of electrical and electronic equipment installation.

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A Hi-Temperature Tested Germanium Diode

The new Hughes type 1N198

Type 1N198 Electrical Characteristics

at 75°C

Forward Current at 1V dc 5 mA (Min.)
Reverse Current at −10V dc 0.075 mA (Max.)
Reverse Current at −50V dc 0.250 mA (Max.)

at 25°C

Forward Current at 1V dc 4 mA (Min.)
Reverse Current at −10V dc 0.010 mA (Max.)
Reverse Current at −50V dc 0.050 mA (Max.)

Temperatures inside operating equipment usually climb well above the equipment ambient temperature. At these elevated temperatures, you need components with *known* characteristics. Most germanium diodes are tested at room temperature and, as operating temperatures rise, their performance deteriorates. But the new Hughes Type 1N198 is a *realistic* germanium point-contact diode.

That's because this diode is tested 100% at 75°C—which is just about as hot as most electronic equipment gets in operation. In addition, samples of the 1N198 are regularly subjected to all standard tests at 25°C. This means that you can use these hi-temperature tested diodes with confidence, can design equipment to take full advantage of the fact that *electrical characteristics at the higher temperatures are specified.*

Like all Hughes Diodes, the hi-temperature tested 1N198 is fusion-sealed in a one-piece, gas-tight glass envelope which is impervious to moisture or other external contaminating agents. The complete Hughes line of fusion-sealed germanium diodes comprises standard RETMA, JAN, and many special types. We'd like to send our Bulletin SP-2A, which lists and describes these diodes, to you. Just send for your copy, or for additional details concerning the new Type 1N198.

Hughes SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif. *New York Chicago*

Outstanding Value

PRESTO SR-11 STUDIO CONSOLE TAPE RECORDER

For the first time . . . a precision Presto tape recorder complete with amplifier in studio console cabinet for less than $1000. Here are the facts about this amazing value:

The R-11* Mechanism Here is the smooth operating, sleekly designed tape transport unit that drew engineers acclaim when it was introduced last year. Embodies the exclusive Presto capstan drive unit where pressure pulley and solenoid are mounted on a single sub-assembly for easy maintenance. Capstan and motor are interconnected by a belt. Two torque motors, each including its own brake system (external contracting type) assure smooth, positive action without the usual hazard of tape breakage. If tape does break, an automatic safety switch instantly stops the mechanism.

The Amplifier Actually there are two separate chassis for amplification. One contains the recording and reproducing channels. The second is the power supply located at the base of the console. This arrangement reduces noise and keeps operating temperature down.

The Console Cabinet Presto's designers have given particular attention to accessibility of every part of the SR-11. The top panel swings upward on a sturdy hinge to expose the underside of the tape mechanism, while the amplifier opens from the front and turns over on gimbals for access to tubes.

Ask your Presto distributor to order your SR-11 today. You'll never match it in value or performance.

*formerly RC-11

- **Three triple shielded magnetic heads**
- **Frequency response: 50 to 15,000 cps. (15"/se**
- **55 db signal to noise ratio (at 2% distortion)**
- **Flutter: less than .15% (15"/sec.)**
- **Push button function switches**
- **Will accommodate reels up to 10½"**

$995 COMPLETE with amplifier in console cabinet

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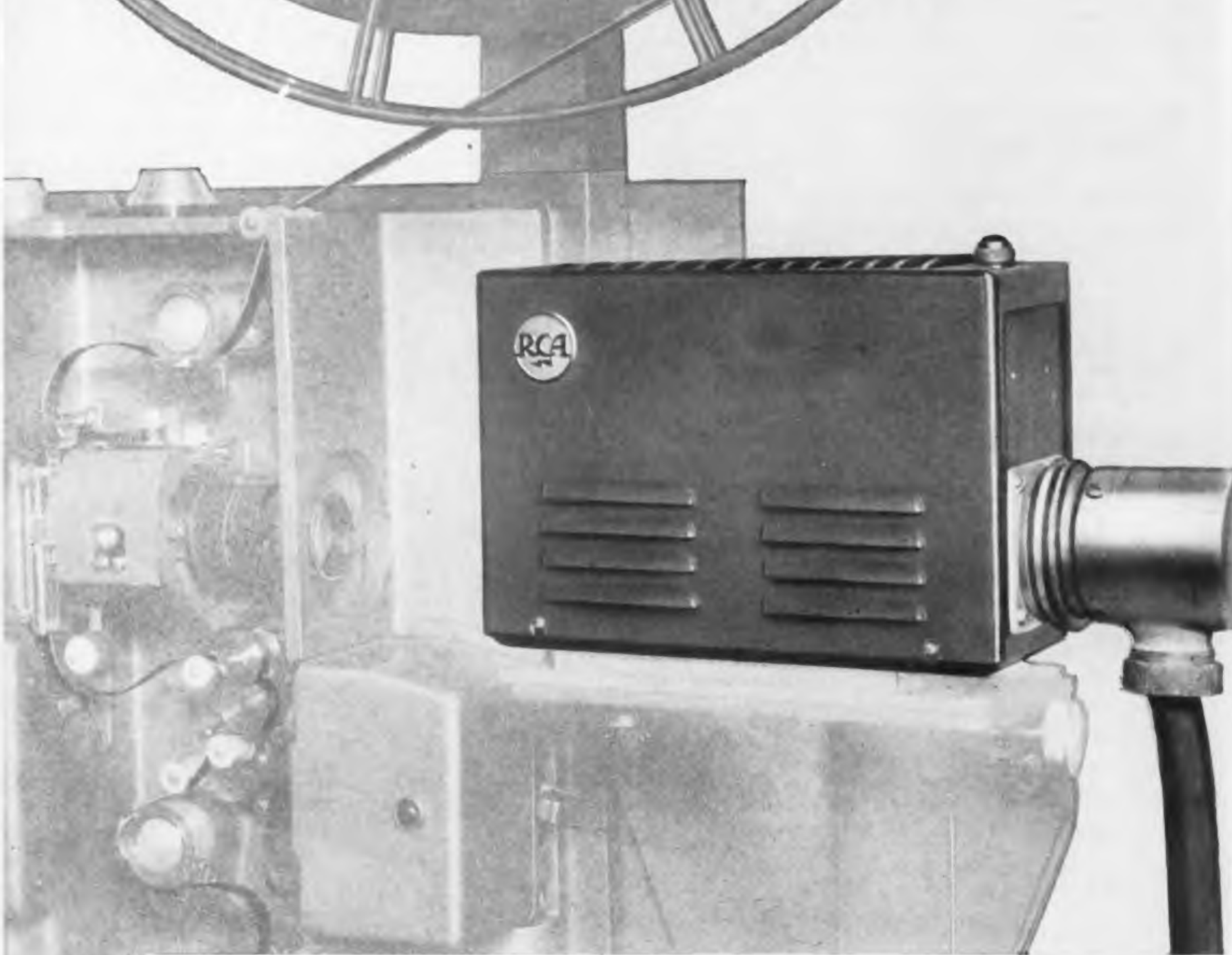
PARAMUS, NEW JERSEY

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

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

NEW VIDICON

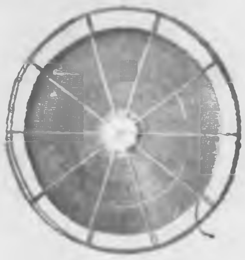
RCA's Superior



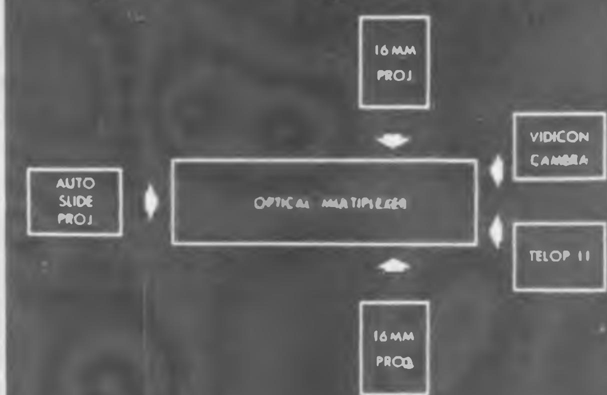
For MULTIPLEXING, or direct use!

RCA's TK-21 Vidicon Film Camera can be used with RCA's Multiplexer, TP-11, for multiple picture inputs (see illustration opposite page). Or, it can be mounted directly on any of the RCA TV Projectors—such as the TP-16, TP-35, or TP-6A (see above).

film-camera

film  camera chain

4 picture sources in multiplexed use!



An RCA Multiplexer, Type TP-11 allows a single Vidicon Camera to accept up to four film picture sources—two 16mm or 35mm film projectors, a TP-3B, 35mm automatic slide projector, and a Telop II slide and opaque projector. The multiplexer is pictured above in a multi-input film system using two RCA TP-6A professional film projectors.

DEVELOPED HAND IN HAND with the new RCA-6326 VIDICON tube, RCA's TK-21 Film Camera does for *film* picture quality what the RCA Image Orthicon Camera has done for *"live"* picture quality.

"Live" picture sharpness!

For unsurpassed picture detail, choose the RCA Vidicon film camera! It's the only film pick-up system with enough signal output (and low enough noise in the signal) to use *aperture response correction.* Aperture response correction brings picture detail to maximum sharpness (detail resolution, 100% at 350 lines) while holding a high signal-to-noise ratio. *Benefit:* You produce finer film pictures . . . with a quality you get from your studio camera.

"Live" picture contrast!

The RCA Vidicon adds "studio" realism to your film pictures. The gamma characteristic of the Vidicon tube is ideal for film reproduction . . . 0.65, constant over a dynamic range of 150 to 1. *Benefit:* You get more realistic film pictures than ever before possible.

Low light source requirements!

The high light sensitivity of the RCA VIDICON film camera enables you to reduce projection lamp voltage, reduce heating, increase lamp life substantially.

Edge-lighting, shading eliminated!

The RCA VIDICON operates entirely without edge-lighting, electrical shading, and any other form of supplemental lighting. Benefit: You adjust "wall focus" and "beam" from day to day . . . *then this camera virtually runs by itself.*

RCA VIDICON Film-Camera Chain TK-21 includes:

- 1 VIDICON Camera MI-26021
- 1 RCA-6326 VIDICON Tube MI-26671
- 1 Control Chassis MI-26061
- 1 Deflection Chassis MI-26081
- 1 Remote Control Panel MI-26241
- 2 WP-33B Power Supplies MI-26085-B
- 1 TM-6B Master Monitor MI-26136-A
- 1 Master Monitor Kinescope MI-26655
- 1 Master Monitor C-R Tube MI-26665
- 1 Blower MI-26579-B
- 1 Console Housing MI-26266-B
- 1 Camera Cable & Connectors MI-26725-A10

For the finest TV film reproduction you've ever seen, specify an RCA VIDICON film-camera system. Ask your RCA Broadcast Sales Representative for technical details. In Canada, write RCA-Victor Ltd., Montreal.

RCA PIONEERED AND DEVELOPED COMPATIBLE COLOR TELEVISION

RCA

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION CAMDEN, N.J.

AS WE GO TO PRESS . . .

PRINTED CIRCUIT TV

New Admiral TV chassis with 21-in., 90° deflection tube also include printed circuits

New Tube Plant

Sylvania has announced construction plans for a 210,000-sq. ft. building in Williamsport, Penna., to function as a centralized packaging and finishing area for the company's Radio Tube Div.

50 KW Transmitter

The TV Transmitter Div. of Allen B. DuMont Labs. has introduced a 50 kw TV transmitter for maximum allowable ERP on channels 7-13. It requires 40% less floor space than other similar units being produced, and features two water-cooled 4W20000A Tetrodes in the final amplifier.

BIG TV FREEZE

This is how the TV antenna atop Mt. Washington, N. H., looks in winter. New installation under construction for station WMTW-TV will employ Caterpillar diesel electric sets to provide power to de-ice tower in the –40° zone

GERMANIUM DIODE INTERCHANGEABILITY CHART

Type & Mfr.	G-E Replacement	Minimum Forward Cur. @ +1V. (MA)	Peak Inverse Voltage (Volts)	Cont. Reverse Voltage (Volts)	Maximum Reverse Cur. (μa) @ −50V	Maximum Reverse Cur. (μa) Other	Remarks
1A (TP)	None	80	5			100 @ −5V 250 @ −15V	Gold bonded diode
1B (TP)	None	30	15			100 @ −5V 250 @ −15V	Gold bonded diode
1C (TP)	None	30	15			100 @ −5V 250 @ −15V	Gold bonded diode
1D (TP)	[illegible]		15 15				60% Rect. Eff. @ 100 Mc
1E (TP)	[illegible]		5 5				75% Rect. Eff. @ 100 Mc
1F (TP)	[illegible]		5 5				40% Rect. Eff. @ 100 Mc
1N34 (S.K.RR)	1N48	5.0 4.0	75 85	60 70	800 833	50 @ −10V	
1N34A (S.A.RCA.RR.NU)	1N58	5.0 4.0	 85	60 70	500 150	30 @ −10V	
1N35 (C.I.Hy.RR)	[illegible]	7.5 4.0	75 85	50 70	 150	10 @ −10V	Matched pair. See Note 1
1N38 (S.K.RR.Hy)	1N70	3.0 3.0	120 125	100 100	 300	6 @ −3V 625 @ −100V 25 @ −10V	
1N38A (S.A.NU.Hy.RR)	1N63	4.0 4.0	 125	100 100	 50	6 @ −3V 500 @ −100V	
1N39A (Hy)	None	3.0	225	200		200 @ −100V 800 @ −200V	
1N39 (S.K)	1N75	1.5 2.5	225 125	200 100	 50	200 @ −100V 800 @ −200V	
1N40 (S)	1N73	12.75 @ +1.5V 15.0 @ +1.7V	75 75	25		40 @ −10V 50 @ −10V	Quad. See Note 2 Quad. See Note 3
1N41 (S)	None						
1N42 (S)	1N73	12.75 @ +1.5V 15.0 @ +1.7V	120 75	50		6 @ −3V 625 @ −100V 50 @ −10V	Quad. See Note 2 Quad. See Note 3
1N43 (WE)	1N69	5.0 5.0	60 75	 60	850 850	20 @ −5V 50 @ −10V	
1N44 (WE)	1N70	3.0 3.0	115 125	 100	1000 300	25 @ −10V	
1N45 (WE)	1N65	3.0 2.5	75 85	 70	410 200		
1N46 (WE)	1N48	3.0 4.0	63 85	 70	1500 833		
1N47 (WE)	1N70	3.0 3.0	115 125	 100	410 300	4 @ −1V 25 @ −10V	
1N48 (GE)		4.0	85	70	833		
1N51 (GE)		2.5	50	40	1667		
1N52 (GE)		4.0	85	70	150		
1N53 (M)	None						Silicon microwave diode
1N54 (S.K.Hy.RR)	1N69	5.0 5.0	75 75	35 60	 850	10 @ −10V 50 @ −10V	
1N54A (S.A.NU.R.Hy.RR)	1N58	5.0 4.0	75 85	50 70	100 150	7 @ −10V	
1N55 (S.K.RR.Hy)	1N75	3.0 2.5	170 125	150 100	 50	300 @ −100V 800 @ −150V	
1N55A (NU.S.RR.Hy.RCA)	1N63	4.0 4.0	170 125	150 100	 50	500 @ −150V	
1N55B (H)	1N63	5.0 4.0	190 125	150 100	 50	500 @ −150V	
1N56 (S.K.Hy)	1N69	15.0 5.0	50 75	40 60	 850	300 @ −30V 50 @ −10V	
1N56A (S.R.Hy.RCA)	1N69	15.0 5.0	50 75	40 60	 850	300 @ −30V 50 @ −10V	
1N57 (S.K)	1N52	4.0 4.0	90 85	80 70	 150	500 @ −75V	
1N58 (S.K.RR.Hy)	1N63	4.0 4.0	120 125	100 100	 50	800 @ −100V	
1N58A (S.A.NU.RR.Hy.RCA)	1N63	4.0 4.0	120 125	100 100	 50	600 @ −100V	
1N60 (S.K.RR)	1N64	 .05 @ +0.25V	30 20	25		25 @ −1.3V	See Note 4 See Note 5
1N61 (K)	1N63	5.0 4.0	140 125	130 100	 50	300 @ −100V 700 @ −125V	
1N63 (GE)		4.0	125	100	* 50		
1N64 (GE)		.05 @ +0.25V	20			25 @ −1.3V	See Note 5
1N65 (GE)		2.5	85	70	200		
1N66 (R)	1N69	5.0 5.0	70 75	60 60	800 850	50 @ −10V 50 @ −10V	
1N67 (R)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ −5V	
1N67A (H)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ −5V	
1N67P (R)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ 5V	

Type & Mfr.	G-E Replacement	Minimum Forward Cur. @ +1V. (MA)	Peak Inverse Voltage (Volts)	Cont. Reverse Voltage (Volts)	Maximum Reverse Cur. (μa) @ −50V	Maximum Reverse Cur. (μa) Other	Remarks
1N37A (N)	None	3.0	40	36		.06 @ −20V	Silicon junc. diode
1N138A (N)	None	5.0	20	18		.01 @ −10V	Silicon junc. diode
1N139 (GE)		20.0	50	40	1500		Gold bonded diode
1N140 (GE)		40.0	85	70	300		Gold bonded diode
1N141 (GE)		20.0	85	70	50		Gold bonded diode
1N142 (GE)		5.0	125	100		100 @ −100V	Gold bonded diode
1N143 (GE)		40.0	125	100		100 @ −100V	Gold bonded diode
1N147 (C)	G7A	10.0 @ 0.75V 0.8 @ +0.5V	2 5			800 @ −0.5V	UHF mixer. See Note 6
1N148 (Hy)	G7E	0.26 @ 0.25V 0.8 @ +0.5V	20 5	15		350 @ −10V 800 @ −0.5V	Harmonic generator diode
1N150 (M)	None						Silicon microwave diode
1N151 (GE)		1570 @ +0.7V	100	30		2400 @ −100V	
1N152 (GE)		1570 @ +0.7V	200	65		1900 @ −200V	
1N153 (GE)		1570 @ +0.7V	300	100		1900 @ −300V	
1N155 (S)	None						Silicon microwave crystal
1N155A (S)	None						Silicon microwave crystal
1N158 (GE)		1570 @ +1.4V	380	185		800 @ −380V	
1N160 (M)	None						Silicon microwave diode
1N175 (NU)	None	20.0		200	50	200 @ −200V	Small area diode
1N191 (H)	None	5.0		90	125 (55° C.)	25 @ −10V (55° C.)	Computer type
1N192 (H)	None	5.0		70	250 (55° C.)	50 @ −10V (55° C.)	Computer type
1N193 (S)	None	1.0 @ +2.0V		40 (150° C.)		50 @ −40V	Silicon whisker diode
1N194 (S)	None	1.5 @ +2.0V		40 (150° C.)		60 @ −40V	Silicon whisker diode
1N195 (S)	None	2.0 @ +2.0V		40 (150° C.)		80 @ −40V	Silicon whisker diode
1N196 (S)	None	1.0 @ +2.0V		40 (150° C.)		40 @ −40V	Silicon whisker diode
600 (T)	1N81	3.0 3.0	30 50	 40		1 @ −1V 8 @ −10V 10 @ −10V	Silicon Junction diode
601 (T)	None	3.0	50			.01 @ −1V .04 @ −40V	Silicon Junction diode
CG2 E (BTH)	None	1.0	150		2.5		
CG5 E (BTH)	None	2.8	40			0.2 @ −10V	
CG6 E (BTH)	1N65	2.0 2.5	70 85	 70	 200	50 @ −10V	
CG8 C (BTH)	None	4.0	15			1.5 @ −3V 2.0 @ −10V	
CG10 E (BTH)	1N65	2.0 2.5	100 85	 70	250 200	50 @ −10V	
CG12 E (BTH)	1N64	3.0 .05 @ +0.25V	25 20			400 @ −10V 25 @ −1.3V	
CK705 (R)							Same as 1N66
CK705A (R)	1N69	5.0 5.0	70 75	60 60	800 850	10 @ −10V 50 @ −10V	
CK705 P (R)	1N69	5.0 5.0	70 75	60 60	800 850	50 @ −10V 50 @ −10V	
CK706-P (R)	1N64	 0.05 @ +0.25V	50 20	40		200 @ −10V 25 @ −1.3V	See Note 5
CK706 (R)	1N64	 .05 @ +0.25V	50 20	40		200 @ −10V 25 @ −1.3V	See Note 7 See Note 5
CK707 (R)	1N58	3.5 4.0	100 85	80 70	100 150	10 @ −5V	
CK707 P (R)	1N58	3.5 4.0	100 85	80 70	100 150	10 @ −5V	
CK708 (R)							Same as 1N68
CK708-P (R)	1N75	3.0 2.5	120 125	100 100	 50	625 @ −100V	
CK709 (R)	1N73	15.0 @ +1.7V	75			50 @ −10V	Quad, See Note 8 Quad, See Note 3
CK710 (R)	G7A	3 @ +0.5V	10	5		200 @ −6V	See Note 9 See Note 6
CK711 (R)	1N73	15 @ +1.7V	75	80	30	50 @ −10V	Quad, See Note 10 Quad, See Note 3
CK712 (R)	1N75	2.0 2.5	225 125	200 100	 50	800 @ −200V	
CK713 (R)	1N58	21 @ +2.0V 4.0	75 85	75 70	 150	250 @ −40V	
CK713A (R)	1N58	21.0 @ +2.0V 4.0	85 85	70 70	 150	250 @ −40V	
CK713A-P (R)	1N52	21.0 @ +2.0V 4.0	85 85	70 70	 150	250 @ −40V	
CK715 (R)	G7E	0.8 @ +.5V	5	40		800 @ −.5V	Frequency Mult. Frequency Mult.
CK715-P (R)	[illegible]	0.8 @ +0.5V	5	40		[illegible]	Frequency Mult.
CK731 (R)	G7E	0.8 @ +0.5V	5			[illegible]	See Note 6
CK739 (R)	None	100 @ +0.8V	60	50	20	2 @ −10V	Gold bonded diode

1N67 (R)		4.0	100	80	50	5 @ −5V	
	1N63	4.0	125	100	50		
1N67A (H)		4.0	100	80	50	5 @ −5V	
	1N63	4.0	125	100	50		
1N67P (R)		4.0	100	80	50	5 @ 5V	
	1N63	4.0	125	100	50		
1N68A (H)		3.0	130	100		625 @ −100V	
	1N75	2.5	125	100	50		
1N68 (R)		3.0	120	100		625 @ −100V	
	1N75	2.5	125	100	50		
1N69 (GE)		5.0	75	60	850	50 @ −10V	JAN type
1N70 (GE)		3.0	125	100	300	25 @ −10V	JAN type
1N71 (S.Hy)	None						Quad
1N72 (GE)		0.8 @ +5V	5			800 @ −5V	See **Note 6**
1N73 (GE)		15.0 @ +1.7V	75			50 @ −10V	Quad, See **Note 3**
1N74 (GE)		15.0 @ +1.8V	75			50 @ −10V	Quad, See **Note 3**
1N75 (GE)		2.5	125	100	50		
1N76							Silicon diode
1N77	None						Photo diode
1N78 (M)	None						Silicon diode
1N79 (S)	None						Silicon diode
1N81 (GE)		3.0	50	40		10 @ −10V	JAN type
1N82 (S.Hy)							UHF Mixer
	G7A	0.8 @ +5V				800 @ −5V	See **Note 6**
1N82A (S)				5			Silicon UHF Mixer
	G7A	0.8 @ +0.5V				800 @ −0.5V	diode. See **Note 6**
1N86 (A)		4.0	85	70	833	50 @ −10V	
	1N48	4.0	85	70	833		
1N87 (A)			30	25			See **Note 11**
	[illegible]	.05 @ +0.25V	20			25 @ −1.3V	See **Note 5**
1N88 (A)		2.5	100	85	100		
	[illegible]	4.0	85	70	150		
1N89 (H)		3.5	100	80	100	8 @ −5V	
	[illegible]	4.0	85	70	150		
1N90 (H)		5.0	75	60	800		
	[illegible]	5.0	75	60	850	50 @ −10V	
1N91 (GE)		470 @ +0.5V	100	30		2700 @ −100V	Diffused Junction Rectifiers
1N92 (GE)		310 @ +0.5V	200	65		1900 @ −200V	
1N93 (GE)		250 @ +0.5V	300	100		1200 @ −300V	
1N94 (GE)		1570 @ +0.7V	380	185		800 @ −380V	
1N95 (H)		10.0	75	60	800		
		5.0	75	60	850	50 @ −10V	
1N96 (H)	None	20.0	75	60	800		
1N97 (H)	None	10.0	100	80	100	8 @ −5V	
1N98 (H)	None	20.0	100	80	100	8 @ −5V	
1N99 (H)	None	10.0	100	80	50	5 @ −5V	
1N100 (H)	None	20.0	100	80	50	5 @ −5V	
1N106 (NU)		20.0		300		70 @ −100V	Gold bonded
	None					200 @ −300V	
1N107 (NU)	None	150.0		10		200 @ −10V	Gold bonded
1N108 (NU)	None	50.0		50		200 @ −50V	Gold bonded
1N109 (Hy)		0.26 @ 0.25V	20	15		350 @ −10V	Harmonic
	G7E	0.8 @ +0.5V	5			800 @ −0.5V	generator diode
1N110 (RR)							See **Note 12**
	G7A	0.8 @ +5V				800 @ −5V	See **Note 6**
1N111		5.0	70		125	25 @ −10V	Computer type
(S,RR,Hy)	[illegible]	4.0	85	70	150		
1N112		5.0	70		250	50 @ −10V	Computer type
(S,RR,Hy)	[illegible]	4.0	85	70	150		
1N113		2.5	70		125	25 @ −10V	Computer type
(S,RR,Hy)	[illegible]	4.0	85	70	150		
1N114		2.5	70		250	50 @ −10V	Computer type
(S,RR,Hy)	[illegible]	2.5	85	70	250		
1N115		2.5	70		500	100 @ −10V	Computer type
(S,RR,Hy)	[illegible]	2.5	85	70	250		
1N116 (H)		5.0	75	60	100		
	[illegible]	4.0	85	70	150		
1N117 (H)	None	10.0	75	60	100		
1N118 (H)	None	20.0	75	60	100		
1N124 (L)		10 @ +0.75V	2				UHF mixer
	[illegible]	0.8 @ +0.5V	5			800 @ −0.5V	See **Note 6**
1N124A (L)		10 @ +0.75V					UHF mixer
	[illegible]	0.8 @ +0.5V				800 @ −0.5V	See **Note 6**
1N125 (Hy)		.05 @ +0.25V	30			25 @ −1.3V	
	[illegible]	.05 @ +0.25V	20			25 @ −1.3V	See **Note 5**
1N126 (H)		5.0	75	60	850	50 @ −10V	JAN type
	[illegible]	5.0	75	60	850	50 @ −10V	JAN type
1N127 (H)		3.0	125	100	300	25 @ −10V	JAN type
	[illegible]	3.0	125	100	300	25 @ −10V	JAN type
1N128 (H)		3.0	50	40		10 @ −10V	JAN type
	[illegible]	3.0	50	40		10 @ −10V	JAN type
1N133 (Hy)		3.0 @ +0.5V	6			300 @ −0.6V	UHF mixer
	G7E	0.8 @ +0.5V	5			800 @ −0.5V	See **Note 6**
1N135 (Hy)		5.0	75		850	50 @ −10V	
	[illegible]	5.0	75	60	850	50 @ −10V	

CK715 (R)				40			Frequency Mult.
	G7E	0.8 @ +5V	5			800 @ −5V	Frequency Mult.
CK715-P (R)				40			Frequency Mult.
	[illegible]	0.8 @ +0.5V	5			800 @ −0.5V	[illegible]
CK731 (R)	[illegible]	0.8 @ +0.5V	5			800 @ −0.5V	See Note 6
CK739 (R)	None	100 @ +0.8V	60	50	20	2 @ −10V	Gold bonded diode
CK742 (R)	None	100 @ +1.0V	125	100		5 @ −10V	Gold bonded diode
						20 @ −100V	
CV425 (BTH)		4.0	65		1000		
	1N48	4.0	85	70	833		
CV442 (BTH)		3.0	25			1000 @ −10V	
						25 @ −1.3V	
	[illegible]	.05 @ +0.25V	20				
CV448 (BTH)		3.0	80		100		
	[illegible]	4.0	85	70	150		
G1CA (IRC)		1.0	125		50		
	[illegible]	2.5	125	100	50		
G1HA (IRC)		1.0	85		500		
	[illegible]	2.5	85	70	250		
HS133 (Hy)				5			UHF Silicon Mixer
	G7A	0.8 @ +0.5V	5			800 @ −0.5V	diode. See **Note 6**
NU34 (NU)		5.0	75	65	800	50 @ −10V	
	[illegible]	5.0	75	60	850	50 @ −10V	
NU38 (NU)		3.0	120	100		6 @ −3V	
						625 @ −100V	
	1N70	2.5	125	100	300	25 @ −10V	
						200 @ −100V	
NU39 (NU)	None	1.5	225	200		800 @ −200V	
NU58 (NU)		4.0	120	100		800 @ −100V	
	[illegible]	4.0	125	100	50		
S4 (TR)	None	1.0	50	40		1 @ −10V	Silicon diode
S5 (TR)	None	1.0	50	40		0.1 @ −10V	Silicon diode
S6 (TR)	None	4.0	22	20		0.5 @ −5V	Silicon diode
T1 (TR)		20.0	50	40	1500		Gold bonded diode
	1N139	20.0	50	40	1500		Gold bonded diode
T2 (TR)		40.0	85	70	300		Gold bonded diode
	1N140	40.0	85	70	300		Gold bonded diode
T3 (TR)		20.0	85	70	50		Gold bonded diode
	1N141	20.0	85	70	50		Gold bonded diode
T4 (TR)		5.0	125	100		100 @ −100V	Gold bonded diode
	1N142	5.0	125	100		100 @ −100V	Gold bonded diode
T5 (TR)		40.0	125	100		100 @ −100V	Gold bonded diode
	[illegible]	40.0	125	100		100 @ −100V	Gold bonded diode
TP34A (TP)		5.0	75	60	500	30 @ −10V	
	[illegible]	4.0	85	70	150		
TP38A (TP)		4.0	120			5 @ −3V	
	[illegible]	4.0	125	100	50	500 @ −100V	
TP39 (TP)		1.5	225	200		200 @ −100V	
	None					800 @ −200V	
TP52 (TP)		4.0	85	70	150		
	[illegible]	4.0	85	70	150		
TP55 (TP)		3.0	170	150		300 @ −100V	
	[illegible]	2.5	125	100	50	800 @ −150V	
TP55A (TP)		4.0	170	150		500 @ −150V	
	[illegible]	4.0	125	100	50		
TP63 (TP)		4.0	125	100	50		
	[illegible]	4.0	125	100	50		
X-16 (TP)	G7E	0.8 @ +0.5V	5			800 @ −0.5V	Harmonic generator

Note 1: Forward resistances matched within 10% at +1V.
Note 2: Four diodes in tube shell with forward resistances balanced within +2.5% at +1.5V. Forward resistances of each pair matched within 3 ohms.
Note 3: Four diodes in hermetically sealed tube shell. Forward resistances matched within 6.7 ohms for 1N73 and 13.4 ohm for 1N74 at 15 MA. Forward resistances of each pair matched within 2 ohms for 1N73 and 6.7 ohms for 1N74 at 15 Ma.
Note 4: Tested with 1.8V. RMS input at 40 Mc, 70% modulated at 400 cycles. Minimum output is 1.8V. peak-to-peak across 4700 ohms shunted by 5 MMF.
Note 5: Tested with 0.1V. RMS, 44 Mc input to last I.F. grid. Minimum output is 330 ua through 3600 ohms shunted by 5 MMFD.
Note 6: Maximum conversion loss is 9.6 db measured at 900 Mc with 0.7 Mw L.O. level and d-c forward bias from a 0.25V., 250 ohm source.
Note 7: Tested with 0.1V. RMS, 50 Mc input to last I.F. grid. Minimum output is 330 ua through 5100 ohms shunted by 5 MMFD.
Note 8: Four diodes in tube shell with forward resistances matched within 2.5%. At −10V. diodes are matched 2.5% or all have a resistance greater than 1.0 meg ohm.
Note 9: Typical noise temperature ratio of 2.
Note 10: Four diodes in tube shell. Each pair of diodes is shunted by 10,000 ohms center tapped and the center tap of resistor and diodes connected by a microammeter. With 0 to +3V. dc applied unbalance current limit is 5 MA.
Note 11: Tested with 5V. peak input at 30 Mc. Output voltage across 3900 ohm load resistance must yield minimum rectification efficiency of 60%.
Note 12: Noise figure 12 db @ 750 Mc with 43.5 Mc I.F. circuit having 3 Mc noise bandwidth and 4 db noise figure.

*For additional information, contact General Electric Company, Electronics Park, Syracuse, New York, or your nearest G-E Tube Representative

For additional information, contact General Electric Company, Electronics Park, Syracuse, New York, or your nearest G-E Representative.

A—Amperex
G—Federated Semi-conductor
GE—General Electric
H—Hughes
Hy—Hytron
K—Kemptron
M—Microwave Associates
N—National Semi-conductor Products
NU—National Union
RR—Radio Receptor
R—Raytheon
RCA—RCA
S—Sylvania
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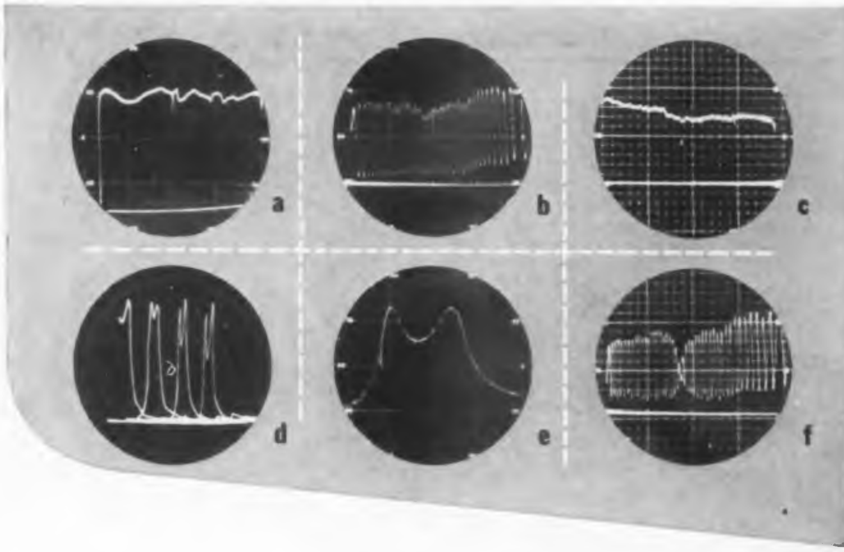
For detailed information on any of these G-E products or a free file copy of the above chart, write: *General Electric Company, Section X4874, Electronics Park, Syracuse, N. Y.*

GENERAL ELECTRIC



470 to 890 MC. CHARACTERISTICS TAKEN WITH 2144-02 GENERATOR

a) Detected output of sweep generator, showing marker at 650 mcs.

b) VSWR display of unterminated transmission line.

c) VSWR display of terminated transmission line.

d) Preselector responses of UHF tuner at channels 14, 20, 30 and 40.

e) Preselector response of tuner at channel 50, expanded on scope.

f) Input VSWR display of tuner at channel 50.

3 Stock models cover 225 to 420 mc. 470 to 890 mc. and 850 to 1275 mc. Special ranges on request.

now sweep over 400 mc. at UHF without tuning

New Kollsman TYPE 2144 Wide Range Sweep Generator

SPECIFICATIONS

Frequency Range	2144-01	225 to 420 mc.
	2144-02	470 to 890 mc.
	2144-03	850 to 1275 mc.
Minimum Power Output		10 milliwatts
Output Impedance		50 ohms
Maximum Source VSWR		1.25
Amplitude Linearity		± 1 db.
Marker Frequency Calibration		5 mc.
Marker Frequency Accuracy	2144-01	± 1 mc.
	2144-02	± 1.5 mc.
	2144-03	± 2 mc.
Sweep Rate		60 cycle
Tube Complement		6AF4, 6J6, OA2, 6X4
Primary Power		117 volts, 60 cycles, 60 watts

Also Available—Step Attenuator TYPE 2171-01

SPECIFICATIONS

Insertion Loss	Less than ½ db.
Attenuation Steps	0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, 70, db.
Frequency Range	DC to 1000 mc.
Maximum VSWR	1.2
Other Attenuation Steps Available	

THE TYPE 2144 SWEEP GENERATOR SIMPLIFIES LABORATORY AND PRODUCTION MEASUREMENTS

- Instantaneous display of frequency response, impedance or VSWR over 400 mc. without test equipment adjustment.
- Simultaneous observation of desired and spurious receiver responses.
- Display antenna characteristics over entire operating band.

WITH THESE DESIRABLE FEATURES

- 50 ohm output.
- Low source VSWR and amplitude non linearity.
- Passive variable marker for stable, accurate frequency indication, with easily read dial.
- Oscilloscope horizontal sweep signal and base line retrace blanking.
- 60 cycle sweep rate for easy observation.
- Voltage regulation minimizes effect of line voltage variation.
- Uses only standard plug in tubes.

Write FOR COMPLETE INFORMATION ON KOLLSMAN TYPE 2144 SWEEP GENERATORS AND TYPE 2171 ATTENUATORS.

kollsman INSTRUMENT CORP.

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NEW! PORTABLE DIRECT READING SPECTRUM ANALYZER

- **10 TO 22,000 MCS**
- **ONLY 3 R. F. HEADS**
- **SINGLE DIAL TUNING**

Model No.	Equipment
Model TSA	Spectrum Display and Power Supply
Model STU-1	R-F Tuning Unit 10-1,000 mc.
Model STU-2	R-F Tuning Unit 910-4,560 mc.
Model STU-3	R-F Tuning Unit 4,370-22,000 mc.

SPECIFICATIONS:

Frequency Range: 10 mc to 22,000 mc

Frequency Accuracy: 1%

Resolution: 20 kc

Frequency Dispersion: Electronically controlled, continuously adjustable from 50 kc/in. to 7 mc/in.

Input Impedance: 50 ohms

Over-all Gain: 120 db

Attenuation: RF...Internal: 120 db continuously variable; IF...60 db continuously variable

Input Power: 400 watts

Now, a new Polarad spectrum analyzer only 21 inches high that covers the entire frequency range 10 to 22,000 mcs with but 3 interchangeable R–F tuning heads. The model TSA operates simply—single dial frequency control—with utmost frequency stability. It provides highest accuracy, and reliability for observation and true evaluation of performance over the entire R–F spectrum—saving engineering manhours.

This instrument is designed for maximum utility and versatility in the laboratory and on the production line providing an easy-to-read 5 inch CRT display of the R–F spectrum.

The model TSA Spectrum Analyzer has these exclusive Polarad design and operating features:

- Single frequency control with direct reading dial. No klystron modes to set. Tuning dial accuracy 1%.
- Only three interchangeable R–F tuning units for the entire frequency range 10 to 22,000 mcs.
- Temperature compensation of Klystron Oscillator.
- Swept IF provides 250 kc to 25 mc display independent of R–F frequency setting.
- Internal R–F attenuator.
- Frequency marker for measuring frequency differences from 100 kc to 25 mc.

Write today to your nearest Polarad representative, or directly to the factory for complete information.

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MAKE VICTOREEN YOUR SOURCE for GLASS-SEALED RESISTORS

and be Assured of ACCURACY, RELIABILITY and LONG LIFE

Victoreen RX series resistors are the deposited carbon type. The element is glass-sealed in an envelope containing an inert gas. Longest possible life and greatest stability are obtained by this method of construction which seals out all dust, fumes, and smoke. Greater ratio of wattage to element is also obtained. The RX-2 and RX-3 series are recommended for high voltage applications. All RX series resistors are available in a wide range of ratings and characteristics.

Victoreen Hi-Meg resistors are vacuum-sealed in a glass envelope. Controlled aging under rigid conditions stabilizes resistor characteristics. Accurate, reliable functioning under extremes of environmental stress make them especially suitable for circuits where accurate measurement at high impedance levels are required. They are available in a variety of ratings and characteristics.

For precision applications use precision resistors. A catalog on resistors and our full line of components is always available upon your request.

The Victoreen Instrument Co.

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INDUSTRY NEWS

Richard J. Flynn has been appointed legal counsel for the TV and Radio Operations of the Raytheon Mfg. Co., 5921 W. Dickens Ave., Chicago. Previous to this appointment Flynn had been located at the main Raytheon offices in Waltham, Mass.

Robert L. Peavy, John C. Hebron, and **Paul T. Grant** have been appointed contract engineering representatives at Kollsman Instrument Corp., Elmhurst, N.Y., manufacturers of aircraft and optical instruments. Mr. Peavy was formerly Quality Control Representative for the U.S.A.F. at Kollsman. Both Hebron and Grant are former Navy pilots with extensive command experience.

Neal F. Harmon was recently promoted to sales manager for mobile communication equipment at G.E.'s Commercial Equipment Dept., Syracuse, N.Y. Other G.E. promotions were **Edwin W. Kenefake** to sales manager for microwave equipment and **James D. Helm** to sales manager for special accounts.

Kenneth J. Shea was elected vice-pres. of sales for the international division of Minnesota Mining and Mfg. Co. His new responsibilities include general sales administration of all foreign subsidiaries, European export sales and supervision of all international product sales managers.

Joseph Weinberg, former head of the purchasing department of Boonton Radio Corp., has been named purchasing agent for Industrial Television Inc., Clifton, N.J.

Daniel Newman, who was formerly field service manager for Dumont Labs., is the new asst. director of service for CBS-Columbia, the TV and radio receiver manufatcuring division of CBS Inc. He will be responsible for operations of district service managers, customer relations and supervision of the technicians training program.

John F. Meagher, general manager of KYSM-AM-FM, Mankato, Minn., has been named vice-pres. in charge of Radio (AM-FM) for the N.A.R.T.B. In his new office, he will represent the interests of the AM and FM members of the association, with responsibility for liaison with State broadcasting associations.

R. E. Holbein has been promoted to service parts manager of the TV and Broadcast Receiver Div., Bendix Aviation Corp. He has been with Bendix since 1940.

WHY generate when you can convert?

GET DC DIRECTLY FROM AC

Cut costs, maintenance and replacements with

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SELENIUM RECTIFIER EQUIPMENTS

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FEDERAL'S FTR-3152-AS POWER SUPPLY

NO costly, bulky, moving equipment to buy . . . no expendable parts to replace frequently . . . virtually no maintenance!

No wonder Federal's compact, silent, rugged, ever-dependable selenium rectifiers are the economical and efficient way to get DC . . . for chucks, brakes, clutches, drums, pulleys, relays, circuit-breakers, motors and many other applications . . . for all DC needs of the machine tool industry.

Federal Equipments are ready to connect to your AC source . . . ready to deliver uninterrupted service. Powered by Federal's completely inert selenium rectifiers, their life is practically unlimited. All are conservatively rated . . . with a wide margin of safety to withstand momentary heavy overloads.

If the DC output you need is not listed in the table, Federal will gladly design and build to meet any specific requirements. Fill out and mail the attached coupon today!

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CODE NUMBER	A-C INPUT			D-C OUTPUT	
	VOLTS	PHASE	CYCLES	VOLTS	AMPS.
FTR 3115-JS	115	1	50/60	115	1
FTR 3116-BS	115	1	50/60	115	5
FTR 3117-HS	115.	1	50/60	115	10
FTR 3117-JS	230	1	50/60	115	10
FTR 3152-AS	220 or 440	3	50/60	115 230	4.4 2.2
FTR 3153-AS	220 or 440	3	50/60	115 230	6.6 3.3
FTR 3154-AS	220 or 440	3	50/60	115 230	8.8 4.4
FTR 3155-AS	220 or 440	3	50/60	115 230	13 6.5
FTR 3228-BS	220 or 440	3	50/60	115 230	26 13

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TELE-TIPS

SOVIET ATTACKS on American scientists appear on the upgrade. The Univ. of Chicago reports that several of its professors are accused of the vague crime of cosmopolitanism, among other things. It's probably all a case of guilty conscience, since the Soviets have been pirating several books written by the slandered American scientists.

ALL-ELECTRONIC ORCHESTRA reproduces the presence of an actual orchestra with astounding realism. In one demonstration, a Pentron Dynacord tape recorder played six high-fidelity channels recorded on ¼-in. tape through a University loudspeaker system. Each of six speakers reproduced a separate musical instrument, and was positioned as musicians would be in a normal orchestra.

"RELIANCE on electronics is now so great that it has reached the stature of a weapon and takes its place with men, food and ammunition as a factor in determining the capabilities and effectiveness of our forces."—Brig. Gen. Preston Corderman, Sig. Corps.

RAILROAD DRAGNET using two-way radio accounted for capture of two prisoners riding an eastbound freight train after escape from midwestern reformatory. For everyday usage, 145 FCC-licensed railroads are operating 10,000 radio and inductive carrier transmitters. Number of authorized installations is 16,792 (10% inductive carrier), double that of two years ago.

EUROVISION set-up during June linked Britain, France, Germany, Italy, Denmark, Holland, Belgium and Switzerland in exchange of 18 TV programs. Experiment involves 44 transmitters, 80 relay stations, and standards conversion equipment.

ELECTRONIC TYPEWRITER recently developed is equal to output of 300 typists. Unit made by Shepard Labs types 120-character line at speed of 15 lines/sec., or 1800 characters/sec. Operation includes decoder which triggers hammers electronically.

(Continued on page 38)

CAREFUL, MAESTRO, DON'T FIDDLE AWAY YOUR REPUTATION!

Yes, you can make one false note and be all washed up . . . with the name you've spent years building, quickly consigned to oblivion. We at Kester know the importance of consistency . . . make sure that the solder alloy and especially the flux formula never varies, never changes. Kester never experiments at the expense of the solder user!

For best results in efficient, economical soldering, remember this Solder Trio: "44" Resin, "Resin-Five" and Plastic Rosin—all made by KESTER . . . Key Name in Flux-Core Solder for More Than 50 Years.

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TELE-TIPS

(Continued from page 34)

SPOTS BEFORE ITS "EYES" are detected electronically by new RCA phototube designed for industrial inspection of liquids. It reacts only to pulses of light caused by particles in motion.

WIN A FORD SEDAN, offered as first prize in the Selenium Diode Contest, sponsored by International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. Also, 50 secondary prizes totaling $1500 will be awarded for best new applications of selenium diodes. Deadline is Jan. 1, 1955.

NON-ROYALTY FILMS for TV are listed in directory of nearly 3000 films available to stations. It may be obtained for $6 from Iowa State College Press, Press Bldg., Ames, Iowa.

INFRARED techniques aid law enforcement, reports J. Edgar Hoover in the Perkin-Elmer *Instrument News.* Spectrograms can check small quantities of substances too minute for chemical analysis.

CARD SHARPS are put on the spot by closed circuit TV system installed in Las Vegas gambling casino. Ten gaming tables are monitored at a central office. Investment in TV is most worthwhile, considering that a major gambling establishment loses an average of $100,000 annually to dishonest sharpers who mark cards and use loaded dice.

LOUD CRASH heard when U. of Calif. first tested its bevatron (which has a 10,000-ton magnet, is 135 ft. outside diameter, and accelerates particles to 25 billion electron volts) proved startling, to say the least. Investigation showed that every loose piece of iron in the building had become magnetized, and had moved abruptly to accommodate the powerful magnetic field.

R-F INTERFERENCE from high-voltage power lines is overcome in Sweden by using the disturbing line itself as a transmitting antenna. The transmitter connected to the power line is chosen so that the signal level of the broadcast by the line exceeds the interference level, thereby making the disturbance practically inaudible.

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Camera boom is raised and lowered smoothly, quietly, effortlessly, automatically by hydraulic system. Extreme high and low lens heights are readily achieved even when dolly is in motion.

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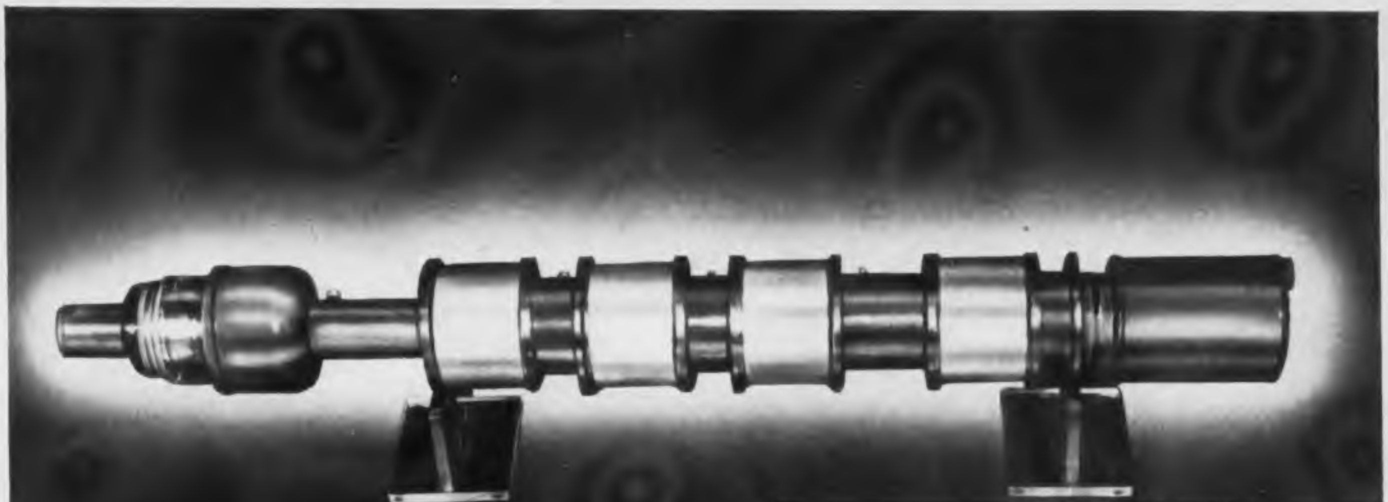
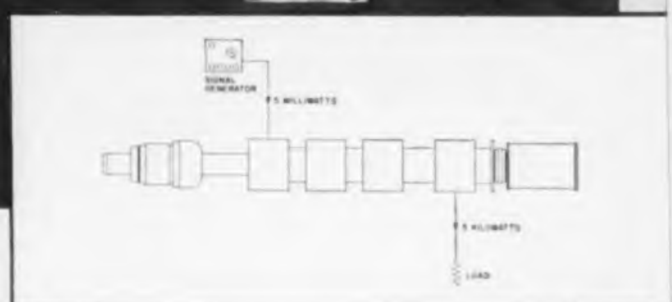
Eimac Klystron Report X561

- **Power gain of one million**
- **5kw power output at 650mc**

four cavity klystron





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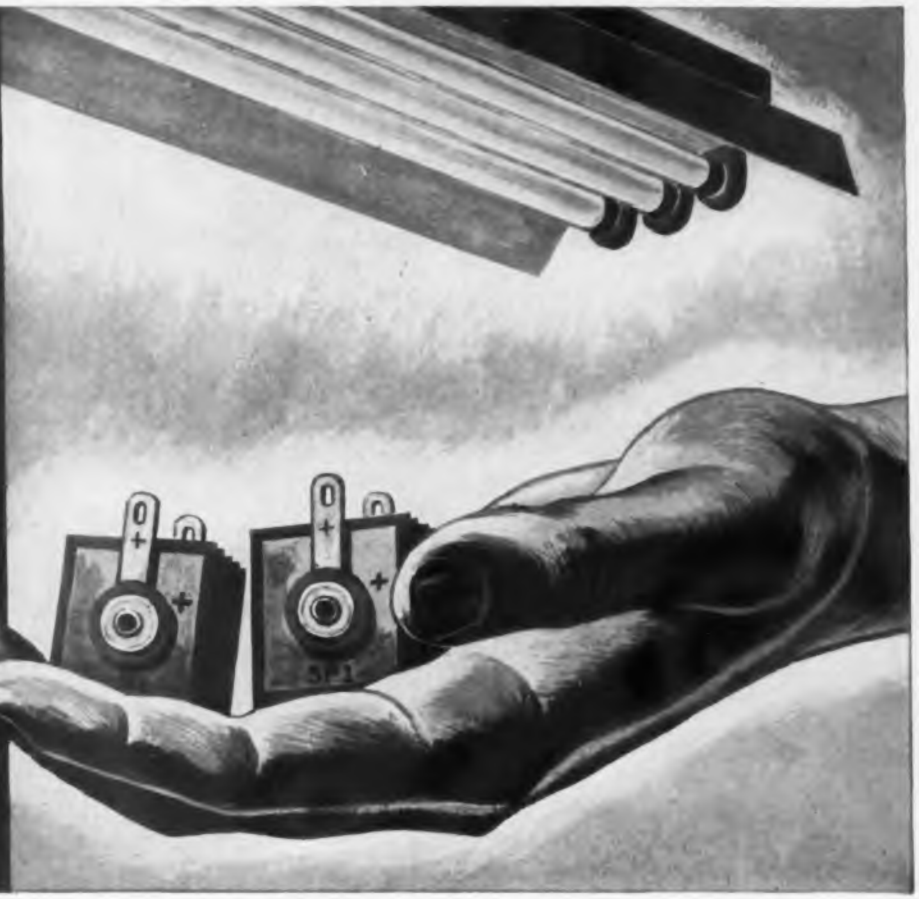
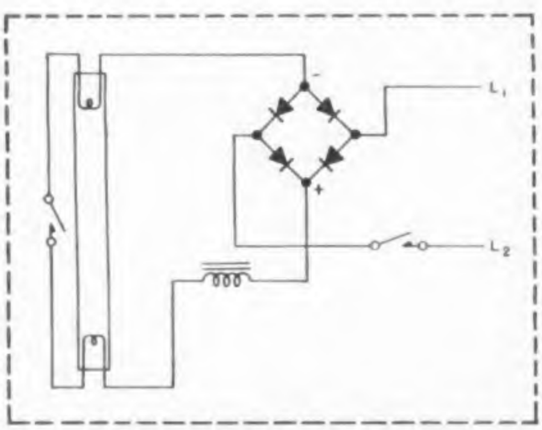


SELENIUM RECTIFIERS



Circuit for eliminating fluorescent flicker in 25 cycle and universal operation, as used in "Noflik" lights.

PLACED IN BRILLIANT LIGHT BY SPECIAL FLUORESCENT FIXTURES

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Canadian Fluorescent, which has licked the flicker in 25 cycle fluorescent lighting with its "Noflik" fixtures, uses four half wave radio type RRco. selenium rectifiers and a specially designed ballast.

Radio Receptor rectifiers as well as RRco. germanium transistors and diodes are *"Really Reliable."* Find out for yourself. If you have a problem where these fine components could be used, make sure to ask us for engineering data. We'll gladly supply it without obligation . . . And request our comprehensive new 24 page rectifier bulletin No. 177-T.

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For a completely sealed connector, select the AN - "E" Series with resilient inserts. **"Interfacial sealing"** around each contact assures a completely sealed continuous conductor from cable to cable. Other resilient moisture resisting AN type series are AF, 1, AO.

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BOOKS

Motion Picture and Television Almanac 1953-54

Edited by Charles S. Aaronson. Published 1954 by Quigley Publishing Co., New York. 1056 pages. Price $5.00

The twenty-fifth annual volume in the series of fact-filled, authoritative compilations on the personalities and particulars of the motion picture and television fields, this edition finds increasing space being devoted to the latter.

Of particular interest to the engineering profession is a complete listing of TV stations throughout the country, with mailing addresses, and a list of TV channel allocations. Also included is a complete reprint of the Television Code for Broadcasters and a review of the top management and engineering personnel of the major networks. CMM

Optical Image Evaluation

Compilation of the discussions and papers presented at the symposium on the Evaluation of Optical Imagery, held Oct. 18-20, 1951, under the auspices of the National Bureau of Standards. Published as NBS Circular 526 by the Government Printing Office, Washington 25, D.C. 289 pages. Price $2.25.

The field of applied optics, or more particularly, geometric optics, has long been handicapped by its lack of standardization. To a very great extent, it has remained an art which varied from one craftsman or engineer, to another. The symposium, from which resulted this series of papers, was planned to coordinate recent discoveries in the field of optics, and in general, to place image evaluation on a more sound engineering basis. CMM

BOOKS RECEIVED

Table of Secants and Cosecants to Nine Significant Figures at Hundredths of a Degree

Prepared by the National Bureau of Standards as part of the NBS Applied Mathematics Series 40. Published 1954 by the Government Printing Office, Washington 25, D. C., 46 pages. Price 35¢. Fulfilling the recent demand for many-figure tables of the trigonometric functions with the argument in decimal division of a degree, this publication will serve as a useful companion to the previously published table of sines and cosines to fifteen decimal places. The values were obtained from those of the sine and cosine by division performed on punched-card equipment carrying ten significant figures and rounding to nine.

Effective Radio Ground-Conductivity Measurements in the U. S.

By R. S. Kirby, J. C. Harman, F. M. Capps, and R. N. Janes. Published as NBS Circular 546 by the Government Printing Office, Washington 25, D. C. 87 pages. 84 maps. Price 65¢. Over the past seven years the NBS has compiled these detailed maps showing the results of effective ground-conductivity measurements made by various broadcasters and consulting engineers throughout the U. S. A study of over 7,000 determinations was made in the standard A.M. broadcast band to see if there was a relationship between effective ground conductivity and surface soil composition, the theory upon which all previous maps had been drawn up. This publication points out that little association exists between the ground-conductivity and the type of soil.

For product information, use inquiry card on last page.

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TRANSMISSION TEST EQUIPMENT

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1071-AR WINDOW GENERATOR (Variable) Determines ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.

1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC) Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.

New Telechrome equipment designed to provide test signals for precise checking of video facilities.

This equipment is now in use by major networks, TV stations, and the Bell Telephone System. This type of equipment was recently described by H. Gronberg of NBC before the NARTB Engineering Conference in Chicago. These units are available individually or as an integrated system with 75 ohm or 110 ohm balance output.

OSCILLOSCOPE CAMERA

MODEL 1521-AR (Polaroid Land Type)

for instantaneous 1-to-1 ratio photo-recording of these test signals.

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Full facilities Transmits, receives, monitors, analyzes composite color pictures

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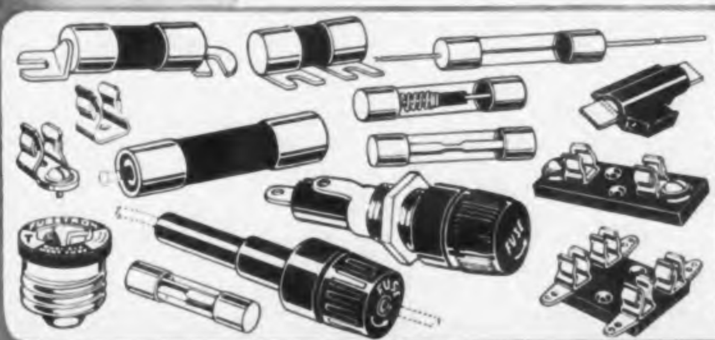

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PATENT NEWS

The patents described in the following list are some of the many patents, presently available for licensing or sale, which may be of interest to TELE-TECH & ELECTRONIC INDUSTRIES readers. Register numbers are those given in the Official Gazette of the Patent Office. Inquiries should be addressed to the owner of the patent rights or other party specified. Complete copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., for $.25 each.

Pat 2,656,419. **Magnetic Tape Recorder-Reproducer,** patented Oct. 20, 1953. Ensures minimum of flutter and wow by reducing the effect of short period variations in the instantaneous velocity of the tape. A program and timing signals are simultaneously recorded on the tape. (Owner) Edward N. Dingley Jr., 4508 N. 18th St., Arlington 7, Va. Group 36-61. Reg. No. 53,071.

Pat. 2,664,486. **Thermistor and Method of Heat-Treating It,** patented Dec. 29, 1953. Method of making uranium oxide thermistors with a temperature-resistance characteristic of high accuracy. (Owner) Northern Electric Co., Ltd., Post Office Box 6124, Montreal, Que. Canada. Group 36-19. Reg. No. 53, 165.

The following three patents owned by the AEC have been made available for non-exclusive, royalty-free licensing. Apply to Chief, Patent Branch. Office of the General Counsel, U.S. Atomic Energy Commission, Washngton 25, D.C.

Pat. 2,668,272. **Voltage Regulator.** Patented Feb. 2, 1954. A voltage regulator of the type in which variations of the output voltage from a desired value are detected, amplified, and then employed to control a variable resistive element in series with the source voltage.

Pat. 2,670,408. **Coupling Stage for Distributed Amplifier Stages,** patented Feb. 23, 1954. An amplifier system utilizing distributed amplification in which the desired over-all gain of the system is maintained, even at low frequencies. A novel coupling between the stages doubles the voltage gain per stage. Group 36-61-62. Reg. No. 53,288.

Pat. 2,672,556. **Electronic Timing Device.** Patented Mar. 16, 1954. Electronic device which generates an audio tone having one selected frequency when impressed with a plurality of impulses all of which occur within a selected time interval and an audio tone of different frequency when one or more of the impulses occur after the selected time interval. Group 36-19. Reg. No. 53,292.

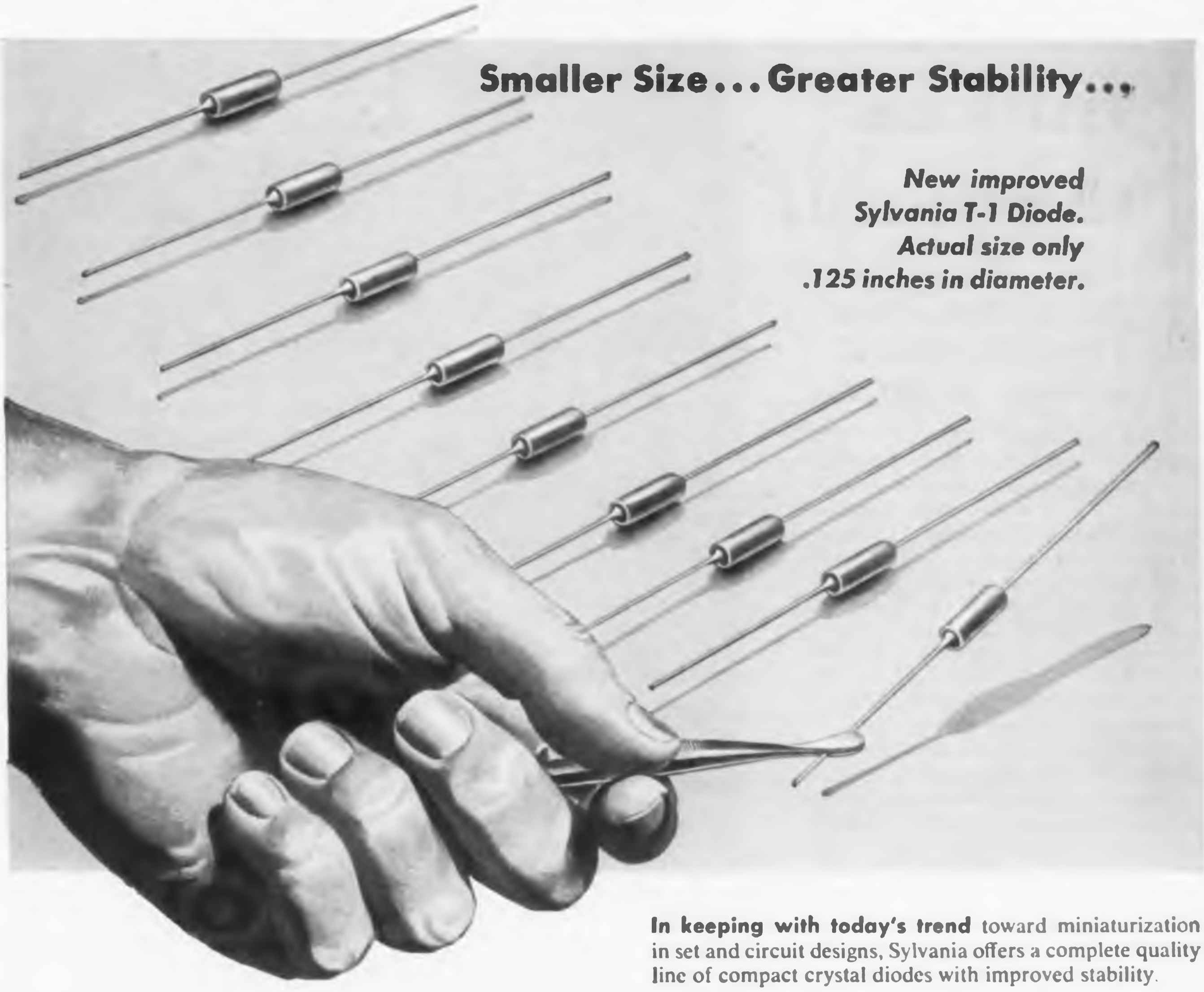
The following two patents, having been assigned to the U.S. government, are available for non-exclusive, royalty-free licensing. Apply to the Solicitor, U. S. Department of the Interior, Washington 25, D.C.

Pat. 2,650,760. **Network Calculating Board.** Patented Sept. 1, 1953. Calculating board for miniature representation of power transmission networks includes a plurality of simulated generators that can be independently adjusted to specified loads.

Pat. 2,654,839. **Electric Pulse Generator.** Patented Oct. 6, 1953. Circuit arrangement in which the phenomenon of current starting and stopping is utilized to produce two brief pulses of voltage at a predetermined time interval. Group 36-19. Reg. No. 53,089.

Sylvania Offers You...

A NEW COMPACT DIODE LINE



In keeping with today's trend toward miniaturization in set and circuit designs, Sylvania offers a complete quality line of compact crystal diodes with improved stability.

These new components measure only .125 inches in diameter . . . require only 1/6th the space of former units. At the same time, due to advanced manufacturing techniques and Sylvania's new automatic precision equipment, they provide far higher performance records.

With these tiny diodes, you can be assured of more uniform characteristics and closer tolerance limits . . . even on large quantity orders.

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Sprague Tantalex capacitors provide maximum capacitance in minimum space . . . exhibit no shelf aging under long testing periods . . . have extremely low leakage current. And most important, they give unusually *stable* performance, because they're made with tantalum, the most stable of all anodic film-forming materials.

There's a complete range of sizes and ratings available in Tantalex capacitors . . . from the ultra-miniature 10 mf, 4 volt unit in a case only ⅛" in diameter by 5⁄16" long . . . to the 7 mf, 630 volt unit in a case 1⅛" in diameter by 2[illegible]" long. As for case styles, Sprague makes them all, from tiny tubular and cup units to the large cylindrical types.

For complete details relating to your miniaturization or high temperature problems, write Sprague Electric Co., 233 Marshall St., North Adams, Mass.

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NEW! TYPE 101D for low-cost transistor circuitry

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NEW! TYPE 102D for −55°C to +85°C operation for military use

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NEW! TYPE 103D ultra-miniature capacitors for transistor circuitry

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NEW! TYPE 104D miniature "cup" capacitor for military use

[illegible]

TYPE 100D for −55 to +125°C operation for military use

[illegible]

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TELE-TECH
& Electronic Industries

O. H. CALDWELL, Editorial Consultant ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York 17, N. Y.

Dry Run Your Plant

The electronic industry is in a temporary lull today, a lull brought about by several diverse factors. These include the normal summer slack season, the hiatus during the transition to color TV, and government economy cutbacks. It might seem like the right time to hang up the "gone fishin'" sign or relax on a sunny beach. So far as overall company operations are concerned, nothing could be further from the truth.

Now is the time to redouble our efforts to put our plants in top operating condition. There are two good reasons for this: National survival and company survival.

NATIONAL SURVIVAL: The frightening presence of cold wars and warm wars all around the world would make it mandatory that we be prepared for all exigencies. The electronic industry plays a vital role in our defense structure. According to top level military authorities the output of our industry, presently geared for close to $6 billion, would have to be increased tenfold in time of complete mobilization. $60 billion! Now, during the summer lull, is the moment to take stock of ourselves to evaluate our capability to effect such phenomenal expansion with relatively short notice.

As an introductory check list, the following salient items should be given serious consideration by managements:

- The formulation of an emergency organizational plan whereby certain key engineers would constitute the nucleus of an expanded body to handle electronic armaments.
- Duplication and safe storage of records to insure rapid recovery in case of bombing attack.
- Cementing government contracts to provide established liaison if and when the time comes.
- Review of financial position in terms of acquiring additional facilities.
- Calm security check of personnel to determine ability to handle top secret material, and clearance of people not now engaged in classified projects.

COMPANY SURVIVAL: Nothing is more beneficial to military preparedness than an economically sound company. And from the strictly commercial viewpoint, there are days of extremely keen competition ahead. The prevalence of rock-bottom pricing makes top-notch operating efficiency a must. Now, before the fall step-up in business tempo makes immediate needs overshadow planning for the future, let's weed out the dead wood in our ranks, and formulate a logical program of acquiring those new tools and production techniques which will slash unit costs.

Fear of the Unknown

And while we're talking of activity during the summer transitional period, it might be apropos to record a few observations on color TV . . .

To some extent, color TV receiver production is stymied. Set manufacturers figure the situation something like this: If I make a big investment tooling up for a receiver using the ABC picture tube, what will happen to my money if the following week the DEF and GHI tubes come out, making the ABC type obsolete? So I guess I'll sit tight for a little while.

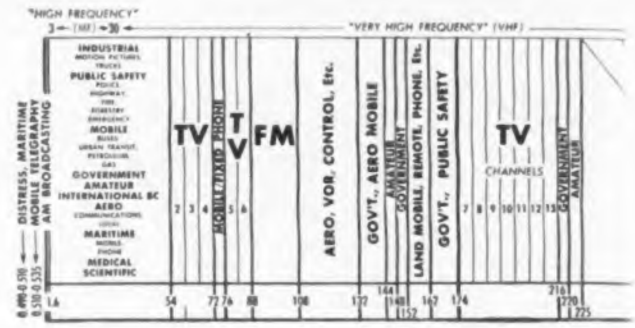
In other words, the picture tube is something of a bottleneck now because the developmental and competitive situations are too fluid. The set maker needs assurance that in tooling up for a particular type he has some measure of security.

We know that color TV production will pick up nicely this fall, but to hasten the day consider this proposal. It is suggested that the half-dozen or so major tube manufacturers pool their resources and accomplishments, and settle on a single standardized tube. This design should be more or less frozen for a very limited period—just long enough to get color set production moving without jeopardizing the investments of set makers. After this relatively short interval, the inherently dynamic nature of the industry could come into play . . . and may the best design win.

The organization responsible for administering the proposed pooling of resources could well be an all-industry "problem guidance" committee, which has been proposed in these pages previously, to handle problems such as color TV—problems which are beyond the normal functions of existing organizations.

RADARSCOPE

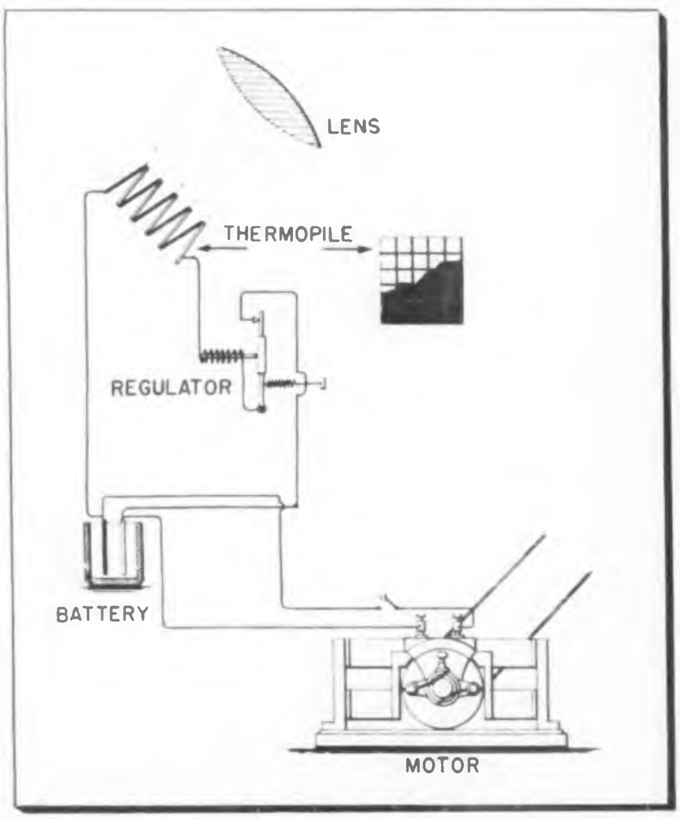
Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation



MAGNETIC TAPE manufacturers are actively competing for agreements with record companies in anticipation of big push in prerecorded tapes. Watch for one little known firm to make a big splash in this field. Also, one of the largest equipment makers is rumored to be preparing prerecorded tapes to play at 5 in./sec.

INVESTIGATIONS have left such a bad taste in mouths of government-employed electronic engineers, that a recent trip through a major Signal Corps installation brought flurry of "subtle" questions on jobs open in private industry. Typical remark was, "They didn't touch me, but I've wanted to move on for some time."

SOLAR ENERGY



There's nothing new under the sun, not even the utilization of solar energy. Above drawing is taken from patent 389,125, issued on Sept. 4, 1888 to Edward Weston, early head of Weston Electrical Instrument Corp. It shows how radiant energy focused on a thermopile is transformed into electrical energy which is stored in a battery or used to run a motor. A very recent experimental barrier layer cell made of cadmium sulphide has been developed at Wright Air Development Center. It employs indium and silver electrodes, and a 1/8 sq. in. area produces 1/3 volt. A thin slab 4 x 15 ft. on a roof could supply enough current to operate practically all lights and appliances in home for 24 hours

COLOR TV, considered by many in a transitional null period before big push this fall, was succinctly summarized by one source: "Production activity minimum, anticipation maximum."

ATOMIC ENERGY, still pie-in-the-sky so far as many industrial leaders are concerned, will require many new developments in electronic controls, particularly as radioactive materials find increasing use in power generation, food preservation, chemical processing and agriculture.

CENTRALIZED DICTATION system shows promise of increasing secretarial efficiency. Operation consists of calling tape recorder bank on telephone. While one letter is being dictated, stenographer is busy transcribing another letter recorded earlier.

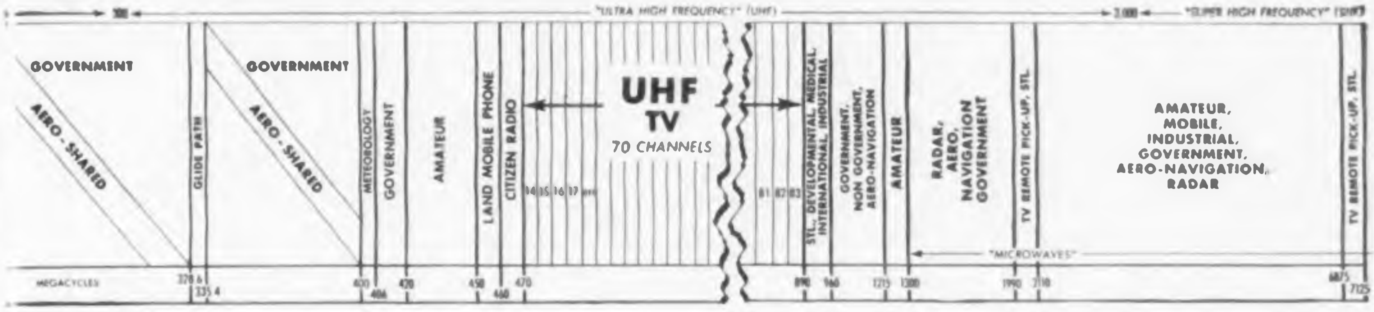
NEW COLOR TV picture tube will be announced by a West Coast firm now engaged in electronic research, but primarily known for their activities in metals and other fields.

PREFERENCE for certain TV picture tube sizes appears to be dictated by many factors. Not the least important of these is the type of home heating system in use. Reports reach us from Britain that the 17-in. tube is most popular because coal fireplaces are common, and people tend to group more closely. On the other hand, Americans with central heating can spread out in their living rooms, so they prefer the 21-in. size.

LABOR SHORTAGE accenting the need for industrial and agricultural mechanization is predicted for 1963 by Steven P. J. Warner, President of Warner Electric Brake. The ratio of U.S. labor force to total population (177 million anticipated) will be about 14% less in 1963 than today, with emphasis on young and old age groups.

PLANT MAINTENANCE is playing increasingly important role in industry, especially as capital investment per worker rises. A recent survey shows that the direct expense and indirect losses due to poor maintenance in the average firm represent from 15% to 20% of the total equipment valuation.

UHF BROADCASTERS are girding for big fight with VHF people which will rock the NARTB. Sounds of this battle will resound in the halls of Congress.



EXPORTS of radio-TV components and equipment are being made at the monthly rate of $17 million.

FM MULTIPLEXING will receive needed shot in arm with FCC ruling restricting use of common "beep" operation. Multi-channel broadcasting will open way to commercially sound storecasting, and possibly binaural FM.

MILITARY

POTENTIAL DEMAND for electronic equipment in the event of another war is sufficiently imposing to make even the calmest of industry leaders sit up sharply and take notice. In surveying the growth and importance of electronics in the armed forces, Brig. Gen. Preston Corderman, Signal Corps, stated: "In 1940 the civilian production base of the electronics industry was about one-half billion dollars. This was expanded to about four and one-half billion in 1944; and the present production base for military and civilian equipment is close to six billion. Nevertheless, a new emergency could mean a tenfold increase over current requirements." *Tenfold!* Much must be done to keep a broad base under the electronic industry to make it capable of such extraordinary expansion. This includes financially sound companies, vigorous research, and expanded engineering training.

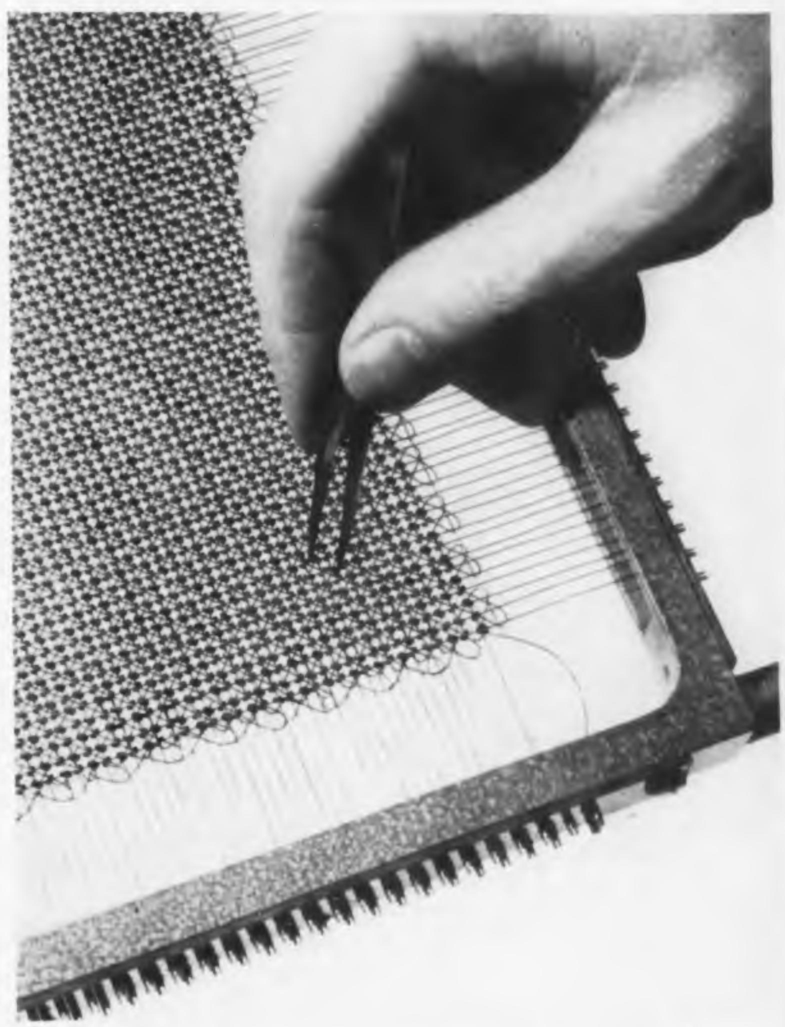
ENGINEERING EDUCATION

TRAINING OUR YOUTH in schools is no longer simply a matter of preparing them for the task of making a living. It is a question of national survival in this scientific age. Mervin J. Kelly, President of Bell Labs, reports that Russia is building a broad, technical capability at an alarming rate through a splendid scientific education. Furthermore, the number of Russians enjoying this opportunity exceeds ours. How are we meeting this challenge? In the words of David D. Henry, Executive Vice Chancellor of New York University, "The elementary and secondary schools of our country are in danger of financial strangulation. In higher education, our accomplishments are also far short of our capacity, our needs, and our faith. At a time when our place as a nation in world affairs is dependent more than ever before on trained leadership, upon the development of scientific achievement, and upon the conquest of the frontiers of knowledge, we allow a situation to continue where able and talented youth are deprived of educational opportunity because they were born into families of limited economic means or in areas of the country where social prejudice or lack of facilities stand in their way."

ENGINEERING MANPOWER

SELECTIVE SERVICE draft policies are not furthering scientific and industrial achievement. According to a joint report by the Engineering Manpower Commission and the Scientific Manpower Commission, despite the fact that engineers and scientists comprise a scant 1% of the labor force, they make up nearly 3% of the armed forces, and are filling 8% of draft quota requirements. The report reflects, "It is time to ask whether we can count on keeping such technological advantages as we have had if this heavy toll is to be exacted from fields where there are already grave manpower shortages."

MAGNETIC MEMORY



Over 1000 tiny magnetic cores strung on criss-cross wires less than 1 ft. sq. make up one unit of new magnetic memory in Whirlwind I digital computer developed at Mass. Institute of Technology, to provide increased speed and reliability. It can take in or give out a piece of information in less than eight microseconds

Bibliography of Magnetic

Comprehensive compilation of articles appearing in world's technical publications traces progress of recording art. Chronological listing provides permanent reference

Compiled by ALFRED JORYSZ
Member, Audio Engineering Society

1900

E. Ruhmer, "The Telephonograph," *Phys. Z.*, pp. 470-472, July; p. 554-556, Sept.

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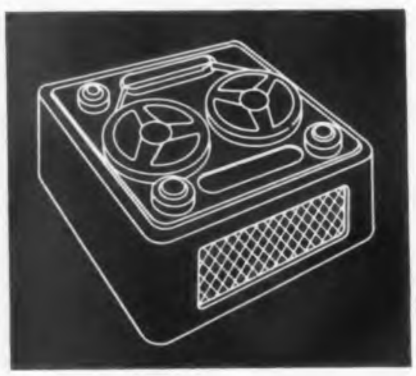

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(Continued on page 111)

Simple Follow-Up System

Economical servo-type coordination between two rotating shafts can be achieved by this unique circuit which features simplification at moderate accuracy

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MUCH present-day equipment requires a shaft located at a remote point (B) to follow the rotation of a shaft at a control point (A). A usual solution of this problem is by means of a servomechanism, involving use of two synchros (transmitter and control transformer), an amplifier, and a servo motor. Where a so-called two-speed system is used, considerable accuracy can be obtained by this method.

For some applications, however, the great accuracy obtainable with a servo is not required. This may be due to an inaccurate available (A) rotation, or a large tolerance on the (B) rotation. Where this is true, the follow-up system discussed here represents an alternative. Considerable simplification is obtained at some sacrifice of accuracy. Within the limits imposed by this method, operation is entirely reliable.

In Fig. 1, switch S1 is driven by shaft A and two-deck switch S2 is rotated by shaft B. S3 and S4 are ordinary stepping switches gauged to B. S3 operates to turn shaft B in a clockwise direction, and S4 operates to turn B counterclockwise. Twelve switch contacts are shown for illustration, although any number of contacts may, of course, be used. Each of the contacts 1 to 12 of S1 is wired to the corresponding contact on both decks of S2. (e.g. contact #4 of S1 is connected to contact #4 of S2(a) and to contact #4 of S2(b)). A dc energizing voltage E is applied between the wiper of S1 and ground. In the position shown in Fig. 1, potential E is connected to S1 contacts #1. It is thus connected to contacts #1 of decks a and b of S2. But neither of the latter contacts is on a wiper. Thus no voltage is applied to either S3 or S4, no stepping action takes place, and shaft B remains in its position.

When shaft A is now turned counterclockwise so that the S1 wiper moves to contact #12, E is applied to contact #12 of decks a and b of S2. E is not applied anywhere through deck b. Through deck a, E is applied to the wiper, to contact #8a, and to stepping switch S4. When S4 is energized, shaft B is turned counterclockwise. Its position now corresponds to the position of shaft A. At the same time the contact associated with S4 opens and S4 is thus de-energized. De-energizing S4 recloses this contact. However, E is still on contact #12 of S2(a), which by virtue of the B rotation no longer makes contact with either of the S2 wipers. Thus no further operation of the stepping switches follows.

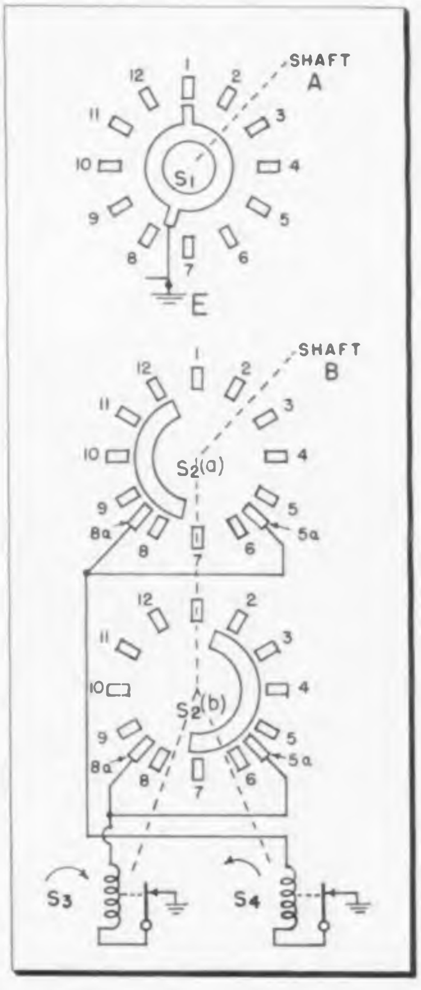

Fig. 1: 3-deck construction and wiper action

When shaft A is turned from position 12 to position 2, E is applied through contact #2 of S2(b) and the b deck wiper to contact #5a and to stepping switch S3. S3 turns shaft B clockwise in a manner similar to that described above for S4. This causes B to be in position 1. But after the contact associated with S3 recloses, E is still applied to S3 through contact #2 of S2(b). Thus S3 is caused to step again, turning B to position 2, where it comes to rest since neither of the S2 wipers is now on contract #2.

It may be seen that, no matter to what position S1 may be turned by A, B is also caused to turn there by the repeated action of S3 or S4. The system always chooses the shortest path between starting and end points. (e.g. it travels from 1 to 10 by way of 12-11 rather than through 2-3-4-5-6-7-8-9.)

The inaccuracy inherent in the system arises from the fact that, as A turns, say, from 1 to 2, no action takes place until the S1 wiper has reached contact #2, giving rise to a dead space between 1 and 2. The error caused by this effect depends on the relative widths of wiper, contacts, and spacing, and may be minimized by using more contacts. Of course the possible improvement is limited where space limitations exist or where it is not desirable to run too many wires between S1 and S2.

But where such errors are allowable, the system represents an economical and reliable solution to the follow-up problem.

The response of the system to various inputs is easily seen, although the response depends on the switch design, and can therefore be described only qualitatively. Where the input shaft rotation at A is of small magnitude and periodic at any frequency, as in Fig. 2a, no output is produced. If a sinusoidal rotation of sufficient amplitude to cause a non-zero response is applied at A, the rotation at B approximates this by a square wave as shown in 2b. The reason for this inaccuracy is as follows: when for example, A is in position 1 and is turned towards position 2, no action takes place until the S1 wiper reaches contact #2, equivalent to some angle between 0 and $\pi/2$ of the input sinusoidal rotation. When this point is reached, the stepping action takes place. As the A rotation proceeds to its peak

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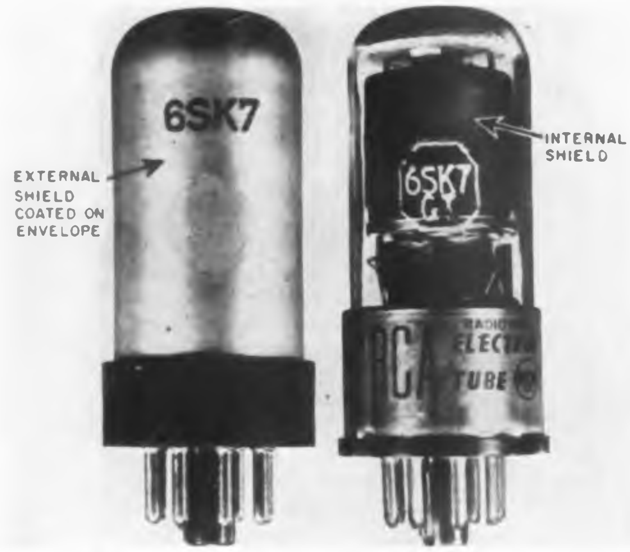

Fig. 1: The well-known 6SK7GT pentode (r), with its foreign equivalent (l). Fig. 2: Cutaway view illustrates sharp differences in construction

Foreign Tube

Scarcity of materials and lack of modern tube-making machinery has spurred foreign engineers to develop a number of techniques which might be profitably adopted

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AN analysis of foreign tube manufacturing techniques can serve the purpose of pointing out those American methods which are inferior, thereby enabling us to improve our techniques. No attempt is made here at an overall comparison of U.S. and foreign tube plants.

Two major requirements are placed upon electron tubes, mechanical quality and electrical reliability. The mechanical quality, the resistance to shock and vibration, is a function of tube design and the ease with which operators can assemble the parts. The electrical reliabilities which are desired by customers are essentially those of uniformity of initial characteristics and long trouble-free electrical life. Basically life is dependent upon a low rate of barium evaporation, a low gas content and a slow rate of interface impedance build-up on the cathode. In both cases the severity of the tube application conditions are of great importance, not excluding of course, the environments surrounding the tubes. It is quite probable that the applications demanded of tubes in the U.S., particularly those of military equipment and large screen TV receivers, are somewhat more severe than the average requirements placed on tubes abroad.

With these conditions in our minds, we have selected several features from the foreign tubes which we believe are of interest to the American tube engineers, and are worthy of further investigation and adoption to use in our own designs.

Heaters

Fig. 3 shows methods used overseas for insuring tight welds between the heater wire and stem leads. The first is the well-known tubular connector which is expensive and has been used to some extent on premium grade tubes in this country. The second method is shown by the drawing of a recent and more simple mechanical method for swaging the foreign tungsten heater wire in the nickel stem leads. This is the one that should appeal in particular to higher production tube types. Apparently a special tool or plier is employed.

One of the reasons for heater failure is the so-called "lighthouse" effect, wherein the relatively thinly coated or bare heater wire overheats when voltage is first applied. One company has painted a black iron oxide paste upon the heater-to-stem wire junction. This not only provides increased mass, but improves the thermal-radiation to avoid local over heating and consequent burn-out of the resistance wire.

The other two drawings are the

Fig. 3: Comparison of foreign and domestic methods of welding heater wire and stem leads

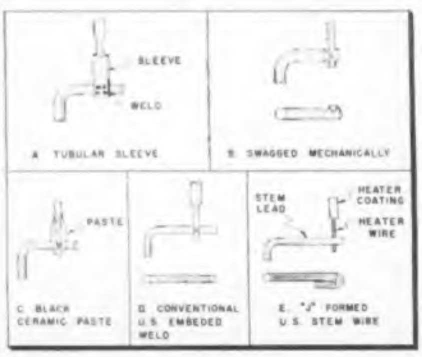
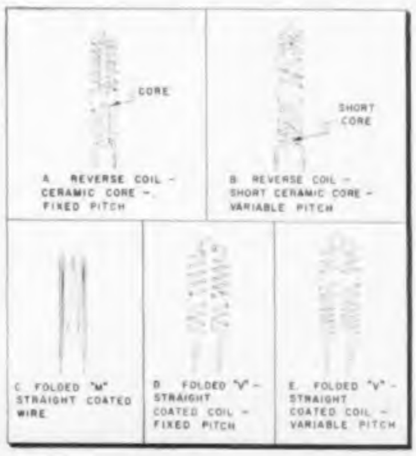
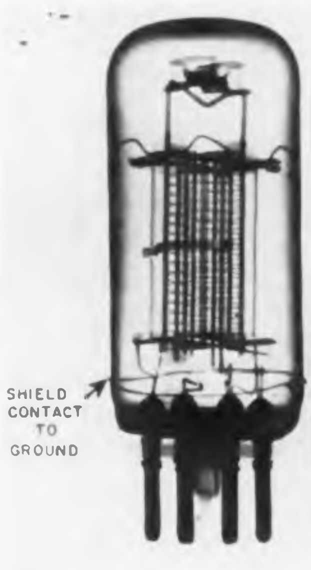


Fig. 4: Greater temperature uniformity has been achieved by adoption of the V-shaped single coil





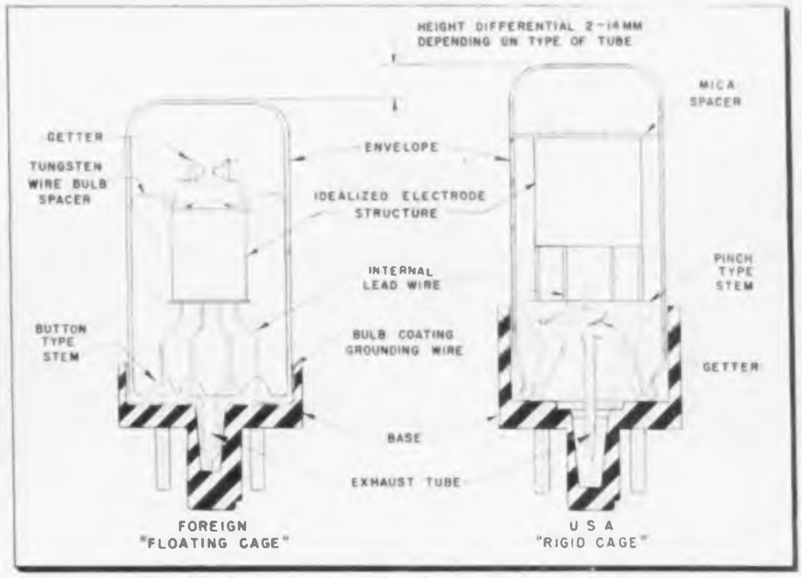


Fig. 5: (l) Overseas 6SK7 (l) as seen by X-ray. U. S. tube right. Fig. 6: (r) Excellent shock resistance is provided by tungsten spacer in foreign model

Design Techniques

conventional U.S. embedded weld and the J-bending of the stem wires which is now being used in certain reliable tubes.

Fig. 4 illustrates various forms of heater construction. The folded wire and the reverse coil are normally used in this country. The V-shaped single coil is being used more and more extensively in certain tube plants abroad. It is believed that one of the reasons is that these coils can be wound with less complex machines and with less severe requirements placed upon the quality of the tungsten and tungsten alloy heater wire. It is also possible to design a variable pitch for this coil which will provide greater temperature uniformity along the length of the cathode sleeve. Variable pitch heaters are used in a wide variety of tubes from close spaced rectifiers through the r-f and power output pentodes. We have found that European engineers do not adopt techniques unless they are well justified both scientifically and economically. There is ample evidence that our own tubes would be improved through greater uniformity of cathode temperature.

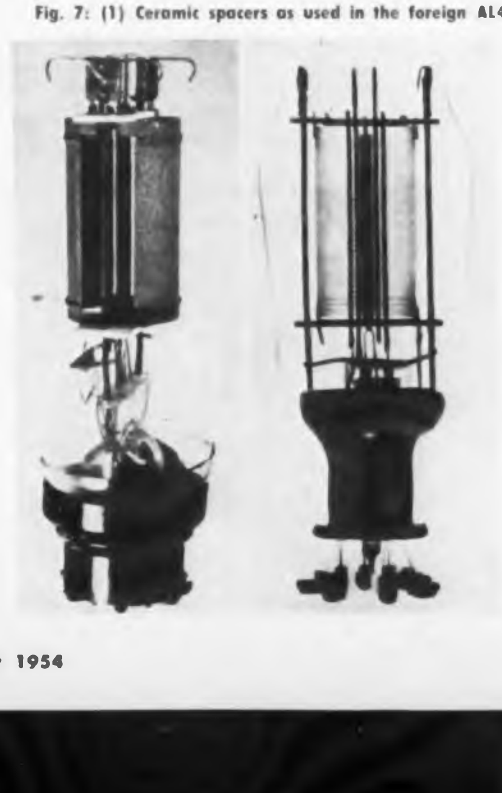
Fig. 1 shows a photograph of a domestic 6SK7GT pentode tube and its foreign equivalent. Note particularly the shorter base shell and the shorter overall height for the foreign tube. These two tubes have the same type designation and electrical ratings. They are completely interchangeable.

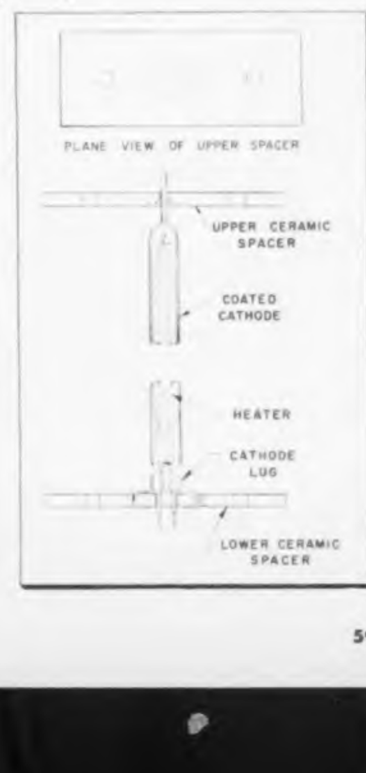
Fig. 2 shows the same tubes with the bulb removed. Fig. 5 shows them in X-ray views. Note that the foreign mount is supported by thin dumet lead wires which are annealed and quite weak in comparison with the one millimeter diameter nickel wires used in this country for mount support. The borate coating apparently is removed by sand blasting prior to welding. The shorter mount height is possible by elimination of the pinch type of stem press. Where the getter is at the top of the mount, a larger bulb volume is permitted for getter flashing and there is freedom from reflected getter material upon the insulating mica spacers.

Fig. 6 shows somewhat more clearly the floating type of mount structure by an idealized drawing. An excellent permanent spring for centering the mount in the bulb and cushioning it against shock and vibration is provided by the "oxbow" tungsten wire of 0.012 in. diameter. This frequently permits the mica spacer to be smaller in area and thus conserves the strategic mica material which is extremely scarce in Europe. Tests are in progress to determine whether or not this floating structure with the small diameter annealed lead wires yields a better shock resistance than the standard American receiving tubes.

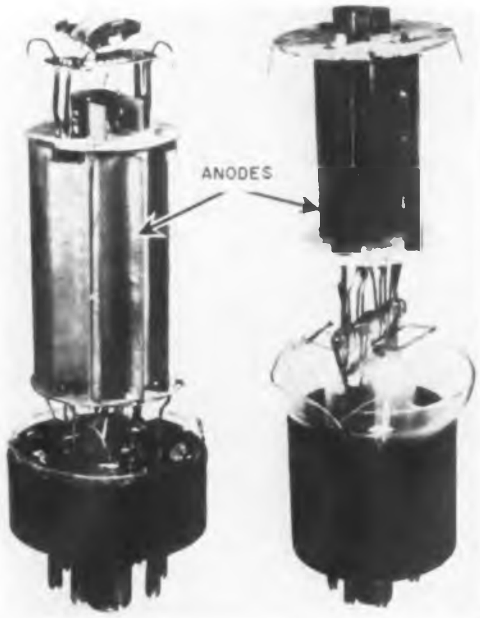
A method of crimping the spring wires to the mount structure has

Fig. 7: (l) Ceramic spacers as used in the foreign AL4. Fig. 8: (r) German pointed-end cathode





Foreign Tubes (Continued)



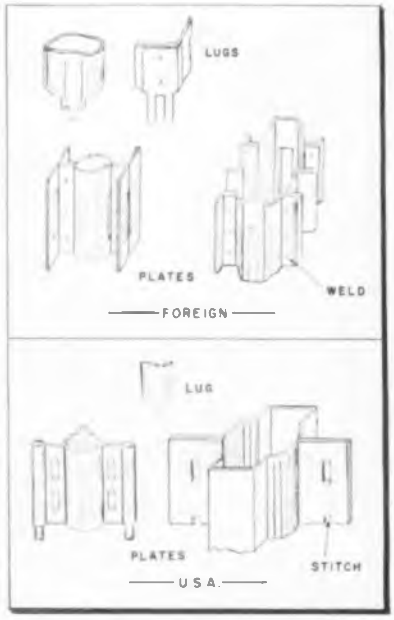
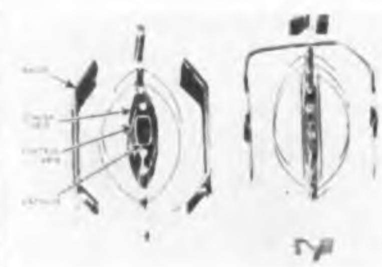


Fig. 9 (l) Aluminized iron plate on imported 6L6 (l). Fig. 10 (r) Simple plate designs cut tooling costs

Fig. 11: (l) Mica spray adheres firmly in foreign tube left. Fig. 12: (r) Plastic section, U. S. right



been well standardized for a wide variety of tube types. There is a definite advantage in comparison with the pointed mica contacts with the bulb in that during continued vibration there is no disintegration of the mica into powder which can result in gases which poison the cathode emission.

Ceramic Spacers

Fig. 7 illustrates dramatically the use of ceramic spacers to replace mica in receiving tubes. So far, this has been seen in rectifiers, triodes and tetrode types. Obviously, it will be more difficult to adapt to pentodes and to pentagrid converters. Development work on the use of ceramics in place of mica is probably continuing at a high priority level. This sketch shows that the ceramic is indented at the cathode hole so that there is a minimum amount of thermal-conduction from the sleeve. One of the best ways in which the ceramic can be used is in conjunction with the German "pointed-end" cathode.

Fig. 8 shows in an enlarged view of the pointed-end cathode which is obtained by swaging a conventional seamless round nickel sleeve. Also shown is the method for adapting to ceramic spacers. Automatic machines are available in Europe for swaging the cathode end. Frequently two additional lugs are welded or cut from the bottom of the cathode sleeve so that the tubing itself does not touch the bottom insulator. This still further reduces thermal-conduction heat losses.

Anodes

Fig. 9 shows a photograph of a standard aluminized iron or P2 plate material in contrast with an equivalent plate of carbonized nickel as produced in this country. For many years even the advocates of the P2 plate material felt that close spaced rectifiers could not be made with this material. However, apparently means have now been found. As a result, aluminized iron is now the standard anode material in at least one tube plant or in one country which produces a fairly large quantity of good quality tubes. There is apparent agreement in both this country and abroad that a single steel works in the Ruhr supplies the best quality aluminized iron strip. Through standardization of the P2 anode stock, it has been possible for good processing controls to be placed upon the conversion process during exhaust, so that the degree of darkening is extremely uniform.

Fig. 10 shows sketches of some recently standardized plate designs. They permit simple die and production equipment. Note that inspection slots have been placed in both shields, plates, and beam confining plates so that operators may check their work with greater surety and adjustment may be made for alignment of the No. 1 and 2 grids during assembly. This slide also shows an improved plate lug design. This lug has an under-cutting adjacent to the shoulders. Thus the lug starts to twist below the mica. This insures a more secure lock since the edges of the lug bite into the mica and a larger degree of twisting above the mica is also possible. One feature

(*Continued on page* 100)

TABLE I: COMPARISON OF FOREIGN TO DOMESTIC GRID—CATHODE DIMENSIONS

Tube Type (Foreign)	Cathode O.D. %	Cathode of Grid #1 Spacing %	Grid #1 Pitch %	Mesh Wire Diameter %	Side Rod Diameter %	Cathode to Grid #2 Spacing %
Triodes						
6AT6	0	+30	+23	−25	0	—
6SQ7	0	+16	+7	−18	0	—
Pentodes						
6AC7	+200	+40	+6	−25	0	+33
6BA6	0	+33	+13	−21	0	−7
6SJ7	0	+44	+7	0	0	−14
Power Output Types						
6AQ5	0	+9	0	+30	0	0
6L6	+150	+100	0	+6	+57	−10

"Stairway" Echo Chamber

Practical design considerations coupled with original idea result in simple, yet highly effective, broadcast reverberation chamber. No equipment modifications required

By HAROLD SCHAAF
Chief Engineer, WRFD
Worthington, Ohio

At one time or another, everyone engaged in sound reproduction has toyed with the idea of producing reverberation or echo effects. For the radio station it can mean something just a little different in dramatic presentations or it can be the something "extra" needed to sell a sponsor an idea. For the music lover it can be a means of brightening an otherwise drab recording or passage.

In order to produce reverberation, or echoes, two sound paths must be provided. One is the undisturbed, amplified signal. The second path must have a means of delaying the signal in some manner. The two sound paths are then mixed into one to produce the desired effect. Fig. 2 illustrates this. Many combinations of equipment can be used to obtain the two sound paths. When new audio consoles were purchased for WRFD they were Western Electric 25Bs. Among the uses planned for these consoles was the production of echo effects. Since they are dual channel, they provided the two sound paths needed.

Several methods have been used such as feeding sound through steel springs to a source of pickup. Series of tubes varying in length from 50 to 200 feet and more in length have been used by placing a loudspeaker at one end and a microphone at the other. Additional heads on tape recorders can also be used. In some respects, none of these are as satisfactory as using a room or chamber in which a microphone and speaker are placed, because a desired growth and decay quality is either not present or is highly damped. For this reason the latter is the type used here at WRFD.

The conventional chamber is usually a room of about 1500 cu. ft. in volume with hard surface walls and cement floor painted with highly reflective paint. Smaller rooms can easily be used with somewhat more of a hollow characteristic than found in larger rooms having overall reverberation, due to frequency discrimination caused by further spacing of resonance frequencies. The author has been in many small, tile-lined rooms which produced beautiful echoes although they were not built for this purpose.

Echo Variations

Since sound travels at about 1100 ft./sec. and 200 to 300 reflections may be produced in a chamber, some means of controlling these reverberations may be desired. Some variation can be achieved by changing the distance between the microphone and the loudspeaker so the ratio between the direct and reflected sound picked up at the microphone is changed. Microphones with different pickup characteristics such as non-directional, cardioid and bidirectional can also be used. Further control can be achieved by using movable panels or baffles as shown in Fig. 1.

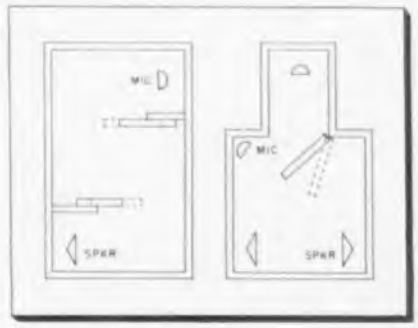


Fig. 1: Movable baffles provide variation in echo

A movable panel between large and small room can also be used. The loudspeaker and microphone are so arranged that they can be moved into either room. The panel opening would act as an acoustical filter so the reverberation characteristics of both rooms could be used.

Originally it had been planned to construct a chamber in the attic space above the studios, however a stairwell leading to the basement was noticed to have an inherent echo which could be heard for about 1½ seconds after a handclap. The walls were painted black and the stairs were painted concrete. The volume was about 1600 cu. ft. However, as pointed out, rooms much smaller than this are capable of producing echoes. No changes were made to any of the surfaces as we were sure the chamber would be highly satisfactory as it was.

Since we already had a dual channel console with house monitor amplifiers on each channel, the only additional equipment needed was a speaker and baffle, connectors and wiring. The speaker was installed at the head of the stairway and fed from one of the monitor amplifiers. A microphone connector was installed in the chamber so the reverberating sound could be fed

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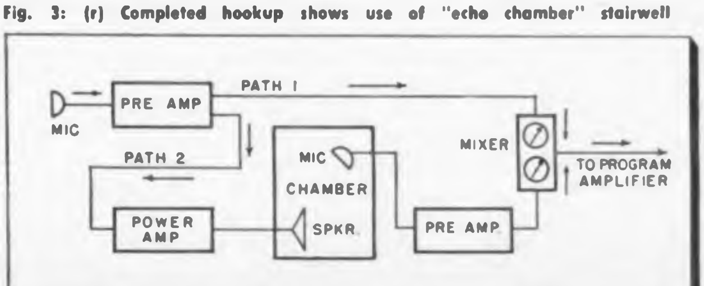
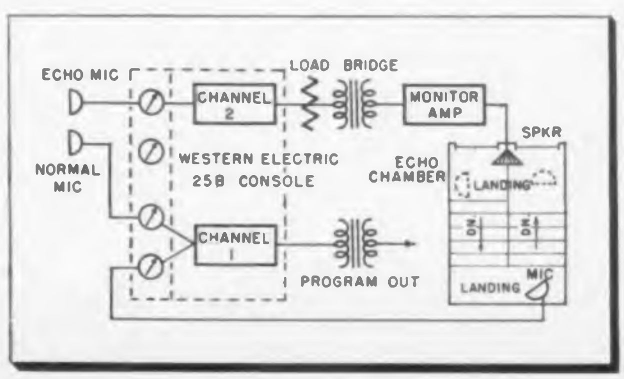
Fig. 2: (below) Two sound paths, direct and delayed, of echo system
Fig. 3: (r) Completed hookup shows use of "echo chamber" stairwell





Level-Indicating Record

Examination of the design considerations followed in adapting the capacity relay circuit to problems of depth measurement, for remote readings and telemetering purposes

By RALPH V. COLES, Manager, Fielden Division, Robertshaw-Fulton Controls Co. 2920 N. 4th St., Phila. 33, Pa.

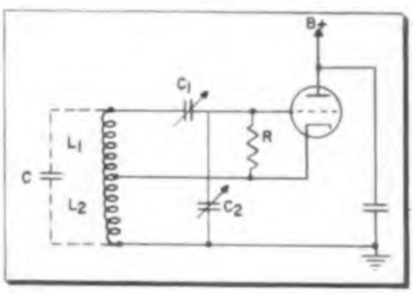


Fig. 1: Basic Hartley oscillator circuit

Fig. 2: Capacity variations control feed-back

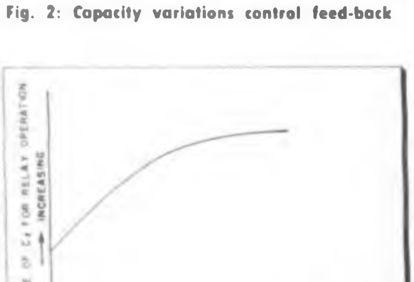


Fig. 3: Supply voltage affects tank capacitance

THE basic capacity relay circuit goes back many years. It consists of a simple Hartley oscillator circuit (Fig. 1) in which the tank circuit L_1/L_2 is tuned, if required, by a capacity (C) and is connected to the grid of the oscillator tube through a capacity potentiometer C_1, C_2. If the impedance ratio of L_1/L_2 is greater than the impedance ratio of C_1, C_2, the grid of the tube will be energized with a component of the output voltage of the proper phase to sustain oscillation, i.e. the feed back will be positive. If the impedance ratio C_1, C_2 becomes greater, the feedback is negative and oscillations will not be sustained. If L_1 and L_2 are fixed, and C_1 preset at a suitable value, any variation of C_2 will control the oscillation of the tube, thus C_2 becomes the measuring or sensing element or electrode. In the early circuits it was usual for a portion of the r-f developed to be rectified and used to control a relay tube.

There are disadvantages to this circuit in its applications to industrial control. These are:

(1) that the amplitude of oscillation is varied smoothly from zero to a maximum as capacity C_2 is varied about the control value and

(2) the circuit is not sufficiently stable particularly with respect to input voltage variations.

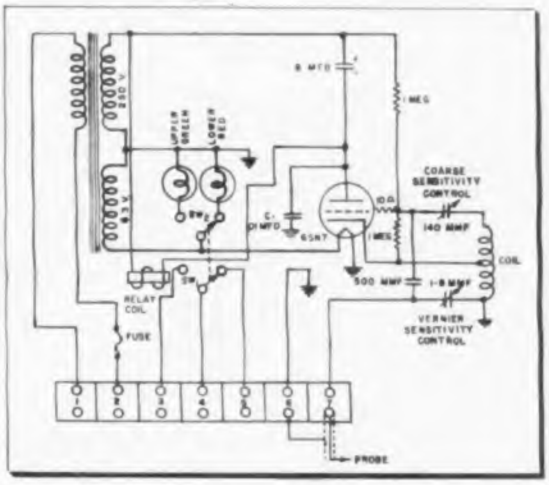
To amplify this, let us assume that the circuit is fed from a 60 CPS source and for simplicity that the coil is center-tapped. If C_2 is substantially smaller than C_1, the tube will oscillate during positive half-cycles reaching maximum amplitude at the peak positive half wave. The amplitude of oscillation is controlled by the gain of the tube and the self bias generated by self rectification at the grid and developed across the grid leak R. As C_2 is increased in value, the amount of feed back is reduced until a value is reached when the amplitude of oscillation begins to be reduced. As C_2 is further increased, the amplitude of oscillations is reduced until there is insufficient feed back of the proper phase to supply the losses in the circuit and oscillation ceases, as shown in Fig. 2. As the amplitude of oscillation and hence the self bias is varied, the plate current of the tube varies from minimum to maximum. In other words, an appreciable change in the value of C_2 is required to change from zero to maximum amplitude of oscillation and this change is progressive. In order to obtain sensitive action with this type of oscillator circuit, a second or control tube is required, operating at its most critical grid characteristic point so that a small change of input bias is sufficient to cause a sharp change of plate current in order to operate a relay. In some cases a thyratron has been used, but other types of power tubes have also been employed.

As regards the second disadvantage, i.e. stability with power supply variations, the value of C_2 for a given amplitude of oscillation varies with supply voltage as shown in Fig. 3. If the change in capacity was small, less than the operational sensitivity of the circuit, this would be unimportant. Unfortunately, it is many times greater.

Improving Stability

For best operation, lowest cost, and greatest reliability, it was considered most desirable to overcome the first of these disadvantages and eliminate the progressive or modulating effects of changes in C_2 around the operating point and thus eliminate the need of using a second tube by using the change in plate current to operate the control relay directly. It was also considered essential to improve stability. After study it was believed that the use of the space charge effect offered the best possibilities. It was known that variations of the space charges in the tube produced variations of interelectrode capacity and in particular the input capacity and leakage resistance. When the grid of a tube is at zero potential or slightly positive with respect to the cathode, the grid-to-cathode grid-to-plate capacity is high and leakage resistance is low. As the grid is made negative the input capacity is reduced and leakage resistance increased. The grid-to-cathode capacity is effectively in parallel with C_2 and therefore increases it, and the leakage resistance is low causing appreciable losses. It

and Control Instruments



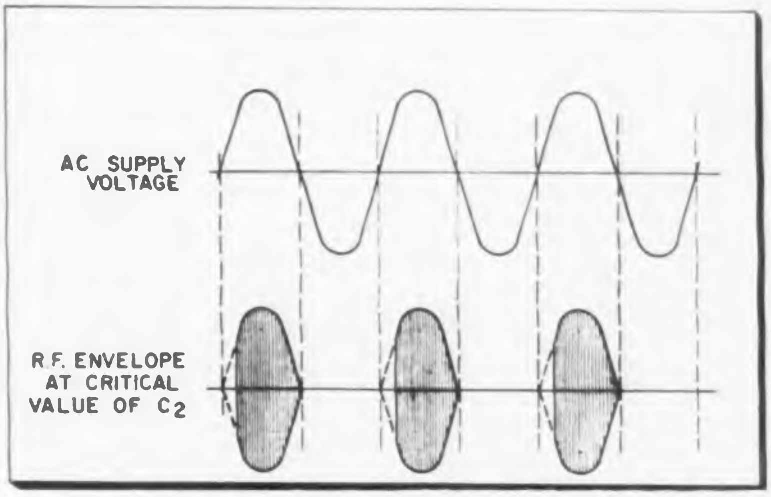


Fig. 4: (l) Operation with positive grid improves stability. Fig. 5: (r) Pattern of oscillation shows crisp snap action between pulses

was decided therefore, to use this effect to the maximum and deliberately apply a positive bias to the grid through a grid leak of sufficient value to limit the grid current well within permissible limits.

This was accomplished by connecting the grid through a high resistance to the ac power supply as shown in Fig. 4, and this circuit produced the desired effect admirably. Thus when the tube is in a non-oscillating condition it has a positive bias and thus a high input capacity and low grid-to-cathode leakage resistance. As the value of the sensing element is decreased, a point is reached where enough positive feedback is developed to overcome these losses, oscillation starts and the grid bias becomes negative, thus greatly reducing the leakage and input capacity so that both these losses are greatly reduced and the tube has more than enough feedback to sustain oscillation at a high amplitude. This results in a snap action during the transition from an oscillating to non-oscillating state and vice versa. Fig. 5 shows this effect. It will be noted that at the critical point while the r-f envelope reaches its maximum possible amplitude for the circuit, it is not quite complete, there being a small portion at the start of each pulse that is missing. Further increase of C_2 merely serves to fill in this missing portion and results in no increase in peak amplitude.

It is found that the value of the resistance is not in the least critical in order to obtain this snap action. It is necessary only to apply a positive bias to the grid to obtain the desired effect. Initially, therefore, a high value was chosen of the order of 5 to 10 Meg. The tube used is a simple triode—one half of a 6SN7 has been found best—and a plate current differential of 3 to 15 ma or greater is obtainable between the oscillating and non-oscillating states, ample for satisfactory relay operation.

The next step was to improve stability, and here fortune was kind. In testing this modified circuit for stability it was found that the variation of the critical value of C_2 for changes in input voltage had been appreciably reduced. By further adjustment to the value of this resistance, it was found that the effect of input voltage variations between 90 and 130 v. could be eliminated for all practical purposes. See Fig. 7.

It is important that no spurious oscillations be present as these can cause instability. A low value grid resistance is included in the circuit as a grid stopper and this has been found completely effective in preventing parasitics which can and do occur if this precaution is not taken.

Level Indicator

We now have a circuit which when applied as a level control has the following sequence of operations. At low levels the probe capacity to ground is low and sufficient positive feedback is generated to sustain oscillations. These oscillations develop a grid leak bias which reduces the plate current sufficiently so that the relay is not energized. As the level of material rises and approaches the probe its capacity is increased by an amount $4C = (K-1)C_o$ where K is the effective dielectric constant of the material and C_o is that part of the probe capacity occupied by the material. As the material rises a point is reached where this change or increase in capacity is sufficient to reduce the positive feedback to a point where oscillation cannot be sustained, the grid leak bias is eliminated, and the plate current increases sufficiently to energize the relay. Thus an energized relay indicates high level. Since line voltage or tube failure would cause the relay to become de-energized and indicate a low level, this circuit is fail-safe as a low level indicator. It is not fail-safe as a high level indicator.

High Level Indicator

In order to make a high level fail-safe circuit it is desirable for a high level to be indicated by a de-energized relay. Thus tube or line voltage failure would result in a high level indication. To accomplish this an increase in probe capacity C must cause oscillations to start. If the circuit is to remain essentially the same, the roles of the two capacitors C_1 and C_2 must be interchanged. This has been accomplished by bypassing the r-f output appearing at the plate of the tube to the opposite end of the oscillator inductance coil. Thus the roles of the two capacitors C_1 and C_2 are interchanged by reversing the roles of two halves of

Level Indicators

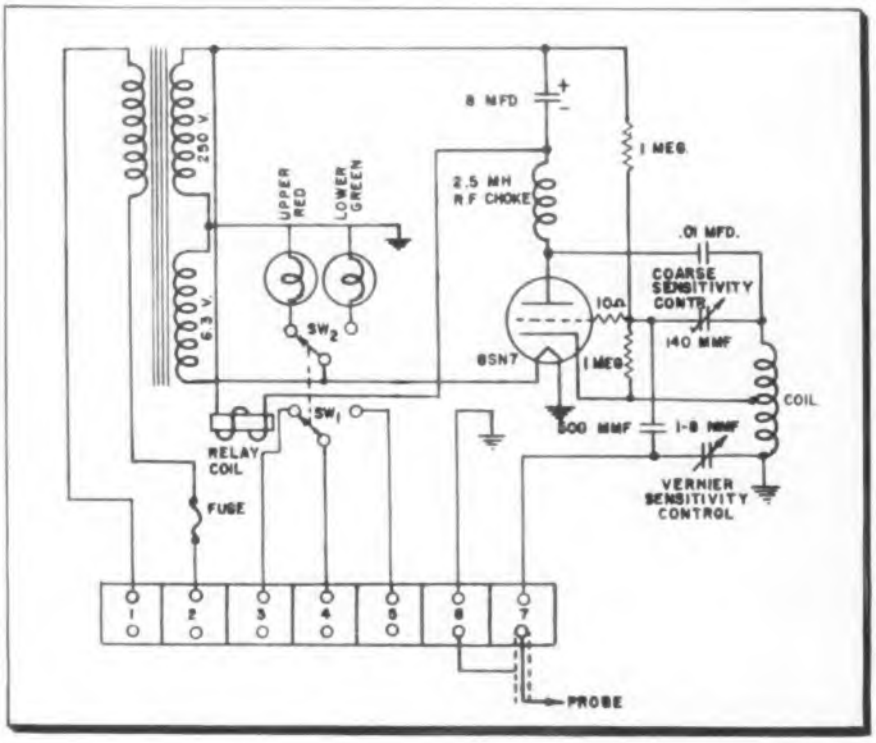


Fig. 6: High level is indicated by de-energized relay in this high level fail-safe indicator

the coils. Fig. 6 shows the circuit of the high level fail-safe indicator.

The circuit design as shown in Fig. 4 remains essentially the same except for the addition of a small r-f choke in series with the plate circuit and the r-f by-pass capacitor is connected from the plate to the high end of the oscillator coil. If this by-pass capacitor is connected to the ground and the r-f choke short circuited, the circuit is converted to low level fail-safe.

In the final design, therefore, the choke is included and the by-pass capacitor can be readily connected to either the high end of the coil or ground, permitting a single basic design to be either high level or low level fail-safe by changing a single connection in the circuit, and making the appropriate changes to the relay connections.

Probe Limitations

For level control, the probes may be of various designs and are connected to the instrument by means of screened coaxial cables. Since the capacity of the cable itself forms part of the value of C_2, there is a definite limit in the distance between the electrode and the instrument that can be used without serious loss of efficiency. We have found that if the electrode capacity when installed—but clear of material—represents approximately 1/5 of the total capacitance change when material is surrounding the electrode, the unit will operate the relay. Normally this change in capacitance will be less than 0.5 μμfd. Electrodes are designed to have a basic capacity of from 15 to 20 μμfd. They may therefore be connected to the instrument through approximately 30 ft. of RG58-U, 5 ft. of RG62-U or 10 ft. of RG114-U cables, without loss of sensitivity. With liquids, and particularly aqueous solutions, the change of capacity at the probe is considerably higher than 0.5 μμfd and much longer cables could be used. Probes may be bare or completely sheathed in insulating material. For corrosive applications probes sheathed in Teflon have been found ideal. Probe forms may be rods or discs and types for high pressure and high temperature applications are available. Fig. 8 shows representative samples of probe constructions.

Sensitivities of 0.5 μμfd have been found adequate for all applications with very few exceptions. Operation, however, does become critical when attempting to control materials of very low effective dielectric constant. Such a material might be a light powdery solid of low dielectric constant containing a very large proportion of occluded air which would still further reduce the effective dielectric constant. But if the effective probe capacity can be increased, these can usually be handled satisfactorily.

Ignition Considerations

Build up on the probe can be a problem but there is usually so much spare sensitivity available that C_1 can be set well back from the critical point, thus permitting appreciable build ups to occur before the adhering material increases the basic probe capacity sufficiently to reach the operating point.

The equipment can be built into explosion proof housings that meet underwriters approval and connected to the probe through heavy duty conduit or explosion-proof flexible conduit. Case can also be provided to meet Class II dust tight conditions. However, we are frequently asked just what energy is available at the probe and if the equipment is really safe. Obviously, energy must be present at the probe when the oscillator is oscillating in order that the equipment may operate.

It has long been known that small sparks may be passed through an explosive gas without producing ignition. There is a considerable volume of literature existing which deals with the threshold conditions of ignition by electric sparks. From this literature we have derived the following information. The values of voltage and capacitance to produce sufficient energy at the ignition threshold is generally calculated as

$$\frac{1}{2} CV^2$$

For a particular explosive mixture of gases at given pressures and temperatures, there is always a minimum ignition energy which can be determined experimentally. There are many effects which control this minimum threshold value such as shape and spacing of the igniting electrodes. In this indicator, the electrodes remain fixed with respect to shape and spacing to ground. This spacing is usually many times greater than the critical distance usually quoted in available literature. In general, it can be stated that if the electrodes are spaced greater than the critical distance, then the energy must be greatly increased in order to produce a spark. If the electrodes are spaced less than the critical distance, generally known as the quenching distance, ignition can-

(*Continued on page 106*)

Tape and Disc Recording System

High quality sound recording, from a number of sources, is made possible by this inexpensive switching arrangement designed for the small station

By CHARLES K. CHRISMON
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THIS recording installation was designed to co-ordinate the tape and disc recorders in use at WFLO. Since it was desired to record during broadcast hours any program source available to the control room console, a secondary control was installed. The latter duplicates every function of the master control and is therefore useful as a standby as well as for its recording functions. A switching arrangement allows the use of any microphone or speaker with either control as required.

The switching panel on the tape rack consists of six switches permitting the following functions: (1) a program source selector; (2) recording input selector; (3) editing switch which feeds the output of the Brush to the Magnecord input through a matching pad; (4) the same function feeding Magnecord to Brush; (5) tape output selector for playback, and (6) input selector for disc recording. With the input selector the program sources available are: air program; secondary control output which may include studio originations, disc programs, remote or net originations, and AM or FM pickup; and master control output when the secondary control is in use for an air program. The selection may be fed via switch two to the Magnecord, the Brush, or to disc. In addition to the other sources the output of either tape may also be fed to disc for dubbing. The tape output selector is terminated on the rack jack strip with the normals connected to a remote input on the master console to eliminate patching when airing tape recordings. Mallory Type 3200 switches are used throughout for microphone, speaker, and recording switching due to the wide variety of pole arrangements available in a single layer switch and having previously been proven dependable in other applications.

The Brush operates at 3¼ ips and is used for playback and editing of recordings made on a portable Mag-

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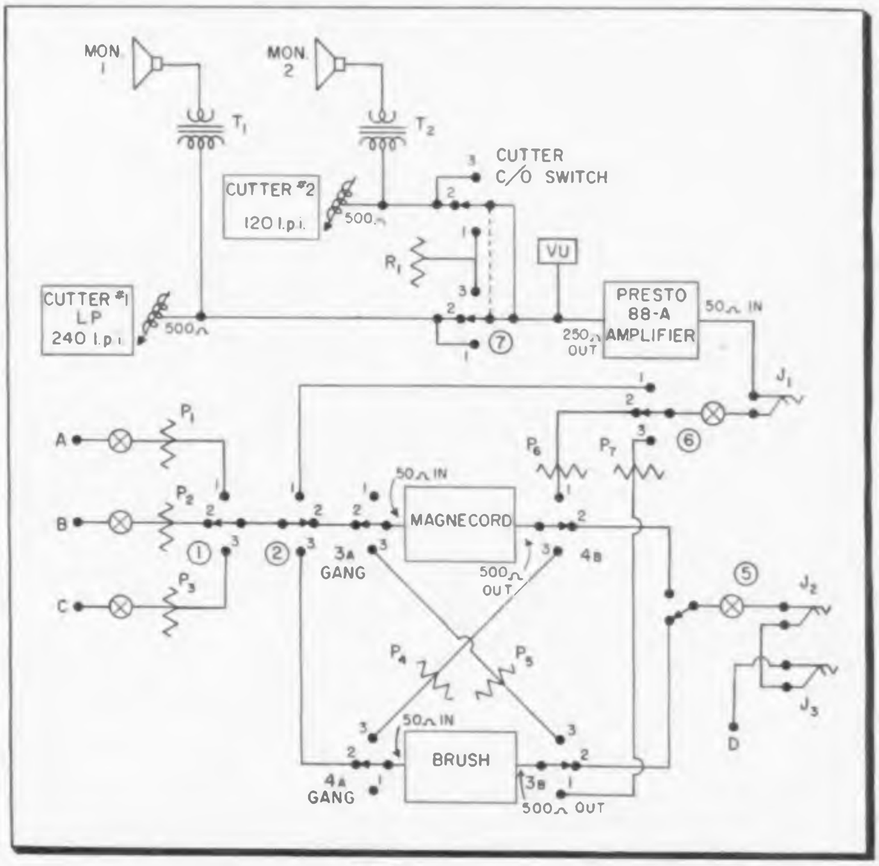

Arrangement of the six switches as seen in diagram allows recording from many sources

Installation at WFLO. Choice of tape or disc recording is made by the switches seen at left

Fig. 1: Middle section, when mounted in case, provides phase-shift action necessary for unidirectional pick-up

Designing a Miniature

Thorough analysis of factors influencing sound wave behavior leads to unit meeting rigid design specifications. Directivity and distance factors, and directivity index explained.

B. B. BAUER, Chief Engr. and J. W. MEDILL, Sr. Development Engr., Shure Bros. Inc., 225 W. Huron St., Chicago 10, Ill.

DURING the past few years the need has arisen for a microphone possessing the characteristics of: 1) good frequency response, 2) unidirectional properties, and 3) inobtrusiveness. A new microphone possessing these properties has recently been developed.

The new microphone derives its directional properties from the use of acoustic phase-shift networks. The transducer element is a ribbon, one side of which is directly exposed to the sound waves, and the other side is accessible through the entrance port of a phase-shifting network.

Referring to Fig. 3, assume that a sound wave travelling with a velocity c_v approaches the microphone frontally, i.e. at 0° incidence. Let the pressure at the front of the ribbon be $p_a(0)$. The sound wave must travel an additional distance d to reach the back entrance port, which entails a delay of d/c_v secs. This delay corresponds to a phase angle $\phi_e = 2\pi fd/c_v$ radians. The pressures $p_a(0)$ and $p_b(0)$ are depicted in the appropriate phase relationship on the vector diagram below.

Before acting upon the inner side of the ribbon the sound pressure must enter through a phase shift network, to be described later in detail. This network is designed to shift the phase of sound entering the port, so that the pressure p_c acting internally upon the ribbon is of the same magnitude as p_b but is further shifted in phase by an angle $\phi = m(2\pi fd/c_v)$ also proportional to frequency. Here, m is a constant of proportionality between ϕ_i and ϕ_e.

Phase Angle

The total phase angle between $p_a(0)$ and p_c is, therefore, the sum of the external phase-shift angle ϕ_e owing to the front-to-back distance d and the internal phase-shift angle ϕ_i arising from the phase-shift network. The resultant pressure difference acting upon the ribbon is represented by the vector R_θ connecting p_a and p_c. The fractional contribution to R_θ owing to ϕ_e is $k = \phi_e/(\phi_e + \phi_i) = 1/(1 + m)$. Next we examine the directional operation of the microphone resulting from varying k.

B. B. Bauer J. W. Medill

If the sound proceeds from a direction θ, the effective distance between the front of the diaphragm and the rear entrance ports becomes d cos θ, corresponding to a phase shift $(2\pi fd/c_v)\cos\theta$. Choosing p_b as a fixed reference vector, as the source of sound rotates about the microphone, the vector $p_a(\theta)$ shifts along the dashed arc in accordance with the cosine law curve at right and concurrently R_θ varies in magnitude. R_θ becomes zero when vectors $p_a(\theta)$ and p_c become coincident. As the source of sound keeps rotating around the microphone, the phase of the resultant force is reversed and rises to a negative maximum at the 180° incidence. The magnitude of R_θ plotted against the angle θ in polar coordinates produces the familiar graph of a limacon defined by the equation:

$$F(\theta) = (1 - k) + k\cos\theta \quad (1)$$

It is seen, therefore, that the choice of k has an important effect on the directional pattern. When k = 1, the pattern is cosine, corresponding to a gradient microphone. When k = 0, the pattern is circular corresponding to an omnidirectional microphone. For the special case of $k = 1/2$, the internal phase shift is equal in magnitude to the maximum external phase shift, and the polar pattern is that of a cardioid. Intermediate results are possible by choosing other values of k. It is clear that k represents the gradient component while 1 − k represents the omnidirectional component of the limacon pattern. The directional indices of these patterns will be examined next so that the most suitable pattern may be selected for the purpose intended.

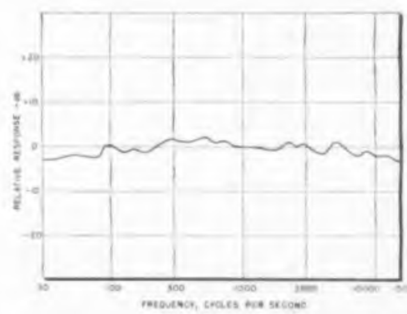

Fig. 2: Frequency response is essentially flat

One of the important directional properties of a microphone is described by a number called the Directivity Factor. This term is defined as the ratio between the power transmitted by the microphone owing to frontal sound and the power transmitted owing to random sounds of equal intensity. The method employed to determine the Directivity Factor can be made clear by reference to Fig. 7. Assume axial symmetry and let the sounds from the performer impinge directly upon the front of the microphone and note the power output. Next remove the direct sound and let the noises and other undesired sounds fall upon the microphone from all directions at random, but with the same average

Unidirectional Ribbon Microphone

intensity as before. What is the power output due to the undesired sounds? In the case of an omnidirectional microphone, the answer is simple; the microphone being equally sensitive in all directions, the output due to the noise is the same as that due to the desired sounds. Therefore, the Directivity Factor is unity. This is precisely why omnidirectional microphones are useful in the measurement of ambient noise.

In the case of a directional microphone, the answer is a bit more complicated. Assume an imaginary sphere of unit radius around the microphone. The area of this sphere is known to be 4π. The area of a zone located at an angle θ from the axis of symmetry and having a width $d\theta$ is $2\pi \sin \theta \, d\theta$. All directions of sound arrival being equally probable, the fractional contribution to the average intensity by sounds transmitted through this area is $(2\pi \sin \theta \, d\theta)/4\pi$. If the fractional angular voltage response of the microphone is given by the function $F(\theta)$, then the fractional angular power response is given by the function $F^2(\theta)$. The fractional contribution to the total power output due to sounds penetrating through this annular area will then be $F^2(\theta) \, (2\pi \sin \theta \, d\theta)/4\pi$, and the total power output from the microphone in terms of the normal incidence power can be obtained by integrating this expression from 0° to π:

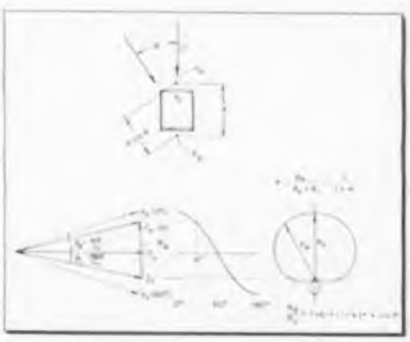

Fig. 3: Phase-shifting action seen graphically

$$\text{R.E.R.} = 1/2 \int_0^{\pi} F^2(\theta) \sin \theta \, d\theta \quad (2)$$

For the microphones of the limacon family $F(\theta)$ is expressed by Eq. 1. The expression for R.E.R. becomes:

$$\text{R.E.R.} = 1/2 \int_0^{\pi} [(1-k) k \cos \theta]^2 \sin \theta \, d\theta \quad (3)$$

$$= 1 - 2k + 4/3k^2 \quad (4)$$

The reciprocal of Eq. 4 is, by definition the Directivity Factor. Another useful index stemming from the Directivity Factor is the Distance Factor. Distance for equal signal-to-noise ratio varies as the square root of the Directivity Factor.

Another pertinent concept in appraising the unidirectional properties of microphones is the front random energy response and the rear random energy response, i.e. the ability to receive random sounds originating from the front and the rear hemispheres. The random response owing to the front hemisphere may be obtained by integrating Eq. 3 from 0 to $\pi/2$ and that owing to rear sound by integrating from $\pi/2$ to π. These integrations have been performed in terms of k, the fractional contribution of the external phase-shift component. The results are as follows:

Front random energy response $= 1/2 - k/2 + 1/6k^2$ **(5)**

Rear random energy response $= 1/2 - 3/2 + 7/6k^2$ **(6)**

These equations enable us to obtain the Unidirectional Index which denotes the relative ability of the microphone to accept sounds arriving from the front hemisphere and to reject sounds originating from the rear hemisphere. This Index is obtained by dividing Eq. 5 by Eq. 6.

The Directivity Factor, the Distance Factor and the Directivity Index are depicted graphically in Fig. 5, in terms of k, the fractional contribution of the gradient component. At both extremes are shown the pressure pattern (circle) with a Directivity Factor equal to 1, and the gradient (cosine or figure-8) pattern, with a Directivity Factor equal to 3. Mixed in equal contributions, for $k = 0.5$ is the cardioid, also with a Directivity Factor equal to 3, a Distance Factor of 1.732, and a Unidirectional Index of 7. Two other recognized members of the family are the hyper-cardioid for $k = 0.75$, which has the highest Directivity Factor equal to 4, a Distance Factor of 2 but possessing, unfortunately, a rather large back lobe, and a Unidirectional Index also equal to 7; and the ultra-cardioid for $k = .63$ which is the most unidirectional member of the family with a Directivity Factor

(*Continued on page* 119)

Fig. 4: Rubber horn (l) insures front pickup. (Center) ribbon element. (r) Shock-mounted model

High-Density

Conversion and storage of telemetered information on punched cards and magnetic tape facilitates data handling for computer analysis in guided missiles and industry

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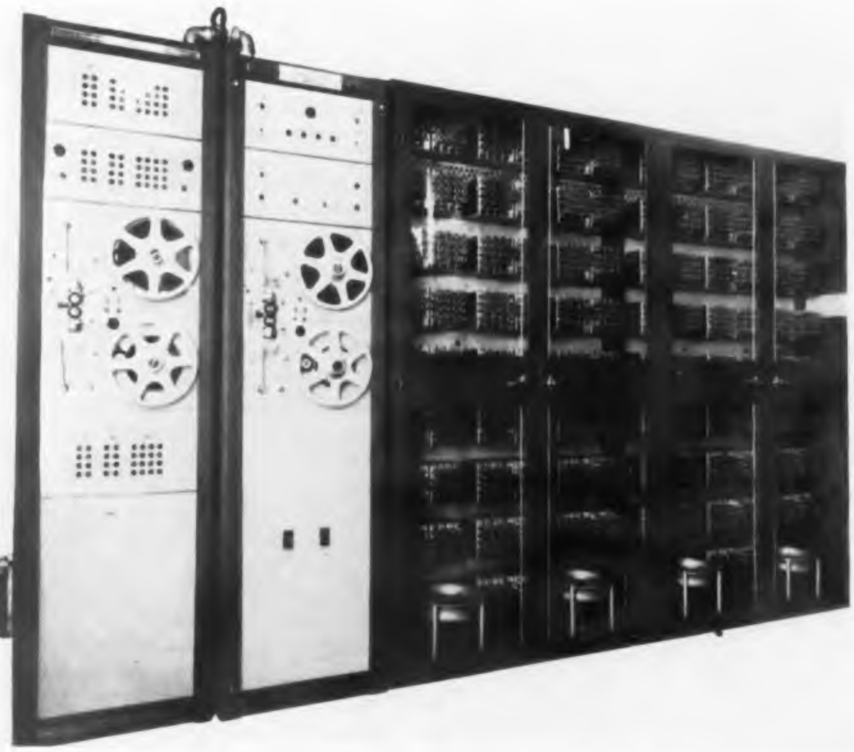


Fig.. 1: Equipment for storing and coding data produced simultaneously by 100 sensing devices

A SINGLE test of a guided missile, an experimental aircraft, or any high-speed industrial operation, can provide sufficient information for complete analysis. However, such information is seldom produced in ideal form for analysis equipment.

For example, the information may be produced on many channels simultaneously, and in addition, each channel may produce information at rates far in excess of currently-available computers and printers. In such cases, some form of intermediate storage is required. Ideally, the storage system should be capable of converting the information into a form suitable for analysis—by slowing down or speeding up, arranging data in logical sequence and translating into an appropriate code.

One approach to the problem involves the recording of information proportional to the phenomena being measured. In this type of storage, stringent requirements are placed on the fidelity with which readings are recorded and played back. The equipment associated with the recording mechanism becomes expensive, bulky, and critical of adjustment.

In the past few years, the trend has been to convert information into digital form at the time it is produced. Once this is achieved, recording consists only of storing yes or no decisions—the exact information is preserved without particular attention to amplifier linearity, etc.

Magnetic tape provides an economical and highly efficient storage medium for digitized information. The data-reducing systems to be described illustrate several typical examples of how magnetic tape recording techniques are used in such applications.

Pressure Recorder

Fig. 1 shows a system capable of storing and coding (for punch card analysis) data produced simultaneously by 100 pressure-sensing devices. Each of the 100 pressure devices is sampled simultaneously several times a minute, and exact four-digit numbers corresponding to the pressure at each point are recorded sequentially on magnetic tape. The readings are later played back into punch-card equipment for analysis.

A block diagram of the system is shown in Fig. 2. One hundred separate pressure-sensitive switches are used. These switches are designed to open an electrical circuit when the pressures on both sides are equal. A pressure to be measured is applied to one side of a switch. The second side of each switch is connected to a common pressure line.

At the beginning of a measuring cycle, the pressure in the common tank is at some value known to be lower than any of the pressures being measured. As the cycle begins, a compressor raises the pressure in the tank in linear fashion.

At the same time pulses from a 1,000 CPS oscillator are gated onto one contact of all 100 pressure-sensitive switches. Initially, since the pressure applied on the common pressure line is lower than any of the pressures applied on the measuring side, the switch contacts are closed, and 1,000 CPS pulses are fed into each of 100 four-digit electronic counters.

As the pressure in the tank increases it will approach and eventually equal each of the pressures applied to the measuring sides of the switches. As each switch sees equal pressure on both sides, the switch electrical contacts are opened, thus interrupting the flow of 1,000 CPS pulses into the corresponding counter. When the tank pressure has attained a value known to be in excess of any of the unknown pressures, each counter registers a count pro-

Digital Data Recording

portional to the pressure being sensed.

The next step is to transfer the readings of each of the 100 counters onto sequential locations on the magnetic tape. A stepping switch first senses the count stored in counter number 1. This count is transferred into a four-digit shift register and these four digits are transferred sequentially to four adjacent locations on the magnetic tape. The stepping switch then moves to position 2, and so on.

When all counters have been sampled and the pressure information is transferred to the tape, the system recycles for another measurement. At some convenient time, and at optimum speed, the information may be transferred to punch cards or fed directly to a computer.

For most efficient use of tape in such applications, the mechanisms

(*Continued on page 110*)

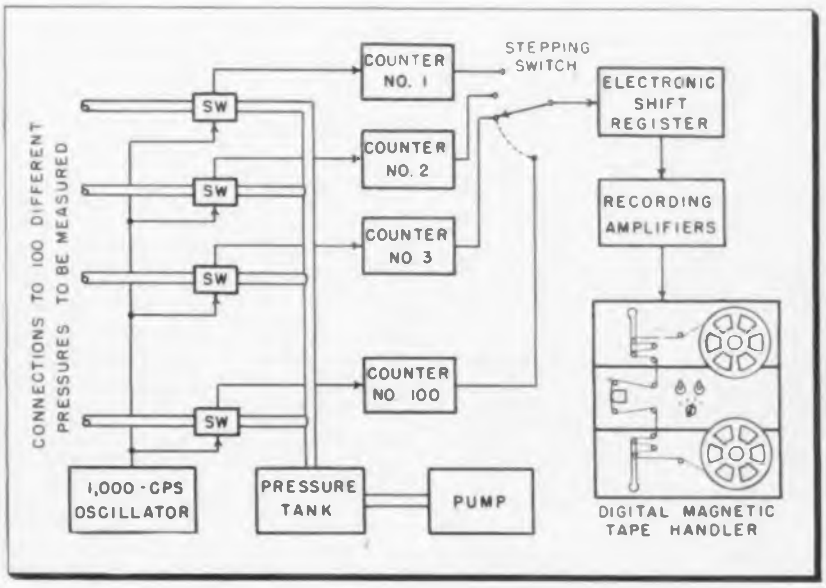
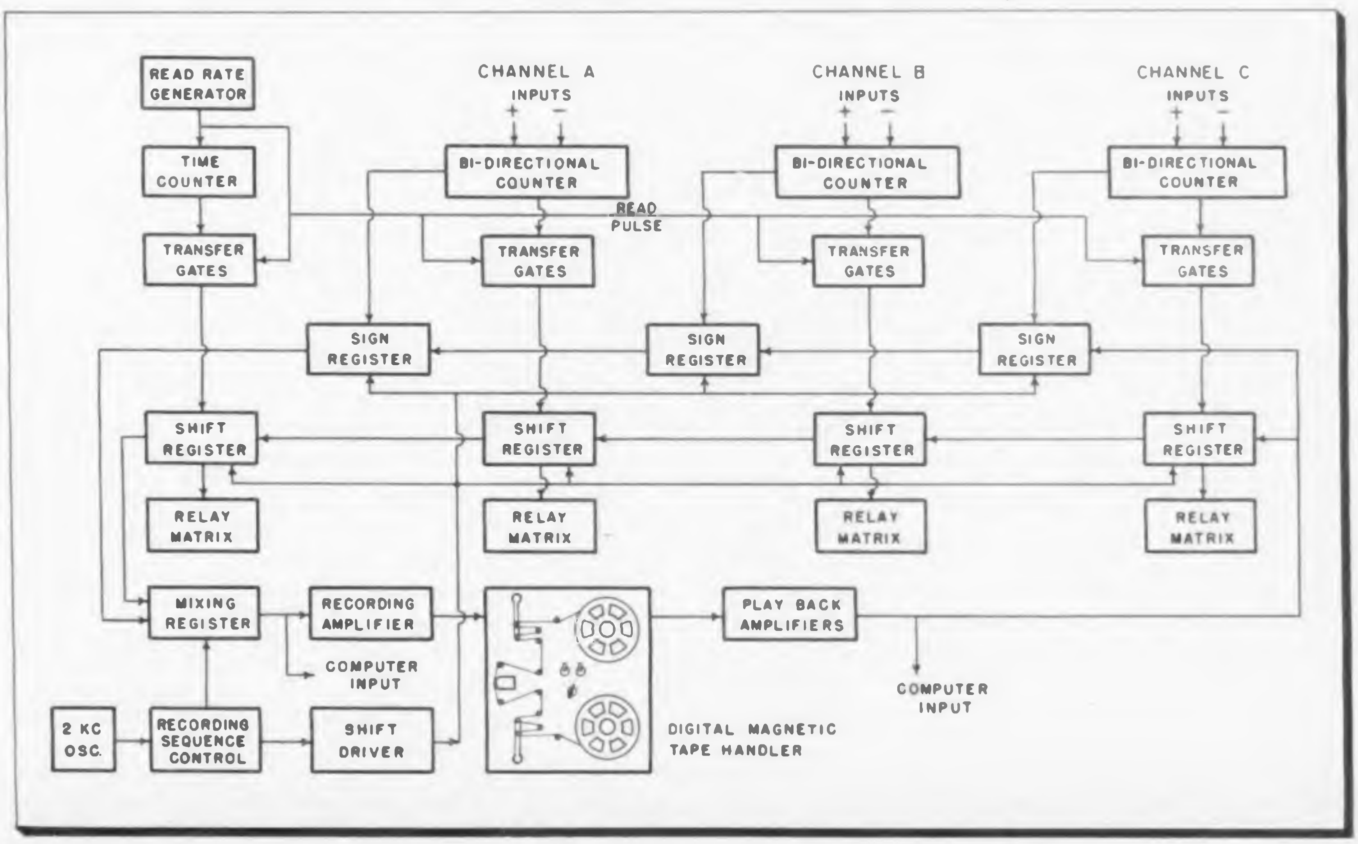


Fig. 2: (l) Block diagram of system in Fig. 1. Fig. 3: (r) Magnetic recording equipment for converting telemetered data for computer analysis

Fig. 4: System for transferring information from magnetic tape to punched cards employs shift registers and relay matrices



Radar Recording System for Air Traffic

Compressing the bandwidth of the video signal to audio range allows recording of the PPI picture, with antenna rotation and air-ground voice, on a standard tape recorder

By JOHN T. McLUCAS, Tech. Dir.
Haller, Raymond & Brown, Inc.
State College, Pa.

A recent innovation is the recording of voice radio traffic at major air terminals. Multi-channel magnetic tape recorders are used; the tapes are stored for a period of weeks and may be referred to if accidents occur. Accident investigations would be more meaningful if a permanent record of the airport radar picture as well as radio were available for reference. In the past, the only practical system for making such a record has been scope photography which is expensive and clumsy, and requires considerable attention from an operator.

The system described here provides for storage of radar information on a standard tape recorder. The recorder can be the same as the one used for recording voice radio traffic. A situation of interest can be recreated by playing back the tape. The PPI picture which results on playback is essentially identical to the original. A 2-channel tape recorder provides for a synchronized radio-radar recording, so that a complete review of the air situation can be made.

Principle Of Operation

Fig. 2 illustrates the method of operation of the system. The signals which must be recorded are: (1) air-ground voice radio traffic, (2) radar video or "picture" signals, and (3) radar antenna position. Since the bandwidth of the video signals greatly exceeds the capability of the tape recorder, a bandwidth compressor must be used to convert video to usable frequencies. The compressor, called "Rafax", reduces the bandwidth of the video from about 1 MC to less than 10 KC. This reduction—better than 100 to 1—is accomplished without noticeable degradation of picture quality. The compressor output signals—narrow-band video—are stored on channel 1 of the tape recorder. As shown in Fig. 2, a servo system is used to generate antenna rotation rate signals and a North mark signal which indicates when the antenna passes North. These signals are mixed with the voice signal and stored on the second channel of the tape recorder.

Fig. 1: Playback unit of radar recorder

On playback, the signals from channel 1 of the tape reproducer are used to provide a sweep and intensity modulation for the PPI picture tube. Signals from channel 2 are used to rotate the indicator presentation at the proper speed to recreate the original picture, while the voice signals and North mark are fed to the speaker.

Bandwidth Reduction

There are two common methods of reducing bandwidth of signals. The first amounts to a sampling of the signal at discrete intervals, the samples being tied together to create a new signal of lower bandwidth. By its nature, sampling involves throwing away the majority of the original signal, and it can be used only where such extravagance is tolerable. The second common method of bandwidth reduction involves storing the original signals in a storage device where signals can be read in at a high rate and read out at a reduced rate. If the storage medium can be made to integrate the signals read into it, then the combined result can be read out with very little loss of signal. Rafax operates as an efficient integrator so that very little signal is lost. In fact, in many operational situations the Rafax output signal is superior in readability to the input.

Fig. 3 shows the details of the recording system. Inputs to the Rafax unit are radar video and radar sync pulses. The video signals are stored on the face of an intensity modulated cathode ray tube. The radar sync pulses are used to start a circular trace on the cathode ray tube, one circle being generated for each radar sync pulse. Targets then appear as bright spots on the circular trace. The angle at which a target appears—with respect to the position of the sync pulse—is an indication of its range from the radar. The circle generator consists of a ringing oscillator which is allowed to ring for one cycle for each sync pulse from the radar. Sine and cosine components of the ringing signal are used to create the circle. The storage properties of the phosphor are used to integrate all the echoes from a single target, and at the same time to remove the inherent redundancy in the radar signals.

An optical scanning mechanism then reads out the signals stored on the scope face by causing successive points on the circular trace to be imaged onto a phototube. An example will serve to illustrate the operation of the compression tech-

Control

nique. A typical airport radar antenna rotates at 20 rpm or 120°/sec. Beamwidth is about 3°, and pulse rate is about 2000/sec. About 50 echoes will be returned from an airplane during the time it is illuminated by the radar beam (illumination time 1/40 sec.). It is sufficient to record merely the average of these 50 echoes, rather than their individual levels. Since all the echoes are returned from the same range, they all are superposed at a single point on the circular trace, and hence they will appear as one composite signal when seen by an observer or by a phototube. For weak signals, an essentially linear integration takes place so that the total excitation is proportional to the sum of the 50 echoes from the weak target. For strong signals, saturation limits the total light output from a given point, but this is of no consequence.

The phosphor in the cathode ray tube is chosen to integrate most of the echoes received and to decay after the integration and read out take place. The P 1 phosphor provides a good compromise for the example chosen here. The scanner rotation speed must be such as to provide at least one scan of the circular trace during the time that a target is illuminated. For this application, a speed of 3600 rpm is satisfactory.

It is necessary to store antenna position data in order to be able to recreate the PPI picture. Fig. 3 shows how this is done. A servo system follows the radar antenna. A techometer attached to the servo motor generates a rate signal whose frequency is directly related to antenna rotation speed. Its nominal output is 60 CPS. Also built into the servo is a North mark cam which closes a switch at North, allowing a North signal to pass to the mixer. The mixer combines voice, antenna rate, and North signals for storage on channel 2 of the tape recorder.

Bandwidth Requirement

The bandwidth requirement is determined by the product of the number of picture elements resolved in range, the number of picture elements resolved in azimuth, and the antenna rotation rate. Range resolution is usually limited by the radar

(*Continued on page* 108)

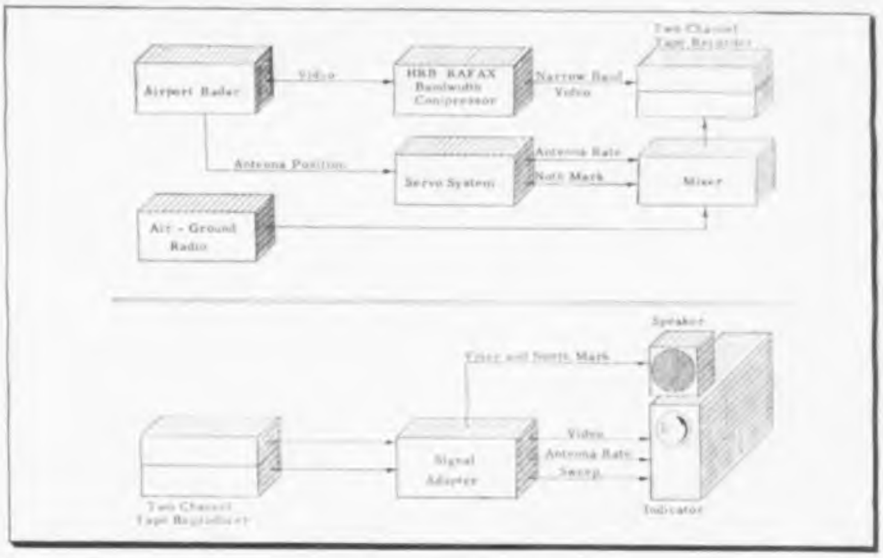


Fig. 2: Air-ground voice, radar video, and antenna position are recorded simultaneously on tape

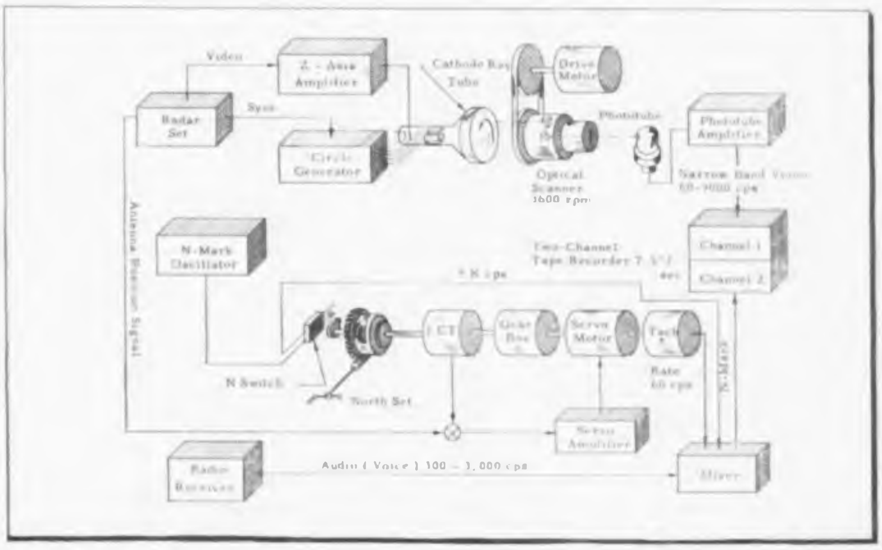


Fig. 3: Video signals are stored on face of an intensity modulated CRT scanned by circular trace

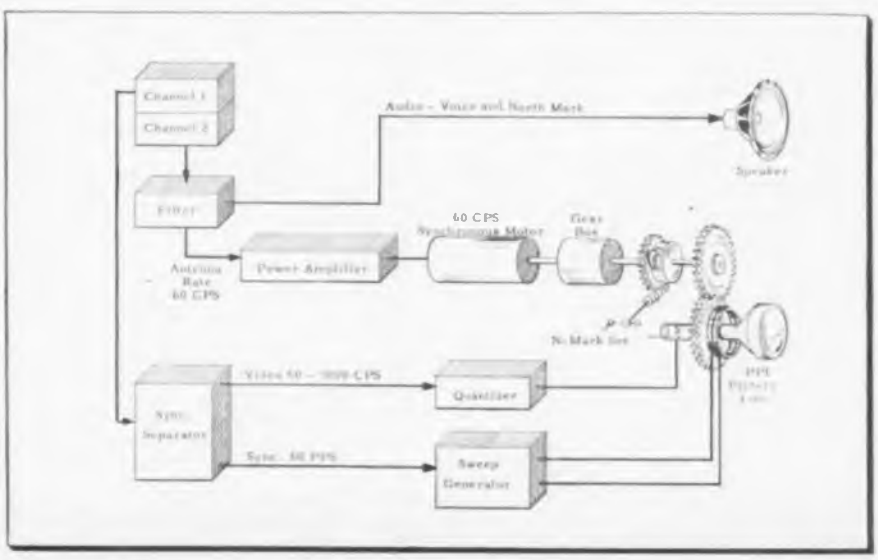


Fig. 4: Reproducing the PPI picture. Video signals may be fed to indicator or through quantizer

Part Two of Two Parts

Graphical Methods Speed

Thorough quantitative analysis of static and dynamic characteristics in different modes of operation shows how high efficiency in power output applications is achieved

By R. F. SHEA
General Electric Co.
Syracuse, N.Y.

PART *One of this article, published in the June 1954 issue of* TELE-TECH & Electronic Industries, *described the basic design considerations for transistorized equipment. In this final part, transistor characteristics in different modes of operation are examined.*

The design considerations for the stage preceding the output stage can be deduced from the above analysis of the output stage. For example, in the example of the 2N44 in the grounded-base configuration, operating at $I_c = 5.0$ ma, $V_c = 20$ volts, we found that the source should present an impedance of about 100 ohms and that the emitter required a voltage excursion of 0.115 volt, current excursion of 9.2 ma. Let us consider the case where the driver is a grounded-emitter stage, also employing the 2N44. Calculation of the output resistance of this stage shows it to be about 22,000 ohms. To reduce this to 100 ohms requires a transformer with a step-down ratio of approximately 15:1. Therefore on the primary side the grounded-emitter stage must supply a signal with an excursion of 15 x 0.115 or 1.73 volts, current excursion of 9.2/15 or 0.61 ma. In order that the driver shall not provide a limitation by clipping before the output stage we should have a good margin of safety. For this particular condition, therefore, a good operating point for the driver would be a collector voltage of 4 — 5 volts, collector current of about 2 ma. The driver would therefore require about 10 mw of dissipation, compared to the 96 required by the output stage. While the driver dissipation could be reduced below this figure the net overall saving would not justify the added fussiness of bias stabilization.

In general it is inadvisable to use either the grounded-base or grounded-collector configurations as drivers. The former has too high an output impedance, making the design of the transformer more complex, while the latter has low power gain. Thus the grounded-emitter configuration is generally used except in special cases.

Resistance-capacitance coupling may be used between the driver and the output stage, also choke-capacitance coupling. This, of course, produces a much greater mismatch, although there may be better fidelity as a compensation. Thus, in the example used above, if a grounded-emitter stage were *R-C* coupled directly to the grounded-base output stage, such that the driver now had to supply a voltage excursion of 0.115 volt, current excursion of 9.2 ma, the driver operating point should be about $V_c = 1.0$ volt, $I_c =$ 10 ma., or again a dissipation of about 10 mw. Direct coupling is much more practical when the output stage is a grounded-emitter or grounded-collector stage, although the distortion due to crowding of the collector characteristics is greater when the source impedance is high.

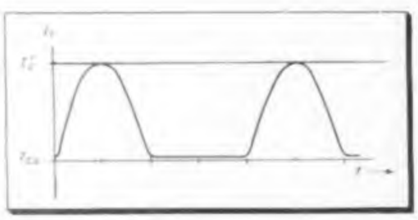


Fig. 13: Collector current—Class B operation

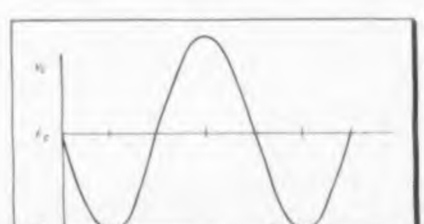
Class B Power Amplifiers

Transistors lend themselves especially well to the design of class B power amplifiers for two principle reasons. In the first place a class B transistor amplifier is capable of very high efficiency, around 75%. Secondly, the elimination of the filament power means that the very low stand-by power required may be a predominating factor in the design of portable battery-operated equipment. In general it is more difficult to achieve the same degree of low distortion as is obtainable with class A amplifiers, however there are a great many cases where distortion of the order of 5% is entirely tolerable, and this can readily be achieved using properly designed class B amplifiers. Lower distortion than this can be obtained by means of feedback, in the same manner as for vacuum tubes.

Static Characteristics; Grounded-Base Configuration: Fig. 10 shows a typical set of static characteristics, such as those of the type 2N44 transistor, with a 1000 ohm load line connecting the $V_c = 20$ volt and $I_c = 20$ ma points. One major difference between class A and class B operation is apparent from this choice, i.e., the considerable difference in range of current. The voltage supplied by the collector battery is the same as that for the class A condition when the limitation in each case is the maximum permissible peak voltage. The reason for this is that when two transistors are used (as they must be in class B), with their output transformers coupled to the load, the peak swing encountered by each will be approximately twice the quiescent collector voltage, since each has the swing from the other applied to its collector during its nonconductive half-cycle, as will be shown later. However, the permissible current excursion is much greater, for the same power dissipation in the transistors, due to the greater efficiency. Thus, in the operation illustrated in Fig. 10 the collector voltage swing is approximately equal to $2E_c$ or 40 volts, while the current swing is approximately 20 ma.

Determination of Quiescent Operating Point: The location of the

Fig. 14: Instantaneous collector voltage



Transistor Power Amplifier Design

operating point with no signal is determined by the amount of dc resistance in the emitter-base circuit. If there is a large amount of resistance in series with the emitter, low resistance in the base lead, such that the emitter current is essentially zero, the operating point will approach the point A, corresponding to the intersection of the dc load line R_l with the I_{c_0} curve. If there is a large dc resistance in series with the base lead the operating point will approach A′, the intersection of the dc load line with the $I_b = O$ curve. If, as is most often the case, there is very little dc resistance between the emitter and base the operating point will be between these two extremes, at that point where $V_e = O$. It will be recalled that in most cases this point is very close to the $I_c = O$ point, hence as a good approximation we can assume that one extremity of the swing is at I_{c0}.

Power Output; Grounded-Base Configuration: The other extremity is the point B, where the a-c load line r_l intersects the current axis. This point corresponds to a peak emitter current designated as I_e', peak collector current I_c' and a corresponding peak emitter voltage V_e'. The collector voltage swing is therefore approximately equal to 2 E_c, the collector current swing approximately $I_c' - I_{c0}$. The power output per pair of transistors, therefore, is

$$P_o = E_c\,(I_c' - I_{c0})/2$$

In the example illustrated by Fig. 10, assuming $I_{c_0} = 0.01$ ma this power is

$$20 \times 19.99/2 \cong \text{mw.}$$

Thus a pair of 2N44 transistors, operating class B in this manner, would be capable of approximately 200 mw of power output.

Half-cycle Operation

Efficiency; Grounded-Base Configuration: In class B amplifiers each of the two transistors operates during one half of the cycle, is cut off during the other half. If the signal applied to the emitter is sinusoidal the resulting collector current for each transistor will have the wave form shown in Fig. 13. The minimum value of current will be approximately eqaul to I_{c_0} (in most transistors the collector current will not decrease appreciably below I_{c_0} even upon the application of cutoff current to the emitter). The average value of this collector current is given by

$$I_c\ avg. = [I_c' + I_{c0}\,(\pi - 1)]/\pi \qquad (28)$$

The power supplied by the battery per transistor is equal to this average value multiplied by the battery potential, E_c, or total power,

$$P_{dc} = 2E_c[I_c' + I_{c0}\,(\pi - 1)]/\pi \qquad (29)$$

The efficiency is therefore the total power output as given by eq. 27) divided by this d-c power, or

$$\eta = \frac{\pi\,(I_c' - I_{c0})}{4\,[I_c' + I_{c0}\,(\pi - 1)]} \qquad (30)$$

If I_{c_0} is negligible as compared to the peak swing I_c', as is usually the case, the efficiency at full swing approaches $\pi/4$ or approximately 78%. Class B amplifiers with efficiencies of 75% have been constructed.

Collector Dissipation: The power dissipated in the collector will be the difference between the power output and the d-c power supplied by the battery, or

$$P_{diss.} = E_c\left[[I_c' + I_{c0}\,(\pi - 1)]/\pi - (I_c' - I_{c0})/4\right] \qquad (31)$$

Under the conditions where I_{c_0} may be neglected this is approximately

$$P_{diss.} \cong 0.068\,E_c\,I_c' \qquad (32)$$

and, in the above example, is approximately 27 mw per transistor.

This illustrates the considerable advantage to be gained from the use of class B with transistors of comparatively limited power ratings. In the case of the type 2N44 transistor, for example, with a rated maximum dissipation of 150 mw about 125-135 mw can be obtained from a class A pair. The same pair will supply about one watt in class B. The reason for this great disparagance is that the collector dissipation is 150 mw in the class A amplifier even with no signal, which limits the operating point. The standby dissipation in the class B case is only a small fraction of this, approximately $E_c\,I_{c_0}$, and full dissipation is only encountered on full swings.

Instantaneous Power Dissipation: Fig. 14 shows how the collector voltage varies during the power cycle. It will drop to zero at one extremity of the swing, corresponding to point B of Fig. 10, and rise to approximately twice the supply voltage. The instantaneous power will be the product of the current, as given by Fig. 13 and this instantaneous voltage. This power will vary as shown in Fig. 15, and will have two peaks during each half cycle. The peak power will occur approximately at that point where the product of the sine and (1-sine) is

Fig. 15: Power variations per half cycle

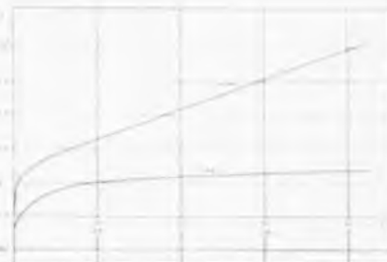


Fig. 16: Emitter current vs. emitter voltage

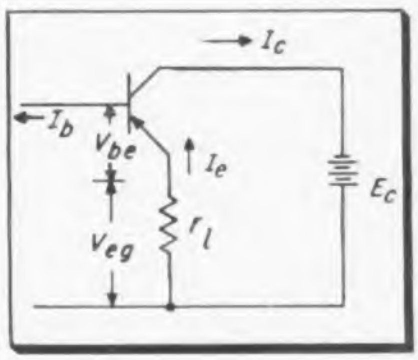


Fig. 17: The grounded collector stage

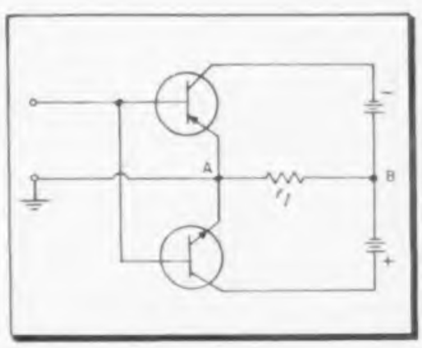


Fig. 18: Parallel n-p-n and p-n-p transistors

Transistor Amplifier (*Continued*)

a maximum. At this point the peak power will be approximately $E_c\, I_c'/4$, or in our example 100 mw. Thus the peak power per transistor will be approximately one half the power output, $3\frac{3}{4}$ times the average power dissipation. The ability of the transistor to withstand this peak power dissipation will depend upon the character of the signal, the frequency and the thermal characteristics of the transistor package.

Load Resistance. Grounded-Base Configuration: From Fig. 10 the load resistance per transistor is seen to be

$$r_l = E_c/(I_c' - I_{co}) \qquad (33)$$

The push-pull load resistance presented by the output transformer to the two collectors will be four times this, hence, if the load on the secondary side is r_l' the transformer ratio will be

$$2\sqrt{\frac{E_c/(I_c' - I_{co})}{r_l'}}$$

Input Resistance; Grounded-Base Configuration: As in the case of class A amplifiers the input circuit is nonlinear, with the emitter voltage varying with emitter current as shown in Fig. 16. This is the same curve as shown previously, extended to the higher current ranges to be encountered in class B operation. In spite of the nonlinearity we can use the peak value of input resistance (i.e. the value at peak emitter current swing, not the maximum value of emitter resistance) as an approximation without too great an error. This will permit the comparison of power gains of the various configurations and also give an idea of the relative mismatch involved. This peak input resistance, per transistor, is

$$r_i \text{ peak} = V_e'/I_e' \qquad (34)$$

The total input resistance from emitter to emitter is four times this value.

Effect of Generator Resistance: This may be visualized by applying the data obtained for the class A amplifier directly, employing a mirror image of the characteristic so obtained to represent the push-pull operation. Fig. 11 shows such a set of curves, obtained from the curves of Fig. 2. The curve for $r_g = 100$ ohms is identical with that of Fig. 2. The other two curves are obtained from the 100 ohm curve by obtaining the emitter currents corresponding to the respective values of collector currents and adding a drop to the 100 ohm values equal to the product of the emitter current and the dif-

(*Continued on page* 92)

Table 1

CLASS B PUSH-PULL AMPLIFIERS

	Grounded-Base	Grounded-Emitter	Grounded-Collector
Ac power output	$\frac{\alpha E_c I_c'}{2}$	$\frac{\alpha E_c I_c'}{2}$	$\frac{E_c I_c'}{2}$
Dc power	$\frac{2\alpha E_c I_c'}{\pi}$	$\frac{2\alpha E_c I_c'}{\pi}$	$\frac{2E_c I_c'}{\pi}$
η, percent	78%	78%	78%
Load resistance	$\frac{4E_c}{\alpha I_c'}$	$\frac{4E_c}{\alpha I_c'}$	$\frac{4E_c}{I_c'}$
Peak input resistance per transistor	$\frac{V_e'}{I_e'}$	$\frac{V_e'}{I_e'(1-\alpha)}$	$\frac{E_c}{I_e'(1-\alpha)}$
Peak ac power out	$\alpha E_c I_c'$	$\alpha E_c I_c'$	$E_c I_c'$
Peak ac power in	$V_e I_e'$	$V_e' I_e'(1-\alpha)$	$E_c I_e'(1-\alpha)$
Peak power gain	$\frac{\alpha E_c}{V_e'}$	$\left(\frac{\alpha}{1-\alpha}\right)\frac{E_c}{(V_e')}$	$\frac{1}{1-\alpha}$

Trend to Transistors in New Equipment

TRANSISTORS are coming in for an increased share of attention from the designers of industrial and other specialized equipment. By way of pointing out this trend, Raytheon Mfg. Co. recently described some of the transistorized units being manufactured with their product.

Fig. 1: Transistor a-f amplifier on 16mm projector

At Ampro Corp., Chicago, Ill., engineers incorporated a transistor into their motion picture projector audio amplifier system. (See Fig. 1) Use of this device eliminated the need for a matching transformer and a tube, and, in addition, it provided better signal-to-noise ratio and eliminated magnetic noise pickup. Most important, it allowed Ampro to produce a single-case optical-magnetic "playback" type 16 mm projector at decreased cost.

Audio Oscillator

In the test equipment line, General Radio Co., Cambridge, Mass., has announced a transistorized audio oscillator designed for use in making tests in telephone, broadcasting and similar fields (Fig. 2). Designated the 1307-A, this transistor oscillator uses a Hartley oscillator circuit designed around a P-N-P junction-type transistor. A switch arrangement sets the operation at 400 or 1000 CPS. Battery operated, its portability makes it useful in continuity checks of audio systems, in setting operating levels, in check-

(*Continued on page* 124)

Fig. 2: P-N-P transistor is heart of this tester

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Renovation of Variable Pads

L. E. RYAN

THE quality of the immediate post-war variable attenuators left plenty to be desired. After a few hours of use, particularly in a turntable circuit, the contacts became scored or showed signs of uneven wear. The usual maintenance with carbon tet and lubricant did not suffice. No doubt they were replaced. Here is how they can be renovated for future use.

Refaced contacts mean new life for this pad

Break down pad by removing nut on sleeve bearing. Do not attempt to remove attenuator "c" ring. Place a piece of sandpaper, "OO" or finer, on the turntable and run at 78. Finish in same manner with *colcothar* cloth, or a piece of canvas and jeweler's rouge. Apply pressure with the forefinger only. This will assure even abrasion of all contacts. Clean thoroughly with a toothbrush and carbon tet.

Before reassembly the wiper contact should be checked for the proper tension. Make sure that corners of same are not digging in.

Video Chopper

WILLIAM E. MORRISON JR., WCAU-TV, Philadelphia, Pa.

AT any TV transmitter console there is need for a dependable and accurate way of measuring modulation percentage of the video signal. We have found a very simple method of chopping out a small amount of the composite signal, which gives a 100% line just above the peak video signal. This line should be approximately 10% above the top picture information, if the video and sync. levels are correct. Having this 100% mark enables one to picture transmitter modulation accurately. This 100% mark shows up as a line on the horizontal position of the master monitor and on vertical position it shows up as one dot just above each frame of the video information.

This is done by a simple multivibrator circuit triggered by injecting 60 cycles on the number one grid. If the RC circuit is well balanced on both sides, a clean saw tooth waveform is produced on plate No. 2 of the 6SN7 tube. In series with the 68K ohm plate load resistor is a sensitive 6K ohm relay, which is energized on each pulse. The two contacts of the S.P.S.T. relay are connected by means of a coaxial line to the RF diode used for picture monitoring the transmitter output. This relay can be set to chop as small an amount as one line per frame. The phase of this chopping is set by the 200K ohm Pot. from grid No. 1 to ground. A 6K ohm resistor is used in place of the relay when it is not being used. This small unit can be placed under the console in some convenient position. Thus the multivator will always be "hot" and the switch need only be on when it is necessary to measure modulation.

The unit consists of two tubes, a 6X5 which is the rectifier for the power supply and the 6SN7 which is the multivibrator itself. Also mounted on the 5 x 7 chassis are a power trans., power switch, pilot light, phasing control and the relay.

Fast Dubbing

DICK MEYER, Recording Director, WAGM, Presque Isle, Me.

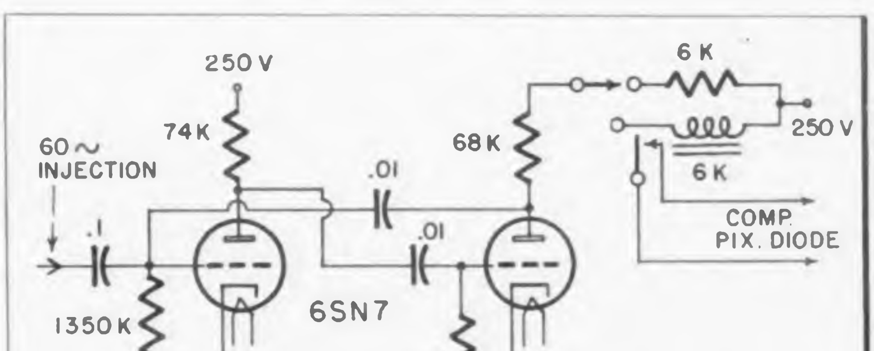
If those stations facing the problem of fast dubbing have two tape machines available with two speeds, i.e. 7½ I.P.S. and 15 I.P.S., their problems are over. WAGM has a system used particularly for dubbing between WAGM and their station in Houlton, 40 miles away. It can also be used for fast dubbing in a station studio operation.

Tape recorded at 7½ I.P.S. is sent at 15 I.P.S. This is received by another machine at 15 I.P.S. When the tape is played back at the regular 7½, the tape is normal.

We lease a 24 hour line from the

(*Continued on page* 82)

% modulation is seen visually by sampling video signal with this multivibrator and relay arrangement



NBS Cathode Emission Tracer

Checking cathode emission visually at NBS labs

A cathode emission tracer developed by L. A. Marzetta of the National Bureau of Standards provides a rapid, convenient method for measuring and evaluating the performance of thermionic cathodes.

The new instrument (see Fig.) automatically produces a calibrated plot of the emission characteristics of the cathode of a diode on the screen of a cathode-ray oscilloscope. A "$2/3$-power network" is incorporated into the system and may be used at the option of the operator for linearizing the plot. Negligible heat is contributed to the diode under test since the tube is subjected to only a 10 or 100 μsec pulse at rates of either 5 or 30 CPS. Provision is made for instantaneous plate currents as high as 10 a. or for plate voltages up to 5000 v.

The instrument developed by NBS scans the tube characteristic curve with a brief saw-tooth voltage wave applied to the diode at a low repetition rate. At the discretion of the operator, the saw-tooth voltage wave can be either 10 or 100 μsecs long, and the repetition rate can be either 5 or 30 CPS. "Single-shot" operation is available as well. Since the duty factor is low, the diode need dissipate only the negligible amount of heat that is contributed by emission current. Furthermore, the gradual voltage rise eliminates most of the sparking.

Two parallel-connected power triodes (type 304TH's) are connected in series with the test diode. The high transconductance of this type of tube permits large changes of plate current for moderate grid swings below zero bias. The grids of the control triodes are raised from cutoff to zero bias with a saw-tooth signal, resulting in a saw-tooth pulse through the test diode. This signal is also applied to the horizontal amplifier of the oscilloscope, and the voltage across the tube appears on the vertical amplifier. The composition of the signals produces the desired emission characteristic.

A convenient feature of the NBS cathode emission tracer is a special network capable of linearizing a tube characteristic in which the plate current varies as the $3/2$-power of the plate voltage. Excursion from the linearized function because of current saturation becomes more evident when this feature is used, and it eliminates the manual plotting of points on $2/3$-power graph paper. The special network uses a series of germanium diodes, each biased to a different voltage level. As the instantaneous input voltage increases, successively more diodes become conductive. The linearizing action is achieved through the resulting variation in impedance.

Parachute Telemetering

A PARACHUTE telemetering system recently developed by the National Bureau of Standards is facilitating tests of experimental parachutes for use with modern high-speed aircraft. Electronic equipment mounted inside a parachute-borne torso-shaped dummy (see Fig. 1) transmits by radio needed information—altitude, and forces at various points—in coded form to a ground station, where the information is decoded. The system was developed for the Navy Bureau of Aeronautics by M. L. Greenough, C. C. Gordon and associates of NBS.

In the NBS parachute telemetering system, resistance strain gages are arranged to sense both altitude (pressure) and the tension in various harness straps. An inductive-commutator arrangement excites one strain gage at a time, the output of the gages being combined to modulate a small battery-powered radio transmitter. Seven measurement channels and a calibration channel are provided. At the ground station, a spot on the face of a cathode-ray tube moves up and down with the amplitude of the modulating signal. This spot is recorded on continuously moving photographic film. The film record is then transcribed, using a semi-automatic film reader, to obtain plots of altitude vs. time and harness tension vs. time.

The airborne transmitter operates on 217 MC and has an output of about 0.75 watt and a range of about 2 to 10 mi.

The tensiometer which senses forces in the parachute harness is an H-shaped steel structure to which resistance-wire strain gages are cemented.

Modulation of the transmitter with the signal from one channel at a time is accomplished by means of a "coder" of novel design. The coder supplies a series of time-sequential pulses to eight resistance bridges—one for the altimeter, one for each of six tensiometers, and one fixed bridge for calibration. 100 PPS are received at each bridge.

The bridge-unbalance signals are first amplified and then converted to amplitude modulation of a 15 KC subcarrier. This subcarrier in turn frequency-moduates the 217 MC transmitter by means of a reactance-tube modulator. A flexible transmitting antenna projects from the top of the dummy that houses all of the electronic equipment.

Fig. 1: Dummy with transmitter and gages

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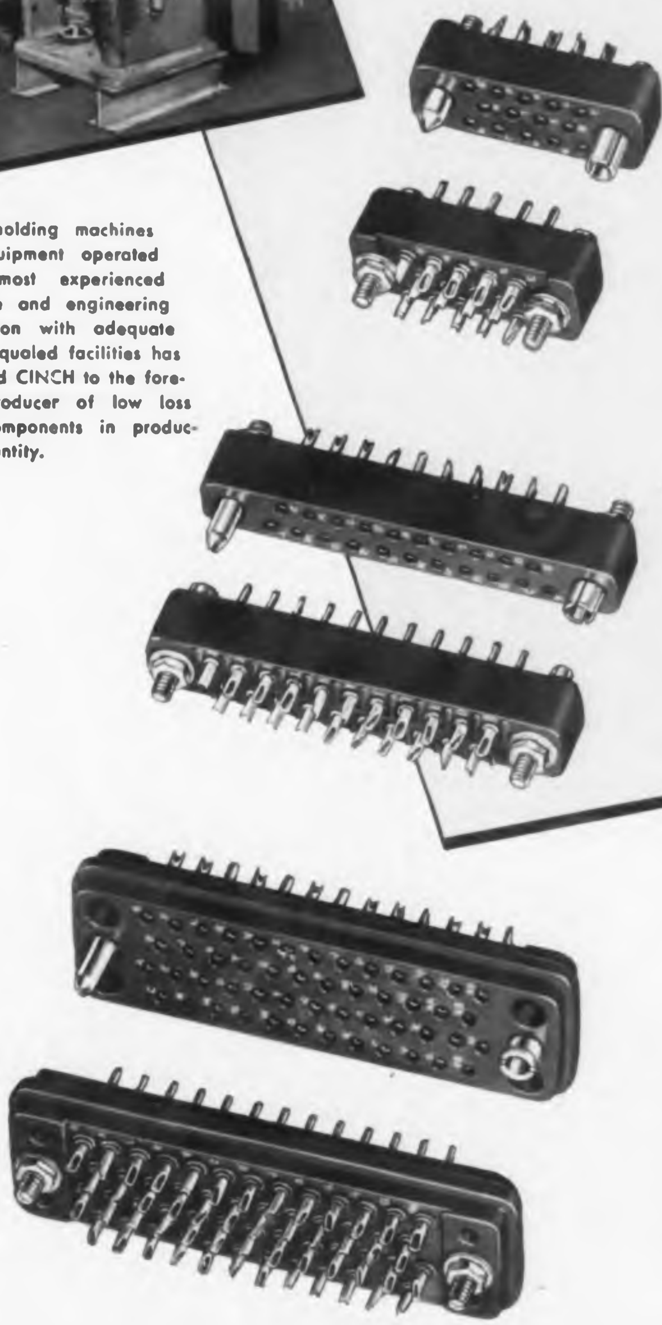

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WASHINGTON

News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

TELEVISION GROWTH—Eighty-six per cent of the approximately 670 television stations serving 325 communities, envisioned as the TV potential for the nation, have been authorized by the FCC, its acting Chairman Rosel H. Hyde recently disclosed. In less than a year the number of television stations has been practically doubled, through the processing accomplishments of the Commission and its staff, in cooperation with the broadcasting industry, Chairman Hyde pointed out. At the beginning of June, 377 TV stations were operating in 237 communities of the United States. Another 200 stations have been authorized to go on the air. The remaining 100 or so applications, in various stages of hearings, will be, for the most part, determined within the next few months. This expansion of the world's greatest medium of mass communication has been accomplished under Mr. Hyde's leadership in a year's span, after it had been forecast that the liquidation of the TV "freeze" would take years.

UHF BEFORE SENATE—Major tangible result of hearings before Senate Interstate Commerce Communications subcommittee, headed by Senator Charles E. Potter (R., Mich.), has been the proposal for the elimination of the 10% federal excise tax on UHF TV sets and component parts at the manufacturing level. With the unanimous backing by this Senate subcommittee and with the strong support of the National Association of Radio and Television Broadcasters and the Radio-Electronics-Television Manufacturing Association, this excise tax slash, which is aimed to encourage the purchase of UHF television sets, appeared the most concrete result of the several weeks' hearings before the subcommittee in its UHF television study. Adoption by the Senate of this excise tax elimination, it was felt, would receive the concurrence of the House which originates tax legislation.

POLICY DEFINED—With the desire of Congress to enact only the administration's "must" legislation, coupled with the mass of conflicting testimony, the Senate Communications Subcommittee was not expected to enact any legislation on UHF television at this session of Congress which is slated to reach the stage of adjournment during July. It was foreseen that Senator Potter and his subcommittee would outline, in their report, some broad policies for the FCC to consider in its blueprinting of UHF television. These policy recommendations would be highlighted, it was felt, with proposals for a revision of the television allocations plan which might include the suggestion of moving all television eventually to the UHF bands. The future role of the networks and network TV, since much of the testimony has been on these subjects, was regarded as another phase on which the Senate subcommittee might give the FCC broad directions.

RAILROAD RADIO—Nine years ago the FCC granted the first frequency allocation for railroad use. The Association of American Railroads pointed out recently that in that brief period the expansion of radio-communication facilities on the nation's railroads has been "phenomenal" and is continuing to grow as a major element of railroad communications. The railroad radio facilities have "mushroomed" by four times the number of installations of four years ago and almost double that of two years ago.

INDUSTRIAL COMMUNICATIONS—Facilities of the Bell System and Western Union were characterized as "the first and best bet" for the communications services of the major industrial organizations of the nation by FCC Commissioner Robert E. Lee in an address at the annual meeting of the Industrial Communications Association. Commissioner Lee emphasized that the telephone and telegraph communications companies can furnish facilities with the most effective use of the limited available spectrum space, avoiding the waste involved in duplicate communication systems.

DEEP CONCERN—Encroachment by the telephone companies on private radio facilities in the mobile, radio, microwave and other point-to-point communications fields through contracts or arrangements with private users was termed "a matter of deep concern" by the leading spokesman of the American Petroleum Institute at a recent meeting of the National Petroleum Radio Frequency Coordinating Association. Eventually, the spokesman emphasized, the telephone companies will exert strong pressure to have the present private radio frequencies assigned to common carriers on the premise of more efficient use of such frequencies.

MICROWAVE COUNCIL—Six leading organizations of microwave radio users have approved the by-laws and policies of the Microwave Users Council. These included Aeronautical Radio, Utilities Radio, National Bus Communications, Association of American Railroads, the Petroleum Industry, and the National Forest Industry Communications.

National Press Building
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ROLAND C. DAVIES
Washington Editor

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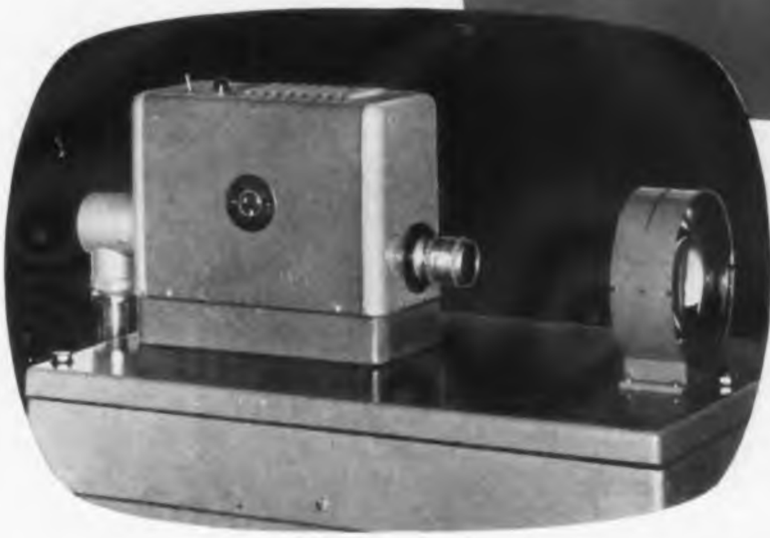

- Low first cost; low operating cost
- Operates unattended; frees studio manpower
- Photo-conductive tube
- Stable black level
- No shading correction required
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- Lowest "noise" level in television
- Easy to multiplex

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Test this GPL chain in your station, with your projectors and monitors . . . your operating conditions. See for yourself its almost automatic operation, its quality with all types of film. No charge, no obligation. Just write, wire or phone.

TWO MAJOR ADVANTAGES for station owners sum up the features of this new Vidicon Film Chain produced by GPL.

First, it sets a new high for quality.

Second, it saves dollars. And more dollars.

It's built around a photo-conductive tube, with long-proven GPL circuits and construction techniques. It is compact, simple and rugged . . . easy to maintain, flexible for 4 *or more* multiplex combinations. All your existing projectors, monitors, master monitor and standard racks can be used. *A stable black level, and almost complete absence of spurious signals, eliminates the need of constant attention. You save man-hours that previously went into monotonous monitoring.*

This GPL chain has the lowest noise level in television. The grey scale reproduction is true. In all, with this GPL combination of both quality and economy, you can afford to retire your iconoscopes to slides. And, in equipping a new station, the GPL Vidicon is unmatched for value.

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New Technical Products

TAPE RECORDER

The 610-A battery-powered portable tape recorder has a spring-wound motor and operates at a tape-speed of $^{15}/_{16}$ ips while maintaining a frequency response of 300 to 2,500 CPS. Constant

tape speeds with low flutter of ±0.25% over the full winding cycle of 30 minutes is accomplished by a patented centrifugal flyball governor on the spring motor. Dual track recording provides 2 hr./track or 4 hrs. total playing time on a 5 in. reel that accommodates 600 ft. of standard ¼ in. width tape. **Magnemite Div., Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TAPE RECORDER

The Model 600 is a 28-pound magnetic tape recorder that measures 16 x 14 x 8 in. Each unit is factory-tested to equal or exceed published figures of its performance. At 7½ ips speed, the unit

has these performance characteristics: frequency response, 40 to 15,000 CPS, signal-to-noise ratio over 55 db, flutter and wow under 0.25%. Timing accuracy within ±3.6 secs. for full 30-minute tape length, direct reading meter for record level control, 3 separate heads (erase, record, and playback) and separate record and playback amplifiers. **Ampex Corp., 934 Charter St., Redwood City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

POTENTIOMETER

Model HP-300 is a precision, high-resolution, low torque linear potentiometer that achieves exceptionally high winding resolution through long winding length and a small diameter cylin-

drical Kohlrausch winding. Ganging is accomplished by interlocking surfaces rigidly secured by threaded tie rods. Housing is one-piece molded BM17748 Bakelite. Phasing can be accomplished by staggering housings in 90° increments, or unit contact brushes can be phased to keep end and collector terminals in alignment. **DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TWO-WAY RADIO UNITS

The MC 2-W and MC 2-N are single-unit mobile equipments that can be interchangeably operated on 6 or 12 v dc. Combinations consist of transmitter-receiver ES-22-A (for narrow band op-

eration) or ES-22-B (for wide band use), EC-9-A control unit, speaker EZ-1-A, spring base antenna, military type microphone, power, and connecting cables. Substitution of power supply control, 4EC14A3, for EC-9-A and EZ-1-A, enables the combinations to be used as 15 w base stations for 117 v ac operation. **General Electric Co., Electronic Div., Electronics Park, Syracuse 1, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

POTENTIOMETER

The Type 910 rectilinear type potentiometer has a rigid construction that provides and maintains tight electrical tolerances. Three through studs, double bearings, rigid front plates, rigidly

mounted resistance elements, a slip ring carrier, and strong cross frames, make the design simple, sturdy, yet flexible. The unit meets or exceeds such military specifications as MIL-S5272A. **Fairchild Camera & Instrument Corp., Potentiometer Div., 225 Park Ave., Hicksville, L. I., N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

More New Products on P. 84

MODULATOR

The Type 1000-P7 balanced modulator has a modulation-frequency response flat from dc to 20 MC, thus making it suitable for short pulses and any wide-band modulation. The useable

carrier-frequency range extends from 60 to 2,300 MC, and 100% amplitude modulation can be obtained throughout this carrier range. Double sideband suppressed-carrier modulation, and pulse modulation with 60-db carrier suppression between pulses are possible throughout the entire carrier frequency range. **General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

NOW Soundcraft brings you tape perfection!

the revolutionary new

LIFETIME® magnetic recording tape

Here is news of monumental importance to every recording perfectionist. It is the all new Soundcraft LIFETIME Tape. We've called this amazing high-fidelity tape "LIFETIME" because . . .

*It will last, to the best of engineering knowledge, forever!**

Your recording machine will never break it. Neither will careless handling. Because LIFETIME Tape is fully a third as strong as machine steel. It ends tape shrinkage and stretch when your home or studio air is dry or humid. It will never cup or curl. You can forget about storage problems.

All this means that for the first time you can preserve your important recordings, capture and keep those precious moments of music and the spoken word, for generations to come—in all their original fidelity!

LIFETIME Tape owes these new and permanent qualities to its new magnetic oxide coating, and to its base of DuPont "Mylar" polyester film. For both are free of plasticizers whose gradual loss from ordinary tapes limits their useful life.

LIFETIME Tape is indeed the biggest development in tape since the tape recorder itself. Your serious recordings deserve it. Order LIFETIME Tape today.

Like all Soundcraft magnetic products, LIFETIME Tape is Micro-Polished®, assuring maximum high-frequency response. It provides uniformity of ±¼ db. within a reel, and ±½ db. reel-to-reel. It is splice-free in 600-, 1200- and 2400-foot reels.

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***LIFETIME GUARANTEE.** Soundcraft unconditionally guarantees that Soundcraft LIFETIME Recording Tape will never break or curl, and that the magnetic oxide will never flake or crack, when the tape is used under normal conditions of recording and playback.

CUES for BROADCASTERS

(*Continued from page 75*)

local railroad and often encounter morse code on the line. Sometimes, even a high output is insufficient to overcome the noise. However, when the noise is recorded at 15 I.P.S. along with the 7½ tape, and then played back later, the frequency of the noise (which is usually in the audible range) is cut in half, making the morse practically inaudible. This is also adaptable to machines with speeds of 7½ and 3-3/4.

Xtal Temperature Control Oven

EDWARD J. WHITE, 136 Woodlawn Street, Chicopee Falls, Mass.

RECENTLY the transmitter location of WMAS-FM, was changed and remote control installed. Since such installations are subject to considerable temperature variations it was decided to protect the crystal from such changes. The crystal was already enclosed in a vacuum which was sufficient for attended operation of our WE 503-B1 transmitter.

The oven to maintain 130° is made from ¾ inch pine, glued and nailed, except for the removable top panel which is of ¼ inch plywood. The sides and back are grooved to receive the sliding top. The box is lined with aluminum for better distribution and retention of heat. A 1¾ inch hole was cut in the back to let the crystal and its shield project into the box which is fastened to the transmitter with self-tapping screws.

All components were mounted externally with the exception of the heating resistors and a pilot lamp. The 100 ohm resistors have a 30 ohm tap and a 6.3 volt pilot lamp shunted across the tap gives a visible indication when the unit is heating.

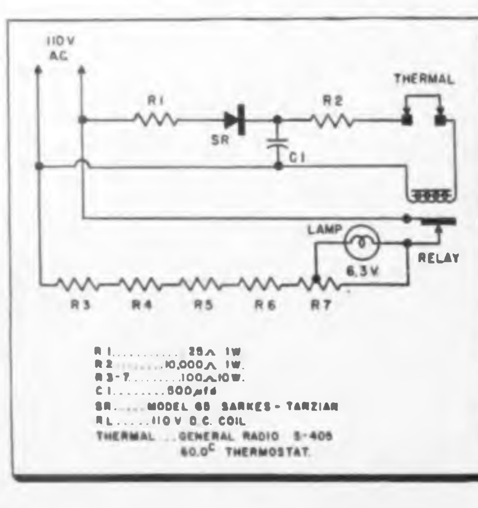
Time & "Beep" Signals

J. C. FRENCH, 5243 LaGrange Rd., LaGrange, Ill.

A Western Union time circuit was not available, and since electric clocks proved undependable, a clock with a setting mechanism was purchased from the Self-Winding Clock Company. Simplexing one of the leased lines between studio and transmitter, and inserting a battery and switch at the transmitter permits the clocks at the studio and transmitter to be set by the transmitter engineer, who checks his clock by comparison with WWV on a monitor receiver.

The General Radio Frequency Deviation Meter has a panel jack for monitoring the 1000 cycle difference between the station carrier and the internal oscillator. This signal is run through a double throw switch to a low level point in the audio circuits. The 1000 cycle signal must normally be grounded, or it will feed through the capacity of the switch and constantly be on the air.

The self-winding clock is designed to be set only within seconds of the hour. The switch to operate the setting mechanism is combined with the "beep" switch so that as the clock is set at the hour, the "beep" is placed on the carrier. This appeals to the management, since it is tailor made for sale as a time announcement to a local jeweler.



(l) Wiring diagram for crystal oven. (below) Box is lined with aluminum, and fastened directly to transmitter. Crystal projects into oven through hole in back

audiotape

TRADE MARK

on Mylar* polyester film offers you these important new advantages

1. **many times stronger**

2. **withstands extreme temperatures**

3. **impervious to moisture**

4. **maximum storage life**

5. **most permanent magnetic recording medium ever developed**

*Du Pont Trade Mark

Audiotape on "Mylar" polyester film provides a degree of permanence and durability unattainable with any other base material.

Its exceptional mechanical strength makes it practically unbreakable in normal use. Polyester remains stable over a temperature range from 58° below zero to 302° Fahrenheit. It is virtually immune to humidity or moisture in any concentration — can be stored for long periods of time without embrittling of the base material.

The new polyester Audiotape has exactly the same magnetic characteristics as the standard plastic-base Audiotape — assures the same BALANCED PERFORMANCE and faithful reproduction that have made it first choice with so many professional recordists all over the world.

If you have been troubled with tape breakage, high humidity or dryness, Audiotape on "Mylar" will prove well worth the somewhat higher price. In standard thickness (1½ mil), for example, the cost is only 50% more than regular plastic base tape.

Ask your dealer for our new folder describing Audiotape on "Mylar". Or write to Audio Devices, Inc.

PHYSICAL PROPERTIES

"Mylar" polyester film compared to ordinary plastic base material (cellulose acetate)

PROPERTY	1 Mil "MYLAR"	1.5 Mil "MYLAR"	2 Mil "MYLAR"	1.5 Mil Acetate
Tensile Strength, psi	25,000	25,000	25,000	11,000
Impact Strength, kg-cm	90	170	200	10
Tear Strength, grams	22	35	75	5
Break Elongation, %	80	95	105	20
Softening Point, °F	464-473	464-473	464-473	149-230
Moisture Absorption, % (at 100% RH)	0.3	0.3	0.3	9.0
Bending Modulus, psi	500,000	500,000	500.000	350,000
Flex Life, cycles at 0° F	20,000	—	—	500

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New Test Equipment

TUBE VOLTMETER

The 302 "Polymeter" offers a subminiature vacuum tube r-f probe, a peak-to-peak scale, a 7-inch meter movement, a lighted scale, a patented linearity circuit, an input impedance of

17 megohms, shielded ac and r-f leads, and screw-on connectors. Reads peak-to-peak voltages from 200 mv to 2,800 v; dc voltages from 200 mv to 2,800 v; dc voltages of plus or minus polarity from 50 mv to 1,000 v; ac voltages from 50 mv to 1,000 v, r-f voltages from 100 mv to 300 v in the bond of 10 KC to 300 MC. **Sylvania Electric Products Inc., 1221 West Third St., Williamsport, Pa.** —TELE-TECH & ELECTRONIC INDUSTRIES.

POWER SUPPLY

The Model TG-3 regulated power supply is a stable source of dc current voltage that is suitable for laboratory or experimental use. Regulated voltage range is 75 v to 225 v. Current range

is 0 to 50 ma, max. Regulation, less than 0.1% from no load to full load at line voltages 105v—125v. Ripple, less than 1.5 mv, rms. AC output, 6.3 v at 1.2 amp, max. Output impedance, 2 ohms. Power source, 105-125 v, 60 CPS, 50 w. Dimensions, 5 x 6 x 9 in. Available for standard rack and panel mounting. **G. W. Associates, P. O. Box 2263, El Segundo, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PHASE COUNTER

A new ultra-low frequency phase counter consists of a plug-in decade counter and switching circuit, plug-in timing unit, and a plug-in function unit consisting of two circuits.

A front panel switch selects the number of output pulses/sec. from the timing unit. One function unit circuit is used to generate a sharp pulse when the input signal E_1 intersects with the zero axis to start the timing unit counting. The other function unit circuit generates a sharp pulse when the input signal E_2 intersects the zero axis and is used to stop the counting. **Advance Electronics Co., 451 Highland Ave., Passaic, N. J.** —TELE-TECH & ELECTRONIC INDUSTRIES.

ANALYZER

The Model TSA spectrum analyzer covers the range of 10MC to 22,000 MC with three interchangeable r-f heads. A single-dial, direct-reading r-f tuning control enables quick selection of any

frequency spectrum. A swept i-f yields constant dispersion characteristics independently of the frequency setting. Frequency dispersion from 250 KC to 25 MC can be realized with a resolution of 25 KC. An internal marker measures frequency differences up to ±12.5 MC on a 5 in. CTR display. **Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

AC TEST SET

The Universal "60" is equipped with 4 separate instruments—2 wattmeters, a voltmeter, and an ammeter. These units, with their switches provide 36 watt ranges, 5 w to 2,000 w full scale,

that can be used down to 10% power factor; also, 7 current ranges from 10 ma to 10 amps, full scale, and 4 v ranges from 30 v to 300 v, full scale. Wattmeter "A" is a high range dynamometer unit; wattmeter "B" is low range. The voltmeter is the moving type. The ammeter is a transformer-coupled instrument. **Sensitive Research Instrument Corp., 9-11 Elm St., Mt. Vernon, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

AMPLIFIERS

Models 490A and 491A traveling wave amplifiers provide 30 and 35 db gain over 2,000 to 4,000 MC band and feature low noise amplification, a full watt of power output, and μsec pulsing over

a full 2,000 frequency spectrum. In their coupled helix design there is no mechanical connection between the outer circuitry and the inner tube helix, yet a full transfer of energy is effected. Original and replacement traveling-wave tubes are completely encapsulated and adjusted prior to installation. **Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

for the Electronic Industries

SWEEP GENERATOR

A sweep generator that covers its complete frequency range in a single sweep without tuning, comes in three ranges. Type 2144-01 has a range from 225 to 420 MC; Type 2144-02, from 470

to 890 MC; type 2144-03 from 850 to 1275 MC. A self-contained passive marker furnishes accurate frequency indication. Marker calibration is in 5 MC steps and frequency accuracy is better than ±1 MC in the low range unit and ±2 MC in the high range unit. The unit has a 50 ohm output impedance with a source of VSWR of 1.25 : 1 or less. **Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VOLTMETER

The Model 316 voltmeter was developed primarily to measure and monitor small potentials in ultra-low frequency systems, such as servomechanisms and geophysical equipment. A range of 20

mv to 200 v peak-to-peak is read directly in four decade steps with an accuracy of 3% throughout the spectrum of 0.05 CPS to 30 KC. When corrections are applied, measurements between 0.01 CPS and 0.05 CPS are possible. Pointer flutter is negligible down to 0.05 CPS while discharge of the storage circuits for a rapid sequence of readings may be effected by a reset device. **Ballantine Laboratories, Inc., Boonton, N. J.** —TELE-TECH & ELECTRONIC INDUSTRIES.

GENERATOR

The Model 183 square wave generator is a precision instrument that provides square waves suitable for testing the transient and frequency response of wide band amplifiers, and accurately

measures their amplitude. Frequency range is from 10 CPS to 1 MC continuously variable over decade steps. A low impedance output provides 10 v p-p. At high impedance, 100 v p-p is available. A 60 db step attentuator and 20 db continuous attenuator enables use of the generator as a voltage calibrator. **New London Instrument Co., P. O. Box 189, New London, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

GENERATOR

The Model 564 pre-set interval generator is designed for testing and calibrating systems that require precise time measurement, as radar, sonar, and telemetering equipment. Intervals and

delays from 1 μsec to one sec. may be generated or measured. The number of μsecs is selected by 6 10-position switches—one for each digit of the delay in μsecs. To measure a time interval, the instrument counts the exact number of pulses produced by a 1 MC, crystal-controlled oscillator during the interval. **Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

More New Products on P. 88

"RADALYZER"

The new "Radalyzer" gain measuring set has a 30 MC i-f low level microwave measurements. The unit has a gain-loss range from 0 to more than 60 db VSWR, 0 to more than 60 db insertion

loss or gain, and a receiver frequency of 30 MC. Operating (signal) frequency range is 40 MC to 10 KMC—furnished by external equipment under test. Input rating is 50 mv maximum of 30 MC into 50 ohm line. Attenuators are 0-101 db—(steps, 1, 2, 3, 5, 10, 20, 20, 20, 20.) Precision 10-turn potentiometer, 0-10 db, calibrated. **Kay Electric Co., Pine Brook, N. J.** —TELE-TECH & ELECTRONIC INDUSTRIES.

DC VOLTMETER

The Model 124 precision dc voltmeter produces an adjustable reference voltage with which to compare another voltage. Equality is indicated on a null-indicating meter which measures volt-

ages between 0-510 v. Reference voltage is indicated on dials associated with adjustments of the voltage. Two adjustments are made in steps of 100.0 v and 10 v. A calibrated multi-turn potentiometer equipped with a vernier dial subdivides the 100.0 or 10.0 v steps, depending on selected range, into 1,000 divisions corresponding to 100 or 10 mv. **Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

DuMont Opens New Tele-Centre

Latest technological facilities included in $5 million installation. Provisions made for color TV originations

A completely self-contained TV production facility, the DuMont Tele-Centre, has been formally opened at 205 E. 67 St., New York City. The $5 million installation contains five studios, including one 110 x 80 ft. in area, and 40 ft. high, reported to be the largest TV studio in the East. Another studio is fully equipped for film and slide color telecasting, which the network plans to inaugurate on a regular schedule soon. In all, the Tele-Centre is the origination point for more than 160 programs each week, many of which are carried by the over 200 stations affiliated with DuMont Network.

The building itself is actually a rebuilt version of Jacob Ruppert's venerable Central Opera House, which was completely gutted to make room for the Tele-Centre. Only the shell of the original structure remains, with 2,500,000 cu. ft. of air conditioned space devoted to TV.

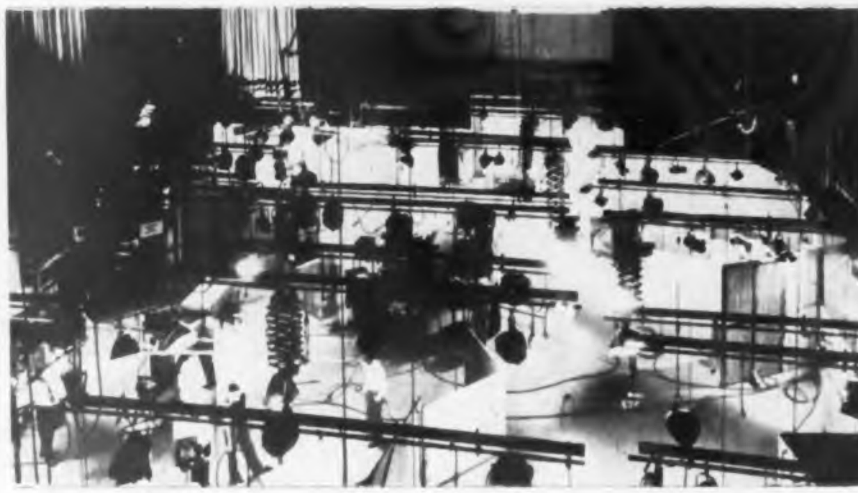
Each of the five studios is sound-locked. Muslin wire mesh on top of spun-glass lining extends three-quarters of the way up the walls, with acoustic plaster covering the remaining area. Each studio is equipped with an electronically operated Izenour Board for lighting control.

The five control rooms for the respective studios are located in a vertical bank through the building, providing the shortest cable runs. The three basic controlling elements of TV broadcasting—sound, sight and production—are isolated by glass partitions from each other. Although control personnel can communicate with each other through an intercom, their mutual isolation eliminates a great deal of the noise and confusion often present in studio operations. (For a detailed technical description of the segregated control plan, see "Television Control Room Layout," by R. D. Chipp, *TELE-TECH & ELECTRONIC INDUSTRIES*, Oct. 1952, pages 48-51.)

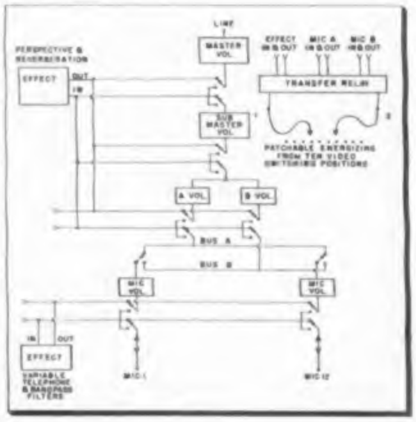
The master control room is characterized by flexibility of operation, with various preset features which enable engineers to set up relays for network programs in advance. From master control a film projector can be remotely operated while an announcer in a different booth supplies the audio. In all, there are circuit facilities for 24 video lines and 50 audio lines to other points from the Tele-Centre.

The four-unit teletranscription or kinescope recording system, developed by DuMont Labs., is available for recording live shows for subsequent distribution to stations carrying delayed programs.

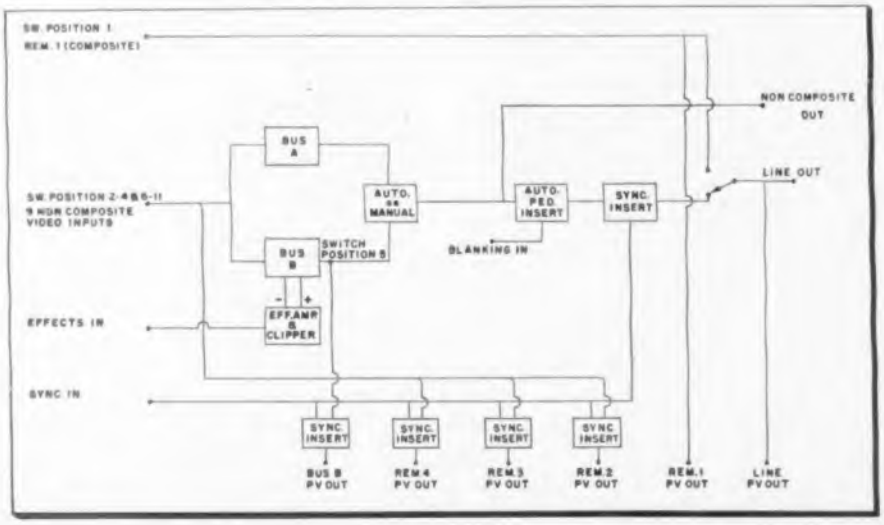
Other features include a film projector room, with two 35 mm and four 16 mm projectors remotely controllable from each studio's video control room. The recently developed DuMont multi-scanner for film, slides and opaques is also used. Three rehearsal rooms, 16 star dressing rooms, film storage vaults, and four editing rooms are included.



Largest of five studios in Tele-Centre has floor space of 110 x 80 ft., is 40 ft. high



Studio microphone system shows method of switching effects into various circuits. One effect is the telephone and bandpass filters, which may be inserted in any mike channel



Block schematic of video mixer. Remote 1 bypasses mixing system. Remote 2 through 4 and Camera 1 through 6 (sw 2-4 and 6-11) feed individual tubes on the A and B buses with a standard 1 volt noncomposite video signal. Position 5 picks up any signals on the effects bus. Sync is then added

C-A-C

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HS SERIES TOROIDS
For IMMEDIATE Delivery

TYPE HS715

DIMENSIONS

Length ..... 2-9/16"
Width ..... 1-5/16"
Height ..... 2-13/16"
Weight ..... 14 oz.
Mounting ..... 2-1/16 x 11/16"
Screws ..... 6/32" studs
Cutout ..... 7/8 x 1/2"

TYPE HS254

DIMENSIONS

Length ..... 1-29/32"
Width ..... 1"
Height ..... 2-1/4"
Weight ..... 8 oz.
Mounting ..... 1-5/16 x 9/16"
Screws ..... 6/32" studs
Cutout ..... 7/8 x 1/2"

TYPES HS930 & HS395

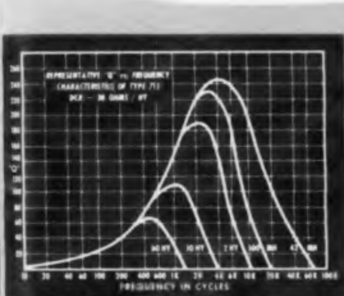
DIMENSIONS

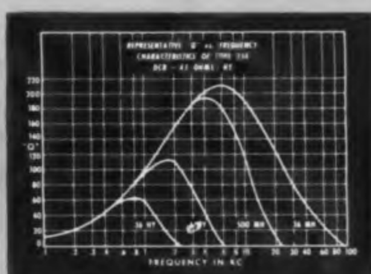
Length ..... 1-9/32"
Width ..... 11/16"
Height ..... 1-23/32"
Weight ..... 4 oz.
Mounting ..... 7/8 x 9/32"
Screws ..... 4/40" studs
Cutout ..... 1/2 x 5/16"

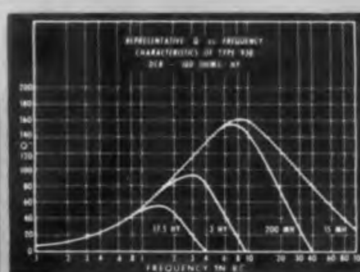
TYPES HS206, HS848, HS608 & HS073

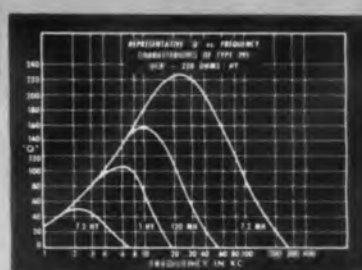
DIMENSIONS

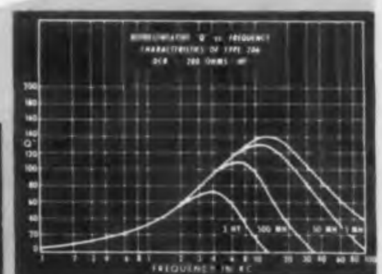
Length ..... 1-1/16"
Width ..... 1/2"
Height ..... 1-1/4"
Weight ..... 1.5 oz.
Mounting ..... 3/4"
Screws ..... 4/40" studs
Cutout ..... 1/2 x 5/16"

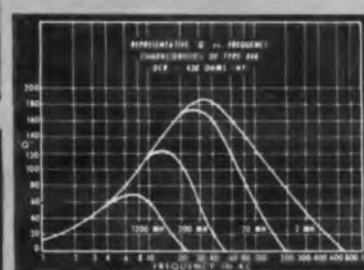


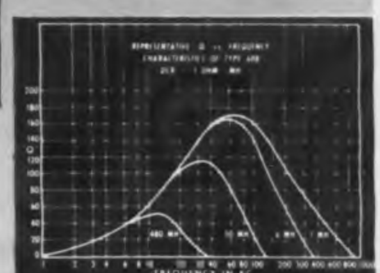


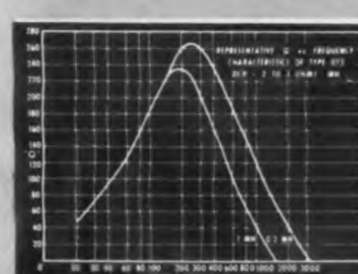












LIST OF STOCKED UNITS
All other values and types on Special Order

Suffix Number	HS 206—	HS 930—	HS 254—	HS 715—
—1	5.0 MH	5.0 MH	20 MH	24 MH
—2	6.0 MH	6.0 MH	24 MH	30 MH
—3	7.2 MH	7.2 MH	30 MH	36 MH
—4	8.6 MH	8.6 MH	36 MH	43 MH
—5	10 MH	10 MH	43 MH	50 MH
—6	12 MH	12 MH	50 MH	60 MH
—7	15 MH	15 MH	60 MH	72 MH
—8	17.5 MH	17.5 MH	72 MH	86 MH
—9	20 MH	20 MH	86 MH	100 MH
—10	24 MH	24 MH	100 MH	120 MH
—11	30 MH	30 MH	120 MH	150 MH
—12	36 MH	36 MH	150 MH	175 MH
—13	43 MH	43 MH	175 MH	200 MH
—14	50 MH	50 MH	200 MH	240 MH
—15	60 MH	60 MH	240 MH	300 MH
—16	72 MH	72 MH	300 MH	360 MH
—17	86 MH	86 MH	360 MH	430 MH
—18	100 MH	100 MH	430 MH	500 MH
—19	120 MH	120 MH	500 MH	600 MH
—20	150 MH	150 MH	600 MH	720 MH
—21	175 MH	175 MH	720 MH	860 MH
—22	200 MH	200 MH	860 MH	1.00 HY
—23	240 MH	240 MH	1.00 HY	1.20 HY
—24	300 MH	300 MH	1.20 HY	1.50 HY
—25	360 MH	360 MH	1.50 HY	1.75 HY
—26	430 MH	430 MH	1.75 HY	2.00 HY
—27	500 MH	500 MH	2.00 HY	2.40 HY
—28	600 MH	600 MH	2.40 HY	3.00 HY
—29	720 MH	720 MH	3.00 HY	3.60 HY
—30	860 MH	860 MH	3.60 HY	4.30 HY
—31	1.00 HY	1.00 HY	4.30 HY	5.00 HY
—32	1.20 HY	1.20 HY	5.00 HY	6.00 HY
—33	1.50 HY	1.50 HY	6.00 HY	7.20 HY
—34	1.75 HY	1.75 HY	7.20 HY	8.60 HY
—35	2.00 HY	2.00 HY	8.60 HY	10.0 HY
—36	2.40 HY	2.40 HY	10.0 HY	12.0 HY
—37	3.00 HY	3.00 HY	12.0 HY	15.0 HY
—38		3.60 HY	15.0 HY	17.5 HY
—39		4.30 HY	17.5 HY	20.0 HY
—40		5.00 HY	20.0 HY	24.0 HY
—41		6.00 HY	24.0 HY	30.0 HY
—42		7.20 HY	30.0 HY	36.0 HY
—43		8.60 HY	36.0 HY	43.0 HY
—44		10.0 HY		50.0 HY
—45		12.0 HY		60.0 HY
—46		15.0 HY		
—47		17.5 HY		

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CHICAGO—Gassner & Clark Co.—Rogers Pk. 4-6121
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New Products

RESISTORS

Model RX3 glass encapsulated, inert gas filled, carbon film resistor is a high voltage unit recommended for applications requiring up to 15 kv. Type RX4 has a resistance range from 200 ohms to

200 kilohms and dissipates up to 5 w. Type RX5 has a rating of 200 ohms to 650 kilohms and is capable of loads up to 10 w. Tolerances can be furnished from a maximum of ±10% to a minimum of ±1%. Operating temperature for maintained stability for all three types is listed as from −65° to +225°C. Available in production quantities. **Victoreen Instrument Co., 3800 Perkins Ave., Cleveland, O.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SILICON TRANSISTORS

The commercially produced silicon transistors recently announced raise power output and double operating temperatures. The new units operate with little change up to 150°C (302°F). Of "grown junction" construction, these first production silicon transistors "grow" the contact between semiconductor materials of dissimilar current-carrying characteristics into the semi-

conductor crystal rather than make it mechanically. The manufacturer specializes in grown junction germanium transistors also. **Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.**—TELE-TECH & ELECTRONIC INDUSTRIES.

THYRATRONS

Types AX-5544 and AX-5545, two standard thyratron tubes, specifically designed for electronic dc motor speed control, counting, and sorting devices, current and voltage regulation etc., are

directly interchangeable with RETMA tubes with the same designation. Each is a three electrode Xenon-filled tube with negative characteristics. The inert gas filling enables reliable operation at maximum ratings over a wide temperature range. Complete data is available at the Engineering Department, **Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

MIDGET CAPACITOR

Types 5A and 1A midget mica capacitors will house 5 to 6 times the capacitance possible in CM-20 and CM-30 cases. Type 5A measures 51/64 x 15/32 x 7/32 in. Type 1A is 33/64 in. square x 9/32 in. Both are available. Exceed MIL-C-5A temperature, immersion and moisture resistance tests. Temperature range, −55°C to +130°C. Over 10,000 megohms at 25°C—10,000 megohms at 130°C. Section, wire leads, and case are

permanently bonded by a hermetic seal. Parallel rigid tinned leads can be cut for printed circuits or left long for chassis mounting. **Cornell-Dubilier Electric Corp., South Plainfield, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

OUTPUT RELAY

Type 23JOXCC output relay for 2-way control and servo systems has 3 positions with either a single or double pole switch of 2 amp rating. With current balanced in two windings, or zero in a single winding arrangement, all

switch circuits are open. One polarity of coil current or unbalance current closes one throw of the switch. Opposite polarity closes the other switch. Rated double-pole sensitivity is 12 mw. The relay measures 2⅝ in. high above octal or magnal socket by 1⅝ in. square. **Sigma Instruments, Inc., 170 Pearl St., South Braintree, Boston 85, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CERAMIC CYLINDERS

Precision cylinders up to 30 inches in length and 8 inches in diameter can now be produced to tolerances of .0001 in., even in the extremely hard alumina or titania ceramics. Grinding techniques employing a 20 in. diamond-bonded grinding wheel enable production of dimensional accuracies at costs that are completely economical for a wide range of industrial applications. Ceramic cyl-

inders can be produced with 1-inch thick walls for mounting on steel shafts and finally grinding the ceramic to produce accurate shaft centering. **American Lava Corp., Chattanooga 5, Tenn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

More New Products on P. 90

New Electronic Products

TRANSISTORS

Types 2N34, 2N36, 2N37, and 2N38 hermetically-sealed junction transistors, have been added to the series RR14, RR20, RR21, RR34, and 2N38. All are in sealed metal cases that measure only 0.325 x 0.328 x 0.344 in. The series is intended for application in low level audio circuits, particularly where small size and economy are needed, and where contamination-free, light and moisture proof operation is necessary. Technical data is available at Selectron & Germanium Div., **Radio Receptor Co., Inc., 251 West 19th St., New York 11, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

DELAY TRACER

The Model EDT-1 envelope delay tracer measures envelope delay characteristics of amplifiers, phase correction and distribution networks, and color or monochrome TV systems. Delay is measured at any frequency over the video range of 0.5 MC to 6.0 MC. Meter reads from zero to 1.25 μsecs. Separate meter determines the amplitude characteristics. Operating controls, adjustments, and circuit test points are accessible on the front panel. Supplied with a Model PS-regulated power supply. **Wickes Engineering and Construction Co., 12th St., and Ferry Ave., Camden 4, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

DC SOLENOIDS

Nos. 20288 and 20287, the first of a new series of dc solenoids that are smaller and lighter than standard, have been announced for use in the operation of keyboards, light springs, control board signal flags, door latches, and similar applications. The former has a coil enclosed in a steel shell; the latter has an open coil with a bracket. The units have a $\frac{3}{4}$ in. diameter and are approximately $1\frac{1}{2}$ in. long. Weights are 0.122 and 0.141 lbs., respectively. Each may be wound for a wide range of voltages. **Cannon Electric Co., 418 West Ave. 33, Los Angeles 31, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

COIL FORMS

According to a recent announcement, coil forms in any shape, size, length, I.D. or O.D. can be met within critical tolerances and supplied in quantity at low cost. Fractional inch to 9 in. inner diameters can be furnished without extra tooling charges. Forms may be wound from a variety of dielectrical materials as kraft, fish paper, acetate, or combinations. Phenol impregnation is also available. Process and inspection assure maximum resistance, dimensional stability, and high tensile strength. **Precision Paper Tube Co., 2035 W. Charleston St., Chicago, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TAPE RECORDER

The M-33 portable recording and playback unit is contained in an easy-to-handle case. The instrument features a built-in output stage and integral loudspeaker, thus permits on-the-spot playback. The output stage delivers 3 w of low distortion power to a heavy 5 x 7 inch PM speaker. A spectrum-compensated tone control enables response adjustment for the loudspeaker. **Magnecord, Inc., 225 W. Ohio St., Chicago 10, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

INTEGRATED CONNECTORS

A new technique molds several components onto wire insulation to produce an integral cable unit. Lowers cost, saves space, and eliminates high-voltage arcover at wire holes. Components are molded in low-loss polyethylene or flame-resistant polyethylene, "Rulan." Stubby pin on the long stud makes female contact after sleeve and stud are sealed. Write to Nelson W. Hearn for information at **Alden Products Co., 117 N. Main St., Brockton 64, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

DIFFERENTIAL ANALYZER

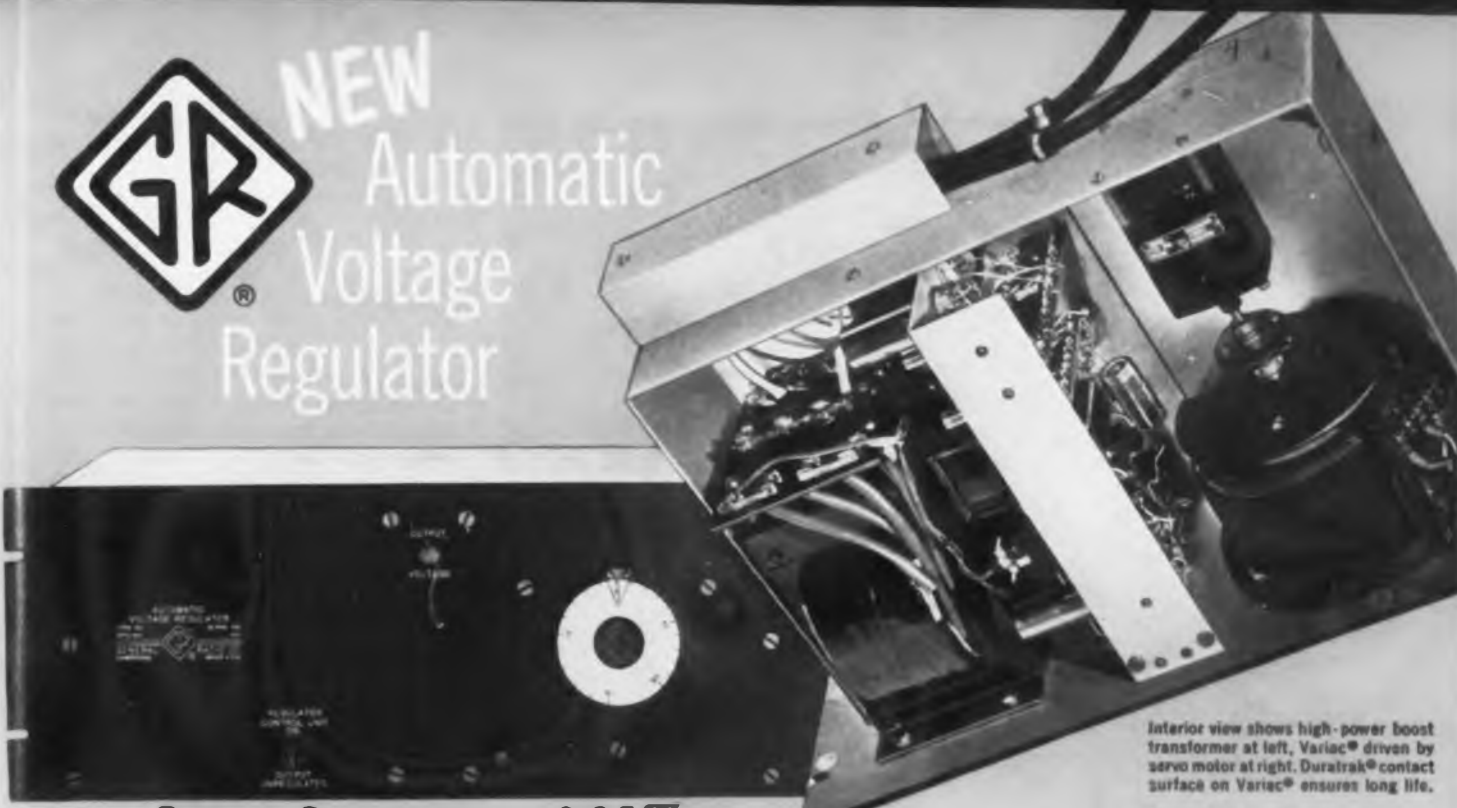
The Model DZ18 differential analyzer sorts pulses according to amplitude, then feeds them into a linear amplifier to produce values between 0 and 60 v. A discriminator circuit covers—within the 0-60 v span—any 10 v span in $\frac{1}{2}$ v increments which form 20 channels where incoming pulses are sorted. A given pulse, within a 10 v span, is accepted by only one channel and registered on a corresponding counter. **Detectolab, Inc., 6544 N. Sheridan Rd., Chicago 26, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CAPACITOR

A new ceramic ring capacitor made to fit around a 7-pin miniature tube socket can contain 2, 3, or 4 capacitor sections. Excellent VHF performance results from zero ground lead length between the capacitor sections and the tube socket lugs. Positive positioning of ultra-short leads between the capacitor terminals and socket terminals enables "hot" circuit design. Available in ratings from 100 to 500 v dc, depending on the capacitance rating. **Sprague Electric Co., 233 Marshall St., North Adams, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

More New Products on P. 99

NEW Automatic Voltage Regulator



Interior view shows high-power boost transformer at left, Variac® driven by servo motor at right. Duratrak® contact surface on Variac® ensures long life.

Output Constant to ±0.25%
Extra Fast Response: 0.1 sec. per volt
Handles up to 6 KVA

For a Detailed Description of this New Instrument, write for the July Issue of the General Radio Experimenter

The Type 1570-A Automatic Voltage Regulator combines *Accuracy* for laboratory use with *High Power-Handling Capacity* for control of industrial processes.

The application of proportional-control servomechanisms to voltage regulator design has resulted in a unique, highly-efficient instrument which should prove of considerable value to those requiring constant a-c line voltage.

This Regulator consists essentially of a Variac® continuously-adjustable autotransformer, a servomechanism sensing circuit which samples the output voltage, and a servo-motor which varies the Variac to correct for input line-voltage changes. This instrument is rugged, requires minimum maintenance, — the G-R trademark guarantees it's been *engineered and built right.*

Features you get with the GR 115-volt, 60-cycle Automatic Voltage Regulator . . .

SPEED *This instrument does things in fractions of a second — response is 10 volts per second*

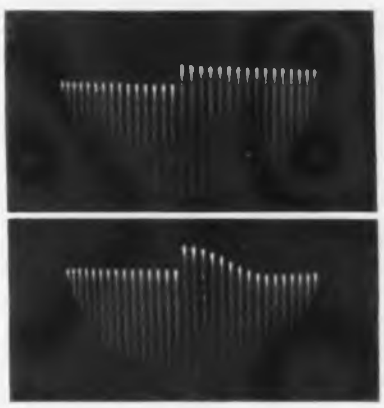
HIGH ACCURACY *Output held constant to within ±0.25% of voltage selected*

±10% SELECTION IN OUTPUT VOLTAGE *Output may be set for any desired value from 104 to 127 volts*

CORRECTS LINE VOLTAGE FLUCTUATIONS OVER WIDE RANGE *±10% of selected output voltage, ±20% or ±40% at reduced accuracy and power rating*

HIGH POWER *Handles 50-amps (6 KVA)*

EXCELLENT TRANSIENT RESPONSE *Adjustments permit setting response characteristic desired — adjustable for no overshoot (see oscillograms)*



Oscillograms illustrate high-speed response of typical G-R Automatic Voltage Regulator. Illustrated at top, is sudden 1% change in 60-cycle voltage input to Regulator. Bottom oscillogram shows instrument correcting for this change in 8 cycles (0.13 seconds)

ADDS NO HARMONIC DISTORTION *Unlike most saturable-core reactors*

SUPPLIES ANY LOAD *No restrictions on power factor*

EFFICIENCY *Better than 98%*

VOLTAGE CORRECTION INDICATED *Panel dial provides continuous indication*

USEFUL FOR CONTROL OF THREE-PHASE POWER *three of these instruments in conjunction will control both amplitude and phase of three-phase systems*

WEIGHT *55 lbs* DIMENSIONS *19" x 7" x 12⅞"*

Type 1570-A Automatic Voltage Regulator
. . . supplied in either 115-v or 230-v model

Type 1570-ALM (115v)
Type 1570-AHM (230v) Table-Top **$470.**

Type 1570-ALR (115v)
Type 1570-AHR (230v) Relay-Rack **$465.**

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TV & BROADCAST MONITORS
U-H-F MEASURING EQUIPMENT
UNIT INSTRUMENTS
VARIACS
V-T VOLTMETERS
WAVE ANALYZERS

Transistor Amplifier

(Continued from page 74)

ference between the generator resistance and 100 ohms.

Inspection of the curves of Fig. 11 shows plainly the effect of generator resistance on linearity. When a low value of generator resistance, such as 100 ohms, is used there will be a definite discontinuity at the origin, which will produce a decided "step" in the output waveform. Three methods are commonly used to eliminate this step:

(a) Use sufficiently high generator resistance. This entails some loss of power gain and puts increased burden on the driver stage.

(b) Use a bias battery. Thus, in the case of the curve for 100 ohms a bias of approximately 0.1 volt would effectively straighten out the discontinuity. The principle disadvantage of this method is that it is difficult to obtain this low value of bias without using a heavy bleeder, which reduces the efficiency, increases the stand-by power drain.

(c) Use degenerative feedback. This will also reduce the overall gain, but will do so at a level where the effect will be minimized. Feedback will also help reduce distortion due to high current nonlinearity.

Power Gain

Input Power, Power Gain; Grounded-Base Configuration: An approximate value (neglecting the nonlinearity of the input circuit) for the input power required to drive a grounded-base class B pair can be obtained in similar manner to that used to determine output power. Thus, if the peak emitter voltage swing is V_e', peak emitter current I_e' the input power is approximately

$$P_i \cong (V_e' \, I_e')/2 \qquad (35)$$

and the power gain of the grounded-base class B pair is approximately

$$G \cong \frac{E_c\,(I_c' - I_{c0})}{V_e' I_e'} \cong \alpha \frac{E_c}{V_e'} \qquad (36)$$

The power required from the preceding driver stage will depend upon the impedance which it must present to the output stage. As noted above this may be considerably greater than the input impedance. Thus to obtain the output requirements of the driver it is necessary to determine the proper source impedance and the peak generator voltage swing, as illustrated in Fig. 11. For example if we choose a source impedance of 300 ohms and the e_g vs I_c curve remains linear we will have a peak e_g' of 7.0 volts at at $I_c' = 20$ ma. This corresponds to an RMS e_g of 4.9 volts, or an input power of

$$\frac{e_g^2}{4r_g} = \frac{24}{1200} = 0.02 \text{ watts} = 20 \text{ mw}$$

The power output, as previously determined, is 200 mw, hence the power gain is 10 db.

If a source impedance of 100 ohms were used, with a bias of 0.1 volt to eliminate the step, the peak generator voltage would only be 2.8 volts, or 1.98 v. RMS and available power required is

$$\frac{(1.98)^2}{0.400} = 9.8 \text{ mw, a reduction of } 2:1$$

and increase of power gain to 13 db. This, finally, should be reduced by the loss in the coupling transformer, which may be about 2 db.

By comparison, the actual input power of the output stage, as calculated from Eq. 35 is only 3.4 mw, indicating the cost of driving the class B stage from an unmatched source.

Grounded-Emitter Configuration

Output Circuit Analysis: The relationship between the collector current and input signal, now applied to the base, may be obtained in the same manner as for the grounded-base configuration. Thus the static characteristics shown in Fig. 6 can be adapted to the class B analysis. Again the quiescent operating point will be determined by the dc resistance in the emitter-base circuit, and will normally lie very close to the intersection of the dc load line and I_{c0} curve.

The output current versus input signal relationship can be shown by constructing mirror images of the curves shown previously in Fig. 7. Fig. 12 shows such a set of curves of collector current versus generator voltage, for three values of generator resistance. Again there is evidence of a discontinuity at the origin, which requires the same treatment as the grounded-base arrangement. In addition, there is the very pronounced curvature due to the crowding of the collector characteristics at high current.

Since the load line is the same as in the grounded-base amplifier, and the extremities of swing are the same, the equations given previously for maximum power output, efficiency, collector dissipation and load resistance still apply. However, while the maximum power output is the same the distortion will be greater, due to nonlinearity at high currents. The power output at a

ANOTHER "BOMB" WILL EXPLODE

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(Western Electronic Show & Convention)

the place . . . Los Angeles Pacific Auditorium, where WCEMA and the Los Angeles and San Francisco sections of the IRE will play host to the largest group of WESCON exhibitors ever . . . who'll "set off" a spectacular show of unequalled proportions. (even a tent annex has been added.)

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As far back as 1944 Caldwell-Clements spotlighted the importance and potential of the growing West Coast electronic industries . . . and was the first publisher to publish a special WEST COAST ISSUE, featuring engineering and productive resources of that region in TV-radio-electronic fields. For the 10th consecutive year, West Coast engineers will contribute to the August issue of TELE-TECH, continuing to bring to the attention of the industry, the increasing importance of the Western Electronic market.

THE AUGUST WEST COAST ISSUE
of
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- **vast editorial coverage of West Coast development**
- **complete, up-to-the-minute review of WESCON program**
- **TWO special West Coast Electronic Industries Directories: (1) manufacturers (2) distributors and representatives**
- **newest technical papers by West Coast engineers**
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Transistor Amplifier

(Continued from page 93)

stated percent distortion may therefore be considerably less than for the grounded-base circuit.

Input Considerations; Grounded-Emitter Amplifiers: The peak voltage, now applied to the base, will be same as before, i.e., V_e'. The input current, however, is much less and related to the emitter current approximately by the factor $1 + h_{21}$ (or $1 - \alpha$). The peak input resistance is therefore higher by this factor, input power lower and power gain higher, also by this factor.

Grounded-Collector Configuration

In small signal operation the grounded-collector configuration offers little operational advantage. In Class B output stages, however, there are frequently cases where this circuit offers definite advantages over the other two. It will pay us, therefore, to analyze this application carefully.

Characteristic Analysis: In analyzing the grounded-collector circuit several important differences are encountered. These may be visualized by reference to Fig. 17, which shows the essentials of this circuit. The battery is normally in the collector circuit, the load resistance in the emitter. In the following analysis we will assume that the maximum collector current excursion is the same as before, so that the battery power remains essentially unchanged. The collector remains at potential E_c and the base is driven up to this value and then through zero to an equal value of opposite polarity. The voltage from emitter to ground, V_{eg} in Figure 17, equals $r_l I_e$ and the voltage between base and ground is the sum of this voltage and the base-emitter voltage, V_{be}, which is the negative of the usual emitter-base voltage, as shown on Fig. 16.

The emitter current swing will be from zero to I_e', which is the collector current swing $I_c' - I_{co}$ divided by the current amplification factor α.

Load Resistance: Grounded-Collector Configuration: At the extreme base voltage, $= E_c$ the emitter voltage will be $E_c - V_e'$. The load resistance will therefore be

$$r_l = (E_c - V_e')/I_e' \quad (37)$$

$$= \alpha(E_c - V_e')/(I_c' - I_{co}) \quad (38)$$

By comparing Eq. 38 with Eq. 33, it is seen that the load resistance for the grounded-collector stage is less than that for the other two, both by

Transistor Amplifier

(Continued from page 95)

virtue of the factor α and because of the emitter-base voltage which is subtracted from the collector supply voltage. Under conditions where the supply voltage is low, e.g. 3 volts, and the emitter voltage swing high this latter effect may be quite considerable.

Power Output: Grounded-Collector Configuration: The power output of the grounded-collector pair is

$$P_o = (E_c - V_e')(I_c' - I_{c0})/2\alpha \quad (39)$$

Thus, depending upon the relative value of α and V_e', the grounded-collector stage may have more or less power output than the other two.

Efficiency: Grounded-Collector Configuration: Since the power required from the battery is the same as for the other two configurations the efficiency can be obtained by dividing the power output, as obtained from Eq. 39, by the dc power, as given by Eq. 29. This gives for the grounded-collector efficiency.

$$\eta = \frac{\pi (E_c - V_e')(I_c' - I_{c0})}{4 \alpha E_c [I_o + I_{c0} (\pi - 1)]} \quad (40)$$

Again, depending upon the relative values of V_e' and α the efficiency of the grounded-collector stage may be greater or less than the other two. Usually it will also approximate 75%, except at low supply voltages, where the emitter voltage assumes considerable importance.

Input Resistance

Input Resistance; Grounded-Collector Amplifier: The input resistance of the grounded-collector amplifier is the highest and most constant of the three configurations. At peak swing the base voltage is E_c, the input current approximately I_e' $(1 - \alpha)$, hence the input resistance of this amplifier is

$$r_i \text{ peak} = E_c/I_e' (1 - \alpha) = r_l/(1 - \alpha) \quad (41)$$

The total input resistance is again four times this value.

Input Power, Power Gain; Grounded-Collector Configuration: The peak input voltage excursion is E_c, peak input current I_e' $(1 - \alpha)$ hence input power is approximately

$$P_i \cong E_c I_e' (1 - \alpha)/2 \quad (42)$$

and power gain is

$$G \cong \frac{1}{1 - \alpha} \left[\frac{E_c (I_c - I_{c0})}{E_c I_e'} \right] \cong \frac{\alpha}{1 - \alpha} \quad (43)$$

It is interesting to note that the

power gain of this configuration is essentially independent of collector voltage, hence the grounded-collector configuration has considerable promise for low voltage applications.

As with the grounded-base and grounded-emitter stages the permissible degree of impedance mismatch will dicate the power requirements of the driver stage.

Summary

The preceding data on the three configurations is summarized in Table 1. In this table approximate values are given, neglecting minor factors, such as I_{c0} and V_e' in the grounded-collector circuit. All data is presented in terms of the emitter current swing I_e', so that input and output signals can be compared. This data will show the relative effectiveness of the three arrangements in a qualitative manner.

Complementary n-p-n p-n-p Class B Amplifiers: Fig. 17 illustrates one of the circuits possible with transistors but not with tubes. Here the two basic types of transistors are used in a parallel or "complementary" arrangement. Each transistor operates only during one half of the input signal cycle, the *n-p-n* when the base is driven positive and the *p-n-p* when the base is driven negative. When one unit is conducting the other is cut off. The obvious advantage of this arrangement is that it makes the usual push-pull input and output transformers unnecessary. As will be shown below the output impedance is the value previously derived for the single transistor, not four times that value, and, under some conditions of low voltage operation, may be low enough to permit the output transducer to be the entire load, without interposition of the output transformer. The input impedance is high and single-ended, hence an additional transformer saving may be effected here. The common base connection makes bias connection to the base unnecessary, each transistor supplying the return for the other. All in all, this arrangement has considerable merit.

Grounded Connection Location

The circuit of Fig. 18 is either grounded-emitter or grounded-collector, depending upon the location of the ground connection. If the point A is grounded, as shown, the circuit is a grounded-emitter pair. If point B is grounded it is a grounded-collector pair. The former has the higher power gain as brought out previously, however the

Transistor Amplifier

(*Continued from page 97*)

fact that the common battery connection B is off ground can make this arrangement undesirable where the battery is also required to supply power for the other stages, as is usually the case. Where an input transformer is used the point B can be grounded, but the low end of the transformer can go to point A, thus connecting the output stage for grounded-emitter operation.

An objection to the complementary arrangement is the necessity for a center-tapped battery. This is not too serious, as the total power requirement remains the same, and, in addition, the availability of the two potentials enables the designer to employ essentially constant current supplies for the emitters of the earlier stages, as will be shown later.

Power Output, Efficiency, Load Resistance: The power output of the complementary arrangement, and efficiency are the same as for the normal push-pull class B amplifier. Since each transistor works into the load half the time the load resistance is as given by Eq. (33).

All the temperature effects noted for class A amplifiers are present in Class B amplifiers as well. Thus the quiescent point, which may be the intersection of the R_t line with the I_{co} curve or the intersection with the $I_b = O$ curve or a point intermediate between these two, will shift very materially with increasing temperature. This will produce a drop-off in power output, a modification of load resistance and an increase in stand-by power and decrease in efficiency. The analysis of these effects is similar to that described previously.

Another effect, more serious in Class B amplifiers, is the temperature shift of the $V_e - I_e$ characteristic, mentioned earlier. As brought out previously the nonlinearity of the $V_e - I_e$ characteristic may produce a "step" at the cross-over point. Any change in this nonlinearity, therefore, will alter this "step" and will complicate the measures necessary to eliminate it. Thus, if a bias is used to offset the "step" this bias may have to be temperature-variable, this, in turn, requiring some nonlinear temperature-sensitive device, such as a nonlinear resistor or a semiconductor device such as a diode. The use of degeneration is of definite benefit in reducing this effect.

New Product Briefs

RECORDER-REPRODUCER, magnetic Model D-24, announced by SoundScriber Corp., 146 Munson St., New Haven 4, Conn., enables recording 2 channels continuously and simultaneously for 24 hours without the attention of an operator.

MICROWAVE NOISE SOURCE, series 2200, by Waveline, Inc., provides a random noise source of known output level over the frequencies from 2,600 to 26,000 MC. Average VSWR over tube frequency rate approx 1.07, max. 1.13.

GERMANIUM DIODES, Type 1N60 video detector for TV receivers, have been added to the line of the Selectron & Germanium Div., Radio Receptor Co., 251 West 19th St., New York 11, N.Y. Also, Types 1N111, 1N112, 1N113, 1N114, and 1N115, recommended for 55 C. operation in computers, etc.

TV RECEIVING TUBES, General Electric Tube Department, Electronics Park, Schenectady 5, N.Y., announced the initial 17 types in its new "600 Series" for string sets. Main feature of the line is uniform heater warm-up time of 10.5 seconds.

DISTORTION-METER, Model 1410, available for immediate delivery by Freed Transformer Co., 1715 Weirfield St., Inc., Brooklyn, N.Y., features 20 KC to 1.0 MC frequency range in 10 overlaping ranges. Distortion range, 0.1% to 30.0%.

TELEMETER PACKAGES, Models TATP-4 and TATP-3, made by Pacific Div., Bendix Aviation Corp., North Hollywood, Calif., incorporate plug-in subcarrier oscillators, which, when used with power supply an r-f transmitter, provide an FM/FM system for telemetering functions.

AUTO-SWEEP, Model 54, by Audio Instrument Co., 133 W. 14 St., New York 11, N.Y., locks onto any signal in its normal voltage-frequency range, and generates constant-amplitude sawtooth voltage at ½ the input frequency.

TUBE SOCKET, by Mycalex Tube Socket Corp., Clifton Blvd., Clifton, N.J., of "Mycalex" 410 glass-bonded mica has loss factor of 0.014 at 1 MC, power factor of 0.0015 at 1 MC. Has high dielectric strength, no carbonization. No cold flow.

CARBON RESISTORS, "Carb-Ohm" resistors are available hermetically sealed in glass in a specification series conforming to MIL-R-10509 Clad in humidity impervious "Kel-F" and "Vinyl" casings. Phaostron Co., 151 Pasadena Ave., S. Pasadena, Calif.

TUBE, "Staticon," Type C-931-B, industrial TV camera tube has an operational life of 500-1,000 hrs. and is guaranteed to operate for 90 days from shipment date, or 300 hrs. by General Precision Lab., 63 Bedford Rd., Pleasantville, N.Y.

POWER SUPPLY PLUG, molded directly to the cable ready for standard octal radio socket connection, is now a standard feature of the thermo-plastic insulated wire and cable cord sets and harnesses made by Phalo Plastics Corp., 25 Foster St., Worcester, Mass.

ANTENNA. The 20-meter, 2-element, Model 520, produced by Telrex, Inc., Asbury Park, N.J., has a maximum element extension of 20 ft. and a boom length of less than 7 ft. Unit is designed to provide beamed rotary operation in 20 meter installations where space is restricted.

MICROPHONE. New Model "666" cardioid dynamic unit for telecasting and broadcasting by Electro-Voice, Inc., Buchanan, Mich., combines a single dynamic element with a new variable-D acoustic principle that provides extended wide range response and high discrimination.

DELAY LINES with phenolic tube outer shells, sealed ends and flexible leads extending from the base, by Ossian Manufacturing Co., Box 151-A, Ossian, Ind., are available with 3,300, 2,700, 2,000, 1,500, and 1,100 ohm impedances.

For product information, use inquiry card on last page.

Foreign Tubes

(*Continued from page 60*)

which makes these lugs so effective is the very narrow slots available in the foreign micas. It is quite common in a mica as thick as 0.010 to 0.015 in. to have the width of the slots as small as 0.012 in. Two reasons may exist for these improved mica slots. First, a slower punching technique is probably used. Second, the mica which is available appears to be extremely well bonded. Our tests indicate that the mica is more closely laminated than the Brazilian material generally available in this country.

Grids

Fig. 13 concerns grid structures. Welded grids are used abroad with great regularity. This requires that the wire and supporting rod materials have compatible welding characteristics. Nickel plated or clad

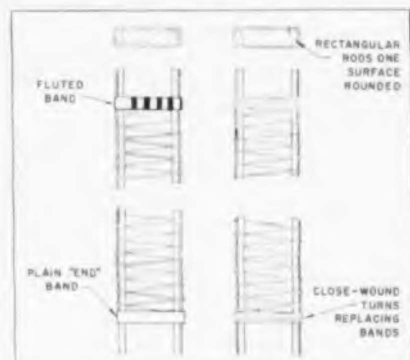

Fig. 13: Typical foreign grid construction

copper rods are frequently used. We believe that this has an advantage since the nickel provides a stiffening sleeve which blends greater strength than for a wire of equivalent weight. The copper does not interfere with the welding, but does provide the greatest mass for maximum conductivity of heat away from the fine grid wire turns.

Rectangular grid side rods are sometimes used to advantage in producing grids with a narrow minor axis. Another technique is the use of a very fine pitch for the end grid turns. This is sometimes used in this country, but is much more prominent abroad. A band of nickel ribbon may also be welded around the ends of the grids to assist in retaining shape and improve the cut-off characteristics. Pushed end grid turns and consequent short circuits are thereby reduced considerably.

Fig. 11 indicates by photographic comparison the mica sprays used in one or more foreign countries in contrast with a conventional thin spray used here. Note that the foreign coating is extremely white, is free from discoloration around the cathode sleeve hole. Scratch tests show that it is extremely well adhered. We believe this is probably one of the most important developments which has been found in the analysis of foreign tubes. To the best of our knowledge the spray is the standard magnesia powder with a nitrocellulose binder added to it.

Tube Processing

After initial processing of tubes, it is normal to find not only conducting deposits upon the mica spray, but also barium oxide or barium films upon the grid wires and upon the insides of the plates and shields. These films have been studied, and the consensus is that they are broken down under electron bombardment and can then become dangerous to cathode life. From experience on the ASTM standard diode on laboratory exhaust systems, we know that it is extremely difficult to reduce this original film deposit. However, analysis of the tubes from several foreign countries indicates that conventionally they do not have such films on micas, grids, or plate surfaces. We do not believe that their exhaust procedures are any better than ours or that their pumps produce a better vacuum. Our information on this type of cathode coating indicates that it is very similar to our own and certainly the materials used in the electrodes of the tubes are not dissimilar from our own.

Electrode Spacings

One of the larger tube plants abroad has taken great pains to bring out the equivalents of the standard American GT types of radio tubes, meeting American electrical specifications.

Fig. 12 shows plastic cross section views of a foreign and U.S. type 6AG7 tube. The foreign cathode cross section has greater strength against bowing. The grid shape is more rugged and is such that expansion due to heating will increase grid-cathode spacing. These design parameters have permitted use of closer grid-cathode spacing in the foreign samples than in the U.S. samples.

However, dimensions and spacings on a large number of tubes, produced over a period of several years, indicates a specific trend to

Foreign Tubes

(Continued from page 101)

larger grid-cathode spacings in foreign tubes than in U.S. tubes.

Table 1 presents data on cathode, control, and screen grid dimensions of a series of tubes from several plants. Note that in the cathode to control grid spacings, it has frequently been possible for the foreign designs to achieve 10 to 100% larger spacing and yet maintain the same electrical characteristics. This, we maintain, is a major contribution to improved tube reliability.

We would cite the use of thorium getters, both as paste on the screen grid which are flashed during aging as well as pellets in the retainers which are flashed during exhaust.

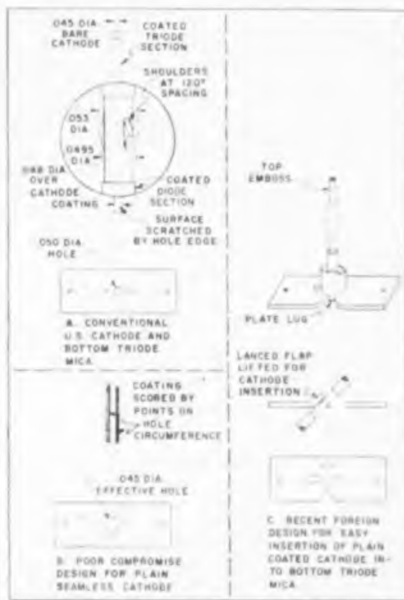

Fig. 14: Flap in mica spacer secures cathode

We could cite the extensive use of cataphoretic coatings, both to conserve materials as well as to obtain uniform deposits on heaters, cathodes, grids, and plates. The latter, of course, for transmitting tubes.

Multi-Section Tubes

Fig. 14 sketches a unique mica design applicable for triode, double diode tubes, such as the 6Q7. Conventionally in the U.S., the bottom triode mica has an enlarged cathode hole which permits the coated portions of the sleeve to pass through without damage. Then, to secure the cathode in axial alignment, three vertical embosses are formed near the mid-point of the lock-seam cathode. These embosses are difficult to produce and maintain within narrow control limits.

Foreign tubes, normally employing seamless cathodes, cannot employ vertical embosses. Often the cathode hole has had three mica figures extending inwardly which position the sleeve but scratch the cathode coating for the diode section.

A recent innovation has been seen, as sketched in Fig. 14 c. The bottom triode mica has a sturdy flap created by an elongated, tear-shaped grid hole, and a lanced slot penetrating from the plate lug and peripheral indent. When the flap is slightly raised, as drawn in Fig. 14 c, the uncoated and unembossed central section of the cathode may readily be slipped into the cathode hole by tilting at an angle. With the flap released and the cathode vertical to the mica, there is a firm contact, and the sleeve is centered with respect to the grid and plate which have been added later. The flap is retained in the plane of the mica by bending an ear from the plate barrel under the mica.

This structure appears to be rapid for assembly, accurate for centering, and avoids difficult cathode production and control problems.

Filamentary Miniature Tubes

When miniature tubes with fine filaments such as 1T4, 3S4, are assembled, there is difficulty threading the bottom connector through the grid structure and welding it accurately to the stem lead. Further, there may be relative motion between mount cage and stem, caused either during bulb sealing, or during shock and vibration. In either case the filament locationing and tensioning can be deteriorated.

A group of foreign filamentary miniature tubes has been seen recently wherein the filament is mounted as an integral part of the cage assembly. This is shown in Fig. 15.

The structure employs a U-shaped stamping which locks tightly into the bottom mica by four lugs. These fold over flush with the top of this mica.

Filament Construction

After the cage is completely assembled the filament is threaded through the mica triangular holes and the control grid. The top anchor coiled spring is welded to the proper support, such as the #3 grid rod. It is positioned by bending the flattened attachment tubing so that the filament top tab is about 1-2 mm above its final desired position.

A three gram weight is attached to the bottom filament connector.

Foreign Tubes

(*Continued from page 103*)

This hangs fire and thereby provides a uniform and controlled tension to the top anchor and filament. The bottom filament tab is welded to the bottom anchor stamping. Thus the 3-gram spring tensioning is retained. Excess length of the tab is cut off. Final adjustments of all cage parts

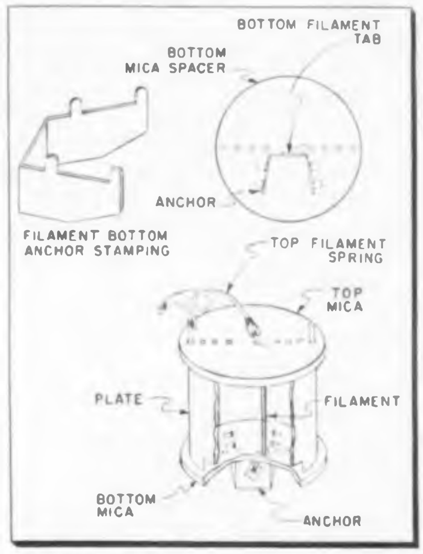

Fig. 15: Filament is part of cage assemaly

and filament positioning is then readily accomplished with the cage unencumbered by the button stem.

The last operation is to weld the inner stem leads to appropriate electrode wires. Deformation of the filament location should be relatively impossible.

Obviously, similar designs might be incorporated into other filamentary tubes, or into cathode types having close working spaces, or rigorous requirements for heater location.

Coatings

Metallized sprays on the glass bulbs are common in European tubes. Where heat radiation is required, a carbon under-coat precedes the aluminum paint spray. On top of the aluminum, a lacquer is normally applied. The adherence of these coatings is tenacious. The electrical resistance is of the order of a few ohms, when application is done properly. Grounding contacts are obtained by wrapping a copper wire around the top of a base shell and soldering it electrically into the cathode base pin. The conducting metallized sprays embed the copper close to the bulb.

PERSONAL

Thomas H. Briggs, former manager of the engineering services department of Burroughs Research Center, and for five years head of the Electronics Lab., Superior Tube Co., announces the opening of his offices as an Electronics Consultant, mailing address Box 185, R. D. 2, Norristown, Pa.

Walter R. Wolfgram, as newly appointed factory superintendent, has taken over all phases of the manufacturing operations at the Chicago plant of the Jensen Mfg. Co., loudspeaker manufacturers.

Dr. Daniel E. Clark, research engineer in charge of transistor development for Automatic Electric Co., has been appointed chief electronics engineer—a newly created executive position. Dr. Clark has been active for the past two years in directing research and setting up pilot plant production of transistors at Automatic Electric.

R. A. Kimes, former manager of American Machine & Foundry Co.'s General Engineering Labs., Greenwich, Conn., has been named director of engineering of the AMF Electronics Div., Boston. Principal products of this division are ultrasonic and electronic trainers for the U.S.A.F.

George A. Brettell has been named chief loudspeaker engineer for the Ampex Loud Speaker Corp., North Hollywood, Calif., subsidiary of Ampex Corp. He has been active in the development of the Ampex line of stereophonic sound systems for theaters.

Albert G. Peifer has been advanced to department head, in charge of low voltage tube development, at Federal Telecommunications Labs., Nutley, N. J.

Donald W. Baker, Frank T. Hata, Claude G. King Jr., Ira W. Martin, Logan E. Setzer, John H. Graham, Jerome C. Hill, James B. Humfeld, Wesley A. Wright and Joseph E. Zimmerle, Jr., have joined the electronic engineering staff of Hughes Research and Development Labs., Culver City, Calif.

Martin D. Bergan is the new engineer technical director of Thomas & Betts Co. Bergan, who was formerly director of research, will review proposals for new product designs prior to their submission to the company's development executive committee.

Bernard S. Cahill, formerly associated with Pioneer Electric and Research Corp., has been appointed vice-pres. and chief engineer in charge of the deflection yoke division of Syntronic Instruments, Inc., Addison, Ill.

Level Indicators

(*Continued from page 64*)

not take place even though an electric spark does occur. This is due to the cooling effect of the electrodes, or as in this case, the cooling effect between the probe and some object that had come loose in the vessel and smashed into the probe. Since both of these would be large compared with usual ignition electrodes, considerable cooling would take place and even if they were separated by the critical distance, they would not cause ignition.

The actual energy that can be present at the probe when oscillating at full amplitude can be calculated. If we take the capacitance of the probe assembly and connecting cable as 100μμf (it is usually less), the r-f voltage at approximately 500 kc generated across the coil has a maximum value of 150 v RMS or 210 v peak. The maximum energy available at the electrode is thus

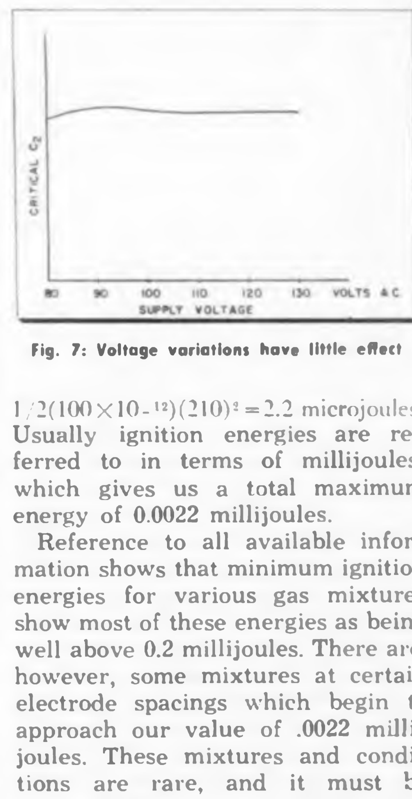

Fig. 7: Voltage variations have little effect

$1/2(100\times10^{-12})(210)^2 = 2.2$ microjoules. Usually ignition energies are referred to in terms of millijoules, which gives us a total maximum energy of 0.0022 millijoules.

Reference to all available information shows that minimum ignition energies for various gas mixtures show most of these energies as being well above 0.2 millijoules. There are, however, some mixtures at certain electrode spacings which begin to approach our value of .0022 millijoules. These mixtures and conditions are rare, and it must be remembered, require the critical spacing and size of the electrodes as well as the minimum ignition energy. For this reason we feel that the energies produced under maximum conditions are below the critical energy required.

In the case of the capacity actuated level control, in the non-oscillating condition, the voltage at the probe is considerably lower. This voltage is always 50 v RMS or less, or 70 v peak.

This gives us a maximum energy of approximately 0.25 microjoules or .00025 millijoules. This is 1/10 of the value when the oscillator is oscillating. It is not sufficient, however, to say that this indicator, using a bare probe, is safe in an explosive gas. In addition, the probe is connected to the circuit through a 500μ capacitor of ample voltage rating to prevent breakdown from any voltage present in the equipment and we always advise that the probe be completely sheathed in a material having a dielectric voltage breakdown, such as Teflon or Neoprene. These coverings always have a minimum wall thickness of 1/16 in. which gives us a large factor of safety.

While this level control is offered in explosion proof form it has not yet received Underwriters Laboratories approval and may not receive such approval for some time to come, as this is the first unit of its type ever submitted to them. However, let me say that in England, they have a somewhat different approach to this question of safety. Specifications are available covering what are termed as intrinsically safe circuits and equipment, and I believe serious consideration should be given to the adoption of similar specifications in this country.

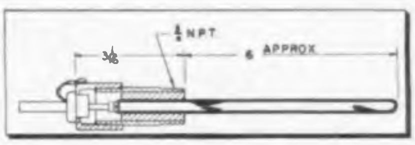

Fig. 8: Cross-sectional view of typical probe

This instrument has been primarily applied as a level control, but it has many other possible uses. To enumerate a few: it has been used as a counter, particularly under conditions of dust or lint when the more usual photo-electric types might be rendered inoperative due to interference with the light beam. It has been used as a safety device on machine tools where the usual metal guard might interfere with visibility. In the field of level control it has been equally useful on liquids or solids, whether conducting or insulating and equally suitable for the control of interfaces between materials of differing dielectric constant. It has found its way into almost every industry.

Plant Changes Hands

The Ceramic Condenser Div. of Radio Ceramics Corp., Angola, Ind. has been purchased by the Gudeman Co., Chicago, Ill., capacitor manufacturers. The former Thermflex Div. becomes Thermflex Corp.

Radar Recording

(*Continued from page* 71)

indicator to about 150 range elements. Angular or azimuth resolution cannot be better than the beamwidth, which in the case chosen is 3°. It is apparent that a total of 6000 picture elements/sec. must be presented (150 range elements per beamwidth or per 1/40 sec.). Using a scanner speed of 3600 rpm for convenience, a picture rate of 9000 elements/sec. is achieved. This is readily achieved in a tape recorder of good quality operating at 7.5 in./sec. Operation at slower tape speeds produces some degradation in picture quality, but the picture is still adequate for most purposes.

Applications

There are many applications where bandwidth is much less than in the case discussed above. For example, a typical long range search radar may operate at an antenna rotation rate of 5 rpm, a pulse repetition rate of 500/sec. and a beamwidth of 3°. With an antenna rate of 30°/sec., an illumination time of 1/10 sec. and a range resolution of 150 elements, the bandwidth requirement is only 1500 cps. This can, of course, be accommodated by a tape speed of 1 or 2 in./sec. The only changes in the basic mechanism between this case and the one discussed earlier are: (1) the scanner speed is reduced to about 10 scans/sec., and (2) the P 1 phosphor is replaced with a longer time constant phosphor such as P 12.

Playback

The playback mechanism is shown in Fig. 4. The sync separator extracts the initial pulses (sync pulses) from the video signals and uses them to actuate a sweep generator. The sweep generator provides a sawtooth current to the magnetic deflection yoke in the indicator. The video signals themselves are fed either directly to the intensity grid of the indicator for "normal" operation or through the "quantizer" which converts all signals above the threshold to a standard level. This feature causes all targets to appear of equal strength on the scope face. Signals from channel 2 are filtered to separate out the antenna rate signal. This signal drives the deflection yoke of the indicator at such a rate as to simulate the original picture. The "North mark set" is manually adjusted so that the audible North mark coincides in time with the arrival of the sweep at the top of the scope face. It is set once when the playback operation is started and no further adjustment is required.

Fig. 1 shows the complete playback system.

The system can be used anywhere that PPI radar information must be recorded. An obvious application is at major airports where proper diagnosis of accidents can be of tremendous importance.

Rafax is a registered trade-name of Haller, Raymond and Brown Inc., State College, Pa.

Echo Chamber

(Continued from page 61)

back to the patch panel and into the console. By moving the microphone up and down the stairway we have some control over the reverberation. This has worked out so well we still have not planned any changes.

Final Hookup

Fig. 3 shows how the final hookup was made. One microphone in the studio is fed into one channel of the console. The house monitor amplifier on this channel feeds the speaker in the chamber. The microphone in the chamber then feeds the second channel of the console. This allows the reverberated sound to be mixed with the normal studio microphone which also feeds the second channel of the console.

This method was used because no modification of existing equipment was necessary and only one patch is needed to alter the board from its normal position to reverberation.

Refinements may be added in the form of equalizers in the reverberation path to compensate for chamber resonance, however in our case this has not been necessary as no bothersome peaks have been noticed. A filter in the reverberation loop could also be used to vary the effects obtainable.

Conclusion

By utilizing what may already be present, or with a little space, some hard surface materials and work, a reverberation chamber producing highly satisfactory results can be built. The final design will have to be left to the builder, of course, since it will depend on the equipment and space he may have available.

Digital Recording

(Continued from page 69)

used to move the tape past the recording heads should be capable of fast starts and stops. In addition, high tape speeds are desirable where it is necessary to record many samples in a short period of time.

These features are necessary for efficient "speed-changing." For example, high frequency measurements may be recorded by running the tape handler continuously at high speeds. In certain applications information is produced intermittently at random rates. A fast-starting fast-stopping tape handler can be arranged to move the tape only when needed to record or play back a burst of information. Between bursts, the machine stands idle.

Telemeter Recorder

Another example of a system using magnetic recording techniques to convert information for computer analysis is illustrated in Fig. 3. In this application it is necessary to record telemetered information from three separate sources for subsequent analysis by a computer having input capabilities much slower than the rate at which the information was produced.

The information consists of pulses occurring on two lines; those arriving on one line are to be added, and those on the other line are to be subtracted. In addition, the counting process can not be interrupted, but samples must be taken several times a second.

Magnetic tape solves the problem as illustrated by the block diagram in Fig. 4. The three inputs are indicated as Channel A, B and C. Each is fed into a separate bi-directional counter capable of adding and subtracting.

Three transfer gates continuously monitor the counts being registered by the counters and at regular intervals as specified by the Read Rate Generator the information is transferred into three shift registers. At the same time, information regarding the time of each sample is transferred into a fourth shift register. Three additional shift registers monitor the sign (+ or −) of the three information channels.

Once the above information is loaded into the shift registers, a 2 KC signal from a separate oscillator is routed to the shift registers to transfer all readings serially into a mixing register that subsequently transfers readings with time and sign information onto the magnetic tape.

The equipment required for transferring the information from the tape to a card punch is also shown in Fig. 4. During playback the recorded pulses are amplified and the binary-coded decimal numbers are fed sequentially back into the shift registers. Once reloaded the shift registers move the information through four relay matrices into the card punch. Playback is at slower rate and is under control of card punch which is fixed in speed.

Economy

Despite the apparent complexity of the described systems, considerable economy results from their use. Information is permanently preserved and recordings may be played back any number of times with complete accuracy. Tapes may be stored indefinitely and re-used any number of times. A single standard-size reel of tape can store information equivalent to 25,000 punch cards.

A tape transport mechanism designed especially for this type of service is seen in Figs. 1 and 3. Fast starts and stops (less than 5 msecs.) are made possible by use of twin servo-controlled tape tension control systems. When the tension on either side of the actual tape transport mechanism increases or decreases, spring-loaded (photoelectrically sensed) tension arms send signals to tape reel motors, instructing them to speed up, slow down or reverse, as might be required.

Up to 8 channels of information may be recorded simultaneously, thus making available 64 binary-coded bits of information across the tape. Typical pulse densities are 200/in. of tape, thus permitting recording of over 50,000 bits of information on an inch of tape. Multiply this figure by the half mile of tape contained on a standard 10½ in. reel, and the information storage capabilities of digital magnetic tape systems can be appreciated.

JET TEST

From this control room, protected by two-foot concrete walls, engineers run dynamic tests on jet engines. Engineers of Ford Aircraft and Minneapolis-Honeywell collaborated on the work

Magnetic Recording

(Continued from page 56)

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(Continued on page 112)

Magnetic Recording

(Continued from page 111)

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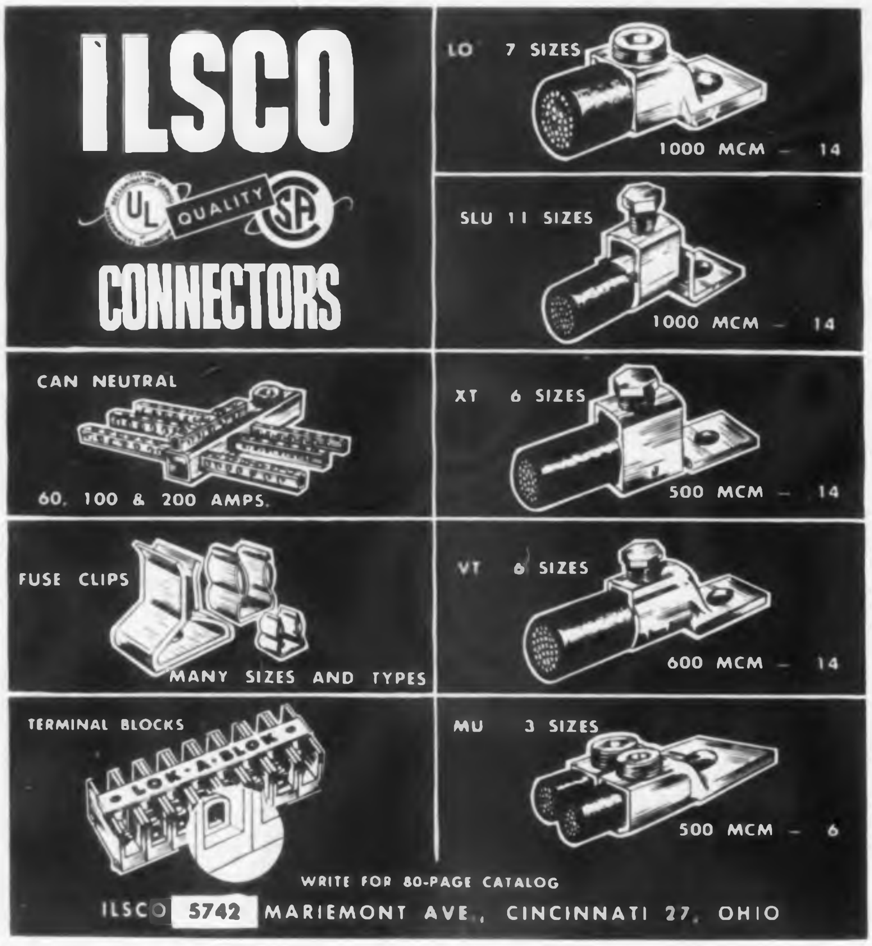
D. W. Thomasson, "Wow Measurements," *Wireless World*, pp. 579-580, Dec.

MOBILE STUDIO FOR WQAN

This unit used by WQAN, Scranton, Pa., is a self-contained broadcasting station with high frequency transmitters, tape recorders and audio equipment, as well as public address equipment all powered by a gasoline engine generator.

INQUIRY CARD Not good after Sept. 1, 1954

For product information, use inquiry card on last page.



BULLETINS

Microwave

An informational brochure describing all the major methods used in microwave survey work, and containing pertinent data on microwave coordination, economics of microwave, and application of high power relay systems is available from Microwave Services, Inc., 45 Rockefeller Plaza, New York.

Diodes and Transistors

Bulletin C-23 released by Radio Receptor Co., Inc., 251 W. 19th St., N.Y. 11, N.Y. provides operating characteristics and interchangeability charts for a full line of germanium diodes and germanium transistors

X-Ray Techniques

The first issue of a new-style industrial house organ, known as the "Radiation Digest," has just been published by the X-Ray Dept., General Electric Co., 4855 Electric Ave., Milwaukee, Wis. The publication serves those fields of industry in which x-ray, electron beam and related radiation devices are employed.

Test Equipment

New items and replacement types in the line of attenuators, waveguide tuners, marker generators, etc., manufactured by Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, New York, are listed in a new release which is available upon request to the company.

Magnetic Tape

Details as to physical properties, characteristics and use of Audio-tape on "Mylar" base are outlined in Bulletin 210, which is obtainable from Audio Devices Inc., 444 Madison Ave., N.Y. 22, N.Y.

Resistors

The Type HFR High Frequency resistors are described in a new release by International Resistance Co. 401 N. Broad St., Phila., Pa.

Crystals

Catalog 354, a 12-page illustrated brochure issued by the Standard Crystal Co., 1714 Locust St., Kansas City, Mo., contains information on the crystal requirements of military equipment, in addition to specifications of individual crystals.

Components

A 36-page guide to electronic components, including resistors, deflection yokes, focus coils, and i-f and r-f transformers and coils, is available upon request from I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Phila., Pa.

Magnetic Amplifiers

A folder issued by Federal Tel. and Radio describes a line of magnetic amplifiers and highlights their applications in industry. Write Components Div., Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N.J.

Resistors

The 1954 20-page catalog, featuring the complete line of Tru-Ohm resistors and power rheostats, contains all pertinent information on resistor specifications and includes data on special rheostat and bushing assemblies, taper wound rheostats, etc. Write Tru-Ohm Products, 2800 N. Milwaukee Ave., Chicago 18, Ill.

Cores

Catalog ML-101 describes the line of laminated cores, laminations and dies produced by Magnetics, Inc. of Butler, Pa. Copies on request if written on company letterhead.

BULLETINS

Tubes

General information on the Tung-Sol line of receiving tubes and germanium diodes, in addition to specifications on new receiving tubes are contained in new release by the Commercial Engineering Dept. Electron Tube Div. Tung-Sol Electric Inc., 95 Eighth Ave., Newark 4, N.J.

Transistors

Bulletins containing engineering data on both the 900 and 901 general purpose silicon transistors and the X-15 medium power silicon transistor are available from Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.

Batteries

Complete electrical data and physical dimensions on more than 24 Yardney Silvercel Batteries can be obtained at a glance from a new Application Guide available from Yardney Electric Corp., 105 Chambers St., New York City.

Selenium Rectifiers

A comprehensive treatment of selenium rectifiers, their applications, and design considerations is contained in Catalog No. 666 which is available from Rectifier Div., Sarkes-Tarzian, Inc., 415 No. College Ave., Bloomington, Ind. In addition to the standard interchangeability charts, there is a large section devoted to design formulae.

Printed Circuits

An interesting 8-page brochure prepared by Photocircuits Corp., Glen Cove, N.Y. explains in details the steps in the production of printed circuits, and describes methods by which they may be applied.

Connectors

A new bulletin describing aluminum hoods and pressurized plugs for use with their line of E-Z Release series Continental Connectors is available from Electronic Sales Div., DeJUR-Amsco Corp., 45501 Northern Blvd., L.I.C., N.Y.

Broadcast

Three new catalogs describing broadcast equipment are available from R.C.A. Catalog B. 423 describes the new RCA Video Distribution Amplifier—Type TA—3A; Catalog B. 424 covers the new Pulse Distribution Amplifier; and Catalog B. 377 provides information on the Type TS-5A Video Switcher. Write Engineering Products Div. R.C.A., Camden 2, N.J.

Oscillograph

A two-page color folder issued by Allen B. Du Mont Laboratories, Inc., Instrument Div., 760 Bloomfield Ave., Clifton, N.J. describes the new Type 323 cathode-ray oscillograph.

Resistors

The Daven Co., 191 Central Ave., Newark, N.J. announces its latest 32-page catalog covering "Super-Davohm" precision wire-wound resistors.

Power Resistors

Form 79-8, a new 27-page catalog issued by P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., is devoted to wire-wound fixed and adjustable vitreous-enamel power resistors and rheostats.

Potentiometers

The new "TIC Potentiometer Handbook" contains 207 pages and 189 illustrations. Available at Technology Instrument Corp., 531 Main St., Acton, Mass. Price of $2.00 includes periodic releases.

For product information, use inquiry card on last page.

Tape & Disc System

(Continued from page 65)

nemite. For 7½ and 15 ips the Magnecord is used.

With the advent of tape, continuous disc recording exceeding fifteen minutes duration was discontinued and one of the 6-N Presto tables was converted to record LP at 240 lines/in. A disc monitoring arrangement is used which enables the operator to check a recording at the cutter. A 5,000 ohm transformer is bridged across each 500 ohm cutter and a small speaker connected to the voice coil winding. This insures that no blank discs will be forthcoming due to the amplifier output being fed in error to the cutter not in use.

Material List

○—Cannon Connectors, Tape Rack Leads

Terminations:

A—Transmitter Line
B—Console 2, Line 2
C—Console 1, Line 2
D—Remote Input Console 1

Pads:

P1—50 ohm bridging pad
P2 thru P7—500/50 ohm matching pads

Switches:

1, 2, 6—DP3pos Mallory 3223J
5—DPDT Mallory 3222J
3, 4—4P3pos Mallory 3243J
7—4P3pos, shorting contacts, Mallory 3143J

Jacks:

J1—88-A input
J2—tape recorders output
J3—remote input, console 1
R1—500 ohms 20 watt
T1, T2—5,000 ohm output transformer

The system is inexpensive since an ordinary ac-dc receiver output transformer may be used.

The tape editing arrangement is far superior to the scissor-wielding method as anyone who has had the experience of having a half-mile of tape distributed about himself and the surrounding territory will agree. The method is standard, the output of one tape feeds another recorder. When a portion is to be edited out, the recorder receiving the edited tape is stopped while the undesired portion is run off on the other. When this portion ends the edited tape is again started. Care must of course be exercised during the editing that the proper spacing is allowed on the edited tape, and that a portion of the old recording is not left on the tape in these intervals due to the erase head being off while spacing. For this reason it is good practice to

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The *cutting arm* has *three* knives: The *center knife* is directional and can be pivoted and set to cut either at perfect 90°, at 67½°, or at 45°. The *spring pads* hold the recording tape firmly in place as the *side knives* cut the splicing tape to the exact width of the recording tape . . . Precision machined, beautifully finished; lightweight, rugged.

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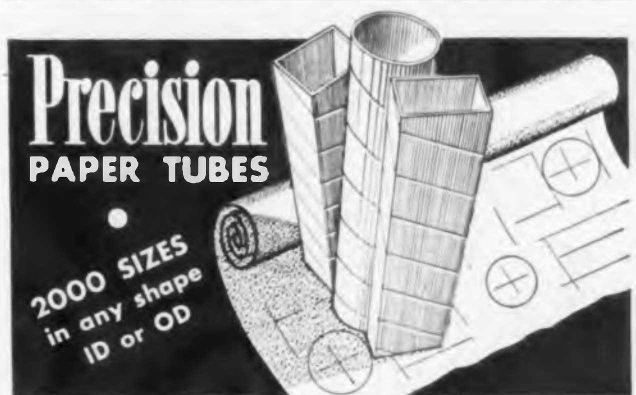

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SARKES TARZIAN, Inc.
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Bloomington, Indiana

Tape & Disc System

(*Continued from page* 116)

erase a tape before using it to receive an edited recording.

The installation has proven to be well worth the cost and effort. Recorded program quality has improved due to the increased use of tape and its editing possibilities. Outside events are easily covered with a portable tape and the results simply edited when necessary. Recording costs have been cut due to the flexibility of the installation as well as the many program sources available while on the air. Our requirements have been satisfied for a small station unit that will consistently deliver professional results with convenience and flexibility in operation.

Miniature Microphone

(*Continued from page* 67)

of 3.75, a Distance Factor of 1.93 and a Unidirectional Index of 14.

It is evident, therefore, that the ultra-cardioid is a much better pattern for applications in which it is desired to exclude the rear sounds than the more commonly used cardioid pattern. Therefore, the ultra-cardioid pattern was selected for the new microphone.

From the previous section it is seen that the new microphone should have a phase-shift network capable of shifting the pressure at the rear through an angle $\omega d_1/c_v$ where d_1 corresponds to $(1 - .63)/.63 = 59\%$ of the front-to-back distance. The acoustical design of the microphone to achieve this objective will now be described. The microphone is shown in schematic cross section in Fig. 6 with its equivalent acoustical circuit.

At the top is the ribbon transducer showing that the pole-pieces are tapered to concentrate the magnetic flux at the ribbon. The tapered portions form a funnel oriented toward the front of the microphone. The funnel is equipped with a short rubber horn which has the dual function of sealing the open ends of the magnetic structure and of improving the response at the high-end of the spectrum.

At lower audio frequencies the horn merely adds an acoustic mass or inertance loading upon the ribbon. The front entry, including the horn, can be assumed to constitute an acoustic impedance comprising the inertance of the horn, L_H, the inertance of the ribbon, L_R, and the

Miniature Microphone

(Continued from page 119)

acoustic compliance of the ribbon C_R. These elements taken in series constitute the front impedance of the microphone, Z_3. The ribbon element is attached to a box-like structure, the rear part of which is provided with an acoustical impedance element in the form of a cloth mounted on a grille-work. This element defines acoustic resistance and inertance, R_1 and L_1, respectively. The box has a given volume V which constitutes an acoustic compliance $C_2 = V/P_0\gamma$.

The sound pressure at the front of the microphone is designated as p_a and at the rear of the microphone p_b. In the equivalent circuit diagram these pressures are shown as potentials to ground at the terminals corresponding to the entries into the network. U_3 is the fluid velocity into the front entry and, therefore, it determines the velocity of the ribbon element and in turn the generated voltage. Solving for U_3 the following equation is obtained:

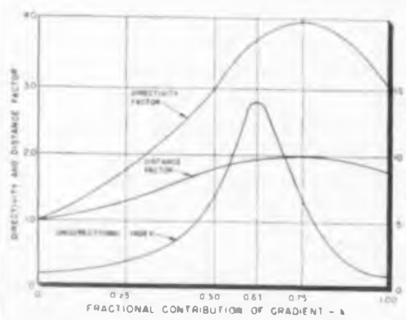

Fig. 5: Ultra-cardioid is highly directional

$$U_3 = \frac{p_a - p_b\,(1 - \omega^2 L_1C_2 + j\omega C_2R_1)}{Z_3 + Z_1\,(1 - \omega^2 L_1C_2 + j\omega C_2R_1)} \quad (7)$$

If it is desired that p_b should be shifted in phase through an angle $.59\omega\, d/c_v$, the quantity in parenthesis must be made equal to the unit vector cos. $.59\omega\, d/c_v + j \sin .59\omega\, d/c_v$. Expanding these quantities the following approximate relation is obtained:

$$1 - \omega^2 L_1C_2 + j\omega C_2R_1 = 1 - \frac{.59^2\,\omega^2\,d^2}{2c_v} + j\frac{.59\,\omega\,d}{c_v} \dots \quad (8)$$

Equating the corresponding terms in this last equation we obtain the following network relationships to produce ultra-cardioid operation:

$$C_2R_1 = .59\, d/c_v \quad (9)$$

and

$$L_1C_2 = .59^2\, d^2/2c_v^2 \quad (10)$$

These equations provide a unique

5 reasons

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1. They're Stable • The resistive element of Corning Resistors is so stable it can be cycled from near absolute zero to red heat without impairing its electrical properties. These resistors withstand high-ambient and high-operating temperatures.

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That's not all! Corning Resistors have other important characteristics to help you. And there are 16 different types, covering a resistance range from 10 ohms to 1 megohm; ratings from ½ watt to 150 watts. Write today for technical descriptions of all of them.

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Miniature Microphone

(Continued from page 120)

choice of C_2, R_1 and L_1 to achieve the ultra-cardioid pattern.

Another interesting observation in the denominator of Eq. 10 is that $Z_1 = R_1 + jL_1$ which is, at low frequency, effectively in series with the transducer impedance Z_3. Suitable choice of R_1 provides critical damping to the ribbon transducer resulting in excellent transient response.

Design and Construction

The basic transducer element is the ribbon cartridge, shown in Fig. 4. It consists of two horseshoe-shaped magnets with magnetic pole-pieces between. Within the gap formed by these pole-pieces is suspended the corrugated aluminum ribbon—which has a length of 1 in., a width of .074 in., and a thickness

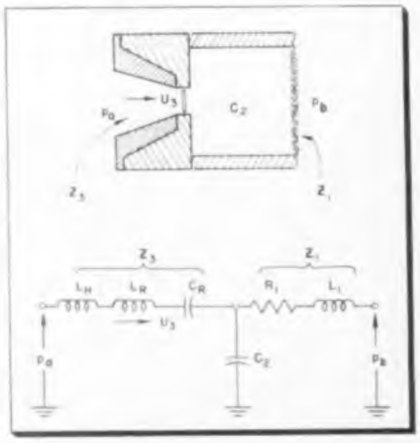

Fig. 6: Magnetic housing-equivalent circuit

of .0001 in. The ends of the ribbon are clamped in place, and are soldered to insure good electrical contact.

Into the front of the magnetic structure is inserted the form-fitting rubber horn described before. This horn improves the high frequency sensitivity; and it seals the ends of the ribbon structure, insuring that sounds reach the rear of the ribbon only through the phase-shifting network. A view into the front of this horn is shown in Fig. 4. At the inner end of the horn may be seen the metal screen, one of which is placed on each side of the magnetic gap to provide protection and to prevent distortion of the ribbon due to excessive motion, however caused. The mouth of the horn is covered by a fine-mesh dust- and wind-screen, which has been omitted in this photograph to permit the interior view.

In Fig. 1 is a partly-disassembled Model 333 microphone. At the left is the entire case—complete with its shock-mounting base, Cannon connector, swivel, and with two switches, a transformer, and a choke in place and wired. In the center is the cartridge proper—consisting of the magnetic structure, rubber horn, and a mounting-base, which, when assembled in the case, provides the acoustic phase-shifting network. At the extreme right is the decorative front grille which also assures dust and wind protection. For convenience in styling, the rear port has been divided into two sections placed

Fig. 7: Measuring random and frontal sounds

at either side of the case.

The response-frequency characteristic of the Model 333 is shown in Fig. 2. A "Voice-Music" switch has been provided to insure flexibility of operation. The Model 333 uses a tapped output transformer and switch, which permit operation at "Low," "Medium" and "High" impedances—corresponding to 35-50 ohms, 200-250 ohms, and 30,000 ohms respectively.

The microphone head has a width of $1\frac{1}{32}$ in., a depth of $1\frac{7}{8}$ in., and a height of $3\frac{5}{8}$ in.

Where additional shock-mounting is required, this head is readily adaptable for such mounting, and one form is shown in Fig. 4.

Color TV Camera Tubes Available

The RCA color TV camera tube formerly available to broadcasters and equipment manufacturers only on a sample basis, is now a full-fledged commercial product, according to Douglas Y. Smith, general marketing manager of the RCA Tube Div.

An image-orthicon type, the tube (RCA 6474/1854) resembles in size and shape the camera developed by RCA for black-and-white TV. When operated in a color camera having appropriate color filters and optical arrangements, it requires only 350 ft.-candles of incident incandescent illumination on the scene and a lens stop of f:5.6 to translate colors with high accuracy.

Three of these image orthicon tubes are required with each color TV camera—one for each of the primary colors.

Equipment Transistors

(Continued from page 74)

ing the sensitivity of oscillographs and in making other preliminary calibrations of electronic systems.

A completely self-contained transistorized servo amplifier the 434-B, (Fig. 3) is manufactured by Industrial Control Co., Wyandanch, L.I., N.Y. It features transistor-magnetic circuitry in a hermetically sealed enclosure, and requires no exterior power supply or damping tachometer. It drives various 400 cycle servo motors in medium performance positional servo loops from single speed autosyn data.

Fig. 3: Transistorized servo amplifier

Microphone

A low noise, high intelligibility microphone, manufactured by the Remler Co. Ltd., San Francisco, Calif. can replace carbon microphones in aircraft, mobile intercommunication equipment, and radio systems. (For description see *TELE-TECH & Electronic Industries*, March, 1954.)

The Vectron Co., Waltham, Mass., manufactures a transistorized, crystal-controlled oscillator which can operate continuously for two years from single self-contained batteries; it has no on-off switch.

A hospital and factory paging system, in which each person subject to call wears a tiny, transistorized receiver, is manufactured by Dictograph Products Co., Jamaica, N.Y.

A flashlight battery powers a miniature high-voltage supply which can turn out up to 2,000 v. for operating radio-activity measuring instruments. In this device, which is manufactured by Technical Operations Inc., Arlington, Mass., a Raytheon transistor does the work of the conventional vibrator.

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News of MANUFACTURERS' REPS

Frank J. Perna, 2506 Stoneybrook Lane, Drexel Hill, Pa., was appointed parts jobber representative by International Rectifier Corp., El Segundo, Calif. to cover eastern Pennsylvania, northern New Jersey, the District of Columbia, and Maryland. **Langhaus-Levy Associates**, 315 Walton St., Chicago, Ill. will represent the company in northern Illinois and eastern Wisconsin.

Avionics Ltd., Municipal Airport, St. Catharines, Ontario, Can., has been appointed to represent Stupakoff Ceramic & Manufacturing Co., Latrobe, Pa., in Ontario and Quebec and Electronic Research Associates, Caldwell, N. J. for the sale of all test and transistor equipment.

The Engineered Products Div., of **Straus-Frank Co.,** 4000 Leeland Ave., Houston, Texas, has been named representative for southern Texas and southern Louisiana by Atomic Instrument Co., Cambridge, Mass.

LeRoy J. Smith, Los Angeles, Calif., has been made representative for southern California, Arizona, and part of Nevada by Mark Simpson Mfg. Co., Long Island City 3, New York.

E. W. McGrade Co., Kansas City, Mo., have been assigned Colorado and New Mexico by Communications Accessories Co., Hickman Mills, Mo. **Cooper-Morgan, Inc.,** Hamburg, N. Y., will represent the company in western New York; **Naylor Electric Co.,** Syracuse, N. Y., will cover central New York. **Henry Lanvin Associates**, Meriden, Conn., will cover six New England States; and **Ernie Kohler Associates**, Cleveland, Ohio, will cover Ohio and Eastern Michigan.

B. B. Taylor Co., 241 Sunrise Highway, Rockville Centre, N. Y., will cover the New York area, and **Holliday-Hathaway Inc.**, 238 Main St., Cambridge, Mass., will service the New England states for International Electronic Research Corp., Burbank, Calif. **Magnuson Associates**, 4358 W. Irving Park Rd., Chicago, Ill., represent the company in Wisconsin, Minnesota, Iowa, Illinois, and Indiana. **Gordon S. Marshall Co.,** 40 S. Los Robles, Pasadena, Calif., will service the California, Arizona, and New Mexico areas.

The **G. McL. Cole Co.,** 4753 N. Broadway, Chicago, Ill., has been appointed sales representative in Illinois and Wisconsin for the complete line of high fidelity, radio, and TV products made by Radio Craftsmen, Inc., Chicago, Ill.

TELE-TECH ADVERTISERS—JULY, 1954

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Follow-Up System

(Continued from page 57)

and then returns toward position 1, no action takes place until the S1 wiper reaches contact #1 again. At this time B returns to its position 1. On the negative half-cycle, the action is similar.

The constant-velocity input shown in Fig. 2C is approximated by a step function the value of which is alternately positive and negative with respect to the desired output rotation.

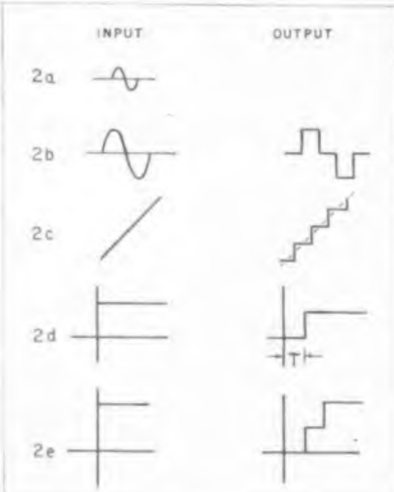

Fig. 2: Stepping function seen graphically

A step function input approximately equal to one step, as in Fig. 2d, is roughly duplicated by the system. The magnitude of the output is the rotation angle which most nearly corresponds to the input angle. A delay of τ is experienced due to inertia and inductance effects. When the step function input equals approximately two steps (Fig. 2E), a delay of 2τ is experienced, in that one delay τ is involved in each step.

As the frequency of the input function (Fig. 2b) is increased, a critical frequency is reached, beyond which no output is produced. The frequency response is thus as shown in Fig. 3.

Expanded Circuit Facilities

Completion of a new plant with additional manufacturing facilities for the mass production of printed circuits and etched circuits is announced by U.S. Engineering Co., 521 Commercial St., Glendale 3, Calif. The new plant is turning out printed circuits in all popular sizes and all Mil. Specs. can be met.

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706 American Lava Corp.—Ceramic assemblies.
706A American Microphone Co.—Microphones.
707 American Phenolic Corp.—Connectors.
708 Ampex Corp.—Portable tape recorder.
709 Andrew Corp.—Antenna systems.
710 Arnold Engineering Co.—Transformer cores.
711 Atlas Sound Corp.—Microphone stands; booms.
712 Audio Devices, Inc.—Recording tape.
713 Audio Instrument Co., Inc.—Reverberation unit.
714 Avion Instrument Corp.—Frequency converter.
715 Bell Telephone Laboratories, Inc.—Engineering.
716 Bendix Aviation Corp., Red Bank Div.—Receiving tubes.
717 Berndt-Bach, Inc.—sound recording equipment.
718 Blaw-Knox Co.—Antenna towers.
719 Burnell & Co.—Toroids & filters.
720 Bussmann Manufacturing Co.—Fuses.
721 Cannon Electric Co.—Connectors.
722 Capps & Co., Inc., Frank L.—Condenser microphones.
723 Coco Distributing Corp.—All-directional dolly.
724 Cinch Manufacturing Co.—Mica components.
725 Cinema Engineering Co.—Audio Filter units.
726 Cleveland Container Co.—Paper base phenolic tubing.
727 Clippard Instrument Lab., Inc.—Automation.
728 Collins Radio Co.—Broadcast equipment.
729 Columbian Carbon Co.—Ferrites.
730 Communication Accessories Co.—Toroids.
731 Corning Glass Works—Film-type resistors.
732 Daven Co.—Wirewound resistors.
733 DuMont Labs., Inc., Allen B.—TV multi-scanner.
734 Eisler Engineering Co., Inc.—Indexing turntables.
735 Eitel-McCullough, Inc.—Capacitors, sockets, connectors.
736 Eitel-McCullough, Inc.—Klystron.
737 Electra Manufacturing Co.—Deposited carbon resistors.
738 Electro Motive Manufacturing Co.—Capacitors.
739 Fairchild Engine & Airplane Corp.—Transistor dynamic analyzer.
740 Federal Telecommunication Labs.—Engineering personnel.
740A Federal Telephone & Radio Co.—Selenium rectifiers.
741 Ford Instrument Co.—Engineering personnel.
742 Freed Transformer Co.—Test instruments.
743 General Control Co.—Limit switches.
744 General Electric Co.—Audio amplifiers.
745 General Electric Co.—Bulbs; dial lamps.
746 General Electric Co.—Germanium Diodes.
747 General Precision Lab., Inc.—Vidicon film chain.
748 General Radio Co.—Voltage regulator.
749 Gertsch Products Inc.—Frequency multiplier.
750 Helipot Corp.—Free potentiometer manual.
751 Heppner Mfg. Co.—Ferrite focusing magnets.

Listings continued on next page ▶▶▶

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755 Hughes Research & Dev. Labs.—Engineering personnel.
756 Ilsco Copper Tube & Products, Inc.—Connectors.
757 International Rectifier Corp.—Selenium rectifiers.
758 Johnson Co., E. F.—Variable capacitors.
759 Jones Div., Howard B., Cinch Mfg. Corp.—Plugs & sockets.
760 Kanthal Corp.—Resistance wire.
761 Kester Solder Co.—rosin-core solder.
762 Knights Co., James B.—Crystals.
763 Kollsman Instrument Co., Inc.—UHF sweep generators.
764 Langevin Manufacturing Corp.—Booster amplifier.
765 Librascope, Inc.—Recording heads.
766 Lockheed Aircraft Corp.—Engineering personnel.
767 Magnecord, Inc.—Professional tape recorder.
768 Mallory & Co., Inc., P. R.—Vibrators.
769 Melpar, Inc.—Engineering personnel.
770 Midland Manufacturing Co.—Frequence control crystals.
771 Mueller Electric Co.—Clips.
772 National Co.—Free equipment catalog.
773 Permag Corp.—Permanent magnets.
774 Phalo Plastics Corp.—Wires & cable.
775 Philco Corp.—Transistors.
776 Polarad Electronics Corp.—Spectrum analyzer.
777 Potter Co.—Noise filters.
778 Potter Instrument Co.—Magnetic-tape handlers.
779 Precision Paper Tube Co.—Paper tubes.
780 Premier Instrument Co.—Waveguides.
781 Presto Recording Corp.—Console tape recorder.
782 Radio Corporation of America—Phototubes.
783 Radio Corporation of America—TV film camera.
784 Radio Materials Corp.—Disc capacitors.
785 Radio Receptor Co., Inc.—Selenium rectifiers.
786 Raypar Inc.—Transformers for printed circuits.
787 Reeves Soundcraft Corp.—Magnetic recording tape.
787A Sarkes Tarzian, Inc.—UHF-VHF TV tuner.
788 Scherr Co., Inc., George—Dynamometer.
789 Shallcross Manufacturing Co.—Rotary switches.
790 Shure Brothers Inc.—Unidirectional microphone.
791 Sigma Instruments, Inc.—Relays.
792 Specific Products Co.—Time-frequency calibration receiver.
793 Sprague Electric Co.—Wirewound resistors.
794 Sprague Electric Co.—Tantalytic capacitors.
795 Standard Electronics Corp.—TV broadcast equipment.
796 Stone Paper Tube Co.—Paper tubing.
797 Sylvania Electric Products Inc.—Crystal diodes.
798 Synthane Corp.—Plastic insulation.
799 Technicraft Laboratories, Inc.—Flexible waveguides.
800 Technology Instrument Corp.—Power amplifier.
801 Telechrome, Inc.—Transmission test equipment.
802 Tel-Instrument Inc.—Sync signal generator.
803 Thermador Electrical Mfg. Co.—Transformers.
804 Transradio Ltd.—Coaxial cable.
804A Triad Transformer Corp.—Transformers.
805 Tung-Sol Electric, Inc.—Receiving tubes.
806 Victoreen Instrument Co.—Resistors.
807 Weckesser Co.—Cable clips.
808 White Dental Mfg. Co., S. S.—Abrasive cutting tools.
809 White Dental Mfg. Co., S. S.—Molded resistors.
810 Williams & Co., Inc., C. K.—Ferric oxides.

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