MAY 24 1954

TELE-TECH

& Electronic Industries

Electronic Aircraft Control

May • 1954

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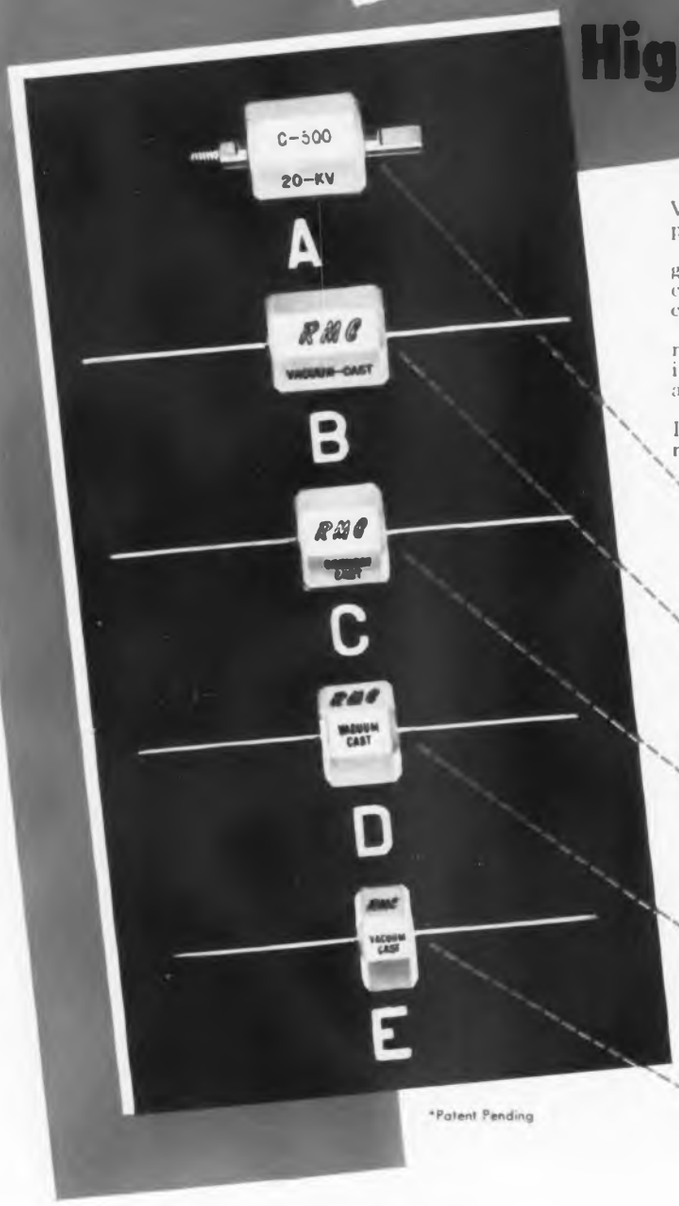
Please Route To

Another RMC First

"VACUUM CAST"*

High Voltage DISCAPS®



*Patent Pending

Vacuum Cast DISCAPS answer the demand for a dependable ceramic capacitor for high voltage applications.

The RMC Vacuum Cast process removes all air and gases to form a hermetically sealed casing in perfect contact with dielectric and terminals. The possibility of cracks or fissures in the casing is eliminated.

The exclusive casting material meets all the requirements of an outstanding capacitor casing; it is highly impervious to moisture, has great mechanical strength and exceptionally good electrical characteristics.

For extra dependability specify RMC Vacuum Cast DISCAPS . . . they are priced competitively with ordinary molded types. Your inquiry is invited.

1" x 7/8" across flats.
20 KV—500 mmfd with standard and special terminals.

Size—1" x 7/8" across flats.
20 KV—500 mmfd with No. 16 wire leads. Lead lengths optional.

3/4" x 7/8" across flats.
15 KV—1200 K—50 to 200 mmfd
15 KV—4500 K—200 to 1000 mmfd

5/8" x 7/8" across flats.
10 KV—1200 K—50 to 250 mmfd
10 KV—4500 K—250 to 1000 mmfd

7/16" x 7/8" across flats.
8 KV—N-1500—10 to 50 mmfd
8 KV—1200 K—50 to 250 mmfd
8 KV—4500 K—250 to 1000 mmfd

C—D—E have No. 16 or No. 18 wire leads—length optional.

POWER FACTOR AT 1000 CPS: 1% MAX.
LEAKAGE RESISTANCE: Guaranteed greater than 50,000 Megohms
LEAKAGE RESISTANCE AFTER HUMIDITY: 5000 Megohms

A New Development from the RMC Technical Ceramic Laboratories

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

DISTRIBUTORS: Contact Jobbers Sales Co., 146 Broadway, Paterson 1, N. J.

MAY 24 1954

TELE-TECH
& Electronic Industries

MAY, 1954

FRONT COVER: ELECTRONIC AIRCRAFT CONTROL—The complex problem of scheduling jet planes to land at the rate of 120/hour appears to be as exacting as threading them through a needle's eye. The critical return-to-base congestion has fostered the need for an automatic air traffic controller capable of much faster operation than human controllers. The solution is the Volscan system, in which the control console operator "shoots" a PPI blip with a light gun, thereby assigning a tracking-while-scanning channel (Antrac) which isolates this target from all others. The Antrac feeds the Volscan computer (Datac) which computes a landing schedule. The Datac control orders are relayed to the aircraft by voice or data link. See page 66

DEPARTMENTS

TELE TECH*, Vol. 13, No. 5. Published monthly by Caldwell-Clements, Inc. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Secretary; Marguerite B. Clements, Treasurer. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. 75c 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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Publishers also of MART and TECHNICIAN

*Reg. U. S. Pat Off.

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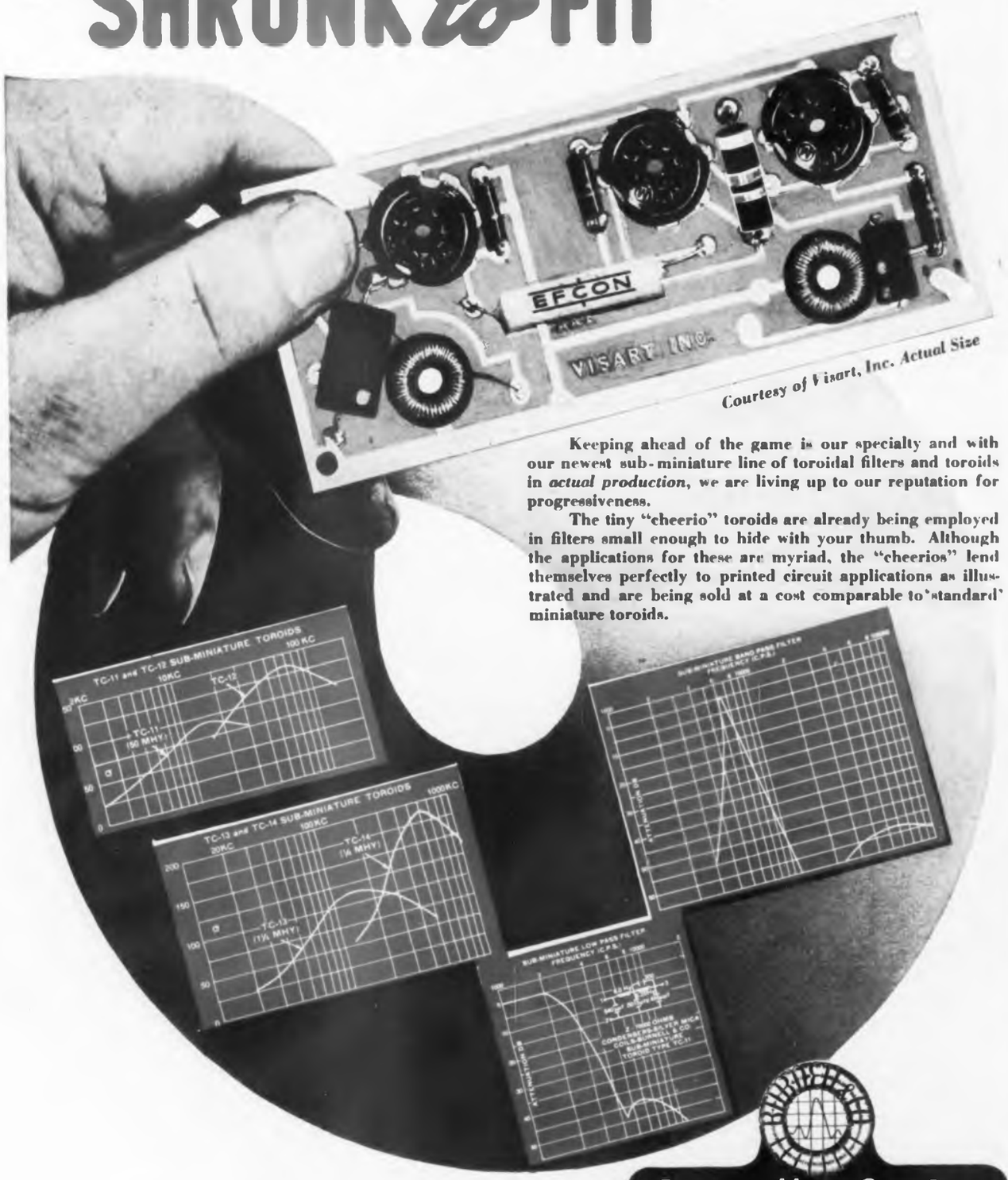
Burnell TOROIDS and FILTERS

"SHRUNK *to* FIT"



Courtesy of Visart, Inc. Actual Size

Keeping ahead of the game is our specialty and with our newest sub-miniature line of toroidal filters and toroids in *actual production*, we are living up to our reputation for progressiveness.

The tiny "cheerio" toroids are already being employed in filters small enough to hide with your thumb. Although the applications for these are myriad, the "cheerios" lend themselves perfectly to printed circuit applications as illustrated and are being sold at a cost comparable to 'standard' miniature toroids.

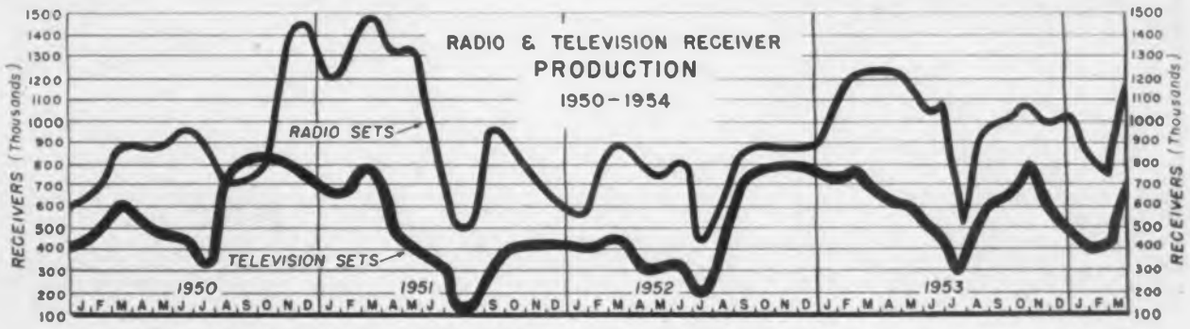
Write for new and enlarged 16 page catalog 102A

Exclusive Manufacturers of Communications Network Components

Burnell & Co., Inc.
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

Facts and Figures Round-Up
May, 1954

ELECTRONIC INDUSTRIES **TOTALS**



Presented below are some interesting results obtained in a recent survey conducted to find degree of electronic engineer employment in the aircraft industries. Replies are from major airframe manufacturers

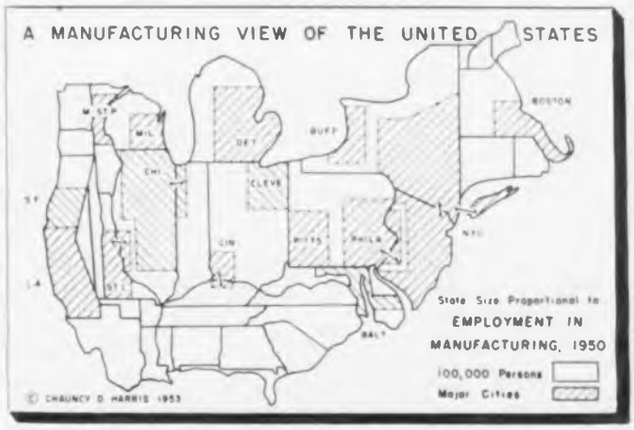
ELECTRONIC ENGINEERS IN AIRCRAFT INDUSTRY

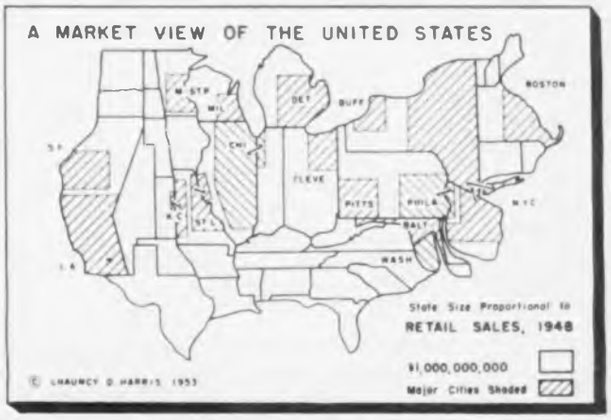
Aircraft Mfgr.	No. of Engineers	No. Elect Engineers	% Elect Engineers
A.	1400	400	29%
B.	1100	185	17%
C.	1277	102	8%
D.	3500	200	5.7%
E.	175	32	18.3%
F.	1050	400	38%
G.	463	58	12.6%
H.	5000	2000	40%
I.	3000	175	5.8%
J.	850	80	9.4%
Total	17,815	3632	
Average	1782	363	18.3%

MAJOR MANUFACTURERS REPORT 1953 SALES

Name Mfr.	Sales (Thousands) 1952	1953	Net Income (Thousands) 1952	1953	Earning Share (Cmn) 1952	1953
Burroughs	$151,327	$162,632	$ 7,894	$ 7,207	$1.58	$1.44
Clevite	54,103	71,305	3,444	3,479	1.97	1.77
DuMont	76,367	91,829	1,425	1,544	0.55	0.60
Hoffman	36,380	50,415	1,624	1,200	2.81	2.07
Minneapolis-Honeywell	165,710	214,019	9,081	10,330	3.00	3.31
Minn. Mining & Mfg.	185,242	219,916	16,090	17,978	1.96	2.14
Motorola	168,735	217,964	7,013	7,076	3.62	3.66
Philco	366,964	430,420	11,491	13,068	3.15	3.43
RCA	693,941	853,054	32,325	35,022	2.10	2.27
Stewart-Warner	122,552	128,798	4,234	4,081	3.30	3.04
Zenith	137,600	166,733	5,846	5,632	11.87	11.44

"Mathematics of Plant Location," appearing in current issue of University of Chicago Reports, is an interesting summary of the work of Prof. C. D. Harris who believes physics formulae can be used to plot industrially important factors. Interesting maps below show manufacturing and marketing area in US





GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Actuators	$ 1,264,447	Handsets	143,417	Resistors, variable	81,958
Actuator Parts	264,838	Indicator, tachometer	64,825	Solder	86,991
Amplifiers	27,985	Kits, radar	35,528	Solder, silver	35,506
Anodes, silver	290,156	Machine, dynetric balancing	50,400	Sonar Sounding Sets	383,955
Antennas	39,600	Master Indicators, directional gyro	10,592,937	Spare Parts, transceiver	1,892,202
Batteries	3,235,799	Meters, frequency	79,141	Suppressors, noise	30,390
Cable, assys	431,540	Motors, generator	51,600	Switches, disconnect	84,800
Cable, & Combustion Heaters	71,467	Oscillographs	158,318	Switchgear	134,885
Cable, power	94,181	Plugs, telephone	49,200	Telephones, sound powered	216,300
Cable, telephone	352,317	Power Supplies, radar X band	27,353	Teletypewriter Sets	1,179,633
Circuit Breakers	43,040	Public Address Systems	36,195	Terminal Boxes	27,375
Compound, Insulating	130,900			Test Sets, radar	60,962

at the NARTB show...

SEE THE *Best* IN TV TRANSMITTING EQUIPMENT AND *Compare* ALL THE FACTS!

THE RIGHT TRANSMITTER FOR YOUR "SPECIAL" NEED

Standard Electronics offers you the most *adaptable* VHF equipment in the industry today . . . to solve your station's expansion problems on the basis of individual needs and market requirements.

For example, to start television service, you may choose an economical, trouble-free 5 or 10 KW 100% air cooled S-E transmitter. Later, go to 20, 25, 40 or 50 KW output, simply by adding a matching S-E amplifier. You get the right combination of the best equipment to give you the ERP you need at any time.

For television stations now on the air who want to improve their competitive status with a maximum power signal . . . Standard Electronics offers a complete line of 100% air cooled amplifiers . . . DESIGNED TO DRIVE DIRECTLY FROM YOUR PRESENT TRANSMITTER, whatever its make . . . *with no need to replace any part of your existing equipment.* YES, EVEN IF YOU HAVE A 2 KW TRANSMITTER, IT CAN BE EXPANDED TO 20 KW WITH ONLY THE ADDITION OF A S-E AMPLIFIER. Your high power broadcasts can begin SOON . . . because Standard Electronics has a reputation for deliveries ON TIME, as promised.

Compare *true* **equipment costs . . . not just initial cost . . . but also tube replacement and power consumption costs. (Within a five year period, an S-E 50 KW—VHF transmitter can save you up to $120,000 in operating expenses alone.)**

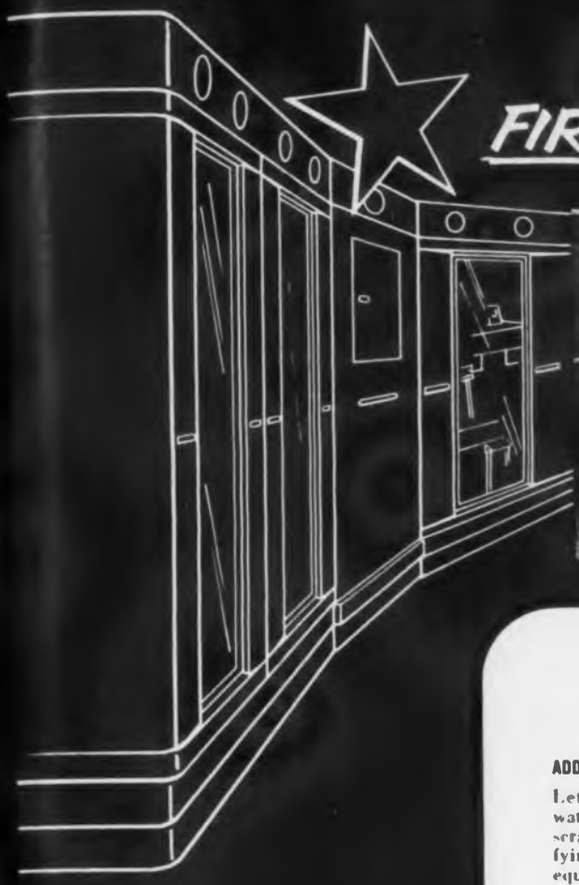
Compare circuitry . . . layout and control simplicity . . . ease of maintenance.

Consider the advantages of S-E's "Add-A-Unit" design that makes it easy for *any* station to expand to higher power . . . and compare delivery schedules for both complete transmitters and high power amplifiers.

Get *all* the facts . . . and let them help you decide truly which transmitter best serves your needs.

Comparison Chart of VHF High Power Transmitters

	SE Transmitter	Transmitter B	Transmitter C	Transmitter D
AMPLIFIER DRIVES WITH 5 KW	★ YES	NO	YES	YES
AMPLIFIER WILL OPERATE WITH ANY MAKE DRIVER	★ YES	NO	NO	NO
TUBE COST [complete set / FCC spares]	★ $6,138 / $1,495	$11,625 / $4,237	$13,230 (est) / $6,429 (est)	$9,250 (est) / $5,050 (est)
AIR COOLED	★ YES	YES	NO	NO
POWER LINE REQUIREMENTS (at black level)	★ 208/230 V 60 cy. 3 ø 145 KW	460 V 60 cy. 3 ø 193 KW	208/230 V 60 cy. 3 ø 150 KW (est)	208/230 V 60 cy. 3 ø 165 KW (est)
FLOOR AREA (including power equipment, blowers, etc.)	★ 152 sq. ft.	154 sq. ft.	160 sq. ft. (est)	———
ALL TUBES VISIBLE FROM FRONT	★ YES	NO	NO	NO
SELF CONTAINED (no separate enclosures, vaults, pumps, etc.)	★ YES	NO	NO	NO
INDIVIDUAL CHASSE CONSTRUCTION	★ YES	NO	NO	NO
INTERUNIT CABLING WITHOUT TRENCHES	★ YES	NO	NO	NO



FIRST WITH 50 KW Transmitter deliveries

Transmitter room at WOR-TV's new Empire State 50 KW transmitter, 130 KW ERP. 100% air cooled. Completely self-contained. Equipment throughout by Standard Electronics.

Only STANDARD ELECTRONICS has these exclusive features

ADD-A-UNIT DESIGN

Lets you go from 500 watts to 50 KW without scrapping or even modifying a single piece of equipment.

VERSATILE AMPLIFIERS

S-E's Add-A-Unit amplifiers can be added to existing equipment regardless of make. Any 5 or 10 KW transmitter will drive a 40 or 50 KW S-E amplifier. Any 2 or 5 KW transmitter will drive a 20 KW S-E amplifier.

ECONOMICAL INSTALLATION

Fewer building alterations. Units fit any station layout.

ADVANCED STYLING

Modern cabinetry by Dreyfuss, leading industrial designer.

SELF-CONTAINED

Compact. No external blowers or external vaults needed.

LOWER OPERATING COSTS

Similar tube types throughout. Low emission visual tubes interchangeable with aural section where power requirements are less. Lower initial tube cost, AND LONG *LONG* HOURS OF LIFE. Lower power consumption too, saving many dollars on your power bill.

ACCESSIBLE

All tubes visible and accessible from the front via full length glass doors.

COLOR ADAPTABLE

Elimination of back porch clamp insures proper operation with color signals.

SEE A COMPLETE S-E *BLUE STAR* 50 KW TELEVISION TRANSMITTER at the

NARTB EXHIBITION May 23 to 27
Palmer House — Chicago, Ill. Exhibit No. 20
Standard Electronics Reception Headquarters, Room 805

Let Standard Electronic engineers give you the facts about today's trend to HIGH POWER VHF broadcasts. Check at first hand the operating and layout simplicity of S-E maximum power BLUE STAR stations. Check, too, S-E's new Multicon camera . . . on demonstration at the show.

FIRST with high power

FIRST to deliver tomorrow's equipment today

STANDARD SE ELECTRONICS

standard electronics corporation

A SUBSIDIARY OF CLAUDE NEON, INC.
285-289 EMMETT STREET • NEWARK 5, N. J.

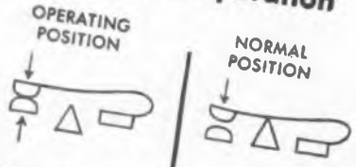
devoted exclusively to the engineering, manufacturing, and servicing of equipment for the broadcast and television industry

EDISON TIME DELAY RELAY'S
Basic Extras at No Extra Cost

Greatest Timing Accuracy and Production Uniformity

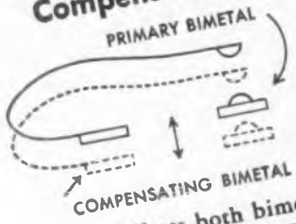
Patented Magnetic Calibrating Slug provides method of factory-adjustment of the timing *through the glass envelope.* All relays are calibrated *after* sealing.

Maximum Contact Pressure upon Contact Operation



Preloading contact spring applies pressure of 50 grams when contacts close. Contact spring also absorbs overshoot thus preventing a permanent set or change in calibration.

Maximum Ambient Compensation



Ambient affects both bimetals exactly alike. Contact gap maintains relative position independent of ambient temperatures from −60°C to +85°C.

GENERAL SPECIFICATIONS

Standard Types

Operating Time: 2 to 300 seconds

Heater: 5 watts continuous excitation at 6.3, 26.5 and 117 V. AC/DC

Contact Rating: 6 Amps Max.

Vibration & Shock: 1/16" overall amplitude at 55 cps. 50 g.

Features

Hermetically Sealed
Micanol base is standard on all types
Over 400 variations to choose from
Delivery from a stock of many types
Greatest range of time delays available in any thermal relay.

Thomas A Edison
INCORPORATED
Instrument Division
93 Lakeside Ave., West Orange, New Jersey

YOU CAN ALWAYS RELY ON EDISON

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TELE-TECH® & ELECTRONIC INDUSTRIES is edited for top-level engineers and executives throughout the electronic industries. It gives the busy engineering executive authoritative information and interpretation of the latest developments and new products, with emphasis on subjects of engineering import and timeliness. Special attention is given to:

MANUFACTURING

—Electronic equipment, communications, broadcasting, microwave relay, instrumentation, telemetering, computing.
—Military equipment including radar, sonar, guided missiles, fire controls.
—TV-FM-AM receivers, phonographs, recorders, reproducers.

OPERATION

—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.
—®Reg. U. S. Pat. Off.

THE ELECTRONIC INDUSTRIES DIRECTORY

Published annually as an integral section of TELE-TECH in June

Midland

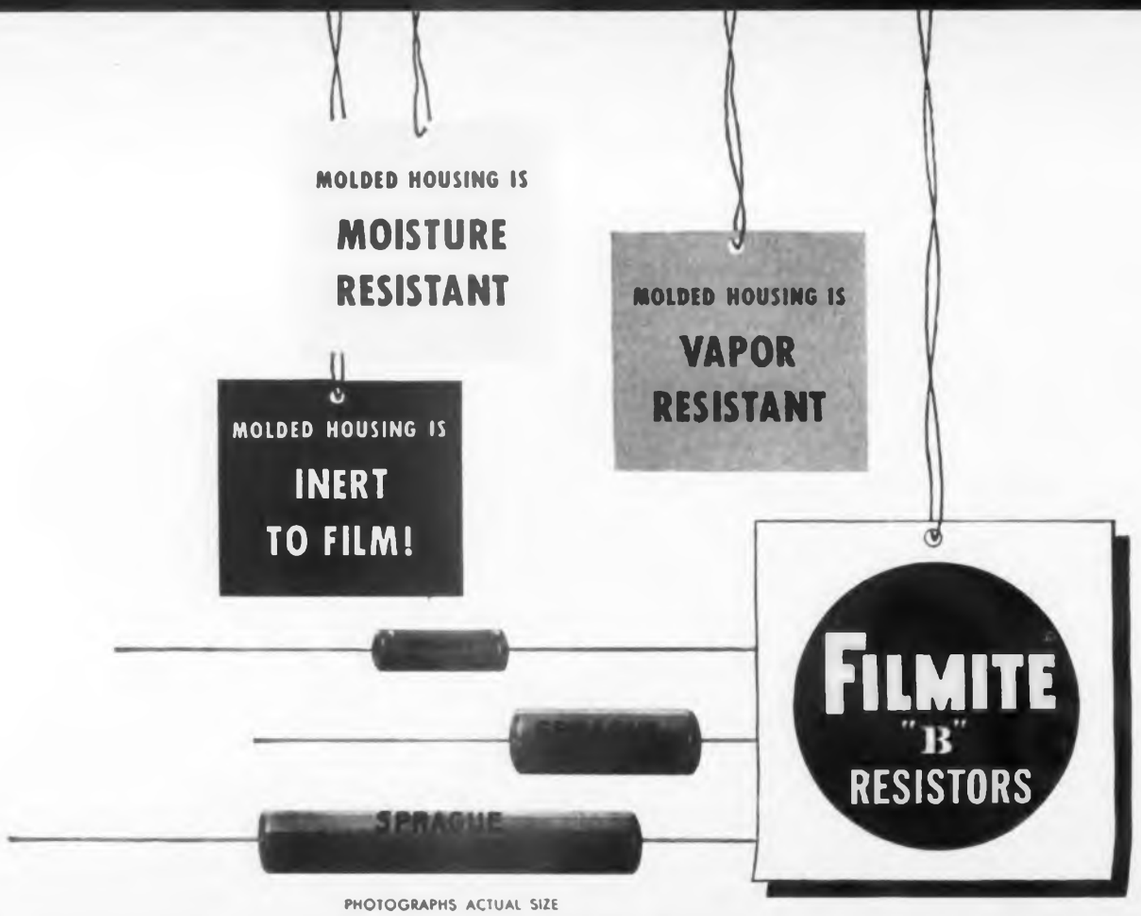
leads again...this time in COLOR

far in Advance in the development of
Frequency Control Crystals
and Circuits for COLOR TELEVISION,
Midland is prepared NOW
to supply you in quantity with
Color TV Crystals to
your exact specifications...
and to counsel on all
matters concerned with this subject.

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

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

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS



PHOTOGRAPHS ACTUAL SIZE

...DEPENDABLE...LOW COST BORO-CARBON FILM RESISTORS

IN ½, 1, AND 2 WATT RATINGS

Now for the first time you can obtain a superior yet relatively low cost film-type resistor for military electronic gear—resistors that not only meet the severe performance requirements of Military Specification MIL-R-10509A, but are capable of full wattage dissipation at 70°C ambient!

Sprague Type 4E, 5E, and 6E Filmite B resistors are housed in a dense molded jacket which not only provides unexcelled physical protection for the film resistance element but serves as a barrier to moisture and vapor, the twin enemies of all film-type resistors.

Boro-carbon films are unusually sensitive to moisture. Protection against moisture in any form is a primary requirement for successful long term stability of resistance. The low-loss phenolic housings on molded Filmite resistors not only shed water but are vapor resistant and inert to the film material. There is minimum possibility of field failure through electrolytic action and penetration of moisture or vapor through the dense molded jacket.

Other features of molded Filmite B resistors are special low-contact-resistance, low noise end terminations held rigidly in place on special ceramic cores, extremely low temperature and voltage coefficients of resistance, and excellent load-life and high frequency characteristics.

For complete engineering data, write for Engineering Bulletin No. 130 to:

SPRAGUE ELECTRIC COMPANY,
233 Marshall Street, North Adams, Mass.

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS (INCHES) L	D	RESISTANCE (OHMS) Min.	Max.	VOLTAGE (Max.)
4E	½	¾	¼	100	1 Meg.	350
5E	1	1 1/16	3/8	100	2 Meg.	500
6E	2	2 3/16	3/8	200	10 Meg.	750

Standard Resistance Tolerances: 1, 2, and 5%

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT

As We Go To Press...

FCC Fees Shelved

The Senate Commerce Committee has asked the FCC to suspend rule making on its proposal to levy fees on broadcasting and other stations.

Westinghouse Announces 24 In. Color TV Tube

Larger screen size, and the use of a phosphor screen which has 20 complete color groups per inch compared to 17 previously used, is claimed to provide improved resolution and color definition on the new 24-in. color TV tube under development by the Westinghouse Electronic Tube Div.

Faceplate of 24-in. Westinghouse color TV tube (top) is sealed to metal ring. Components of 70° tube with 200 sq. in. screen (bottom)

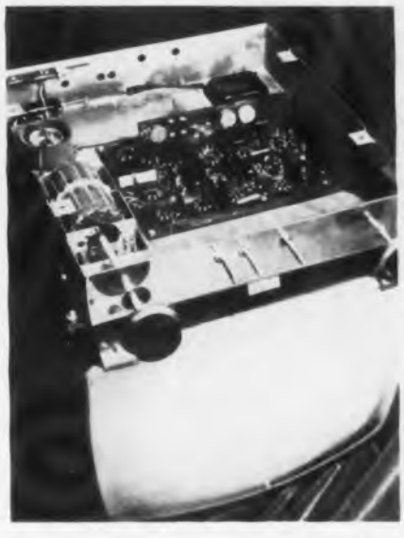
ATOMIC BATTERY

Unusual atomic battery developed by Alexander Thomas of Tracerlab uses radioactive tritium, can produce up to 400 volts at 0.01 to 1.0 μw, and has a useful life of 10 to 30 years.

Printed Circuits Developed for TV

The main obstacle to the use of Modular Design in the large scale production of TV receivers has, until now, been the inability of flat printed circuits to duplicate the more complicated stages, particularly those in which wires cross without making a connection. To solve this problem, Sanders Associates of Nashua, N.H., have developed a new unit, trademarked the "Reliaplate" which provides low-cost method of "covering-over" in flat printed wiring.

These panels—in themselves, small printed circuits—are approximately 1 in. square, and are mounted at right angles to the flat printed wiring sheet. They have small, comblike teeth, which are plugged into existing holes and then dip-soldered. The solder acts as both a mechanical mounting and an electrical connection. From a 3 x 3 ft. sheet of clad laminates, almost 1000 units can be produced.



Compact, orderly construction is achieved in TV set using Sanders' printed circuit plates

Close-up of "Reliaplate" printed circuit used in TV set shows perpendicular construction

New Four-Channel Tape Recorder

A sound recorder that will register four conversations simultaneously on a single magnetic tape and play them back individually or in pairs, was demonstrated recently by Magnecord, Inc. of Chicago. The new model is an adaptation of the four channel recorder being used to monitor air-to-ground communication at a number of major airports.

Differential Analyzer

The ETT-100 magnetic drum digital differential analyzer recently put into operation at Stevens Institute of Technology is the largest electronic computer of its kind. And, according to its designer, S. M. Shackell, its present capacity of 100 integrators, or problem-solving centers, can be expanded to 200 integrators with little difficulty. The next largest computer of this type has 60 integrators.

Precision Gyroscope

Angular measurements up to 1/36,000th of a degree are possible with a new precision gyro developed for the U.S. Air Force by Minneapolis-Honeywell. Officially called the Hermetic Integrating Gyro, or HIG, the device can detect motion 3,000 times slower than the hour hand on a watch.

MORE NEWS on page 10

As We Go To Press . . . (Continued)

High Vacuum Pump Has No Moving Parts

Two GE research scientists, Dr. A. M. Gurewitsch and Dr. W. F. Westendorp, have built an experimental air pump with no moving parts, which can produce a vacuum as high as one billionth of normal atmospheric pressure The device, known as an ionic pump, may eventually simplify the exhaustion of radio and TV picture tubes.

One form of the pump consists of a circular steel box which is supported between the poles of a powerful permanent magnet. In the middle of the box is mounted a positively-charged tungsten ring: The walls of the pump, which are lined with carbon plates, form the negative side of the circuit. A tube connects the pump to the vessel from which gas is to be exhausted.

When a high voltage is applied, an electrical gas discharge occurs. Electrons in this discharge are attracted toward the tungsten ring, but the field of the magnet prevents them from being collected immediately. Instead, they are caused to perform numerous oscillations through the ring. During these oscillations, they hit many of the gas atoms, which are partly broken, or "ionized."

The molecular fragments, called "ions," having positive electrical charges, are hurled toward the pump walls, which are negatively charged. On the way, the ions hit the carbon plates and are driven into them and held. Since they are removed from the open space, gas pressure is reduced. When the evacuation is completed and the pump disconnected from the vessel, the absorbed gases can be driven out of the carbon by simply heating the whole pump.

Dr. A. Gurewitsch adjusts "ionic pump" at GE

Megawatt UHF-TV Seen

Eitel-McCullough is planning to place its 60-kw klystron in production within the year. It will be similar to current 12-kw types, and will make possible 1,000,000 watts ERP for UHF-TV.

New Color TV Developments Announced

Announcing the production of RCA's first commercial color TV receiver, the CT-100 (list price $1,000), at the Bloomington, Ind. plant, J. B. Elliot, exec. v.p. of the Consumer Products Div. of RCA declared that ". . . the market for color today is as great as the market for black-and-white television was seven years ago." Present plans call for the production of 10,000 sets by the end of '54.

For televising color motion picture film and slides, a new camera employing three RCA Vidicon pickup tubes and a light-splitting system of dichroic mirrors, is announced by RCA.

A new color TV test signal generator developed by the RCA Service Co. for use in TV stations will simplify the adjustment of the color receiver in the home.

Designed specifically for UHF color-TV broadcasting, RCA's new 6448 beam-power transmitting tube is capable of 12 kw output at a frequency of 900 MC.

Third Educational TV Station Gets $10,000

WQED, the non-commercial station in Pittsburgh, is the third station to receive a $10,000 grant from Emerson's $100,000 fund for the purpose.

MORE NEWS on page 12

AIR FORCE OPERATES OWN TV STATION

Control console program monitor (l) of the Air Force TV station at Limestone, Maine, which broadcasts programs of information and entertainment furnished without charge by major networks. Station is operated 5½ hours daily by base personnel under FCC approval. Power is 8 watts on channel 8. Vidicon camera chain (r) in 20 x 20 ft. studio is directed at slide projector. Camera may be swung by hand to face motion picture projector (reel visible at right)

first choice again!

FIRST CHOICE AGAIN!

President of WJBF-TV, Augusta, Ga., reports, "The GPL Camera is superior to any other TV camera on the market."

"The remote control feature impressed us, especially as it makes possible the practical use of two cameras with only one cameraman, the second camera being controlled from the control room.

"The workmanship in the GPL cameras is superior to that of any TV camera on the market. Maintenance and testing are extremely simple, as every part of the camera is easy to get to," reports J. B. Fuqua.

GPL

FIRST CHOICE AGAIN!

Mgr. of WROM-TV, Rome, Ga., operates 5 live half hours "back to back" on one staging area with GPL equipment!

"I don't know how we could have begun operations as smoothly as we did with any other video equipment," writes Ed McKay, "especially in view of the fact that for the first three months, WROM-TV operated with as many as five live half hour shows back to back on ONE staging area using only the GPL Dual Chain, and picking up all film with one of the cameras from an intermediate screen,to boot!"

FIRST CHOICE AGAIN!

Managing Director, WFBG-TV, Altoona, Pa., says, "Never lost a show due to the failure of any GPL camera in our studios!"

"I asked our chief engineer, George Burgoon, to comment on GPL," writes Jack Snyder, "and he said, 'We do not service on a routine basis, but only when necessary, and, believe me when I tell you that if every bit of equipment we use worked as well and as consistently as GPL, I would be a very happy man. We have never lost a show due to the failure of any GPL camera.'"

FIRST CHOICE AGAIN!

Chief TV Facilities Engineer of Empire Coil Co., owners of KPTV, Portland, Ore., says, "I can vouch for GPL dependability!"

"Our experience with GPL cameras," writes Thomas B. Friedman, "has been that they are very dependable, require little maintenance, and are easily operated even by inexperienced cameraman. One feature we particularly like is the remote iris control, which permits the video control operator to adjust readily the lens opening for the optimum picture."

FIRST CHOICE AGAIN!

Production Staff of KOB-TV, Albuquerque, N. M., calls GPL a "Cameraman's Camera" . . . fine picture quality day after day.

"The production staff here," writes George S. Johnson,"says the GPL is a cameraman's camera. They like the consistently good picture quality we obtain day after day. We believe this consistent operation is due to the carefully designed controls, enabling the video operator to get finer adjustments, hence better quality."

Write, wire or phone for information on complete television station equipment

General Precision Laboratory

INCORPORATED

PLEASANTVILLE NEW YORK

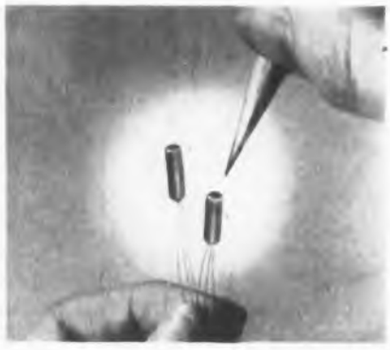
GPL

Regional Offices: Chicago • Atlanta • Dallas • Glendale, California

As We Go to Press . . . .

Transistor Reliability

The long life of transistors is emphasized in a report by Norman B. Krim, v.p. of Raytheon Mfg. Co., Waltham, Mass., which points out that over one billion transistor operating hours have been passed and the rate of failure in the field



Transistors reported having 1% failure rate in first year of operation in hearing aids

now runs approximately 1% yearly. This high quality, he said, has been obtained in the first year of volume transistor production. By comparison, high quality subminiature tubes, after 15 years of production, show ½% failure during their first year of service in hearing aids.

New Stations Join Network TV Service

Stations WTRI Schenectady, N.Y., and WSLI-TV, Jackson, Miss., have joined the network TV facilities of the Bell Telephone System. Network programs are now available to 287 stations in 182 cities in the U.S.

TRANSISTORIZED AUDIO AMPLIFIER

Transistorized 20 watt linear audio amplifier, developed by GE, uses two 6-watt, three 2-watt, and four 1/10-watt experimental transistors. The power transistors will be commercially available within two years

COMING EVENTS

May 3-6—URSI, U.S.A. National Committee and IRE Professional Group on Antennas and Propagation. Joint Spring Technical Meeting. National Bureau of Standards, Washington, D.C.

May 3-14—The British Industries Fair, London and Birmingham, England.

May 4-6—1954 Electronics Components Symposium, RETMA and others, U.S. Department of Interior Auditorium, Washington, D.C.

May 4-7—1954 AWS National Spring Technical Meeting, Hotel Statler, Buffalo, N.Y.

May 4-9—SMPTE 75th Annual Meeting, Statler Hotel, Washington, D.C.

May 5-7—Third International Aviation Trade Show, 71st Regiment Armory, New York, N.Y.

May 5-7—IRE Seventh Region Conference and Electronic Exhibit, Multnomah Hotel, Portland, Ore.

May 5-7—AIEE Northeastern District Meeting, Schenectady, N.Y.

May 5-8—1954 Welding and Allied Industry Exposition, Memorial Auditorium, Buffalo, N.Y.

May 7-8—IRE North Atlantic Region, New England Radio Engineering Meeting, Sheraton Plaza Hotel, Boston, Mass.

May 7-9—AFCA National Convention, Shoreham Hotel, Washington, D.C.

May 10-12—IRE National Conference on Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio

May 17-20—Basic Materials Exposition, International Amphitheatre, Chicago.

May 17-20—1954 Electronic Parts Show Conrad Hilton Hotel, Chicago, Ill.

May 17-20—New York Import Show, 34th St. Armory, New York, N.Y.

May 24-26—IRE, AIEE, IAS, ISA 1954 National Telemetering Conference, Hotel Morrison, Chicago, Ill.

May 24-27—1954 NOMA Conference and Office Machinery and Equipment Exposition, Kiel Auditorium, St. Louis, Mo.

May 25-27—NARTB Convention Engineering Conference, Palmer House, Chicago, Ill.

June 7-10—National Plastics Exposition, sponsored by the Society of the Plastics Industry, Inc., Public Auditorium, Cleveland, Ohio.

June 9-11—Eighth Annual Convention American Society for Quality Control, St. Louis, Mo.

June 13-18—ASTM Annual Meeting, 11th Exhibit of Testing and Scientific Apparatus and Laboratory Supplies and Ninth Technical Photographic Exhibit, Sherman and Morrison Hotels, Chicago, Ill.

June 15-17—RETMA Convention, Palmer House, Chicago, Ill.

June 16-18—High Vacuum Symposium, Berkeley Carteret Hotel, Asbury Park, N.J.

June 21-25—AIEE Summer General and Pacific Meeting, Hotel Biltmore, Los Angeles, Calif.

June 24-25—1954 International Convention 50th Anniversary of Oxide Coated Cathodes, 44 Rue de Rennes, Paris, France.

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.

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. 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. 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. 8-20—RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N.Y.

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.
AFCA: Armed Forces Communications Assoc.
AIEE: American Institute of Electrical Engineers.
ASTM: American Society for Testing Materials.
AWS: American Welding Society.
IAS: Institute of Aeronautical Science.
IRE: Institute of Radio Engineers.
ISA: Instrument Society of America.
NACE: National Assoc. Corrosion Engineers.
NARTB: National Assoc. of Radio and TV Broadcasters.
NOMA: National Office Management Association
RETMA: Radio-Electronics-TV Manufacturers Assoc.
SMPTE Soc. of Motion Picture and TV Engineering.
URSI: International Scientific Radio Union.
WCEMA: West Coast Electronics Manufacturer's Association
WESCON: Western Electronics Show & Convention.

MORE NEWS on page 22

CLEVELITE*

LAMINATED PAPER BASE PHENOLIC TUBING

Outstanding for many years as the Top Performer, Clevelite is unmatched in its ability to meet unusual specifications.

Built-in Dimensional Stability, High Dielectric Strength, Low Moisture Absorption, Great Mechanical Strength, Excellent Machining Qualities and Low Power Factor make Clevelite Tubing outstanding.

Available in diameters, wall thicknesses and lengths as desired, for Collars, Bushings, Spacers, Cores and Coil Forms.

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Our new Torkrite internally threaded and embossed tubing affords better control of adjustments in coil forms using threaded cores.

Write for your copy of the latest Clevelite brochure.

WHY PAY MORE? For Good Quality . . . call CLEVELAND!

*Reg. U. S. Pat Off.

Take advantage of our Fast Dependable Delivery.

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PLANTS AND SALES OFFICES at Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario

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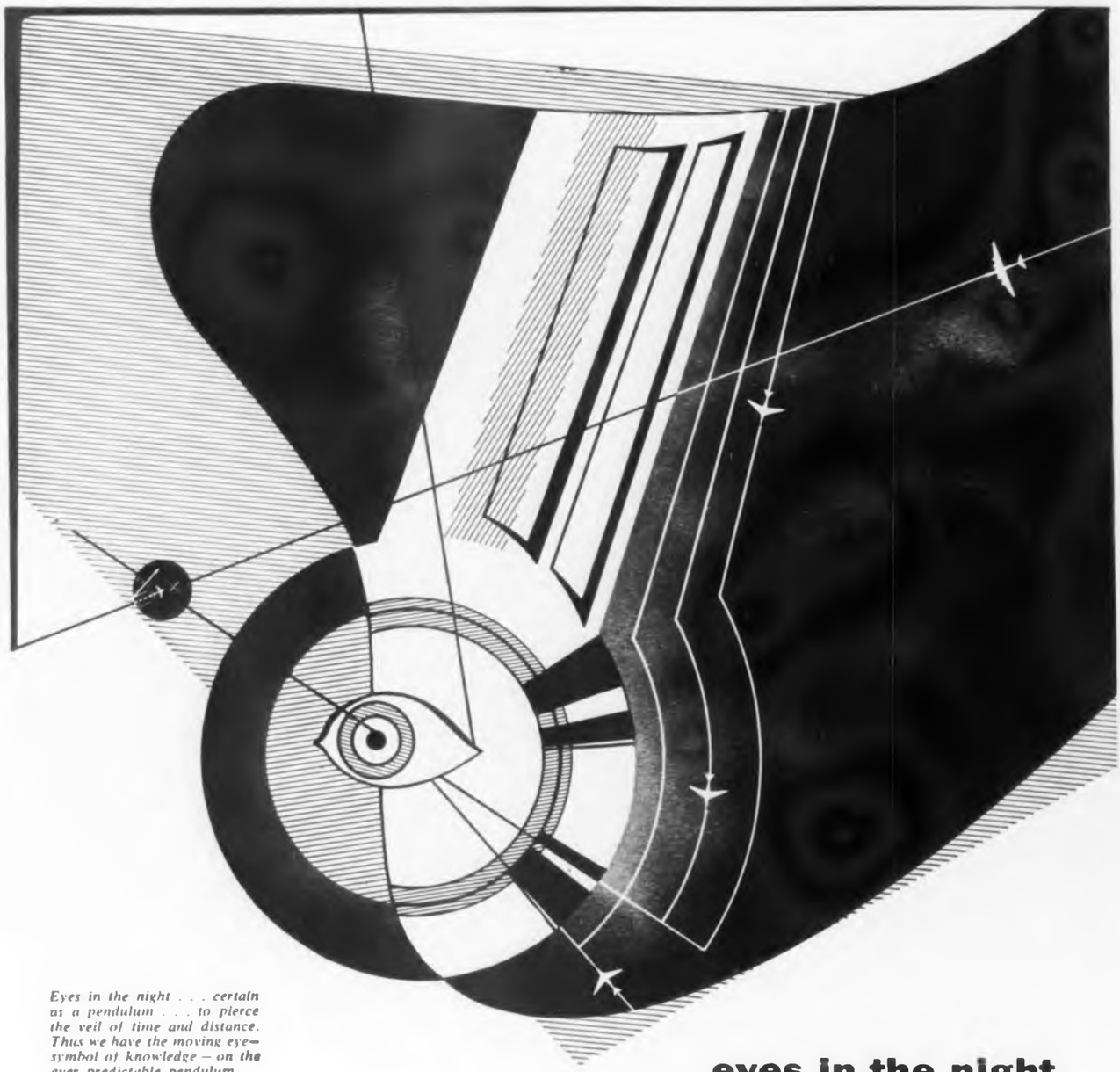


Eyes in the night . . . certain as a pendulum . . . to pierce the veil of time and distance. Thus we have the moving eye—symbol of knowledge — on the ever predictable pendulum.

eyes in the night

The victory over time and darkness is certain with Kollsman instruments. Certain because of our quarter century dedication to accuracy in controls and instrumentation.

Today our activities encompass four fields:

AIRCRAFT INSTRUMENTS AND CONTROLS
OPTICAL PARTS AND DEVICES
MINIATURE AC MOTORS
RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT

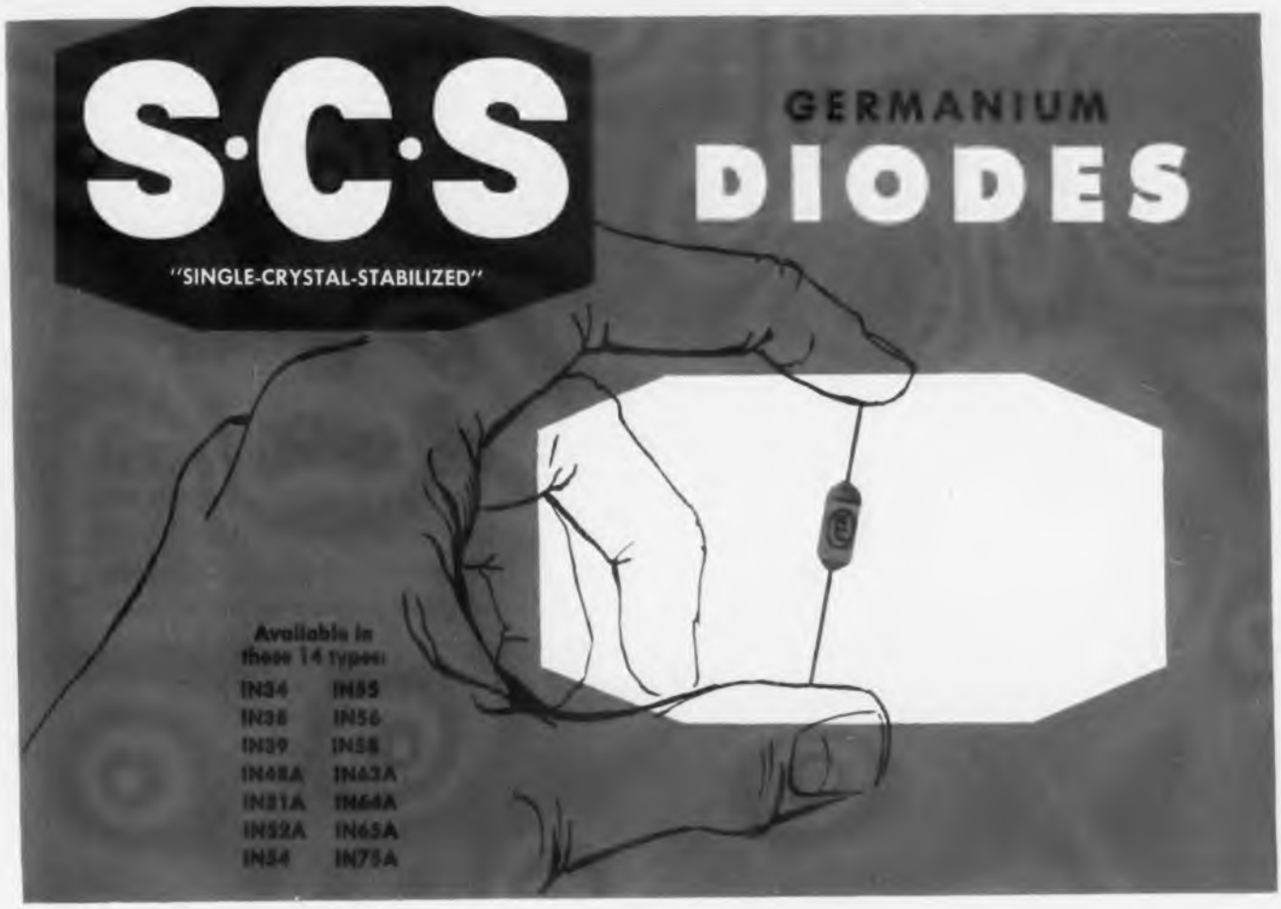
Our manufacturing and research facilities . . . our skills and talents, are available to those seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORP.

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

Announcing another outstanding

DESIGN ACHIEVEMENT by *Federal*



CHECK THESE FEATURES—

- **SINGLE-CRYSTAL GERMANIUM**—the finest for reliable performance
- **MOISTURE-PROOF**—vacuum-sealed, all-ceramic construction to provide stable characteristics
- **EVERY DIODE TESTED** for all characteristics, including oscilloscope tests for hysteresis and non-linearity
- **COMPLETELY INSULATED CASE**
- **POLARITY** clearly identified
- **HEAT SINKS** protect during soldering
- **SMALL SIZE** (—¼" diameter, ½" long)
- **FLEXIBLE LEADS** for easy mounting
- **NO FILAMENT**—no heater power drain or hum
- **LOW SHUNT CAPACITY** (average 1 mmf.)
- **SELF-HEALING** for temporary overloads
- **NO CONTACT POTENTIAL**
- **WITHSTANDS** adverse temperature and humidity cycling

"SINGLE-CRYSTAL-STABILIZED"

. . . precision-made and vacuum-sealed to provide a new high in performance for germanium diode applications!

Product designers! Now it's Federal's new *single-crystal-stabilized* diodes . . . bringing to you high-quality single-crystal germanium for the utmost in reliable performance, combined with a construction to provide stable operation over long hours of use.

Federal "S-C-S" Diodes are vacuum-sealed . . . solidly encased in a non-porous ceramic that firmly bonds both ends to case and leads, resulting in *moisture-proof* construction.

Federal "S-C-S" Diodes withstand repeated temperature and humidity cycling—without adverse effect on their electrical characteristics. Their small size, fully insulated case and flexible leads permit fast, easy mounting in all types of equipment.

Get all the facts about Federal "S-C-S" Diodes . . . a notable contribution to diode progress . . . insuring tens of thousands of hours of dependable performance!

Federal Telephone and Radio Company

SELENIUM-INTELIN DEPARTMENT 100 KINGSLAND ROAD, CLIFTON, N. J.

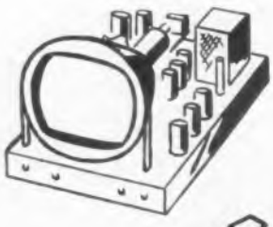
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

For details on Federal "S-C-S" Diodes, write to Dept R-166

New... Revolutionary—the *only* color TV voltage regulator to offer fool-proof performance and *complete protection* against circuit failures.

Victoreen's new corona regulators offer the only sure, safe regulation of the second anode potential of color TV kinescopes. Advanced engineering has eliminated the filament, with consequent complete protection to the picture tube from voltage surges arising from filament or circuit failures. Victoreen now offers the only regulator in which the voltage *drops* when mechanical or circuit failures occur. Being a non-filament type, complicated design problems are eliminated. You need only know the voltage required. A rugged metal envelope minimizes damage from handling. A clamp-type mounting eliminates the need for costly installation.

Contact our components division for technical advice on the application of these tubes.



For the 3 gun picture tube, use the type 6353, 20,000 volt regulator.
For the 1 gun picture tube, use the type 6392, 18,000 volt regulator.

The Victoreen Instrument Co.

COMPONENTS DIVISION: 3800 PERKINS AVE. • CLEVELAND 14, OHIO


Color cast equipment

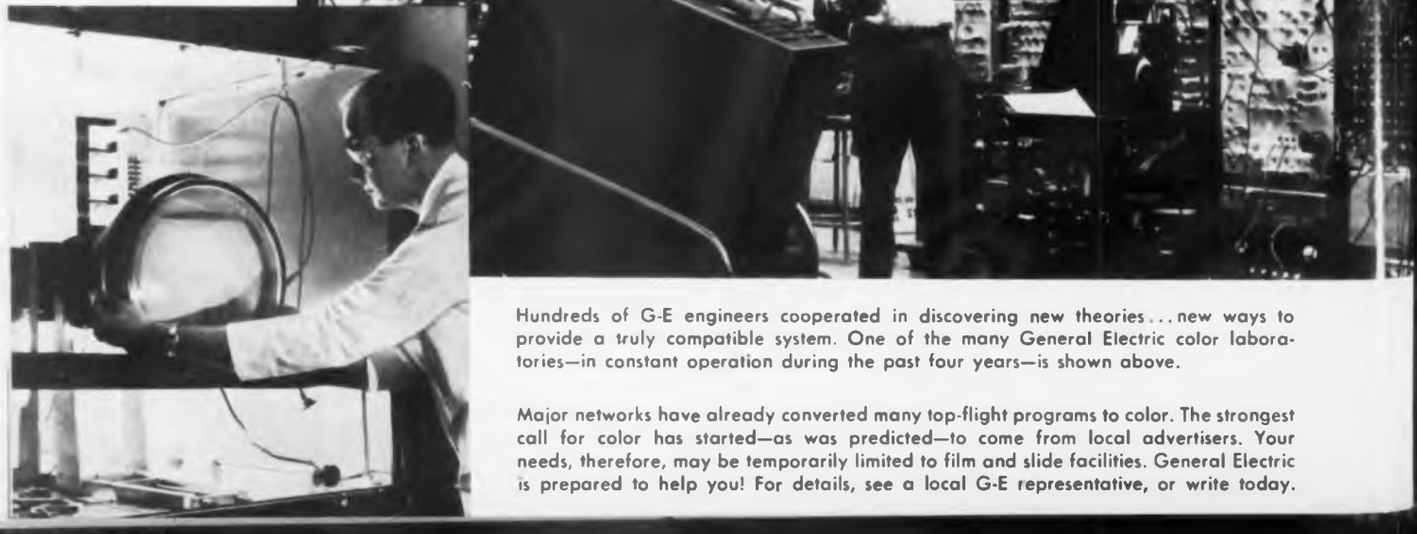
THE compatible color television system approved by the FCC last December—which will soon bring color TV to *your* market area—represents an investment of more than a million man-hours and nearly ten million dollars by the *entire* television industry.

G.E.'s role in this development is exemplified by Dr. W. R. G. Baker, General Electric Vice President and General Manager of the Electronics Division. Dr. Baker was chairman of the National Television System Committee which formulated the system as it was finally approved.

Nearly four years ago, Dr. Baker and his staff of color engineers (above) established a network of color signals at Electronics Park for research and equipment development. Their main consideration throughout these years has been *your future in color TV*.

NOW'S THE TIME!

Plan your color TV future with G



Hundreds of G-E engineers cooperated in discovering new theories . . . new ways to provide a truly compatible system. One of the many General Electric color laboratories—in constant operation during the past four years—is shown above.

Major networks have already converted many top-flight programs to color. The strongest call for color has started—as was predicted—to come from local advertisers. Your needs, therefore, may be temporarily limited to film and slide facilities. General Electric is prepared to help you! For details, see a local G-E representative, or write today.

Chromacoder color equipment will soon be in production at General Electric's Electronics Park. Featuring a compact camera with only one I.O. tube, you will note there is little obvious difference between it and a standard black and white television camera. Size, simplicity of design, weight, maneuverability, ruggedness, economy and flexibility are important operating points.

GENERAL ELECTRIC

Using the Chromacoder Camera Channel, a single picture signal (containing *all* color intelligence in sequence) is selected for transmission. This signal is then fed into the Chromacoder and translated to simultaneous red, green and blue images. Subsequently, a Multiplexer forms a color signal for transmission under the compatible standards approved by the FCC. Only one Chromacoder is needed at each station to translate the signals of all its cameras.

The unique designed-in flexibility of General Electric's projection room equipment for color slides and film allows you a choice of the equipment you want... when you want it!

2" x 2" color slide scanner with color scanner pickup—the *basic* equipment you'll want first for color commercials...

Just add the high quality continuous motion film scanner to the slide scanner to provide color film programs...

Carry this *black-building* technique one step further... and add a second continuous motion film scanner. This entire combination occupies *only* 32½ square feet of floor space!

General Electric COLOR for your station!

1 **Modify Existing G-E Equipment To Broadcast Network Color Programs For Black and White *and* Color Reception!** General Electric is providing its present customers, on a no-charge basis, all necessary *internal* transmitter parts, thus permitting stations with G-E transmitters to broadcast color. Engineering supervision for the installation of this equipment is on this *same no-charge basis* if it is done at the same time external color equipment is installed. *External* parts (Gamma Amplifier, Stabilizing Amplifier, Color Monitor, and other miscellaneous items) required for performance within FCC color specifications are being supplied at a moderate cost of approximately $7300 to $8800 (VHF-UHF). Optional test equipment is available as required. It is important to note that any of the above changes can be accomplished *without loss of air time.*

2 **Locally Originate Color Slides and Film With G-E Equipment!** General Electric provides the ideal solution to the demands of local advertisers for color commercials. Its top-quality film and slide facilities are designed for amazingly versatile effects. Slide Scanner equipment cost is in the order of $32,500; additional for Film Scanner equipment, approximately $36,000. To this must be added the cost for achieving best possible color transmission service as outlined in Plan 1.

3 **Put Live Local Color Programs On-The-Air With G-E Equipment!** This final step of your color objective incorporates a live camera channel, Chromacoder and allied equipment, Calibration Monitor Console, Monitor Switching Unit and miscellaneous accessories. With these G-E facilities broadcasters are assured of obtaining the ultimate in programming and performance . . . at what we believe to be the most economical cost figure you'll see in the industry!

Extra! G.E. is making rapid progress with an economy plan to factory-convert your existing G-E black and white cameras for live color program origination. This conversion will similarly apply to non-G-E cameras that are interchangeable. Moderate conversion cost will result in outstanding savings.

Plan your color *future* with General Electric—NOW!

Our local G-E broadcast representative has all the facts. Call him today or write:
General Electric Company, Electronics Park, Syracuse, New York.

You can put your confidence in—

GENERAL ELECTRIC

ECB-87

Printed in U.S.A.

Stop Troubles Before They Start... With Mallory Vibrators

The best time to do this is while your equipment is still in the design stage. Each element . . . the vibrator, transformer and buffer capacitor . . . must be carefully selected for balanced electrical characteristics if your power supply is to give top performance in service.

You can avoid vibrator power supply trouble by calling on the specialized knowledge and experience of Mallory engineers. Let them translate the power requirements of your equipment into a smooth operating, trouble-free design. You will save time and money and get the kind of performance you want.

Why call on Mallory? There are a lot of reasons . . . good ones. Our experience in this field is backed by an unmatched fund of engineering knowledge that started over 20 years ago when we produced the *first* commercial Vibrator. Our experience includes supplying more Vibrators for original equipment than all other makes combined.

That's not all. If you wish, we are equipped to design and manufacture complete power supply units . . . to your exact requirements . . . to meet your production schedules.

To save engineering time and reduce production costs, write us today. It is the best way to stop troubles before they start.

Expect more . . . Get more from **MALLORY**

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

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

NEW

FOR FIELD FACTORY OR SERVICE USE

THE ONLY PORTABLE GENERATOR THAT PROVIDES ALL THE SIGNALS REQUIRED FOR

COLOR TV

Chromalyzer

by TELECHROME INCORPORATED

Chromascope (Signal Certification)

Phase Slope (Envelope Delay) Curve Tracer

Accurately aligns and checks color TV receivers, monitors and checks video systems. Push button selection of Blue, Red, Magenta, Green, Cyan, Yellow, G-Y ∠90°, R-Y, B-Y, Q, I as well as Black, White, Luminance, Chrominance, Burst and Sync. Output is either Video or R.F. picture with sound carrier on channels 2 to 6. Specifically designed for serviceman, engineers and maintenance personnel. Portable. Can be locked into a system.

Complete equipment for generating color bars; creating encoded and composite pictures from transparencies; color signal certification; transmission, reception, monitoring, and analysis of color pictures — literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment

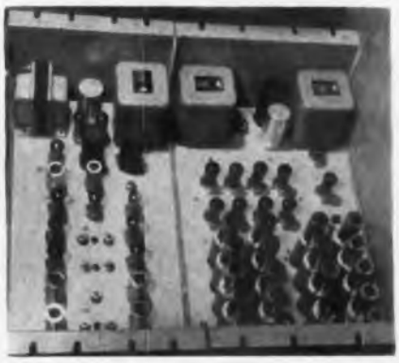
88 Merrick Road Amityville, N. Y.

AMityville 4-4446

As We Go to Press . . . .

Video Recording

A system for recording video signals on magnetic tape has been revealed by Bing Crosby Enterprises.



Revised version of recording chassis used in video tape recorder developed by Bing Crosby Enterprises. Complete technical data on p. 77.

Ten video tracks are used simultaneously, and tape speed is 100 in./sec. New unit uses thinner and narrower tape (½ in.) than earlier developmental models.

Alarm System Monitors Remote Control Equipment

An alarm system to report breakdown of remote control telemetering apparatus or unattended equipment is now available from the Hammarlund Mfg. Co. of New York, N.Y. The basic system consists of a battery-powered tone transmitter and frequency selective receiver. A coding unit can be added for classification of the types of failure involved.

"CHROMATRON" PRODUCTION

21 in. Chromatron, Lawrence tube, produced by Thomas Electronics Co., Passaic, N.J., under licensing from Chromatic TV Labs Inc. Emeryville, Calif. Plans call for 25,000 21-in. and 24-in. color TV sets this year.

MORE NEWS on page 28

Continental

INTRODUCES

the new Type 317

50 KW AM TRANSMITTER

Here's important news for radio broadcasters from coast to coast — from the manufacturer of the world's finest transmitters. The brand new Type 317 50,000 watt transmitter marks the first advanced development in high power AM Transmitters offered to broadcasters in several years — a revolutionary design that presents new standards of efficiency, performance and stability in the most compact 50 KW unit yet produced.

Outstanding Features

1. Higher efficiency — low power consumption.
2. Ease of installation — less floor space required.
3. Conservative design — all tubes and components operated well below maximum ratings.
4. Unexcelled performance — very low distortion.
5. Simplicity of circuitry — fewer operating controls.
6. Grounded grid high efficiency power amplifier — unusual stability.
7. Built-in "cut-back" for economical, high quality performance at 5 KW or 10 KW.
8. Automatic voltage regulation for all filaments.
9. A unique water cooling system for hot and dusty climates (also available air-cooled).
10. Transview type cabinets for style and maximum accessibility.

For Broadcast Equipment *above* and *beyond* the usual standards . . . you can rely on

Continental Electronics
MANUFACTURING COMPANY
4212 S. Buckner Blvd. • Phone EVergreen 1137 • Dallas 17, Texas

Distributed by GraybaR ELECTRIC COMPANY
IN OVER 100 PRINCIPAL CITIES

ONLY ONE — out of many — IS FIRST

They all started equal...
but ONLY ONE WON!

A spanking breeze across the bay . . . the echoing boom of the race steward's deck cannon . . . ropes and sails straining for advantage of position. Each boat, sleek and ship-shape, is out to win — but only *one* will come in first.

. . . most capacitors start even, too

. . . but EL MENCO Capacitors always win first place in specification requirements because their superiority and dependability have been *proven*. They're factory-tested at more than double their working voltage . . . they're guaranteed stable under the most adverse conditions of application.

No matter what your requirements — from the mighty high-capacity CM-35 (5-10,000 mmf) to the midget low-capacity CM-15 (2-525 mmf) — EL MENCO gives you superior job-rated, job-tested performance. They're built to win!

Electro Motive is now supplying special silvered mica films for the electronic and communication industries in any quantity — just send us your specifications.


CM-15


CM-35

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.

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

El-Menco

MOLDED MICA CAPACITORS **MICA TRIMMER**

Foreign Electronic Manufacturers Get Information Direct from our Export Dept. at Willimantic, Conn.

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

WORLD'S TALLEST TV TOWER

WHIO-TV now operating with new tower **1104** feet high

This tremendous Blaw-Knox Tower . . . which is five times taller than the highest building in Dayton, Ohio . . . plus a boost in power to 316,000 watts on channel 7, makes WHIO-TV one of the nation's most important *area* stations.

Tower equipped with two-passenger elevator

Gliding up and down inside the Blaw-Knox Tower, this 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.

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION • TOWER DEPT.
PITTSBURGH 38, PENNSYLVANIA

BLAW-KNOX

ANTENNA TOWERS

Guyed and self-supporting—
for AM • FM • TV • radar
microwave • communications

Distributed by Graybar

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

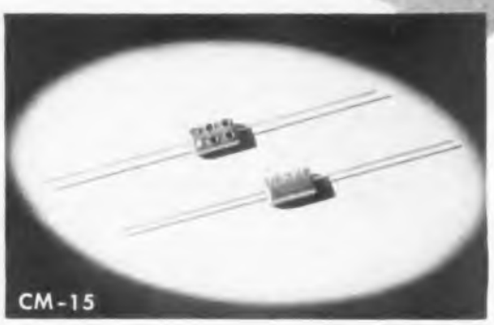
ONLY ONE — out of many — IS FIRST

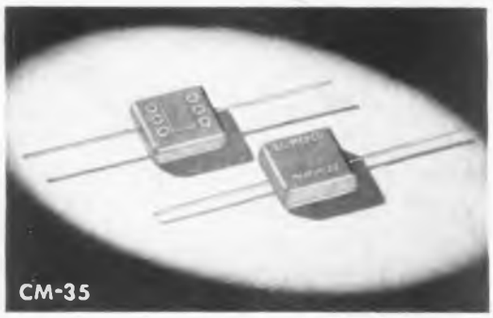
They all started equal . . . but ONLY ONE WON!

A spanking breeze across the bay . . . the echoing boom of the race steward's deck cannon . . . ropes and sails straining for advantage of position. Each boat, sleek and ship-shape, is out to win — but only *one* will come in first.

. . . most capacitors start even, too

. . . but EL MENCO Capacitors always win first place in specification requirements because their superiority and dependability have been *proven*. They're factory-tested at more than double their working voltage . . . they're guaranteed stable under the most adverse conditions of application.


CM-15


CM-35

No matter what your requirements — from the mighty high-capacity CM-35 (5-10,000 mmf) to the midget low-capacity CM-15 (2-525 mmf) — EL MENCO gives you superior job-rated, job-tested performance. They're built to win!

Electro Motive is now supplying special silvered mica films for the electronic and communication industries in any quantity — just send us your specifications.

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.

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

MOLDED MICA **El-Menco** MICA TRIMMER
CAPACITORS

Foreign Electronic Manufacturers Get Information Direct from our Export Dept. at Willimantic, Conn.

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

WORLD'S TALLEST TV TOWER

WHIO-TV now operating with new tower **1104** feet high

This tremendous Blaw-Knox Tower . . . which is five times taller than the highest building in Dayton, Ohio . . . plus a boost in power to 316,000 watts on channel 7, makes WHIO-TV one of the nation's most important *area* stations.

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.

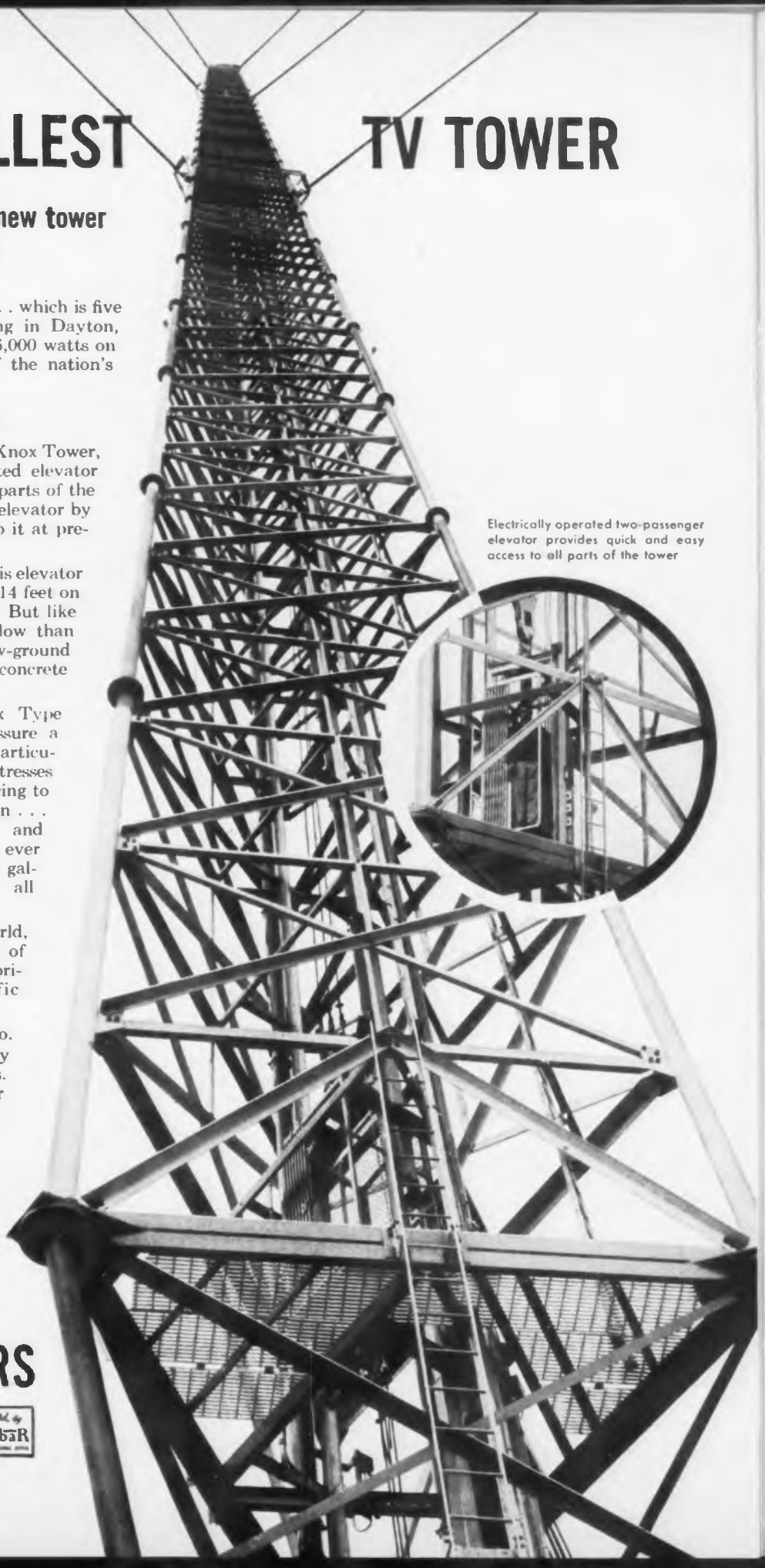
BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION • TOWER DEPT.
PITTSBURGH 38, PENNSYLVANIA

BLAW-KNOX

ANTENNA TOWERS

Guyed and self-supporting—
for AM • FM • TV • radar
microwave • communications

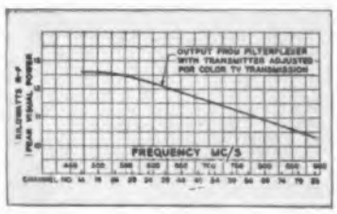
Distributed by GraybaR



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

RCA 12.5-KW UHF Transmitter
type TTU-12A

❶ 12.5-KW UHF Power Available



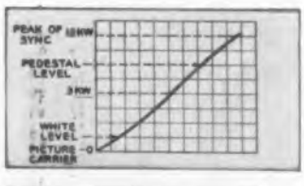
With RCA's new transmitter, you get full *12½-kilowatt output* (at the low end of the band). Moreover, you get this with all adjustments made for optimum color transmission—and with an extra-large allowance (10%) for losses in the Filterplexer. In most cases, loss is actually much less, so that output on some channels is nearly 14 KW.

❷ 300-KW to 500-KW Effective Radiated Power (ERP)

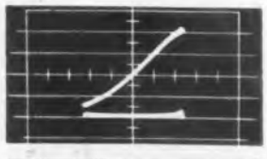
Operated in combination with a non-directional RCA high-gain UHF Pylon Antenna, this 12.5-KW transmitter is capable of providing an ERP of 300 KW. With a directional RCA Pylon Antenna, powers up to 500 KW are possible (in a given direction).

❸ Designed for Color

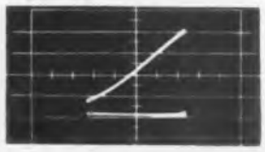
Performance requirements for color are much more stringent than for monochrome. The TTU-12A was designed to meet color requirements. Over-all linearity is virtually a straight line—from white level to sync signal peaks. Wide band width provides excellent response out to 4.2 MC. And the very important phase vs. amplitude response is constant over the whole operating range.



Curve illustrating the linearity characteristic of the RCA TTU-12A transmitter.

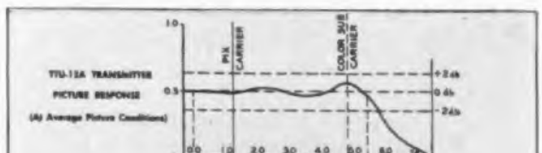


A linearity trace (taken directly from an oscilloscope) of the TTU-12A transmitter at 12 KW "peak-of-sync."



...nother linearity trace (taken directly from an oscilloscope) of the TTU-1B when driving the TTU-12A to 12 KW "peak-of-sync." "P.A." output.

❹ Unsurpassed Monochrome Quality



Equally important—you get SUPER MONOCHROME QUALITY with this RCA UHF transmitter. It exceeds FCC requirements for satisfactory monochrome operation by a wide margin! Since the RCA transmitter is adjusted for the more stringent color requirements, it is particularly good for monochrome.

❺ Conventional Tubes Throughout

The latest circuit principles and techniques are employed in the TTU-12A—but they are easily understood by all station operators. That's because *only conventional type tubes are used.* For example, the RCA-developed high-power tetrode (RCA-6448) is used in both aural and visual "P.A.'s". This tube is small and easy to handle—fits into a unique "glide-in" cavity assembly that can be interchanged quickly and easily. The result is a high-power UHF transmitter that is as simple, reliable, and convenient to operate as standard broadcast transmitters.

❻ Economical To Operate

Average power consumption of the TTU-12A is less than other UHF transmitters of equivalent power. Tubes are designed for long operating life. At conservative estimates, these provide total savings up to $34,000—based on a 10-year operation. See the typical readings and performance characteristics in Table I.

TABLE I

(Typical Transmitter Specifications and Meter Readings)

Transmitter Power Consumption (approx.):		
Average Picture		85 KW
Power Factor		0.9
Transmitter Output Meter Readings:	**Peak of Sync**	**Aural (C.W.)**
Power Output (transmitter)	14.0 KW	8.4 KW
Power Output (Filterplexer)	12.6 KW	7.6 KW
Plate Efficiency	47.6%	33.3%
Transmitter Overall Dimensions:		
Width (front line cabinets)		235"
Height		84"
Depth		32-9/16"
Weight		6000 lbs. (approx.)

Only the RCA 12.5-KW "UHF" has all these 11 features!

⑦ RCA 1-KW Driver—Plenty of Reserve

The RCA 12.5-KW UHF transmitter uses the famous RCA TTU-1B 1-KW UHF transmitter as the driver. This transmitter, now used by nearly a hundred UHF stations, has established an outstanding record for performance and reliability. If you want to begin UHF operations with one kilowatt now, you can do so with an RCA TTU-1B 1-KW transmitter. Then add an RCA 12.5-KW UHF power amplifier later.

⑧ Space-Saving Mechanical Features

Horizontally sliding doors, front and back, save on workable floor space—give the operators more elbow room. Small cubicles (27" wide, 32" deep, 84" high) enable you to move them through standard doorways and in and out of standard elevators. Pre-formed intercabinet connecting cables reduce installation costs.

⑨ 10 Micro-Second, Fault-Protection

Unique electronic overload protection completely safeguards power tubes and circuitry against momentary or sustained overload. (For example, the protection circuit will remove power so fast it will prevent damage to a wire as fine as 0.005-inch diameter shorted across the 7000-volt power supply!)

⑩ Hi-Lo Cutback Reduces "Off-Air" Time

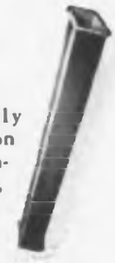
With the TTU-12A transmitter you can cut back to a generous 1-KW power level—and stay "on-air" while making emergency repairs to the 12½-KW amplifier. Moreover, small size tube cavities in the power amplifiers may be interchanged in less than 5 minutes—enabling you to return to full power promptly.

RCA TTU-12A Filterplexer

⑪ You Pay Nothing for "Extras"

The price of the RCA 12.5-KW UHF includes the complete transmitter package. No "extra" charge for UHF Filterplexer (combination sideband filter and diplexer). No "extra" charge for one complete set of tubes. No "extra" charge for two sets of crystals, two P.A. "glide-in" cavity dollies, one spare cavity, two water pumps, and pyranol-filled plate transformer.

Specify a Completely Matched UHF System



RCA UHF Waveguide Section

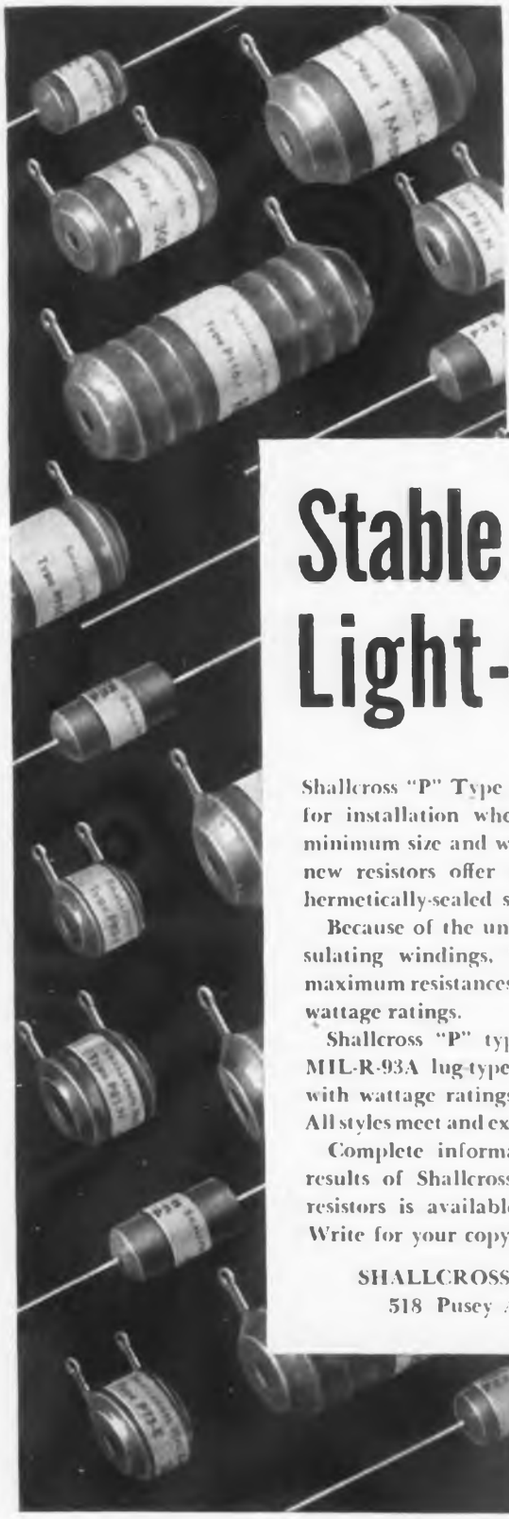
RCA can supply a completely matched system to meet any station requirement. This includes the antenna and tower, transmitter, console, monitoring equipment, transmission line or waveguide, and the many other accessories needed to put a UHF station on the air. Everything is matched for peak performance and you get everything from one reliable source—RCA!

For complete information on the RCA 12.5-KW UHF transmitter—and RCA UHF accessories—call your RCA Broadcast Sales Representative.

New brochure on the RCA 12.5-KW UHF transmitter. Includes technical specifications, floor plans. Free from your RCA Broadcast Sales Representative.

RCA PIONEERED AND DEVELOPED COMPATIBLE COLOR TELEVISION

RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DIVISION CAMDEN, N.J.



New!

"P" TYPE ENCAPSULATED RESISTORS

Stable...Small... Light-weight...

Shallcross "P" Type Encapsulated Resistors are ideal for installation where stability, dependability, and minimum size and weight are a must. These radically new resistors offer the performance advantages of hermetically-sealed steatite resistors at less cost.

Because of the unique Shallcross method of encapsulating windings, "P" type resistors have greater maximum resistances, longer leakage paths, and higher wattage ratings.

Shallcross "P" type resistors are available in six MIL-R-93A lug-type styles and five axial lead styles with wattage ratings ranging from .500 to 3.5 watts. All styles meet and exceed JAN-R-93A, Characteristic A.

Complete information on sizes, ratings, and test results of Shallcross "P" type precision wirewound resistors is available in Engineering Bulletin L-30. Write for your copy today.

SHALLCROSS MANUFACTURING CO.
518 Pusey Avenue, Collingdale, Pa.

Shallcross

Our 25th Year 1929 1954

As We Go to Press . . . .

Color TV Test Equipment

Performance tests for color television circuits can be conducted with the new TV Sync. and Color Bar Generator developed by the Electronic instruments Div. of Burroughs Corporation, Philadelphia, Pa. Designed to show the versatility of Burroughs' unitized pulse-control equipment, the TV Test Set simulates actual signal conditions in testing circuit response to synchronizing and color information.

Electronic Tube Replaces Mechanical Recording Dials

The Inditron tube, developed by the National Union Radio Corp., at Orange, N.J., has a filament which shows, with split second changes, the digits and letters usually recorded on mechanical dials. The figures are formed by electronically controlling the gas discharge operation, which is similar to that found in common neon tubes.

Printed Wiring Board

An improved printed wiring board, capable of simplified manufacturing methods, has been made available by the components department of GE. Use of the "printed eyelet boards" removes need for specially designed terminal pins or eyelets to connect opposite sides of the board.

Patent Rights to Terminate

RCA's right to grant certain sublicenses in the radio and television fields under General Electric patents will terminate Dec. 31, 1962 according to an agreement reached between the two companies.

COLOR TV PRODUCTION

Color TV Chassis being assembled at GE plant in Syracuse, N.Y. Shipments of these sets are being made to areas covered by color TV broadcasts

MORE NEWS on page 32

Introducing A New DECADE COUNTER TUBE

The 6476 is Another New Sylvania Development

Now Sylvania offers a new, visual electronic counting device. It's specially designed for control and totalizing applications in high-speed production equipment.

Operating by electrical impulses, this tube visually indicates consecutive numbers by light flashes within the tube—counting from one to ten.

All cathode leads are brought out individually and can be plugged into a socket, permitting independent control of pulses. Additional tubes may be added to the circuit thereby increasing counting capacity to hundreds or thousands.

You will find this new Sylvania tube is low in cost, compact in size, and extremely reliable. For detailed specifications address Dept. 4E-4405, Sylvania.

Electrical Data

Anode Current . . . . . **6 ma. max.**
Supply Voltage . . . . . **350 volts**
Max. counting rate . . . . . **4,000 pulses per second**

One more reason why it pays to specify Sylvania.

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg.
St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

4 ways to b

The PHILCO 16mm CineScanner provides the finest film reproduction in either color or monochrome. 35mm model also available.

Broadcasters . . . here is the finest equipment available for color and monochrome film reproduction. Continuous film motion and flying-spot scanning techniques produce high-definition pictures with superb light values. Whether you plan to use slide and film in monochrome; or a versatile combination of film and slides in both color and monochrome, the Philco CineScanner gives longer film life and utmost dependability . . . *it's the only practical method for color!* For complete information, write to Dept. T, today:

Check These PHILCO *Features*

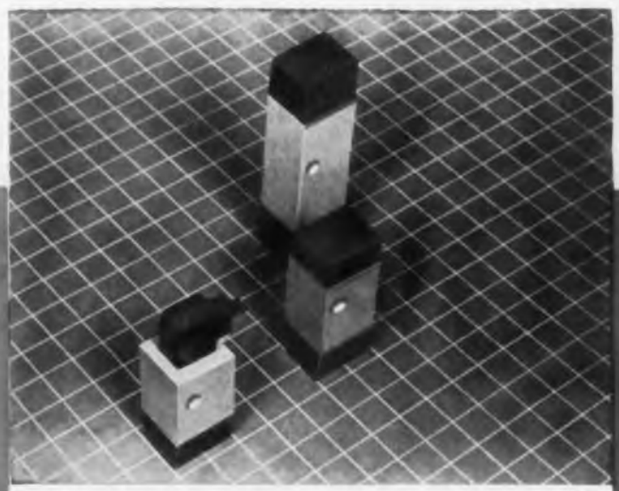
- Quiet, continuous film motion . . . no complicated intermittent mechanism to cause film wear and breakage.
- Cold light source . . . no film burning.
- Instantaneous run-up time with provisions for quick starts and stops . . . remote control available.
- Highest quality production in monochrome and color.

PHILCO CORPORATION

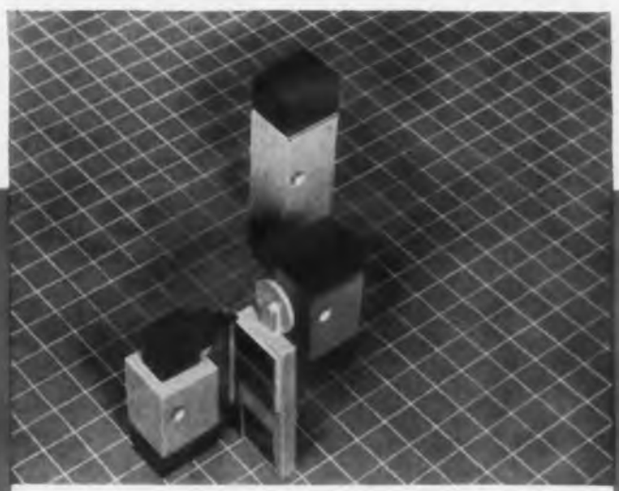
better TV film reproduction!

with the new PHILCO

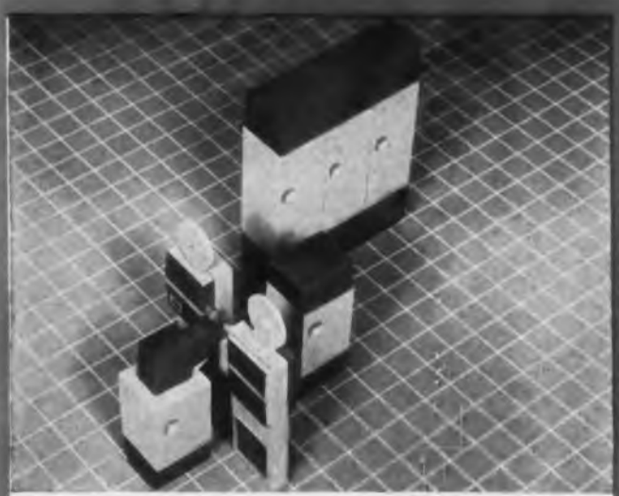
Cine Scanner



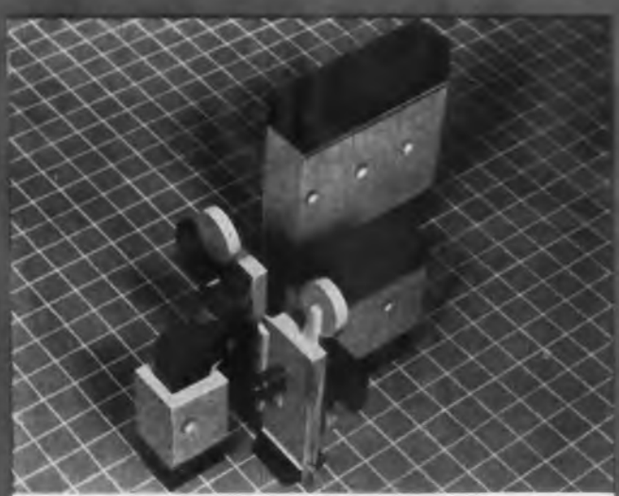
Dual slide changer facing 54" light source unit; 84" equipment rack in background. This setup will handle monochrome (positive or negative) slides with rack space to spare.



Slide changer and single 16mm film combination for monochrome projection. The multiplexing mirror facilitates the use of only one light source for both of the film units.



A slide changer, dual 16mm film units, light source and three equipment racks complete the facilities for monochrome, and both positive and negative film . . . leaving extra rack space.



Dual 35mm and slide changer combination with three racks provides color and monochrome (positive and negative) film programs and either color or monochrome slide presentations.

See PHILCO'S Exhibit at MART!

GOVERNMENT & INDUSTRIAL DIVISION • PHILADELPHIA 44, PA.

Thousands of engineers and audio enthusiasts have improved Hi-Fi performance with DUBBINGS' tests.

Here is what Audio Experts are saying about our latest development:

HAROLD D. WEILER, author of "Hi-Fidelity Simplified" in his forthcoming book states:

"The Dubbings' Test Tapes are an absolute must for anyone interested in obtaining and maintaining peak performance from his tape recorder . . ."

ROBERT L. MARSHALL, Chief Engineer, Fairchild Recording Equipment Co.:

"Dubbings' new Test Tapes are welcome complements to that company's series of fine Test Records . . . Getting all the important tests on a single reel is a tribute to advanced engineering know-how."

DUBBINGS'

"The Measure of Your Tape Recorder's Performance"

TEST TAPE

the first and only comprehensive

D-110, 5" REEL 7½ IPS
D-111, 7" REEL 15 IPS

ON ONE REEL — ALL MAJOR TESTS FOR PERFECT ADJUSTMENT OF:

WOW AND FLUTTER

HEAD ALIGNMENT

FREQUENCY RESPONSE
30 to 7,500 cps at 7½ ips
30 to 15,000 cps at 15 ips

SIGNAL LEVEL

SIGNAL TO NOISE RATIO

TAPE SPEED

A complete instruction book, "Tape Recorder Maintenance", is enclosed

individually recorded on REEVES SOUNDCRAFT **LIFETIME** *professional tape!*

no costly voltmeter needed . . . the simplified D-500 TEST LEVEL INDICATOR *is noted for accuracy (use with both test tape and records) . . . only $3.95*

the accepted standard in audio tests

DUBBINGS' TEST RECORDS

D-100 TEST RECORD
"Measure of Your Phonograph's Performance." The test record for:
FREQUENCY RESPONSE RUMBLE AND HUM WOW AND FLUTTER TRACKING STYLUS COMPLIANCE

D-101 TEST RECORD
"Measure of Your Phonograph's Equalization." The only record with each of these response curves:
COLUMBIA LP AES NARTB
RCA's "New Orthophonic"

ORDER WITH CONFIDENCE . . . UNCONDITIONAL MONEY BACK GUARANTEE

Enclosed find ☐ CHECK ☐ MONEY ORDER

NAME _____

ADDRESS _____

CITY ZONE STATE

The DUBBINGS CO., Inc. Dept. 45 K
41-10 45th St., L.I.C. 4, N. Y.

Quantity Amt.

☐ D-110 5" Reel 7½ ips @ $12.50
INTRODUCTORY TILL MAY 15 @ $10.95 $ ____

☐ D-111 7" Reel 15 ips @ $17.50
INTRODUCTORY TILL MAY 15 @ $15.95 ____

☐ D-500 TEST INDICATOR @ $3.95 ____

☐ D-100 TEST RECORD @ $3.50 ____

☐ D-101 TEST RECORD @ $4.95 ____

Postage & Handling $ .50

Please Print . TOTAL $ ____

As We Go to Press . . . .

235 TV Stations Carried Musical

The largest hook-up of TV stations ever assembled for a commercial program carried the recent Rogers and Hammerstein birthday party. The program was broadcast by 235 TV stations connected by coaxial cable or radio relay facilities.

New Color Dot Generator

A new color dot generator for aligning the electron beams in three-gun color TV picture tubes is in production at Sylvania. This device for assuring proper color convergence is designated as Type 506, and sells for $129.50.

International Geophysical Program for 1957-1958

A major international geophysical program, involving cooperation of 28 nations, is being planned by the U.S. National Committee, International Geophysical Year, National Academy of Sciences, 2101 Constitution Ave. N.W., Washington 25, D.C. Among the subjects under study are solar activity, geomagnetism, ionosphere, cosmic rays, and upper atmosphere rocket studies.

Future Electronic Market

The electronic market for 1960, in terms of factory sales, is estimated as $10 billion, according to a study by Stanford Research Institute. Commercial equipment sales are predicted to reach $1275 million.

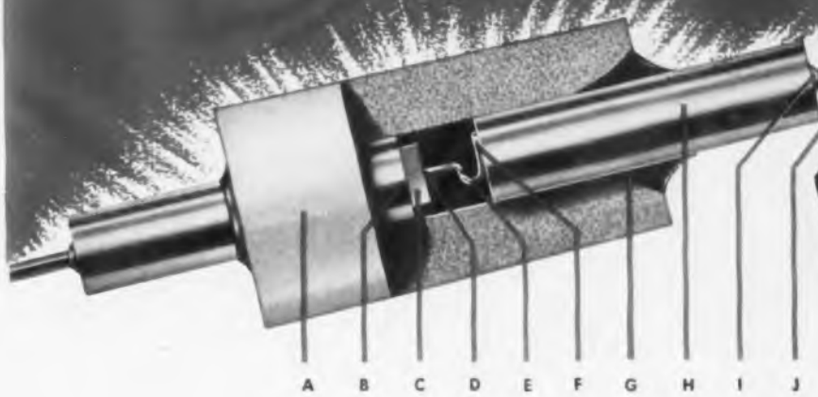
HEART MICROPHONE

Heart microphone system developed by Altec Lansing includes small mike attached to stethoscope and power supply. Special cardiac conditions may be tape recorded for medical study. Amplifier is also used

TELE-TIPS on page 42

SAME PRICE . . . NEW PERFORMANCE!

HERMETICALLY SEALED Germanium Diodes



SPECIAL NON-POROUS CERAMIC CASE! GAS TIGHT!

JAN TYPES

A. Ceramic Case
B. Solder
C. Germanium Pellet
D. Weld
E. Platinum-Rhuthenium Whisker
F. Weld
G. Solder
H. Nickel Pin
I. Weld
J. Leaded Copper Clad Wire

IN General Electric, research aimed at product improvement never stops. And, here are the results of that effort...*a special, non-porous ceramic case diode plus perfection of a metal to ceramic seal!* This ceramic has already been successfully applied to seal high quality tubes. Used in G-E diodes, it voids gas contamination...adds many years of efficient performance!

Order the types you need *in quantity now!* Phone or write: *General Electric Co., Sec. X4854, Electronics Park, Syracuse, N. Y.*

COMPLETE METAL TO CERAMIC SEAL. Gas-tight ceramic cases with metalized ends permit solder seal to nickel pins.

MOISTURE PROOF. These new diodes exceed the requirements of JAN humidity specifications.

REQUIRED ELECTRICAL PROPERTIES. More than two years of development were necessary to perfect this combination of hermetic seal and superior performance.

MECHANICAL STABILITY. Platinum-rhuthenium whisker is welded to the germanium pellet.

LONG-LIFE. The elimination of moisture effects adds years to the life of your equipment!

MAXIMUM RATINGS (At 25° C)

Hermetically Sealed DIODES	1N69	1N70	1N81*
Peak Inverse Voltage	75	125	50
Continuous Operating Inverse Voltage	60	100	40
Min. Forward Current (MA) at + 1V	5.0	3.0	3.0
Max. Inv. Current (μa) At — 50V	850	300	—
At — 10V	50	25	10
AV. Rectified Current (MA)	40	30	30
Peak Rectified Current (MA)	125	90	90
Surge Current (MA)	400	350	350

*JAN approval applied for

You can put your confidence in—

GENERAL ELECTRIC

Anyway you look at it...

Excellent color fidelity. Special Masking Amplifier plus overall quality of system results in superlative reproduction.

Continuous film movement. No intermittent action. Optical immobilizer eliminates claws and shutter.

Film may be run forward or backward. Stopped at any point. Speed may be varied.

Sensitivity of system faithfully reproduces all tonal gradations through gamma-corrected amplifier.

No shading adjustments necessary. Picture free from edge flare and shading. Completely automatic from remote panel.

Entirely new standard of operating economy for both color and monochrome operation.

DUMONT®

YOU'RE YEARS AHEAD with the 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

COLOR TRANSPARENCIES

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.

16 mm. FILM MONOCHROME

. . . 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.

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

TELEVISION TRANSMITTER DEPARTMENT ALLEN B. DU MONT LABORATORIES, INC. CLIFTON, N. J.

Styroflex Coaxial Cable

FIRST CHOICE FOR

AM, FM and TV APPLICATIONS

Phelps Dodge Copper Products Corporation's semi-flexible, aluminum sheathed Styroflex cable is specially designed to meet the need for a high-power, efficient, low-loss coaxial cable in the AM, FM and TV (both VHF and UHF) fields. The cable reduces reflections—which cause ghost images in television and distortions in communications—to an absolute minimum. Phelps Dodge's wide application and installation experience in these fields is at your service.

Visit us in Room 720,
The Palmer House, Chicago, Illinois,
during the N. A. R. T. B. convention,
May 23-27, 1954

PHELPS DODGE COPPER PRODUCTS CORPORATION
40 WALL STREET, NEW YORK 5, N. Y.

Fast Delivery AlSiMag®

DIE PRESSED *Ceramics*

FAST DELIVERY . . . Our own die shop and four modern plants speed deliveries.

LARGE OR SMALL QUANTITIES . . . We have the most complete press facilities in the industry.

ECONOMICAL PRODUCTION . . . The right press for every job permits utmost economy.

ON SPECIFICATION . . . Backed by a reputation for accurate compliance with specifications for more than half a century.

WIDEST CHOICE OF MATERIALS . . . AlSiMag property chart gives more compositions and more physical data than any other source.

ENGINEERING COOPERATION . . . Send sketch and details of requirements for practical, cost-saving, delivery-expediting suggestions.

53RD YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

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SEE OUR DISPLAY

BOOTH NO. 340

BASIC MATERIALS EXPOSITION

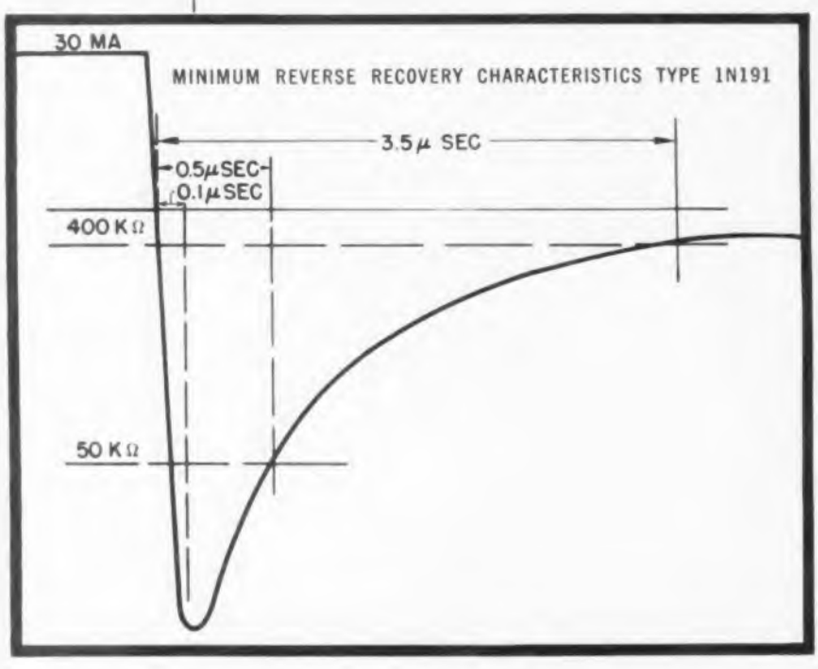
The Product Development Show

CHICAGO • MAY 17-20, 1954

Hughes Diodes for Computer Applications

Types 1N191 and 1N192

Actual dimensions of diode body 0.265" x 0.130"



Recovery Time Characteristics

at 25° Centigrade

Type 1N191

50 KΩ @ 0.5 μsec and 400 KΩ @ 3.5 μsec maximum

Type 1N192

50 KΩ @ 0.5 μsec and 200 KΩ @ 3.5 μsec maximum

Maximum Back Current

at 55° Centigrade

Type 1N191

400 KΩ min. between −10 and −50V

Type 1N192

200 KΩ min. between −10 and −50V

To measure pulse recovery for both types, diodes are pulsed at 30 mA in the forward direction and then a back voltage of −35 volts is applied.

Now, as part of the continuing program to meet the expanding requirements for computer components, Hughes announces the registration of *Diode Types 1N191* and *1N192*. Both are selected for their outstanding performance in computer service.

These computer type diodes, like all Hughes diodes, are designed to ensure extremely high moisture resistance... thermal stability... electrical stability... subminiature size... thorough dependability. These features mean long life with minimum maintenance.

If you need special computer type diodes, chances are that we can furnish them on a production basis—because we are constantly producing and providing *many* types to meet literally hundreds of electronics and communications applications. Among these are high forward conductance, low-voltage diodes, used for certain computer applications.

Just Off the Press

A new, eight-page descriptive brochure. Lists and describes all the more widely-used RETMA, JAN and special types in the Hughes line. Just write for your copy of Bulletin SP-2.

SEMICONDUCTOR SALES DEPARTMENT

Hughes

Aircraft Company

Culver City

California

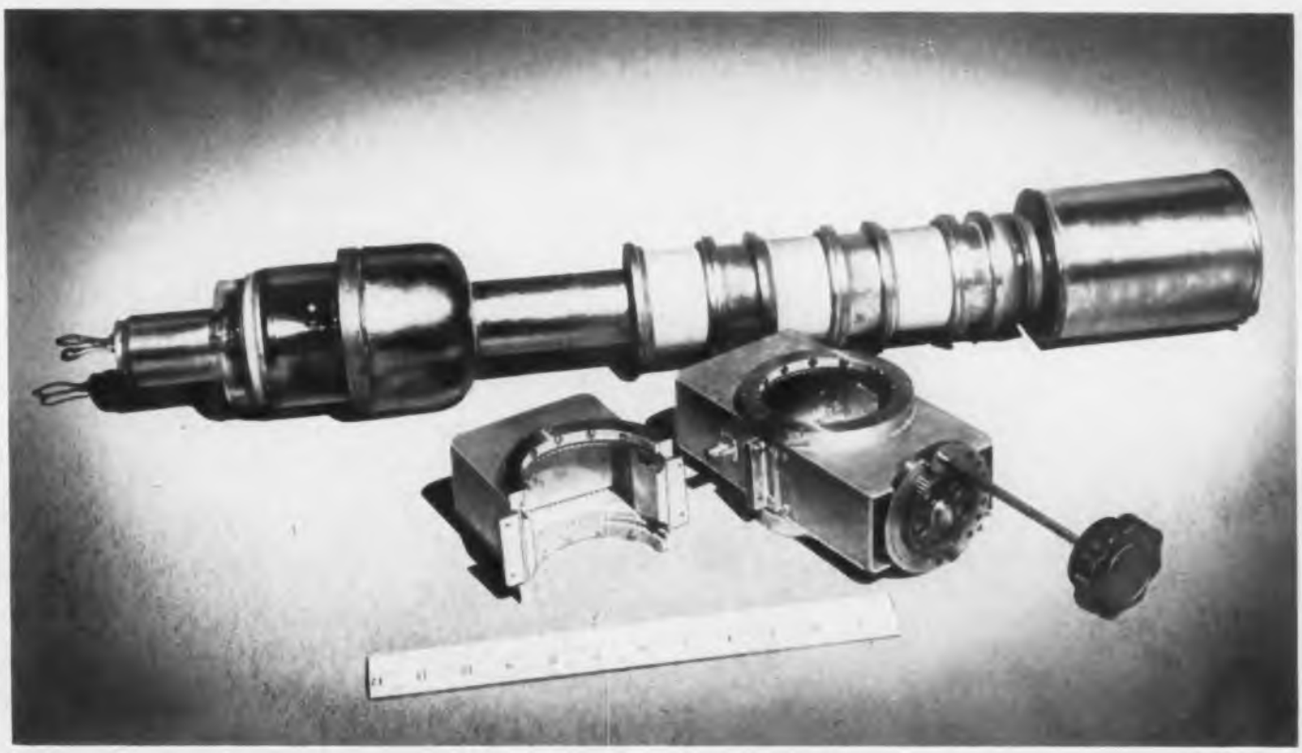
NEW YORK CITY CHICAGO

Eimac Klystron Report

X544

L BAND KLYSTRON

- **3 kw CW power output at 1400 mc**
- **Power gain of 1000 times**



Eimac X544 and external tuning boxes.

A power gain of 1000 times at 1200-1400mc in CW operation has been registered by the new Eimac X544 three cavity, cascade type klystron. With only three watts driving power the X544 delivers 3kw power output. This high power and high power gain is possible over a 200mc range through the exclusive Eimac feature of completing tuning circuitry external to the vacuum system. Other features of the Eimac X544 are a long life cathode, ceramic tube cavities, practical design and light weight.

The X544 is another Eimac advancement in klystrons for higher power at higher frequencies. Other Eimac klystrons include high power amplifiers for UHF-TV and sturdy reflex klystrons for use in conditions of severe shock, vibration and sustained acceleration at frequencies to 9600mc.

- *For further information contact our Application Engineering Department*

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA

Eimac

MARK OF EXCELLENCE IN ELECTRON-POWER TUBES

COMPLETE CIVILIAN LINE

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

TYPE C45-70

NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL— ***Performance Fully Equals Larger Types.***

TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.

TYPE C2-45

TYPE C2-35

TYPE C2-252

TYPE C2-25

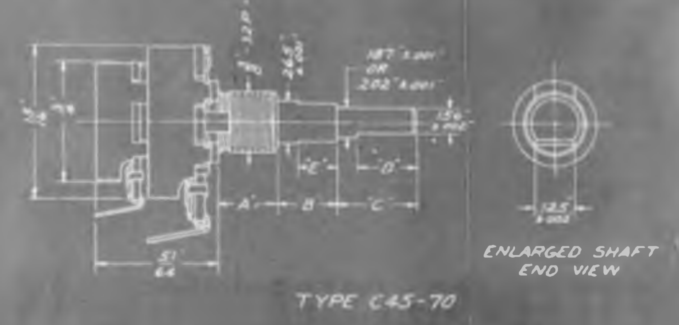
TYPE OC-45, 15/16" diameter variable composition resistor. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms, 1/4 watt with 500 volts maximum across end terminals for resistances over 100,000 ohms. Available with or without illustrated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

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

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

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

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



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OTHER EXPORT

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Specialists in Pre

COMPLETE MILITARY LINE

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

NEW 38-PAGE ILLUSTRATED CATALOG—Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor. *Write today for your copy.*

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

TYPE 65, (Miniaturized) *1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.*

TYPE 25, (JAN-R-94, Type RV2) *1/2 watt, 1 1/8" diameter variable composition resistor.* Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

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

TYPE 252, (JAN-R-19, Type RA20) *2 watt, 1 17/64" diameter variable wirewound resistor.* Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

UNPRECEDENTED PERFORMANCE CHARACTERISTICS

Specially designed for military communications equipment subject to extreme temperature and humidity ranges. −55°C to +150°C...aridity to saturation.

TYPE 95, (JAN-R-94, Type RV4) *2 watt 70°C, 1 1/8" diameter variable composition resistor.* Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 25, (JAN-R-19, Type RA30) (May also be used as Type RA25) *4 watt, 1 17/32" diameter variable wirewound resistor.* Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

Burton Browne Advertising

CTS

CHICAGO TELEPHONE SUPPLY *Corporation*

ELKHART, INDIANA

... in Precision Mass Production of Variable Resistors

STAINLESS, INC.
NORTH WALES, PENNA.

AM

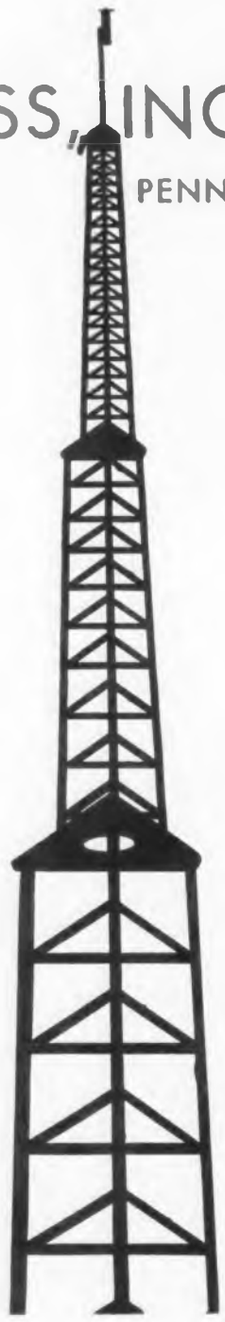
FM

TV

Mobile

Microwave

TOWERS



TELE-TIPS

FIFTH ESTATE—What with TV, atom bombs, electronic controls, plastics and wonder drugs drastically affecting the lives of every person, it was inevitable that the engineers and scientists responsible for technological developments would be looked upon as something special and powerful. So it was without too much shock that we overheard them referred to as the Fifth Estate, adding one more to the long estabished four estates which have molded the ways of man: Royalty, Clergy, Commons and Press.

HOW'S THAT AGAIN? Commented Dean W. L. Everitt of the Univ. of Illinois upon receiving the IRE Medal of Honor at the 1954 Convention: "This award is the most awful honor an engineer can receive." He smilingly explained that awful was defined by Webster as "awe inspiring" and "impressive."

SECURITY RISK as defined by President Eisenhower:

1. A person unreliable or untrustworthy because of behavior, misrepresentations, personal habits, mental health or outside pressure.
2. One who commits sabotage, espionage, treason or sedition.
3. Anyone who associates with spies, foreign agents or Communists.
4. A person who advocates overthrow of the government by force or unconstitutional means.
5. One who belongs to Communist, Fascist, or subversive organizations.
6. A person who gives to another any security information in violation of regulations.
7. One who serves the interest of a foreign government.
8. One who declines to testify before a Congressional committee, claiming protection of the Fifth Amendment.

ADRIAEN VAN DER DONCK, first lawyer to arrive in the New World Colony of the Dutch West Indies Co. of Amsterdam was refused a permit to practice law. The Dutch, a canny lot, reasoned that since he had no competition he might become a one-man Supreme Court.

(*Continued on page* 44)

Foremost in the field

RAYTHEON TRANSISTORS are FOREMOST IN THE FIELD with PROVEN RELIABILITY Over 1,000,000,000 OPERATING HOURS of actual field performance in commercial equipment with only a FRACTION OF 1% FIELD RETURNS proves their reliability to be superior to the reliability of vacuum tubes.

RAYTHEON TRANSISTORS are foremost in number of units in use in commercial equipment. Raytheon successfully made transistors in "experimental," "pilot" and now MASS PRODUCTION phases. The latest continuous, mass production, and inspection techniques are employed in the making of Raytheon Transistors. HUNDREDS OF THOUSANDS are IN ACTUAL COMMERCIAL USE — MANY TIMES MORE THAN ALL OTHER MAKES COMBINED. No other manufacturers can make these statements.

RAYTHEON GERMANIUM DIFFUSED JUNCTION PNP TRANSISTORS

RATINGS: — ABSOLUTE MAXIMUM VALUES:	CK722	CK723	CK721	CK725	CK727	2N63*	2N64*	2N65*
Collector Voltage (volts)	−22	−22	−22	−22	−6	−22	−22	−22
Collector Current (ma)	10	10	10	10	10	10	10	10
Collector Dissipation (30°C) (mw)	33	33	33	33	30	33	33	33
Emitter Current (ma)	10	10	10	10	10	10	10	10
Ambient Temperature (°C)	50	50	50	50	50	50	50	50
AVERAGE CHARACTERISTICS (27° C)								
Collector Voltage (volts)	−6	−6	−6	−6	−1.5	−6	−6	−6
Emitter Current (ma)	1	1	1	1	0.5	1	1	1
Collector Resistance (meg)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Emitter Resistance (ohms)	25	25	25	25	50	25	25	25
Base Resistance (ohms)	250	350	700	1500	500	350	700	1500
Base Current Amplification Factor	12	22	45	90	35	22	45	90
Cutoff Current (approx.) (ua)	6	6	6	6	6	6	6	6
Noise Factor (max) (db)**	30†	25†	22†	20†	12††	25†	22†	20†

*Hermetically sealed in metal package
**In a one cycle band width at 1000 cycles

†Measured at $V_c = -2.5$ volts in common emitter circuit
††Measured at $V_c = -1.5$ volts; $I_c = 0.5$ ma in common emitter circuit

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

RAYTHEON MAKES ALL THESE

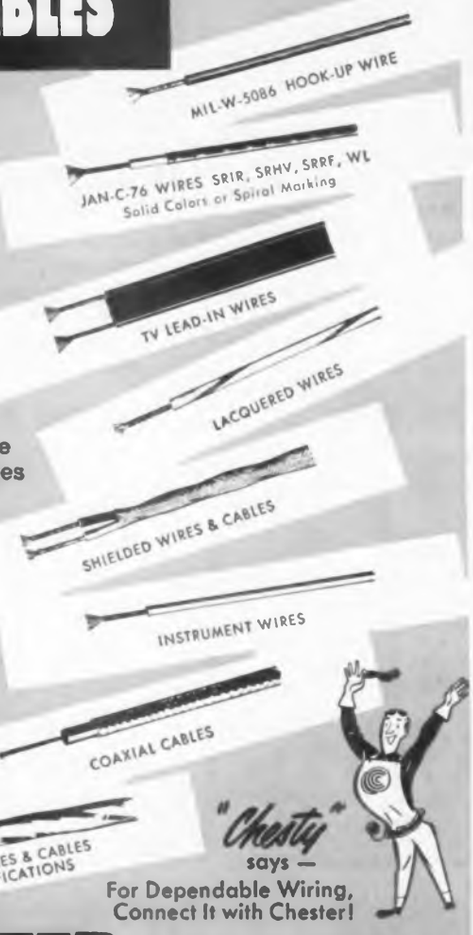
Standard and Special Constructions—

CHESTER
plasticord-plasticote
WIRES & CABLES

—FOR EVERY ELECTRICAL AND ELECTRONIC NEED!

It pays to make CHESTER quality-engineered wire and cables your standard for both commercial and military requirements. Every foot of conductor bearing the Chester label is laboratory tested and service-proven to perform as specified. Chester extra-strength plastic coatings are made super-durable for longer life and smooth pliability assures the easier working qualities that speed wiring production.

NEW CHESTER BULLETINS
Complete data and specifications on quality conductors for all electronic wires and cables will be supplied promptly. Call or write, today!



"Chesty" says —
For Dependable Wiring, Connect It with Chester!

CHESTER CABLE CORP.
CHESTER, NEW YORK

TELE-TIPS

(*Continued from page* 42)

AIRCRAFT ELECTRONIC devices are reported to account for half the cost of fighter planes.

SEMANTIC problem posed by an Emerson employee is why people say we listen to *the* radio, but watch TV. Could be that TV has a more personal impact. Or maybe when radio started people said, "Let's listen to radio," and gradually changed. Perhaps "the" will be inserted before TV eventually.

MORE STUDENTS are enrolled in engineering courses at Illinois Tech than at any other educational institution. This includes 4,743 undergrads and 591 graduate students. Engineering enrollment totals for other schools are: Brooklyn Poly, 4,805; Purdue, 4,705; Univ. of Ill., 4,597; CCNY, 4,495; Georgia Tech, 3,669; MIT, 3,380; NYU, 3,218; Penn State, 3,059; Ohio State, 2,949; Newark, 2,932; Texas A & M, 2,655; Univ. of Wis., 2,499; Renssalaer, 2,497; Univ. of Mich., 2,430; Carnegie Tech, 1,935; Case, 1,616; Columbia, 1,222; and Cal. Tech, 484. Grand total for all accredited schools is 171,832.

CIRCUS attendance and interest has increased because of TV, says Clyde Beatty, noted animal trainer.

LEARNING by TV can be as effective as classroom instruction, according to results of an experiment conducted by the Army and Univ. of Houston station KUHT-TV. Students reported lhat TV study was at least as interesting and easy as classroom instruction, or more so.

GERMANIUM is literally almost worth its weight in gold. At $350 per pound, it comes to 65% of the cost of the glittering metal. Only one pound of germanium is recovered from over 1000 tons of zinc ore.

FLUORESCENT lamps may be operated with increased light output by using GE's new 5-kw static frequency converter that provides 360-cycle square-wave current at 600 volts. Remote location of unit reduces noise. Ballasts are not required.

(*Continued on page* 48)

Announcing G-R's NEW Unit Pulser

Pulse Durations: 0.2 to 60,000 μs
Repitition Rates: 0 to 100 kc
Rise Time: .05 μs

Type 1217-A Unit Pulser $185
shown with plug-in **Type 1203-A Unit Power Supply $40**

The Type 1217-A Unit Pulser is the first *laboratory-quality* pulse generator to be made commercially available at *moderate cost*. Its wide range of pulse durations and repetition rates, stability, high output voltage and variable amplitude control make this instrument a highly versatile piece of equipment for every industrial and college laboratory.

Pulse-modulated UHF signal sent through tv-convertor, into tv-set antenna-input, and through tv-set to screen — overall transient response from front to end determined quickly and easily — convertor and receiver manufacturers may in this way effectively determine ability of their products to pass uhf signals, under simulated operating conditions.

The Type 1000-P7 Balanced Modulator Is A Unique New Device Which Permits Full 100% Amplitude Modulation Of Carriers From 60 to 1300 Mc — Modulating Signal May Be Any Frequency Over 0 to 20-Mc Band.

Where good rise time characteristics and negligible incidental f-m *are essential*, these instruments are highly recommended.

With the Unit Pulser and this Modulator, signal generators may be pulse modulated over extremely wide ranges. The two instruments make a highly useful combination for pulse work . . . such as testing of television broadcast and receiving equipment . . . and measurements on radar, omni-range and DME, and telemetering apparatus.

The G-R Unit Pulser . . . Small . . . Compact . . . Economical

Provides square waves from 10 cycles to 100 kc for checking Overall Audio-Amplifier Transient Response.

For TV-Receiver Testing — a Unit Pulser locked to the receiver line frequency produces a visual response directly on the picture tube in checking operation of video detector and amplifier.

Invaluable in Educational Laboratory and Demonstration Class — an Oscillocope and Unit Pulser may be used in student experiments to illustrate ability of linear, passive networks to pass pulses of varying durations and repetition rates.

Useful in Telemetering, Computing and Nuclear Research and Development — Pulser produces clean pulses controllable over wide ranges — combination of two Pulsers produces a flexible phasing system and source of delayed pulses or gates adjustable with time.

Write for the recently published VHF-UHF Bulletin which gives specifications and technical details for the new Unit Pulser, the Balanced Modulator, and G-R's completely integrated line of high-frequency equipment.

Since 1915 —

Manufacturers of Electronic Apparatus for Science and Industry

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

Admittance Meters ☆ Amplifiers ☆ Coaxial Elements ☆ Distortion Meters ☆ Frequency Measuring Apparatus ☆ Frequency Standards ☆ Impedance Bridges ☆ Light Meters Megohmmeters ☆ Modulation Meters ☆ Polaristopes Precision Capacitors ☆ Oscillators ☆ U-H-F Measuring Equipment ☆ Parts & Accessories ☆ Signal Generators Wave Analyzers ☆ Variacs ☆ TV & Broadcast Monitors Pulse Generators ☆ R-L-C Decades ☆ R-L-C Standards ☆ Unit Instruments ☆ Sound & Vibration Meters ☆ Stroboscopes ☆ Null Detectors ☆ Motor Controls ☆ Wave Filters ☆ V-T Voltmeters

RPC Type J resistors where subminiature requirements specify full size reliability and performance

Precision Wire Wound

Type JA ¼" diameter X ¼" long. Maximum resistance 125,000 ohms. 0.10 watt.
Type JC ¼" diameter X ⅜" long. Maximum resistance 250,000 ohms. 0.15 watt.
Tolerance 1% standard, tolerances to 0.05% available. All resistors furnished with low temperature coefficient alloys.
Special wire and impregnation available for greatly increased power rating.

rpc

RESISTANCE PRODUCTS CO.

714 Race Street · Harrisburg, Pa.

REMEMBER, MERLIN, WAND WAVING IS STRICTLY HOCUS-POCUS!

Pulling a rabbit out of a hat is fine for entertainment, we agree. But not even a magician can make good on the fantastic claims attributed to cheaper solders, *the mystery alloys with a secret ingredient*, that are supposed to equal the performance of higher tin content solders. Today, as always, Kester believes, the quality of the soldered connection is what counts . . . *not* an infinitesimal saving. That's why Kester Solder has been a "star performer" for more than 50 years!

For your specific solder requirements, remember Kester "44" Resin, "Resin-Five" or Plastic Rosin-Core Solder . . . with exact core size or flux-content "tailored" to every job.

KESTER

SOLDER COMPANY

4210 WRIGHTWOOD AVENUE, CHICAGO 39, ILLINOIS
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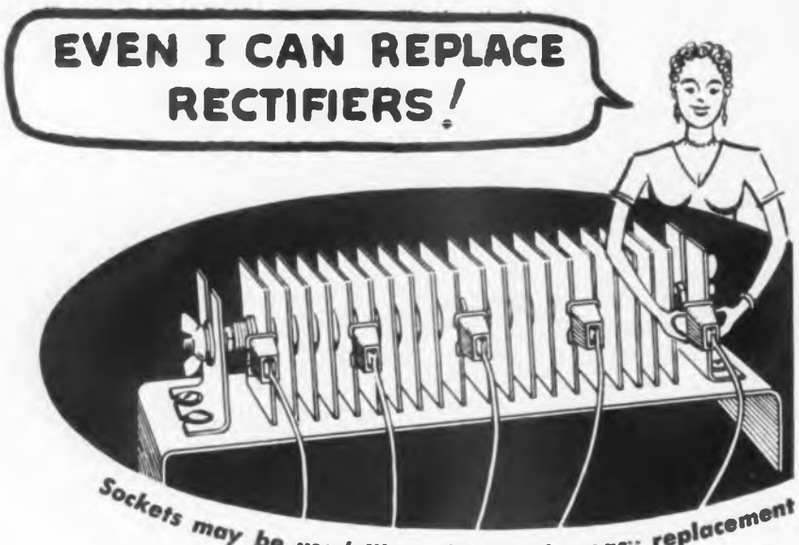


Request

PLUG-INS

THE UNIVERSAL SELENIUM RECTIFIERS

Rectifier failures are infrequent—**BUT**—here is a power rectifier that can be replaced on a moment's notice without tools. Bring your equipment up to date by installing Sarkes Tarzian Plug-In Rectifiers. Our engineers will design these rectifiers for your application. Please send us your requests.

New 72-page Selenium Rectifier Handbook Available. Latest Engineering Information. Send For Your Copy. Price $1.00.

Sarkes Tarzian, INC.

RECTIFIER DIVISION

415 N. College Ave., Dept. T-3, Bloomington, Indiana

In Canada—50 St. Clair Ave., N. W., Toronto

TELE-TIPS

(*Continued from page* 44)

FOUNDING DATE of the Army Signal Corps has been set back to June 21, 1860, the date Congress authorized the first signal officer. Official birthday observed previously was March 3, 1863, when Congress authorized the creation of the Signal Corps to serve as an integral Army unit.

UNDERGROUND TV station being built in London will be completed in two years. The transmitters beneath the site of the old Crystal Palace will be fed by land line from remote studios. The 640-foot steel tower (mounted above ground) will have an ERP of 200 to 250 kw in the 44-88 MC band.

"SCIENCE itself must be pushed ahead in every area, in theoretical fields that are now so remote from application that no one can see any connection, in fields so abstruse that they cannot be successfully explained to laymen. For unless we continuously restore the fund of basic knowledge, we shall ultimately exhaust it. And the greatest steps forward rest on accomplishments of pure science which are now in infancy."—Vannevar Bush.

INVESTMENT IN YOUTH is going to pay big dividends in the long run, and many electronic organizations are missing a bet by not spending some money and time for this purpose. Typical of the efforts of private firms is Telrex President Michael Ercolino's leadership of the Boy's Club of Asbury Park, N.J. There, 600 boys learn teamwork, have fun, and receive radio instruction. For young adults, the WCEMA Scholarship Fund, supported by 56 contributing companies, offers opportunities to study engineering. Locally and nationally, many more dollars and man-hours are still needed.

PRIMARY TV COLORS, as most engineers know, are red, green and blue. Ever try to explain to laymen why yellow isn't used instead of green? Early schooling is sometimes overpowering.

"Trouble-Free"

BUSS FUSES

can help you build CUSTOMER SATISFACTION

Manufacturers and service organizations know from experience that BUSS fuses won't let them down. For over 39 years, under all service conditions, BUSS fuses have given dependable electrical protection.

Rigid quality control is the reason for "trouble-free" BUSS fuses. Every BUSS fuse normally used by the electronic industries is tested in a sensitive electronic device that rejects any fuse not properly constructed, correctly calibrated and right in all physical dimensions.

So for the finest possible electrical protection, turn with confidence to BUSS fuses. The fuse that can be relied on to protect when there is trouble in the circuit. The fuse that eliminates those needless blows, which otherwise could be so annoying to your customer.

And there is another reason it pays to standardize on BUSS fuses. You can simplify your buying, stock handling and records by using BUSS as the one source for fuses. The line is complete: — standard type, dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 ampere up.

If you have a special problem in electrical protection, Buss places at your service the world's largest fuse research laboratory and its staff of engineers. Let our engineers, who are fuse specialists, save the time of your engineers by helping you select the right fuse and fuse mounting for your job—if possible a fuse that is already available in local wholesalers' stocks.

For more information mail this Coupon ▶

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

*Name*_____

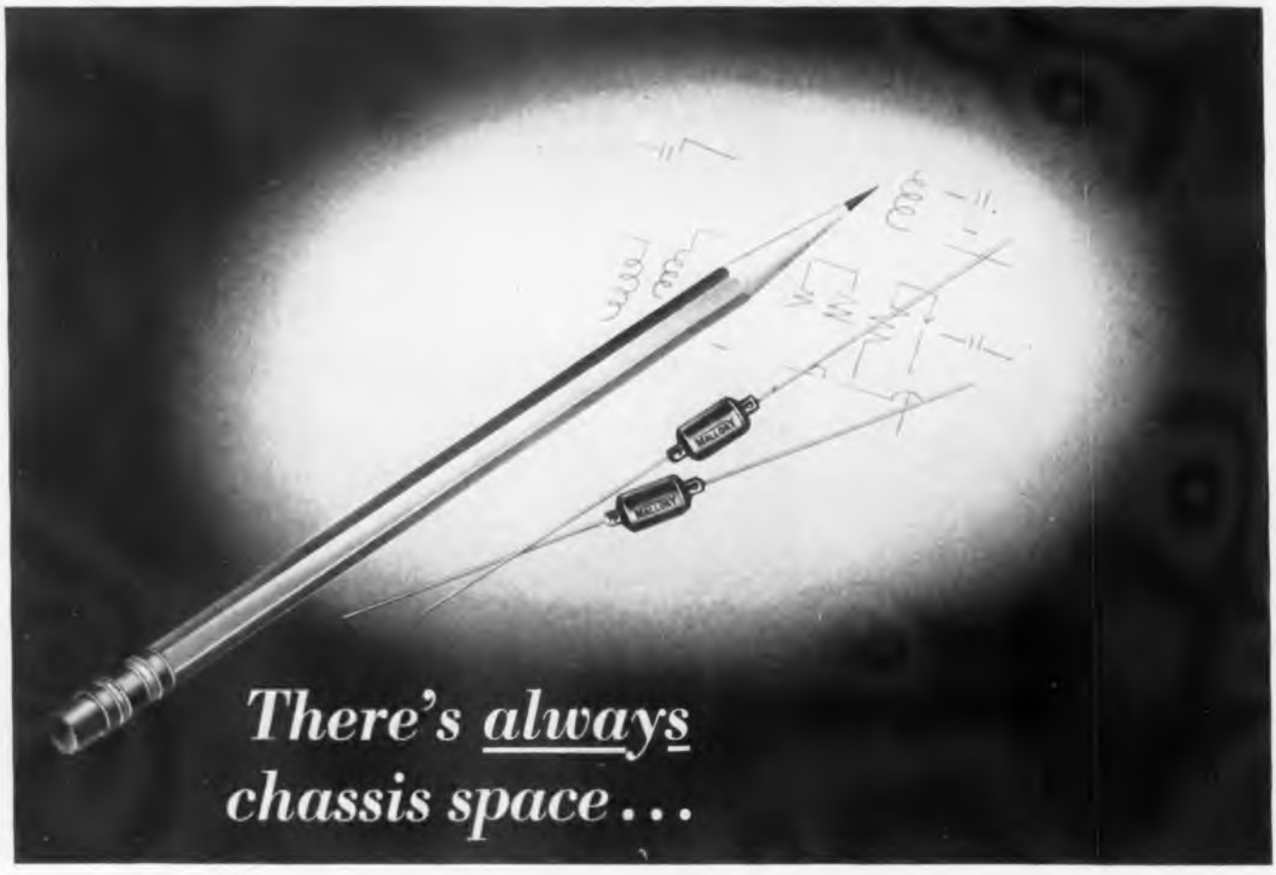
*Title*_____

*Company*_____

*Address*_____

*City & Zone*_____ *State*_____ TTS54

Makers of a complete line of fuses for home, farm, commercial, electronic & industrial use.



For Silverlytic Subminiature Capacitors

Compare these characteristics of Type ALA Silverlytic Capacitors

Ratings available:

4 mfd.	4 volts DC max.
2 mfd.	5 volts DC max.
1 mfd.	10 volts DC max.
.5 mfd.	10 volts DC max.
.3 mfd.	10 volts DC max.
.2 mfd.	10 volts DC max.
.1 mfd.	10 volts DC max.

Temperature range: −30° to +65° C.
(other types for −55° to +85° C. available)

Capacity tolerance: −10% to + infinity
Max. leakage current: 2 microamps. after 5 min. at rated voltage

When you're designing transistor circuits and other miniature electronic equipment, Mallory Silverlytic Capacitors are a space-saving solution to your low-voltage capacitor problems. They provide high capacitance in a case so small that it fits into the tightest chassis layouts. They're only 7/32 inch in diameter and 3/8 inch long.

Silverlytics can be mounted by their leads with complete assurance of reliable operation. An improved method of attaching the axial lead wires eliminates the danger of intermittent open circuits under normal production line handling and service vibration.

An outstanding product of Mallory's continuing program of research in the field of transistor circuit components. Silverlytics offer electrical characteristics comparable with those of larger electrolytics. Our new Technical Bulletin gives complete data on these newest members of the Mallory line of electrolytic capacitors that have set the standard of the electronic industry. Write for your copy today.

Expect more... Get more from **MALLORY**

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

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TV Color COMPONENTS

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104-51 HORIZONTAL LINEARTY CONTROL
104-55 HORIZONTAL DYN. CONV. PHASE CONTROL
104-54 HORIZONTAL CONVERGENCE TRANSFORMER
104-52 WIDTH COIL
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For precision Hi-Cycle power generating equipment to meet one of a myriad of special power requirements ranging from highest quality laboratory power to precision electronic testing, industry relies on Bogue Precision Power. Bogue as the recognized leader in the Hi-Cycle field offers these performance characteristics—

LOW HARMONICS

CLOSE VOLTAGE REGULATION

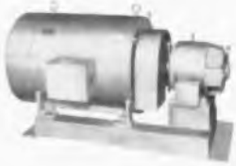
400 CYCLE REGARDLESS OF LOAD & INPUT VARIATIONS

For example, Bogue special 400 cycle single shaft, two-bearing synchronous motor driven units eliminate belts, gears and other special speed changers, yet, faithfully deliver 400 cycles—exactly—no load to full load regardless of voltage variations . . . . truly the standard of 400 cycle power . . . . the reason so many prominent companies have been depending on equipment built by Bogue Electric Manufacturing Company . . .

5 KW portable regulated 400 cycle motor-generator set with integral control panel.

Variable frequency 320 to 1000 cycle M-G set. Bogue magnetic amplifier maintains voltage and frequency to within one-half of 1% of any preset value

5 KW low harmonic set. 400 cycle regardless of input voltage, loading or heating.



400 cycle voltage & frequency regulated inverter. Operates from 28 volt DC supply.

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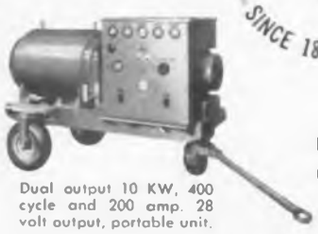
Low harmonic 400 cycle AC generator and low ripple 28 volt DC generator, synchronous motor driven.



Dual output 10 KW, 400 cycle and 200 amp. 28 volt output, portable unit.

REQUEST ILLUSTRATED CATALOG 440

BOOKS

Inventions and their Protection

By George V. Woodling. Published 1954 by Clark Boardman Co. Ltd., New York and Matthew Bender Co., Albany, N.Y. 495 pages. Price $10.00

What rights has the employed research engineer toward his own inventions? What is meant by a strong patent? By super-invention? These and many other similar questions are answered in this factual, carefully-documented book by an eminent lawyer-engineer.

This revised edition of the author's original work on patent law was written to cover the changes involved in the new Patent Codification Act. The book opens with a basic analysis of patent law and common law, and then proceeds to apply each to the problems of the inventor. Actual case histories are supplied, with the pertinent correspondence, showing the pitfalls suffered by former inventors through ignorance of patent law. Of particular interest to the engineering profession is a very detailed section on the employee-employer relationship, and on jointly-owned patents.

The most striking feature of this book is its style. In contrast to the ponderous involved phraseology expected of law books, the author here has carefully weighed the limitations of the non-legal mind, and has scrupulously avoided the use of technical terms. The happy result is a book which is simple, clear and easily read. The value of this book as a text book is obvious: It may well become, also, a standard reference book for engineers and engineering management. CMM

Radio Receiver Design, 2nd Ed.

By K. R. Sturley. Published 1954 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 667 pages. Price $10.

This is the first part of a two-part work on designing communications receivers. It covers electron tubes, antennas, r-f and i-f amplification, frequency changing, oscillators and detection. The author, Head of the Engineering Training Dept. of the British Broadcasting Corp., takes the reader briefly through general considerations, and then presents the detailed circuitry and mathematical analyses of the elements composing the radio system. As might be expected, this volume is straightforward and contains no startling revelations. However, it is clearly written, packed with practical engineering information, and should be a valuable reference for designers of communications equipment. AJF

Proceedings of the National Electronics Conference, (1953)

Published 1954 by National Electronics Conference Inc., 84 E. Randolph Street, Chicago, Ill. 959 pages. Price $5.00

(*Continued on page* 56)

Rely on C-A-C for PRECISION • QUALITY • DELIVERY...

COMMUNICATION ACCESSORIES COMPANY Hickman Mills, Missouri

SIZE
1-1/16 OD
1/2 H
6-32 MTG.

TYPES	Q max.	Freq.
MP206	140	14 KC
MP848	185	35 KC
MP608	170	60 KC
MP073	265	250 KC

SIZE
1-5/16 OD
23/32 H
6-32 MTG.

TYPES	Q max.	Freq.
MP930	160	8 KC
MP395	225	25 KC

SIZE
2 OD
1 H
8-32 MTG.

TYPE	Q max.	Freq.
MP254	210	6 KC

MP TOROIDS

MP (Molded Plastic) units are the result of a long development program. CAC MP toroids have repeatedly passed all tests for MIL-T-27, Grade 1, Class A without exception. Most compact design—may be stacked — mounted by center bushing — absorbs mounting pressures — sturdy silver plated terminals — arrangements available up to 5 terminal connections — standard inductance values listed below shipped from stock—special inductances and configurations supplied promptly on request.

STOCKED VALUE TABLE

MP206 IND.	MP206 PART. No.	MP848 IND.	MP848 PART. No.	MP930 IND.	MP930 PART. No.	MP395 IND.	MP395 PART. No.	MP254 IND.	MP254 PART No.
5.0 MH	MP-206-1-	2.0 MH	MP-848-1-	5.0 MH	MP-930-1-	5.0 MH	MP-395-1-	20 MH	MP-254-1-
6.0 MH	MP-206-2-	2.4 MH	MP-848-2-	6.0 MH	MP-930-2-	6.0 MH	MP-395-2-	24 MH	MP-254-2-
7.2 MH	MP-206-3-	3.0 MH	MP-848-3-	7.2 MH	MP-930-3-	7.2 MH	MP-395-3-	30 MH	MP-254-3-
8.6 MH	MP-206-4-	3.6 MH	MP-848-4-	8.6 MH	MP-930-4-	8.6 MH	MP-395-4-	36 MH	MP-254-4-
10 MH	MP-206-5-	4.3 MH	MP-848-5-	10 MH	MP-930-5-	10 MH	MP-395-5-	43 MH	MP-254-5-
12 MH	MP-206-6-	5.0 MH	MP-848-6-	12 MH	MP-930-6-	12 MH	MP-395-6-	50 MH	MP-254-6-
15 MH	MP-206-7-	6.0 MH	MP-848-7-	15 MH	MP-930-7-	15 MH	MP-395-7-	60 MH	MP-254-7-
17.5 MH	MP-206-8-	7.2 MH	MP-848-8-	17.5 MH	MP-930-8-	17.5 MH	MP-395-8-	72 MH	MP-254-8-
20 MH	MP-206-9-	8.6 MH	MP-848-9-	20 MH	MP-930-9-	20 MH	MP-395-9-	86 MH	MP-254-9-
24 MH	MP-206-10-	10 MH	MP-848-10-	24 MH	MP-930-10-	24 MH	MP-395-10-	100 MH	MP-254-10-
30 MH	MP-206-11-	12 MH	MP-848-11-	30 MH	MP-930-11-	30 MH	MP-395-11-	120 MH	MP-254-11-
36 MH	MP-206-12-	15 MH	MP-848-12-	36 MH	MP-930-12-	36 MH	MP-395-12-	150 MH	MP-254-12-
43 MH	MP-206-13-	17.5 MH	MP-848-13-	43 MH	MP-930-13-	43 MH	MP-395-13-	175 MH	MP-254-13-
50 MH	MP-206-14-	20 MH	MP-848-14-	50 MH	MP-930-14-	50 MH	MP-395-14-	200 MH	MP-254-14-
60 MH	MP-206-15-	24 MH	MP-848-15-	60 MH	MP-930-15-	60 MH	MP-395-15-	240 MH	MP-254-15-
72 MH	MP-206-16-	30 MH	MP-848-16-	72 MH	MP-930-16-	72 MH	MP-395-16-	300 MH	MP-254-16-
86 MH	MP-206-17-	36 MH	MP-206-17-	86 MH	MP-930-17-	86 MH	MP-395-17-	360 MH	MP-254-17-
100 MH	MP-206-18-	43 MH	MP-848-18-	100 MH	MP-930-18-	100 MH	MP-395-18-	430 MH	MP-254-18-
120 MH	MP-206-19-	50 MH	MP-848-19-	120 MH	MP-930-19-	120 MH	MP-395-19-	500 MH	MP-254-19-
150 MH	MP-206-20-	60 MH	MP-848-20-	150 MH	MP-930-20-	150 MH	MP-395-20-	600 MH	MP-254-20-
175 MH	MP-206-21-	72 MH	MP-848-21-	175 MH	MP-930-21-	175 MH	MP-395-21-	720 MH	MP-254-21-
200 MH	MP-206-22-	86 MH	MP-848-22-	200 MH	MP-930-22-	200 MH	MP-395-22-	860 MH	MP-254-22-
240 MH	MP-206-23-	100 MH	MP-848-23-	240 MH	MP-930-23-	240 MH	MP-395-23-	1.00 HY	MP-254-23-
300 MH	MP-206-24-	120 MH	MP-848-24-	300 MH	MP-930-24-	300 MH	MP-395-24-	1.20 HY	MP-254-24-
360 MH	MP-206-25-	150 MH	MP-848-25-	360 MH	MP-930-25-	360 MH	MP-395-25-	1.50 HY	MP-254-25-
430 MH	MP-206-26-	175 MH	MP-848-26-	430 MH	MP-930-26-	430 MH	MP-395-26-	1.75 HY	MP-254-26-
500 MH	MP-206-27-	200 MH	MP-848-27-	500 MH	MP-930-27-	500 MH	MP-395-27-	2.00 HY	MP-254-27-
600 MH	MP-206-28-	240 MH	MP-840-28-	600 MH	MP-930-28-			2.40 HY	MP-254-28-
720 MH	MP-206-29-	300 MH	MP-848-29-	720 MH	MP-930-29-			3.00 HY	MP-254-29-
860 MH	MP-206-30-	360 MH	MP-848-30-	860 MH	MP-930-30-			3.60 HY	MP-254-30-
1.00 HY	MP-206-31-	430 MH	MP-848-31-	1.00 HY	MP-930-31-			4.30 HY	MP-254-31-
1.20 HY	MP-206-32-	500 MH	MP-848-32-	1.20 HY	MP-930-32-			5.00 HY	MP-254-32-
1.50 HY	MP-206-33-			1.50 HY	MP-930-33-			6.00 HY	MP-254-33-
1.75 HY	MP-206-34-			1.75 HY	MP-930-34-			7.20 HY	MP-254-34-
2.00 HY	MP-206-35-			2.00 HY	MP-930-35-			8.60 HY	MP-254-35-
2.40 HY	MP-206-36-			2.40 HY	MP-930-36-			10.0 HY	MP-254-36-
3.00 HY	MP-206-37-			3.00 HY	MP-930-37-			12.0 HY	MP-254-37-
				3.60 HY	MP-930-38-			15.0 HY	MP-254-38-
				4.30 HY	MP-930-39-			17.5 HY	MP-254-39-
				5.00 HY	MP-930-40-			20.0 HY	MP-254-40-
				6.00 HY	MP-930-41-			24.0 HY	MP-254-41-
				7.20 HY	MP-930-42-			30.0 HY	MP-254-42-
				8.6 HY	MP-930-43-			36.0 HY	MP-254-43-
				10.0 HY	MP-930-44-				
				12.0 HY	MP-930-45-				
				15.0 HY	MP-930-46-				
				17.5 HY	MP-930-47-				

IN ORDERING...

Add suffix "A" to above numbers for clear bushing
Add suffix "B" to above numbers for tapped bushings
Replace "MP" prefix with "HS" for metal encased toroids (see back page for description).

TELEPHONE SCIENCE GUIDES A PUNCH NO ENEMY CAN DODGE

(Upper left) – Nike's missile climbs to destroy an enemy, under guidance of complex electronic controls. A radar is shown at right. Nike (pronounced Ny'kee) is named after the Greek goddess of Victory.

BELL TELEPHONE LABORATORIES

Is it possible to guide an anti-aircraft missile so that it will track down and destroy a rapidly maneuvering target? No one knew the answer for sure when the U. S. Army put this question to Bell Telephone Laboratories in 1945.

The special skills and techniques developed to create the nation's communications network uniquely fitted Bell scientists to answer this question. They recommended a new system, Nike, and then worked to bring it into being with engineers from Army Ordnance, Western Electric Company and Douglas Aircraft Company.

The first Nike installation has been made, and more will follow. Thus, America's defenses grow stronger through a new extension of frontiers in the communications art. It is a proud achievement of the knowledge and skills first developed at Bell Telephone Laboratories to make the nation's telephone service ever better.

Improving telephone service for America provides careers for creative men in scientific and technical fields

Polarad NTSC Color TV Equipment consists of fully integrated units that combine ease of operation with maximum flexibility.

COLOR BAR GENERATOR—PT-203 Provides color TV test signals, NTSC standards, for color TV equipment, networks and components. Supplies complete composite video signal in the form of seven fundamental color bars simultaneously with seven gradations of gamma bars. White dot pattern superimposed on both color and gamma bars. Color test pattern can be used for adjustment of both color transmitter and receiver circuitry. Internal switching permits 19 different test patterns.

COLOR SYNCHRONIZING GENERATOR—PT-201 Furnishes NTSC color TV subcarrier frequency component and contains divider network to yield 31.5 KC signal Provides driving, blanking and synchronizing pulses, as well as vertical and horizontal dots for linearity checks. Used to drive color bar generators, or any other NTSC color TV generating equipment. Utmost stability assured by driving all pulses from leading edge of crystal controlled oscillator. Unit may be locked to synchronize with 60 cps line. **Also available** as a separate unit, PT-202 Subcarrier Frequency Generator to modify any existing standard (B/W) synchronizing generator in accordance with NTSC color TV standards.

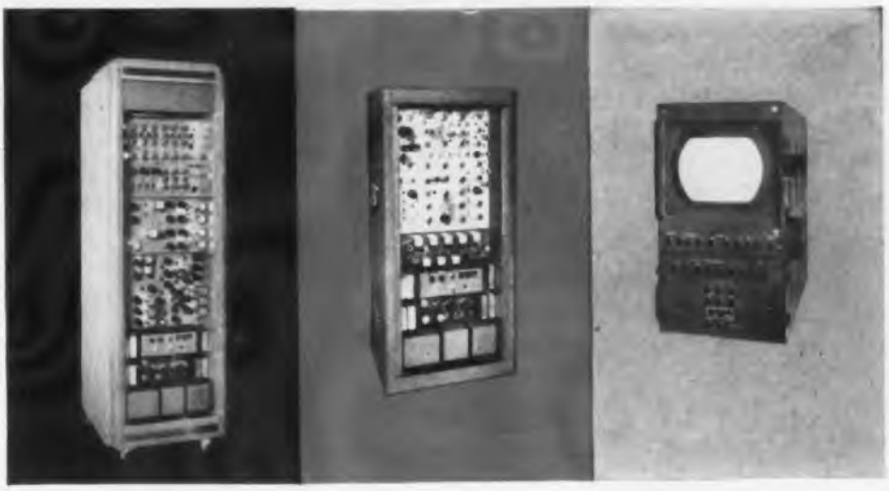
COLOR TV VIDEO MONITOR—M-200 Compact, rugged instrument consisting of two portable units. Uses 15 inch RCA tri-color Kinescope. Checks quality of NTSC color video signals in studio, on transmission or in factory Excellent synchronizing stability. Displays highest definition transmitted pictures with exceptionally good color rendition. All controls on front panel. Instrument may be rack mounted or employed as field test equipment.

ALSO AVAILABLE An NTSC color TV Flying Spot Scanner, furnished as a completely packaged unit supplying a standard color video signal. For further information, contact your nearest Polarad representative or write directly to the factory.

Polarad

COLOR TV

equipment for studio and laboratory



COLOR BAR GENERATOR PT-203
OUTPUT SIGNALS: Composite Video (2 outputs) (Sync negative & positive)
SIGNAL INFORMATION
7 Bars of Color
7 Bars of Gamma Gradations
White Dot Pattern (Vert. and Hor.)
EXT. VIDEO INPUT FOR MIXING
2 Volts neg. polarity

COLOR SYNCHRONIZING GENERATOR PT-201
OUTPUT SIGNALS:
Synchronizing Signal (Neg.)
Camera Blanking Signal (Pos., Neg.)
Horizontal Drive Signal (Neg.)
Vertical Drive Signal (Neg.)
Composite Video Output (Neg., Pos.)
NTSC Color Subcarrier Freq. (3.579545 mc/s)

COLOR VIDEO MONITOR M-200
Signal Polarity—Positive, Negative, Balanced
Input Video—0.25 to 2.0 Volts, peak to peak
Input Impedance—66 mmf across 2.2 megohms
Resolution—250-300 lines (Full Utilization of NTSC Color Signal Bandwidth)
Linearity—Better than 2% across raster Horizontal and Vertical

Polarad **ELECTRONICS CORPORATION** 100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

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a little more of everything

Yes, in a way, a second helping—for we are trying to express the factors which have helped raise the AMERICAN PHENOLIC CORPORATION by its boot straps in a little over twenty years. In the early thirties AMPHENOL was just another struggling industrial infant in one small factory and our main concern then was radio sockets. Today there are five modern plants producing over 11,000 cataloged products ranging all the way from AN connectors to television antennas.

"A little more of everything"—we think a little more courage, a little more imagination, a little more faith have been responsible for the growth of AMPHENOL during the last two decades. And we look forward to the same "little more" qualities, a second helping of the same, to keep AMPHENOL a vital member of the electronics industry for many, many years to come.

AMERICAN PHENOLIC CORPORATION . chicago 50

BOOKS

(*Continued from page 52*)

This volume contains all of the 98 technical papers and addresses presented at the 1953 national conference. The topics covered include research, development and application in the fields of microwaves, communications, ultrasonics, audio, transistors, servomechanisms, and nucleonics. This years issue is volume IX of the series, and volumes from earlier conferences are available from the same address at the same price.

Coil Winding

By W. Querfurth, Published 1954 by George Stevens Mfg. Co., Pulaski Road at Peterson, Chicago 30, Ill. 128 pages. Price $6.50

Here is a practical book for manufacturing electronic engineers containing a description of coil winding procedures, winding machines and associated equipment. It is unfortunate that more books of this type are not written because it contains many of the answers to the "how it is done physically" questions. Interestingly, it is pointed out that no basically new coil shapes have been developed over the past ten years and that thus this handbook promises reference value for many years to come. Aside from the time saving alignment charts and gear tables contained in the appendix, section headings include: rack driven machines, cam driven machines, resistor strip winding machines, wire guide and tension devices, counters, arbor and chuck design, heavy wire winding, multiple paper section winding, wire insulation behavior, pi windings, i-f transformer windings, self resonant coils and many others. Another valuable asset with this book is the enclosed registration card through which purchasers will receive periodic up-to-date fillin information on new techniques. BFO

Low Frequency Amplification

By Dr. N. A. J. Voorhove. Published 1953 as a new volume in the Philips Technical Library. 497 pages, 479 illustrations. Price $9.00. Available through Elsevier Press, 155 East 82 Street, New York 28, N.Y.

An extremely interesting volume on Audio Frequency Engineering. Although written essentially about available European equipment, the technical discussion nonetheless parallels American techniques. Of particular interest is the illustration showing a series of elliptical load lines for a pentode tube as traced on a cathode ray oscilloscope contained in the chapter on "Characteristics of amplifier valves." Other sections include; preamplification; output amplification; feedback; matching, control and limiting; Rectifiers-tubes, metallic, vibrators etc. Extensive foreign and domestic bibliographies are included throughout the volume.

(*Continued on page 60*)

Fast, convenient distortion measurements—20 cps to 20 kc

WAVE COMPONENT MEASUREMENTS

-hp- 300A Harmonic Wave Analyzer **incorporates a unique selective amplifier that isolates individual wave components quickly and easily. Instrument covers frequencies 30 cps to 16 kc, gives full scale readings with inputs of 0.001 to 500 volts. $625.00.**

BROADCAST MEASUREMENTS

-hp- 330C Distortion Analyzer, **for FM measurements, is identical with *-hp-* 330B except meter has VU ballistic characteristics meeting F.C.C. requirements. $425.00.**

-hp- 330D Distortion Analyzer, **for AM and FM, includes detector to rectify AM carrier, plus VU meter described above. $440.00.**

HIGH QUALITY AUDIO TESTS

-hp- 201B Audio Oscillator **covers all frequencies 20 cps to 20 kc, provides 3 watts or 42.5 volts output into 600 ohms. Stability better than ± 2% including warmup; frequency response ± 1 db full range. $250.00.**

HIGH QUALITY VOLTAGE SOURCE

-hp- 206A Audio Signal Generator **covers frequencies 20 cps to 20 kc; is highly accurate, highly stable. Provides continuously variable signal with less than 0.1% distortion. Includes VTVM, 111 db attenuator adjustable in 0.1 db steps, and transformer for matching to 50, 150 and 600 ohm loads. Maximum output level + 15 dbm. $550.00.**

***-hp-* 330B DISTORTION ANALYZER**

Want to measure total distortion quickly and accurately? Study individual wave components simply and directly? Determine transient and frequency response? Make AM or FM broadcast measurements for F.C.C. reports?

Whatever your requirement, *-hp-* has proper instrumentation; the broad *-hp-* line provides complete coverage for all distortion measurements 20 cps to 20 kc.

Typical of quality-built *-hp-* distortion measuring equipment is *-hp-* 330B Distortion Analyzer. This instrument provides fast, accurate measurement of values as low as 0.1%, 20 cps to 20 kc, and also measures voltage level, power output, amplifier gain, response, audio noise and hum (direct readings) unknown audio frequencies; and serves as a high gain, wide band stabilized amplifier. *-hp-* 330B, $395.00.

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Please send me complete data on:
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SILECTRON C-CORES...BIG or LITTLE

...any quantity and any size

Wound from precision rolled oriented silicon steel strip as thin as .00025"

WBD 4363

For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

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• Vertical split

• Vertical wipe

• Vertical wedge wipe

• Diagonal wipe

• Horizontal split

• Diamond insert and wipe

• Controllable corner insert

• Horizontal wedge wipe

• Rectangular insert and wipe

• Controllable corner insert

• Optional special effect

12 ways *to present your "commercial"*

Now—with RCA's new Special Effects Equipment—you can have these 12 attention-getting effects right at your fingertips. You push the button for the effect you want. You swing the "control stick" (rotatable 360°) and put the selected effect in the picture wherever you want it. It's simple, inexpensive—requires no complicated equipment or extra cameras.

RCA's Special Effects Equipment consists of just two separate units; (1) a TG-15A control panel (shown below) and generator, (2) and a TA-15A amplifier. The Special Effects Panel can be inserted in any RCA Console housing. The other units can be mounted in your video racks. Installation couldn't be easier.

For quick delivery, order your RCA Special Effects Equipment direct from your RCA Broadcast Sales Representative.

← RCA Special Effects Control Panel—with 12 push-button selection and 360° rotatable stick control.

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precision electronic instruments by DeJUR

Built to JAN-R-19 Spec's

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L-400

potentiometer

- The moderately priced precision potentiometer that incorporates features of more expensive models
- Miniaturized (only 1⅝" diameter) for military airborne instrumentation and similar applications
- Built to rigid JAN-R-19 and Air Force specifications
- 300° electrical and mechanical rotation
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- Ganging up to 10 units
- Many models and special designs available

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DeJUR AMSCO CORPORATION

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BOOKS

(*Continued from page* 56)

Mechanical Vibration

By G. W. van Santen Published 1953 as part of Phillips Technical Library Series. 308 pages, 6 x 9 in. Price $7.50. Available through Elsevier Press Inc., 155 East 82 Street, New York 28, N.Y.

Here is an interesting volume for those engaged in vibration studies and vibration measurements. The author discusses the theory involved in vibration phenomena in such a way that it can be readily assimilated by anyone having an ordinary knowledge of mathematics. The results of the computations are presented in most every case in the form of tables or charts. Specific topics covered include: undamped free vibrations; damped free vibrations; forced vibrations; analogies between mechanical and electrical oscillations; resonance curves; propagation of vibrations; and vibration measuring equipment. Most vibrations, the author points out, are detrimental being either unpleasant or actually dangerous. The volume is a written work to study such effects closely and to develop means of vibration elimination.

BOOKS RECEIVED

Tables of Integral Transforms

Compiled and edited by the staff of the Bateman Manuscript Project, California Institute of Technology, under Professor A. Erdelyi. Published 1954 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y. 391 pages. Price $7.50. The first of two volumes of tables of integrals involving higher transcendental functions. This volume contains tables of Fourier transforms (sine, cosine and exponential), of Laplace transforms and inverse Laplace transforms, and of Mellin transforms and inverse Mellin transforms.

Tables of Lagrangian Coefficients for Sexagesimal Interpolation

Prepared by the National Bureau of Standards as part of the NBS Applied Mathematics Series 35. Published by the Government Printing Office, Washington 25, D.C. 157 pages. Price $2.00. The Lagrangian interpolation formula is a fundamental tool in problems of interpolation. Additional flexibility is gained here with tables designed for use in arguments in sexagesimal measure, such as angles given in units of degrees, minutes and seconds.

History of American Industrial Science

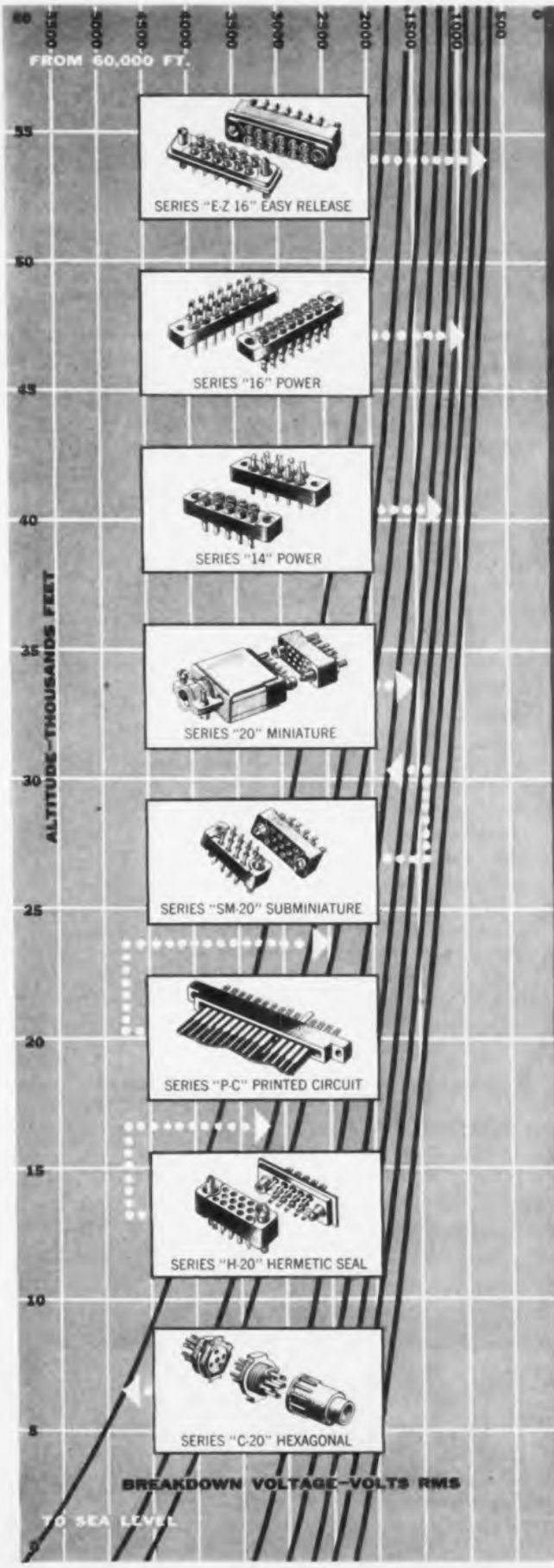
By Courtney Robert Hall Published 1954 by Library Publishers, 8 West 40th Street, New York 18, N.Y. 453 pages. Price $4.95. A study of American "know-how" covering transportation by land, water and air, chemicals, electrical and communications industries, non metallic minerals, rubber and rubber products, etc.

Techniques of Photo Recording from Cathode Ray Tubes

3rd Edition published by Allen B. DuMont Laboratories, Clifton, N.J. 36 pages. A review of the problems encountered in photographing cathode ray tube patterns and of the means for overcoming them.

Evaluation of C-Band (5.5 cm) Airborne Weather Radar

Published 1954 by United Air Lines Inc., Denver, Colo. 108 pages. Results of a four-month evaluation of C-Band weather radar.



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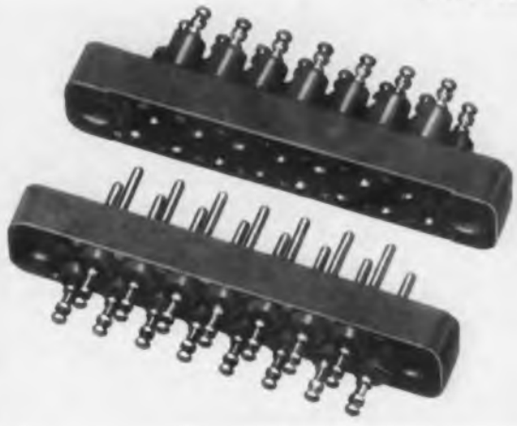


Power Connectors

with turret terminals or solderless taper pin wiring

Heavy-duty types for applications requiring larger current capacities of #14 and #16 AWG wire. Available with 7, 10, 15, 18 or 20 contacts, and insulating material in choice of Melamine, Plaskon-Alkyd, or Diallyl Phthalate. Turrets on the socket and pin contacts permit easy wrap-around wiring. No soldering is necessary with the taper pin wiring type.

Submit your design problem to us, or send for Engineering Data Sheets on your company letterhead. Write or wire to Department TTT5, DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, New York.

Electronic Sales Division **DeJUR**

45-01 Northern Blvd., Long Island City 1, N. Y.

*WORLD'S LARGEST MANUFACTURERS OF MINIATURE PRECISION CONNECTORS

Sprague PULSE TRANSFORMERS for digital computers

Type 10Z pulse transformer at left is color-coded to customer specifications. Unit at right is standard.

As a new line of reliable components for digital computers, Sprague has introduced and is in production on pulse transformers of a new type. This transformer line is principally directed to high speed, low power computer circuits, with some designs also finding application in blocking oscillator circuits, memory ring driving circuits, etc.

Two major types are offered: a miniature transformer, Type 10Z, for 0.05 to 0.5 microsecond pulse circuits, and a larger transformer, Type 20Z, for handling pulses up to 20 microseconds in length. Intermediate sizes and plug-in units are also available for special customer requirements.

Basic data on the high reliability miniature transformer is tabulated at right. Complete details are in Engineering Bulletin M 502. A copy will be sent you on letterhead request to the Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of pulse transformers for computers.

BASIC CHARACTERISTICS OF TYPE 10Z PULSE TRANSFORMERS

Pulse Duration	.05 to 0.5 microseconds.
Applications	flipflop circuits • buffer circuits pulse amplifier circuits • gating circuits • other circuits with pulse lengths up to about 0.5 microseconds.
Physical Description	Hermetically sealed. Housed in corrosion-resistant can with glass-to-metal solder-seal terminals at each end. Can length is ¾" and diameter is ½". Transformers can be mounted and supported by lead wires in most applications.
Ratios Offered	Ratio 1:1 — Cat. No. 10Z3 Ratio 2:1 — Cat. No. 10Z5 Ratio 3:1 — Cat. No. 10Z4 Ratio 4:1 — Cat. No. 10Z2 Ratio 5:1 — Cat. No. 10Z1 Special Ratios Available
Maximum Repetition Rate	For a pulse length of 0.1 microsecond, pulse repetition rates up to 2 megacycles per second can be employed.
Pulse Amplitude	Normally used in circuits whose pulse amplitude varies up to 60 volts.
D-C Rating	Maximum working voltage, 300VDC. Flash tested between windings at 600VDC. May be life tested at 450 VDC between windings, 85°C, for 250 hours.
Temperature	May be operated between −55°C and +85°C. Higher temperature units available on request.
Insulation Resistance	20,000 ohms minimum between windings, measured at 25°C and 180 Volts DC.

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE

Export For The Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

TELE-TECH
& Electronic Industries

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

A NEW LOOK IN PLANT SITES

The recent announcements revealing the startling effectiveness of the hydrogen bomb necessitates a review of the position of the electronic industries in the event of a sneak attack or all-out war. Our Pearl Harbor experience alerts us to the fact that we will have no hindsight on electronic plant sites. A thermo-nuclear bomb delivered from a plane or lobbed from a submarine on one of the coastal cities would show how woefully inadequate is the dispersion of our electronic manufacturing facilities.

This concentration in large metropolitan areas makes our nation extremely vulnerable. Reports indicate that about 50% of our overall industrial capacity is concentrated in 25 metropolitan areas. However, the electronic industries, key to the entire defense structure, is overwhelmingly centralized in only five areas! This is based on a study by the editors of *Tele-Tech & Electronic Industries* of the 4000 companies in the electronic field. (See map below.) It shows that 80% of all electronic facilities are crammed into the densely populated metropolitan areas of New York, Chicago, Baltimore, Los Angeles and San Francisco. This does not necessarily apply to the dollar value of contracts. The concentration is truer when it concerns the executive and engineering brains behind the electronic defense effort.

There are many incidental advantages which accrue from decentralization. From management's point of view, moving to communities with very little industry promises lower land and labor costs, lower taxes and lower insurance rates. Many regions anxious to attract industry are offering concessions such as factory sites, free recruiting of personnel, subsidized installation of utilities and transportation facilities, and many other benefits.

From the viewpoint of labor and management, getting away from soot-filled air, traffic snarls and slum housing, so prevalent in large cities, is nothing short of a blessing.

But most important, to survive in this atomic-electronic age fraught with the peril of instantaneous mass destruction, dispersal is a must.

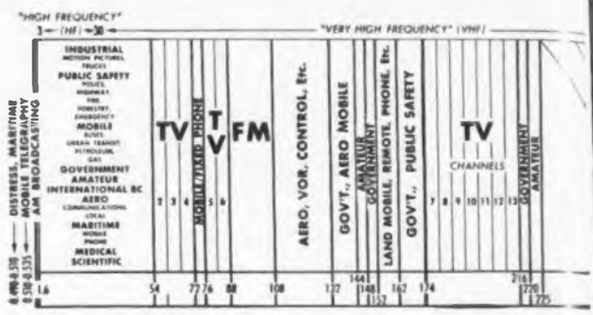
Because preparedness is the best deterrent to aggression, now is the time for government officials, associations and manufacturers to plan decentralization in a methodical and deliberate manner which will include the allocation of contracts on the basis of dispersion. A duplication or "twinning" of contracts should be an essential part of government purchasing, and secret projects should continue to have priority over our own consumer goods planning.

80% OF U.S. ELECTRONIC MANUFACTURERS IN FIVE H-TARGET AREAS

Densely populated city areas in which electronic industries are concentrated. Solid dot represents 50-mile diameter susceptible to direct H-bomb destruction. Outer circle shows 100-mile diameter subject to radioactivity

RADARSCOPE

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



BUSINESS FAILURES among electronic manufacturers during 1953 was second highest figure for 1946-1953 period. Some 26 firms ceased operations with over $12 million total debts. Highest year was 1947, with 39 companies in the red for $16 million. Smallest number, 13, occurred in 1946 and 1951.

COAXIAL CABLE such as RG-59/U is giving color TV engineers a bad time, producing large phase shift variations with temperature and frequency changes. Strangely, effectiveness of cable suffers below 100 kc. Look for a big development coming up regarding cable and color.

RADIO CONTROLLED airport lights operated by the pilot are being tested for future use in fields which are unattended at night. Approaching pilot presses mike switch a predetermined number of times, and receiver at airport automatically turns lights on. Lights are extinguished by similar action after take-off.

TO THE READERS OF TELE-TECH & Electronic Industries

With this issue of TELE-TECH & ELECTRONIC INDUSTRIES, I am assuming the role of Editorial Consultant to all Caldwell-Clements publications. I am now completing my 46th year in electronic and electrical business paper publishing and since it is my desire to take things a bit easier, I am turning over my responsibilities to Maurice Clements, my associate of 32 years.

In its growth to leading rank in electronic-radio-TV publishing, the company has developed many capable younger executives in the editorial, financial and business departments. Especially do I take pride in the editorial leadership and thoroughness of such strong editorial associates as J. L. Stoutenburgh, B. F. Osbahr, A. J. Forman, S. Heller and S. C. Silver, thus assuring our readers that the company's publications will continue in capable hands.

I wish the company every continued prosperity in the years ahead and, as Editorial Consultant to the company for the next seven years, I will always be ready to help with any problems.

O H Caldwell

O. H. Caldwell

ULTRASONICS is expected to become one of the most vital tools in the hands of medical men. Experiments have indicated successful results in treating cancer and mental disturbances. Similar treatment of other grave diseases are also being investigated.

SURGERY is continuing to benefit from electronically-controlled mechanical devices such as the man-made heart-lung combination. The instrument saved one patient's life during a delicate heart operation by doing the work of a human heart and maintaining constant temperature and balancing the flow of oxygen and carbon dioxide.

COMMUNICATIONS equipment will make extremely efficient use of channel space in the coming years, carrying voice messages within bands only a few hundred cycles wide. System will be based on statistical sampling of sounds which are then coded and compressed.

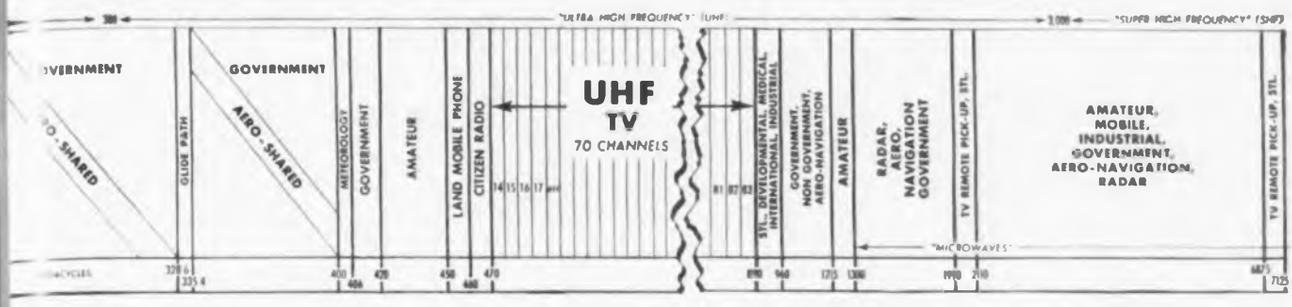
COLOR X-RAY could be a boon to the study of mechanical parts as well as humans because they show up much more detail than standard black-and-white. Operation requires three ordinary X-ray pictures, each taken at a different wavelength. Material's absorption characteristics will make each slightly different. They are then combined by projection through colored filters.

3-D RADAR pictures similar to stereoscopic movies may eventually be combined with color radar, which actuates different phosphors depending on type of reflection.

COMPASSES totally independent of the earth's magnetic field are vitally needed, particularly by the Air Force people mapping out military operations in the Polar regions.

PRIMARY FREQUENCY STANDARD with at least the accuracy of that used at the National Bureau of Standards will be coming out of the laboratory soon. Production model should sell for about $30,000.

SPECIAL HIGH-Q circuits being investigated show Q's as high as 800,000.



RECORDING COLOR TV pictures on black-and-white film is being seriously evaluated in several quarters, but evidence of actual developmental work on a system is lacking. Biggest drawback is the fact that three images are needed instead of one.

PRINTED CIRCUITS are gaining increasing acceptance among test equipment manufacturers.

ATOMIC POWER will not be able to compete with present fuels for a long time to come. Reason is that only 3% of the total cost of electric power generation in the past 50 years has gone for fuel expense.

MAGNETIC TAPE developments on the horizon are: Tapes which clean heads as they play, non-thermosetting splicing tape, and non-erasable prerecorded tapes.

MANAGEMENT

INDUSTRY-WIDE PROBLEMS such as advertising ethics and standard nomenclature (hi-fi and printed circuits, for example) are continuing to exert pressure. Growing inclination in influential quarters parallels editorial in March 1954 TELE-TECH & ELECTRONIC INDUSTRIES, which pointed out why we need a permanent committee for self-policing and all-industry guidance, particularly concerning problems not within the present scope of activities of RETMA and IRE. Heartening indication is the news that the Joint Technical Advisory Committee set up by RETMA and IRE is now grappling with the difficult problem of how to deal with the electronic industry's problems.

ENGINEERING PERSONNEL

SOVIET SCIENCE is making every effort to train a huge pool of technical personnel. In 1953, 43,000 engineers graduated in the USSR, compared to 24,000 in the U. S. This despite the fact that our college enrollment (based on 1951 statistics) is 2,116,000; the Soviet's is 916,000. Our slim margin of engineers and scientists in the labor force, 743,000 to USSR's 550,000 highlights the need for encouraging more young people to enter the scientific field.

INDUSTRY

DECENTRALIZATION of industrial plants has been far from adequate. Over 70% of our industrial capacity is located in 50 large metropolitan areas. As was so forthrightly stated in a recent *York Report*, "We've goofed. Despite all that Democratic and Republic administrations have done, despite the investments and sacrifices of many industrial statesmen, U. S. industrial plants are like sitting ducks." Dispersion is one of the primary defenses against the Holocaust-Bomb.

Watch for the 1954
ELECTRONIC INDUSTRIES DIRECTORY

to be published in the June issue of TELE-TECH & ELECTRONIC INDUSTRIES . . . . the most complete listing of products, manufacturers, trade names, distributors, reps, consultants and engineering societies.

BIOLOGICAL INVESTIGATION

An electronic technique capable of measuring the microscopic constituents of living cells has been developed by Carl Berkley of Allen B. DuMont Labs. and Dr. C. N. Loeser of Western Reserve Univ. It holds potential for detecting cancer and other diseases. The system notes the comparative absorption of dyes by normal and abnormal cells. Tissues are specially illuminated, magnified by a microscope, picked up by the TV camera, and transferred to an oscillograph. Differences in the light pattern appearing on the picture tube indicate abnormal conditions. It is an advance over known scanning techniques in that living tissues and chemical changes in the body can be studied

Aircraft-Electronic Progress

Radar, computer, communications and navigational control systems are among the many new electronic developments resulting from the joint program of the Air Research and Development Command and private firms

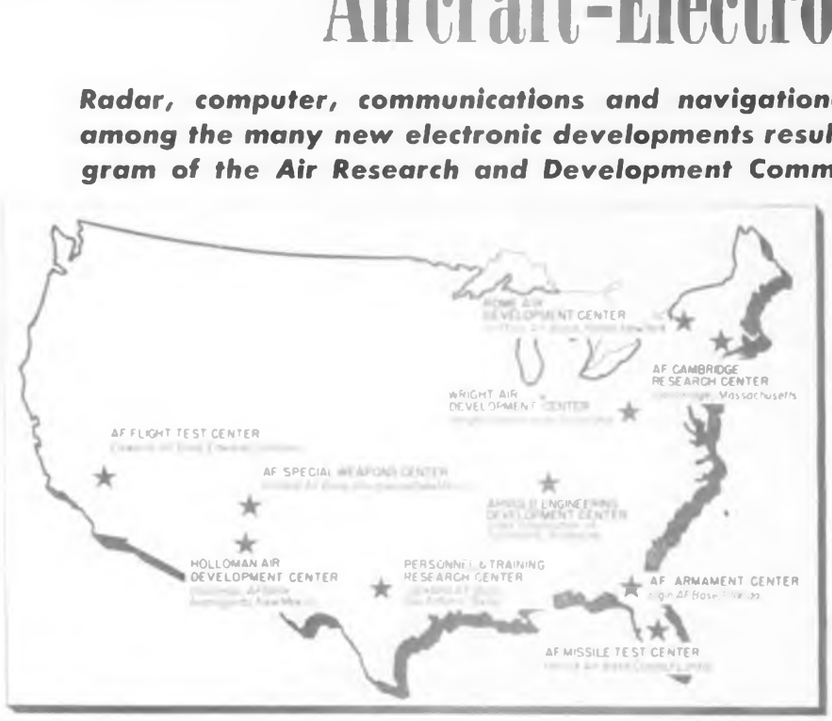


Fig. 1: Ten major testing and research centers of the Air Research & Development Command

By ALBERT J. FORMAN,
Associate Editor, TELE-TECH & ELECTRONIC INDUSTRIES

THE Air Research and Development Command (ARDC), established by the Air Force on April 2, 1951, is responsible for a notable number of scientific developments evolved during 1953-1954. An important part of its work is the planning and direction of a coordinated military and civilian program.

Lt. General Donald L. Putt, ARDC Commander, reports that 86% of the ARDC's funds in 1953 were spent for work by non-Air Force agencies, including approximately 160 colleges and non-profit organizations, and 1520 industrial companies. Also, extensive research and testing has been done at the ten major ARDC installations located throughout the country. See Fig. 1.

One of the most important phases of development work is centered about electronic equipment. Presented below is a complete round-up of ARDC aircraft-electronic developments for 1953-1954. Other advances, as well as certain phases of those to be described, lie within the realm of security restrictions.

The increasing use of jet planes and high density of return-to-base traffic demands an automatic device to control air traffic—a device which can handle 120 aircraft per hour instead of the usual 40 for manual systems. An automatic computation and control system called "Volscan" accomplishes this, directing aircraft to the final approach path at the instant the landing system is ready.

When used in conjunction with a radar system (Fig. 2), Volscan operates as follows: At the control console, a light gun is pointed at the PPI blip corresponding to a particular aircraft (see front cover), which isolates the target and assigns a track-while-scanning channel, called Antrac, to the plane. Antrac functions as an automatic plotter, continuously reporting the craft's position to Volscan's computer, called Datac (Fig. 3). Acting as an automatic controller, Datac selects a scheduled arrival time and calculates necessary heading and altitude orders, which are relayed to the aircraft by voice or data link for zero reader display or autopilot injection. The plane's response to control orders is reported by the radar, thus completing a closed loop. Volscan covers a 60-mile radius, costs about $100,000 per base, and may be integrated with almost any GCA, ILS or other landing control system.

Radar Stations

On the ground, the first experimental units of a line of Arctic radar stations, known as the "Distant Early Warning Line," were es-

Fig. 2: (l) Radar truck and antenna may be used with Volscan. Fig. 3: (r) Datac computer acts as Volscan automatic controller, selects scheduled arrival time, and calculates heading and altitude orders which are relayed to plane

1953-1954

tablished. Installation work is being done by Western Electric. In the air, a reconnaissance version of the Lockheed Super-Constellation (Fig. 4), the RC-121C, was developed. This flying radar station provides for extra-early warning in the event of airborne attack. Also, a free space radome testing facility was developed for measuring differential phase delays through radomes.

A step toward completely automatic flight was made. The automatic sequence selector (Fig. 5) evolved by Minneapolis-Honeywell is designed to tape-record preselected flight plans and feed them to an aircraft's controls. The selector takes over many duties of the pilot by memorizing flight plans on punched tape and converting them into control directions.

In addition to guided missiles, several planes remotely controlled

Fig. 5: Punched tape automatic sequence selector feeds flight plan data to controls

Fig. 6: Beep pilots in control plane ready radio-controlled drone (rear) for take-off

Fig. 4: Flying radar station with bulging radomes is part of extra-early warning system

by radio were tested. The QF-80 drone (Fig. 6) was used to penetrate radioactive clouds in nuclear tests at Nevada Proving Grounds. The Q-2 drone for air-to-air gunnery training was publicly demonstrated. Robot systems controlled by beep pilots on the ground and in the air were developed.

Data Link

A new data link system requires only an adapter to existing communications systems to present guidance and navigation information on cockpit instruments or transmit it directly to the plane's automatic pilot. The instructions do not interfere with normal voice communications.

COZI

A communications zone indicator (COZI) developed by ARDC and Raytheon determines the best frequency to use for radio communications under prevailing atmospheric conditions. COZI sends out a radar beam which follows the same path as the radio waves, and then returns to show whether a given frequency is being reflected at the proper skip distance. It also indicates enemy jamming.

Speech Compression

A compression system converts speech into coded pulses so that it can be transmitted over 100-CPS bandwidth instead of the customary 3000-CPS. This improves channel utilization of the spectrum.

GCA Turntable

Added capability is given ground control approach (GCA) by a large turntable (Fig. 7) on which a single GCA radar can be rotated to cover bad weather landing approaches from either runway direction. The turntable eliminates the need to move and realign the GCA set in mobile trailers in the event of a sudden change in wind direction. In permanent GCA installations, more hazardous downwind landings can be avoided.

Electron Tubes

Considerable progress is noted in the broad program for improving electron tubes. A liquid-cooled miniaturized tetrode transmitting tube, using ceramics instead of glass, has a 100-watt dissipation rating, is very rugged, and is one-fourth the size of its air-cooled counterpart.

A new approach to electron tube specifications has resulted in the consolidation of Air Force, Navy and Army requirements into a single set of "Military Controlled Specifications for Electron Tubes." This should result in higher quality, more rapid standardization, and more efficient procurement.

Subminiature voltage amplifier tubes with small heater power of only 0.5 watt instead of the normal 2 watts have been developed by National Union and ARDC. The reduced heater power is intended to eliminate bulky blowers and heat exchangers.

Progress was made in the development of a complete line of high-

(*Continued on page* 144)

Fig. 7: Turntable for GCA radar eliminates need to move and realign mobile trailers

Preview of NARTB Conference

Master control installation at TV network originating station

THE Eighth Annual Broadcast Engineering Conference of the National Association of Radio and Television Broadcasters will be held May 25-27, 1954, at the Palmer House, Chicago, Ill. The technical paper program planned for this meeting is as follows:

May 25, 1954

Presiding Officer: Raymond F. Guy, NBC. Opening, A. Prose Walker, NARTB.

"The Story Behind The NTSC Color Standards," Donald G. Fink, Philco.

"Equipment Operating Characteristics For Color Television," Charles E. Page and Knox McIlwain, Hazeltine.

"Preparing The Television Transmitter For Network Color Television," Robert M. Morris, ABC.

Presiding Officer: James D. Russell, KKTV.

"Seeing Light And Color," Ralph Evans, Eastman Kodak.

"Economy In Radio And Television Operations Through Organization And Management," Willard J. Purcell, GE.

"Results Of Experience To Date In Color Television Operations," Robert E. Shelby, NBC.

"Special Television Effects," Paul F. Wittlig, CBS.

May 26, 1954

Presiding Officer: Dr. William L. Everitt, Univ. Ill.

"Basic Components Of Color Television For Local Originations," William J. Morlock and C. Graydon Lloyd, GE, and Roland E. Connor, Eastman Kodak.

"Simultaneous Color Cameras And Tubes," John H. Roe, RCA.

"Color Television Test Equipment," John W. Wentworth, RCA.

"Routine Test And Alignment Procedures For Amplifiers And Circuits Used For Color Television," Howard C. Gronberg, NBC.

Presiding Officer: William B. Lodge, CBS.

"Color Encoders," Robert Deichert and Robert Casey, DuMont Labs.

"Color Television Motion Picture Film Reproduction," Keith E. Mullenger, NBC.

"Lighting, Makeup, Costumes And Sets For Color Television," Reid R. Davis, NBC.

"CBS Color Television Staging And Lighting Practices," Richard S. O'Brien, CBS.

"Save A Seat For The Engineer," Harold E. Fellows, NARTB.

May 27, 1954

Presiding Officer: Earl M. Johnson, MBS.

"Automatic Editing And Sequencing Of Magnetic Tape," Edgar F. Vandivere, Jr., Vandivere, Cohen and Wearn.

"Remote Control Of Transmitters," William F. Rust, Jr., Rust Industrial.

"FM Broadcast Multiplexing," William S. Halstead, Multiplex Development.

"Allocation Philosophy," Curtis B. Plummer, FCC.

Harold E. Fellows
President & Chairman of the Board, National Association of Radio & Television Broadcasters

Presiding Officer. William J. McDonell, FCC.

"Image Orthicon Optimum Performance," Robert G. Neuhauser, RCA.

"Television Preventive Maintenance Unique To The Television Transmitting System," Philip G. Caldwell, ABC.

"Video Switching," Ben Adler and Louis Katz, Adler Communications.

"The DuMont Telecenter," 1. Video Patching System—Rodney D. Chipp 2. Video Switcher And Effects Amplifier—Robert I. Brown 3. Audio Console Design—Robert F. Bigwood (DuMont TV Net)

"Technique Of Television Station Coverage Measurement," James C. McNary, Consulting Engineer.

EXHIBITORS

Equipment manufacturers presenting displays at 1954 NARTB Conference

Adler Communications Labs.
Altec Lansing Corp.
American Tel. & Tel. Long Lines Dept.
Ampex Electric Corp.
Andrew Corp.
A-V Tape Libraries, Inc.
Blaw-Knox Equipment Div.
Caterpillar Tractor Co.
Century Lighting, Inc.
Collins Radio Co.
Continental Electronics Mfg. Co.
Dage Electronics Corp.
Allen B. Du Mont Labs., Inc.
Electro-Voice, Inc.
Federal Telecommunication Labs.
Federal Telephone & Radio Corp.
The Gabriel Co.
Gates Radio Co.
General Communications Co.
General Electric Co.
General Precision Labs., Inc.
Gray Research & Development Co.
Graybar Electric Co.
The Houston Fearless Corp.
Hughey & Phillips, Inc.
IDECO Towers
International Business Machines Corp.
Kalbfell Labs., Inc.
Kleigl Bros.
Machlett Laboratories, Inc.
Musicolor, Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.
Presto Recording Corp.
Prodelin, Inc.
Radio Corp. of America
Raytheon Manufacturing Co.
The Rust Industrial Co.
Paul Schafer Custom Engineering
Standard Electronics Corp.
Teleprompter Corp.
Television Zoomar Corp.
Tel-Instrument Company
Tower Construction Co.
Willys Motors, Inc.

Preview of

Airborne Electronic Conference

The Sixth Annual National Conference on Airborne Electronics will be held May 10-12, 1954, at the Dayton-Biltmore Hotel, Dayton, Ohio. It is sponsored by the Dayton Section of IRE, and the Professional Group on Aeronautical & Navigational Electronics. There will be 60 exhibits on display. Some 80 technical papers will be presented.

The following is the program of technical papers:

Parasite F-84F about to make contact with retrieving mechanism of RB-36F carrier plane

May 10, 1954

TRANSISTOR SESSION I (POWER)

Moderator: P. H. Miller, Univ. of Penn.

"Recent Advancements on Surface Barrier Transistors," W. H. Forster, Philco.
"Power Transistors," E. G. Roka, Minneapolis-Honeywell.
"Power Transistors for Lightweight Equipment," J. S. Saby, GE.
"Characteristics and Some Applications of 2 Watt Power Transistors," M. A. Clark, Bell Labs.

ANTENNAS SESSION I

Moderator: J. V. N. Granger, Stanford Research.

"Antenna Pattern Recorder," L. Lechtreck, Emerson.
"A Flush-Mounted Omnidirectional Beacon Antenna for Horizontal Polarization," T. Kinaga, Hughes.
"A Square Diffraction Antenna for UHF," E. T. Wierman, Hughes.
"Test Gear for Elliptically Polarized Antennas," C. W. Bradford, Dalmo Victor.
"The Performance of a Folded-Dipole Type Wing Antenna in the 2 to 9 MC Frequency Range," R. L. Hensell, H. M. Ikerd, USN.
"Cavity Mounted Helical Antennas for Airborne Applications," A. Bystrom Jr., D. G. Berntsen, J. D. Kelley, Boeing.

Robert J. Doran, President,
National Conference on Airborne Electronics

MANAGEMENT SESSION I

Moderator: Tom C. Rives, GE.

"Required Capabilities for the Military Aircraft Systems Engineer," L. B. Hallman Jr., USAF.
"The Role of Engineering Literature," J. W. Wight, McGraw Hill.
"Role of Research and Development in Aviation Electronics," H. R. Oldfield, Jr., GE.
"The Program on Reliability of Electronic Equipment," L. M. Clement, RETMA-Avco.

ELECTRONIC COMPONENTS SESSION I

Moderator: F. E. Wenger, WADC-USAF.

"Precision Wire-Bound Resistors," C. H. Fritz, Shallcross.
"Electrical Wire Design Study and Standardization," A. L. Malo, C. J. Woodka, USAF.
"Electric Contacts in Electronic Relay Applications," S. T. East, USAF.
"Some Notes on a Resolver Induction Potentiometer," L. E. Wolaver, USAF.
"Printed Resistors in Electronic Equipment Miniaturization," O. C. Jahnke, Emerson.

TRANSISTOR SESSION II

Moderator: J. Bardeen, Univ. of Ill.

"Relay Properties of the Double-Base Diode, Semi-Conductor," J. J. Suran, GE.
"Application of Transistors to Airborne Communications," D. E. Shumaker, A. A. Paris, RCA.
"The Raytheon CK 721—A Year's Experience," F. M. Dukat, Raytheon.
"Transistor Noise Measurements," H. F. Stark, Raytheon.
"Some Recent Developments in Silicon and Germanium Materials and Devices," G. K. Teal, Texas Instruments.
"Transistor Circuit Components," C. Doyle, USAF.

ANTENNAS SESSION II and RADOMES

Moderator: L. C. Van Atta, Hughes.

"A Theoretical Study of Reflection of Radio Waves from Buildings and of the Effects of Reflected Signals on ILS and VOR," A. Alford, G. J. Adams, F. E. Parisi, Andrew Alford, Consultants.
"Wide Angle Scanning with Double Layer Pillboxes," W. Rotman, USAF.
"Constant-Phase Retardation in Radomes," E. J. Luoma, USAF.
"Estimation of Aircraft Radar Cross-Section with Specular Models," E. B. Cole Jr., Glenn L. Martin.
"Microwave Measurement of Anistropic Radome Materials," J. Vaccaro, USAF.

MANAGEMENT SESSION II

Moderator: Archibald Brown, Stanford Research.

"Automatic Production of Electronic Equipment," C. Brunetti, T. R. James, E. R. Van Krevelen, General Mills.
"The Creation of a New Source for Military Electronic Equipment," M. R. Johnson, GE.
"The Objectives of Development and Acceptance Testing," A. A. Brown, Frederick Research.
"Reliability Considerations in Systems Planning," R. F. Mettler, Hughes.
"Improving Equipment Reliability by Analysis of Field Performance," P. G. Fritschel, GE.

ELECTRONIC COMPONENTS SESSION II

Moderator: Joe Kaufman, NBS.

"A Subminiature I.F. Amplifier Using Etched Wiring Techniques," B. Raboy, J. R. Endicott, Glenn L. Martin.
"Design of a Gain Stabilized I.F. Transformer for Wide Temperature Range," J. F. Clemens, Avco.
"Design of Prediction Filters," J. T. Fleck, Cornell Aero. Lab.
"UHF-MHF Isolation Filter," W. L. Hamilton, Boeing.
"The Design of a Flat Strip or Printed Circuit Microwave Low-Pass Filter," H. C. Hyams, Melpar.
"Reliable Power Transformers for High Temperature Environments," G. Tarrants, USAF.
"Taper Pin Electrical Connector Techniques," W. Watts, Aircraft-Marine Products.

May 11, 1954

FERRO-MAGNETICS SESSION

Moderator: C. L. Hogan, Harvard Univ.

"The Determination of Ferromagnetic Properties of Materials from Hysteresis Measurements," J. R. Horsch, GE.
"Ferrites in Microwave Applications," J. H. Rowen, Bell Labs.
"Properties of Ferrites for Microwave Applications," H. C. Rothenberg, GE.
"A High Power Ferrite Isolator for X-Band Radar," E. Strumwasser, C. W. Curtiss, Hughes.

HUMAN ENGINEERING SESSION

Moderator: J. M. Christensen, WADC-USAF.

"Some Aspects of Aircraft Navigation Display Using Ground Track Information," T. L. Senecal, USAF.
"The Tactical Sensory Guidance System for Psychological Studies of Aircraft Attitude Control," R. W. Hessinger, J. W. Ballard, Commonwealth Engineering.
"A Comparison of the Visual and Auditory Senses as Channels for Data Presentation," R. H. Henneman, E. R. Long, Univ. of Va.
"Human Engineering in Aviation Electronics," J. R. Hafstrom, GE.

(*Continued on page* 120)

Guided Missile

A review of the design considerations that must be met by units maintaining the "umbilical" connection up to the moment of take off

By LESLIE BAIRD and HARLAN UPSTON
Cannon Electric Co., 3209 Humboldt Street, Los Angeles 31, Calif.

Fig. 1: Type GME ball and detent type latch, hand-wheel actuated engagement, manual lanyard release. One of seven variations of general GME type having 39, 41, 44 and 56 contacts ranging from No. 16 to No. 2

THE era of the guided missile and pilotless aircraft has created for the electronic industry, as for the many other industries associated with the missile development program, new problems of design and manufacture. Not the least of these problems is the one arising from the necessity for establishing and maintaining a direct wire communication between the missile and the master control point. This direct connection, or "umbilical circuitry," as it is also called, is usually required for set-up and check-out during the last stages of preparation immediately preceding launching. Since in most cases it is necessary to maintain the "umbilical" connection right up to the instant of launching, it is required that the cable used be terminated at the missile with a disconnect device capable of ejection either by motion of the missile itself, or by remote control from the master control station.

With the exception of the "rapid disconnect," "quick release" or "breakaway" connector, most of the electrical disconnect devices used in missile interior construction are similar or identical to those used in conventional airframe, radio, radar, and general instrumentation applications. These include the wide range of AN (Air-Force Navy) standard and special-purpose connectors, types DPB, DPD, K, RK (the latter original aircraft series which predates the "AN" designed line) and a variety of smaller or sub-miniature types, including the relatively recent hermetic sealed types.

In the connector field, the breakaway type connector is one of the most interesting electronic aids to come out of the missile program. Prior to launching, it is the life line of the missile, through which preflight control impulses must pass. The configuration and functional characteristics of the breakaway connector are controlled to a large extent by the application; but, generally speaking, the several types now in use may be categorized into two main groups:

Group (A) covers those connectors in which a mechanical hold, or interlock, is used between the cord plug and its mating receptacle to hold the two halves of the connector in the engaged position (See Fig. 1).

Group (B) takes in those connectors which are held in engagement by extraneous mechanical means. Basically, this type is not as flexible as Group (A). For satisfactory operation, it demands close control of the position of the missile in relation to the launching device. In many installations this factor is not objectionable, and in some it is de-

Fig. 3: Illustrating the four distinct phases of breakaway connectors incorporating ball and detent interlock

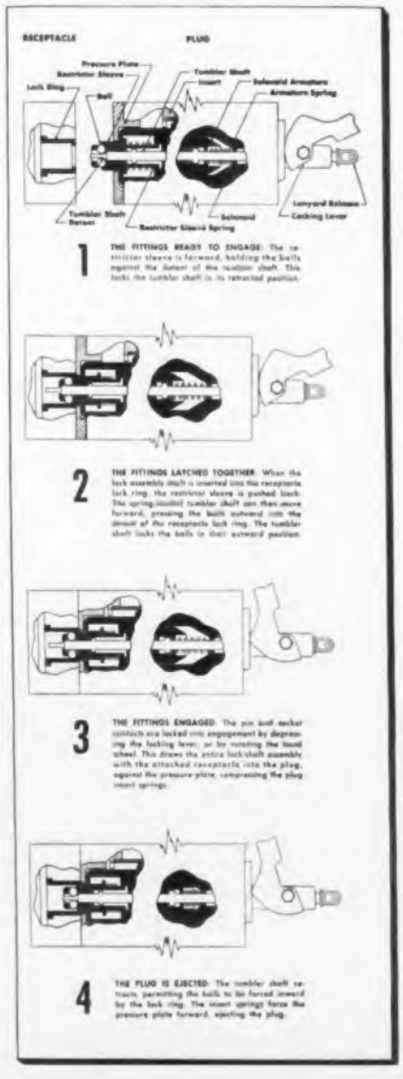


Fig. 2: Closeup view of a type GMJ guided missile connector for platform launching, manual or fallaway ejection

Launching Connectors

sirable (See Fig. 4).

In turn, Groups (A) and (B) may be broken down into sub-groups, as determined by such factors as (1) the type of contacts used, or (2) the means ejection or disengagement is accomplished.

Of the many types of interlock devices known to the designer, the ball-and-detent type has been found to possess probably the greatest number of desirable attributes (See Fig. 4). It is a flexible design, adapted to any desirable release method (such as mechanical, electrical, or electro-mechanical), and is suitable for use in combination with either cam-actuated or screw-type engaging means. One of the outstanding advantages of the ball and detent mechanism is its ability to withdraw, turtle fashion, into the plug body at the moment of ejection, thus eliminating any projections which might catch in the receptacle and thereby cause damage to the missile or control cable.

The operating cycle of all breakaway connectors incorporating the ball and detent interlock divides characteristically into four distinct phases (See Fig. 3):

(1) The detent portion of the interlock mechanism is adjusted to the position of maximum projection from the plug face;

(2) The plug is placed against the receptacle, and the detent mechanism is locked into the receptacle;

(3) By actuating either the handwheel or cam type engaging mechanism, the contacts in the plug portion are brought into engagement with the contacts of the receptacle. The connector is now operable and remains in this phase until time for ejection; and

(4) When it is desired to eject the plug from the receptacle, the tumbler shaft in the detent mechanism is retracted either by means of mechanical linkage or by energizing the solenoid-type actuating mechanism built into many of these plugs. The retraction of the tumbler shaft releases the interlock, and because the plug is under spring tension when engaged to the receptacle, it springs clear and the cycle is completed.

Motion Actuated Devices

In many installations it is not considered desirable to use the interlock to hold the plug and receptacle in engagement; instead, it is better to pre-position the plug and receptacle in relation to one another, and to depend on the relative motion of missile vs. launcher to perform the disengaging function, for which the "skid" and "swing-away" connectors have been developed.

The "skid" type (Figs. 2 and 6) is based on the action of skids or runners working on an inclined ramp. In most installations the plug portion is rigidly attached to the launcher frame, and the receptacle is mounted at the skin level of the missile itself. The normal operating cycle of this type consists of only two phases: (1) the missile is mounted in the launcher, which automatically brings the connectors into engagement; and (2) as the missile moves forward out of the launcher, the skids in the plug portion ride up on the inclined plane in the receptacle, which, through mechanical linkage, retracts the plug contacts. The contacts disengage and rise clear of the receptacle face to prevent accidental shorting.

The "swing-away" installation is similar to the type described except that the plug connector is suspended in a pendulum-type mount. This design allows the plug to be positioned in engagement with the receptacle by the utilization of short positioning pins between plug and receptacle, and spring loading of the pendulum arms to maintain engaging pressure. As the missile moves forward, the plug support allows the plug to move with it until

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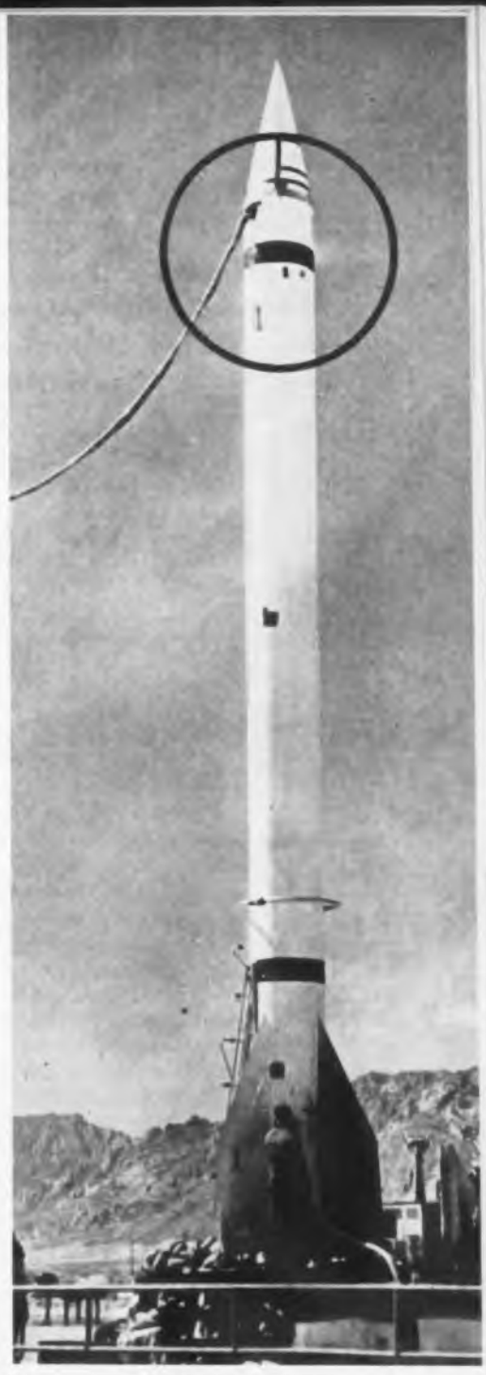

Fig. 5: Breakaway type rocket connector shown (in circle) on missile of Glenn L. Martin Co.

Fig. 4: Forty-four contact connector with ball and detent type latch, hand wheel actuated engagement, remote solenoid disconnect and lanyard release safety device, angle 45° end bell

Low-Distortion FM Demodulator

Demodulating device for testing transmitter performance measures deviations up to 1 mc over wide range of audio frequencies. It provides continuous monitoring for TV and FM stations

By DR. J. J. HUPERT, S. TORODE and A. M. RESLOCK,
A. R. F. Products, Inc.,
7627 Lake St., River Forest, Ill.

Fig. 1: FM demodulator and deviation meter

QUALITY requirements for FM communication sets and instruments are steadily becoming more stringent. Thus a signal generator used to test high quality receivers should maintain all features of performance required from the receiver to at least one order of magnitude higher degree of perfection. Conversely this is true of a demodulating device used for testing transmitter performance. See Fig. 1.

If we choose to regard a signal generator as a miniature transmitter and add that the demodulator described is intended for quality tests and development of modern FM signal generators, we realize that standards of performance required from such an instrument would be very high indeed. In actual fact they are limited by the state of the art, which does not unfortunately show any signs of progressing beyond a certain point. Taking, for example, the feature of low nonlinear distortion as an illustration: we consider 1% nonlinear distortion in a receiver as adequately low and as a realizable target, but engineering targets of nonlinear distortion suppression to 0.1% in the signal generator used to test the receivers and to 0.01% in the demodulator used to test signal generators would be very unrealistic. The actually achieved performance data are closer to the figure of 0.5% for the signal generator and 0.3% for the demodulator in the above example.

Following features of performance of the instrument are considered essential:

(a) Low signal sensitivity.
(b) Good AM rejection.
(c) High deviation sensitivity.
(d) High degree of linearity of demodulation at all modulation frequencies.
(e) Low inherent hum and noise of the instrument.

Of these good linearity is the most essential requirement which will be

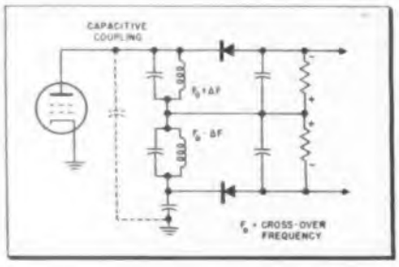

Fig. 2: "Amplitude" type FM discriminator

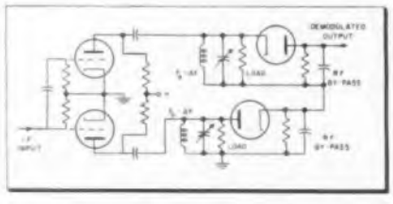

Fig. 3: Twin-driver "amplitude" discriminator

discussed at greater length.

The correct choice of discriminator circuit is the main consideration influencing the design of the instrument. The conventional and frequently used Foster-Seely discriminator circuit was not used because percentage-wise it does not lend itself well for wide bandwidth design, or at least not within the limits comparable with those of the circuit described.

The counter demodulator circuit, which is naturally well suited to demodulate high deviations with high degree of linearity, has the disadvantage of requiring a very short rise time of the square pulse formed in its limiter section, which implies considerable circuit elaboration. If this requirement is not satisfied the dependance of distortion on the frequency of modulation is exhibited. Since in many applications it is quite important to maintain accuracy of calibration and good linearity features at fairly high frequencies of modulation the authors have endeavoured to find a simple circuit capable of even and good performance throughout the range of modulation frequencies of interest. Surprisingly the answer was provided by a very well known circuit, namely the Travis "amplitude-type" discriminator, but with a modification which, although apparently trivial, proves quite essential for practical alignment. In the original circuit, as shown in Fig. 2, there is a certain degree of mutual capacitive coupling between the two tuned circuits, provided by the interelectrode capacity of the tube. For high L/C ratio of the circuits (resulting from the bandwidth and sensitivity requirements) this coupling capacity may result in appreciable undesirable mutual coupling and difficulties of aligning each tuned circuit in succession for the extremely low distortion required. To avoid this effect modification was introduced such that each of the two component tuned circuits is supplied by its own tube (see Fig. 3). In this manner a discriminator circuit is formed, the bandwidth of which can be conveniently adjusted by the adjustment of Q and relative mistuning of component circuits. Fig. 4 shows a simplified circuit diagram of the entire instrument. It is composed of the

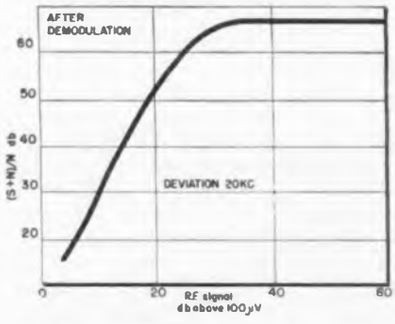

Fig. 5: Signal-plus-noise/noise ratio after demodulation as function of r-f input signal

following principal parts:

(a) *R-F amplifier* and oscillator forming a complete radio frequency tuner, which transposes the radio frequency of the signal to be demodulated to the intermediate frequency value of 8 MC.

and Deviation Meter

(b) *I-F amplifier:* Total gain of this part prior to limiting is approximately 55 db—the bandwidth is very broad and approaches the figure of 2 MC between the 3db points. Numerical check and experimental data indicate that the contribution of the i-f part to non-linear distortion is negligible.

In amplifier tuned circuits, coils are arranged to resonate with inter-electrode capacities of the tubes. High L/C tuned circuits thus formed are heavily damped by means of parallel loading resistors.

(c) *Discriminator:* This part of the instrument is arranged in the form of the above described twin driver amplitude discriminator circuit.

(d) *Monitoring and metering system:* Discriminator output voltage is amplified in a two-stage audio amplifier (total gain approximately 40 db). The amplifier feeds two parallel channels: one for monitoring (aural. monitoring or demodulated voltage for further circuits) and the other leading to the meter rectifier which converts the demodulated voltage into dc for the purpose of deviation measurement.

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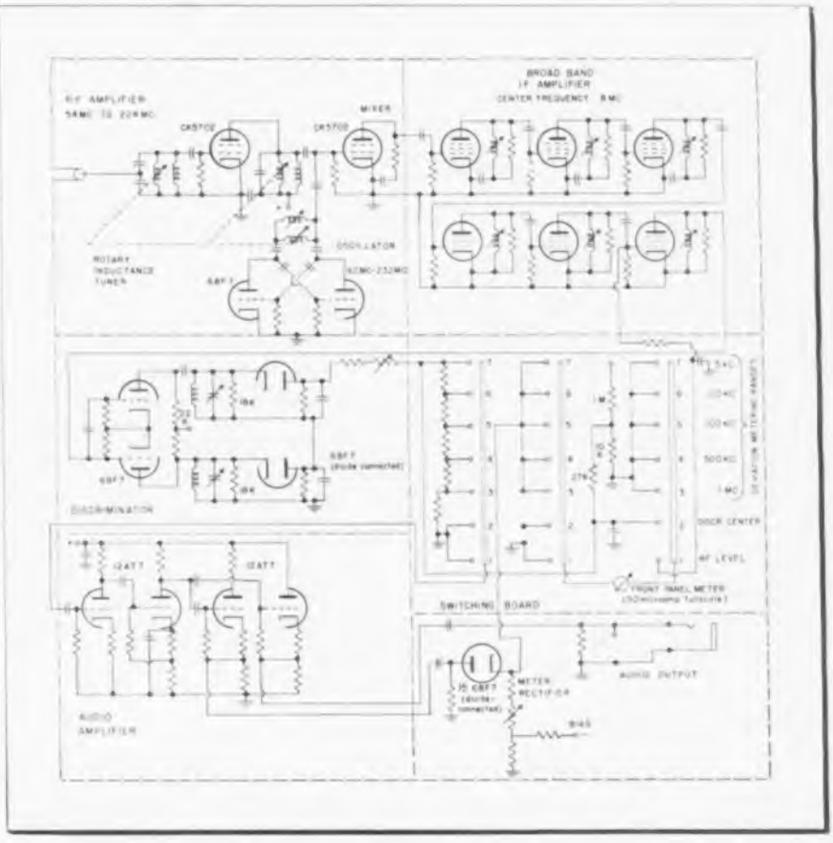

Fig. 8: Circuit diagram of FM demodulator and deviation meter

Selenium Commutator Eliminators

THE development of a rotating selenium rectifier capable of replacing the commutator in dc generating equipment has been announced by the International Rectifier Corp., El Segundo, Cal.

Electrical engineers have long been aware of the many shortcomings inherent in commutator design: sparking, brush maintenance, explosion hazard, the need for turning down the commutator and undercutting of mica at regular intervals; also, particularly, that the weight and price of dc generators has been largely dependent on the degree of commutation desired.

The ideal, then, is a device or system providing the same rectification, yet having relatively frictionless, non-sparking action and, if possible, allowing for simplification and reduction in size of the armature. The rotating selenium rectifier fulfills these requirements.

The design and operation of selenium rectifiers appears, at first glance, to have no common features with the rotating commutator. However, note the following similarities:

The action of the well known full-wave polyphase selenium rectifier is essentially the same as that of a commutator which is connected to a closed ac armature winding rotating in a static magnetic field.

The similarities do not end in the idealized case. It can be shown that the equivalent circuits of the two are closely analogous.

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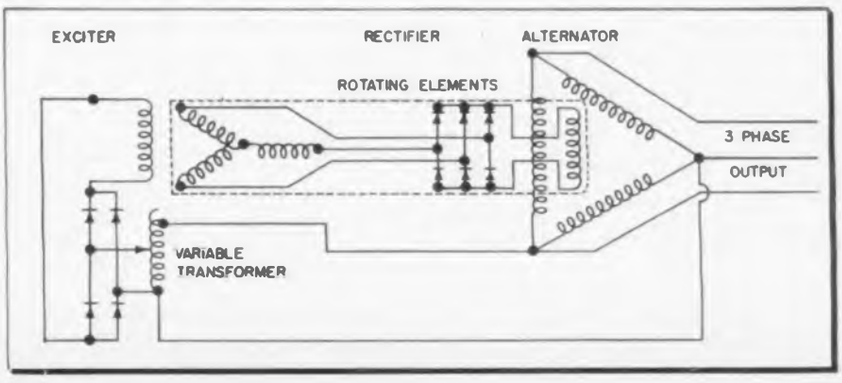
Fig. 1: Circuit for 3-phase bridge rectifier on alternator shaft



Multilayer Distributed Constant

By ***WILLIAM J. CARLEY,***
U.S. Naval Ordnance Lab., White Oak, Silver Springs, Md.

INCREASING application is being made of distributed constant delay lines as circuit elements in present day electronic equipment. The characteristic impedance of these lines has been limited to values between 400 and 3,000 ohms and delay times up to ½ μsec/ft. The author recently reported preliminary investigations on multilayer band wound delay lines with impedances from 5,000 to 10,000 ohms and delay times up to ½ μ sec/in.[1,2,3] This paper reports further work in the design of multilayer lines, and substantiates this design with experimental results in the impedance range of 2,500 to 5,000 ohms.

Fig. 1 is a view of the line, with a section taken along the axis of the solenoid. The line is assumed to be infinite in length and of a multilayer bank-wound construction with capacitance to ground. Z is taken along the axial direction of the winding with its zero value at the nth turn. It is assumed that a mutual inductance exists between two elementary lengths of the wire which is dependent solely on this distance. A stray capacitance also exists between each turn and several of its neighbors. The overall diameter of the wire with its insulation is b and that of the uninsulated wire is a. The number of layers in the bank winding is p. It is assumed that the wire in traveling from a top layer to a bottom layer, does not take up any space and has no reaction with the turns.

To solve the delay line rigorously, the appropriate transmission line

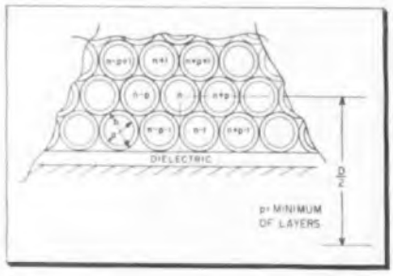


Fig. 1: Cross section of delay line

integral differential equations should be solved. The details become very complicated, but if some simplifying assumptions are made including the requirement that the radial depth of the winding is very small compared with the mean line diameter, the solution to these equations for cissoidal variations of current and voltage are:

$$\frac{j\omega v}{v} = Ri + j\omega iL\,(\omega/v) \qquad (1)$$

and

$$\frac{j\omega i}{v} = Gv + j\omega v\left[C_o + \left(\frac{\omega}{v}\right)^2 \frac{C_t K}{s}\right] \qquad (2)$$

where

$$L\left(\frac{\omega}{v}\right) = \left[2I_1\left(\frac{\pi D}{\lambda}\right) K_1\left(\frac{\pi D}{\lambda}\right)\right] L_o \qquad (3)$$

v=velocity of propogation (meters/sec)

C_o=capacitance from line to ground (farads/meter)

C_t=capacitance between two adjacent turns

K=a constant depending on the number of layers (Fig. 2) (calculated from the geometry)

s=1/b=number of turns/meter/layer

I_1 and K_1 are modified Bessel Functions of the first and second kind[4]

L_o=inductance of the line at low frequencies (henries/meter)

D=mean line diameter

λ=axial wavelength along the line.

v=ac component of voltage

Eqs. (1) and (2) resemble the standard transmission line equations of

$$L = L\,(\omega/v) \qquad (4)$$

$$C = C_o\left[1 + \left(\frac{\omega}{v}\right)^2 \frac{C_t K}{s C_o}\right] \qquad (5)$$

If the line is now assumed to be lossless, the well known solution of the transmission line equations of interest are:
time delay (per unit length) =

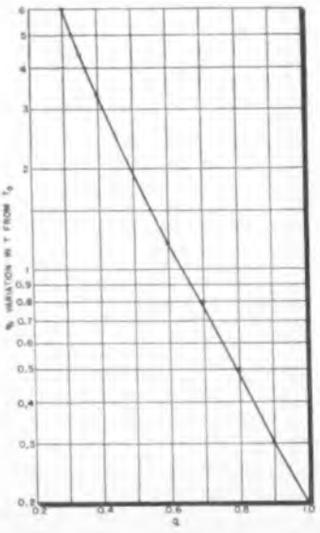


Fig. 3: (below) Plot of T/T_o vs. $\pi D/\lambda$ for various values of q

Fig. 4: (left) Plot of % variation in T vs. q

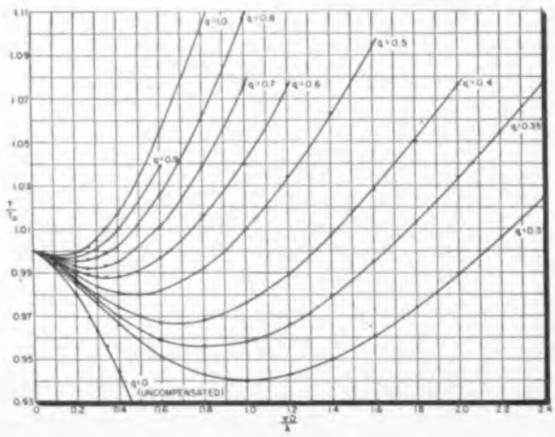
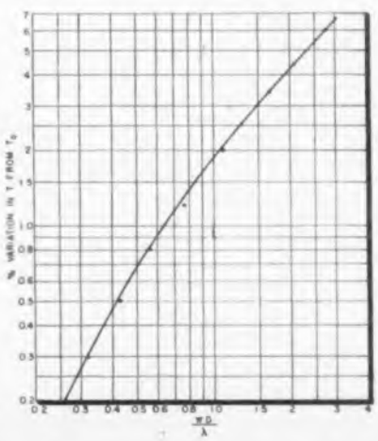


Fig. 5: (below) % variation in T vs. $\pi D/\lambda$



Delay Lines

New development in self-compensated delay line technique provides time delays up to 1/2 μsec/in, by utilizing bank wound construction. Thorough analysis of time problem includes specific design information

Fig. 7: End portion of bank wound delay line

$$T = \sqrt{LC} \quad \text{(sec/meter)} \qquad (6)$$

phase shift =

$$\beta = \omega\sqrt{LC} \quad \text{(rad/meter)} \qquad (7)$$

characteristic impedance =

$$Z_o = \sqrt{L/C} \ \text{(ohms)} \qquad (8)$$

Inserting Eqs. (4) and (5) in Eq. (6) we obtain

$$\left(\frac{T}{T_o}\right)^2 = 2I_1\left(\frac{\pi D}{\lambda}\right) K_1\left(\frac{\pi D}{\lambda}\right) \times \left[1 + \left(\frac{\omega}{v}\right)^2 \frac{C_t K}{C_o s}\right] \qquad (9)$$

where $T_o = \sqrt{L_o C_o}$, is the low frequency time delay. Substituting in Eq. (9) for ω/v we obtain

$$\left(\frac{T}{T_o}\right)^2 = 2I_1\left(\frac{\pi D}{\lambda}\right) K_1\left(\frac{\pi D}{\lambda}\right) \times \left[1 + q\left(\frac{\pi D}{\lambda}\right)^2\right] \qquad (10)$$

where $$q = \frac{4 C_t K}{C_o D^2 s} \qquad (11)$$

It is thus apparent that the stray capacitance between turns, C_t, is multiplied by a factor K. For a single layer line (K = 1) the effect of this capacitance is negligible. For a three or more layer line K has been increased many fold and actually is large enough to compensate for the decrease of inductance with frequency as far as time delay is concerned. It is true that the characteristic impedance will suffer from this compensation, as it does with all other known compensation measures in delay lines. This stray capacitance actually becomes our compensation capacitance and these lines are thus called self compensated lines.

A plot of T/T_o from Eq. (10) is shown in Fig. 3. It will be observed that for a given delay line T/T_o decreases as the frequency increases to some minimum value and then increases without limit. If the maximum variation in time delay is prescribed q may be determined. If a dispersion in the phase shift up to the highest frequency of interest is as high as 1/2 radian, the total error ($T - T_o$) in time delay would be 0.02 μsec if a frequency limit of 4 mc were set. Thus if the total delay was 1 μsec the error could be 2%. A plot of the % error in time delay vs q appears in Fig. 4. Fig. 5 is a plot of the % error in time delay vs $\pi D/\lambda$. It should be noted that

$$\frac{\pi D}{\lambda} = \frac{\pi D f}{v} = \pi D f T = \pi D f \sqrt{L_o C_o} \qquad (12)$$

The parameters have been assumed per meter length. If the line is less than 1 meter long

$$\frac{\pi D}{\lambda} = \frac{\pi D f \ \text{time delay desired}}{\text{length of line (meters)}} \qquad (13)$$

The variation in time delay of these multilayer self compensated lines are very similar to single layer lines with compensation patches.[5]

The design equations of multilayer lines may now be stated. Rewriting Eq. (11) as

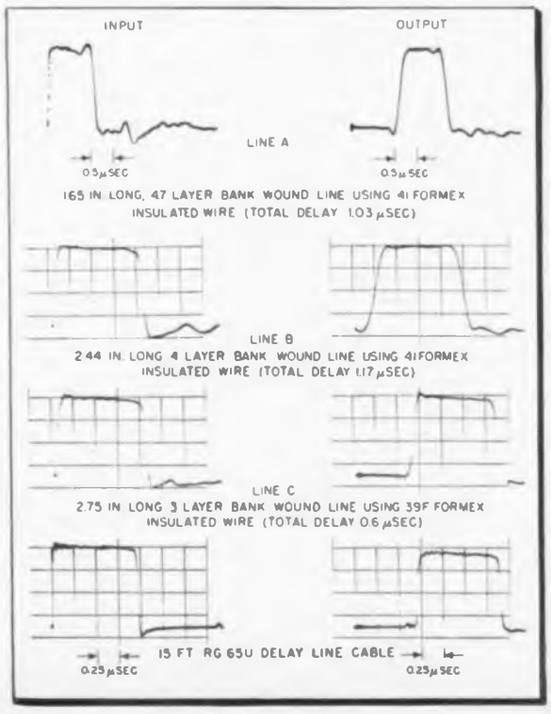
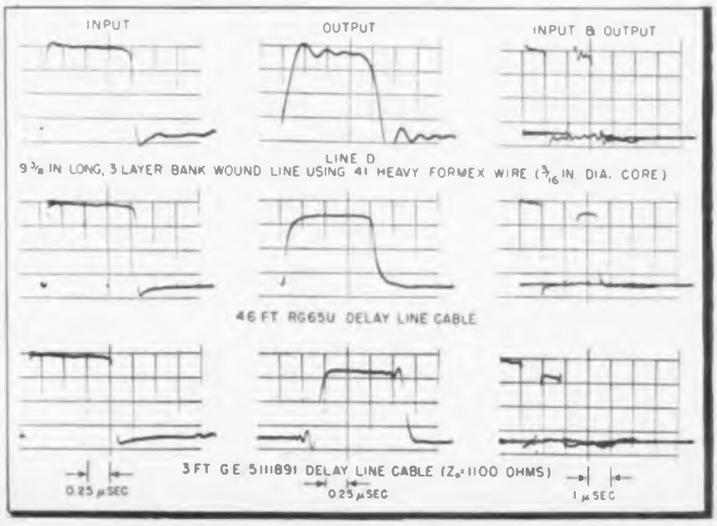


Fig. 8: (left) Pulse response of several bank wound lines and a short length of RG-65U delay line cable

Fig. 9: (below) Pulse response of bank wound line compared with RG-65U delay line cable and GE 5111891 delay line cable



Distributed Delay Lines (continued)

$$C_o = \frac{4C_t K}{D^2 sq} \quad \text{farads/meter} \quad (14)$$

and using

$$C_t = \frac{\pi^2 D K_e E_o}{\sqrt{2}} \sqrt{\frac{a}{b-a}} \text{ farads,} \quad (15)$$

where K_e is the dielectric constant of the insulation on the wire, we finally get

$$C_o = \frac{4\pi^2 K_e E_o K}{D\sqrt{2}\, sq} \sqrt{\frac{a}{b-a}} \text{ farads/meter} \quad (16)^*$$

(*A typographical error occurred in reference (3) in this equation.)

This is a convenient form to relate the compensation capacitance (C_t) to the capacitance to ground (C_o) as we have equations to relate C_o to the physical dimensions of the components given by

$$C_o = \frac{2\pi E_o}{\frac{1}{K_e}\ln\left[\frac{b}{a}\right] + \frac{1}{K_{ed}}\ln\left[\frac{D}{b+D}\right]} \text{ farads/meter,} \quad (17)^6$$

where K_{ed} is the dielectric constant of the insulation between the core and the winding and

$$L_o = \frac{\pi N^2 D^2 \mu_o}{4}, \quad (18)$$

where N is the number of turns per meter. Thus with the aid of Eq. (6), (8), (16), (17) and (18) and Figs. 2 and 4, this type of line may be designed. Lines have been wound when the average number of layers was not an integer. In this case the value of K was read from Fig. 2 for the average number of layers. No difference in performance of these lines has been noticed.

A plot of the time delay vs characteristic impedance from Eqs. (16) and (18) appears in Fig. 6 for wire sizes from AWG 32 through 47 and layers from 1 through 5. The wire insulation used in this calculation was single formex. The graph was normalized about a mean diameter of 5.08 x 10^{-3} meters (0.2 in.) and a value of q of 1. The characteristic impedance is proportional to the diameter to the 3/2 power and the square root of q while the time delay is proportional to the square root of q while the time delay is proportional to the square root of the quotient of the diameter/q. The nominal published wire dimensions were used. The characteristics of lines wound with other types of insulation would be similar. Values of characteristic impedances over 10,000 ohms are shown although no attempt has been made to wind any such lines experimentally. In general lines have been bank wound with layers from 2 through 5 and wire sizes from 32 through 47 with several kinds of insulation substantiating Fig. 6 experimentally. These lines have had impedances from 2,000 ohms through 10,000 ohms and time delays from 2.5 to over 30 μsec/meter. Examples will be given in Table 1.

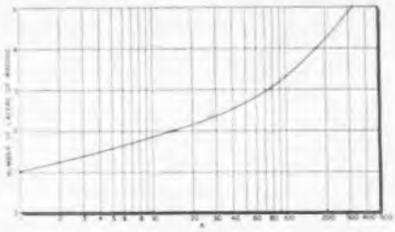
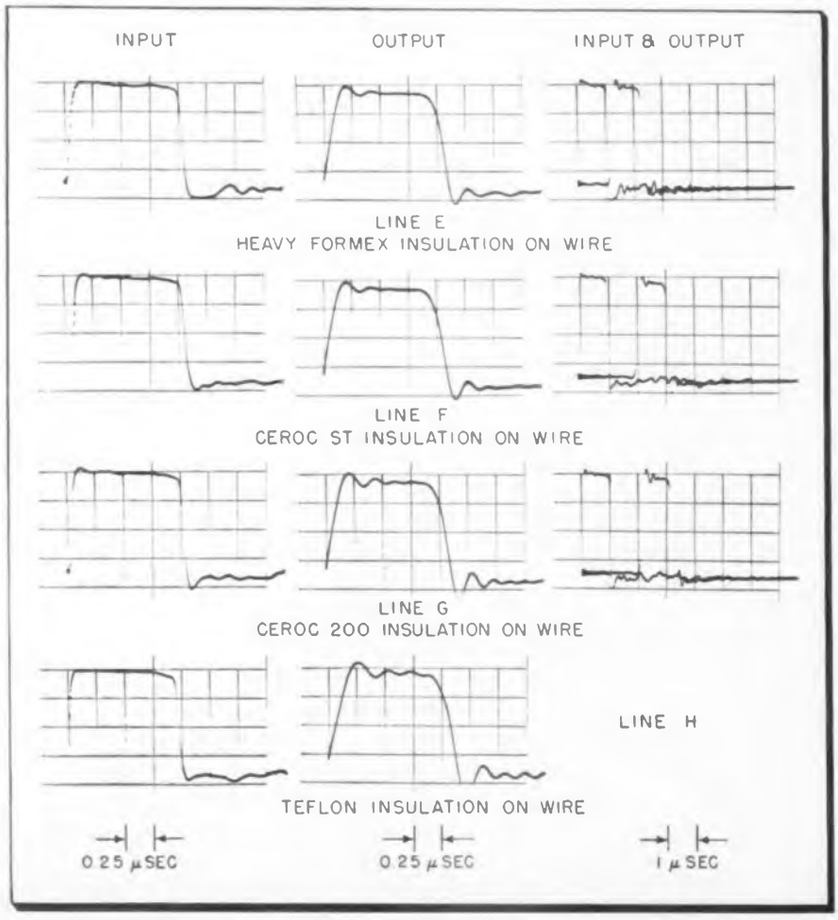


Fig. 2: Graph shows number of layers of multilayer bank vs. K (constant)

Fig. 10: Comparison of several 3 layer bank wound lines for various types of insulation on A.W.G. 41 wire



Line Construction

The lines were wound on 3/16 in. diameter polystyrene cores 12 in. long. These cores were given several coats of silver conducting paint to form the ground strip. Although the cores could be slotted after an overnight drying period a much cleaner cut was made if the drying period was several days. The cores were axially slotted forming 36 thin strips, each strip being about 0.015 in. wide. The slots were about 0.003 in. wide. A 1-in. length of the core was left unslotted to facilitate the connection of the external ground lead. The core was covered with a layer of insulating material to give the required winding-to-core capacitance. A piece of thin teflon tape was wound around the core. A number of small pieces of cellophane tape held the teflon on the core until the line was wound. The tape was removed piece by piece as the line was wound.

The winding was done on a lathe. In order to provide uniform wire tension, both to secure a good winding and to prevent breakage, a wire feeding device was used.[1,2,3] The wire tension was adjustable over a range of about 10 to 70 grams. The tension was continuously indicated by a pointer.

A wire guide attached to the longitudinal feed of the lathe was placed about 1/16 in. from the core,

(*Continued on page* 100)

Video Magnetic Tape Recorder

Crisp sampling technique of new 12-channel recorder provides smear-proof recording. Video, sync and sound signals recorded on single magnetic tape at 100 ips

Fig. 3: Tape drive mechanism

The following information is taken from a talk delivered on March 24 at the 1954 IRE Convention by John T. Mullin, Chief Engineer, Bing Crosby Enterprises.

THE operation of video tape recording (VTR) is based on a method which is introduced primarily to conserve tape velocity. That is, 10 tracks are recorded simultaneously. An eleventh track records vertical and horizontal synchronizing signals. A twelfth carries the sound channel. See Fig. 1.

The manner of recording is shown in Fig. 2. Horizontal sync from the incoming video signal is used to lock a series of counters in such manner that the output of the unit is a pulse, p having a relation to the horizontal line rate, f_h, such that its frequency f_p is:

$$f_p = f_h(43\ 2 - 1/42)$$

When the line rate is the standard 15,750 cycles, then:

$f_p = 339{,}000$ cycles.

The pulse at the rate of f_p is used to lock a multivibrator which operates a polarity reversing switch, SW_{rev}. Inspection of waveforms in Fig. 2 shows how the incoming video signal is reversed in polarity by this switch. This is a precisely balanced switch, reversing and stabilizing on either polarity in less than 0.05 μsec. The video signal, alternating at the rate of 169 kc, is applied through a cathode follower stage to a series of ten switch units in parallel. The pulse occurring at the rate of f_p meanwhile is applied to a delay line as indicated. This pulse is of approximately 0.15 μsec duration and, as previously mentioned, occurs at a rate of 339 kc.

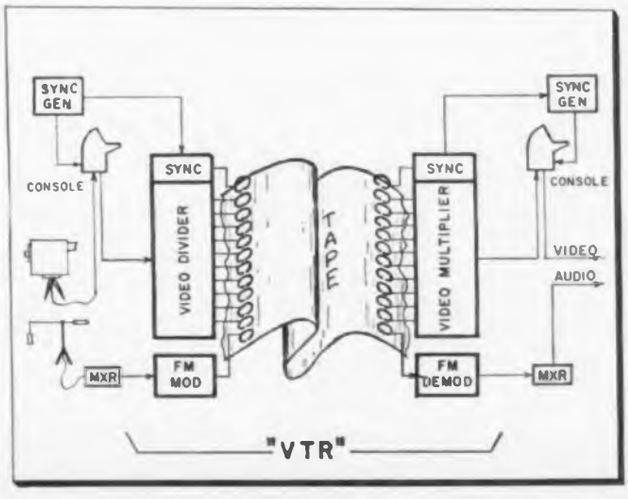
The delay line contains nine taps, equally spaced in time. Thus it is that the excitation of successive taps occurs at the rate of 0.34 μsec, while any one tap is excited at the rate of 3.39 μsec. The 0.15 μsec pulse permits each switch to sample the video signal for the duration of the pulse. By means of each switch a burst of current is applied to its associated recording head during this period, and the signal recorded on the tape becomes an elementary bar magnet. The intensity of this magnet is a function of the amplitude of the video signal at the instant of sampling, and its polarity is a function of the video signal polarity, as previously determined by SW_{rev}. Because the magnet so recorded is the result of a current burst of extremely short time duration, there is little smearing of the magnetic record due to tape motion, and the length of the elementary bar approaches that of the head gap length. Shortly after a sample has been recorded in head No. 1, the pulse appears again, delayed by the line, at the next switch in the chain where it causes resampling of the video signal and similar recording by its associated head No. 2. This process is continued through all ten switches and heads.

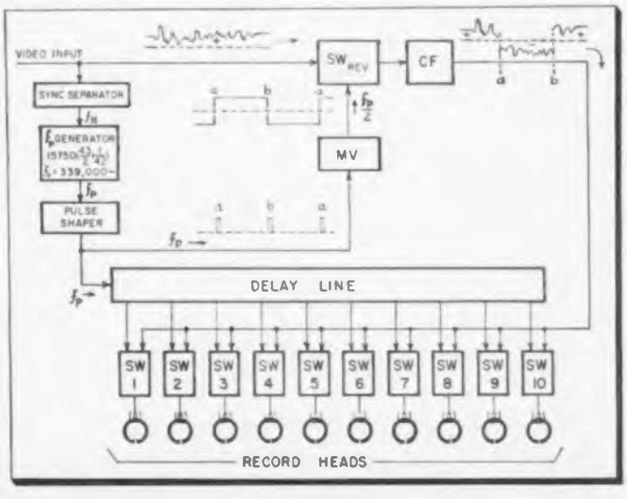
At the end of this sequence, the polarity of the input video signal reverses and each recording head is excited in the reverse manner. The original bar magnet, whose formation we described, has now barely moved out of the gap of head No. 1 in the interval required for the other nine heads to make their respective recordings. When its switch closes this time for the interval of 0.15 μsec, head No. 1 records a bar magnet of opposite polarity whose amplitude is again a function of the instantaneous video signal amplitude. The sequence is repeated for the remaining nine heads.

Thus it is that an alternating signal is recorded on each track. Both

(*Continued on page 127*)

Fig. 1: (l) Track containing video and sync signals recorded on magnetic tape. Fig. 2: (r) Block diagram of recorder system





Designing Transistor Relaxation

Among several variations of basic oscillator circuit are those which provide certain advantages, including lower peak currents and a closer realization to rectangular waves

By STANLEY I. KRAMER,
Fairchild Guided Missiles Div., Wyandanch, N.Y.

THE conventional relaxation oscillator circuit uses a capacitor across the emitter input and utilizes the negative resistance for switching. This configuration is shown in Fig. 1a and its operation can be analyzed in conjunction with the emitter N-curve. The emitter N-curve is the volt-amp characteristic of this circuit taken from emitter-to-ground and is shown in Fig. 1b. This concept for analysis has been described elsewhere,[1] but is reviewed here briefly as a basis for the discussion to follow.

The curve described by the solid line abcd is a plot of emitter current versus emitter voltage to ground and can be obtained point by point or dynamically. The segment ab represents the high input resistance at cut-off and is generally of the order of 1 megohm, bc is the negative resistance region which is largely a function of R_b and alpha, and cd represents saturation, the slope being a function principally of r_e and the external circuitry.[2]

Considering the operation of the circuit, capacitor C slowly charges from point a to the peak point b. At this instant the emitter resistance breaks down and the current suddenly increases. The voltage across C, however, cannot change instantly and corresponds in effect to a zero impedance load line which intersects the N-curve at d. The capacitor then proceeds to discharge through the emitter, whose impedance to ground is defined by the slope of dc, to the valley point c. Here the current suddenly decreases and the capacitor again prevents any change of voltage which causes the current to return to the value corresponding to point a and the cycle is complete.

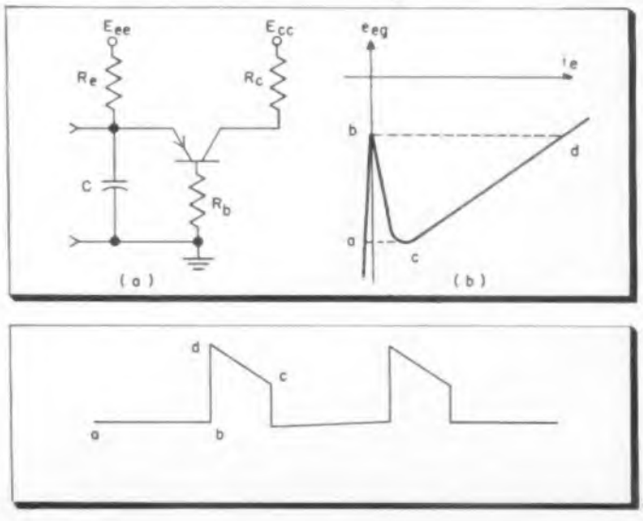
Two undesirable features of this circuit are the sloping top in the collector waveform (Fig. 2) caused by the changing emitter current in segment dc (Fig. 1b) and the very high peak currents, especially of the emitter, which exist at point d.

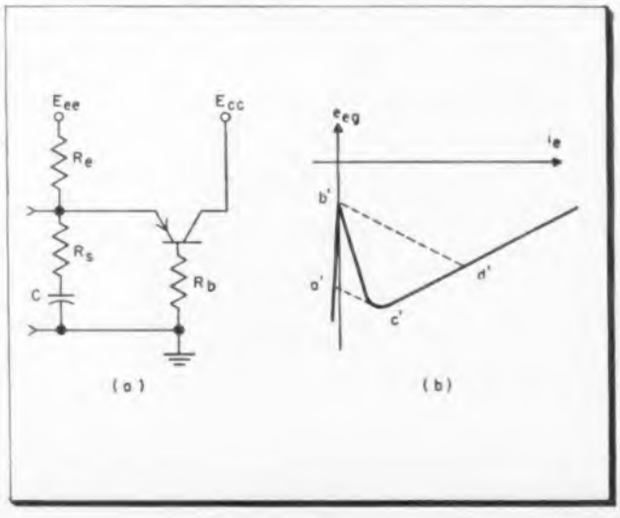
Fig. 3a shows a modification of the basic circuit having most of its desirable features and few of its shortcomings. The changes in the basic circuit are the addition of a loading resistor, R_s in series with C and the elimination of R_c. Fig. 3b is the corresponding N-curve for this circuit and is referred to in the analysis which follows. Beginning at a′, the voltage at the emitter rises as capacitor C charges from E_{ee}. At b′ the current is suddenly increased by the switching action, but this time, although the capacitor voltage remains momentarily constant, the voltage across the emitter terminals is subject to change due to the drop in R_s. Thus, b′d′ has a slope corresponding to the resistance R_s. From d′ the voltage falls due to the discharge of C to c′. Here, again, the emitter resistance changes abruptly and c′d′ is generated parallel to b′d′ to complete the cycle.

Emitter Loaded Circuit

If $R_s << R_e$, this circuit degenerates to the simple case of a loading resistance in series with the emitter as shown in Fig. 4a. The N-curve of this circuit taken at the points shown in the diagram is illustrated in Figs. 4b and 5a and may be compared with the N-curve of the previous circuit, Figs. 4c and 5b. It will be noted that the current end points are substantially the same except for those corresponding to a′ and a″ which is generally second order and due to the approximation that R_s is very much less than the emitter resistance in ab. This shows, therefore, that resistance loading of the emitter is equivalent to altering the N-

Fig. 1: (u-l) Relaxation oscillator circuit (a) and N-curve (b). Fig. 2: (l-l) Collector waveform. Fig. 3: (r) Modified circuit (a) and N-curve (b)





Oscillators

curve by a controllable amount in the saturation region. The slope of the curve in this case is approximately equal to R_s if $R_c = 0$. This is shown by the following analysis which makes use of the equivalent circuit of Fig. 6.

The loop equations are

$$V_e = (R_s + r_e + r_b + R_b)\, I_e + (r_b + R_b)\, I_c$$

$$0 = (r_m + r_b + R_b)\, I_e + (r_b + R_b + r_c + R_c)\, I_c$$

Solving for V_e/I_e

$$R_{in} = \frac{V_e}{I_e} = \frac{(R_s + r_e + r_b + R_b)}{r_b + R_b + r_c + R_c} \times \frac{(r_b + R_b + r_c + R_c) - (r_b + R_b)\,(r_m + r_b + R_b)}{(r_b + R_b + r_c + R_c) - (r_b + R_b)\,(r_m + r_b + R_b)}$$

In the saturation region the internal parameters r_e, r_c, r_m, and r_b are very small, generally less than 100 ohms.[3] If these are small compared with the external circuitry the expression reduces to

$$R_{in} = R_s + R_b R_c / R_b + R_c$$

and if, in addition, R_c is made zero, the final expression reduces to

$$R_{in} = R_s$$

In a similar manner it can be shown that with $R_c = 0$, alpha approaches unity during saturation. Alpha by definition is

$$(r_b + r_m)/(r_b + r_c)$$

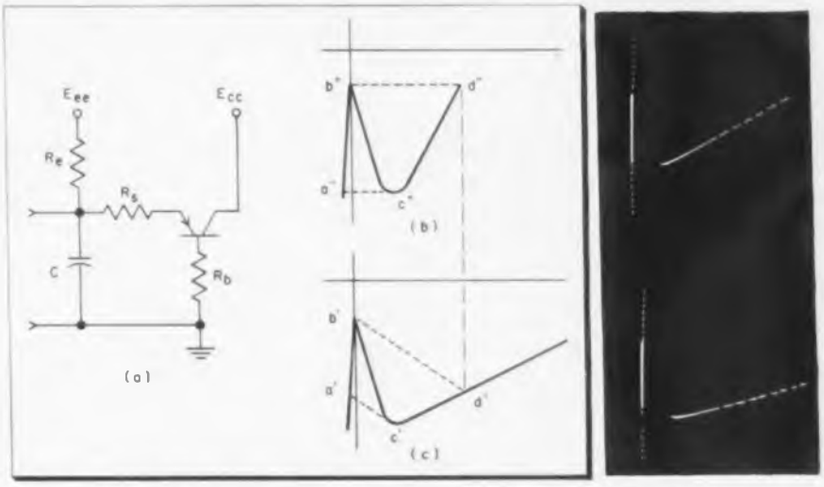


Fig. 4: (l) Circuit (a) and N-curve (b) when R_s is much smaller than R_c. Comparison with N-curve of Fig. 3 (c). Fig. 5: (r) Scope traces of Fig. 4b (a) and 4c (b)

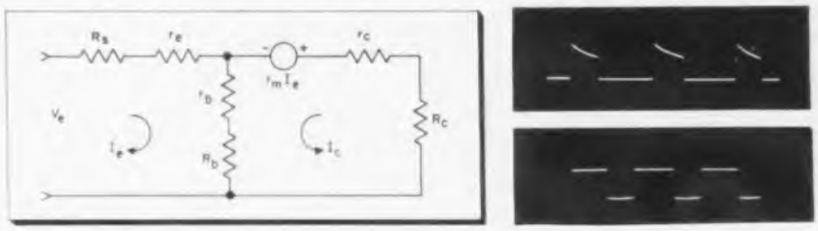


Fig. 6: (l) Equivalent circuit of Fig. 4. Fig. 7: (r) Resulting flat-topped waveform

In the subject circuit, however, this becomes

$$(r_b + R_b + r_m)/(r_b + R_b + r_c)$$

and if r_b, r_m, and r_c are small compared with R_b, alpha is very nearly unity. The consequence of this fact is that during saturation $\Delta i_c/\Delta i_e = -1$, and the net current through the base is constant. This results in the flat topped waveform illustrated in Fig. 7. Thus, two effects have been achieved. First, the N-curve has been altered to permit large amplitude waveforms without excessive peak currents by controlling the saturation region and secondly, the waveform has been flattened by adjusting alpha to unity by removal of R_c and by taking the output at the base.

Table I: Comparative performance of batch of transistors in circuits of Figs. 1 and 3

Trans. Sample	α	R_{ro} (K)	T (us) (Fig. 1)	Output (relat.)	T (us) (Fig. 3)	Output (relat.)
1*	2.0	8	750	2.0	——	—**
5	3.8	12	875	2.0	1180	1.9
7	2.8	7	875	1.9	——	——
29	2.0	11	875	2.2	500	1.4
39	2.4	13	825	2.0	——	——
45	2.8	14	1150	2.0	1300	1.0
53	2.2	7	675	1.8	——	——
33	3.3	9	850	2.0	750	1.6
59	1.8	6	650	1.9	——	——
69	2.3	16	1335	2.3	1600	2.6
67	1.6	8	240	1.6	——	——
11	3.6	10	800	1.9	950	1.6
25	2.6	10	775	2.0	700	1.7
2	2.0	5	545	1.7	——	——
52	3.1	14	825	2.2	1100	2.1
30	4.3	20	1000	2.3	2100	2.6
40	4.1	20	890	2.0	1400	2.2
24	4.2	20	1125	2.2	2400	2.4
50	2.1	10	875	2.1	——	——
18	3.3	11	675	2.0	——	——
56	2.8	10	900	2.0	1200	1.7
12	3.1	8	750	2.0	——	——
38	4.3	20	1025	2.3	2800	2.6
60	2.0	6	725	2.0	——	——
32	3.4	8	860	2.0	1550	1.6
28	2.4	7	775	2.0	——	——
20	3.4	8	712	2.0	1300	1.7
42	2.8	10	800	2.1	1050	1.6
22	2.5	11	835	2.2	1200	1.8
46	4.5	17	1000	2.2	2300	2.2
4	2.6	9	560	1.9	——	——
34	3.6	10	800	2.0	1100	1.6
44	3.1	14	912	2.2	1100	1.9
36	3.2	6	750	1.8	——	——

* Odd numbered transistors are type 1698, even are type 1768.
** These transistors could not be made to oscillate under the prescribed conditions.

Time Constants

The foregoing discussion using the N-curve analysis makes no mention of the time constants involved. This is more readily analyzed with the aid of the simplified equivalent circuit of Fig. 8 which assumes; 1) r_e is infinite during cut-off and zero during saturation, 2) r_c is zero during saturation, and 3) $r_b << R_b$. Then, starting from cut-off (point a′ in Fig. 3b), S_e and S_c are open and capacitor C charges toward E_{ee} with a time constant $(R_s + R_e)C$. When the peak point is reached, the switches close and C begins to discharge toward E_{cc} with a time constant R_sC. The discharge continues until the valley point is reached at which time the switches re-open and the cycle is completed. It should not be concluded from the foregoing that the charge time is necessarily longer than the discharge time, since the voltages involved

(*Continued on page* 132)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Obtaining Maximum Modulation

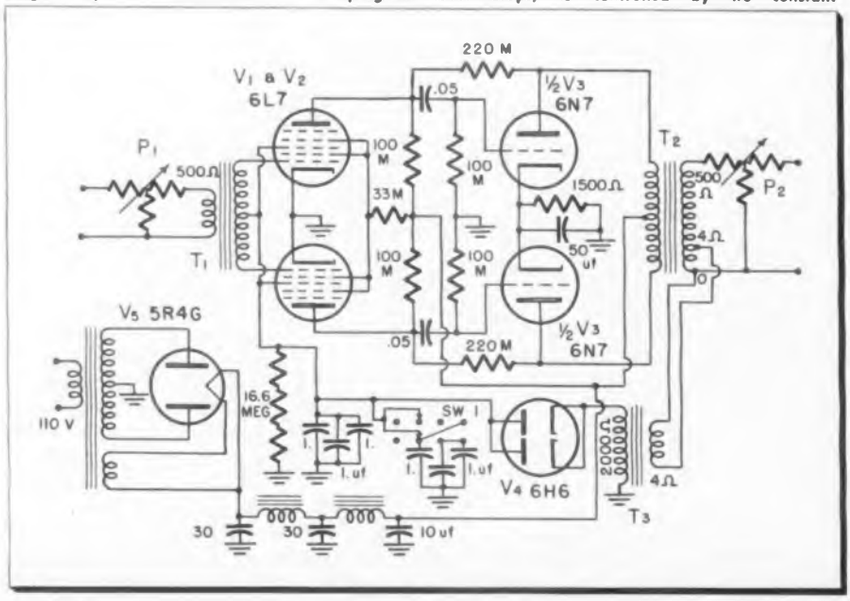
STAFFORD E. DAVIS, Chief Engineer, KGVL, Greenville, Tex.

THE limiter control which we built to help keep the modulation of the station at the highest possible level without distortion was designed to have less action than some others. For example, if the console VU meter is reading 95%, the modulation monitor will read 100% modulation. If the console level drops to 60%, the limiter control will bring modulation back to 95% after a delay of three seconds. Should the console level drop to 30%, the level control will bring the modulation back to 75% after a three second delay. A 20% reading at the console will produce a 60% modulation signal at the transmitter. This unit is designed to be used with the station's existing limiter.

Extensive tests were made on this unit to test its frequency response, distortion and noise level. The frequency response is flat from 200 cps to 200 KC, dropping to −1.8 db at 100 cps. (This response is well within the 2 db limit set by the FCC.) Distortion at any frequency does not exceed 0.6 db. Noise at usual program level is −62 db, dropping off to −56 db during the control action.

The cathode of the 6L7 tubes must be grounded to achieve proper limiter control. Since the transformers constitute a greater part of the cost, the unit can be built for a reasonable cash outlay if one or more of the transformers can be found in the scrap box. Adding three 1μf paper capacitors and a switching system increases the time lag by 6, 10 and 15 seconds as each capacitor is added to the circuit.

Electronically controlled time delay circuit maintains maximum modulation by restoring highest possible modulation after program level drops, is controlled by RC constant



Ampex Reverberation

ED MARZOA, Chief Engineer, WJWL, Georgetown, Del.

FOR those who may have an Ampex 400 Tape Recorder, here's a suggestion for its use in producing spot announcements with an echo or reverberation effect that has proved very successful in our area.

Feed the tape recorder from a two position mixer. Place the machine in normal play mode with the VU Meter switch in play position. Start the machine and press the record button. By feeding the output of the tape recorder back through the mixer, an echo is recorded on short phrases or words. The level of the reverberations can be controlled, but of course the frequency cannot, this being determined by the tape speed and head spacing which are fixed. Tape speed should be 7 in. sec. Any sound or word that can be recorded on a length of tape the distance between the heads can be reverberated.

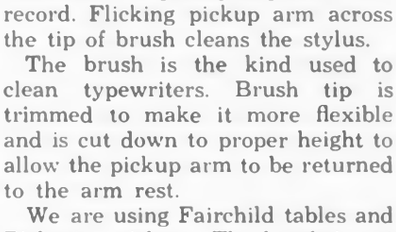
Turntable Brush for Cleaning Stylus

GEORGE A. DODGE, Chief Engineer, WFOX, Milwaukee 2, Wis.

DUST and record static conditions frequently clog the pickup stylus and it fails to ride in the groove properly. A small nylon brush, when installed at the proper height, can overcome this condition each time the pickup is placed on a record. Flicking pickup arm across the tip of brush cleans the stylus.

The brush is the kind used to clean typewriters. Brush tip is trimmed to make it more flexible and is cut down to proper height to allow the pickup arm to be returned to the arm rest.

We are using Fairchild tables and Pickering pickups. The brush is cut



Typewriter brush cleans stylus automatically

to 2 in. overall height and mounted between platter and pickup rest. The base of brush is drilled and tapped for a 6/32 screw and is secured to the turntable base.

Talkback Circuits

J. N. LAFRENIERE, Technical Director, WPEP, Taunton, Mass.

INSTEAD of the usual "cough button" installed in the leads from the studio microphones to their respective outlets, we installed DPDT relays between the output of the mike preamps and the inputs of the mixers. When a button is pressed in the studio, these relays transfer the outputs of the studio mike preamps from their mixing controls to the cue amplifier input. This provides talkback to the control room in addition to cutting the studio mikes off the air. Calculations and subsequent tests showed that the mixing controls provided sufficient isolation from the mixing busses without the use of loading resistors to prevent level changes when the relays were operated.

Because our control room is frequently used to originate programs,

another relay was installed to cut off the cue speaker when the control room mike is on. Split headphones are used in the control room with program fed to one side and cue signal to the other. A word of caution may be necessary in connection with the realys: be sure you have enough relay power available to provide for the additional load. Since the Gates SA-40 obtains its relay voltage from a dropping resistor in the ground lead of the high voltage winding of the power transformer, we had to install an additional low voltage rectifier unit.

Console Modification

W. W. BLAIR, WCMB,
Harrisburg, Pa.

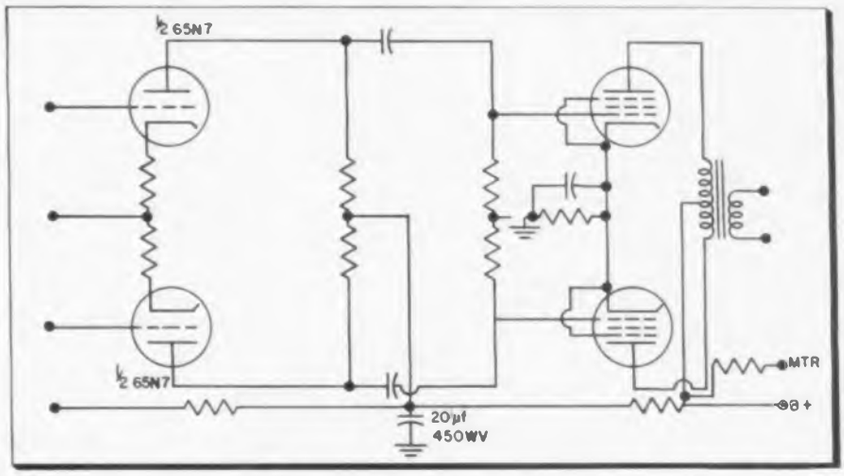
A CURE for noisy volume control on the monitor amplifier of the Collins 212A Console, is to connect a 470,000 ohm resistor from each input grid to ground in the monitor amplifier. This same monitor amplifier may motorboat at certain volume levels. This is due to lack of filtering in the plate supply of the second stage, a condition most prevalant when an unbalance occurs between the two triode sections of the second stage. This being a dual triode tube, the most simple cure was to add a 20 μf, 450WV electrolytic capacitor at the junction point feeding the two plate resistors of the second stage of the monitor amplifier.

Remote Switching Panel

HAROLD SCHAAF, Chief Engineer, WRFD, Worthington, Ohio

FOR several years we have handled remote broadcasts from the Ohio State Fair with several program origination points on the fairground. Since we are twelve miles from the fairground and five miles from our own exchange, it isn't economically feasible to run lines from each originating point on the fairground to the studio. To use one line we set up a switching point in our tent. This permits us to switch any of the originating points into the line to the studio.

The heart of the switching point is a station built panel which not only performs the function of switching lines, but selects either the program line from the fairground or a receiver tuned to the station to feed to the tent and outside public address, controls volume of the public address units and tallies the various switch positions. There is also a headset connection for constant monitoring of the station if desired.



Simple addition of 470 k. resistor from grid to ground cures noisy volume control

The 6.3 volt tally lights are lighted by a 6.3 volt transformer. Colored lenses are used to show "use" or "off" positions for the lines and public address systems. Switches are rotary wafer type and the PA controls are ordinary potentiometers ganged so only one knob is used to set the level of both systems after each amplifier volume is preset.

Transformers are used to isolate the program line from the ground side of the public address amplifiers. Ouncer types with about a 20/1 impedance ratio feed sufficient level to drive the public address amplifiers at their phono inputs.

Extending Tower Beacon Lamp Life

B. G. FINKBEINER, WHRV,
Ann Arbor, Mich.

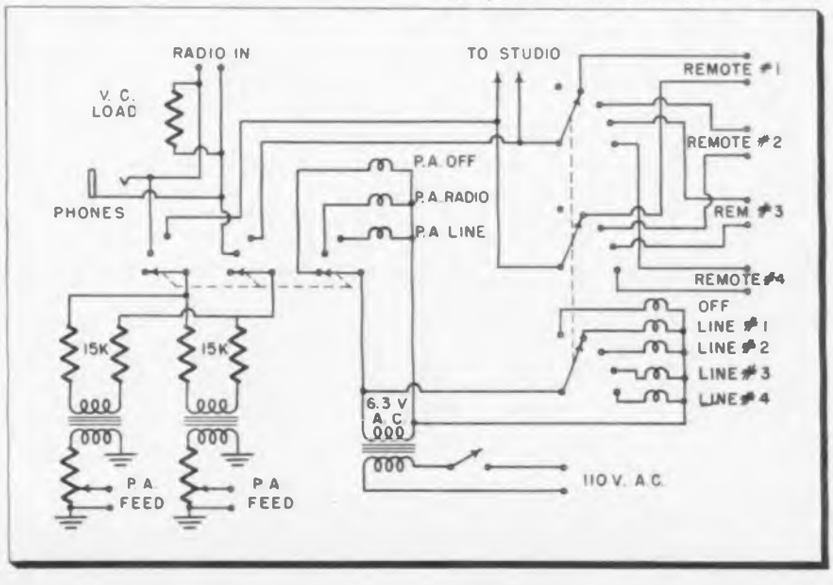
TWO tower lighting problems were a nuisance at WHRV. The first of the two 500 watt lamps in the flashing beacon were short-life and the blinker mechanism froze in cold weather. A three tower array made the situation even worse.

The remedy was a simple heater revision made from half of a 660 watt toaster element and located in each blinker box. This resistor lengthens lamp life by lowering the operating voltage to the minimum value, and limiting the starting current at the beginning of each flash. It also heats the interior of the box and prevents freezing of the blinker mechanism in the winter time, and drives out moisture in the summer time. The idea of locating the blinkers indoors was out of the question because considerable rewiring would have been required.

Take half of an element, unwind the nichrome wire, parallel it, and wind it back on the center portion of the mica form. This will give a resistor with 12 amp. capacity with a calculated hot resistance of 2.3 ohms. A 1000 watt beacon assembly

(*Continued on page* 106)

Remote switching panel provides multiple inputs from many remote sources and also feeds station signal or local program into PA system. Tallies show circuit condition



Indicator unit (l), Shown in special explosion-proof case, is calibrated in thousandths of an inch. (r) Transducer head contains mutual inductance micrometer, is mounted at shaft extremity

NBS Shaft Displacement Indicator

A non-contacting distance gage that measures the relative position of a highspeed rotating shaft to within 50 micro-inches has been developed by L. A. Marzetta of the National Bureau of Standards. The device employs a mutual inductance-type gage to indicate the longitudinal movement of the shaft, such as might be caused by failure or wear of a thrust bearing.

In the field of heavy rotating machinery such as steam turbines and internal combustion engines, it is sometimes desirable to monitor the relative position of some moving member. Turbines, in particular, under certain types of load, are subject to rapid, unpredictable thrust bearing wear. Since the rotor and stator of a turbine are machined to close tolerances, excess longitudinal movement of the shaft presents the danger of interference of these parts and possible destruction of the machine. The NBS shaft position indicator detects and measures accurately the shaft displacement in either direction. When the displacement exceeds a prescribed limit, the indicator actuates an alarm to warn operating personnel of imminent machine failure.

The detecting element in this system is a mutual inductance micrometer developed by M. L. Greenough of the NBS. A transducer

(*Continued on page* 104)

New Electronic Thermostat At NBS

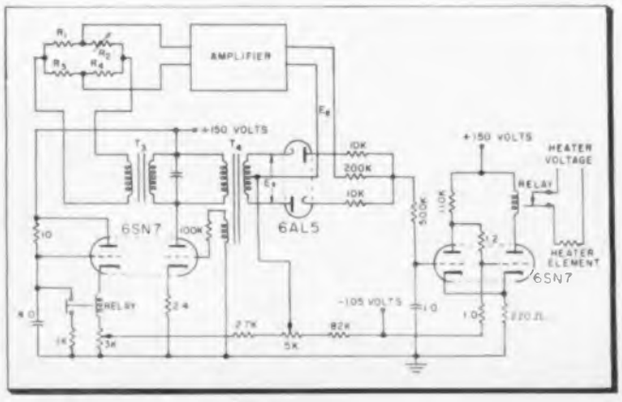
A wide range, precision electronic thermostat, developed by F. A. Ransom of the National Bureau of Standards electronic instrumentation laboratory, is finding many applications as a general purpose temperature controller at NBS.

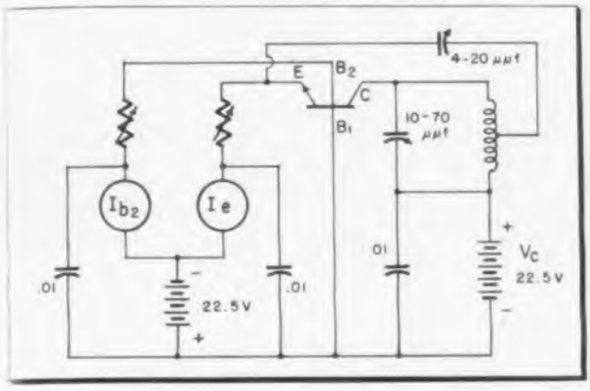
The device (Fig. 1) features such advantages as (1) no appreciable dead zone; (2) the sensitivity may be raised very high without objectionable loss of stability, reducing the deviation from the control point to a minimum with any load changes; (3) capability of handling power requirements ranging from milliwatts to kilowatts for control; (4) the use of sensing elements which may be a resistance thermometer or a thermistor connected in a bridge circuit, or a thermocouple connected to a chopper circuit; and (5) the use of standard commercial components. The thermostat utilizes a principle originally described by M. Gouy;[1] the power supplied to the heating element is switched on and off in a regular cycle, but the fraction of the cycle during which the power remains on is proportional to the deviation from the desired temperature.

The temperature sensing element —usually a resistance thermometer or thermistor—is connected in one arm of an ac bridge. See Fig. 2. The adjacent arm of the bridge is a variable resistor adjustable to the desired temperature control point. A 164-CPS oscillator energizes the

(*Continued on page* 135)

Fig. 1: (l) Two channel model of electronic thermostat being used at NBS. Fig. 2: (r) Schematic diagram of the time-proportional control circuit





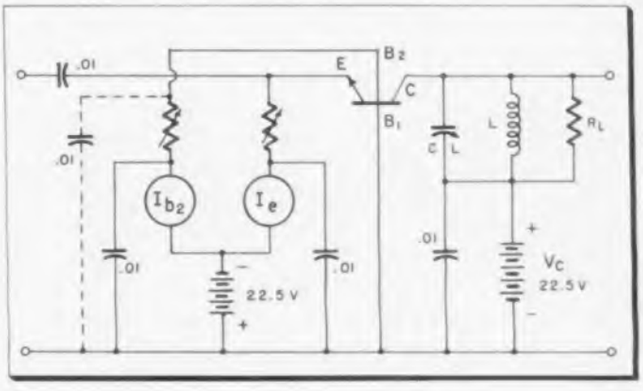


Fig. 1: (l) Oscillator circuit employing tetrode transistor. Fig. 2: (r) Tetrode transistor tuned amplifier

Commercial Tetrode Transistors

TETRODE transistors are to be specially recommended for high frequency oscillators (Fig. 1) and amplifiers (Fig. 2) at frequencies above the limits of triode transistors. Three types of grown junction n-p-n tetrode transistors, RDX-302, RDX-301 and RDX-300, are commercially available from Germanium Products Corp., 26 Cornelison Ave., Jersey City, N.J., for $30, $40 and $50, respectively. The technical specifications for these three hermetically sealed units at 20°C are:

Maximum Ratings	RDX-302	RDX-301	RDX-300
Collector voltage	30 v	30 v	30 v
Collector current	5 ma	5 ma	5 ma
Collector dissipation	50 mw	50 mw	50 mw
Base-to-base current	5 ma	5 ma	5 ma
Typical operation at V_c = 22.5 v., I_e = 2 ma, I_{b2} = 2 ma			
Max. frequency of operation, Fig. 1	10–20 MC	20–35 MC	above 35 MC
Max. power gain at 5 MC, Fig. 2	12±3 db	14±3 db	16.5±3 db
Input impedance approx. 25 ohms			
Output impedance approx. 9000 ohms			
Collector current cutoff, I_{co}, at V_c = 4.5 v.	10 μa	10 μa	10 μa

Operation at V_c = 4.5 v., I_e = 1 ma, I_{b2} = 1 ma at 5 MC will yield a maximum power gain of 1 to 3 db less than the same unit at 22.5 v., 2 ma. Base 1 and base 2 may be interchanged in the circuit and may give different characteristics.

For details on tetrode junction transistor construction and operating characteristics, see TELE-TECH & ELECTRONIC INDUSTRIES, Nov. 1952, page 38.

Texas Instruments, 6000 Lemmon Ave., Dallas 9, Texas, has gone into production of a grown junction n-p-n tetrode transistor, Type 700, especially designed for use in low-level, low-frequency, automatic gain control circuits. List price is $17.20. In a typical grounded emitter amplifier circuit, the output signal can be attenuated 20 db by introducing less than 100 μa into the second base lead. These units may be soldered or welded directly to circuit terminals or used with sockets Cinch 11953 or Elco 803 BC.

Specifications for the hermetically sealed Type 700, is as follows:

Ratings, Recommended Maximum	
Collector voltage	30 v
Collector dissipation (at 25° C)	50 mw
Typical Characteristics (at 25° C)	
Collector voltage, V_c	5 v
Emitter current, I_e	−1 ma
Base current, #2 I_{b2}	0
Collector resistance (r_c)	1 megohm
Emitter resistance (r_e)	30 ohms
Base resistance (r_b)	1000 ohms
Current amplification factor (α)	0.95
Collector cutoff current (at V_c=5v, I_e=0)	10 μa

Transient-Free Switch

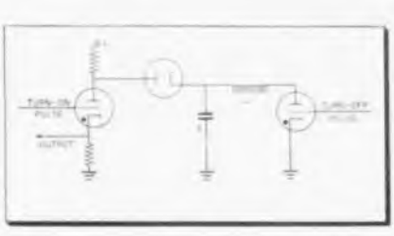


Fig. 1: Electronic switch uses three tubes

A relatively transient-free externally-triggered electronic power switch has been devised by J. Sargent of the National Bureau of Standards. The output waveform of this switch has rise and cut-off times of less than one microsecond. Over a frequency range from zero to 10,000 CPS, the "time-on" interval can be varied from one microsecond to the maximum of about 50 μsec less than the repetitive period.

During a study of spark recorder transformers, it was found that the usual cross-coupled thyratron power switches which use two thyratrons had several disadvantages for this application. They are wasteful of power since one thyratron is conducting during the entire "off" period of the switch. Moreover, this type of circuit is not sufficiently transient-free for the pulse excitation of the transformers in this study. The conventional circuit has been modified so that the turn-off tube is self-extinguishing, and the undesired transient has been removed with the addition of a diode between the two thyratrons. The new design also provides an output voltage of rectangular waveform with negligible overshoot, leading and trailing edge times of less than 0.25 μsec, and a wide duty-cycle range.

The electronic switch (Fig. 1) utilizes three tubes—two thyratrons and a diode rectifier. A condenser is connected to the plate of the power-delivering thyratron through the diode, and to the plate of the turn-off thyratron through an inductance. The other side of the condenser is

(*Continued on page* 153)

Techniques for Designing

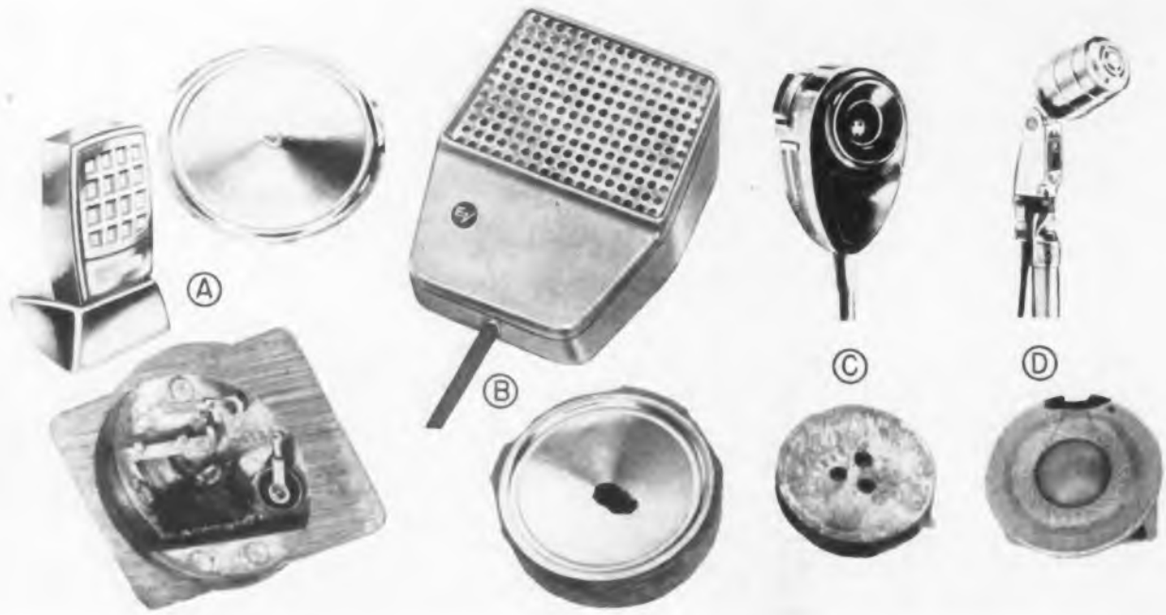


Fig. 1: Electro-Voice microphone models and generating elements. (a) 915, rochelle salt. (b) 713, barium titanate. (c) 210, carbon. (d) 630, dynamic

THE complexity of high-quality microphone design becomes apparent when we consider that uniform response of an electro-acoustical-mechanical system is desired over a range of about nine octaves (40—15,000 cps). The first item to be considered is the type of generating element which should be selected as the core around which the microphone is to be developed. A brief discussion of the most common types of microphones will be helpful in selecting the type of generating element to be incorporated.

Piezoelectric Microphone

A piezoelectric microphone is a transducer which depends upon the mechanical deformation of a piezoelectric element to change acoustical energy into electrical energy. The several common piezoelectric materials which may be used in this type of microphone are rochelle salt, barium titanate, and ammonium dihydrogen phosphate. See Fig. 1a, b. All three types of generating elements result in the following equation for the electrical output of the device,

$$e = Kx \qquad (1)$$

where e = internal voltage,

K = constant of the piezoelectric material,

X = effective amplitude of the deformation of the generating element by the applied force.

The piezoelectric microphone may be of the direct or diaphragm actuated type. Eq. (1) can be applied to either type of michrophone. The only difference to be considered is that the diaphragm area is used in calculating the force to produce the displacement rather than the crystal area.

This type of microphone is a stiffness controlled, displacement device below the fundamental resonant frequency. As a result the microphone output voltage measured on open circuit is independent of frequency below the resonant frequency. Generally the diaphram size is chosen so that the baffle effect causes the pressure on the front of the microphone to rise at a frequency slightly above the resonant frequency in order to extend the useful high frequency response.

The rise in pressure is caused by diffraction effects which occur as the wavelength of the impinging sound becomes comparable to the size of the microphone. When the wavelength of the sound striking the microphone is equal to the diameter of the microphone the pressure is increased by about 10 db. This results in the response of the crystal microphone being held uniform beyond the point at which the crystal resonates. This phenomenon can be and is applied to other types of microphones.

Wide range barium titanate microphones have a lower output level than the Rochelle salt type. The other piezoelectric types have higher output. However, all three piezoelectric microphones are high impedance devices and require special shielding to avoid electrical noise pickup. In addition rochelle salt and

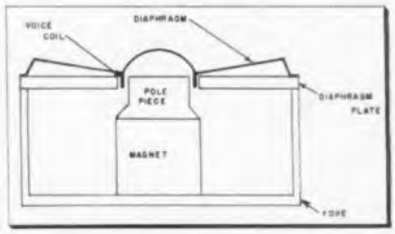
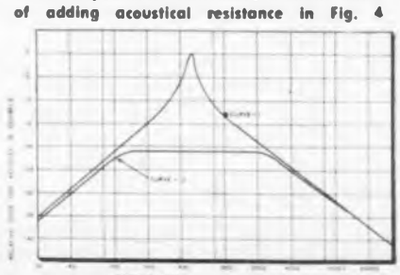


Fig. 2: Basic components of generating elements in the dynamic microphone

Fig. 3: Curve 1 is velocity-frequency function in undamped voice coil. Curve 2 shows effect of adding acoustical resistance in Fig. 4



Pressure Microphones

Effects of acoustical resistance, voice coil resonance, diffraction and baffle size described. Piezoelectric, condenser, carbon and moving conductor types evaluated

By WAYNE A. BEAVERSON, Chief Engineer, Microphones, Electro-Voice, Inc., Buchanan, Mich.

ADP are subject to moisture damage. Rochelle salt types are permanently damaged by temperatures in excess of 122° F.

Condenser Microphone

A condenser microphone generates an output voltage resulting from changes in capacity caused by variations in sound pressure. This class of microphone utilizes a stretched conductive membrane spaced in front of a parallel rigid plate. The generated voltage is proportional to the product of polarizing voltage times maximum change in capacity, and inversely proportional to the steady state capacity. The condenser microphone is fairly sensitive and can be constructed so as to have a wide useful frequency range. The polarizing voltage and adjacent preamplifier may be considered disadvantageous for many applications.

Carbon Microphone

A carbon microphone depends upon the variation of the resistance of carbon granules to convert the energy of sound waves into electrical energy. The carbon microphone diaphragm motion causes variation in the pressure between carbon granules which are retained in a pocket adjacent to the diaphragm. See Fig. 1c. The carbon granules are specially processed particles of anthracite coal. The applications of a carbon microphone dictates the use of a power supply and load resistor in series with the carbon button. The current in amperes, in the load resistor across which the output is taken can be written as,

$$i = \frac{e}{r_{eo} + Kx \sin \omega t} \qquad (2)$$

where e = battery voltage in volts,
x = amplitude of diaphragm displacement in cm.
K = constant of the carbon granules in ohms per cm. meter of displacement,
$\omega = 2\pi f$ in radians
f = frequency in CPS,
r_{eo} = steady state electrical resistance, in ohms.

When expanded into a series, the equation above contains terms which disclose multiples of the frequency applied to the diaphragm. This nonlinear distortion is quite high in a carbon microphone and is very objectionable. Several ways have been devised to combat this distortion. One of the most common methods of elimination has been the use of two carbon buttons working in push-pull and feeding into a tapped transformer in order to cancel some of the generated harmonics. The cancellation is not complete since the two carbon buttons do not have exactly equal responses and only the even harmonics can be eliminated in this sort of arrangement.

The mechanical impedance of a carbon microphone is a stiffness below the resonant frequency. Therefore, the displacement of the diaphragm is independent of frequency in the range below the resonant frequency. Under these circumstances Eq. (2) shows that the output is independent of frequency below the resonant frequency. Carbon microphones have very high output but are extremely unreliable for exacting uses because of the unpredictable action of the carbon granules.

Moving Conductor Microphones

The moving conductor microphone is a device in which the electrical output resulting from the acoustical input is caused by the movement of an electrical conductor in a magnetic field. One of the best known microphones of the moving conductor type is the dynamic microphone. See Fig. 1d. The moving conductor of the dynamic microphone takes the form of a coil secured to a diaphragm. The velocity of the voice coil in centimeters per second, can be written as,

$$v = \frac{f_m}{r_m + j\omega m + (1/j\omega C_m)} \qquad (3)$$

where f_m = driving force in dynes,
r_m = mechanical resistance in mechanical ohms,
$_m$ = mass of the diaphragm and voice coil in grams,
C_m = compliance of the suspension system in cm./dyne.

The generated open circuit voltage of the coil in abvolts is expressed,

$$e = Blv \qquad (4)$$

where B = flux density in the air gap in gauses,
v = velocity of the voice coil in cm./sec,
l = length of the voice coil conductor in cm.

A study of Eqs. (3) and (4) will show that the microphone response

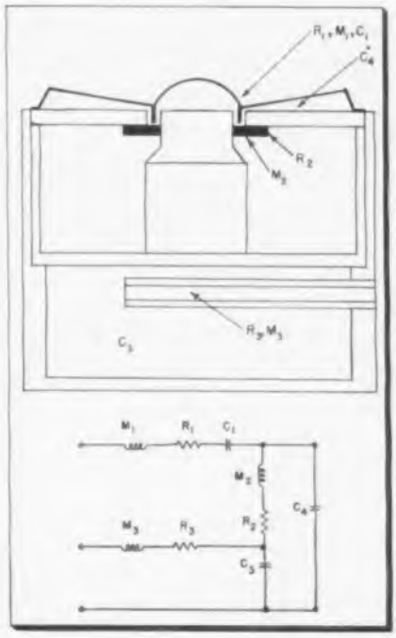


Fig. 4: Coupling acoustical cavity and resonance tube to unit of Fig. 3. Equiv. circuit

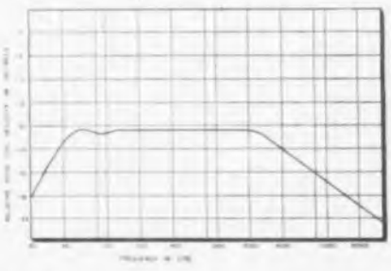
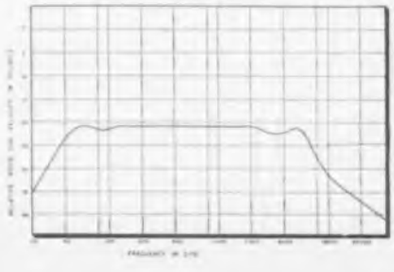


Fig. 5: Improved bass with cavity and tube

Fig. 6: Effect of voice coil resonance with cavity below diaphragm on coil velocity



PRESSURE MICROPHONES (Continued)

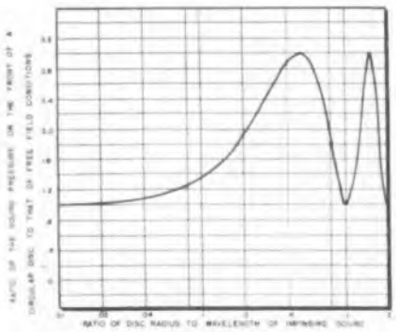


Fig. 7: Effect of baffle size on pressure

as to frequency response, and can be made to match a wide range of impedances by the use of a transformer.

Another example of a moving conductor microphone is the ribbon microphone. A ribbon microphone consists of a light metallic ribbon suspended in a magnetic field. One side is exposed to the atmosphere and one side couples to an acoustical resistance. The acoustical resistance usually consists of a loose material in a pipe. This pipe usually is coiled in the form of a labyrinth.

Neglecting the acoustic impedance of the slots on either side of the ribbon and the effect of the electrical impedance on the mechanical system, the velocity in cm/sec can be written as,

$$v = \frac{P}{A_R(r_{AP}+R_{AA}+jX_{AR}+jX_{AA}-jX_{AP})} \qquad (5)$$

where P = sound pressure in dynes/sq. cm.,

A_R = area of the ribbon in sq. cm.

r_{AP} = acoustical resistance of the labyrinth in acoustical ohms,

r_{AA} = acoustical resistance of the air load upon the ribbon in acoustical ohms,

X_{AR} = acoustical reactance of the inertance and acoustical capacitance of the ribbon in acoustical ohms,

X_{AA} = acoustical reactance of the air load upon the ribbon in acoustical ohms and,

X_{AP} = acoustical reactance of the pipe in acoustical ohms.

The open circuit generated voltage at the ends of the ribbon is as shown in Eq. (4). In the past years ribbon microphones have been widely used. In general, ribbon microphones are not sufficiently rugged for general use and ribbon sag is not uncommon. The permanent deformation of the ribbon causes the microphone response to change, and may in some cases lower the output level to an unuseable value.

Miscellaneous Microphones

There are many other types of pressure microphones which will not be discussed at this time for lack of space. Among these types are the magnet-ostrictive, magnetic, hot wire, electret, inductor, and electronic microphones. The generating types just mentioned are not widely used at the present time in normal applications for one or more of three reasons—low level, distortion or restricted frequency response.

After consideration of the foregoing the dynamic type microphone seems a preferred choice for the microphone which is to be designed to meet the specifications for the desired michophone.

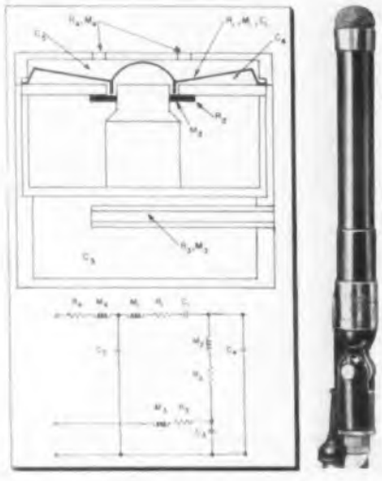


Fig. 8: (l) Addition of Helmholtz resonator to unit of Fig. 4. Fig. 9: (r) Model 655 mike

Specifically the dynamic microphone has the following advantages:

1. High output.
2. Ruggedness.
3. Moisture resistance.
4. Heat resistance.
5. Wide frequency response range.
6. Choices of impedance.
7. Negligible distortion.
8. Requires no power supply.
9. The moving parts of the microphone system have an indefinite stable life.

Microphone Design

Having chosen a moving coil type of generating element one of the first things to be considered is the magnetic structure. A magnetic structure which is simple and effective is shown in Fig. 2.

Various materials can be selected for the pole piece, diaphragm plate, and yoke materials. Armco magnetic iron is preferred since it has reasonable permeability, high saturation point, and is easily fabricated. The magnet material used should be one which will give a maximum flux density for a given weight of material. Alnico V appears to be the best practical choice for the magnetic material because of its extremely high energy product.

Assuming flux density (usually around 10,000 gauss) and the desired air gap dimensions, the constants of the magnet can be found from the following.

$$L_m = f B_g L_g / H \qquad (6)$$

where L_m = length of magnet in cm.,

f = leakage factor which accounts for flux which is not perpendicular to the pole piece and is usually somewhat less than 1.5,

H = field strength in oersteds at the maximum BH product point of the demagnetization curve,

B_g = flux density in the air gap in gauss,

L_g = length of air gap in cm.

The length of air gap is considered optimum at about 0.05 cm. for practical cases. The magnet area can be calculated from the equation,

$$A_m = F B_g A_g / B \qquad (7)$$

where A_m = area of the magnet in sq. cm.,

F = leakage coefficient which is the ratio of total flux in the center of the magnet to useful flux in the air gap,

B_g = flux density in air gap in gauss,

A_g = area of gap in sq. cm.,

B = induction in gausses at the maximum BH product on

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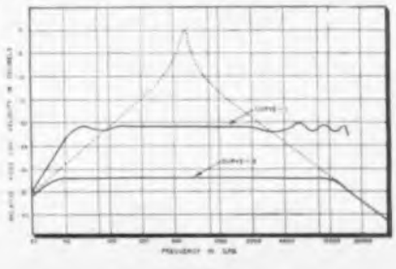
Fig. 10: (Curve 1) Response of final microphone design. (Curve 2) Damping which would be required of Fig. 4 unit to achieve high frequency response made possible by added resonances



Vari-Focal TV Lens

Designed for use with standard equipment, new lens attachment eliminates need for second camera in changing from distant shots to extreme close-ups

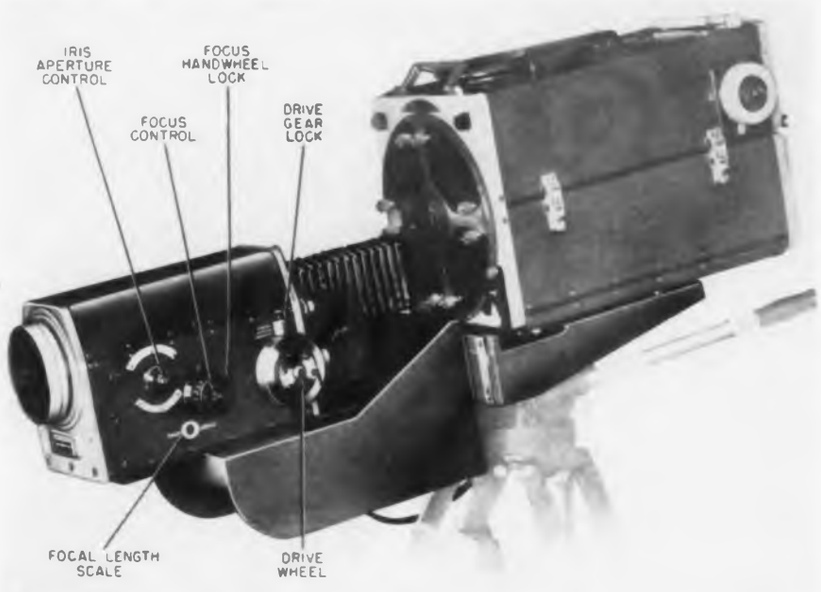


Fig. 1 Vari-focal lens, shown with standard camera. Conventional lens turret is no longer necessary

By JOHN RADICK,
General Precision Laboratories, Pleasantville, N.Y.

CAMERA technique in today's TV studio has reached such complexity that there is urgent need for reducing the overwhelming jungle of necessary but costly equipment. One effective means of simplifying overall studio operation—and at the same time, of increasing the efficiency of operational personnel—lies in the use of a variable focal length TV camera lens having the same standard of definition as a high quality lens of fixed focal length.

Use of the new GPL-Watson varifocal lens eliminates the requirement of a second camera in most simple studio applications by its inherent ability to change continuously from a far shot to an extreme close-up without disturbing pickup continuity or camera orientation. The mounting cradle permits mounting the lens on conventional tripods. The lens may be used with any standard camera. See Fig. 1.

A single spring-loaded leaf type switch controls the "zoom" effect. Seven pre-set speeds are available to enable the operator to run through the complete focal length range in intervals varying from 2 to 30 seconds.

By simply interchanging the supplied back lens element, the transition from the 3—15 in. to 6—30 in. focal range is made. Object distances as short as 10 ft. 6 in. are possible with this lens and, once the lens is focused, an object remains constantly in focus as focal length is varied.

The lens has only five components, with ten air-glass surfaces. The field is flat and the definition over the whole field is equal to that of high quality fixed focus camera objectives. All air-glass surfaces are coated.

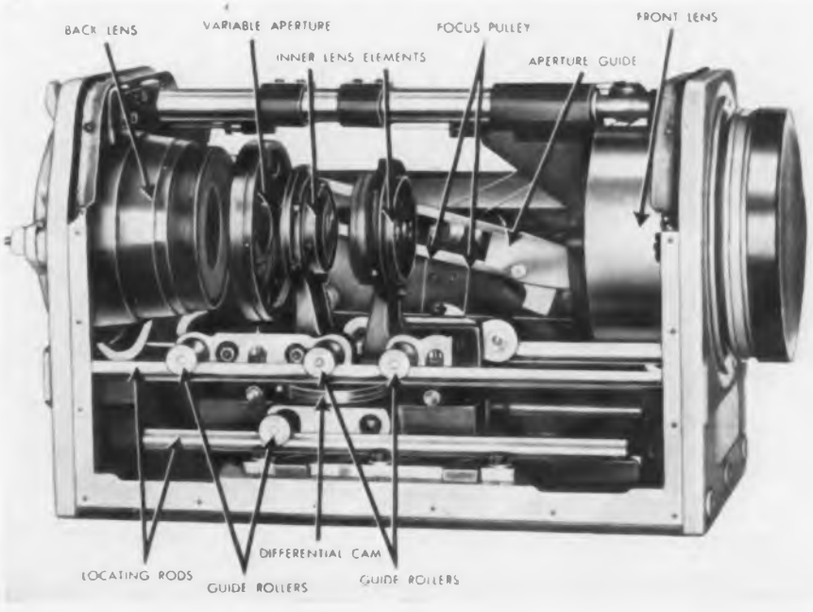
The front lens component (Fig. 2) moves only to change the plane of focus. The next two components move in a compound fashion—they move together and differentially—to provide the variation in focal length. The last two components are fixed, and the rear one of this pair is the replaceable element which provides the alternate focal range.

The two inner lenses are mounted on trolleys, each supported by three rollers running on steel rods which are mounted on the main carriage. The two rollers on one side of each trolley are V-shaped and locate the trolley directionally on one rod; the remaining roller on the other side is plain and serves only to support the trolley. The trolleys are held flush against the steel rods by a powerful spring which operates against the rollers on the underside of the main carriage.

The main carriage which carries the inner lens units on their trolleys is supported by rollers on steel rods located in the base. The suspension

(*Continued on page* 110)

Fig. 2 Differential movement applied to two inner lenses provides variation in focal length



Designing Instrument Rectifiers

Considerations involving frequency, voltage and current responses, and conversion efficiency examined. Cell size calculated from known temperature range

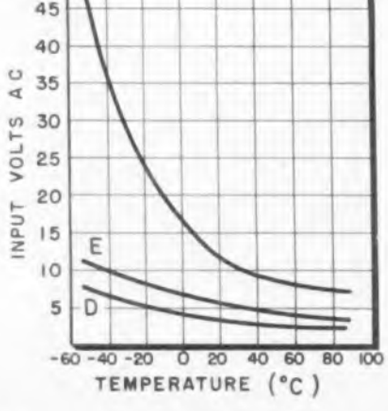
By EDWARD L. PAGANO,
Development Engineer,
Bradley Laboratories Inc.,
New Haven, Conn.

IN the design of a miniaturized meter rectifier, the basic concepts to be considered are the selection of the proper rectifier circuit and rectifier cell size to produce optimum results for the particular application for which the instrument is intended. Some of the important requirements to be considered in the selection of the rectifier circuit and the rectifier cell size are overall size, temperature range, frequency response, life, efficiency, voltage and current response, impedance, and ruggedness.

The decisive characteristic to be considered in the selection of a rectifier circuit is the conversion efficiency, that is, the ratio in percent of the dc output current to the ac input current. If efficiency is important (milliammeter application), it is definitely advantageous to select the full-wave bridge circuit as shown in Fig. 1, illustrating this circuit along with some of its equivalent circuits under specific conditions. The full-wave bridge produces a high efficiency primarily because it utilizes both halves of the ac input, and offers a minimum resistance to current flow. There can be modifications of this basic circuit for temperature compensation; however, it should be understood that these modifications will tend to reduce the efficiency. If a reduction of efficiency can be tolerated, resistance can replace two sections of the bridge.

Fig. 1 (r) Equivalent circuits (a) of bridge rectifier and meter (b) of complete unit (c) for constant current and frequency applied (d) for constant temperature and current applied

Fig. 2 (below) Input voltage required to produce full scale deflection of basic full wave bridge circuit with 0-1 ma., 100 ohm dc meter. (C) 0.080 in. dia. cell (D) 0.5 in. dia. cell (E) 0.187 in. dia. cell



Rectifier Cell Size

The selection of the rectifier cell size will depend primarily upon the operating temperature range, how the instrument will be used (voltmeter or milliammeter) in conjunction with the temperature, efficiency and frequency response.

The operating temperature range will determine both the voltage and current response of the rectifier. To explain the effect of temperature and how proper selection of cell size will produce optimum response at various temperature conditions, a copper-oxide full-wave bridge rectifier will be used in conjunction with a 0-1 ma, 100 ohm dc meter, and although the curves and specific values apply to this combination only, the basic concepts are valid for any combination.

Voltage Response: Fig. 2 illustrates how the variation of voltage with temperature changes increases as the cell size decreases. This effect can be explained with the aid of the equivalent circuit of Fig. 1c, but, since a rectifier is a nonlinear device, the term forward or reverse resistance is meaningless unless accompanied by either a definite value of current or voltage. For the purpose of this article, the term forward resistance shall be defined as the average resistance throughout the half cycle in which current flows internally within the rectifier from the negative electrode to the positive electrode at rated values of current for this application. Similarly reverse resistance is the average resistance throughout the remaining half cycle in which current flows internally within the rectifier from the positive electrode to the negative electrode at rated values of voltage for this application.

The reverse resistance is much

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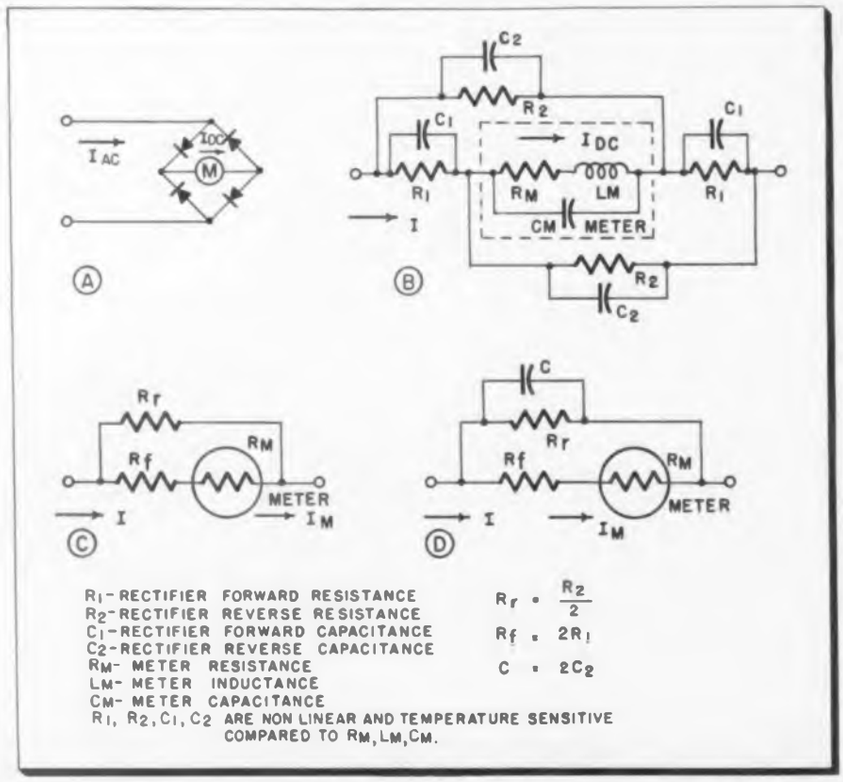


Manufacturing Computers for Aircraft

Sufficiently compact for mounting in small military aircraft, a new navigational analog computer, designed and built for the U. S. Air Force by Ford Instrument Co., provides the pilot with a continuous indication of his bearings without external radar-type beaming

1 Shown (l to r) are: the Computer Control and the Indicator—instrument panel units—and the Amplifier and Computer. Four manual adjustments, the wind direction and force, the magnetic variation and the starting point position must be made before take-off. In flight, the computer automatically integrates these readings with additional flight information—air speed and compass deviations—to provide the pilot with a continuous reading of his position in latitude and longitude. Design is pointed at jet fighter problems of fuel economy and tight cockpit space

2 Moving aircraft being tracked on display model of Ground Position Indicator. Accuracy depends largely on wind information and original settings

3 The assembly of precision units machined to within 0.0005 in. requires skilled workmanship. Here, jeweler's glass aids delicate adjustment of Computer section

4 Checking of units in high altitude chamber ensures efficient operation over wide temperature range—from −65° F to +160° F—and at altitudes up to 50,000 feet

5 Hot salt spray rises from tank subjecting units to 50 hours of corrosive atmosphere. Hermetic sealing and durability of plating and paint are rigidly controlled

6 Amplifier being vibrated. All units undergo sustained four-hour vibration test. Prototypes of this equipment have operated for two years without servicing.

7 Units mounted on the instrument panel must be checked for magnetic properties. Compass needle indicates effect of computer control being rotated in magnetic field

Page from an Engineer's Notebook

No. 26 — Critical Damping Nomograph

Simple series circuit shunted across electromagnetic device such as a relay minimizes switching transients and arcing which result from circuit being de-energized. Component values may be chosen quickly from graph. Contact wear and radio interference are sharply reduced

By ROBERT T. MOORE, Computer Research Corp., Hawthorne, Calif.

CRITICAL damping of electromagnetic circuits may be employed to minimize radio interference and relay and switch contact wear. For critical damping, an essentially pure resistance is presented to the switch terminals for any frequency. That is, minimum interference and wear will be achieved independently of frequency of operation or of the repetition rate.

Fig. 1 illustrates the circuitry involved in the usual application. L and R_1 are the inductance and internal resistance of the relay, or other electromagnetic device. C and R_2 comprise the transient-suppressing network. S is the switch, or contacts which cause the relay to be

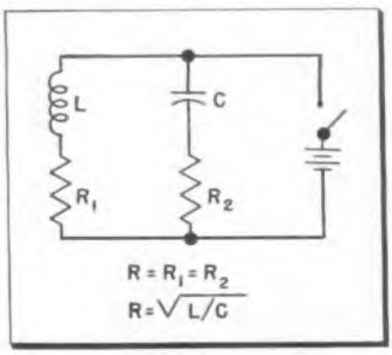


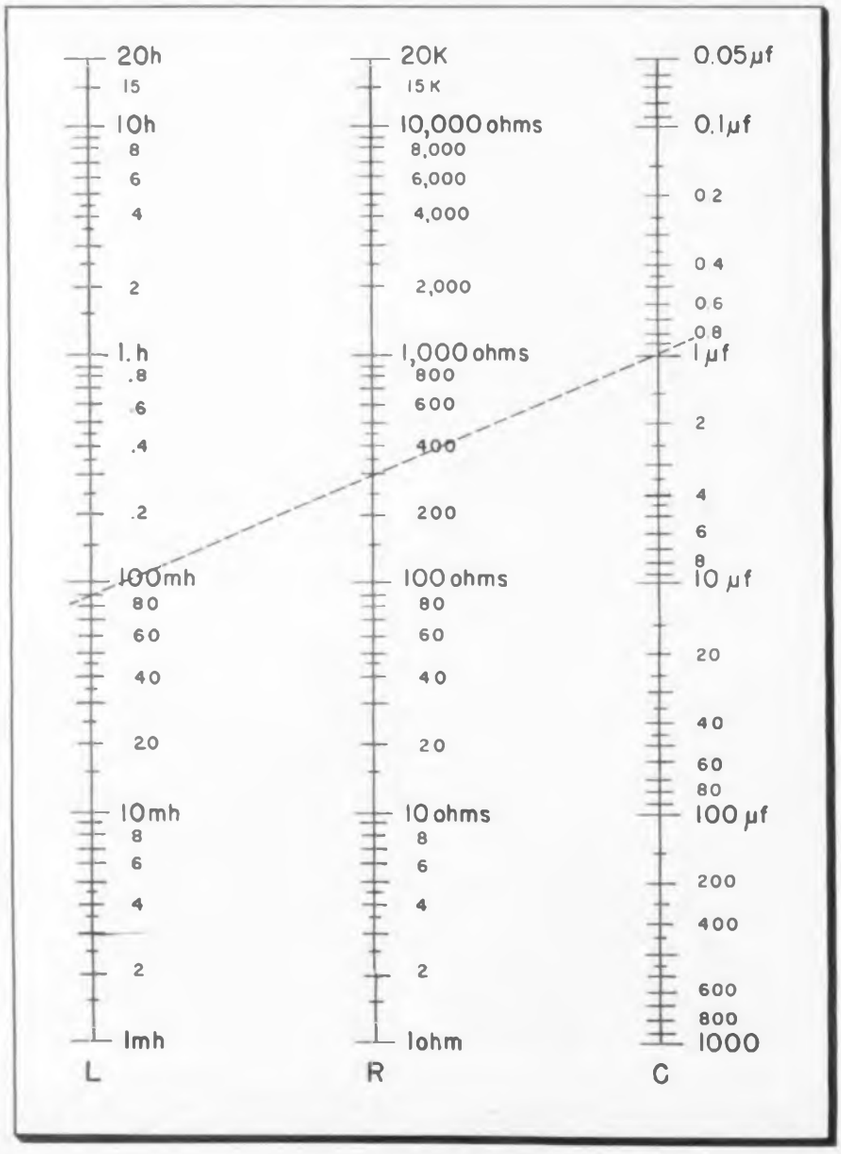
Fig. 1: Typical electromagnetic circuit

energized from a battery or other source, B. For critical damping, $R_2 = R_1 = R$ and $C = L/R^2$. Since R_2 may be determined by measurement of R_1, only the value of C is required. C may be found by simply placing a straight-edge across the nomograph so as to intersect the inductive and resistive values, R and L, of the relay. The point where the straight-edge crosses the capacitive, C, column will give the value of the capacitor.

To illustrate, consider the following example:

Critical damping of a relay coil circuit is required for purposes of transient suppression and radio interference reduction. This relay coil has an inductance, L, of 90 mh and a dc resistance, R_1, of 300-ohms. Placing a straight-edge across these values, the required capacity, C, is indicated by the intersection of the straight-edge with the C column. In this example, 1 μf is the required value. The combination of 1 μf in series with 300-ohms, R_2, placed across the relay coil will provide critical damping.

Nomograph for selecting component values for critical damping in electromagnetic circuits



New Broadcasting Equipment

"TELEJECTOR"

The 3-B single lens "Telejector" for television station projection of 35 mm. transparent slides features a new optical mixing system with an automatic 2 x 2 in. transparency projector. The system

superimposes two images on one optical axis which enables smooth lap dissolves and instantaneous switching. The instrument automatically changes through a sequence of 12 slides with one loading. Additional loaded "turrets" can be substituted in a matter of seconds. Available with either 6 or 7½ in. coated projection lens. Main power requirement is 115 v., 60 cps., ac. with 300 w. maximum. Control circuit operates from 24 v. dc., lw. maximum. Two 150 w. projection lamps operate at reduced voltage. **Gray Research and Development Co., Inc., 598 Hillard St., Manchester, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES

COLOR SIGNALS

Model 509-DR color bar generator provides eleven color standard signals. I,Q, R-Y signals representing the wide band, narrow band, and red color difference signals are produced in addition to green, yellow, red, magenta, blue, cyan, black and white standard color bars. The bars can appear in various combinations across the top, bottom, or all of a color tube; or, they may be combined with monochrome pictures. Also, the generator produces a dot pattern which can be superim-

WIDE ANGLE TV LENSES

A new Pierre Angenieux, retrofocus 28 MM., *f*3.5 lens has recently been brought into production. The new 28 mm. retrofocus has an angle of view of 74° as compared with the standard 50

mm. view angle of 47°. The lens is supplied in a focusing mount with iris diaphragm and effective aperture of *f*3.5. **Ponder & Best, Telelens Div., 814 North Cole Ave., Hollywood 38, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

posed on any of these displays for convergence alignment. **Telechrome Manufacturing Corp., 88 Merrick Road, Amityville, L. I., N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

TV COLOR CAMERA

The new RCA "3-V" camera for televising color motion picture film and slides and major programming elements in color TV broadcasting, employs "Vidicon" pickup tubes and a light-splitting optical system. The color image produced by the film projector is focused on the first of two dichroic mirrors mounted at angles in front of the projector. This light-splitting mirror reflects the blue portions of the image to a Vidicon in center background, but transmits the red and green portions to a second mirror. The latter transmits the green picture elements to a Vidicon in the right background, but reflects the red portions to a Vidicon in the right foreground. A small verticle element in front of the second mirror filters out unwanted infra-red wavelengths. Each Vidicon chassis generates a signal representing its own image color portion. **RCA Victor, Div. Radio Corporation of America, Camden, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES

TV DOLLY-TRIPOD

A new portable television camera dolly and tripod combination incorporates the advantages of heavier dollies. Its tubular and square-cross-sectioned telescopic members and hinged, struc-

TV EQUIPMENT

A newly developed camera for televising film completes the FTL broadcast equipment line. Using a small photoconductive camera tube, the camera chain (FTL-105A) features high

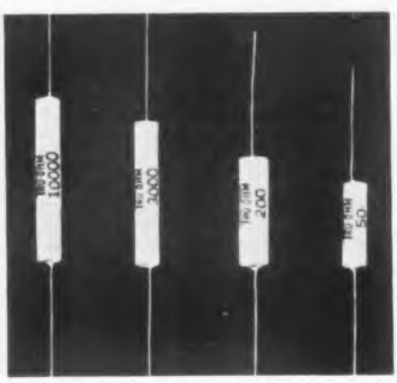
definition, excellent contrast range, low initial and operating costs. Consisting of a small 7-½ camera head, control monitor, and a rack-mounted power supply, the chain can be used in a number of operating arrangements which require no shading operator. An optical multiplexer (FTL-287A) when used with the camera, provides pictures from two film projectors, a 2 x 2 in. slide projector, and a 4 x 5 in. opaque projector—all automatically controlled. **Federal Telecommunication Laboratories, Div., of International Telephone and Telegraph Corp., 500 Washington Ave., Nutley, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES

tural base elements are assured rigidity and collapsibility by easily locking mechanisms. When dismounted from the caster-mounted dolly base, the tripod can be used as a lightweight unit for outdoor use. Height is adjustable from a low-level 8 inches to a full 52 inches. The tripod unit folds into a 31-inch length, and weighs less than 40 lbs. **Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES

New Components for the

AXIAL LEAD RESISTORS

"Tru-Ohm" axial lead resistors are wound on a continuous fibre glass cord. Cut to the required length, the leads are then securely clamped at each end. Then, the core is coated with silicone cement and inserted into a ceramic tube. The tube provides maximum mechanical protection and high dielectric strength. The ends of the resistors are



then sealed with silicone cement which precludes moisture coming in contact with the resistance element. The units are supplied in standard watt ratings of 5, 7, and 10 w. and maximum resistance values of 1,000 ohms, 5,000 ohms, and 7,500 ohms, respectively. **Tru-Ohm Products, Div. of Model Engineering & Mfg. Inc., 2800 N. Milwaukee Ave., Chicago 18, Ill.**—TELE-TECH ELECTRONIC INDUSTRIES

CROSSBAR SWITCH

A crossbar switch for automatic control systems and computers enables the interconnection or selection of many different circuits. Mounted for drawer-like removal from its rack, the switch incorporates palladium contact points and can provide any circuit connection in approximately 50 msecs. by energizing 2 specific coils. The unit is capable of many applications, such as connecting any 3 of 60 circuits to any 75, or choosing one circuit from as many as 936. Its modular construction provides many of the interconnections which must be made in relay trees, etc. **Kellogg Switchboard and Supply Co., 79 West Monroe St., Chicago 3 ,Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

K-BAND TEST HORNS

Types Nos. 68053, 68052, and 68051 K-band test horns for use in radar and microwave testing procedures, have respective ranges of 12.4 to 18.0 KMC, 18.0 to 26.5 KMC, and 26.5 to 40.0 KMC. Used as test receiving antennas, these horns can locate r-f leakage and approximate gain checks on microwave antennas. Employed as transmitting

horns, they can be applied in antenna pattern measurements, illumination of parabolic reflectors or lens arrays, and for termination of high-power systems into space. Each rectangular exponential-shaped horn is cast in one piece, which insures minimum deviation from extremely close tolerances demanded at K-band frequencies. Smooth surfaces and high dimensional accuracy assure low VSWR, and secondary lobes over the entire waveguide frequency range. **Airtron, Inc., 20 East Elizabeth Ave., Linden, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES

DELAY LINES

Type SDL-15 solid ultrasonic delay line provides delay intervals of 1,000 yds., 3.051 μsecs; Type SDL-16, 2,000 yds., 6.102 μsecs. Carrier frequency is 30 MC. Attenuation is 26 db into 1,000 ohms. Bandwidth is 8 MC. **Bliley Electric Co., Union Station Building, Erie, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES

VARIABLE RESISTOR

The Type YGC-B45 composition variable resistor has a self-supporting snap-in bracket that enables mounting directly to the printed circuit panel. The control is held tightly by the bracket during the soldering process, and anchored to the printed circuit panel by the solder. The bracket also prevents any mounting or operating strain on the control or switch terminals. Further, bracket anchor tabs enable mounting directly to the cabinet when it is desired to eliminate possibility of strain on the printed circuit panel. Adequate clearance for circuit paths is provided for by ample spacing between terminals and the design of the bracket mounting lugs. **Chicago Telephone Supply Corp., 1142 W. Beardsley Ave., Elkhart, Ind.**—TELE-TECH & ELECTRONIC INDUSTRIES

PULSE MAGNETRON

The RK-6410/QK-338 fixed frequency pulse magnetron was shown recently for the first time. Operating between 2,750 and 2,860 MC peak powers of 5 megawatts, the unit is said to be by far the highest power magnetron available. Recently declassified, data is available on request. **Raytheon Manufacturing Company, Equipment Engineering Div., 148 California St., Newton 58, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES

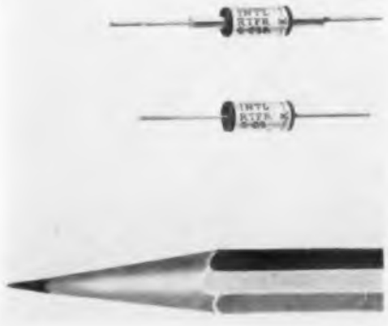
CONNECTOR

The Series "C-20" high-voltage, single-contact, cable and panel connector is suitable as a feed-through that provides an easy way to pass a single lead through a rack and panel arrangement. The hood serves as a grip for disconnecting both parts. The miniature connector has the extra-long barrier required for high arc resistance applications. Accidental disconnection of plug

and socket is prevented by a vibration ring with a detent vibration spring. The units are available in three materials: asbestos-filled "Melamine" for high dielectric and mechanical strength; "Plaskon Alkyd," glass re-inforced 440A, for high impact strength and arc resistance; and "Diallyl Phthalate" with high dimensional stability. Socket and pin contacts are of temper phosphor bronze and brass, respectively, and gold plated over silver for low contact resistance and ease of soldering. **DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

DIODES

Designed for circuit frequencies up to 3,000 MC/sec with a low noise figure of 10-14 db at 500 MC, Type G02 is for solder-in applications where space is limited. The mixer diode is $\frac{5}{32}$ in. in diameter and $\frac{3}{8}$ in. in length and provided with No. 24 tinned copper leads



SHIELDMOUNT

The T-2x3 shieldmount is fabricated from spring temper phosphor bronze. Having excellent heat dissipating qualities, it is said to prolong tube life and protect closely spaced components from concentrated high temperatures. The unit can be obtained silver plated, blackened, or unfinished. Further, it can be riveted directly to the chassis or terminal board and has a grounding lug

for use on insulated material. **National Electrical Machine Shops, Inc., 919 Jesup-Blair Drive, Silver Spring, Md.**—TELE-TECH & ELECTRONIC INDUSTRIES

0.020 in. in diameter. Type G02A, with the same dimensions, includes $\frac{5}{16}$ in. clip pins for plug-in applications and has No. 22 tinned copper leads 0.025 in. in diameter. Both units are direct replacements for any UHF diode employed for mixers in TV tuners and converters. **International Rectifier Corp., El Segundo, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

TUBES

RCA-3A3 half-wave vacuum rectifier tube is a glass octal type that utilizes an indirectly heated cathode. It is designed for use as a rectifier of high-voltage pulses produced in the scanning systems of TV receivers. RCA-6BD4 is a low-current beam triode of the sharp-cutoff type. It is designed specifically to regulate high-voltage, low-current dc. power supplies. It has a maximum dc. plate-voltage rating of 20,000 v., a maximum dc. plate-current rating of 1.5 ma., and a maximum plate dissipation rating of 20 w. The high-voltage insulation in this unit is obtained by a double-ended structure that uses an electron gun consisting of a thermionic cathode and one grid. The plate connection is made to a small cap at the end of the bulb. **Tube Department, Radio Corporation of America, Harrison, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES

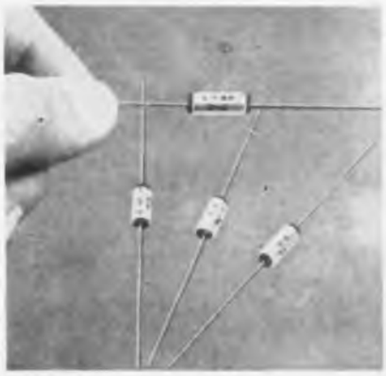
DC MOTOR

The Type DC-8-A-1 permanent magnet dc. motor, designed for 28 v. operation in airborne navigational, fire control and photographic equipment, has a no load speed of 25,000 rpm. Minimum stall torque is 1.0 oz. in. At 12,000 rpm, useful power at the shaft is in excess of 6 w. Maximum efficiency exceeds 70%. A 12-section commutator enables delivery of torque without cogging effects at low

speeds. Overall diameter of the unit is 0.750 in. Maximum length is 1.250 in. **Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES

CAPACITORS

Type TAN sub-miniature tantalum-foil electrolytic capacitors have a $\frac{9}{16}$ in. length and only a $\frac{3}{16}$ in. diameter. Their operating temperature range is from −55° to +85°C. and they have a considerably lower leakage current than other electrolytic types—which extends service life and provides exceptionally long shelf life. It is said that power factor characteristics are excellent even at the lowest rated operating temperature. Thirty-five new subminiature units are available that range in capacity from 0.01 μf to 8.0 μf and from 3 WVDC to 150 WVDC in both polarized and non-polarized types. **Cornell-Dubilier Electric Corp., South Plainfield, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES



New Electronic Amplifiers

MAGNETIC AMPLIFIER

The low level magnetic amplifier Model M-21, suitable for current measurement from high impedance sources, contains only one half-wave rectifier. Input current from 0 to 50 μa dc. pro-

duces a linear output from 0 to 5 ma. dc. into 100 ohm load. Model M-22, a self-balancing type, contains only one full-wave bridge rectifier. Suitable for voltage measurement, dynamic impedance of the control loop is as high as 100 to 500 times the actual dc. resistance. An input voltage from 10 to 10 mv. dc. produces a linear output from 0 to 5 ma. dc. into 1,000 ohm load. DC voltage gain up to 5,000 in 100 ohm load. For both models, the supply voltage is 50 v. ±10 v., 60 cps. Supply voltage variation of 20% has negligible effect on output. Zero drift for 10 hrs. is in the order of 10^{-12} w. Time constant 1 cps. Dimensions 2 x 2¼ x 2½ in. **Magnetic Controls, Inc., 119 West 63 St., New York 23, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

SERVO AMPLIFIER

Type SA118H miniaturized servo amplifier eliminates the need for an external dc. source. The plug-in, hermetically-sealed type unit is designed to control its companion 400 cps, two-

PREAMPLIFIER

Four units of a new series of binaural equipment are identical in panel appearance. All are playback preamplifiers that feature balance and gain control and are provided with proper equaliza-

tion. Two of the units are designed for tape and two are for disc use. Further information on the series is available at the company's audio division. **Eder Engineering Company, 1568 South First St., Milwaukee 4, Wis.**—TELE-TECH & ELECTRONIC INDUSTRIES

phase servo motor which requires 2 w. electrical input to the control phase. The two units function as a unified "controller assembly" for any precision servo mechanism application. The amplifier is furnished with three precisely matched 1.0 megohm mixing resistors to provide summed inputs of equal gain. Maximum plate dissipation is less than 2 w. Plate current varies between 5 and 17 ma. The 400 cps amplifier in-put power requirements are 300 v. for the plates of the four tubes and 6.3 v. (2.1 amps.) for the heaters. **Servomechanisms, Inc. Westbury Div., Post and Stewart Avenues, Westbury, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

DIFFERENTIAL AMPLIFIER

Type 501 differential amplifier is a wide-band unit that will convert a differential signal into a single-ended signal. It consists of two identical channels and an output voltmeter for indicating the potential of the output signal. Each channel has a high differential ratio amplifier stage and a balance-to-unbalance converter with no transformer, Therefore the degree of rejection of the common-mode signal can be made very high over a wide frequency range. The ratio of the amplification for differential signals to common-mode signals over 38 x 10^{6} from 8 cps. to over 500 KC.

DC AMPLIFIER

The Series 80 dc. amplifiers convert low level dc. μa. or mv. inputs to a high level dc. current output. Incorporating a high gain feed back loop, the new unit is said to have exceptionally long and

short term stability characteristics. Of the null balance type, the amplifiers have extremely high input impedance when used with voltage inputs. Consequently, they draw no current from the source. Where the input is current, the input impedance is negligible. Ranges extend from five μv. and 20 μa. full scale and the output is five ma. full scale. **Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 North Fourth St., Philadelphia 33, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES

Frequency response is flat with in 3 db. from 2 cps. to 1 MC. Voltage amplification is approximately 30. Input impedance is 2.7 megohms shunted with 15 μμf. from any terminal to ground; 5.4 megohms shunted with 10 μμf. between two off-ground terminals. **Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES

New Computer Products

CODED KEYBOARD

The Model FK-104 coded automatic keyboard is a manually operated electro-mechanical device for producing parallel electrical pulse codes. Twenty-one keys produce codes for

numbers 0 through 9, letters *a* through *f*, decimal, plus, and minus characters, and tabulate and carriage return typewriter functions. The code is formed by a mechanical matrix consisting of six spring-loaded permutation bars operated by a solenoid-controlled restoring bail. The Model FK-104 can accommodate any keyboard arrangement up to 22 keys and produce any type of binary code. Other models can be supplied to include any number of keys up to 64 with any desired code of six binary digits or less—i.e., binary decimal, binary-coded decimal, or combinations thereof. **Soroban Engineering, Inc., Box 117, Melbourne, Fla.**—TELE-TECH & ELECTRONIC INDUSTRIES.

COMPUTER

An electronic computer that is a digital differential analyzer, utilizes the decimal numbering system in both programming and in calculating solutions. The fundamental operation of the machine is the numerical integration of any variable with respect to any other variable, linear or non-linear, which generates a third variable. Integrators may also be coded to perform addition,

multiplication, division, comparison, limiting, decision, and servo operations. The instrument has a capacity of 60 integrators. Normal operation rate is a speed of 100 iterations/sec. Should a problem require 30 integrators or less, the iteration rate of the independent variable may be doubled to 200 iterations/sec. Critical electronic components have been rated at 50% of manufacturer's specifications to assure reliable operation. **Bendix Computer Division 5630 Arbor Vitae St., Los Angeles 45, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

GENERAL COMPUTER

The model 30-203 electronic digital computer employs an easily understood binary number system in which four binary digits form each decimal digit. The four binary digits are operated

upon in parallel, while each successive decimal digit is handled serially. By this series—parallel operation, computational speed is materially increased over ordinary series operation, and the necessity for conversion from and to the decimal system for input and output is eliminated. **Consolidated Engineering Corp., Computer Div., 300 N. Sierra Madre Villa, Pasadena 15, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

"INDITRON" TUBE

The "Inditron" tube shows on a filament the digits or letters usually recorded on the mechanical dials af tabulating machines. The number of digits, or letters flashed from the recording device is determined by the number of "Inditrons" lined up in readable rows. The tube can be built to any size. Its inventors expect it to replace mechanical recording devices in electric clocks, pin-ball machines, electronic computors, scoreboards, and other devices requiring quick portrayal of tabulated information. **National Union Radio Corp., Jacksonville Road, Hatboro, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES

STORAGE ELEMENTS

Model SR-200 encapsulated magnetic storage elements are designed to serve as storage elements, shift registers, and control elements. The unit is a high-speed device using but one core per

stored digit, and it is capable of working at rates up to 350 KC. Designed for dip-solder assembly, its overall size is $^{9}/_{16}$ x $1^{5}/_{8}$ x $1^{7}/_{8}$ in. Nominal shift current is 300 ma. Shift pulse width is 0.5 to 1.5 μsec. Output signal amplitude is 15 v. **Epsco, Inc., 126 Massachusetts Ave., Boston 15, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES

COMPUTING DIFFERENTIAL

The $^{1}/_{8}$ in. single spider-gear differential is designed to meet the military and commercial standards. The unit adds and subtracts mechanically with high accuracy, and can operate over a wide environmental range. It weighs less than 1 ounce, and performs in a working circle of one inch maximum diameter. Breakaway torque at no-load is 0.01 oz.-in., The unit is made of stainless steel to ensure low wear and high corrosion resistance. **Ford Instrument Co., Div. of the Sperry Corporation, 31-10 Thomson Ave., Long Island City 1, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

New Test Equipment

FREQUENCY MULTIPLIER

The Model FM-4 microwave frequency multiplier measures and generates frequencies in the microwave region with continuous coverage. It has a basic fundamental range of 500-1000

MC. Utilizing harmonics of the basic fundamental oscillator, frequencies as high as 12,500 MC. can be generated and measured. Frequencies as low as 100 MC. can be successfully measured by selecting a harmonic of the unknown which falls with the 500-1,000 MC. fundamental range, and dividing the measurement by the harmonic number. The unit can be driven from any source that generates frequencies within the 500-1,000 MC. range or generates harmonics within that range; or, has sufficient output to generate harmonics in that range within the FM-4. Completely self-contained, the instrument can be operated from a 105-127, 60 cps. ac. line. Dimensions 16 x 12 x 21½ in. Weight 40 lbs. **Gertsch Products Inc., 11846 Mississippi Ave., Los Angeles 5, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

BRIDGE

Model 601 high resistance bridge measures resistance in a range from, 100K to 100 megohms to an accuracy of better than 0.25%. The circuit is a simple wheatstone bridge network with the unknown and a 10-turn Helipot in adjacent legs. Bridge unbalance voltage

is amplified by a vacuum tube voltmeter and fed to a null indicating panel microammeter. At balance, resistance values correspond to Helipot dial setting multiplied by appropriate factor of 10. The unit is basically ac. mains operated, but contains a long-life 45 v. B battery for greater stability of bridge voltages. It is housed in a miniature Shasta "A" cabinet. **Shasta Division, Beckman Instruments Inc., P. O. Box 296, Sta. A, Richmond, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

TV ADAPTOR

The Type 124 adapts any triggered wide-band oscilloscope to the observation of the TV composite video signal. Its delay trigger output is continuously variable from zero to 24 milliseconds

after receipt of a vertical sync pulse. By adjusting the delay, an oscilloscope can be triggered at the start of any desired line in a field. Panel push button provides instant shift to opposite field. Triggering occurs at half the TV vertical rate. Output pulse duration is less than 1 μsec. Amplitude is 2 v. positive. Triggering may be accomplished by the composite video signal of either polarity, 0.5 v. minimum to 20 v. maximum, peak-to-peak, or a 60 cps. sine wave. The time-marker generator requires a gate of 20 v. minimum to 60 v. maximum, peak-to-peak. Amplitude is continuously variable from zero to 30 v. Size: 6¾ x 12¾ x 12½ in. Weight 20 lbs. **Tektronix, Inc., P. O. Box 831, Portland, Ore.**—TELE-TECH & ELECTRONIC INDUSTRIES

TIMER

Model 432 interval timer is a precision instrument for measuring short time intervals in three ranges; 0.01 to 9.99 msec., 0.10 to 99.9 msec., and 1 to 999 msec. Additionally, the instrument serves as a high-speed totalizing counter with a count capacity of 999, and as secondary frequency standard with outputs of 100 KC., 10 KC., 1.0 KC., 100 cps., 10 cps., and 1 cps. A choice of three time-base frequencies is provided: 100 KC., 10 KC., and 1 KC. All time-base signals originate in a 100 KC. crystal-controlled oscillator. Counts are indicated by neon lamps that show through transparent numbers from 0 to 9 arranged in vertical columns-one column for each digit. **Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

INSTRUMENTS

The Model 281 line of portable miniature dc. instruments (accuracy within 1%) incorporate a self-shielding mechanizm and other improved features. Shielding is such that the magnetic field

of a conductor carrying 15,000 amps. at a distance of 3 ft. causes a temporary indication error of less than 1%. Furnished in "Bakelite" cases, the instruments withstand a dielectric test of 2,600 v., ac., rms. between case and terminals, applied in accordance with the A.S.A. specifications. Scales are hand-calibrated with mirror and knife-edge pointers combined to eliminate parallax errors. The instruments are supplied in a wide variety of ranges in single and multi-range voltmeters, ammeters, and voltammeters. Dimensions: 4½ x 4½ x 1½ in. **Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.** —TELE-TECH & ELECTRONIC INDUSTRIES

—meeting requirements as needed with sound engineering design, volume production, efficient and prompt handling, these form the basis of CINCH service.

CONSULT CINCH

Countless problems have been solved by the large variety of adequate CINCH components. Flexibility of CINCH design and production meets emergencies and changes in application; supplies custom made components to fit when occasion demands.

CINCH SOCKETS:

- Tube (Receiver, Transmitter and Special): Battery, all types
- C-R Tube
- Crystal
- Electrolytic
- Glass Type; 4 to 7 prong laminated
- Infra-red Ray Tube
- High Altitude Airborne Types
- Kinescope; Magnal, Duodecal, Diheptal
- Loktal-Miniature-Multiplug-Noval-Octal (Molded bakelite, steatite, teflon, Kel-F and laminated)
- Plexicon
- Printed Circuit
- Special Sockets to Specs
- Sub-Miniature; Hearing Aid Types
- TV; 110V Circuit Breakaway
- Vibrator
- Pencil Tube Transistor
- Diode

Precision-built metal plastic assemblies, such as the Plexicon socket equipped with ceramic condensers, are in constant and continuous production. CINCH demonstrates ability to hold tolerances on mica, to mold high dielectric powders, to meet the most exacting requirements in metal plastic assemblies.

CINCH electronic components are available at leading jobbers—everywhere.

CINCH-ERIE "Plexicon"

Tube Socket, a joint development of ERIE RESISTOR CORP., and CINCH MANUFACTURING CORP., now in universal use, commercial and military types: available also in Octal, Loktal and Noval types.

. . . provides shortest electrical path to ground . . . simplifies wiring . . . reduces space required by circuit components.

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

WASHINGTON
News Letter

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

SENATE VIEW AT UHF—Exploration of ways to develop UHF television in the nation was the subject of an intensive two-day hearing in the latter part of April by the Communications-Radio subcommittee of the Senate Interstate Commerce Committee, particularly with the aim of securing the economic facts and operational status of that television service of the future. The hearings were scheduled for April 27-29 by Senator Charles E. Potter, Michigan Republican, who heads the subcommittee and who announced the plans for the inquiry just before TELE-TECH's press deadline. Major points to be considered are UHF acquisition by multiple TV station owners; network affiliations; adequate power for UHF stations; and differences in the cost of equipment between UHF and VHF. Leading Senators are greatly concerned with withdrawals of UHF video applications at the FCC.

LICENSE FEES—As a result of the unanimous action by the Senate Interstate & Foreign Commerce Committee that the FCC should suspend its promulgation of license fees for broadcasting-television, communications companies and mobile radio applications, the FCC was certain to hold up any action on its fee plan for another year. At presstime it appeared certain that the FCC was prepared to inform the Budget Bureau that the Commission intended to honor the Senate committee's resolution unless the budget agency directed it to do otherwise. The largest fee proposal in the schedule as originally announced by the FCC would have been imposed on new types of radio-electronic equipment and systems for type approval by the agency.

UTILITIES' MOBILE RADIO—Representing the electric power utilities of the nation, rural electric cooperatives and gas, steam and water utilities, the National Committee for Utilities Radio in its recent annual meeting in Washington became the first organization in the mobile radio field to ratify the objectives of the Microwave Users' Council. The NCUR at its meeting also formulated a program so its users of mobile radio services would speedily adopt split-channel operation for mobile radio frequencies and geographical sharing with other radio services.

FCC MICROWAVE PLAN—Divergent views as to how the FCC should handle the proposed reallocation of microwave frequency space in the division of specific portions of the band above 890 megacycles for exclusive allocations for common carrier and safety and special radio service operations were filed with the Commission by the American Telephone & Telegraph Co., Motorola, Raytheon and several of the larger private radio user groups. AT&T's position in essence was that the Bell System had a comprehensive program toward effective utilization of frequencies within this range long under way, and that the proposed reallocation should not disturb this plan. Raytheon asked for specific frequency space for industrial television operations. Motorola advocated that the proposed reallocation be postponed until results of a current study of the private user mircrowave picture, instituted at the request of the FCC, are evaluated. Motorola was joined in this position by four major user groups—National Committee for Utilities Radio, American Petroleum Institute's Central Committee on Radio Facilities, National Forest Industries Communications, and the Special Industrial Radio Service Association.

LAND-MOBILE RADIO SURVEY—A plan to survey approximately 25,000 land-mobile radio licensees in an effort to assemble concrete data on the number of transmitters in use and in the degree of use of the land-mobile frequencies has been inaugurated by the FCC in cooperation with the Radio-Electronics-Television Manufacturers Association. The information sought from the approximately 25,000 licensees holding nearly 50,000 grants authorizing more than 350,000 mobile transmitters will aid the FCC in determining actual frequency usage, ratio of equipment authorized to equipment installed and operating, and the comparative saturation of the frequencies in different parts of the country. The survey covers the public safety, industrial and land transportation radio services and is anticipated to be of assistance to the FCC in the establishment of frequency assignment criteria and in planning for the future of these radio services.

REDUCED FCC STAFF—Approval by the House in early April and anticipated similar action by the Senate by the end of last month of the FCC appropriations for the next fiscal year starting July 1 means a reduced staff of 120 persons in the Commission's safety and special radio services bureau. The Congressional action was for an appropriation of $671,000 for this segment of the FCC's functions during the next fiscal year as compared with $772,442 during the current fiscal year which ends June 30. The reduced staff is slated to handle growth in the mobile radio and microwave fields to an anticipated total of 289,000 base and mobile stations by June 30, 1955. The FCC spokesman before the Congressional committees stressed that with the numerically inadequate staff the Commission has had to be occupied with current problems resulting from the rapid expansion of the various services to the exclusion of long range planning necessary for orderly regulation and use of frequencies in this field.

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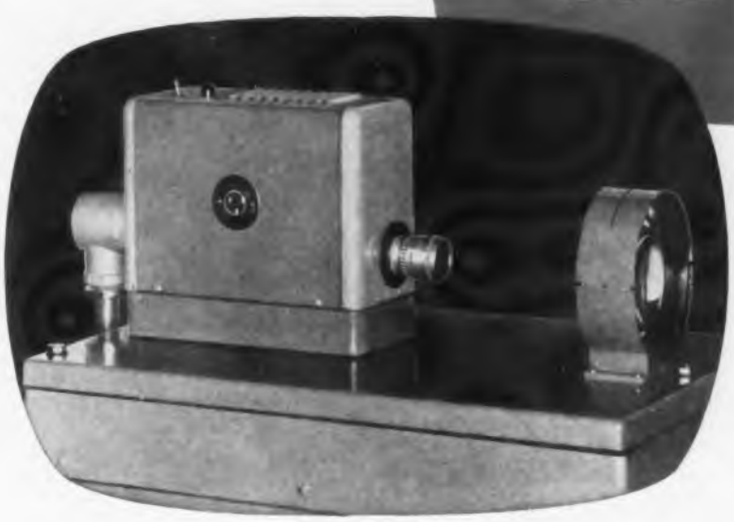

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DISTRIBUTED DELAY LINES *(Continued from page 76)*

which was chucked in the lathe. The longitudinal travel of the wire guide could be as low as 0.00066 in./turn. As this distance is a fraction of the wire diameter, the result was a multiple layered coil approximating a bank winding. The far end of the core was attached to a counter chucked in the tailstock. A steel drill rod was inserted through a hole in the core for rigidity. A 10-in. long winding was wound on the core. Lines have been wound with speeds varying from about 200 to 800 rpm.

A magnified view of the end of the line showing details of construction appears in Fig. 7.

Measurements

The method for determining the characteristic impedance of these delay lines was based upon the fact that no reflections occur in an idealized delay line terminated in its characteristic impedance. The value of the characteristic impedance in a practical case involving complex waves must therefore be compromised for minimum reflections over the band of frequencies for which the line is designed to operate. The lines were terminated at the input as well as the output to minimize any possible secondary reflections at the input. A suitable means of determining the effective characteristic impedance when the line is used to delay rectangular pulses is to feed the pulse itself into the delay line and to adjust the terminating impedances for minimum reflections. The oscilloscope sweep was triggered by the input pulse. A camera, mounted on the oscilloscope, was used to record the input and output wave shapes of the delay line. A video amplifier was placed between the delay line and the pulse generator. The load impedance of the video amplifier was made equal to the characteristic impedance of the line.

The pulse distortion and attenuation were also measured with the same equipment. The oscilloscope camera was used to record the wave forms of both the input and output signals and the measurements were made directly from the photographs as the sweep of the type 517 oscilloscope is quite linear and the sweep time in milli-microseconds per centimeter quite accurate. The vertical gain was kept constant for both input and output pulses so that attenuation measurements could be made from the photographs.

The delay time as well as the rise time and fall time was likewise measured on the oscilloscope. The delay time was defined as the time between the mid-point of the leading edge of the input and output waveforms. The rise and fall times were defined as the time duration between the 10% and 90% values of the pulse amplitude. The pulse duration was defined as the time between the 50% values. The attenuation was measured by comparing the amplitudes of the input and output pulses.

Although the pulse response of the lines was used as a measure of their ability, some sinusoidal data were taken. In order to determine the validity of the equations, a line was connected to a r-f signal generator through a 10,000 ohm resistor. The Tektronix 517 oscilloscope was used as a VTVM. With the line short circuited the frequencies at which the impedance of the line was a minimum was noted. The line was thus electrically $\lambda/2$, λ, $3\lambda/2$ etc. long. The measurements were repeated with the line open circuited, the line then being $\lambda/4$, $3\lambda/4$, $5\lambda/4$ etc. long electrically. From this data, the measured values of L_0 and C_0 at low frequencies, and the physical dimensions of the line, $\pi D/\lambda$ could be calculated. A plot of T/T_0 vs $\pi D/\lambda$ is of the form of Fig. 4.

Photographs of the input and output waveforms for several short lines appear in Fig. 8. All input pulses are 1 μsec duration. Line A has an average of 4.7 layers of AWG 41F wire and was 1.65 in. long with a delay of 1.03 μsec. This line had a bad reflection occurring near the middle of the line as can be observed. Line B has 4 layers of AWG 41F wire and was 2.44 in. long with a delay of 0.6 μsec. Line C has 3 layers of AWG 39F wire and was 2¾ in. long and had a delay of 1.17 μsec. The last row of photographs are the input and output waveforms observed using a 15-foot piece of RG-65/U cable which has a delay of 0.7 μsec. The gain of the scope was kept constant in each line so that the attenuation in the lines may be observed.

Waveform Variations

Photographs of the input, output and input and output waveforms superimposed appear in Fig. 9. Line D has 3 layers of AWG 41HF wire and was 9.75 in. long. It had a delay of 2.1 μsec. In the photograph of input and output waveforms superimposed some small variations are observed in the base line. Those not originating with the pulse itself (due to finite passband and compensation limitations) probably occur due to minor reflections from discontinuities in the line. Reflections of this magnitude are present in most of the lines wound. For comparison purposes the response of a 46-foot piece of RG-65/U cable is shown as well as a 3-foot piece of General Electric 1100 ohm cable.

Examples of lines wound with other insulated wires appear in Fig. 10. All these lines were wound with 3 layers of AWG41 wire with different types of insulation. Line F was wound with heavy formex insulation ($K_0 = 3.1$). Line F was wound with Sprague Electric Co. Ceroc ST insulation (assumed $K_0 = 3$). This wire has an inorganic ceramic insulating coating thinly deposited on copper wire with an overlay of teflon. Line G was wound with Sprague Electric Co. Ceroc 200 insulation (assumed $K_0 = 3$). This wire has an overlay of silicon instead of teflon but otherwise the same as Ceroc ST. Line H is a teflon insulated wire ($K_0 = 2$) of Hitemp Wires, Inc. In general the characteristics of all these lines are similar. Due to the lower dielectric constant of the teflon line H has a higher characteristic impedance and a shorter delay. The value of q used in designing all the lines shown in these photographs was 1.

More data on these lines appear

(*Continued on page 102*)

TABLE 1: CHARACTERISTICS OF DELAY LINES USED IN THIS PAPER

	dia (in)	length (in)	wire	Z_0	T (usec)	rise time of line	Attenuation DB	DB/usec	Time Delay/in	f_0 mc
Line A	3/16	1.65	41F	3900	1.03	0.1	—	—	0.63	4.4
Line B	3/16	2.44	39F	3900	1.2	0.11	—	—	0.45	4.2
Line C	3/16	2.75	41F	2650	0.6	0.07	—	—	0.22	6.8
Line D	3/16	9.75	41HF	4200	2.0	0.17	0.81	0.39	0.20	2.7
Line E	3/16	5.3	41HF	3900	1.2	0.14	0.72	0.58	0.21	3.2
Line F	3/16	9.9	41 Ceroc ST	4250	2.0	0.16	0.76	0.37	0.20	2.8
Line G	3/16	10.0	41 Ceroc 200	4250	2.0	0.15	0.72	0.33	0.19	2.9
Line H	3/16	10.0	41 Teflon	4750	1.75	0.14	0.52	0.3	0.17	3.2
RG65U	—	180.0	—	1000	.78	0.05	—	—	0.0043	8.8
RG65U	—	552.0	—	1000	2.4	0.12	1.68	0.7	0.0043	2.8
GE	—	36.0	—	1100	1.7	0.08	1.38	0.8	0.047	4.3

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in Table I. The cutoff frequency is computed from the rise time.[7]

$$f_0 = 0.445/T_r \qquad (21)$$

It is observed that these multilayer bank wound lines have considerably longer delays per axial inch, have considerably reduced attenuations for the same delay time, but suffer from poorer rise times, lower cutoff frequencies, and more internal reflections.

Experimental evidence indicates that the rise times of these lines increases slowly with delay time for delay times greater than 1 microsecond. The shape of the output pulse remains largely unchanged. RG-65/U cable has an exponential rise and fall with a flat top. It thus appears that multilayer bank wound lines might have a shorter rise time than RG-65/U cable as greater delays.

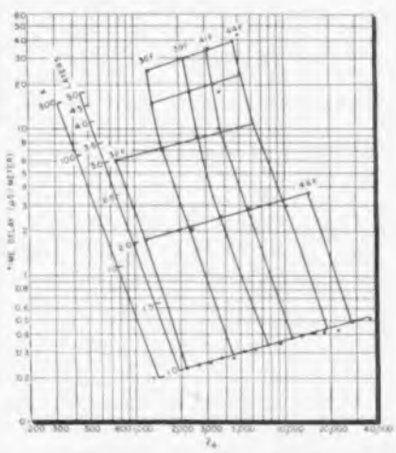

Fig. 6: Time delay vs. characteristic impedance for various wire sizes and number of layers

Experimental evidence indicates little variation of attenuation with different wire insulating materials. A higher dielectric constant material on the wire would give increased compensation and greater delays per unit length.

This paper was presented at the 1953 National Electronics Conference held in Chicago.

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7. David K. Cheng, "A Note on the Reproduction of Pulses," *Proc. I.R.E.*, vol. 40, p. 963; 1952

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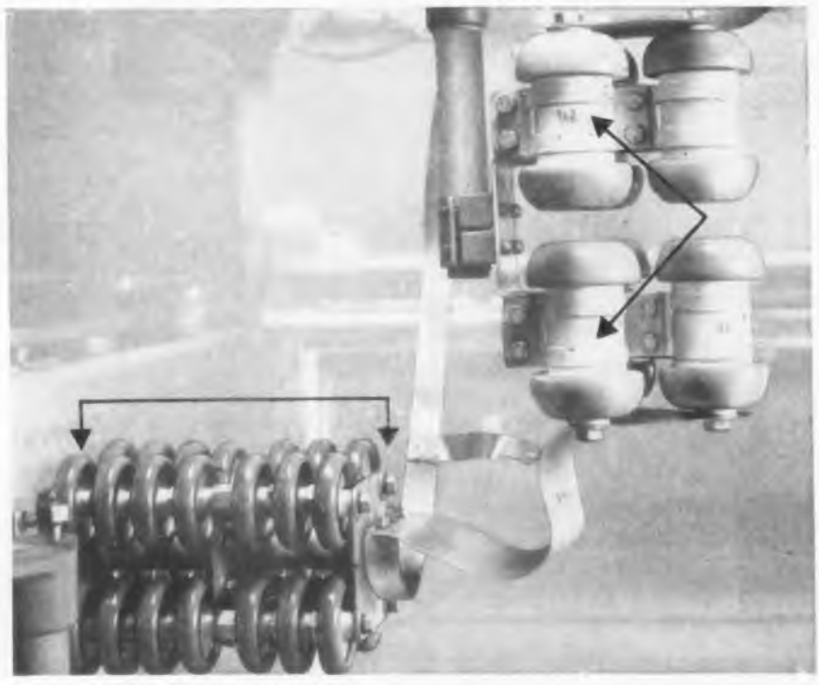

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NBS Indicator

(Continued from page 82)

probe, consisting of two coaxial coplanar coils wound on a dielectric core about ½-in. in diameter, is mounted on the turbine frame near the shaft. When the primary coil is energized from a regulated r-f source, a voltage is induced in the secondary coil. On the end of the turbine shaft is fastened a brass disk which forms part of the electrical system. Motion of the disk toward or away from the probe changes the mutual inductance between the two windings. Thus, the output voltage from the secondary is dependent on the spacing between the probe face and the brass disk. This voltage is indicated on a meter calibrated in thousandths of an inch and shows the shaft position relative to the main frame of the turbine. The probe assembly includes a graduated micrometer that provides for accurate adjustment of the spacing between the probe face and the disk.

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Joseph H. Gillies, Philco Corp. and Director of the RETMA Government Relations Department (left), talking with F. R. Lack, Western Electric Co. and Chairman of the RETMA Electronics Industry Committee, at the third annual membership luncheon of RETMA manufacturers of commercial and military electronic equipment. The one-day meeting and luncheon was held in connection with the IRE show.

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CUES for BROADCASTERS

(*Continued from page 81*)

consumes 8.7 amps. at 115 v. so a 20 v. drop will take place with the resistor in series. If the line voltage averages 120, leave the resistor as is, but for lower line voltages remove enough of the nichrome wire to give a lamp voltage of from 100 to 105. Fasten the ends of the wire to the mica form with 8-32 screws, nuts, and washers. Use #14 solid asbestos, or bare wire, to connect the resistor in series with the beacon. In most cases the wire will be stiff enough to make it self supporting.

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COMPARATOR

Model 60 impedance comparator has been designed for production line testing of resistors, capacitors, and inductors. The percentage deviation of the component under test from a standard component is read on a large meter. Four ranges are provided: 1%, 5%, 10%, and 20% full scale. One simple linear scale serves all ranges. No zero adjustment is required, and the range calibration is performed by a built-in standard. Operating push buttons and relays are unnecessary. Component impedance from 1.0 ohm to 5 megohms at 60 cps. can be compared. Built-in regulator permits line voltage variations from 105-125 v., 60 cps. Dimensions 9 x 15 x 8 in. **Industrial Test Equipment Co., 55 East 11th St., New York, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

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DESIGNATION AND TYPE					TYPICAL OPERATING CONDITIONS		
Type	Prototype	Bendix No.	Description	Base And Bulb	Heater Voltage	Plate Voltage Per Plate	M.A. Load
5838	6X5	TE-3	Full Wave Rectifier	Octal T-9	12.6	350.	70.
5839	6X5	TE-2	Full Wave Rectifier	Octal T-9	26.5	350.	70.
5852	6X5	TE-5	Full Wave Rectifier	Octal T-9	6.3	350.	70.
5993	6X4	TE-10	Full Wave Rectifier	9-Pin Miniature	6.3	350.	70.
6106	5Y3	TE-22	Full Wave Rectifier	Octal T-9	5.0	350.	100.

Type	Prototype	Bendix No.	Description	Base And Bulb	Heater Voltage	Plate Voltage	Screen Voltage	Grid Voltage	Gm	Plate Current	Power Output
5992	6V6	TE-8	Beam Power Amplifier	Octal T-9	6.3	250.	250.	12.5	4000	45. MA	3.5 W
*6094	6AQ5 6005	TE-18	Beam Power Amplifier	9-Pin Miniature	6.3	250.	250.	12.5	4500	45. MA	3.5 W
6385	2C51 5670	TE-21	Double Triode	9-Pin Miniature	6.3	150.	—	−2.0	5000	8. MA	—

*Tube Manufactured with Hard (Nonex) Glass for High Temperature Operation (Max. Bulb Temp. 300°C.)

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Vari-Focal TV Lens

(Continued from page 87)

and spring-loading is similar to that described for the lens trolleys.

The "zoom" action is produced by the rotation of a lead screw which moves the main carriage from one position to another while the necessary differential movement is applied to the two inner lens trolleys, coupled through racks, gears and cams.

The differential movement of the two inner lenses is provided by two identical plate cams which operate against ball bearing followers attached to the under side of the lens trolleys. The cams are provided with inner rims parallel with their outside contours and spring-operated rollers press against these. The reaction of the springs on the lens trolleys holds the cam followers firmly against the outer edges of the cams. The design of the spring-loaded mechanism is such that the compression of the springs remains constant, thus combining the accuracy of plate cams with the positive action usually associated with tracked cams.

Cams Rotate

The cams are mounted on the main carriage on ball bearing arbors. On the underside of the carriage, helical gears are attached to the cam arbors. These gears mesh with racks secured to the base. Thus, as the carriage moves, the cams rotate, varying the spacing of the inner lens elements to maintain precise focus as focal length is varied.

Movement of the main carriage is accomplished by a lead screw arranged parallel with one side of the carriage in ball bearings mounted on the side wall. A nut on the lead screw engages with a forked bracket on the main carriage in such a way that while linear motion is transmitted, the nut is free to float axially with respect to the carriage. The error in pitch normally associated with the production of a lead screw will, in this case, have no effect on the definition as focal length is varied.

Motor Control

The lead screw is driven through bevel gears which, in turn, are driven by a dc motor through belt drive. Control of the motor is brought out to a leaf type switch mounted on a control box. Forward motion of the switch effectively in-

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21ALP4A	Lo Es	Mag	85°	S	20 7/16"
21AMP4A	Mag	Mag	85°	S	20 7/16"
21EP4B*	Mag	Mag	65°	S	23"
21FP4C*	Lo Es	Mag	65°	S	23"
21WP4A	Mag	Mag	66°	S	22 1/4"
21XP4A	Lo Es	Mag	65°	S	22 1/4"
21YP4A	Lo Es	Mag	65°	S	23"
21ZP4B	Mag	Mag	65°	S	23 1/32"
24CP4A	Mag	Mag	85°	S	21 1/8"
24DP4A	Lo Es	Mag	85°	S	21 1/8"
24VP4A	Mag	Mag	85°	S	21 1/8"
27EP4	Mag	Mag	85°	S	23 1/16"
27LP4	Mag	Mag	85°	S	24 23/64"
27RP4	Mag	Mag	85°	S	23 1/16"

*Cylindrical Face. All others have Spherical Face Plates

Lo Es—Low Voltage Electrostatic
Mag—Magnetic
S—Single Ion Trap

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For those that don't know how interested they are in our products, we have a free four page bulletin highlighting the basic Sigma relay types. The next step from this is that, in response to a specific inquiry we will send, also free, the specific manual pages that we believe will apply to your problem.

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creases the focal length at a rate determined by the setting of a speed selector mounted on the same control box. Backward motion of the switch decreases focal length. Spring-loading returns the switch to a neutral position. Control of the drive motor is also brought out to a three-conductor Cannon connector on the underside of the lens housing to permit control of the "zoom" from any other location, for example, the camera "pan" handle, or camera control room.

Drive-Motor Circuit

Two switches open the drive motor circuit when the limit stop pins are approached by the lens trolleys. This prevents jarring the camera, causing visible picture displacement. The lens trolleys are actually brought to a halt by the friction of the motor.

Focusing is accomplished by movement of the front lens element. The bracket carrying the lens cell slides on parallel rods, one locating directionally and the other supporting. The movement is transmitted from a handwheel located on the side of the main case via a cable drive.

The initial iris setting is done with a knob on the side of the main case. Rotation of this knob presets a mechanical linkage which then maintains the preset aperture throughout the focal range by causing the operating pin of the iris to follow a prescribed incline.

Available Apertures

The highest apertures available through the complete focal range are as follows: In using the 3 to 15 in. back lens element, f/3.0 is available from 3 to 6.75 in. focal length. If the aperture is set at f/3.0 and the focal length is varied from the 3 in. position past the 6.75 in. position, the aperture decreases linearly, reaching f/6.3 at the 15 in. focal length. Hence, f/6.3 is available throughout the entire range while f/3.0 may be used at focal lengths shorter than 6.75 in. When using the 6 to 30 in. back lens element, f/6.0 is available from 6 to 13.5 in. focal length. If the aperture is set at f/6.0 and the focal length is varied from the 6 in. position past the 13.5 in. position, the aperture decreases linearly, reaching f/12.5 at the 30 in. focal length. In this manner, f/12.5 is available throughout the entire focal range while the f/6.0 stop may be used at focal lengths shorter than 13.5 in.

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Instrument Rectifiers

(Continued from page 88)

greater than the series combination of the forward resistance and meter resistance, and since the reverse resistance shunts this combination, its effect upon voltage response is negligible. Although the effect of the reverse resistance can be neglected, the rectifier forward resistance has a very pronounced effect upon voltage response. As the ambient temperature decreases, the rectifier forward resistance increases in a logarithmic manner and necessitates an in-

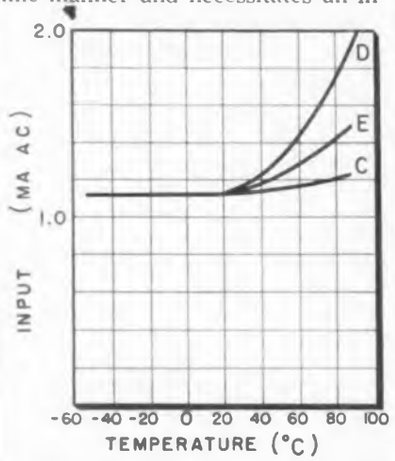

Fig. 3: Full scale deflection, full wave bridge with 0-1 ma, 100-ohm dc meter. (C) 0.080-in. dia. cell; (D) 0.5-in.; (E) 0.187-in.

crease of input voltage to maintain a constant output indication. This undesirable effect can be reduced by increasing the rectifier cell area. Referring to Fig. 1c,

$$FE_m = \frac{E_i R_m}{R + (R_f + \Delta R_f)}$$

$$E_m = \left(\frac{E_i}{F}\right) \frac{1}{1 + \frac{R_f}{R_m} + \frac{\Delta R_f}{R_m}}$$

F = form factor
E_m = meter response
E_i = input voltage
ΔR_f = change of forward resistance with temperature.

As the cell area increases the forward resistance decreases proportionally, and since ΔR_f is directly related to the initial value of R_f, it too is decreased thereby reducing the variation of meter response as temperature changes.

The variation of voltage response with temperature changes could also be reduced by using a meter with a larger internal resistance; however, if the unit must function as a milliameter, or as a multimeter, it would be desirable to maintain the overall resistance of the basic unit as low as

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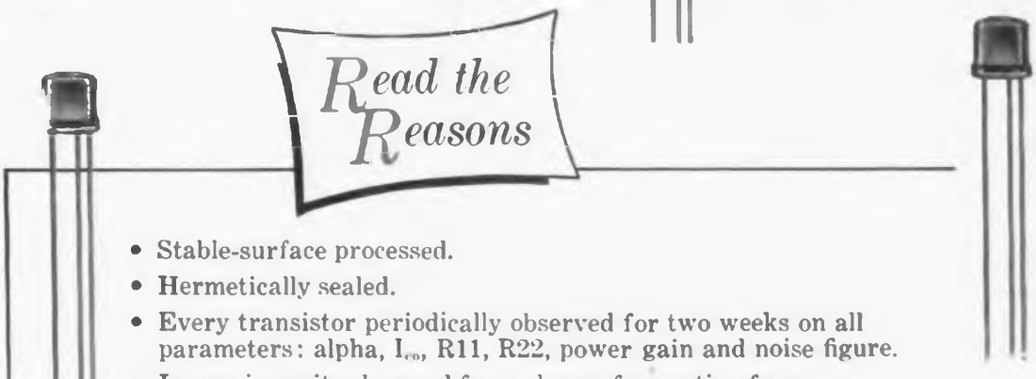

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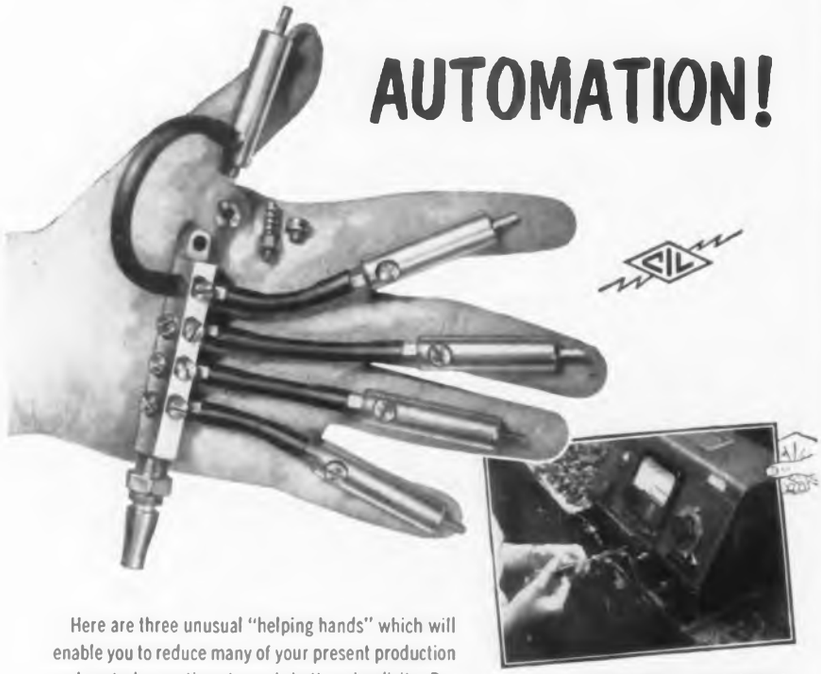

Here are three unusual "helping hands" which will enable you to reduce many of your present production and control operations to push-button simplicity. Because of their versatility, they will fire your imagination—suggest challenging new ways to manufacture better products faster, at lower cost.

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If your manufacturing process involves the testing, sorting, grading or matching of resistors, the Clippard P. R. 5 Automatic Resistance Comparator will pay for itself very quickly, permitting you to compare unknown resistors with a standard resistor simply by touching them across two terminals. Work can be handled either by unskilled operator or automatic production set-up.

The Clippard P. C. 4 Automatic Capacitance Comparator is a companion instrument permitting you to accurately check, grade, sort or match up to 8000 condensers of any type (10 mmfd to 1000 mfd) in one day. Either unskilled labor or automatic set-ups can be used.

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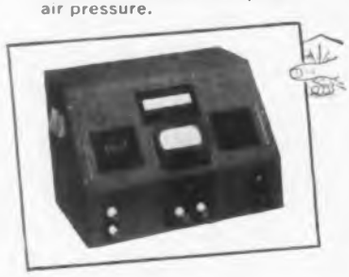
Clippard **MINIATURE PNEUMATIC CYLINDERS** (No. MAC 38), are shown above in a typical test jig set-up activating electrical contacts. Size of cylinders overall is 2 3/16" x 7/16" dia., stroke 3/8" maximum, spring return piston. Operates on as little as 12 pounds air pressure.



P. R. 5 AUTOMATIC RESISTANCE COMPARATOR permits unskilled operator or automatic set-up to test, grade, sort or match as many resistors a minute as can be touched across two front terminals. Range 100 ohms to 100 megohms. Three scales of deviation from your standard: —5% to +5%, —25% to +30% or —50% to +100%.

P. C. 4 AUTOMATIC CAPACITANCE COMPARATOR grades, sorts, checks or matches all types of condensers (10 mmfd to 1000 mfd) at production speeds with laboratory accuracy. Requires no accessories other than the standard capacitor against which unknowns are to be compared.

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possible. An increase of meter resistance would also tend to increase the current variation with temperature changes but this phenomenon will be discussed in detail later in the article.

Current Response: The change of current with temperature as illustrated in Fig. 3, varies directly with cell size. As the cell size is decreased, the current variation with temperature is minimized due to the increase in reverse resistance. This effect can be analyzed with the aid of the equivalent circuit of Fig. 1c.

$$FI_m = I \frac{R_r}{R_r + R_m + R_f}$$

$$I = FI_m \left(1 + \frac{R_m}{R_r} + \frac{R_f}{R_r}\right).$$

As the temperature of the rectifier increases the resistance decreases, and at high temperature the reverse resistance decreases to a point where it can greatly effect the amount of input current required to produce full scale current deflection. The small diameter cells have a high reverse resistance; therefore, this effect can be minimized. The current variation with temperature changes can also be reduced by decreasing the internal resistance of the meter, but this would tend to increase the voltage variation with temperature as explained earlier in the article.

Efficiency: The term efficiency shall be defined as the ratio, in percent, of the D. C. output to the A. C. input current. Efficiency varies indirectly with cell area, that is, an increase in cell area will produce a decrease in efficiency and vice versa. This variation can be analyzed with the aid of the equivalent circuit of figure 1(C).

$$E_{ff} = \frac{I_m\,(100)}{I} = \frac{I_m\,(100)}{FI_m\left(1 + \frac{R_m}{R_r} + \frac{R_f}{R_r}\right)}$$

$$= \frac{100}{F\left(\frac{1}{\frac{R_m}{R_r} + \frac{R_f}{R_r}}\right)}$$

An increase in efficiency will result with either a decrease of forward resistance or an increase of reverse resistance. Since the meter resistance is relatively constant, the ratio of R_m/R_r will decrease with an increase of reverse resistance tending to increase the efficiency; however, the ratio of R_f/R_r will decrease only if the increase of reverse

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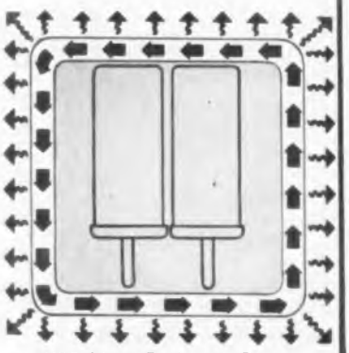

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INSTRUMENT RECTIFIERS (Cont.)

resistance is greater than the increase of forward resistance. As the reverse resistance increases the efficiency tends to increase, and since reverse resistance varies indirectly with cell area, the efficiency will improve as the cell diameter decreases.

The frequency response improves as the cell size decreases, and this phenomenon can be explained with the aid of the equivalent circuit of Fig. 1b and 1d. For all practical purposes the forward capacity of the rectifier, as well as the meter capacity and inductance can be neglected.

Frequency response limits are normally defined as the frequency at which the power ratio is down 3 db.; therefore, at this frequency the reactance of the network is equal to the resistance.

$$X_c = R$$

$$\frac{1}{2\pi fC} = \frac{R_r (R_f + R_m)}{R_r + R_f + R_m}$$

$$f = \frac{R_r + R_f + R_m}{2\pi C R_r (R_f + R_m)}$$

normally $R_r >> (R_f + R_m)$

therefore:

$$f = \frac{1}{2\pi C(R_f + R_m)}$$

$$C \cong K_1 A$$

$$R \cong \frac{K_2}{A}$$

Therefore the frequency limit can be expressed as,

$$f = \frac{1}{2\pi K_1 (K_2 + AR_m)}$$

As the cell area decreases the frequency limit increases improving the frequency response of the unit.

Summarizing the effect of cell area: A decrease in cell size produces an improvement of frequency response, efficiency and reduces the variation of current with temperature, whereas an increase of cell size only reduces the voltage variation with temperature.

To increase the range of a voltmeter a specific resistance is inserted in series with the unit; therefore, its response is directly related to the current flowing through this resistance. Similarly, to increase the range of a milliammeter a specific resistance is shunted across the unit; therefore, its response is directly related to the voltage across this specific resistance.

If the requirement is a voltmeter only, a small diameter rectifier cell would be desirable because of its

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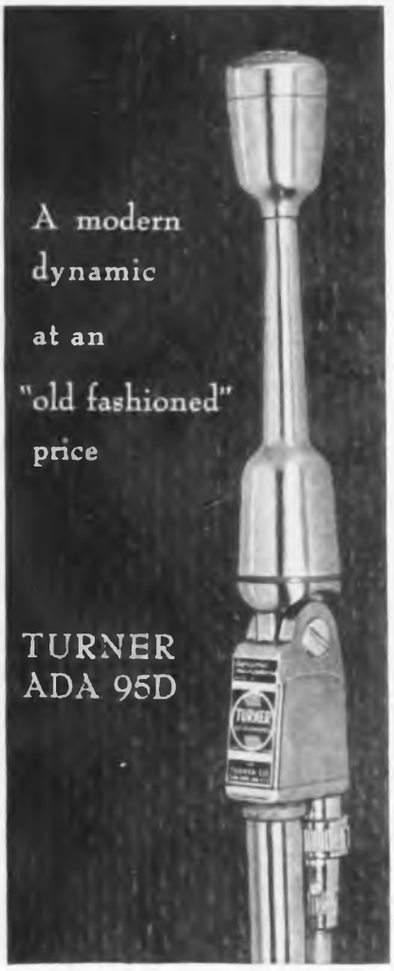

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INSTRUMENT RECTIFIERS (Cont.)

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Airborne Conference

(Continued from page 69)

COMPUTER SESSION

Moderator: M. S. McDowell, WADC-USAF.

"**Application of Cold Cathode Counting Tubes to Light Weight Airborne Digital Computer,**" J. M. Mayer, USAF.
"**Programming of Navigational Computation for an Airborne Digital Computer,**" R. M. Gustin, USAF.
"**Automatic Plotting Computer for the Crash Rescue System,**" A. A. Kunze, C. A. Strom, USAF.
"**A Flight Data Computer,**" L. Bogdan, Cornell Aero. Lab.
"**The TRADIC (Transistor-Digital) Phase I Computer,**" J. R. Harris, Bell Labs.

SERVO SESSION

Moderator: Ralph F. Redemske, Servomechanisms, Inc.

"**Experimental Evaluation of Amplitude-Dependent Nonlinearities,**" R. J. Mead, Goodyear Aircraft.
"**Synthesis of Carrier-Frequency Networks for Servomechanisms Phase-Lead Compensation,**" T. F. Mahoney, R. B. Wilcox, Raytheon.
"**Rotating Components and Their Application to High Performance Systems,**" R. N. Brown, Kearfott.
"**Modern Trends in Electronic Fuel Quantity Gauging,**" R. J. Levine, M. J. Minneman, Avien-Knickerbocker.
"**Magnetic Amplifier Miniaturization,**" F. Ainsworth, R. Heartz, Minneapolis-Honeywell.
"**Cascading Resolvers,**" L. Scheuer, Ford Instrument.

FORUM

Moderator: W. R. G. Baker, GE.

"**In the Challenge of the Jet Age, How Complex Can Military Electronics Equipment Get and Still be Practical, Maintainable and Tactically Effective?**" Representing Electronic Equipment Manufacturers: Fred Henderson, WE. Arthur F. Van Dyke, RCA. John F. Byrne, Motorola. E. K. Foster, Bendix. C. F. Draper, MIT. Representing Electronic Equipment Users: Maj. Gen. Clarence S. Irvine, USAF. Maj. Gen. Gordon S. Blake, USAF. John Keto, USAF. Henry C. Rempt, Lockheed. T. H. McNary, Boeing.

CIRCUITS SESSION

Moderator: Roy O. Sather, USAF.

"**Cathode Bypass Stabilization of Feedback Amplifiers,**" G. M. Strauss, W. L. Maxson.
"**A Simple Ground Range Sweep,**" E. Vogel, NYU; R. Gilbert, W. L. Maxson.
"**Circuits Designed to Amplify Closely Packed Pulses Over a Large Dynamic Range,**" S. Smith, J. Gerig, Melpar.
"**Smooth-Curve Function Generation Using Diodes,**" J. J. Stone Jr., Battelle.
"**Wideband Frequency Discriminators for AFC Systems,**" L. Mautner, Electronic Control Systems; L. S. Stokes, Hughes.
"**Stabilization of Microwave Signal Generators Through Tuning Techniques,**" D. L. Hockman, USAF; J. J. Brunelly Jr., USAF.

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ELECTRON TUBE SESSION I

Moderator: C. R. Knight, Aeronautical Radio.

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Evaluation of the Effects on Electron Tubes of Double Testing, Burning and Burning with Vibration," R. S. Whitlock, USAF.
Vacuum Tubes of High Reliability Under Extreme Environmental Conditions," J. H. Cyman, Bendix.
Electron Tube Life and Reliability—Variation of Life Performance with Usage Conditions," M. A. Acheson, Sylvania.
Reliable Receiving Tubes Designed for Automatic Production," W. R. Wheeler, E. L. Evans, Sylvania.
Advance Work on Electron Tube Reliability," H. E. Sorg, Eitel-McCullough.

EQUIPMENT SESSION I

Moderator: John F. Morrison, Bell Labs.

An Electronic System for Zeroing the Electrostatic Charge on Aircraft," F. M. Pelton, Cornell Aero. Lab.
The RAWIN, A Necessary Tool for Flight Operations," John A. Doremus, Cardwell Mfg.
An Improved Automatic Frequency Control System for Pulse Receivers," R. W. Howery, A. M. Sheeder, S. C. Stribling, RCA.
Effect of Alternating Power Characteristics on Electronic Equipment Design," J. W. Cramer, C. T. Anderson, GE.

NAVIGATION SESSION I

Moderator: M. Barry Carlton, Office of Secy. of Defense

Materials Application Techniques for Airborne Electronic Equipment," E. R. Gamson, Stanford Research.
The Design of Versatile and Reliable Computing Components for Use in Flight Training Equipment," R. M. Byrne, R. W. Snyder, Goodyear Aircraft.
Radar Reliability," A. S. Baran, GE.
Airborne Radar as a Navigational Aid," D. Mannheimer, Sperry.

MEASUREMENT SESSION

Moderator: K. C. Black, Polytechnic Res. & Dev.

An Automatic Test Set for DME Interrogator," S. A. Rinkel, Polytechnic Res. & Dev.
Measurement of Frequency During A Radar Pulse," H. P. Raabe, USAF.
Recent Developments in Microwave Refractometry," D. Metcalf, C. M. Crain, Univ. of Texas.
The Effect of the Variability Problem on the Validity of Magnetic Data for Materials Used in Electronic Transformers," W. T. Sackett Jr., C. F. Salt, Battelle.
Evaluation of Electronic Test Equipment," C. L. Frederick, E. E. Blanche, Frederick Research.

ELECTRON TUBE SESSION II

Moderator: Mr. A. Piori, Office of Naval Research

Design and Performance of Two New UHF Pencil Triodes for High-Altitude Operation," K. E. Hanft, W. E. Babcock, RCA.
Practical Considerations in the Design of Low-Microphonic Tubes," T. M. Cunningham, RCA.
Comparison of Random Noise and Sinusoidal Sweep Vibration Testing of Radio Tubes," L. Feinstein, Sylvania.
A Tunable Millimeterwave Oscillator of the Wavelength Range 0.5 to 0.9 cm," M. O. Thurston, Ohio State Univ.
A Voltage-Tunable Centimeterwave Oscillator of the Barkhausen Type," M. Uenohara, E. M. Boone, Ohio State Univ.
An RF Amplifier Tube for Airborne Communications Receivers," R. E. Moe, GE.

EQUIPMENT SESSION II

Moderator: John Woodward, RCA.

Airborne UHF Communication Equipment," G. H. Scheer, USAF.
Development of Super Hi-Power Test Components 'S' Band," Tore Anderson, Airtron.
High Capacity PTM-AM Telemeter," G. Anderson, Radiation.
Minimizing Clutter Residue in a Scanning MTI Radar," G. M. Kirkpatrick, M. M. Santa, GE.
Advancements in Pulse Radar Altimeters," D. H. Westwood, RCA.

NAVIGATION SESSION II

Moderator: V. I. Weihe, Air Transport Assoc.

Rotor Modulation in Omnirange Receivers," I. C. Gunning, USN.
A Flare Out Altimeter System," B. L. Snyder, USAF.
Trajectory Precision Requirements for Automatic Landing," J. L. Ryerson, USAF.

(*Continued on page* 124)

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New Color Stripe Generator for TV Stations

THE new color stripe generator developed by RCA for use by TV stations facilitates installation of color receivers in homes despite the relatively few hours of color programming presently being aired. The new unit, costing approximately $500, will add a narrow color stripe to the station's regular black-and-white signal. The color stripe, practically unnoticeable on black-and-white receivers, will enable the serviceman who is making a color TV installation to determine whether the station's color signal is reaching the receiver, after the set operation has been checked with the company's new portable dot and color bar generator.

How Stripe Generator Operates

The color test generator is designed for insertion in the video line feeding the TV transmitter in such a way that the normal system operation is not changed. The normal signal at this point in the system is a composite (video and sync) monochrome signal such as that shown in (a) of Fig. 1. The inserted color test generator does not change this basic signal at all but simply adds to it a small amount of color information. This information consists of (1) a color sync "burst" signal which appears on the "back porch" of the regular monochrome sync pulse and (2) a short test "burst" of color signal which is superimposed on the monochrome video signal at the right side of the raster as shown in (b) of Fig. 1.

Monochrome receivers are relatively "blind" to these added signal components because most receivers have relatively low response at 3.6 MC. In a color receiver, however, the color sync signal and color test burst signal operate to generate a single greenish-yellow bar (¼ to ⅜ in. wide) at the extreme righthand side of the picture.

On a color receiver, this bar will appear with the color gain control advanced as for a normal color picture. With the color control turned down, a normal b-w picture will result. Naturally, during a color transmission the color bar will be deleted. On a monochrome transmission however—even for such brief periods as station breaks (5-15 seconds)—this color bar will provide a color test signal. If the color bar is not apparent in its true color and intensity, it will be an indication that additional work is needed at that location, apart from the receiver. This work (antenna change, relocation or reorientation, distribution check, termination, etc.) could well be scheduled before the next transmission of the color bar.

Generator Construction

The RCA Type WA-8A Color Stripe Generator is built on an 8¾ in. wide bathtub chassis designed for standard rack mounting. It employs 11 tubes, two of which are used in the self-contained power supply.

A block diagram of the WA-8A Generator is shown in Fig. 2. Referring to this diagram the operation is as follows:

The input video signal is fed to a "sync separator" which amplifies the signal, then strips off the picture part

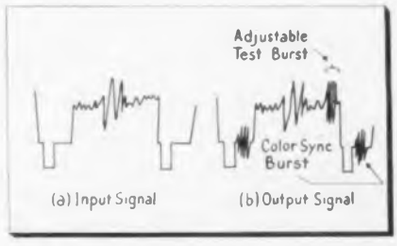

Fig. 1: Color signals added to video by test generator in line feeding the TV transmitter

of the signal, leaving only the sync signal to be passed on.

The "pulse width discriminator," to which the signal is next fed, blocks off the equalizing and vertical sync pulses, leaving only the horizontal sync pulses.

The separated horizontal sync pulses are used in two ways. First, they are fed to a "burst keyer amplifier and shaper" which amplifies and shapes these pulses and passes them on to a "gate" circuit. Here these pulses allow bursts of sub carrier frequency to go through to the putput amplifier at just the right time for these bursts to appear on the back porch of the standard monochrome horizontal sync signals.

The second use made of the separated horizontal pulses is to trigger a "delay" circuit which in turn triggers a "picture stripe keyer." The amount of delay determines the position of the color stripe on the picture. The "picture stripe keyer" is also variable so that the width of

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STRIPE GENERATOR (Cont.)

the stripe also may be varied.

The output of this keyer goes to a "gate" which allows bursts of subcarrier frequency to be passed to the putput amplifier. The timing and duration of these bursts depends on the setting of the delay and the keyer. Ordinarily these bursts are of very short duration and appear at the end of the raster as shown in (b) of Fig. 1.

The subcarrier oscillator which is the heart of the WA-8A Generator is a crystal-controlled oscillator which is not locked to the picture sync signals. However, it is mounted in a heat-controlled chamber so that it maintains its frequency of 3.58 MC within sufficient limits for the purpose.

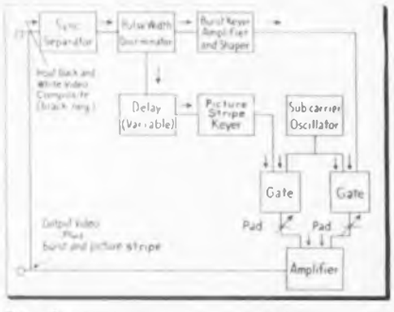

Fig. 2: Block diagram of WA-8A generator

The output of the two "gate" circuits are fed into an amplifier, the output of which is loosely coupled to the signal line.

It will be noted that there is a straight-through circuit from input to output. Thus a failure in this unit will not interrupt regular monochrome operation. The switch from normal b-w to b-w *plus* color stripe is effected simply by applying B+ voltage to the output amplifier and oscillator.

AIRBORNE CONFERENCE

(Continued from page 121)

"The Effects of R-F Phase Shifts on Delay Accuracies in Precision Ranging Systems," R. E. Williams, D. F. Gumb, Melpar.
"Navigation of Aircraft by Intermittent Commands from Ground Based Equipment," D. V. Gnau, Cornell Aero. Lab.
"Electronic Simulators for Study of Aircraft Flight Paths," S. L. McDonough, Cornell Aero. Lab.

ENVIRONMENTAL CONDITIONS SESSION

Moderator: John C. Wightman, WADC-USAF.

"Armament Electronics Installation Requirements Based on Human, Operational and Logistical Factors," L. Easley, USAF.
"Aspects of Missile Vibration Requirements Viewed from the Standpoint of Electronic Equipment Design," J. A. Hohos, W. H. Eggerton, Melpar.
"Effects of Non-Periodic Vibration on Electronic Equipment," C. R. Gates, Cal. Tech.
"Military Electronic Equipment Environments," K. D. Wuerl, USAF.
"A Sound Chamber for Environmental Testing of Small Electronic Components at High Intensities," F. Mintz, M. B. Levine, Armour.

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Video Recorder

(Continued from page 77)

positive and negative halves of this signal represent bits of picture information. This alternating rate is 169 KC. Consequently, each head records 339,000 bits per second and since there are ten heads the system is capable of recording 3,390,000 bits per second, or video signal information up to 1.60 MC.

It is not necessary to employ bias in this form of recording since the minimum signal amplitude remains sufficiently high to result in linear amplitude response.

Playback Action

On playback each of the ten video heads is excited by a strong carrier frequency rate of 169 KC, amplitude modulated in accordance with the original video information. By means of a full wave rectifier, each signal is converted at the output of its pre-amplifier from 169 KC ac to dc with a strong 339 KC component. This rate is used to control the sampling pulse generation and timing since it exists even at minimum signal levels. Thereby a 339 KC pulse of 0.15 μsec is formed. By means of a delay line this sequentially samples the rectified outputs of the various tracks by operating switches whose outputs are in parallel on a video bus. This video bus thereby receives a recreation of the original video signal. Such a signal contains a strong switching component at the rate of 3.39 MC, but this gives a half tone characteristic to the picture which is agreeably acceptable in the laboratory, although not directly suitable for TV broadcast transmission.

It has been pointed out that the sampling pulse is of 0.15 μsec duration but the highest sampling rate of the video signal is 0.34 μsec. There is consequently a dead time of 0.19 μsec between samples when no reading is taken. By shifting the time of sampling of the entire system such that it is alternately delayed between zero and 0.19 μsec at a 15-cycle rate, the entire field of the picture may be effectively made up of twice as many samples. This results in a high definition picture which appears to the eye to contain detail well beyond that of a 3.39 MC image. This is partly due to the fact that the sampling technique with its sharp edges results in a crispening effect since there can be no smear in this type of recording. Generally, no flicker is observed from employing this tech-

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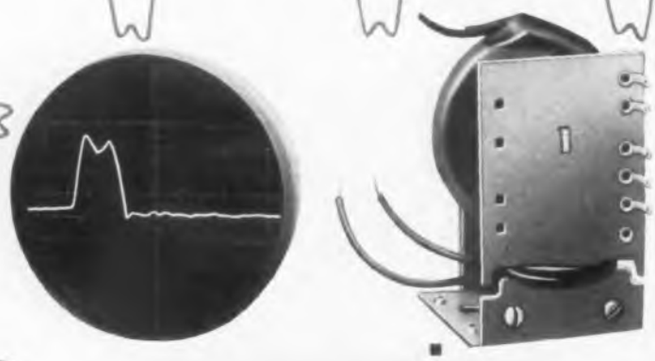

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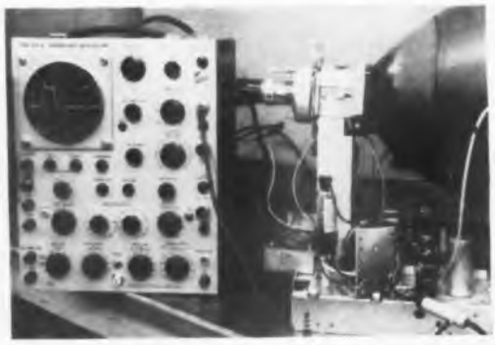

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VIDEO RECORDER (Cont.)

nique, but there are times on sharp edges when the 15-cycle rate becomes noticeable.

To be transmissible, the signal must have a high duty cycle. To achieve this we have constructed units which find application at the output of the video bus and which read only the peak value of successive samples. Thereby the picture is brought to an average energy level, the same as that of a customary signal. This "boxcarring", or dot connecting device, when used with the 15-cycle shift results in a picture having a fairly indeterminate high frequency cut-off, lying between 1.69 and 3.39 MC.

Sound is recorded in one track by means of a high quality FM system. A carrier of 100 KC is modulated through wide deviation from 50 to 150 KC. On playback this results in better than 65 db signal-to-noise ratio measured below ½% harmonic distortion.

The tape drive mechanism is shown in Fig. 3.

The machine occupies a floor area of 40 by 26 in. It operates the tape at 100 in./sec. It can accommodate reels of tape providing more than 16 minutes of continuous recording. Thus, sufficient overlap time is allowed for starting a second machine where half-hour programs are rebroadcast.

Tape Operation

In operation, tape unwinds from the left spindle, past the capstan drive and head assembly to be taken up on the right hub. Rolls of tape are essentially self-supporting. No reels are required for half inch tape. For rewinding at high speed, a "tight winder" is employed. No equipment other than drive motors is concealed in the cabinet.

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To be in the future acceptable to television stations, the magnetic

video recorder must be capable of handling color signals with similar fidelity. Construction of our first color recorder is in progress.

Since sight and sound signals are recorded side by side on one tape, a single cut with scissors edits both without disturbing synchronization. Splicing is accomplished by use of the familiar pressure sensitive adhesive tape.

A logical objection to editing magnetic tracks—video or sound—is that the editor has no visual guide. The problem is not as formidable as it may appear. Workable techniques for general cutting have been devised. We have often assembled material from various reels with complete success. However, an editing device will be provided. It will enable any single "frame" to be observed as a picture on the monitor tube for as long as the editor wishes, before determining his course of action. By this means, and by continuous reproduction of sound associated with the particular frame in view, editing will be rendered as simple as in editing film.

For a description of a different video recording system, see "Recording TV on Magnetic Tape," Jan. 1954 TELE-TECH & ELECTRONIC INDUSTRIES, page 81.

Missile Connectors

(*Continued from page* 71)

the point in which its travel arc is such that it swings free. After it clears the missile, the plug and supporting arms, through spring-loading, retract to an out-of-the-way position.

As in the other phases of missile connector development, the contract design is controlled by the application. These have envolved two distinct groups: Group (A) includes contacts of the conventional "pin" and "socket" types. See Fig. 7 and 8. Because of this mating action, it is relatively simple to provide coaxial or heavy duty contacts as desired. In general, Group (A) contacts are restricted in their use to those connectors having the interlock feature, or to those installations where ejection of the plug is instantaneous and in a direction parallel to the longitudinal axis of the contacts.

Group (B) contacts are adapted for use in either interlock or motion actuated installations which comprise a group of unusual, articulated butt-type contacts. The novel feature of this contact is that the engaging end consists of a flat button, while the terminal end has a solder

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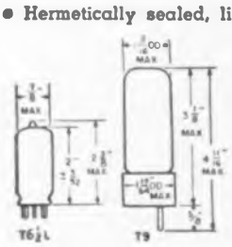

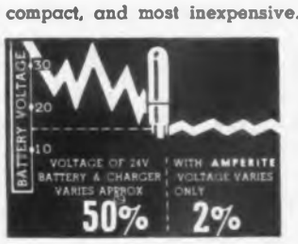

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MISSILE CONNECTORS (Cont.)

cup of conventional design.

In the plug there are rigidly affixed pin type contacts terminating in conventional solder cups for attachment of the conductors. Between the receptacle's button contact and the plug's pin contact is a floating, spring-loaded, intermediate contact member that is retained in the plug portion. This contact member provides sliding engagement to the pin contact, and pressure butt-type engagement to the receptacles button. In addition, the terminal

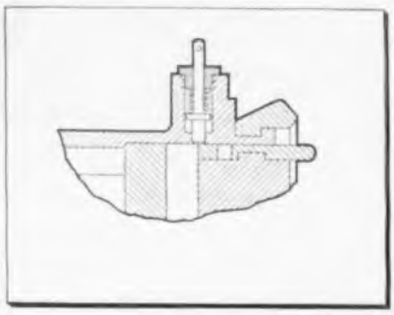

Fig. 6: Diagram illustrating skid type connector

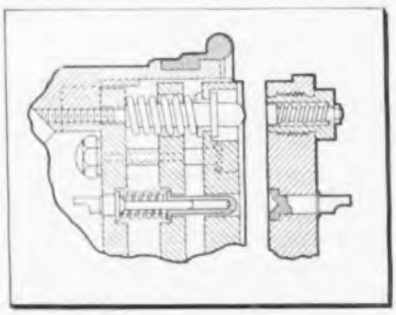

Fig. 7: Spring-loading feature of GMC connector

ends, being fixed, do not wear on the connecting conductors.

In the consideration generally of multi-contact electric connectors, the insulator and its contacts are considered the "heart" of the fitting and therefore rank at the top in importance in connectors having shells or some type of housing, the insulator (insert) is not visible and can only be inspected by disengagement or disassembly. Even disassembled, the condition of the insulator's contacts is not visible unless the contacts are removed from the insulator. Hence, the quality construction of both contact and insulator must be of the best and suited to the application in order to deliver satisfactory performance.

The vital circuits of the missile, therefore require the precision manufacture only obtainable with machined contacts to narrow tolerances. Some missile connectors con-

tain the greatest variety of known contact types.

For the most part the materials and finishes used in missile connector construction are those used in the more conventional lines. Housings are usually aluminum alloy and may be furnished in any of the conventional finishes. Standard contacts are brass or copper with a silver-plated, or gold plated finish. Contacts are also available in thermocouple materials. For insulators, plastic laminates are preferable because of their high strength characteristics and ease of fabrication.

The "umbilical circuitry" missile connector is by far the most complicated and inter-related type of connector built to date. Generally, it is larger and heavier than conventional connectors, although a few external power connectors have attained considerable size and

Fig. 8: Cut away view of early GMC type multi-contact connector designed for missile use. A number of contacts have been wired.

weight. In components, the missile connector may include the following unusual combination of parts: (a) standard coaxial and spring-loaded, butt-type contacts, (b) mechanical launching engagement and release mechanism, (c) solenoid release mechanisms, (d) lanyard release safety devices, (e) special high current contacts and (f) auxiliary connectors, above all, it is a remote controlled connector whose application may find other uses requiring this new disconnect principle.

The spring-loaded and butt-types contact is by far the most interesting of new contact designs. The same general butt-type contact is used in the Signal Corps U-79/U (BG). The design overcomes the extraction force problem and also makes possible the inclusion of large numbers of contact in a single connector, exemplified by a special 500-contact disconnect made for a pipe organ disconnect.

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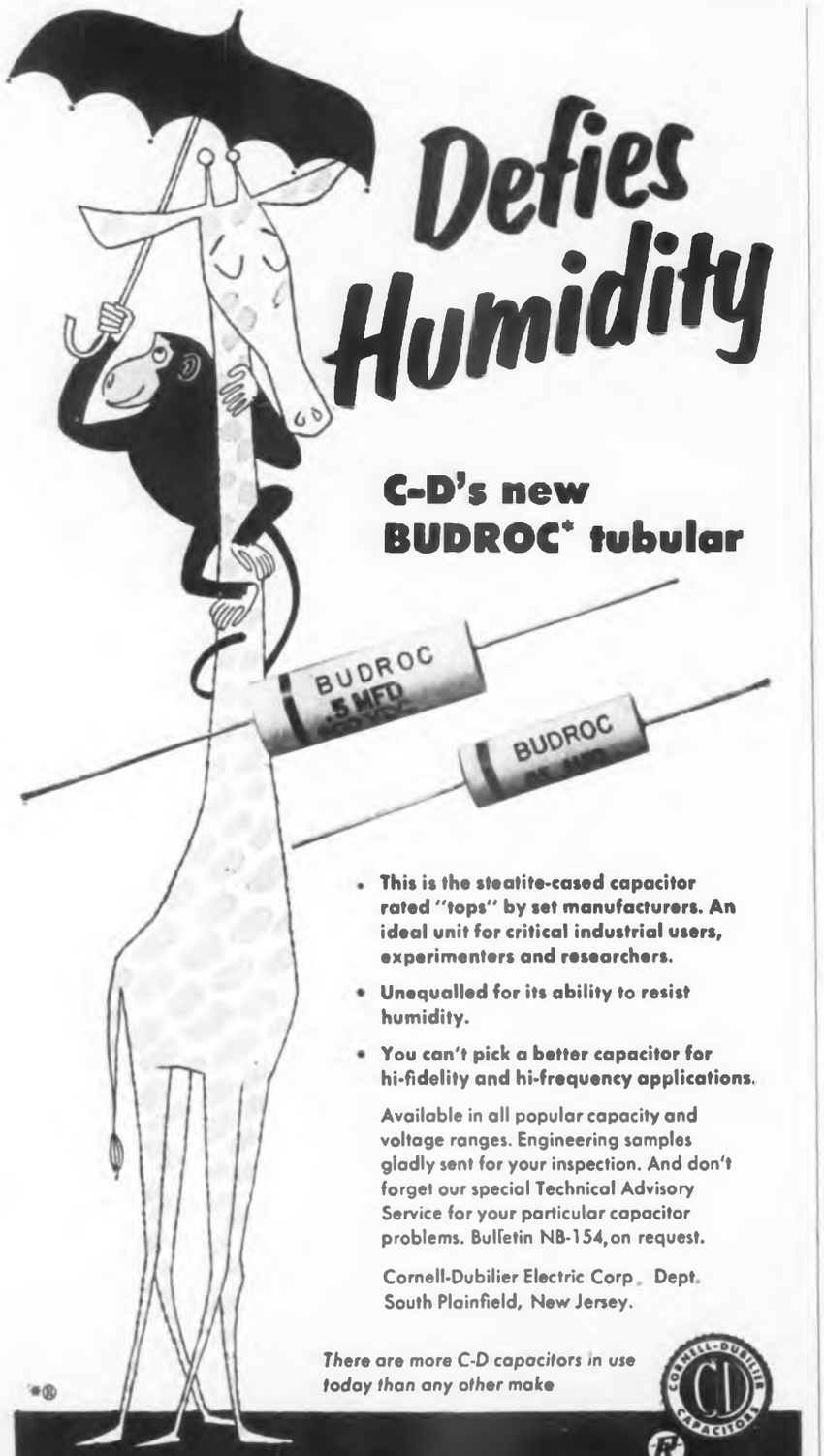

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Relaxation Oscillators

(Continued from page 79)

are different for the two cases. By making E_{ee} and R_e small, it is possible to obtain a symmetrical waveform or even to go beyond. To summarize, the cut-off time is a function of the time constant $(R_s + R_e)C$ and voltage E_{ee}, whereas the time spent in saturation depends upon time constant R_sC and voltage E_{cc}. This is not exact since the transistor characteristic, naturally, enters into the analysis.

The amplitude of the output voltage is comparable with that obtainable from the basic circuit and in practical circuits may approach the collector supply voltage. However, the waveform has a flat top unlike the sloping top of Fig. 2 and so the useable amplitude for most applications is considerably greater.

The top of the waveform for $R_s = 2K$ is generally flat within 10% for W. E. 1698 and 1768 transistors. By trimming R_s it is possible to make the top absolutely flat or even give it a positive slope. A typical waveform is shown in Fig. 7.

The pulse width is determined largely by the product R_sC and it is essential that the ratio be con-

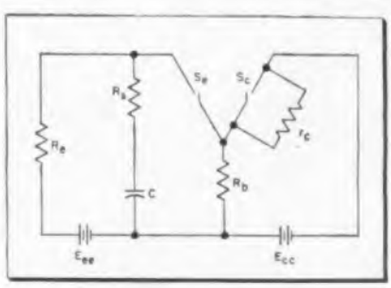

Fig. 8: Equivalent circuit for time analysis

trolled. The limitation being that large values of C should not be used with very small values of R since this may cause excessive dissipation by maintaining high peak currents for too long a time. The waveform in Fig. 7 has a period of 1 millisecond and was obtained with $R_s = 1K$, $C = 0.1$ μf. The rise and fall times are comparable with those obtained in other transistor relaxation oscillators and vary from 0.1 to 0.4 μsec for the rise time with W. E. 1698 and 1768 transistors, and roughly twice this figure for the fall time.

One of the principal advantages of this circuit is the reduction of both the peak and average currents compared with those obtained in the classical circuit. In this case the peak emitter current can be held at any desired value beyond the valley point by proper choice of R_s (see

circuit and curve of Fig. 3b).

While the discussion up to now has been directed at free running oscillators, these circuits are equally adaptable to mono-stable or triggered operation by proper choice of emitter bias. Synchronization pulses may be injected either at the base or emitter depending on the polarity of the pulse voltage. This is often a distinct advantage over the circuit of Fig. 1 which can only be triggered at the base, the emitter being effectively bypassed by the capacitor.

Finally, the reliability is increased by controlling the slope of the saturation region of the N-curve with stable elements external to the transistor. This can be used in conjunction with other, more direct, schemes of stabilization to obtain even better uniformity.

A comparison between this circuit and the basic one is shown in Table I as a function of transistor characteristics. The particular batch of transistors used in the test had considerably poorer uniformity than is usually encountered, but helps to demonstrate the improvement in uniformity obtainable.

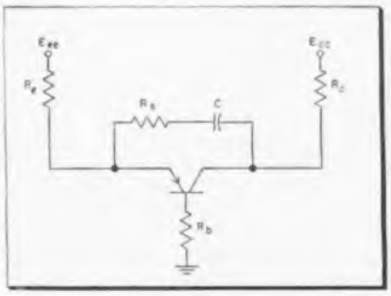

Fig. 9: Circuit with finite value for R_c

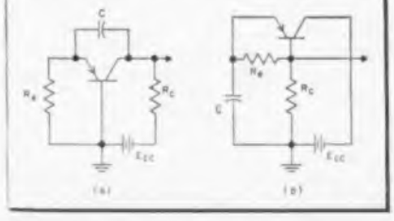

Fig. 10: (a) Circuit for generating high amplitude rectangular pulses. (b) Transformed circuit with signal ground moved to collector

A variation in this circuit is shown in Fig. 9 where a finite R_c is inserted and the R_sC network is positioned between emitter and collector. Much of what has been said concerning emitter loading also applies to this circuit. The principal difference is that R_c is now finite. Performance of this circuit is similar to the previous one, but two separate outputs may be taken; one from the base and the other from the collector. The waveshapes are practically

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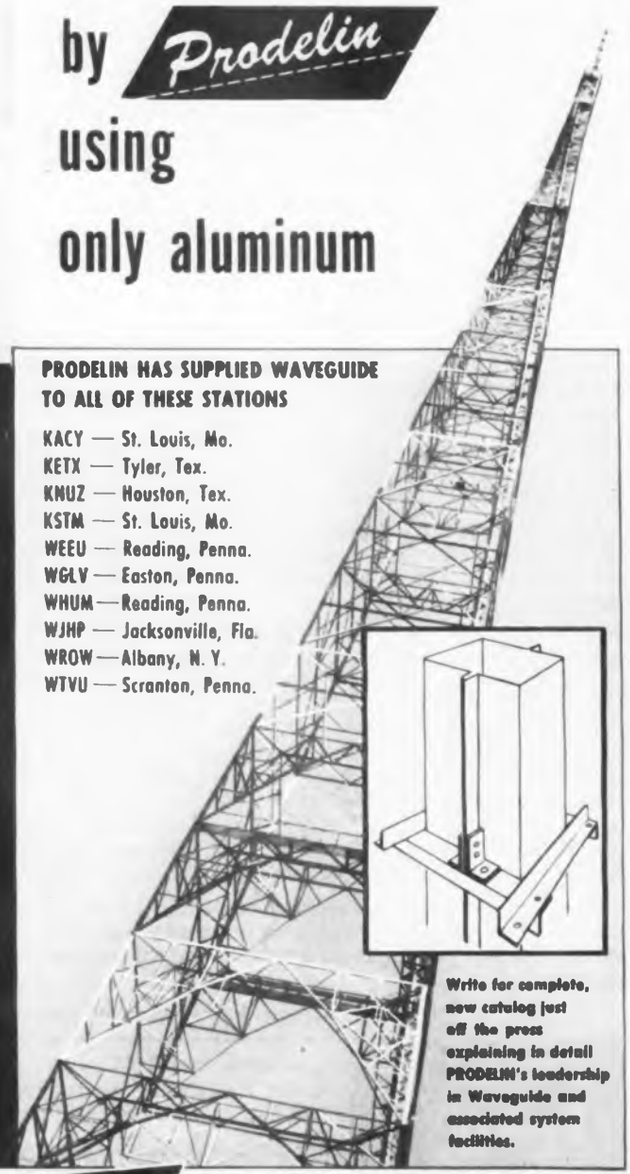

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identical except for opposite polarity and their relative amplitudes may be adjusted by proper choice of R_c and R_b. It is not immediately obvious that the waveforms should be equal and opposite but if R_s is large compared with the other circuit parameters as is generally the case, nearly all of the emitter current must flow through R_c and of course through R_b.

The flat-topped waveform is not theoretically realized in this circuit since alpha is not necessarily unity during saturation. This is a consequence of R_c being finite, but practically, the slope can be reduced to 10% or less of the total amplitude.

The final circuit to be discussed is useful for generating short, high amplitude, rectangular pulses. The circuit diagram is shown in one form in Fig. 10a.[4] Quite arbitrarily, ground has been chosen to be at the base. By a simple transformation, which consists primarily of moving the signal ground to the collector, the circuit of Fig. 10b is obtained. This is similar to the circuit of Fig. 3 with two main differences; first R_s has been eliminated and second R_e is returned to the base instead of to ground. This circuit now combines the features of the basic circuit (Fig. 1) in that

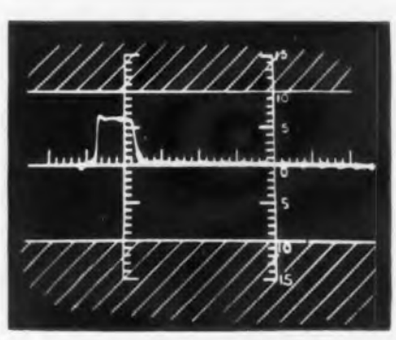

Fig. 11: Typical waveform with 1 μsec markers

R_s is omitted, with those of the modified circuit (Fig. 3) where R_s is omitted and output is taken from the base. Analysis of this circuit follows the ones described earlier and need not be repeated. The omission of R_s results in rather narrow pulses (order of a microsecond) but with high peak currents. The peak current is especially high with zero collector load since this forces the saturation segment of the N-curve to have a very small slope and pulls point d, Fig. 1b far out to the right. In order to prevent failure of the transistor due to excessive current, it has been painfully determined that the maximum

safe capacity for the 1768 and 1698 transistors is no more than 0.01 μf. The maximum pulse amplitude that was obtainable using a 45-volt supply was 30-40 volts depending on the transistor. This is pushing to the limit and should not be attempted without an adequate supply of transistors. At lower voltages or with larger values of R_c the circuit is quite safe, however. Either version of Fig. 10 may be used according to the polarity desired. With the positive side of E_{cc} grounded, positive pulses are obtained in Fig. 10a, negative in Fig. 10b.

Returning R_c to the base in Fig. 10b, results in better stability and was first discussed by Anderson.[5] Bias is obtained from the collector current flowing through R_c. Most of the transistors used in this circuit operated as monostable oscillators with R_c greater than about 20 K. If a stable operation is desired, an additional positive bias may be shunted from emitter to ground.

Triggering or synchronization is applied to the emitter or base according to which version is being used and the sensitivity of the mono-stable circuit is dependent on the bias.

Fig. 11 is a typical waveform showing a 30-volt pulse. The markers are spaced at 1 μsec intervals.

The author wishes to thank the following members of the Transistor Group for their cooperation: E. W. Burke, E. Gaynor, A. Z. Gutterman, and H. J. Tate.

1. A. E. Anderson, "Transistors in Switching Circuits", *B.S.T.J.*, vol. XXXI, No. 3, pp. 411-442.
2. ibid
3. ibid
4. D. R. Brown, J. F. Jacobs, N. T. Jones, "Study of a Transistor Blocking Oscillator", Report E-435, Digital Computer Lab., M.I.T., pp. 6, 7.
5. A. E. Anderson, "A Stabilized Transistor Delay and Switching Circuit", *The Transistor*, Bell Tel. Labs., pp. 429-436.

Electronic Thermostat

(*Continued from page* 82)

bridge and also supplies synchronizing voltage to a twin-diode synchronous detector. When the actual temperature at the sensing element deviates from the control temperature, the resulting bridge error signal is amplified and applied to the center leg of the synchronous detector. The resulting current in the center leg is determined by the amplitude and phase of the error voltage, being zero when the error voltage is zero.

Also applied to the detector, in series with the error voltage, is a voltage from a sawtooth oscillator. The result is that the output of the detector consists of a sawtooth voltage that operates about a reference level

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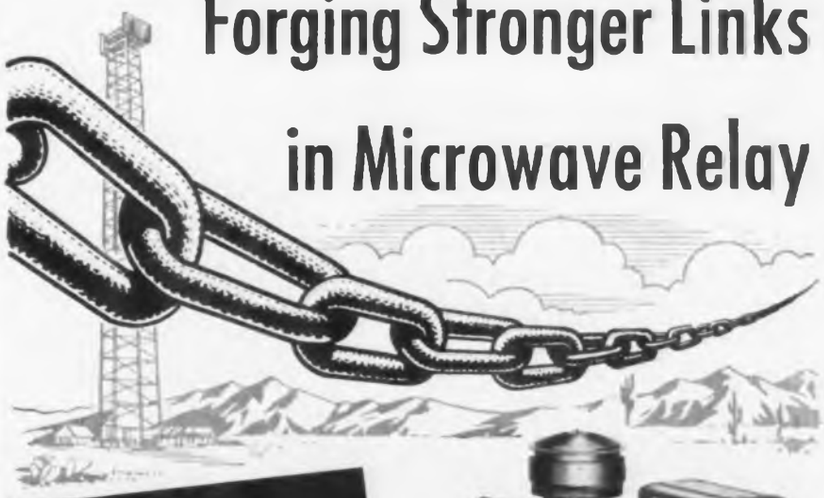

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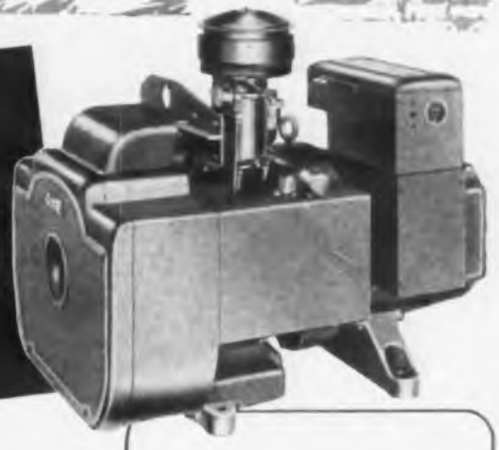

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ELECTRONIC THERMOSTAT (Cont.)

which varies with the error voltage. This detector output is applied to a Schmitt trigger circuit, which in turn actuates a relay that switches the power applied to the control heater.

With this arrangement the sawtooth voltage applied to the detector can be adjusted so that, when the temperature deviation and thus the error voltage are zero, the control relay applies power to the heater 50% of the time. Any temperature deviation from the control point then alters the proportion of the "duty cycle" during which power is applied to the heater; this proportion varies above or below 50% depending on the magnitude and direction of the temperature deviation. Large temperature deviations, beyond the proportional control range for which the instrument is set, result in the heater power being either on or off continuously—depending on the direction of the deviation—until the temperature is again brought within the proportional range. The duty cycle, determined by the frequency of the sawtooth oscillator, is designed to be adjustable over a range of about 5 to 15 seconds to meet the needs of any particular controlled process.

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Since the controller is of the time-proportioning type, its time of response to a temperature change is slightly longer than that of other types of controllers. Also, if the total power is switched in the control of processes having small thermal capacities and short thermal time lags, the temperature may cycle about the control point. In such cases the magnitude of the cycling can easily be minimized by supplying a portion of the required power continuously and switching only the power needed to compensate for any load changes in the controlled process.

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1. *Journal de Physique* (3rd Series) *6*, 479-483 1897; *J. Am. Chem. Soc.* 42, 60-68, 1920.

PERSONAL

Harold W. McCrae has been named manager of the development engineering department of the Communication Products Division of the Allen B. DuMont Laboratories, Clifton, N. J. In his new post, Mr. McCrae will be directly responsible for the engineering development of all electronic communication products made by the division. He first joined the Du Mont organization in 1951 and has been project head in charge of the company's bright-screen radar program.

Edward J. Davenport, for eight years

E. J. Davenport

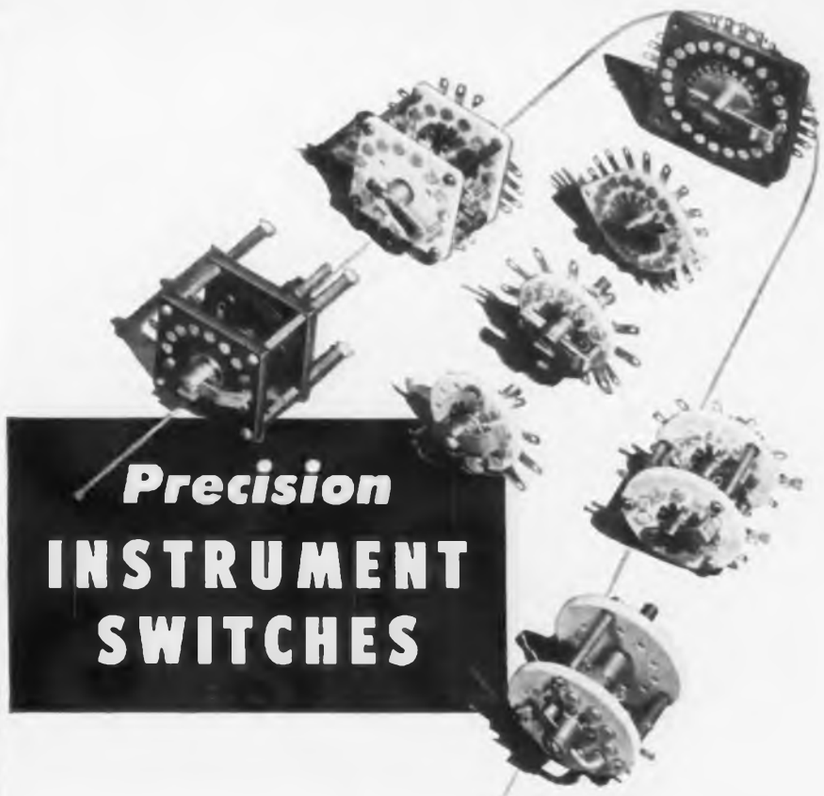
H. W. McCrae

with National Union Radio Corp., has joined Chromatic Television Labs., New York, N. Y. following a survey of the tube possibilities in the color TV field. He has been in the electronics and TV engineering field about 15 years.

R. G. Frederick was recently promoted to the position of assistant sales manager of commercial sales for The Gudeman Company, Chicago, Ill., manufacturers of capacitors. and other electronic components. **Wasyl Zaricki** was promoted from field engineer to assistant sales manager in charge of application engineering at the same time.

Dr. Dean E. Wooldridge and **Dr. Simon Ramo,** of Los Angeles, California, president and vice-president of the Ramo-Wooldridge Corporation, respectively, were recently elected to the board of directors of Thompson Products, Inc., Cleveland, Ohio. Drs. Wooldridge and Ramo resigned managerial positions with Hughes Aircraft Co. last year and organized the Ramo-Wooldridge corporation to specialize in advanced system developments in guided missiles, radar, computers, electronic controls and automatic intelligence devices.

Edward S. Miller, for six years chief engineer in charge of high fidelity product development at The Radio Craftsmen Incorporated, Chicago, Ill., has been made vice-president. **John Narrace,** recently in charge of TV design for the corporation, has been promoted to chief engineer.



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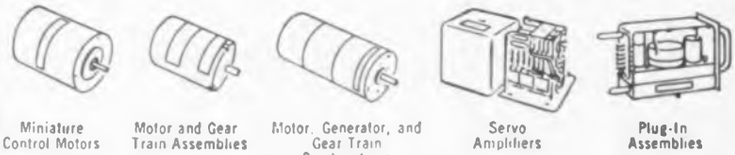

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Pressure Microphones

(*Continued from page* 86)

the demagnetization curve

The leakage factor, F, is often very large. An estimate of 4 to 6 is reasonable for the type of structure under consideration. For optimum use of alnico V magnets the operating point should be such that B and H are 9800 gauss and 460 oersteds respectively. Assuming a diaphragm plate thickness of 1/16 in. and a voice coil diameter of 1/4 in., the approximate dimensions of the alnico V magnet are 5/8 in. diameter and 17/32 in. long.

Diaphragm and Voice Coil

The design of diaphragm and voice coil is influenced considerably by the desired dimensions of the final product in view of appearance and acoustical considerations. A microphone diameter of 1 inch meets the modern trend toward slender unobtrusive microphones. The diffraction effect of the baffle will help to add to the response by increasing the pressure on the front of the diaphragm in the range of 5,000 cps to 10,000 cps. With the overall microphone diameter of 1 in., the diaphragm diameter will be somewhat smaller.

The most widely used diaphragm at the present time is the domed type with tangential ribs which give added compliance while maintaining a piston-like action over a wide frequency range. The diaphragm material should be rugged when used in thin cross sections in order to be very compliant and yet sufficiently stiff to avoid break-up at high frequencies.

Free Resonance

The diaphragm and voice coil assembly should have a free resonance of about 300 cps to be most effective in reproducing the low frequencies and maintain a smooth high frequency response. If the resonance is placed lower in the spectrum mechanical pickup becomes objectionable. If the resonance is at a higher frequency the low frequency response will be adversely affected.

The voice coil should be very light and yet strong. Sufficient length of voice coil is desired to insure that the voice coil extends thru the air gap. A self supported voice coil of No. 38 aluminum wire has proved to be satisfactory in many instances. The voice coil must be rigidly secured to the diaphragm.

A common cause of high frequency roll-off is a compliant bond between the voice coil and diaphragm.

Curve #1 of Fig. 3 shows the response of the system and indicates the reason why the microphone is not useable in its present state. A review of Eqs. (3) and (4) shows that for a uniform response the velocity must be constant as a function of frequency. The addition of a felt resistance (M_2, R_2 in Fig. 4) will cause a portion of Curve #1 to become fairly flat, resulting in Curve #2. Note that the resistance is not so effective at the high frequency end, and that the voice coil velocity tends to follow the undamped curve. This condition is a result of the resistance being decoupled from the diaphragm by the cavity between the diaphragm and the felt. The amount of resistance used determines the width of the portion of the curve which becomes flat. It determines also the amount by which the output level is reduced.

In order to improve the low frequency portion of Curve #2 of Figure 3, a cavity with a tube connecting to the outside atmosphere can be coupled to the back side of the diaphragm as shown in Fig. 4.

Observe the equivalent electrical circuit of Fig. 4. The cavity stiffness is effectively in series with the diaphragm stiffness at low frequencies. Therefore, the effective stiffness of the cavity should be reasonably close in value to the stiffness of the diaphragm.

The effect of a closed cavity on a diaphragm system can be calculated from the following expression,

$$C = V/\rho\, c^2\, S_d^2 \qquad (8)$$

where C = effective compliance of the cavity in cm./dyne,
V = volume of the cavity in cu. cm.,
ρ = density of air in grams per cu. cm.,
c = velocity of sound in cm./sec,
S_d = effective area of the diaphragm in sq. cm.

Note in Eq. (8) that to produce a given compliance the required volume is proportional to the square of the diaphragm area.

The acoustical inertance of the tube in Fig. 4 in grams/cm^4 is:

$$M = 4\, l\, \rho/3R^2 \qquad (9)$$

where l = length of tube in cm.,
ρ = density of air in grams per cu. cm.,
R = radius of the tube in cm.

By using Eq. 9 the length of the tube required, in cm., for a resonance at a given frequency is expressed as:

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$$l = 3c^2 R^2/16V \pi^2 f^2 \qquad (10)$$

where c = velocity of sound in cm./sec,
R = radius of the tube in cm.
V = volume of cavity in cu cm,.
f = frequency in CPS.

The tube and back cavity resonance is usually placed in the range of 40–60 CPS and results in the curve of Fig. 5.

From consideration of the equivalent electrical circuit of Fig. 4, the response below the tube and cavity resonance falls at a rate of 12 db rather than the previous 6 db per octave. Thus it is seen that the low frequency response at and slightly below resonance has been improved by sacrificing the bass response well below the resonance point.

The low frequency and mid range response of this microphone now appears very useable. The frequency response in the range of 3000 to 5000 CPS can be improved by arranging a resonance between the compliance of the air volume between the diaphragm and felt and the mass of the diaphragm system. The volume of the cavity in cu. cm. can be found from,

$$V = \rho\, c^2 S^2/\omega m \qquad (11)$$

where ρ = density of air in grams per cu. cm.,
c = velocity of sound in cm./sec.,
S = area of diaphragm in sq. cm.
$\omega = 2\pi f$,
f = frequency in CPS,
m = mass of the diaphragm system in grams.

The addition of this resonance has changed the response shown in Fig. 5 to that shown in Fig. 6. The microphone response is now satisfactory to about 6000 CPS.

An outside microphone diameter of 1 in. was previously chosen. The rise in sound pressure on the front of the microphone due to diffraction effect may be calculated from the equation,

$$|P_0| = |P|(5\text{-}4\cos kr)^{1/2} \qquad (12)$$

where P = free space sound pressure in dynes/sq. cm.,
$k = 2\pi\lambda$
λ = wavelength in cm.,
r = radius of the microphone in cm.

Note from Eq. (12) as plotted in Fig. 7, that the sound pressure may reach a value of about three times the free field pressure under the correct conditions. From this we see that the microphone output will be

raised considerably in the region of 10,000 cps. Thus the frequency response range has been extended considerably merely by the choice of a physical dimension.

A further extension of the high frequency response may be gained by the addition of a Helmholtz resonator in front of the diaphragm. The Helmholtz resonator will change the microphone construction and its equivalent electrical circuit to that shown in Fig. 8.

The two additional reactive elements can be designed to resonate near 14,000 cps and complete the acoustical structure. Other parameters can be brought into the picture to influence the microphone response. One simple addition which may be used is a ¼ wavelength hole in the pole piece of the magnetic structure to add an additional resonance. This particular type of resonance is very helpful in filling in a dip in the response curve. For physical reasons the resonance must be placed at the high frequency end of the spectrum. Electrical filters may also be used to control the response of the microphone system.

The response of the final product is shown as curve #1 of Fig. 10. Curve #2 indicates how much the previously discussed microphone level would have to be damped to achieve an equal high frequency response range if no resonances were used. Thus, one of the benefits of the additional resonances is to allow the general microphone level to be somewhat higher without sacrificing the bandwidth.

The addition of a matching transformer to couple the voice coil to the desired impedance will complete the unit. The choice of transformer core material is quite wide, depending on how large the transformer can be. For small transformers, materials such as hi-mu 80, mu-metal or permalloy are the most useful. The transformer laminations chosen should be as thin as practical, and should be of such shape as to tend toward a closed magnetic circuit. Once a choice of core material size and shape has been made, the volume of the transformer windings is determined. The number of turns on the primary of the transformer must be such as to have an inductance of approximately twice the dc resistance of the voice coil at the lowest frequency which will be reproduced. This is a rule of thumb which may be modified for particular instances.

For a 3 db down point at a given frequency, the inductance in henries of the primary should be,

$$L = (R_{ve} + R_p + Z_{em}) / \omega \qquad (13)$$

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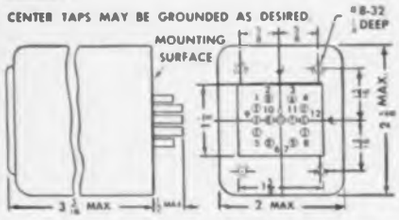

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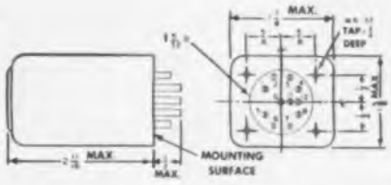

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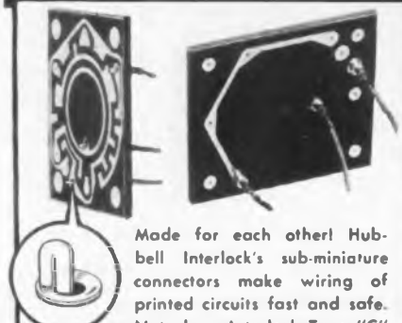

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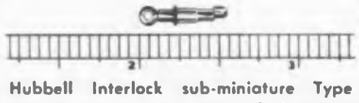

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where R_{vc} = voice coil resistance in ohms,
R_p = primary resistance in ohms,
Z_{em} = electrical impedance resulting from the mechanical impedance in ohms.
$\omega = 2\pi f$, and
f = frequency in CPS.

The choice of wire size for the primary is influenced by the space available for windings, but the dc resistance of the primary of a well designed transformer does not exceed approximately 10% of the impedance to be matched.

The number of turns on the secondary is given as:

$$N_s = N_p \left(\frac{Z_o}{R_{vc} + R_p + Z_{em}} \right)^{1/2} \qquad (14)$$

where N_s = number of turns on secondary winding,
N_p = number of turns on primary winding, and
Z_o = desired output impedance in ohms.

The Z_{em} in Eqs. (13) and (14) is the electrical impedance due to the mechanical system. This is known as the motional impedance. In a well damped pressure microphone the motional impedance is small. However, at the low frequencies near the tube and cavity resonance the motional impedance may become fairly high and require a better transformer (i.e. greater inductance) that it would appear from other considerations. A more complete understanding of the motional impedance effect can be found from the equation,

$$Z_{em} = \frac{(Bl)^2}{Z_m} \qquad (15)$$

where Z_{em} = electrical impedance in abohms,
B = flux density in air gap in gausses,
l = length of voice coil in cm.,
Z_m = total mechanical impedance in mechanical ohms.

From Eq. (15) it can be seen that the reflected impedance depends upon the square of the flux density and the length of voice coil conductor. Secondly, it is seen that when the mechanical impedance is a minimum the electrical impedance is a maximum. It is seen also that the two impedances must be conjugates since Bl is a constant for a given unit.

Fig. 9 is a photograph of the Electro-Voice Model 655 mike.

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ELECTRICAL DESCRIPTION—The Spectrum Analyzer, a self contained portable unit, is a very sensitive microwave receiver whose output is displayed on a 3 inch cathode-ray tube. The analyzer employs a resonant cavity type frequency-meter calibrated to read directly in megacycles, a frequency-swept (Velocity Modulated) R F oscillator, a crystal mixer and associated plumbing, narrow band I-F amplifiers, and both regulated and unregulated power supplies.

This versatile equipment provides a visual indication of the spectra of R-F oscillators within the range of 8470 to 9630 megacycles per second as a function of power versus frequency. Other uses are:

1. As a frequency meter for measuring frequencies of resonant cavities, echo boxes, magnetrons, and local oscillators within the range of 8470 to 9630 MC/S. The Analyzer is so sensitive that a magnetron signal can usually be picked up at some distance from the source without the use of connecting cables.

2. As a measuring device for setting the frequency of radar and beacon local oscillators in radar sets.

3. As a frequency modulated oscillator for tuning T/R Boxes and R/T Boxes in transmitter converters. It can be used to check magnetron pulling and AFC circuits.

4. As a performance tester for local oscillator tubes. Type 2K25 and 723A/B tubes may be tested by inserting them in the analyzer R-F oscillator socket and checking their output curves on the analyzer scope.

5. As a means of measuring bandwidths of resonant cavities.

MECHANICAL DESCRIPTION—The equipment is built into a sheet aluminum housing. The electrical components are built on an aluminum chassis located inside the removable dust cover. As many components as possible are mounted on terminal boards to facilitate quick and easy servicing. The Analyzer is transported with an Auxiliary and Spare Parts Box in a carrying case. The Analyzer is cushioned in a shock mounted carriage. This carriage can be removed from the carrying case if it is necessary to provide a shock mounting for the Analyzer when it is used outside of the carrying case.

SPECIFICATIONS

POWER SUPPLY: 50-1200 CPS; 105-125 volts; 125 watts.
TUNING RANGE at least 8470 MC/S to 9630 MC/S.
FREQUENCY METER RANGE: 8470 MC/S to 9630 MC/S.
SWEEP FREQUENCIES continuously variable from 10 to 30 CPS.
SPECTRUM AMPLITUDE ATTENUATION variable from 3 to 70 db, uncalibrated.
OPERATING TEMPERATURE RANGE: —40°C. to + 55°C.
FREQUENCY SWING OF ANALYZER RF OSCILLATOR 40 to 50 MC/S.
OVERALL I-F BANDWIDTH AT HALF-POWER POINTS 50 KC/S.
R-F SENSITIVITY at least —40 dbm for 1 inch scope deflection.
MAXIMUM DISPERSION OF SPECTRA: 1.5 MC/S per inch.
POWER OUTPUT: Approx. 1 milliwatt.

TUBE COMPLEMENT

1 — 2K25	1 — 6SA7
1 — 2X2A	3 — 6SJ7
1 — 3BP1A	3 — 6SN7 — GT
1 — 5R4GY	1 — 6Y6
1 — 6AC7	1 — 884
	4 — 931

ACCESSORY PARTS SUPPLIED

1 — FLEXIBLE WAVEGUIDE 18" LENGTH
1 — CHOKE TO CHOKE ADAPTER
1 — WAVEGUIDE TO COAX ADAPTER
1 — DIRECTIONAL COUPLER
2 — CRYSTALS 1N23A
4 — PILOT LIGHT BULBS
6 — FUSES 2A 250 V
1 — ANTENNA HORN
1 — POWER CABLE
1 — MIXER INPUT CABLE
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Operating shock resistance exceeds 50 "G's"; temperature range is from −65° to +200°C. They operate consistently over 400,000 cycles without failure at 5 A. and go 3,500 or more under 30 A. at 30 V., D. C. resistive. Voltages up to 300 D. C. at 4/10 A. are carried for more than 400,000 cycles. Coil resistances up to 50,000 ohms available. Operating time is 10 ms. or less; drop out time 3 ms. or less. Sensitivity approaches 100 mw. at 30 "G's" operational shock resistance. Inter-electrode capacitance is less than 5 mmf. contacts to case; less than 2½ mmf. between contacts. All standard mounting arrangements.

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Aircraft Progress

(Continued from page 67)

temperature small tubes by Raytheon and Sylvania (Fig. 8). These tubes are hermetically sealed and used in expendable assemblies.

Automatic Assembly

Investigation continued on the use of automatic assembly techniques for the fabrication of miniaturized electronic equipment. Pilot production lines and test circuits entered the advanced stages.

Transistors

Devices for testing and evaluating transistors were developed, including noise, impedance and four-pole parameter testers; gain, frequency and time indicators; and oscilloscope display of static characteristics. Flip-flop circuits for 9-mc operation was achieved by establishing a stable point in the active region of the transistor characteristics. Significant advances were made for growing single crystals.

Data Storage

A machine for storing and searching for engineering data on electronic components was developed by Batelle Memorial Institute. It is

Fig. 8: High temperature subminiature tube

known as the Electronic Component Information Center (ECIC). Also, the development of a special ceramic material at MIT has opened a new avenue for storing digital computer information.

The development of flight simulators for additional aircraft is con-

tinuing to provide efficient and economical training pilots. Among these is the F-89D (Fig. 9), made by Link Aviation. Duplication capabilities include radar fire control.

Computers

Computer development has made several forward strides. Basic research at a number of universities has resulted in significant progress for new techniques related to aerodynamic design as well as aircraft control.

An electronic polynomial evaluator which can instantaneously evaluate 12th degree equation automatically presents results on an oscilloscope or plotting table.

General Electric's digital computer, Oarac, (Fig. 10), was placed in operation to solve aircraft design, guided missile and ballistics problems. It can multiply two one-digit numbers in 0.004 second.

Fig. 9: Link F-89D flight simulator

A small digital calculator, Monrobot, suitable for calculating sines or tracing rays through microwave optical systems has gone into operation. Its storage capacity is 100 numbers and 100 orders.

The C-2A true airspeed and mach number computer, developed by Kollsman Instrument, eliminates the need for a multiplicity of separate units. It provides five outputs for various system applications. True airspeed, indicated air speed, mach number and altitude may be displayed on a single dial.

An improved dead-reckoning computer, the A-1, was developed by Ford Instrument in conjunction with ARDC. The aircraft's initial latitude, longitude, wind velocity, heading and magnetic variation are fed to the computer. During flight, similar information goes to the A-1, which continuously calculates and indicates aircraft position.

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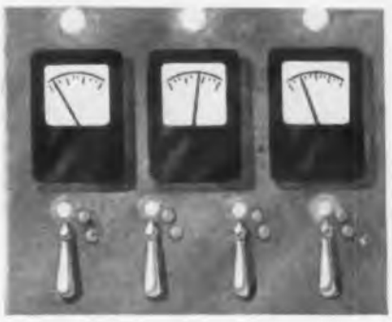

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AIRCRAFT PROGRESS (Cont.)

taneously controls the operation of all aerial cameras reached its final stages of development. The device operates 12 separate cameras located throughout the aircraft, adjusting continuously for speed, altitude, aperture, shutter and light.

A new five-unit radar camera system developed by Bolsey is known as the 0-30. It photographs radarscope images in various modes of operation on 35 mm film.

Extensive work was carried out on the study of upper atmosphere conditions. Fruit flies were sent aloft to obtain data on the effects of cosmic rays. A new droppable radiosonde (AN/AMT-6) and airborne radiosonde receptor (AN-AMR-1) were developed to increase weather reconnaissance capability

Fig. 10: Oarac digital computer developed by GE for ARDC contains 1400 tubes, 7000 diodes

of aircraft. Daily global variations in the electric current flowing from the high atmosphere to the earth were measured. These observations indicate a correlation between periodic solar flares and upper atmosphere cyclones. Special rocket instruments are being devised to measure the number and types of charged particles in the ionosphere.

Falcon Electronics Bought By Trio Manufacturing Co.

Falcon Electronics Co. of Quincy, Ill., and its entire line of antennas has been purchased by Trio Manufacturing Co. of Griggsville, Ill. Roy Wade, formerly General Manager of Falcon Co., has been appointed General Sales Manager for Trio.

All Falcon operations will be moved to the new Trio plant in Griggsville, where the Falcon line of antennas will be manufactured. These include colinears, conicals, yagis, radar and other types.

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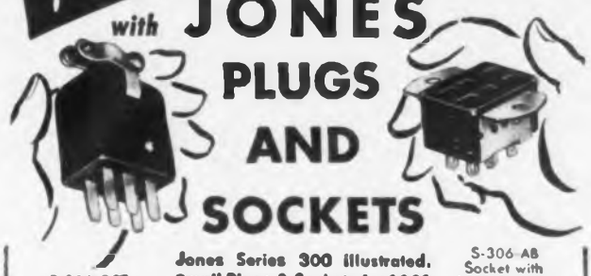

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BULLETINS

Heat Treatment

Metallurgy involved in the heat treatment of aluminum alloys is covered in a new manual, "Heat Treating Aluminum Alloys," just published by Reynolds Metals Company, 2500 South Third St., Louisville, Ky. The manual will be sent without charge to engineers, metallurgists, instructors, and technical men who request it on company letterhead. To others, the price is $1.00 per copy.

Contacts

Bulletin "Series E-Z 16" describes "Continental" connectors with coaxial contacts and includes suitable cable types, schematics, and special features on one side. The reverse side presents complete information on "Series E-Z 16" connectors with bayonet locks. Available at the Electronic Sales Division, De-Jur-Amsco Corporation, 45-01 Northern Blvd, Long Island City, N.Y.

Mixer

A data sheet released by Waveline, Inc., Caldwell, N.J., describes and presents the electrical specifications of a two channel mixer that is designed to operate over the frequency range of 8,500 to 9,600 MCS.

Capacitors

A new capacitor manual, AC-4, released by Astron Corporation, 255 Grant Ave., East Newark, N.J. contains detailed engineering data and specifications covering the company's complete line of capacitors and filters for electronic applications. A copy can be obtained by a request on professional or company letterhead.

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BULLETINS

Machine Work

A 20-page photographically illustrated booklet presents the staff, facilities, and products of the Eisler Engineering Co., Inc., 750 South 13th St., Newark 3, N.J.

Coaxial and Waveguide

Prodelin, Inc., 307 Bergen Ave., Kearny, N.J. recently made available a completely new catalog on their line of coaxial transmission lines, waveguide, and antennas. The catalog discusses and illustrates transmission lines, microwave cable adapters, hangers, dehydration and accessories, antennas for UHF and microwave, and many other components.

Controls

Catalog No. 54, recently published, features standard controls and resistors for radio and electronic equipment. Printed in two-colors the new format presents concise descriptions, dimensional drawings, listings, prices, and standard packings. Copies are available at the Clarostat Mfg. Co., Inc., Dover, New Hampshire.

Variable Resistors

Data Sheet 168, released by Chicago Telephone Supply Corp., Elkhart, Ind., describes the Type YGC-B45 variable resistor with a self-supporting snap-in bracket and line of controls for printed circuit applications. Electrical and mechanical specifications and 17 diagrams are given.

Networks

Bulletins 500 and 410, issued by White Instrument Laboratories, 203 Riverside Drive, Austin 4, Texas, respectively describe and present engineering data covering the Series 500 twin-T networks and the Series 410 servo lead networks designed by the company.

Shielded Enclosures

An engineering study, "Evaluating Shielded Enclosures," by Richard B. Schulz, Electro-Search, reduces the major factors involved in shielded enclosures to their basic engineering equivalents. Copies are available free on request to the Ace Engineering and Machine Co., 3644 N. Lawrence St., Philadelphia 40, Pa.

Resistors

Atlas Resistor Co., 24 East Coulter St., Philadelphia 44, Pa. has released a 2-page folder that illustrates and describes the company's fixed pack wound and adjustable resistors.

Voltage Standard

Bulletin RI-401, released by Radiation Inc., Melbourne, Fla., describes the Type M-DC-3 super-regulated voltage standard that extends the voltage range of the M-DC-2, and discusses the individual and combination benefits of the two units.

Coaxial Cable

Issue No. 2 of "Styroflex Coaxial Cable," a 19-page booklet, recently issued by Phelps Dodge Copper Products Corp., 40 Wall St., New York 5, N.Y., presents the properties, electrical characteristics, ratings, and installation procedures, etc. of the company product.

Coils and Filters

Catalog 102-A, a new 16-page publication, presents performance characteristics of a line of standard and miniature toroids, plug-in decade inductors, communication and telemetering filters made by Burnell & Co., 45 Warburton Ave., Yonkers, N.Y. Units for specialized applications include r-f bandpass filters and delay line.

IF IT'S NEW . . . IF IT'S NEWS . . . IT'S FROM ELCO

The need for a high-quality octal socket for commercial applications has been answered with the new Elco socket illustrated here. Elco's "commercial octal" offers an all-molded body of general purpose or mica material, equipped with fully-floating brass or phosphor-bronze contacts. The steel saddle is available with or without ground-lugs, cadmium-plated or hot-tinned for ease of soldering. This octal socket is also available for printed circuits and solderless connections. Full information concerning this newest Elco quality-product is yours upon request; as is data about Elco's complete quality-line of miniature and sub-miniature tube-sockets, shields and the world-famous Varicon connector—now available with brackets, handles and covers.

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Features continuous frequency coverage in one band; at least one volt output into 75 ohms; wide sweep; blanked signal on return sweep provides a reference baseline.

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Sweep: 60 cycle, sine wave.
Output: (1.) 0.1-1.0 volts
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News of MANUFACTURERS' REPS

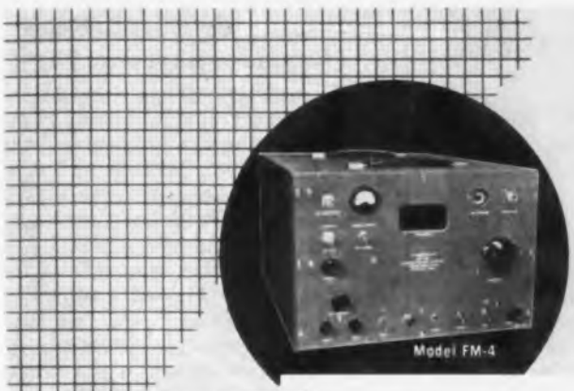
Henry P. Segel was recently elected president of the New England Chapter of **"The Representatives."** Mr. Segel, one of the founders of the chapter, in addition to the presidency, assumed the chairmanship of the committee selected to publish a directory to appear about May 1 that will cross-reference products, manufacturers, and representatives in the New England territory. Other officers of the chapter elected were **Stanley Harris**, vice-president, and **Peter H. White**, secretary-treasurer. The advisory board consists of **Walter T. Hannigan**, past president, **Ray Perron**, **K. C. Stevens**, **Dan Greene**, **Stanley Harris**, and **Peter White**.

Alfred Crossley & Associates, 4501 North Ravenwood Ave., Chicago, Ill., has been appointed representative of the Electronic Instruments Division, Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa. They will cover Minnesota, Wisconsin, Iowa, Illinois, Indiana, North and South Dakota, Nebraska, and Western Ohio. **S. Sterling Company**, 15310 W. McNichols Road, Detroit, Mich., will represent Burroughs in Michigan and Eastern Ohio. **Land-C-Air Sales**, 42 Oak Ave., Tuckahoe, N. Y. will represent the company in New York and northern New Jersey.

W. J. Doyle Co., Chicago, Ill., will represent the American Screen Products Co., Miami, Fla. in the sales of TV antennas and associated equipment in Illinois, Wisconsin, and Lake County, Ind.

Howard Feiner has become a member of the **Land-C-Air Sales Co.**, 42 Oak Ave., Tuckahoe, N. Y. in the capacity of sales engineer. Mr. Feiner will open a branch field engineering office in Syracuse, N. Y. and cover all industrial accounts in upstate New York. **Jim Schnitter** will continue to cover all jobber accounts out of the Buffalo field office.

G. S. Marshall, 40 South Los Robles, Pasadena 1, Calif. has been appointed sales representative for the California-Arizona-New Mexico area of Waveline, Inc., microwave instrument and accessories manufacturers in Caldwell, N. J. **J. R. Dannemiller** Associates, 1791 Oakmont St., Cleveland 21, Ohio will represent the company in Michigan, western Pennsylvania, and West Virginia. **Murphy & Cota**, 1409 Peachtree St., NE, Atlanta 5, Georgia, will cover the southwestern United States and **E. A. Ossman & Associates**, 65 Webster St., Saratoga Springs, N. Y., will be the Schenectady, N. Y. area representative.



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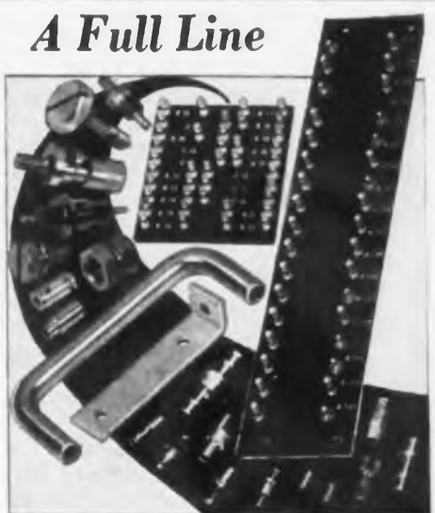

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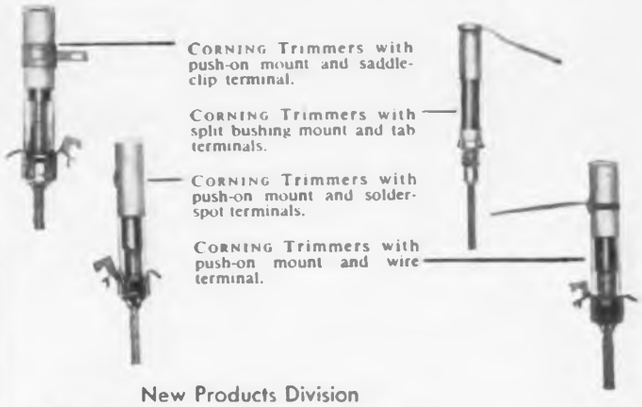

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Commutator Eliminators

(*Continued from page* 73)

The rectifier voltage drop in the forward direction corresponds to the voltage drop of the brushes and the contacts between brushes and copper bars of the commutator. The resistances involved have nonlinear characteristics in both cases.

The commutating reactance of the rectifier is determined mainly by the leakage reactance of the supplying apparatus. It corresponds to the leakage reactance of the armature coils passing through the neutral zone between the magnetic poles.

The ohmic drop of the apparatus supplying the selenium rectifier is equivalent to the ohmic drop of the commutator winding.

The rectifier current during the overlapping of two adjoining phases corresponds to the curent flowing into the armature coil while it is short-circuited by the brush during commutation.

One possible circuit, using the rotating rectifier, is shown in Fig. 1. The exciter 3-phase armature, the 3-phase bridge rectifier and the alternator rotating field are all mounted on a common shaft. The field of the exciter is supplied from a static rectifier and a variable transformer.

As seen from the diagram, by using an ac exciter, the commutator is eliminated. Also, since the rectifier is mounted on the same shaft with the alternator field, the usual slip rings are not required. The result is absence of wear and sparking, with its attendant r-f interference.

Traditionally, the selenium rectifier power unit was considered only as self-contained conversion apparatus. It is therefore interesting to follow its increasing application as part of generating equipment, replacing the commutator of an armature in a magnetic field. The exciter can also be designed for a much higher generated frequency than generally used for commutator machines.

Dr. R. M. Soria Pres. of '54 Electronics Conference

Dr. R. M. Soria, Director of Research at the American Phenolic Corporation, Cicero, Ill., has been elected president of the 1954 National Electronics Conference, Inc. Mr. R. R. Batcher, Chief Engineer of the Radio-Electronics-Television Manufacturers Assn., New York, was elected Chairman of the Board of Directors.

Electronic Switch

(*Continued from page 83*)

returned to ground. The condenser is normally in a charged state when the circuit is in use. The output voltage appears across the cathode of the power tube.

The switch is turned on in the usual way by applying a pulse to the grid of the power tube. When the circuit is to be turned off, a pulse is applied to the grid of the turn-off tube, which then begins to conduct and discharges the condenser through the inductance. The L-C series circuit provides an oscillatory discharge whose frequency is determined by the condenser and the inductance. The thyratron, however, conducts in but one direction and current flows for only one-quarter of a cycle, but this is sufficient time to discharge the condenser completely. The rapidly decreasing voltage of the condenser appears on the plate of the power thyratron, thereby cutting off the flow of current through the tube and at the same time extinguishing the turn-off tube. After the thyratrons have deionized and the condenser has become recharged, the cycle may be repeated.

An experimental model of this circuit, built at the Bureau, is capable of delivering 50 watts into a 200-ohm resistive load, at as much as 95% duty factor or as low as desired. Leading and trailing edges of the output rectangular waveform are less than 0.25 μsec, and there is no appreciable distortion from transient voltages when the switch is pulsed on or off.

STABILIZED TRANSISTOR DUNKED

E. Finley Carter, Sylvania vice president and technical director, demonstrates by means of electronic testing equipment that an uncased transistor, stabilized by new scientific methods developed by Sylvania Electric Products Inc. was not affected by immersion in water. Demonstration took place recently in Washington before a group of high-ranking military officials.

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TYPE	mμF/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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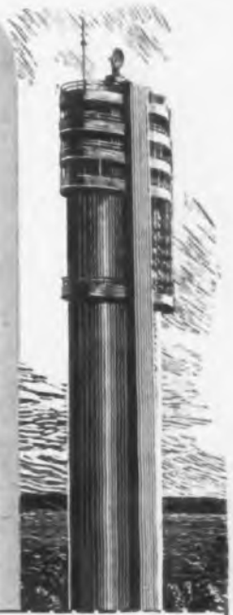

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FM Demodulator

(Continued from page 73)

Sensitivity: The r-f input necessary for accurate measurements is 1 mv at 200 Mc and 200 μv at 54 Mc. Fig. 5 shows the degree of quieting as a function of r-f signal input.

Deviation reading accuracy: As shown in the schematic Fig. 4 the instrument provides five ranges of deviation scale: 0—5 Kc, 0—20 Kc, 0—100 Kc, 0—500 Kc, and 0—1000 Kc for full scale deflection of the meter. Accuracy obtainable for modulation frequencies between 100 cps and 40000 cps is ± 0.5 db on four low deviation ranges and ± 2 db on high deviation range, as checked by the Crosby (vanishing carrier) method. High deviation metering accuracy at high modulation frequencies is important for many applications to multi-channel FM links.

Harmonic Distortion: The results of distortion measurements at high deviations and for carrier located at the cross-over point are shown in Fig. 6.

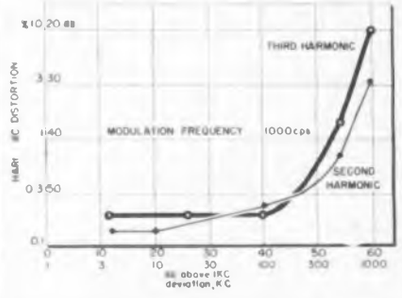

Fig. 6: Measurements of harmonic distortion at crossover frequency at large deviations

Hum: In the presence of carrier the unwanted voltage at the output of the demodulator is mostly composed of residual 60 cycle hum suppressed to —51db below the audio frequency level corresponding to 20 Kc deviation. The above corresponds to the residual FM deviation of 28 cps which value is considered harmless for most applications.

Penn. State Offers Summer Seminars

Pennsylvania State University, in cooperation with industry, is offering summer seminars on the following subjects:

Transistors	June 9 to 18
Color Television	June 21 to July 2
Analog Computers	June 21 to July 2
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Additional information may be secured by contacting the School of Engineering, State College, Pa.

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This new technique just worked out for Color TV can give you connectors and cables for solving many problems involving high voltage and corona suppression.

NEW SOCKET TECHNIQUE

As illustrated in this Alden 220FTSC Color TV Tube Connector, the new technique permits a jacket of high voltage insulation to be integrally molded around each high voltage contact and lead, while the low voltage leads take the resilient "figure 8" clips in the regular isolated pockets providing air space leakage.

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8101FP/M High Voltage Disconnect for 20,000 volt anode cable.

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911SL Molded in-line Tube Cap.

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INDUSTRY NEWS

Charles E. Jacobs has been made field sales representative to cover electronic products sales for Sylvania Electric Products Inc., New York, N. Y. and will handle renewal tubes, TV picture tubes, electronics, and test equipment for the company in the northern New Jersey area.

Frank J. Hogan has been named district manager for CBS-Columbia, TV receiver manufacturing division of CBS. He will make his headquarters in Euclid, Ohio, and work with the company distributors in Ohio, Indiana, Michigan, and Kentucky. **William Rider**, who covered the area formerly, has been assigned to New York, central Pennsylvania, and Charleston, West Virginia.

Martin Silver was recently appointed manager of the new broadcast equipment division of Tel-Instrument Co., Carlstadt, N. J. Mr. Silver was formerly

Martin Silver

manager of the TV division of the Federal Telecommunications Laboratories. During 1953, Mr. Silver served as manager of the UHF TV Station WTVU, Scranton, Pa.

William F. Hafstrom was recently appointed manager of sales of the General Electric Company's light military electronic equipment department.

Charles W. Nelson was made manager of product service. **Benjamin Parran** became manager of marketing research and product planning, and **Robert T. Pennington** became manager of marketing administration. The appointments followed the integration of the government marketing activities with other operations of the military department.

Nat Welch has been named vice-president in charge of sales by ORRadio Industries, Inc., Opelika, Ala., manufacturers of sound recording tape. Mr. Welch joined the company last year as sales manager.

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TELE-TECH ADVERTISERS — MAY, 1954

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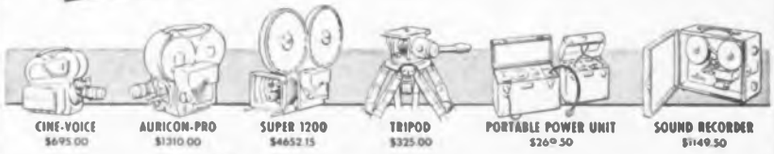

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INDUSTRY NEWS

(*Continued from page* 156)

David Garrison has become a member of the Philadelphia district sales staff of the Synthane Corporation, Oakes, Pa., where he had been associated with the research and development staff since 1937.

Thomas L. Taggart, comptroller since 1951, has been elected treasurer of Ampex Corporation, Redwood City, Calif. Mr. Taggart will make his headquarters in Redwood City, but will continue as vice-president and general manager of the Ampex Loud Speaker Corp., in North Hollywood, a wholly-owned subsidiary established last year.

E. W. Glasenapp has become general manager of the Victoreen Instrument Co. Resistor Department. Beyond the supervision of research and development work, Mr. Glasenapp is organizing a national sales and service program and developing a national staff of district sales managers and factory representatives.

H. C. Westcott has joined the Research Center of Burroughs Corporation, Philadelphia, Pa. as associate director for products diversification. Mr. Westcott will give specific attention to product diversification and the exploitation of research results outside the office equipment field.

Sidney A. Standing has been appointed manager of the cathode ray tube division of the Raytheon Manufacturing Company, Waltham, Mass. He will make his headquarters in the firm's new cathode ray tube plant in Quincy, Mass. **John F. Morten.** has been appointed to the new position of marketing services manager of the equipment sales division of the company. He will be responsible for marketing research, order service, advertising, sales promotion and exhibits.

Greibach Instruments Joins Gulton Mfg. Corp.

Dr. Leslie K. Gulton, President of Gulton Manufacturing Corp., has announced the affiliation of Gulton with Greibach Instruments Corp. for the production of the new Greibach multimeters.

Greibach Instruments, headed by Dr. Emil Greibach, will make its headquarters at the Gulton plant in Metuchen, N. J., with laboratories in New Rochelle, N. Y.

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BEST BECAUSE...
Gold-plated Grid No. 1—minimizes grid emission

BEST BECAUSE...
Special mica insulator processing—minimizes picture "jitters" caused by charging effects and leakages

BEST BECAUSE...
Carbonized Grid No. 2 runs cooler, reduces stray emission

BEST BECAUSE...
Higher quality, lead-glass bulb insures better performance at higher tube voltages

BEST BECAUSE...
Specially processed glass bulb minimizes electrolysis, improves tube life

You get more for your money when you buy RCA receiving tubes because RCA makes extra effort to keep pace with new requirements for tube applications. For instance, the 1B3-GT and 6BQ6-GT illustrate how RCA makes improvements in tube type designs . . . makes RCA receiving tubes best for top performance in your TV-receiver designs.

The RCA-1B3-GT rectifier has been *improved* to handle the higher voltages required by "big-picture" TV sets. Tube safety factors have been increased.

The RCA-6BQ6-GT horizontal output tube is another improved tube. Its improvements minimize grid emission, stray emission, and TV picture "jitters."

The improvements built into RCA receiving tubes give you: (1) Superior tube performance, (2) fewer factory-line rejects and "in-warranty" failures, (3) substantially greater tube value.

For circuit application help, call your nearest RCA Field Office:

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