ULTRA COMPACT UNITS...OUNCER UNITS
HIGH FIDELITY.... SMALL SIZE .... FROM STOCK

UTC Ultra compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. High fidelity is obtainable in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles.

True hum balancing coil structure combined with a high conductivity die cast outer case, effects good inductive shielding.

UTC OUNCER components represent the acme in compact quality transformers. These units, which weigh one ounce, are fully impregnated and sealed in a drawn aluminum housing ¹/₄" diameter...mounting opposite terminal board. High fidelity characteristics are provided, uniform from 40 to 15,000 cycles, except for 0-14, 0-15, and units carrying DC which are intended for voice frequencies from 150 to 4,000 cycles. Maximum level 0 DB.

Type
No.
Application
Primary Impedance
Secondary Impedance
List Price
A-10
Low impedance mike, pickup, 50, 125/150, 200/250, 50 ohms or mult line to grid 333, 500/600 ohms 50,000 ohms or to 1 or 2 grids (multiple alloy shields for low hum pickup) $15.00
A-11
Low impedance mike, pickup, 50, 200, 500 50,000 ohms 16.00
A-12
Low impedance mike, pickup, 50, 125/150, 200/250, 80,000 ohms overall, or mult line to grids 333, 500/600 ohms in two sections 15.00
A-14
Dynamic microphone to one 30 ohms 50,000 ohms overall, in two sections 14.00
A-20
Miking, mike, pickup, or mult line to line 333, 500/600 ohms 15.00
A-21
Miking, low impedance mike, 50, 200/250, 500/600 ohms 16.00
A-24
Low impedance mike, pickup, 50, 125/150, 200/250, 50, 200, 250, 500/600 or mult line to line (multiple alloy shields for low hum pick). 16.00
A-26
Single plate to single grid 15,000 ohms 60,000 ohms, 2.1 ratio 13.00
A-27
Single plate to single grid 15,000 ohms As above As above 15.00
A-28
Single plate to two grids, 15,000 ohms 8 MA unbalanced D.C. 80,000 ohms overall, 2.3:1 turn ratio 14.00
A-29
Single plate to two grids & 15,000 ohms Split primary 80,000 ohms overall, 2.3:1 turn ratio 18.00
A-30
Single plate to multiple line 16,000 ohms 50, 125/150, 200/250, 333, 500/600 ohms 50, 200, 250, 333, 500/600 ohms 15.00
A-31
Single plate to multiple line 15,000 ohms 50, 125/150, 200/250, 333, 500/600 ohms 60,000 ohms 14.00
A-32
Puff push low level plates to multiple line 30,000 ohms Plate to plate 50, 125, 150, 200, 250, 333, 500/600 ohms 50, 200, 250, 333, 500/600 ohms 15.00
A-33
Crystal microphone to multi 100,000 ohms grids 50, 125/150, 200/250, 333, 500/600 ohms 15.00
A-34
Audio choke, 250 henrys or 5 MA 6000 ohms D.C., 55 henrys or 10 MA 1500 ohms D.C., 16.00
A-35
Audio choke 60 henrys or 15 MA 2000 ohms D.C., 15 henrys or 30 MA 500 ohms D.C., 9.00

Type A Case
1½" x 1½" x 2" high

Ouncer Case
3/8" Dia. x 1½" high

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Export Division: 13 East 40th Street, New York 16, N. Y.
Cables: "Aranab"
MICROFILM OMNIRANGE LENS
New Sperry 5,000-mc omnirange antenna lens eliminates ground reflections (see p 118)

NEW IDEAS IN TELEVISION STUDIO DESIGN, by N. F. Smith
Separation of programming and technical control increases flexibility

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Phototube-controlled servo-drive motors track sun in upper-atmosphere research

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Prediction of television propagation for 470 to 850 mc including nulls and maxima

CATHODE FOLLOWER VIDEO RESPONSE, (Reference Sheet), by R. H. Baer
Chart gives ratio of permissible pulse drive to low-frequency sine-wave input

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ELECTRONICS—October, 1950
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is important

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October, 1950 — ELECTRONICS
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BUT NEVER EQUALLED!

AN IMPORTANT MESSAGE TO MANUFACTURERS OF
ELECTRONIC EQUIPMENT AND THEIR ENGINEERS

NOW... in these hurried days of war-conversion, we stress again the importance of solder as a component—a working part—of your equipment. The thousands of soldered joints in your complex product are more than “just joints”... they are the very nerve ends which control performance, the collective guardian of your reputation as a manufacturer.

Ersin Multicore solder is the world's finest, and our advertisements have consistently described the little-understood standards by which to judge a solder. Through the years, we have had the satisfaction of seeing this internationally preferred product adopted by America’s leading manufacturers, for exclusive use in soldering applications where the quality of the solder and its technical performance are of such importance that they are willing to pay the initially higher price in order to save production time and avoid rejects and failures.

Resulting economies in production have more than compensated for the slightly higher initial cost, so that Multicore has actually proved to be the “cheapest” of all solders. We have won acclaim for the advantages of three-core construction, for the activated, yet non-corrosive nature of Ersin Flux, and for the speed and surety of bond... which Multicore alone brings to your assembly line.

One by one, these characteristics have been adopted by competing brands. Today, Ersin Multicore is one of the most widely imitated solders in the market. Imitated, yes, but never equaled... because quality and rigid manufacturing control are the main precepts which guide the production of this superior product. Constant research perpetuates this leadership.

The continuous, reliable functioning of electronic equipment in wartime assumes special significance, because the maintenance of military communications is measured in lines “Little things” like high resistance joints (often directly linked to the failure of solder) may affect more than the business aspects of your contracts... they can affect the very timing and success of military operations.

A soldered joint costs but a fraction of a cent. Entrusted as you are with the manufacture of military communications equipment... can you afford to use less than the best?

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October, 1950 — ELECTRONICS
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4. Stop, of cup design, provides superior switch shielding . . . gives ycu excellent torque strength without distortion.
5. High grade laminated phenolic shoe maintains high insulation resistance under humidity conditions.
6. Contact Spring gives you double wiping contacts on both resistor and center terminal ring . . . is accurately formed to maintain uniform pressures and minimize noise.
7. Electro tin-plated terminals provide soldering ease . . . gives ycu excellent torque strength without distortion.
8. Resistor is made of special resistance material bonded to high quality phenolic for smooth operation, low noise level, outstanding humidity characteristics.
9. Cadmium-tipped center terminal provides easy soldering . . . good shelf life without oxidation. Adequately lubricated for good rotation life, center terminal is finished to give you smooth take-off . . . minimum noise.
10. Laminated phenolic base maintains high insulation resistance under humidity conditions.
11. Cadmium-plated steel ground plate assures positive grounded cover.
12. Cadmium-plated steel bushing is accurately finished and fits to shaft for smooth rotation.
13. Retaining ring.

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You'll find Centralab a good source of supply for a wide range of controls, switches, ceramic capacitors, and printed Electronic Circuits in standard or custom-built models, sizes and values — for all type electronic devices — military and commercial.

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New Centralab Model 2 Radiohm Control. Left, single unit plain type, untapped; right, twin unit plain type, untapped. Both with single shafts.

New Centralab Model 2 Radiohm Controls. At left single unit switch type, tapped with single shaft. Right — twin unit switch type, untapped with single shaft.

New Centralab Model 2 Radiohm Control. Left, twin unit plain type, front section tapped; right, twin unit switch type, rear section tapped. Both units have concentric shafts.
Centralab Triode Couplates save space and weight. They actually replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values.

Centralab Vertical Integrators give you big savings in assembly costs, particularly in TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads ... reducing the formerly required 16 soldered connections to only 3! There's a big saving in the number of parts handled, too!

Centralab's TC (Temperature Compensating) Tubular Hi-Kaps, left, are the most stable capacitors available. With TC Hi-Kaps, there's practically no variation due to aging or changes in temperature or humidity. For applications where temperature compensation is unimportant, use Tubular BC Hi-Kaps, right.

Centralab's development of a revolutionary, new Slide Switch gives you improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. CRL Slide Switches are rugged and dependable.


Great step forward in switching is CRL's New Rotary Coil and Cam Index Switch. Its coil spring gives you smoother action, longer life.
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- 42-10 — HI-VO-KAPS — high voltage capacitors for TV application.
- 42-59 — CERAMIC TUBULAR TRIMMERS — designed for TV and VHF application.
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- 970 — LEVER SWITCH — shows indexing combinations.
- 995 — ROTARY SWITCH — schematic application diagrams.
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If your business is amplifiers, or controls, it will pay you to take another look at Permeron!

For additional information write—I-T-E Rectifier Division, or consult your local I-T-E Representative

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ELECTRONICS — October, 1950
to control high frequencies

USE LOW-CAPACITANCE RELAYS . . .

by

AUTOMATIC ELECTRIC
Chicago

For smooth, chatter-free control of microwave circuits . . . switch them with Automatic Electric relays. Automatic Electric made its first low-capacitance relay more than ten years ago, and today offers two types, each providing exceptionally low capacitance between contact springs, and between springs and ground (frame, mounting, etc.)

In addition to these low-capacitance characteristics, Automatic Electric relays provide the dependability of "twin" contacts and the small size you need for compact mounting. The Class "C" relay (background above) is especially suitable for strip mounting; it is only 0.687" wide and 2 1/8" high and is 5 13/32" in over-all length. The Class "S" relay (two views in foreground) is 1" wide, 1 1/4" high and 1 15/16" long, over-all. Operating mechanisms are basically standard Automatic Electric designs, thus assuring the high operating efficiency for which Automatic Electric controls are famous.

To receive complete information, simply let us know your specific needs. Address AUTOMATIC ELECTRIC SALES CORPORATION, Chicago 7, III. In Canada: Automatic Electric (Canada) Ltd., Toronto. Offices in Principal Cities.

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Stepping Switches
Relays
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Efficient, dependable Automatic Electric controls are available also for many other uses. Lever, turn and push-type keys; telephone-type dials; stepping switches; lamp jacks and caps—as well as a complete range of telephone-type relays carrying the Automatic Electric name—are now in service in hundreds of industrial applications.
announces four new OSCILLOGRAPH-RECORD cameras

...FOR more versatile SINGLE-TRANSIENT recording
The New Du Mont Type 295

...FOR thrifty SINGLE-FRAME recording
The New Du Mont Type 296

...FOR improved FINISHED-PRINT recording
The New Du Mont Type 297

...FOR simplified MOVING-FILM recording
The New Du Mont Type 321

NOW! more than ever it's DuMont when you RECORD TO REMEMBER
A new and complete line of oscillograph-record cameras.

The Du Mont Type 295

Transient phenomena representing writing rates as high as 180 inches per microsecond are recorded effectively with the Du Mont Type 295. The high-writing-capabilities of the Type 295 are obtained by the use of an f/1.5, 50mm, coated lens having excellent resolution and a minimum of rectilinear distortion. The camera accommodates plain or perforated 35mm film or paper and will make 40 exposures from a standard 36-exposure cassette. Film may be removed from the camera as it is exposed by use of a cut-off knife and a detachable, light-tight, film take-up cassette. Thus, a portion of the film may be developed while subsequent exposures are being made. Comfortable binocular viewing is possible while recording. An illuminated data card records pertinent handwritten information directly below the exposed trace. The housing has a side-access door through which the lens aperture is accessible. The aperture control has "click" settings. Both Time and Bulb exposures may be taken. The camera may be adapted for remote control of film advance and shutter release.

The Du Mont Type 297

For applications where minute-to-minute comparison of waveforms is required, the Du Mont Type 297 furnishes a finished print in a minute, by the Polaroid-Land Process. The Polaroid-Land camera-back is attached to the mirror housing by means of a slide adaptor which has three snap stops making it possible to record one, two, or three traces on a single print. The camera may be set at any point along the slide so that adjustment may also be continuous where more than three traces are desired on a single print. An illuminated data card permits recording information photographically on the print. All possible confusion between similar prints is eliminated. The camera is positioned so that the operator pulls the film toward him. Thus, the quick, smooth motion necessary to obtain clean prints is achieved with ease and comfort. The Type 297 incorporates a special, f/2.8 coated lens. Exposures may be taken at shutter speeds of 1/200, 1/100, 1/50, 1/25, 1/10 sec., Time, and Bulb. The recorded image is reduced to one-third the object size. The Type 297 is mountable on my 5-inch cathode-ray oscillograph and is supported completely by clamping it to the Du Mont Type 2501 Bezel.

The Du Mont Type 296

Single-frame recording provided by the Type 296 represents the most versatile and inexpensive general-purpose technique. Oscillograph-record application of the Type 296 is unlimited except by the specialized needs of moving-film recording and ultrahigh writing speeds. Compact in design, light in weight, and sturdy in construction, the Type 296 is easy to handle and is mounted quickly to all 5-inch cathode-ray oscillographs equipped with the Du Mont Type 2501 Bezel. A high-quality, f/2.8, 41.5mm, coated lens increases the writing-rate capabilities of the Type 296 approximately 57% over the Type 271-A, which it supersedes. Shorter focal length shortens the overall length of the Type 296. A self-inducing shutter has speeds of 1/200, 1/100, 1/50, 1/25, 1/10 sec., Time and Bulb. A comfortable, soft-rubber eyepiece permits simultaneous viewing and recording. The Type 296 weighs only 5 lbs.

The Du Mont Type 321

The moving-film camera makes possible the presentation of waveforms upon an unusually long time-base, and augments the performance of the cathode-ray oscillograph. Many improvements from the standpoints of performance and operation have been incorporated in the Type 321 to simplify moving-film recording. The camera accommodates 400 feet of perforated or unperforated 35mm film or recording paper. Both the load and take-up magazines may be detached from the camera in a few seconds. Film-loading is amazingly simple - there is no threading necessary, no complicated path to follow. Film speed is variable in eighteen steps from approximately one inch per minute to 10,000 inches per minute (15 feet per second).

Full speed is attained almost instantly. Less than one inch of film is wasted in stopping the motion of the film even when the camera is operating at the highest speed. Special designed film-braking minimizes the possibility of clogging, jamming, or breaking of the film. A film-supply indicator gives positive indication when the recording film is exhausted. The camera may be rotated 90 degrees, permitting either vertical or horizontal recordings to be made without rotating the cathode-ray tube or reversing deflection-plate leads. Single-frame records may also be made with the Type 321. Film travel may be time-calibrated by a flashing glow lamp. The light shield permits simultaneous viewing and recording. An illuminated data-card transfers pertinent information to the film. The Type 321 uses an f/1.5, 50mm, coated lens. Focus is fixed for general oscillographic applications but may be adjusted where required. Any desired length of exposed film may be removed from the camera by means of a cut-off knife. The take-up magazine may be removed quickly and carried to the darkroom. Additional magazines are relatively inexpensive. Stand mounting makes the Type 321 highly mobile. It can be mounted either from the floor or bench top. There is no mechanical connection between the camera and the oscillograph. A sponge-rubber sleeve makes the mounting light-tight and vibration proof.

ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
1000 MAIN AVE., CLIFTON, N. J.
WHAT is a MILLIWATT?

-for the correct answer from VHF to EHF, ask PRD

**INDICATION:**
Direct reading power measurement in four ranges of 0.1, 1, 10, and 100 milliwatts full scale is provided by the Type 650 Universal Power Bridge. This instrument may be used with positive or negative temperature coefficient bolometers operating from 50 to 250 ohms with bias currents of 3 to 40 milliamperes.

**DETECTION:**
PRD now offers a complete series of Broadband Coaxial Bolometer Mounts covering in three bands the range from 20 to 10,000 megacycles per second. Both 1 mw and 100 mw units are available for direct operation with the PRD Type 650 Universal Power Bridge. Additional wave-guide detectors provide coverage of the 12.4-40 kilo-megacycle band.

**RANGE EXTENSION:**
A full complement of fixed and variable attenuators permits extension of the power range of bolometer elements to higher input levels. Directional couplers are also available for this purpose.

PRD now provides the instrumentation to permit accurate power measurement over broad frequency bands with great precision and comforting ease of operation. Thus, another parameter is erased from the realm of the unknown by PRD's continuing program aimed at providing the r-f engineer with the best in test equipment. For full information concerning our complete list of products write Dept. E-9 today.

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Erie manufactures a complete line of Ceramic and Button Mica Condensers for transmitter and receiver applications: Carbon Suppressors, Custom Injection Molded Plastic Knobs, Dials, Bezels, Name Plates and Coil Forms. Our engineering department will work with you in developing specially designed components for efficient space-saving sub-assemblies. Complete technical information on request.

*Ceramicon, Hi-K, GP, and Plexicon are registered trade names of Erie Resistor Corporation.*

**Electronics Division**

**ERIE RESISTOR CORP., ERIE, PA.**

LONDON, ENGLAND • TORONTO, CANADA
When the job calls for vacuum processing, keep Kinney High Vacuum Pumps in mind. Thousands and thousands of successful installations prove beyond doubt that it's wise to make Kinney Pumps your first thought for vacuum!

Why do so many modern vacuum processing systems employ Kinney Vacuum Pumps? Because these Pumps save processing time, because they conserve operating costs, and because they can be trusted on the job. If you want fast pump-down and minimum equipment “down-time”, the Kinney Pump is the pump you need. Write for Bulletin V45, the complete story on Kinney High Vacuum Pumps and Equipment.


Making old things better
Making new things possible

KINNEY Vacuum Pumps
A pair of Eimac 4-400A tetrodes provides the ideal answer for a one-kilowatt AM or FM broadcast power amplifier stage. The 400-watt plate dissipation rating of these tubes allows extremely conservative operation at the 1-kw level, thus assuring long, trouble-free tube operation.

In AM service, the 4-400A is FCC rated for 500 watts output per tube in high level modulated amplifiers. In FM applications, the superlative performance of the 4-400A at VHF allows an easy 1-kw of useful power output from a pair of tubes.

The low driving-power requirement of these tetrodes allows the driving equipment to be reduced to simple low power stages employing low cost tubes. The rugged construction of the 4-400A, plus a Pyrovac plate and the use of other time-proven materials and manufacturing processes, contributes to the tube's long life and ability to withstand both physical and electrical abuse.

To simplify transmitter design, an Eimac air system socket and chimney assembly is available for the 4-400A. This assembly provides a balanced flow of cooling air to the tube with minimum air waste, as well as completing the shielding between input and output circuits.

The low driving-power required by the 4-400A makes it an ideal choice for audio as well as r-f application. High audio power at low distortion can easily be obtained with zero driving power. (See accompanying data.)

For tube economy in one-kilowatt equipment, consider the service-proven 4-400A developed by America's foremost tetrode manufacturer... Eimac. Complete technical data are available... write today.
Seven Copper Alloys Resist Corrosion in Bi-Metal Switch

Rusting and other forms of corrosion change the electrical characteristics of parts, decrease strength of springs and jam bearing points in small control instruments.

To combat such conditions, copper-base alloys were primarily selected for all functional parts in the illustrated water heater thermostat. This unit operates with a bi-metal actuator which curves forward as the result of one metal expanding more rapidly than another.

Since each copper alloy has different mechanical and physical characteristics, seven were used in this unit, and, in some cases, several tempers for each alloy.

Cartridge brass, 70% copper and 30% zinc, because of its ability to withstand heavy working better than high brass, is used for the cover (1), bracket (2), pointer (4), yoke (9), and staple (3). Half hard metal was necessary to permit drawing, forming and bending of the cover, pointer and yoke, and in the staple to permit the prongs to be bent at assembly. The bracket is spring hard (8 numbers) as it acts as a flat spring.

Phosphor bronze Grade A, 95% copper, 5% tin, 0.15 phosphor, produces flat springs in light gages (.006 and up) due to its excellent spring properties and resistance to fatigue. This alloy is used for the contact springs (16), push button spring (17), spring link (18) and flat spring (20). All have spring temper.

Nickel Silver Grades A, B

Two grades of Nickel silver find use in this unit. In the pivot bracket (8) grade B, 55% copper, 18% nickel and the remainder zinc, gives the part fine spring characteristics, high strength (better than 90,000 psi in its extra hard temper), and the ductility in this hard state to permit heavy bending and forming.

Grade A, 65% copper, 18% nickel and remainder zinc, has greater ductility than B which permits dimpling, bending and forming on the actuating lever (10). The base metal is hard (4 numbers) and has a tensile strength of 85,000. The coldworking done on this lever increases its strength to around 90,000.

Several Parts Machined

Free machining brass rod, with the highest machinability of the copper alloys, can be accurately machined with good finishes at high speeds. For these reasons, it is used for the counterweight (shown on assembly 9), adjusting nut (5), terminal (6), stub (7), and calibrating screw (12). This alloy also has a conductivity 26% that of copper.

The hollow rivets (11) and (13) are produced in cold headers from 70-30 (cartridge brass) wire. When the hollow rivets are such that drilling is required rather than extrusion in the header, a light leaded wire is used (65% copper, 0.3% lead and remainder zinc) to facilitate the drilling.

The cold headed and roll threaded screws (14) and (15) are made from high brass, 65% copper, 35% zinc. Although not as ductile as the cartridge brass used in the hollow rivets, it is sufficiently ductile for medium-sized heads and roll threading.

Silver Rivets

The hollow rivets used for electrical contacts in the switch under the silver links are also of silver to eliminate danger of arcing.

Bridgeport's laboratory can be of help to product engineers in the selecting of the best alloy from a functional as well as fabricating standpoint. Write the nearest district office or contact Bridgeport directly.

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BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA

In Canada:
Noranda Copper and Brass Limited,
Montreal
Measuring Split Seconds... with the help of Holtzer-Cabot motors!

This ingenious electronic device, made by American Time Products, Inc., tells in 30 seconds exactly how fast or how slow any watch is running per 24 hours (a job that used to require weeks of checking). Here’s how it works: — the ticks of a watch, picked up by a sensitive crystal microphone, activate a stylus which prints a dot for each tick on a revolving chart drum. The pattern made by these dots indicates the slightest variation of time-keeping accuracy, and also indicates the cause of any irregularity.

Designing a suitable motor for this high-precision instrument presented a difficult problem, due to the demanding specifications of the application:

- The motor must rotate the drum with an accuracy of one part in one hundred thousand.
- The motor must be exactly synchronous.
- It must have the necessary torques to operate the mechanical system with a margin of safety.
- The velocity of rotation must be perfectly smooth and uniform.
- The motor must be free from all electrical and mechanical noises which might be picked up by the microphone.

Holtzer-Cabot engineers were called in at the prototype stage and, working with American Time Products’ engineers, met all requirements by designing a modification of the Holtzer-Cabot RWC 2505 synchronous motor. Result — years of trouble-free performance in the field.

This is just another example of Holtzer-Cabot’s ability to meet the most demanding specifications in small-motor applications. Holtzer-Cabot motors range from 1/2000 up through 1 1/2 H.P.; from 24,000 RPM to 1 revolution per day!

HOLTZER-CABOT DIVISION OF NATIONAL PNEUMATIC CO., INC.
BOSTON 19, MASSACHUSETTS
builders of fine electric motors for three quarters of a century

INVESTIGATE NOW... Holtzer-Cabot welcomes inquiries involving special motors.

This is the WatchMaster... Watchmakers, watch manufacturers and jewelers everywhere use it to measure the accuracy of timepieces.

Photos Courtesy of American Time Products, Inc.
Can you suggest a good use for

**PRESSED BOARD**

Recently, we completed a new plant, devoted exclusively to the fabrication of pressed board. We feel certain it will be of great service to the television industry. We are already producing the pressed board television backs shown. Somewhere in your product there may be other parts, now made of metal, that can be made more economically out of pressed board. What is it? Our engineers welcome a challenge. Write us today.

**DONNELLY MANUFACTURING**

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PRECISION SHEET METAL & PRESSED WOOD FABRICATION

October, 1950 — ELECTRONICS
New BRUSH Combination Oscillograph has interchangeable electric stylus and inking pen

To improve the recording of variable phenomena under extreme conditions such as high or low room temperatures, The Brush Development Company introduces the Model BL-221 Single Channel and Model BL-222 Double Channel Combination Magnetic Oscillographs for use with either electric stylus or inking pen. These combination units are furnished with Model BL-944 Electric Stylus Power Supply, electric stylus, inking pen, inkwell and both standard and electric-recording chart paper.

The Model BL-944 Power Supply, shown above on the left, has a switch on the front panel to increase stylus voltage for recording high frequency phenomena.

Write for details on these new Brush instruments... or for information on conversion of standard direct-inking oscillographs to combination types.

THE Brush DEVELOPMENT COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio, U.S.A.
Canadian Representatives: A.C. Wickman (Canada) Ltd., P.O. Box 9
Station N, Toronto 14, Ontario
To All Users of Powdered Iron Cores
Anywhere, U. S. A.

Next time your order is placed for cores, ask your core maker this question: What material do you use in these cores?

If his answer is Carbonyl Iron Powders, good. He's using the highest quality material on the market. If he gives you another name, ask yourself this question: Can I be sure of high Q, of temperature and atmospheric stability at no extra cost? Can I be sure I'm getting the finest core possible if he doesn't use Carbonyl Iron Powders?

The answer is obvious. Your core maker can supply you with the best -- if he uses GA&F Carbonyl Iron Powders. Ask your core maker next time you place an order. See for yourself what a difference these low-cost, high Q materials can make!

Sincerely,

ANTARA PRODUCTS
General Aniline & Film Corporation
to all users of powdered iron cores...

Core users—here's a tip that will guarantee you cores made of the highest quality materials on the market. Ask your core maker for cores made with Carbonyl Iron Powders. You will guarantee yourself high quality cores because Carbonyl Iron Powders are high quality products with low loss characteristics. They are manufactured and tested for quality under the most rigid conditions.

It costs no more to secure Carbonyl Iron Powder cores. On a performance basis, they offer savings not possible with other magnetic powder.

Your core maker knows about these high Q materials. He is familiar with their stability, their ease of insulation, and the controlled particle size distribution. That's why we say, next time you order, insist on Carbonyl Iron Powders for best results!

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**GENERAL**

**ANILINE & FILM CORPORATION**

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**Iron Powders...**
A RELIABLE SOURCE OF SUPPLY for DEPENDABLE RESISTORS for OVER 20 YEARS

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STACKPOLE CARBON COMPANY • ST. MARYS, PA.

Electronic Components Division

October, 1950 — ELECTRONICS
Precision Voltmeters...

FAST ACCURATE READINGS

2 cps to 700 mc

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Almost anywhere in America, -hp- field representatives can give you personal help with your measuring problems. They have complete data on -hp- instruments, their performance, servicing and adaptability. Call the nearest -hp- field representative whenever, wherever you need help with a measuring problem.

From 2 cycles to 700 megacycles, there’s an accurate, easy-to-operate -hp- voltmeter to fit every voltage measurement requirement. You can choose from 5 precision voltmeters (including a battery-operated instrument) the ones which precisely fit your measuring need. Each has the familiar -hp- characteristics of high sensitivity, wide range, versatility, compact size, and time-saving ease of operation. These -hp- precision voltmeters are used by radio stations, manufacturers, research laboratories and scientific men throughout the world.

For complete data on any -hp- instrument, write directly to factory or contact the nearest -hp- technical representative.

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MODEL

400C

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Export Agents: Frazor & Hansen, Ltd.
301 Clay Street, San Francisco 11, California, U.S.A.
General Electric panel instruments have long been known for their reliability and accuracy. Recent design changes provide for better performance, readability, durability, and appearance. G-E voltmeters, kilovoltmeters, ammeters, milliammeters, microammeters, and vu volume-level indicators; thermocouple types and rectifier types; round or square, with conventional or long 250-degree scales—all will give your measurements the accuracy required and your panel that smooth, modern appearance. To bring you up to date on the latest improvements in cases, faces, and mechanisms, G.E. offers a comprehensive 24-page bulletin containing all information necessary for ordering. Write for Bulletin GEC-368. For vu indicators, see Bulletin GEC-369.

SAVE PANEL SPACE WITH ONE-UNIT PUSH-BUTTON AND INDICATING LIGHT

This space-saving pilot-circuit switch consists of a sturdy push-button unit, 2¾ inches high, with a hollow translucent cap and 6-volt lamp. The switch is the momentary contact type, single-pole, with one normally open and one normally closed circuit. It uses movable-disk type contacts. Buttons are supplied in clear, red, green, blue, amber, and white. For more data on this and other G-E push-button units, see Bulletin GEA-4254.

SOLVE DESIGN PROBLEMS WITH THE SWITCH OF 10,000 USES

A member of the well known SB-1 switch family can find a useful place on almost any large electronic control panel. The precision-built parts of this all-purpose switch permit as many as 40 stages—four banks of ten stages each—to be operated in tandem. Switches with up to 16 stages and 12 positions are commonly furnished. Over 10,000 circuit-sequence combinations are possible. Ratings go to 20 amperes at 600 volts a-c or d-c. See Bulletin GEC-270.
PERMAFIL CAPACITORS

NO DERATING AT 125° C OPERATION

For operation at high ambient temperatures, these standard-line G-E Permafil capacitors are naturals. They’re paper dielectric units and can be used at temperatures up to 125° C without derating. All are metal encased, compression-sealed, and have long-life silicone bushings. Ratings: up to 2 muf for operation at 400 volts d-c and below. Case styles: 53, 61, 65, and 65 (JAN-C-25 specifications). For more data, write Capacitor Sales Div., General Electric Co., Pittsfield, Mass.

INDUCTROLS

STEPLESS VOLTAGE VARIATION

Inductrols are G-E dry-type induction voltage regulators for 120 and 240-volt operation. Hand-operated models provide smooth and extremely precise voltage adjustment for such uses as instrument calibration and rectifier control. Motor-operated models are used with automatic control to maintain voltage within narrow limits, irrespective of supply variations. Sizes range from 10½ x 6½ x 7½ inches for the smallest hand-operated unit to 14 x 6 x 10½ for the largest motor-operated unit. One unit provides a voltage range of 10% raise and lower on 3 and 6-kva circuits. Another gives 100% raise and lower for 2.4 and 3.6 kva circuits. Complete information in Bulletin GEA-4508.

HIGH-VOLTAGE SELENIUM RECTIFIERS

WITH LIFE EXPECTANCY OF 60,000 HOURS!

Now available from G.E. are 26-volt RMS selenium rectifier cells with a continuous-service life expectancy of over 60,000 hours. Their initial forward resistance is very low and samples show an average increase in resistance of less than 6% after 10,000 hours of operation. General Electric knows of no other high-voltage selenium cell on the market that can even approach their performance.

The high output voltage permits the design of smaller stacks while the low resistance means cooler operation and the space saving that goes with it.

Stacks made with the new G-E cells may be obtained with rated outputs from 18 to 126 volts d-c at .15 to 3.75 amps. Write now for Bulletin GEA-5280.
In the shop... 28 ranges in one case to locate circuit troubles on production equipment.
On the bench... 28 ranges in one case for checking electrical equipment during manufacture.
In the lab... 28 ranges in one case immediately available for research and development work.

28 Instrument Ranges
D-C VOLTS: 100 mv, 1/10/50/200/500/1000 volts (20,000 ohms per volt).
A-C VOLTS: 5/15/30/150/300/750 volts.
D-C CURRENT: 50 microamps; 1/10/100 milliams; 1/10 amps.
A-C CURRENT: 5/1/5/10 amps.
RESISTANCE: 3000/30,000/300,000 ohms; 3/30 megohms.

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The valuable time of your engineering staff can be conserved appreciably by letting Ohmite help solve your difficult resistance problems. Because Ohmite engineers are resistance specialists, they can quickly analyze your requirements and recommend the correct rheostats and resistors—or frequently a moneysaving combination—for your particular application. Both Ohmite’s engineering help and its laboratory facilities are available to you for the asking. Years of experience in building dependable resistance units... and in helping others to economically solve their resistance problems... are your assurance Ohmite can help you.

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The Most Complete Line of Wirewound Resistors...
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No matter what your resistor requirements, the chances are that Ohmite has exactly the resistor you need. Ohmite offers fixed, adjustable, tapped, non-inductive, and precision-type resistors in many sizes, types of terminals, and in a wide range of wattage and resistance values. Ohmite application engineers will be pleased to help in the selection of the right resistor for your needs.

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Write on Company Letterhead for Catalog 40

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For Every Resistor Need!
In addition to the many types of resistors shown, Ohmite offers resistors in more than 60 sizes—ranging from 2½" diameter by 20" long, to ¼" diameter by 1" long—to meet your exact requirements. Many sizes are carried in stock.

MANY TYPES OF TERMINALS

LUG TYPE
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CUP STYLE FERRULES

SLEEVE STYLE FERRULES
CARTRIDGE STYLE FERRULES
LIVE BRACKETS
Combines Longevity and Dependability

ELECTRICAL CHARACTERISTICS

DRIVING COIL REQUIREMENTS—18 volts, 94 milliamperes, 400 cycles ± 10 per cent.

CONTACT RATING—SPDT switching. Nominal rating, 28 volts to one microvolt, 1.0 milliampere; maximum power, 100 microwatts.

SWITCHING ACTION—Each contact closed 55 per cent of each cycle, closed simultaneously 5 per cent of the time.

SYMmetry—Within 5 per cent.

LOAD CHARACTERISTICS—Resistive or inductive.

SHIELDING—Shell and coil shields, both grounded through pin No. 2.

VIBRATION RESISTANCE—Output voltage will vary less than 2 per cent, with rates of vibration from 0 to 10 g.

PHASE SHIFT—Output voltage differs from that of driving voltage by 45 to 50 degrees.

STRAY PICK-UP—Sufficiently low for the measurement of a one microvolt d-c signal after amplification by a suitable audio frequency amplifier.

...The Brown 400 Cycle Converter

Practically identical to the service-proved 60 cycle converter used in the Brown line of Electronik precision instruments, this component is ideal for use with any system involving the conversion of low-power direct voltage signals of the order of 100 microvolts to 400 cycle alternating voltages. It is particularly useful for applications requiring error voltage measurements or null detection. The design and arrangement of its contacts practically eliminate electrostatic stray potential pick-up. For detailed information, write for a copy of Data Sheet 10.20-1. MINNEAPOLIS-HONEYWELL REGULATOR CO., Industrial Division, 4428 Wayne Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS HONEYWELL

BROWN INSTRUMENTS
Designed for Application

GRID DIP METERS

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use, with a range from 220 kc. to 300 mc., incorporates features desired for both industrial and laboratory applications, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range of 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extend range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe. These instruments are complete with a built-in transformer type A.C. power supply and interstitial terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 270° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Grid Dip Meters may be used as:
1. A Grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

Site of Grid Dip Meter only (less probe): 7 in. x 3 3/16 in. x 3 1/8 in.

Millen Laboratory Instruments are illustrated and described in our Laboratory Equipment catalogue, a copy of which will be mailed upon request.
Those in the Radio and Television Industries know from actual use the fine performance of these Tubes. They also know that our large production capacity assures them of a dependable source of supply with prompt delivery.

Ask us about these spirally laminated paper base phenolic tubes in diameters, wall thicknesses and lengths that will meet your needs.

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LAMINATED PHENOLIC TUBING
is used also for many other electrical products at a considerable saving where exacting specifications must be carefully followed. For the best . . . "Call Cleveland."

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ELECTRONICS — October, 1950
"with AMERICAN AIRLINES

EXTRA SAFETY IS A MUST..."

States HERSCHEL WOLF
of American Airlines

"...G-E High-Reliability Tubes
Lift SAFETY and SAVINGS, Too!"

AYS Herschel Wolf, in charge of aircraft radio communications for American Airlines: "You can trust G-E High-reliability Tubes to do their job all the time. They've helped us lift our high safety standards still higher."

You can't beat these special G-E miniatures for steady performance "under fire"—the kind of day-in, day-out job you can count on. So take a tip from American and other enthusiastic users, and specify G-E High-reliability Tubes in the equipment now on your drawing-boards! You'll lower upkeep costs, increase safety factor, widen your product's acceptance.

Altimeters, radio compasses, radio control apparatus, h-f aircraft receivers—all are employing G-E High-reliability miniatures with marked success. Every tube gets 50 hours' service at the factory under Class A conditions. Also, frequent samples are chosen for life tests, during which the tube is operated normally but intermittently by turning the heater on and off at one-minute intervals.

Communications... industry... along with aviation, find numerous applications for G-E High-reliability miniatures—the better tubes for better service where conditions are exacting! Write for further information. Learn more about what these tubes are; what they will do; how they can serve your needs more efficiently.

Electronics Department, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC
pH Meter

CAMBRIDGE INSTRUMENT CO., INC., Grand Central Terminal, New York City. The industrial model pH Meter is a precision instrument for the determination of acidity and alkalinity of fluids, which finds wide application in medicine, science and industry.

For many years, Cambridge has used KENYON Transformers in various industrial, research, laboratory and medical instruments.

Electrocardiograph

Another example of Cambridge pioneering is the Simpli-Trol Portable Electrocardiograph-Stethograph, a diagnostic instrument used by prominent cardiologists, hospitals and medical schools throughout the world for the study of heart disease.

Many important developments in science and industry have been furthered by instruments designed and manufactured with KENYON Transformers by the Cambridge Instrument Co.

For over 25 years, leading manufacturers and engineers in all fields have specified KENYON Transformers for industrial, communication, sound, electronic and scientific applications. Cambridge, too, specifies KENYON Transformers for quality, dependability and sound construction!
electronic voltage regulators
by Sorensen

- MAXIMUM ACCURACY
- MINIMUM DISTORTION
- FREQUENCY INSENSITIVITY

SORENSEN REGULATORS can be designed to meet JAN specifications.
SORENSEN engineers are always available for consultation about unusual regulators to meet special needs not handled by THE STANDARD SORENSEN LINE.

Write for Complete Literature

Sorensen and company, inc.

375 Fairfield Avenue, Stamford, Conn.

October, 1950 -- ELECTRONICS
CERAMIC PLATE CAPACITORS

Essentially similar, except in shape, to Hi-Q Disk Capacitors except that in the multiple units they do NOT have to have a common ground as is the case with disks. These Hi-Q Plates can be produced in an unlimited range of capacities, the number on a plate being limited only by the K of the material and the physical size of the unit. They offer the greatest available capacity per unit volume of any type condenser on the market.

Guaranteed minimum values of capacity up to 33,000 muf per sq. in. are available. This is based on the use of Body 41 ceramic having 3000 as K dielectric constant "K" and .020 in. thickness and the formula:

\[
C (\text{muf}) = \frac{224 \times K}{D} \text{ (Sq. in.)}
\]

If temperature compensating ceramics are used, the capacity will be considerably lower. Typical circuits are shown here, but almost any combination can be produced for your specific needs. Consult our engineers for complete details. Write for new Hi-Q catalog.
Products bearing the registered trademark “*dag*” originate only with the Acheson Colloids Corporation, Port Huron, Michigan, or with Acheson Colloids Ltd., London, England. Acheson Colloids is the world’s largest producer of colloidal graphite dispersions for the metalworking and electronic industries, and also supplies dispersed pigments to a large segment of the color-consuming trade. The trademarks “Oildag”, “Aquadag”, “Prodag”, “Glydag”, “Castordag”, “Varnodag” and “Gredag” identify particular products of Acheson Colloids Corporation or its affiliates, and are duly registered in the United States and in other principal countries of the world.
QUICK, RELIABLE
impedance measurements
up to 500 megacycles

Any signal generator with 0.1 volt maximum
into 51.5 ohms output furnishes sufficient
power for operation.

Crystal detector and audio amplifier with
output meter have sufficient sensitivity as
a detector above 100 megacycles.

Compact, simple, accurate instrument for the measurement of impedance, attenuation,
reflection coefficient and standing-wave ratio at frequencies up to 500 megacycles.

Read relative voltages of incident wave, reflected wave and resultant. Plot diagram of
voltages on Smith Chart and impedance can be determined to ±5%.

Requires no unusual accessories—only those found in every laboratory and test shop
working in the frequency range of the instrument: signal generator with 0.1 volt maximum
output, crystal detector, audio amplifier, and output meter. Below 100 megacycles a radio
receiver is desirable for its greater sensitivity.

In addition, the FTL-42A Impedometer can be operated with input power up to
several hundred watts when it is desired to drive the load in this manner.

Adapters for 13/8 inch line to type N are furnished so that the instrument can be used
with flexible cables.

The FTL-42A Impedometer can be used directly with 13/8 inch line, or with other
sizes of lines or cables by use of various adapters that are available.

It can be built for other impedances such as 72 ohms coaxial, according to require-
ments of user.

Dimensions of cabinet: 61/4 inches long by 53/8 inches wide by 7 inches high. Net
weight including adapters is 7 pounds.

Price—$400.00

Write for complete FTL-42A brochure.

Federal Telecommunication Laboratories, Inc.

500 Washington Avenue
Nutley 10, New Jersey
A NEW SERVICE TO TV MANUFACTURERS

A NEW MARKET FOR TV SERVICEMEN

with General Electric TV Components

EM-PM FOCUS COIL—These units combine the effects of Alnico 6 permanent magnet and an electromagnet to provide uniform focus with a minimum of circuit power.

NEW DEFLECTION YOKE—Sweeps 70° with only 20 watts of power from a 250-volt supply. Ferrite core units available for high efficiency applications.

HORIZONTAL SWEEP TRANSFORMER—When used with high efficiency yokes, these ferrite core transformers provide 70° deflection at 13 kv.
RECEIVER MANUFACTURERS

You can cut replacement parts servicing problems to a minimum...keep your sets in the field with the assurance of ready serviceability...reduce material and handling costs...by designing General Electric TV components into your product.

More than twenty TV receiver manufacturers are now using G-E components. Big makers like them because they're expertly fabricated, dependable, backed by a name you can depend on.

Smaller manufacturers turn to G.E. for components specially adapted to fit particular designs. Remember—when you use G-E parts, duplicates are stocked by G-E distributors and dealers everywhere—automatic assurance that your sets will be repaired in the field, not returned to the factory.

SERVICEMEN

Estimates peg the TV market at ten million sets in use by the end of 1950...that's your opportunity!

Millions of G-E parts are now in receivers everywhere...and more manufacturers are turning to General Electric every day...Be sure you get your share of the skyrocketing replacement business that supports these receiver sales...that's your market!

Now—for the first time—dealers and servicemen can stock the complete line of General Electric components shown here! They're available through parts jobbers and distributors in your area.

Put yourself in the replacement business for keeps—and for profit. Call your jobber or distributor for full details. Meanwhile, send for the complete G-E Parts Catalog, just off the press. Mail the coupon and the catalog will be rushed to you—free!

ARE YOU READY?
MAIL THIS COUPON TODAY!

General Electric Company, Section 4100, Electronics Park, Syracuse, N. Y.

I want my share of the new TV replacement market. Send me complete catalog of TV components and facts on service sales.

NAME

ADDRESS

CITY

STATE

ELECTRONICS — October, 1950
Miniaturization Specialist Capacitors—

1000 to the Pound!

AEROVOX MICRO-MINIATURES
(TYPE P83Z AEROLITE® CAPACITORS)

- A thousand to the pound! Smaller than previous “smallest,” these molded thermoplastic tubulars unfold an entirely new concept of capacitor construction.

The smaller physical sizes are directly attributed to the latest metallized-paper technique which combines both dielectric and electrodes in a single winding strip. Unusually strong lead connections to capacitor section. Since capacitance is predetermined mechanically in the initial processing, it is no longer necessary to rely on the human element for capacitance control.

Type P83Z Micro-miniatures are particularly applicable to that portion of the electronic field where low capacitance paper capacitors and high-capacity disk capacitors are now being used.

Featuring . . .
Two sizes: 3/16" d. x 7/16" L: 1/4" d. x 9/16" L.
200, 400 and 600 rated voltage; 300, 500 and 900 test voltage.
Hytol K impregnated in humidity-resistant molded thermoplastic case.
Operating temperature from -15°C to +85°C. without derating.
Power factor less than 1% when measured at or referred to frequency of 1000 cps and ambient temperature of 25°C.
Life test: 1000 hours at 1.25 times rated voltage in ambient temperature at 85°C.
Insulation resistance of 25,000 megohms or greater, measured at or referred to temperature of 25°C. Insulation resistance at 85°C, 500 megohms or greater.

Try Aerovox Micro-miniatures in your miniaturized assemblies. Write Dept. MM-83 for engineering data, samples, quotations and application-engineering aid.

AEROVox capacitors
FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS
AEROVox CORPORATION, NEW BEDFORD, MASS., U. S. A.
Sales Offices in All Principal Cities • Export: 41 E. 42nd St., New York 17, N. Y.
Cable: AEROCAP, N. Y. • In Canada: AEROVox CANADA LTD., Hamilton, Ont.

October, 1950 — ELECTRONICS
1 SUB-MINIATURE "GUIDED MISSILES" FILTERS
For security reasons details of this development in miniaturization must be omitted. It can be told, however, that all six channels are contained in a total volume of 18 cubic inches or 3 cubic inches per channel.

2 TONE CHANNEL FILTERS *
Available for either 120 or 340 cycles spacing between channels. These filters have received wide acceptance and are extremely popular among manufacturers of carrier telegraph equipment. In addition to the many standard types of tone filters we are supplying, special characteristics can readily be incorporated into designs to suit your application.

3 HIGH Q TOROIDAL COILS
"Actually the first essential requirement in the design and manufacture of high quality audio filters, these toroids wound on molybdenum permalloy cores have provided the almost impossible solution for many network problems. As the leading independent manufacturer of toroids, our products are backed by years of experience and specialized knowledge."

4 TELEMETERING FILTERS *
Among the earliest to be employed in the improved telemetering system now in general use. Particular attention has been paid to linearity of phase shift and good transient suppression as well as high inter-channel attenuation in order to eliminate distortion in telemetering reception.

* "Filters such as these are included in a wide variety of types which we are now producing for manufacturers and users of microwave communications and relay equipment. We would be pleased to discuss your application for filters in this field and bring you up to date on the latest developments in the application and design of filters which have resulted from our close association with the carrier communications industry."
Checks on...
- 24 Omni courses
- Left-center-right on Phase-localizer
- Left-center-right on Amplitude-localizer
- Omni course sensitivity
- To-From and Flag-alarm operation
- All necessary quantitative bench tests

MICROWAVE TEST SET...TYPE H-10
23,500-24,500 MEGACYCLES
Provides source of cw or pulse frequency-modulated RF, power level -37 to -90 dbm. RF power meter measures levels from +7 to +30 dbm. Frequency meter for measuring output or input RF accurate to better than 20 mc. Primary purpose of the H-10 is to measure receiver sensitivity, bandwidth, frequency, recovery time, and overload characteristics, plus transmitter power and frequency. Recommended as a standard source of RF for research or production testing. Equal to military TS-223/AP.
PRICE: $1692.00 net, f.o.b. Boonton, N. J.

UHF SIGNAL GENERATOR...TYPE H-12
900-2100 MEGACYCLES
Provides source of cw or pulse amplitude-modulated RF, power level 0 to -120 dbm. Internal pulse circuits with controls for width, delay, and rate, and provision for external pulsing. Single dial tuning, frequency calibration accurate to better than 1%. Built to Navy specifications for research and production testing. Equal to military TS-419/U.
PRICE: $1950.00 net, f.o.b. Boonton, N. J.

Aircraft Radio Corporation also manufactures LF and VHF airborne communication and navigation equipments—all CAA-Type-Certificated for scheduled air-carrier use or for those whose type of flying requires a high degree of reliability and performance. Equipment consists of light, small units which can be combined to provide the required operation, whether it be the 1 Receiver/1 Transmitter (15-pound) installation in a 2-place helicopter, or a 3 Receiver/2 Transmitter/VHF Omni installation (70 pounds) in larger 2-engine aircraft.

WRITE TODAY for descriptive bulletins on any of these instruments
In medieval times, a coat-of-arms had an importance that could not be overestimated. It was granted as a personal badge, signifying the attributes and accomplishments of its proprietor—and as such was respected throughout the civilized world. It had no duplicate.

In turn, the emblem imposed upon its owner a responsibility for maintaining an enviable reputation—a condition which stimulated general confidence in him.

Times have changed, but not all things. The sense of sanctity of an emblem is prevalent today as it was hundreds of years ago. That is why we take such pride in our trademark: NICHROME.

It is evidence of our accomplishment; our unique, personal badge—respected everywhere. Granted solely and wholly to us by the United States Patent Office over forty years ago, it symbolizes a series of superb electrical heat and corrosion-resistant alloys (developed and produced only by Driver-Harris Company) which today is serving industry all over the world.

Yes, there are other excellent heat and corrosion-resistant alloys, but only one NICHROME—the product of exclusive Driver-Harris knowledge and techniques.

We are well aware of our obligation to maintain its reputation, both here and abroad. In fact, such obligation is an inspiration to give of our best—now, tomorrow, and always.

Nichrome® is manufactured only by
Driver-Harris Company
HARRISON, NEW JERSEY
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco,
Manufactured and sold in Canada by
The B GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. Registered in United States Patent Office by Driver-Harris Company August, 1908
12 Improvements IN NEW 1951

MODEL O-6

PUSH-PULL

Heathkit

OSCILLOSCOPE KIT

* New AC and DC push-pull amplifier.
* New step attenuator frequency compensated input.
* New non-frequency discriminating input control.
* New heavy duty power transformer has 68% less magnetic field.
* New filter condenser has separate vertical and horizontal sections.
* New intensity circuit gives greater brilliance.
* Improved amplifiers for better response useful to 2 megacycles.
* High gain amplifiers .04 Volts RMS per inch deflection.
* Improved Allegheny Ludlum magnetic metal CR tube shield.
* New synchronization circuit works with either positive or negative peaks of signal.
* New extended range sweep circuit 15 cycles to over 100,000 cycles.
* Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier. The vertical amplifier has frequency compensated stage input into a cathode follower stage. The gain control is of the non-frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers. 15 cycles to cover 100,000 cycles. The new model O-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser, has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing. The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability. The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit Model O-6 Shipping Wt., 30 lbs.

The Heath Company
Benton Harbor 14, Michigan

Only $39.50

New INEXPENSIVE MODEL S-2

ELECTRONIC SWITCH KIT

Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — super-impose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittent, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

His individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space inside the scope. Better get one. You'll enjoy it immensely. Model S-2 Shipping Wt., 11 lbs.

Only $19.50
It's no accident that AlSiMag components give you the plus performance and the smooth assembly that they should. It's planned that way.

Every new design goes through two groups of engineers at the AlSiMag plant. The first group studies the design to see if it can be made to do its job more effectively or if it can be modified for more efficient production.

Production engineers in the second group study the design to adapt it to the most efficient production methods in our plant. On complex designs, both groups study the prints, then get together for final discussions. Thus the men who are directly responsible for production see the design before the order is accepted. They point out any design features that might lead to trouble or unnecessary expense.

These engineering recommendations are sent to the customer. Specialized experience and intimate knowledge of available production methods thus give you better AlSiMag components at a saving.

In many instances, our engineering groups recommend hand made test samples of the original design and of modified designs. These can be made promptly and at reasonable cost. Once the proper design is found, production orders can be entered with assurance that the design does the job and that it is practical to produce.

When production orders are entered, Quality Control takes over. If the job gets off specification at any point, the trouble is corrected immediately. This saves a lot of time and a lot of money and helps us make delivery as promised. And it assures that your AlSiMag parts will fully meet all specifications.

Weak points removed from the ceramic and load carried on metal caps. Overall strength greatly increased. Losses in production and in use greatly reduced. Precision manufacture at minimum cost attained through redesign.

49TH YEAR OF CERAMIC LEADERSHIP

AlSiMag
AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENNESSEE

OFFICES: METROPOLITAN AREA, 671 Broad St., Newark, N. J., Mitchell 2-8159 • CHICAGO, 228 North LaSalle St., Central 6-1721
PHILADELPHIA, 1449 North Broad St., Stevenson 4-2828 • LOS ANGELES, 232 South Hill St., Mutual 9076
NEW ENGLAND, 38-8 Bishop St., Cambridge, Mass., Kirkland 7-4498 • ST. LOUIS, 1123 Washington Ave., Garfield 4259

"AlSiMag engineers have always had the answer to our ceramic problems."

"AlSiMag delivers as promised and gives us parts that do the job."

"In many cases AlSiMag engineers have helped us work out a better component that costs us less money."

"AlSiMag cannot always give us the delivery date we want but they have always delivered as promised."

"AlSiMag is the only one that has always met our tolerance requirements."

"AlSiMag is always right on the specifications."
As "Big Business," television came suddenly. Just as suddenly, Clarostat was ready. Three decades of pioneering and specialization, backed by a plant second to none, assured TV designers and manufacturers of an outstanding selection of resistors, controls and resistance devices. And when ion spot blemishes became a major problem, again Clarostat was ready with simpler and cheaper beam-benders. Thus Clarostat products are already represented in over 5,000,000 sets and in countless radios in daily use. All because, for quality, uniformity, dependability, economy, it's CLAROSTAT.

WRITE FOR Engineering Bulletins on resistors, controls and resistance devices. Let us collaborate on your control and resistance problems and requirements.

Controls and Resistors
CLAROSTAT MFG. CO., INC. • DOVER, NEW HAMPSHIRE
IN CANADA: CANADIAN MARCONI CO. LTD., MONTREAL, P. Q., AND BRANCHES
ANTON

ADVANCED ELECTRONICS

ANTON LABORATORIES is a complete, self-contained electronic establishment in which the advanced designs of skilled technicians are converted into a wide range of outstanding instruments and components for measurement and generation of radiation—equipment that has won the acclaim of users in research laboratories, schools, hospitals, and the acceptance of manufacturers and the Armed Forces.

Located in the center of research activity, in New York City, cooperating with eminent scientists in many fields, the ANTON Laboratories provide completely integrated facilities for research and production. We design what we make—and make what we design—all under one roof and one management. We do an outstanding job, because we do all of the job.

Most recently, our work in cooperation with the U.S. Navy and the Naval Research Laboratories has resulted in the development of Counter Tubes of greatly improved sensitivity, performance and dependability. These are now available to laboratories and manufacturers of quality instruments.

Complete Tube Catalog, containing detailed specifications and technical data, is available upon request.

ADVANCED G-M COUNTER DEVELOPED FOR U.S. NAVY

TYPE 201—U. S. NAVY TYPE BS-1.
High sensitivity end mica window counter for β, γ, and high energy α detection. Specifically designed for precision survey instruments.

IMPROVED COUNTER TUBES

Anton Tubes are the product of years of intensive research effort—employing new methods in design and manufacturing, improved materials, precision workmanship, and controlled production techniques.

- GROOVED CERAMIC INSULATORS
A basic improvement over conventional flame-worked glass bulb: Precision molded . . . uniform diameter . . . accurate alignment . . . mechanically stronger. Deep grooves lengthen surface path to minimize external leakage. No bulge around cathode to interfere with probe assembly or restrict "stacking". . . no wax coating to be scratched . . . and non-photosensitive.

- HALOGEN QUENCHED
Uniform, stable characteristics unaffected by use . . . cannot be damaged by sustained over-voltage . . . operating range —55°C to +75°C . . . long shelf life . . . large pulse amplitude.

- MECHANICAL DESIGN
Mechanically rugged, capable of withstanding shock and vibration . . . designed for convenient incorporation in instruments . . . exhaust tip protected by screwed-on terminal cap.

This is the new Collins 51V-1 glideslope receiver for aircraft. Note the orderly design, and the accessibility of all tubes, components, and wiring.

The 51V-1 provides reception of 90/150 cps tone modulated glideslope signals on any of the twenty channels in the uhf range of 329-335 mc. This receiver together with Collins 51R navigation equipment will fulfill ILS receiving requirements for military, commercial and private aircraft. The design of the 51V-1 is based on "Glideslope Receiver Characteristics" issued by Aeronautical Radio, Inc., and on U. S. Airforce specifications.

Output circuits of the 51V-1 receiver feed standard 1D-48ARN deviation indicators including flag alarm. By means of the flag alarm the pilot has a positive indication of the reliability of the glideslope signals and instrumentation.

The 51V-1 control circuits are integrated with the standardized R/O channeling system with channel selection provided by means of a Collins 314U remote control unit.

More complete information, in the form of an illustrated bulletin, is yours on request.
New Tough Insulation
Speeds Coil Production

In coil manufacture, the amazing flexibility of BH "649" Fiberglas Tubing and Sleeving permits ease of push-back with no loss of physical or dielectric properties. Saves valuable production time. Cuts down rejects. BH "649" can be twisted, compressed, folded — with no cracking or rupture of the film.

BH "649" has a smooth bore, handles easily during production with no snagging. Will not support combustion. Resists moisture, oils, grease or ordinary chemicals. Remains supple after baking at 302°F. for 24 hours. Unaffected at temperatures as low as −67°F. Suitable for use with most impregnants — for complete test data, see our Technical Data Folder. BH "649" is made in Grades A-1, B-1, C-1 and C-2 — in all sizes from No. 24 to 5/8" inclusive. Write for production samples.

BENTLEY, HARRIS MANUFACTURING COMPANY
CONSHOHOCKEN, PA.
Now MYCALEX offers both 7-pin and 9-pin miniature tube sockets... with superior low loss insulating properties, at prices that offer ceramic quality for the cost of phenolics.

MYCALEX miniature tube sockets are injection molded with precision that affords uniformity and extremely close tolerances. MYCALEX insulation has high dielectric strength, very low dielectric loss, high arc resistance and great dimensional stability.

Produced in two grades: MYCALEX 410 conforms to Grade L4 specifications, having a loss factor of only .015 at 1 MC. It is priced comparably with mica filled phenolics.

MYCALEX 410X is for applications where low cost of parts is vital. It has a loss factor only one fourth that of "everyday" quality insulating materials, and a cost no greater.

Prices gladly quoted on your specific requirements. Samples and data sheets by return mail. Our engineers will cooperate in solving your problems of design and cost.

Mycalex Tube Socket Corporation
"Under Exclusive License of Mycalex Corporation of America"
30 Rockefeller Plaza, New York 20, N. Y.
Airborne Instruments Laboratory Specifies

CLARE SEALED RELAYS

For Aircraft, Ship and Submarine Control Equipment

Front view of Airborne Instruments Laboratory control panel, with cover removed, showing group of eight CLARE hermetically sealed relays which perform important circuit control functions.

Cutaway view of typical CLARE Type "K" d-c Relay which is hermetically sealed in a permanent atmosphere of dry, inert gas to give maximum performance under the most extreme conditions of dust, moisture, air pressure and combustible gases.

Close-up view of the CLARE relay installation which demonstrates the economical use of space which use of CLARE sealed relays makes possible.

Airborne Instruments Laboratory of Mineola, N. Y. uses CLARE Type "J" and Type "K" sealed relays as components of ruggedly designed but delicately operated control equipment for aircraft, ship and submarine.

These small, compact, space-saving relays are used in circuit applications that cover the broad field of low and high current, a-c and d-c switching and video switching. CLARE Type "J" and Type "K" Relays were selected for their outstanding speed of operation, dependable performance, resistance to vibration and very small size. Hermetically sealed in dry, inert gas, they are immune to changes in atmospheric pressure, humidity, dust or dirt . . . will operate as required over a long period. CLARE relays have long been first choice of manufacturers whose products must not fail. Selection of highest quality materials, precise manufacture and ability to "custom-build" just the relay for a specific requirement have made CLARE relays first choice with engineers who insist on . . . and get . . . the best.

Sales engineers are located in principal cities to cooperate with you in the development of a CLARE "custom-built" relay that will meet your most difficult relay need. Look in your classified telephone directory or write: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable Address: CLARELAY.

CLARE RELAYS . . .

First in the Industrial Field
The BIGGEST LINE of LITTLE SWITCHES

The BIG NAME in ELECTRICAL SWITCHES

Now United under the strong ownership-management of Acro Manufacturing Company, Mu and Acro snap-action switches comprise the finest and most complete line obtainable. The combined plants, with enlarged engineering and research facilities, are equipped to precisely manufacture (or develop, if required) the style switch which best suits your needs. To old or new Acro and Mu customers our expanded facilities will bring even better products and service. Design engineers are invited to submit their switch problems to us for speedy, economical solution. Write either location.

ACRO MANUFACTURING COMPANY

MU SWITCH DIVISION
CANTON, MASS.

ACRO SWITCH DIVISION
COLUMBUS 16, OHIO

COIN SWITCHES, OPEN BLADES, PHENOLIC ENCLOSED, METAL CLAD, MINIATURES, HIGH VOLTAGE, D.C., PUSH BUTTON, PANEL MOUNTS
the

PRESTO
PT-900

America's finest
portable tape recorder

Look at these features:

• Three heads for recording, playback, erasing.

• Separate recording and monitoring amplifiers.

• Three microphone input.

• Speeds: 15" and 7½"/sec.

• Frequency response: 50-15,000 cps.

• Power supply and amplifier in separate, leatherette covered cases.

The PRESTO PT-900 has been chosen by discriminating engineers, educators and broadcasters throughout the country as the best constructed, best performing, most durable, portable tape recorder available today. Combining the features of machines costing hundreds of dollars more, the PT-900 answers the need for a recorder of ultra-high fidelity in a completely portable, compactly designed unit. Built by the world's largest manufacturer of recording equipment and discs, the PRESTO PT-900 is precision engineered for years of satisfying service.

PRESTO RECORDING CORPORATION
Paramus, New Jersey

In Canada: Walter P. Downe, Ltd., Dominion Square Bldg., Montreal, Canada
BUSINESS BRIEFS

By W. W. MacDONALD

Better Men than this Business Briefs editor, in government and industry, are reshaping our economy to meet the requirements of peace, part-time police action or full-scale war. We are glad they are doing such planning, for the transition from the first condition to the second has already occurred and the third step seems probable. The only real uncertainty appears to be one of terminology and timing.

We think that no matter which way the bear jumps the devotion of American men and materials to purely military projects will eventually be at least equal to that which applied at the close of World War II. We think the electronics industry will ultimately face a greater manpower shortage, receive more military equipment orders, and have to suspend more civilian business than most people believe at this time. We think this will be more apparent after the November elections.

Having said all this, we can now report current news out of Washington, without further editorial comment.

Mobilization Plans already being implemented as this item goes to press lead Washington officials to believe that military orders for electronic items through the remainder of 1950 and fiscal year 1951 will total between $2 billion and $2.4 billion, with equipment actually shipped totalling about $1.5 billion.

Electronic industry spokesmen say that if this is so military business will require about 25 percent of their plant capacity and manpower to handle. This might permit an industry goal of 6 million television sets and 10 million radio receivers to be reached in 1950, despite an anticipated sharp drop in December. A reduction in civilian business of from 20 to 25 percent would be sufficient in 1951. Military people think this is over-optimistic.

Some raw materials are already in short supply due to military needs. Some component parts are in short supply due to heavy television receiver production and protective stockpiling. Allocations in some categories seem likely.

Three Major Groups have been set up by the electronics industry to work closely with the military. They are: (1) the National Electronics Mobilization Committee, which is a joint undertaking of RTMA and NSIA; (2) the Electronics Industry Advisory Committee, appointed in 1948 by the Munitions Board and NSRB; and (3) the Army Signal Corps Advisory Council.

Navy has set up a new Electronics Office, part of the Office of Navy Materiel located in the Executive Office of the Secretary of Navy. It will serve as a central point of contract for contractors formerly dealing individually with BuShips, BuAer, BuOrd, BuSupplies and Accounts.

Training Servicemen capable of handling electronic equipment to the satisfaction of the Navy Department in time of war costs from 10 to 100 times the value of the equipment these men maintain, according to L. V. Berkner of Carnegie Institute. It takes from two to four years, plus an additional four to ten weeks on each new highly specialized piece of equipment.

Editorial Assistant Jack Carroll went on ELECTRONICS' masthead last month. This month he is back in his Ensign's uniform and somewhere in the Pacific.

Fascinating Fact of the month is the granting of permission to remain silent for one day to radio stations KFGQ and KFGQ-FM by the FCC. It seems that the stations are run by a biblical college and the staff needed a day off to attend graduation exercises in Iowa City.

Puerto Rico, because of a very lenient corporation and personal
All Germanium Diodes are notable for their low forward impedance. But the 1N56 is specially engineered to make the most of this quality.

Use this diode for high efficiency circuits with low input and output impedances. Use it for relay activation, heavy current and surge applications with low impedance coils, transformers and condensers.

Try the 1N71 varistor in carrier telegraphy and telephony work. The low shunt capacitance insures high efficiency throughout the high frequency range. You will find this varistor equally efficient in low impedance modulator circuits of the carrier suppression or carrier transmission type.

Both the 1N56 Germanium Diode and 1N71 Varistor are available from Your Sylvania Distributor. Also ask him for a copy of the new book "40 Uses for Germanium Diodes." Priced at only $1.00, it is the most complete collection of germanium diode applications yet published.

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Unit isolators designed to meet Army, Navy, and CAA requirements. Stock mountings — 1/4 pound to 45 pound load range. Others on order.

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For mobile, railroad, and shipboard electronic and electrical equipment. Also for isolation above 2000 c.p.m., and for general sound isolation.

INSTRUMENT MOUNTINGS

For electronic components, tiny fractional H.P. motors, record changers, dictating machines, and other lightweight apparatus.

INDUSTRIAL MOUNTINGS

For fans, motor generator sets, transformers, presses, other heavy industrial equipment.

Free Catalogs give dimensions and load ratings of stock BARRYMOUNTS. Catalog 502 covers aircraft applications. Catalog 504 covers industrial and general-purpose mountings. WRITE TODAY to

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BUSINESS BRIEFS (continued)

There is a tax policy that is unique in the U.S., is being eyed as a plant location by a number of manufacturers. Already several people in our business have set up shop in the unincorporated territory and one or two others appear to be on the verge.

First Six Months of 1950 saw production of the following receiver totals by RTMA members:

<table>
<thead>
<tr>
<th></th>
<th>TV (Incl. portables) Car Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>12,588</td>
</tr>
<tr>
<td>Feb</td>
<td>16,716</td>
</tr>
<tr>
<td>Mar</td>
<td>20,894</td>
</tr>
<tr>
<td>Apr</td>
<td>24,062</td>
</tr>
<tr>
<td>May</td>
<td>27,323</td>
</tr>
<tr>
<td>Jun</td>
<td>30,572</td>
</tr>
</tbody>
</table>

The 2,413,145 tv sets produced in the first half of 1950 compared with 913,071 made in the corresponding period of 1949. The 5,228,170 radio sets made compared with 3,481,858 made in the preceding comparable period.

F-M and F-M-A-M radios included in the figures above totalled 539,852 in the first six months of 1950, an increase of 115,000 over the first six months of 1949. In addition, 225,673 of the television sets made from January through June this year had f-m reception facilities.

Receiving Tube Sales by manufacturers totalled 170,375,921 in the first half of 1950 as against 81,663,213 in the first half of 1949.

Electrons, Inc. says Detroit is still number one market for industrial thyatrons of its manufacture, but that Milwaukee and Cleveland are running a close second and third. We wonder how these and other cities stack up as industrial electronic equipment markets for others.

Heard In A Lab, and applicable in many other walks of life: "He has an unerring instinct for the unimportant."

Mexican XHTV is now transmitting television programs on a commercial basis two hours nightly, transmits music and a test pattern two additional hours each day. At least three major U.S. television receiver brands are be-
ing sold in quantity in Mexico City.

In July we mentioned a 700-outlet master television antenna system installed in New York and invited correspondence from anyone who knew of a bigger job. Curtis Pierce of RCA Victor Distributing now tells us that Roberts-Stage Electric is completing a 740-unit installation suitable for both television and f-m on Chicago’s Lake Shore Drive.

New Product Ideas are always interesting to manufacturers. If you have one tell us about it. Maybe we can help.

Advertising Copywriters are indeed ingenious in the art of artwork. Looking through the ads in one of our recent issues we note the presence of such widely assorted eye catchers as flying saucers, Indians, tight-wire artists, ghosts, magicians, elephants and butterflies.

September Issue Ads:

Just two pieces of copy make a direct bid for military business. However, several makers of temperature, pressure and humidity test chambers, and vibration testers, are back in print for the first time since World War II.

Three tube makers feature special long-life industrial types.

We are intrigued by the terms “mush-wound” coils and “ground worms (hard or soft)”.

Quality of editorial material is the thing we strive for on ELECTRONICS, but you get quantity too. The average issue weighs 23 ounces.

Self-Hypnosis may be accomplished with a photoelectric relay controlling a 10-watt lamp, according to the Photobell Company. “The lamp is placed near the phototube, causing rapid oscillations controllable by varying the adjusting knob. Adjust the frequency by trial to match your eye requirements, look closely, and...”

And what wakes you up, a power failure?

SIGMA Sensitive Relays

SPDT GENERAL PURPOSE SENSITIVE D.C. RELAY. Inexpensive Balanced armature for vibration resistance on aircraft at 10 millivolt adjustment. Sensitive enough for V-T operated relay circuits can be set to operate down to 10 millivolts. Precision adjustments for pull-in and dropout. 7 amp. nominal contact rating. Coil resistance up to 14,000 ohms.

SPDT VERY SENSITIVE D.C. RELAY. Balanced armature and magnetic efficiency react aircraft vibration on inductors as low as 3 millivolt. Withstands 600g shake without damage. Precision adjustments. 2 amp. nominal contact rating. Coil resistance up to 16,000 ohms. Special adaptation. Balance rectifier, two-wind differential instruction, constant voltage temperature compensation.

SPDT SENSITIVE RELAY AC-DC-KEYING. Unusual characteristics at low cost. Same D.C. sensitivity as Series 4 but less flexibility of adjustment. Available with long life and houset-free contacts, is noted to high-speed running and keying. Mechanical life exceeds 10,000 operations. Good for place circuit needing moderate precision and vibration immunity. Contact ratings up to 10 amp. Nominal contact rating. Coil resistance up to 14,000 ohms. A. C. sensitivity exceeds 0.1 V.A. at 60 cps. Serviceable on frequencies from 10-400 cps. Protects delicate thermostats or instrument contacts.

MULTICIRCUIT POLARIZED SENSITIVE RELAY. Single or double (differential) windings. Resistance up to 2500 ohms total. Contacts up to 6PDT, 3 amp. nominal rating. Balanced armature for strong vibration resistance. FORM X-Three Point or Null Seeking. For automatic positioning or 2-WAY current control. Sensitivity (depending on contact complexity) from 10 to 100 milliwatts. FORM Y-Biased (Spring Return). Use as an ordinary sensitive relay if a complex contact combination is needed. Combines function of pilot, relay and contacts. Sensitivity same as Form X. Responds only to one polarity. FORM Z—Latching (Permanent Magnet). Replace mechanical latch electrical reset relays, where longer life and greater vibration resistance is required. Sensitivity from 100 to 250 milliwatts.

SPDT SENSITIVE HIGH SPEED POLARIZED RELAY. Single or multiple windings up to 10,000 ohms (single); Balanced armature. Nominal contact rating 2 amps. For reversing bi-polar inputs at speeds up to 6600 RPM Smaller in size and weight. Hermetically sealed. Mechanical life exceeds 10,000 operations. FORMS X, Y and Z (see Type 6 above) available in Series 7. Sensitivity from less than 1 to 10 milliwatts depending on form and requirements. Form X is useful as the detecting element in positioning bridge circuits.

VARIETY OF ENCLOSURES

In addition to the open styles shown, SIGMA Relays are available with dust-proof or hermetically sealed enclosures. Most types are available for either plug-in or permanent solder leg connections.

WRITE FOR FULLY DESCRIPTIVE CATALOG

SIGMA Instruments, Inc.

ELECTRONICS — October, 1950
Outstanding Advantages of the new Mallory Spiral Inductuner:

1. A single control for easy selection and fine tuning of any television or FM channel.
2. Easily adapted to UHF converter use.
3. Excellent stability eliminates frequency drift.
4. Supplied in three- or four-section designs.
5. Far more quiet operation; permits high signal-to-noise ratio in front end designs.
6. Greater selectivity on high frequency channels.
7. Eliminates "bunching" of high band channels.
8. Simplifies front end design and production.
9. Eliminates "dead zone" from continuous tuning; covers entire TV range from 54 to 216 megacycles, including FM, in only 4 revolutions!
10. Reduces assembly costs.

*Reg. trademark of P. R. Mallory & Co., Inc. for inductance tuning devices covered by Mallory-Ware patents.

New Improvements in Mallory Inductuner* for Television Receivers

Now there are important new reasons why the Mallory Inductuner should be first choice for your TV receiver. Each one offers more convenience to the set owner, new economy for you, without any sacrifice in the performance advantages of the continuous tuning principle...

Improved Inductuner eliminates "dead zone" from continuous tuning; covers entire TV range from 54 to 216 megacycles, including FM, in only 4 revolutions!

Improved Inductuner covers entire TV spectrum in only 3 revolutions, if FM is not required!

Improved Inductuner can be channel-indexed for touch-tuning without dial watching... still provides fine-tuning adjustment!

Finally, the Improved Inductuner is available at low cost and will make important savings for you in assembly and alignment operations.

That's Value Beyond Expectation!

Write for technical details. Also inquire about the surprisingly low cost and superior performance of the suggested front end designs which Mallory engineers have developed around the Inductuner.

Television Tuners, Special Switches, Controls and Resistors

SERVING INDUSTRY WITH

- Capacitors
- Controls
- Rectifiers
- Special
- Switches
- Resistance Welding Materials

P.R. MALLORY & CO., Inc.

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

October, 1950 — ELECTRONICS
**BLOOPERS** . . Major Armstrong has reminded the industry that local oscillator radiation, now so troublesome in the f-m and tv bands, is an old problem, licked long ago in regenerative and superhet sets for the broadcast band. In a strong letter read before the RTMA f-m receiver committee he cites measurements on a particularly bad f-m receiver, with no r-f stage, that developed a full volt of local oscillator voltage across the antenna terminals, and compares it with a better receiver developing 20 millivolts.

We agree with the Major that keeping the radiation voltage down to 20 millivolts is good engineering, but unfortunately it's not good enough. If it were, the tv band would not be in the trouble it's in today. Measurements on tv receivers of twelve manufacturers, recently conducted under RTMA auspices, showed that the voltage across the antenna on channels 2 through 6, adjacent to the f-m band, was under 20 millivolts in 12 models of the 14 tested. The majority were below 10 millivolts on channels 2 through 6. The mark to shoot at is one millivolt across 300 ohms for these channels. Such a radiated voltage represents only 3 billionths of a watt radiated, and produces a field of 15 microvolts per meter at 100 feet. Even on the low-band channels, achieving this low level is difficult. On the higher channels, thus far, it has proved almost impossible to meet this mark, because radiation direct from the chassis comes into play when the wavelength is only a few times the maximum dimension of the chassis.

The development that licked the problem on the broadcast band, so far as we are able to determine, is the built-in loop antenna. The majority of a-m sets now make use loops, and no r-f stage. But the loop is such a poor radiator that the radiation is held to an acceptable level. We wish that some equally simple solution were available to f-m and tv designers.

**TV NATIONS** . . A checkup reveals that as of September 1, public television service of one sort or another is being rendered in eight countries. In the Americas, stations are operating on 525 lines in the U.S.A., Mexico City and Sao Paulo (Brazil). A second Brazilian station, in Rio de Janeiro, is scheduled to start on 625 lines, the difference in scanning being predicated (wrongly!) on the power supply frequency. Equipment for 525-line service has been shipped to Cuba and should be on the air this fall. In Europe stations are on the air in London and Birmingham, Paris, Eindhoven (Holland) Milan, and in Russia. Experimental transmissions, without public participation, are reported to be under way in Denmark and Sweden.

Many new stations can be expected in Europe, now that the European standards have been agreed on. Word from Geneva has it that the European nations (except France and England) have definitely settled on 625-line, 25-frame scanning, as anticipated in our last report (August issue, p 70). Negative modulation and f-m sound, following U.S.A. practice and opposed to the British recommendations, have been adopted. The channel width is 7 me. Except for the adoption of 25-frame scanning, which will put the European system at a disadvantage from the flicker standpoint, the choices made at Geneva are a sound basis for television service, and reflect a careful study of alternatives.

**RED FEATHER** . . The symbol on our cover this month is a reminder that October is Community Chest month. Two of our leading industrialists, whose names are 100 percent correlated (Charles E. Wilson, president of General Electric and Charles E. Wilson, president of General Motors) are national campaign chairman and vice-chairman respectively. The Wilsons point out that the one-campaign method is a very sound way of raising money, from a business standpoint, because the production costs drop as the volume increases. The campaign is not only sound in method, it is free-enterprise humanitarianism at its best. Give enough!
DEMANDS ON TECHNICAL FACILITIES at television studios vary from program to program and from day to day as new techniques and ideas are developed. In order to keep up with constantly-changing requirements, the arrangement of equipment must be extremely flexible.

A new approach to the problem of television studio design has been made at WOR-TV. A maximum of attention has been directed toward getting the most out of available technical equipment. Facilities are provided for rapid and effortless interchange of equipment from scene to scene and from studio to studio. Careful planning has reduced the number of camera chains required, while at the same time production problems have been eased.

The setup includes two large studios, two announce studios, three program control rooms, film...
Television Studio Design

Separation of program direction and technical control solves many problems and enables station to get more out of available facilities. Central camera control provides increased flexibility and efficiency with less confusion and complication.

projection facilities and a camera control center. The space is divided as shown in Fig. 1.

All camera-control facilities for all studios are centrally located in the camera control center. Thus, camera-control operation is removed from the actual studio control rooms which are called the program control rooms.

Program director, video switcher, and audio operator are located in these program control rooms. The program director’s console has seven 10-inch picture monitors. These monitors are directly in front of the director, enabling him to have a close view of each camera and signal available for his program make-up. The console has a lower top than is normally used in television consoles, providing a good view through the studio window onto the studio floor. Here the program director finds no distraction from the camera control operators being between him and his monitors, as in the usual setup, making concentration on his production that much easier.

Video Switching

To the right of the program director, who normally sits in the center of the console desk, sits the video switcher. He has, in front of him on the desk top, a sixty-button control panel, which enables him to do the necessary camera switching as called for by the director.

The panel uses d-c voltages to energize video-switching relays which are centrally located for all studios in the camera control center. The control panel consists of five rows of buttons. It may be seen on the right-hand end of the desk in the program control room photograph. The lower row of controls provides for the switching of any one of the twelve inputs to the outgoing program line, and represents, therefore, the program output of this studio. The next two rows select inputs for the effects mixer amplifier. The gain of each section of the mixer amplifier can be controlled independently or simultaneously by a fader lever located to the right of the buttons. The output of the effects mixer is brought back into the main switching bank in the number twelve position, thus providing for the switching of a super-position or a lap dissolve directly onto the program line by pressing the number twelve button in this row.

Two additional rows of buttons on the top of the panel enable either of the two preview monitors located in the console to be switched at will to any one of the twelve inputs to this switching system.

Program Patching

All required signals for a particular program are sent to the program-control-room switchboard through a coax patch panel located in the camera control center. With the normal arrangement, the first eight positions on each studio-control switching system are reserved for camera inputs, that is, signals with video and blanking only. The next three positions are reserved for composite video signals. This enables a remote signal to be switched in as part of a studio program in any of the studio control rooms where it is required.

The video switching relays used in the system are the standard RCA TS-20A switching relays. In these, the timing is dependent on only one relay for each outgoing channel, thus simplifying adjustment. In

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FIG. 1—WOR-TV’s new 67th Street studio building is designed to afford most efficient use of technical facilities
switching a television signal, time delay is very important and has been reduced in these relays to approximately one millisecond. In the case of the program bank of relays, the transfer relay is set to produce an overlap in the switching. That is, the two cameras are momentarily on together at the time of switchover. This gives a smoother appearance on the outgoing signal than a gap between the two cameras. It does, however, momentarily parallel the output of the camera control units during the one-millisecond switchover. This does not reflect back in any other outgoing signal.

In the case of the effects and preview switching relays the timing has to be set for a gap in switching. It is necessary to use gap switching here in order that switching of cameras on the preview or effects busses will not disturb cameras that may be feeding the outgoing program line.

The camera switching system, which is identical for all studios, is shown in block form in Fig. 2. The switching relays incorporate in each outgoing bank a cathode follower which isolates the capacitance of the outgoing line from the incoming camera circuit. In this manner a uniform frequency characteristic through the video bank is obtained out to seven megacycles. It is necessary, however, to keep the cable to the isolation amplifier as short as possible.

**Camera Control Center**

All control units for both film and studio cameras are located in the one central control room as shown in Fig. 3. Central camera control operators merely set levels on the outgoing video signals and maintain proper background and electrical focus on each of the cameras. A line monitor is incorporated in the camera control console for each of the studio control rooms. Thus, the camera control operator can readily check his levels after being switched onto the program line.

The camera cable patch panel on the wall of the camera control center enables any of the eight studio camera control units to be patched into any of fifteen outgoing cables. These cables are routed to the different studios and announce booths. Any combination of the eight studio cameras can be distributed to the studios as required for a given program. In addition to distributing the cameras to the various studios as required, it is, of course, necessary to patch the video output of the camera chain to the proper camera-switching control position, where the show is to be directed.

A tally-and-intercom patch panel enables the tally light signals that are furnished by the switching relays to energize the corresponding camera control monitors and cameras when they are switched on the air. The same patch cord also carries order wire and program audio to the headsets of the camera control operators and the camera men. Thus, at each of the camera control positions the operator can plug in a headset which will give him communication with the video switcher in the appropriate program control room, and also with the cameras that he is controlling. In addition, the program audio is fed to the camera operator from his studio.

The film camera controls located to the left of the studio camera controls are operated in a similar manner, with the exception that the camera cable is connected directly from the film cameras to the projection room to their corresponding camera control units. The video outputs of the film camera controls may be patched at the video patch panel into any of the three studio control rooms for switching as required. Thus we have the provision in any one of three studio control rooms to switch in film inserts or

![Diagram of Camera Control Center](image-url)
slides, as well as any of a number of studio cameras, depending upon the size of the production.

Advantages

By centralizing the camera control units some of the control operators who have been working with one studio can switch immediately to a program from a second studio, since it requires no physical movement from one room to another. It is possible to realize a saving in operating personnel. Also, the quick interchange of camera control sections, by use of the camera cable patch panel, makes it possible to replace defective units quickly in case of trouble during a rehearsal or actual program.

An additional advantage of the centralized control room is a simplification of the cable-delay problem which normally occurs when several studios are operated at different distances from a central master control room. In this case it is customary to delay the horizontal driving and blanking pulses of the nearer studio control rooms, so that the time delay is equal to that of the studio control room having the greatest cable distance to the master control room. By having all of the camera control units for all studios located at one point the same delay between synchronizing and blanking pulses holds, regardless of which studio control room is used.

By centralizing the camera-control equipment and the camera-switching equipment for all studios in one place, the actual program signal does not appear in nor is it routed through any of the studio control rooms. The monitors in the individual studio control rooms are fed by lines from the camera control center, which merely bridge the program circuits in the camera control center.

Power Supplies

In addition to the switching relays and associated amplifiers, the camera control center contains the necessary power supplies for all of the studio equipment, including monitors in the individual program control rooms. There are approximately 150 power supplies which occupy 20 cabinet-type racks. All of these power supplies are of either of two standard types. They are all of the plug-in type, which means that spare units can be quickly substituted in case of failure of any individual power supply. A power-cable extension cord with suitable connectors is always kept available for patching in the d-c outputs of the spare supplies when required.

Centralizing all power supplies simplifies the power distribution problem and eliminates much of the heat from the studio control rooms. Furthermore, a reduction can be made in the number of spare units required to take care of several studios.

Projection Room

The projection room, located adjacent to the camera control center, contains three TK-20A iconoscope film cameras. Each of these is multiplexed by means of a mirror system to provide three sources of film or slides for each film camera. Two 16-mm projectors, two 35-mm projectors, opaque projectors, and slide projectors comprise the projection equipment.

Cabinet racks contain picture monitors for each of the film camera chains as well as space for audio and intercom amplifiers. An intercom system consisting of a microphone and talk-back speaker is suspended over each film camera assembly. The intercom system can be tied in individually with any of the studio control rooms that the film camera should be associated with on a given program. In this way one film camera chain can be used for a rehearsal with one studio control room, while another film camera chain is being used with a second control room to produce a show on the air. In the same way that tally lights indicate studio cameras are on the air, tally lights on the individual film cameras show when each is placed on the air by a studio control room. The tally signals are fed through the tally patch panel in the same way that the studio camera tallies are fed.

Master Control

The master control facilities are located in the same room as the

Video switching relays like these are energized by d-c from program control rooms.
camera control center, and actually are one half of the large U-shaped console. The switching facilities consist of equipment to switch six incoming studios to four outgoing channels. Both audio and video are switched here, and individual picture and audio monitors are provided on each outgoing channel. All switching is done by relays. The switching relays set for gap timing are used for the video switching and a special audio-relay switching system has been built up to accompany this.

All switching can be preset and provision is made for either simultaneous audio-video switching or independent audio and video switching if required. Normally, only simultaneous audio-video switching is used, since only complete programs are switched at the master control point. However, if required to hold over the audio from one studio to another, and switch only the video, this can be accomplished, and the audio switched at a later moment. Provision is also made for tripping all four outgoing channels simultaneously when required, or for switching them in groups or individually.

At this point in the system only composite signals are handled, and no provision is made for lap dissolving or fading. Fading is always a program function, and should be handled when so required at the direction of a program man in one of the studio control rooms. Each outgoing channel is provided with a stabilizing amplifier in its output, so that the picture level and synchronizing level may be set independently on that particular channel. Corresponding audio-gain controls are also provided on each outgoing channel.

The transmission center is really a part of master control. Two additional console sections are provided with TM-8A picture monitors, which can be fed from any of the six inputs to master control. The inputs to these monitors are switched by control buttons directly in front of the monitor. Any of the six inputs to master control can be previewed here before actual switching.

Adjacent to the monitors are located remote controls on six stabilizing amplifiers. The controls enable the operator to match the levels on all of the studio outputs as well as any remote outputs which may be patched in for checking.

**Phase Comparison**

A means is provided for comparing the phase of an incoming remote signal with that of the local synchronizing system. This is done by switching the vertical driving pulses of the local sync generator onto the grid of the cathode-ray oscilloscope in one of the preview monitors. This blanks out the period of the local vertical synchronizing signal, and when a remote signal is switched up on this monitor a portion of its synchronizing will be blanked out. When the blank period is phased so that the vertical disappears, then the two synchronizing generators are properly phased as regards vertical synchronizing. Normally, the phase of the remote sync generator is changed to bring it in with that of the local studio sync generator. Thus, the studio sync generator is kept as a standard.

Remote controls on the phasing of the local sync generators are brought over to this console section also, so that when required the phase of these generators can be changed conveniently. In addition, a remote-control switch is provided so that a stand-by sync generator can be switched in in place of the regular generator as an emergency. It is important that the two local generators be previously phased.

 Provision has been made for utilizing the new RCA Genlock unit. This will enable remote signals coming in to control the phase of the studio sync generator line-by-line. A remote signal coming in can be treated as a local camera, and when patched into any of the studio control rooms can be faded and lap dissolved with local cameras. To treat the signal this way it is necessary to wipe off the synchronizing component on the incoming remote by means of one of the TA-5C stabilizing amplifiers. The synchronizing thus removed is fed into the Genlock unit to provide a/cf control on the local sync generator. Synchronizing from the local generator is then finally mixed with the output of the studio control room to provide a composite signal for both local cameras and remotes.

Remote signals come into the building through Telco video lines. Approximately twenty-four circuits are available from different points within the city where remotes are handled. One circuit comes from the microwave receiving location on the Empire State Building, where many remotes are received, and is then routed to the master control.

**Results**

This studio system has been in use since the first of the year, and has worked out very well. On some of the larger productions both studios have been used for one show. In this case as many as seven camera signals have been switched in one studio control room to make up a given production. On other occasions rehearsals have been conducted in one studio concurrent with an on the air show from another studio control room. The flexibility of the system has been very apparent in the rearranging of camera facilities to meet the individual requirements of different types of productions.

With the present setup, only three program control rooms are used. Undoubtedly, the future of television will require many more studios. In such a system the same basic principles that have been used in the WOR-TV studios could be extended to provide the same advantages. It may be that a practical limit, as to the number of camera control units that might be located in one center, would be reached. In that case, two or more camera control centers might be provided for, say, six or eight studios, to form a practical arrangement.
SUN FOLLOWER
for V-2 Rockets

Automatic tracking device keeps spectrograph in nose of V-2 rocket pointed at sun for making intensity measurements at wavelengths as low as 500 angstroms. Servo-drive system resembles SCR 584 auto-track principle, except that error signal is derived from photocell mounted in rocket

Keeping a spectrograph in a spinning V-2 rocket pointed at the sun is accomplished by a photocell-controlled servo-drive mechanism called the sun follower. By lengthening the available exposure time, measurement of radiation intensities down to 500 angstroms has been made possible. Hitherto observation of solar spectra from photographs taken by ultraviolet spectrographs in the nose or tail of V-2 rockets passing through the ozone layer has been limited to wavelengths above 2,000 Å.

To overcome the effects of the rocket's angular motion, a two-axis tracker was developed for stabilizing the spectrograph and keeping it pointed at the sun regardless of the spin and precession of the rocket. Automatic detachment and descent by parachute are provided to facilitate recovery of the sun follower and spectrograph.

Requirements

The behavior of the rocket in flight is depicted in Fig. 1. During the burning period, axial-spin and precessional velocities are imparted to the rocket and remain approximately unchanged from a few seconds after burn-out until the denser atmosphere is encountered on descent. A typical rocket assumes axial-spin velocities up to 50 rpm in either direction, and precessional velocities up to 10 rpm in either direction at angles up to 20 degrees to a precessional axis which may be inclined up to 20 degrees from the vertical.

By HARRY L. CLARK
Head, Applied Optics Branch
Naval Research Laboratory
Washington, D. C.

Built into the nose of the rocket, as shown in Fig. 2, and timed to operate above the denser portion of the earth's atmosphere after doors in the rocket's nose have opened, the sun follower stabilizes by means of error signals derived from the sun. This is accomplished with a photocell error-signal generator and two independent servo-drive units. The azimuth axis is collinear with the longitudinal axis of the rocket. The elevation axis is perpendicular to the axis of the rocket and rotates about it. By tracking with an error of less than one-half degree in both azimuth and elevation, the sun follower permits the use of a spectrograph capable of recording wavelengths as short as 500 Å.

Stabilization

The principle of the stabilization system is similar to that of the tracking unit employed in the SCR-584 radar, except that the photocell error-signal generator and low-frequency amplifier replace the radar's r-f transceiver. A block diagram is shown in Fig. 3. A real image of the sun is focused by a lens onto a rotating shutter situated in the focal plane with its center on the optical axis. The shutter (Fig. 4) is constructed of transparent material upon which is placed a number of equally-spaced, radial, opaque spokes. Superimposed on the spoke design is a pattern of linear shading. The spokes chop the sun's radiation at 400 cps producing a 400-cps carrier. The linear shading modulates the carrier at 40 cps. The degree and phase of modulation of the 400-cps carrier are determined by the position of the sun's image on the shutter. A photovoltaic cell placed immediately behind the shutter intercepts the 40-cps-modulated, 400-cps light signal and converts it into a proportional electrical signal which is amplified, maintained at constant level with ave, and demodulated.

The resulting 40-cps signal is then fed into a two-channel phase-comparator circuit. In the azimuth

FIG. 1—Typical V-2 flight pattern shows precession and spin that limit spectrograph exposure time
channel the phase of the signal is compared with the phase of a fixed 40-cps voltage from a reference generator which rotates in synchronism with the shutter. In the elevation channel, the phase of the signal is compared with that of a second fixed 40-cps voltage which is in quadrature with the fixed voltage of the first channel. The results of the phase comparisons in both channels are two independent d-c voltages whose magnitudes are functions of the differences in phase between the respective signals and fixed voltages which produced them and are proportional to the magnitudes of the respective demodulated signals.

This dual relationship makes the respective d-c output voltages directly proportional to the horizontal and vertical displacement of sun from the center of the shutter and hence the optical axis.

Displacement Voltages

For example, if the sun's image is positioned on the optical shutter at a distance $R$ from the optical axis and the resulting differences in phase angle between the 40-cps modulation on the 400-cps carrier and the azimuth and elevation reference voltages are $\alpha$ and $\beta$ respectively, then the following proportionality hold for the d-c voltage swings, $\Delta V_a$ and $\Delta V_e$, in the azimuth and elevation channels

$$\Delta V_a \propto \cos \alpha$$
$$\Delta V_e \propto R$$

and

$$\Delta V_a \propto \cos \beta$$
$$\Delta V_e \propto R \cos \beta$$

combining

$$\Delta V_a \propto R \cos \alpha$$
$$\Delta V_e \propto R \cos \beta$$

define

$$R \cos \alpha = x$$
$$R \cos \beta = y$$

In other words, the d-c voltage swing in the azimuth channel is directly proportional to the right-left displacement, $x$, of the sun's image and the d-c voltage swing in the elevation channel is directly proportional to the up-down displacement, $y$, of the image. This is true for image displacements up to 25 degrees off the optical axis and is determined by the extent of the linear portion of the shading on the optical shutter. Beyond 25 degrees to the edge of the shutter the shading is a maximum and constant.

After amplification the two d-c voltages are employed to control, individually, the outputs of the azimuth and elevation amplidynes. These in turn control the azimuth and elevation servo motors. Portions of the amplidyne outputs are fed back into the last stages of the amplifiers for antihunt control.

The only stable condition for the system exists when the image of the sun is on the optical axis of the error-signal generator. Other positions of the sun's image result in the generation of restoring torques in the azimuth and elevation channels which are directly proportional to the magnitudes of the respective horizontal and vertical displacements of the image. Since the optical axis of the ultraviolet spectrograph is mechanically aligned with the optical axis of the error-signal generator; and, since the error-signal generator tends to line up with the sun, the spectrograph is brought into alignment with the sun.

Automatic Search

In addition to the simple tracking function, the sun follower automatically searches for the sun in the azimuth plane when energized at the start of the rocket's flight and
will do so automatically if it loses the sun during the flight. The search rate is 70 rpm relative to the rocket in a clockwise direction.

Since the rate of search must be greater than any anticipated rocket spin velocity, the rotational velocity of the sun follower relative to the sun may be high under some conditions. The stopping and locking-on requirements are severe. Under the worst possible condition, when the direction of search and the direction of spin are the same, net search velocities up to 120 rpm can be expected. Because of the limited field of view of the error-signal generator, it is necessary to stop the sun follower in less than an 80-degree sector so the tracking unit can take over. This amounts to a deceleration of approximately 600 rpm per second. A velocity-sensitive unit providing for such deceleration has been incorporated in the sun follower.

Since the vertical coverage of the error-signal generator includes the sun in its field of view under normal conditions, no added provision for rapid acceleration and deceleration is required in the elevation plane.

The sun follower also provides rocket-aspect data for telemetering. Since the error-signal generator tracks the sun in both azimuth and elevation, its instantaneous position with respect to the main body of the rocket is the same as the rocket's instantaneous position with respect to the sun. Potentiometers attached to the sun follower provide d-c voltages for telemetering the rocket's attitude. In addition, the sun follower's tracking errors in azimuth and elevation are telemetered.

**Rocket Installation**

The first sun follower was installed in V-2 rocket No. 38 which was fired on April 19, 1948. The rocket's flight was off course and had to be terminated at an altitude of eighteen miles. The cycle of operation of the sun follower had not begun at that time. In hope of saving the sun follower, the ejection mechanism was actuated immediately following radio-fuel cutoff. Signal Corps motion pictures taken with the aid of a tracking telescope show that the sun follower was ejected properly. However, at the time of the ejection the rocket's velocity was 3,830 ft per sec and it is doubtful if the parachute withstood the shock of opening in the earth's atmosphere. No part of the sun follower has been recovered.

A simplified version of the sun follower is now being prepared for installation in the Venus and Viking rockets as well as in some of the few remaining V-2 rockets.

**BIBLIOGRAPHY**


Electronic Inspection of ENGINE CAM CONTOURS

Cam pushes rod-shaped permanent magnet back and forth inside pickup coil to generate voltage proportional to velocity, for viewing on cathode-ray screen to reveal contour errors. System can also be used directly on engines to study valve motion at high speeds.

The camshaft lobes that lift the valves of internal combustion engines must be accurately ground if good engine performance is to be obtained. In the production of camshafts, errors in profile can arise from factors such as wear in master cams and machinery, uneven grinding operations, lash and inertia. A cam lobe possessing a contour deviating noticeably from the theoretical can affect engine performance and cause failure of parts in the valve gear. This points to the need for cam contour inspection.

**Inspection Methods**

The conventional method of inspection involves using a suitable fixture to record the cam contour lift at intervals of one or two degrees. This method is sufficiently accurate for most inspection purposes as it provides data comparable to the design lift figures. However, small contour errors are not easily found without plotting a lift curve several times size or taking differences between adjacent lift figures and plotting the resulting data which will resemble a velocity curve. Also, differences of these differences can be taken to secure data which will resemble that of an acceleration curve.

Using inspection data in this manner gives erratic results since the fifth decimal place greatly affects the acceleration curve. Furthermore, this method of checking a cam contour is time-consuming and is impractical for production testing except when done in rather infrequent intervals. When each lobe is to be inspected on a sixteen-lobe camshaft for an eight-cylinder engine, the inspection time can require from eight to thirty hours unless the fixture is suitably designed to handle production inspection. Small errors in indexing, errors in bearing supports for the camshaft and clearance errors in the tappet follower can affect the accuracy considerably.

An alternate method is to use a template for comparative purposes; this, however, is not suitable for any real accuracy. A modified form of the template method involves...
using a magnifying comparator to cast an enlarged shadow of the profile on a ground glass screen. This is much more accurate, but still does not lend itself to production inspection.

In view of the shortcomings of the two established methods of inspection, the electronic method was evolved to obtain a rapid, accurate and more reliable method of determining the type of motion a particular cam will produce.

By using the electronic method of cam contour inspection it is possible to inspect each lobe in approximately one minute. All of the cam lobes of a camshaft can be inspected and photographed in only a fraction of an hour, once the equipment is set up. This method is equally suitable for supplementing production inspection and for cam contour development work.

**Electronic Method**

In the electronic method of inspection, the camshaft is mounted in a lathe, and each cam contour is checked by observing curves that appear on the screen of a cathode-ray oscilloscope. The general arrangement of the equipment is shown in Fig. 1, along with the lift, velocity and acceleration curves that are selected at will with a three-position switch. Individual curves can thus be studied without going through the process of plotting them from data obtained by tedious micrometer measurements.

In actual inspection work the lift curve is of much value as small errors are not apparent. The velocity curve reveals errors more readily, and is especially useful for checking the ramps provided at each end of the cam contour. The acceleration curve is best of all for critical cam contour inspection, as it reveals local irregularities even better than by calculation from lift figures measured to 0.0001 inch.

The camshaft to be inspected is mounted in a lathe and rotated at a uniform speed somewhere in the range of 200 to 400 rpm. A tappet follower (flat, roller or shoe) is held against the cam lobe by a light spring to simulate the motion of a tappet in a valve gear. Attached to the follower is a small rod-shaped Alnico magnet that moves inside the pickup. The design of the pickup, also detailed in Fig. 1, is such as to give a high sensitivity factor along with linear response in its operating range.

The electronic equipment comprises a cam contour inspection unit, a 5-inch 208-B DuMont scope employing a blue screen for photographic purposes, and a 215 DuMont linear time-base generator. The scope has sufficient Y-axis gain to design a pickup for direct connection without an additional electronic amplifier. A more recent model of scope (DuMont 304-H) can be used without the separate generator as it has a sufficiently linear X-axis time base built-in.

The associated electronic circuit, shown in Fig. 2, provides two types
of pulse voltages, one for synchronization of the scope to the rotative speed of the camshaft and the other to provide 10-degree markers on the X axis for photographic use. These pulse voltages are obtained by using a rotating disc as in Fig. 1 to trigger light to two phototubes. Two series of holes are used; one series has one hole for 360-degree rotation for synchronization purposes, while the other series has holes spaced 10 degrees apart for X-axis calibration purposes.

The upper phototube and its associated amplifier serve to produce a stationary image on the screen by injecting into the X-axis sweep generator circuit a voltage pulse directly related to camshaft speed. Good results are obtained with this method of synchronization; however, the photoelectric circuitry can be satisfactorily replaced by a magnetic type of synchronization trip actuated by a steel pin on the lathe shaft.

The lower phototube and its amplifier serve to inject positive voltage pulses onto the control grid of the c-r tube. This gives Z-axis pulses producing dots every 10 degrees on the X axis.

When the permanent magnet (attached to the tappet follower) reciprocates within the pickup coil, a voltage is generated across the pickup terminals equal to $k_dN\frac{d\phi}{dt}$, where $N$ is the number of coil turns and $d\phi/dt$ is the rate of cutting flux lines. But $d\phi/dt$ is equal to $k_dV$, where $V$ is the velocity of the magnet, hence the generated voltage is equal to $k_NV$. This shows that the output voltage from the pickup is directly proportional to the velocity curve when the output terminals from the pickup are connected directly to the c-r tube.

When the selector switch is set to give the lift curve, an R-C integrating network is connected across the pickup coil and the integrated output voltage is taken across $C$, as shown in Fig. 2. Values of $R$ and $C$ are selected to give a high ratio of resistance to capacitive reactance and a high ratio of time constant ($RC$) to the reciprocal of the frequency of operation ($1/f$).

When the selector switch is set to give the acceleration curve, an R-C differentiating network is placed across the pickup coil and the differentiated output voltage is taken across $R$. Values are chosen to give a high ratio of capacitive reactance to resistance and a low ratio of time constant ($RC$) to the reciprocal of the frequency of operation ($1/f$).

**Calibrating Technique**

A 60-cycle calibrating voltage is used for adjusting the gain controls to predetermined settings and to secure curves on the c-r screen with calibrated ordinates. This requires that the pickup be calibrated to determine its sensitivity factor by measuring the voltage generated as related to the maximum reciprocating and velocity of the small reciprocating magnet.

Calibration is accomplished by employing an eccentric to reciprocate the tappet follower. Here the actual acceleration of the tappet is known and voltage measurements...
are easily made on the screen due to the sinusoidal waveform output from the pickup. To secure adequate sensitivity a higher speed is used for calibration than for actual cam contour inspection. Low speeds are desirable during cam contour inspection to keep inertia and spring loads to a minimum.

To find the sensitivity factor of the pickup coil, its output is fed through the cam contour inspection unit to the oscilloscope. The Y-axis gain is adjusted to give a certain amplitude on the screen, such as 2 inches overall. The selector switch is then set on CALIBRATION and the calibration switch is set on ACCELERATION. Finally, fine and coarse calibration controls are adjusted to give the same height as before on the screen. The reading of the voltmeter in millivolts, multiplied by the appropriate multiplication factor given on the coarse calibration control, is then used to establish the acceleration sensitivity factor of the pickup. This factor is used for all later adjustments, providing the pickup and magnet are not altered, the test speed is held at the pre-selected value, and the differentiating circuit is not altered. The velocity calibration is made in the same manner.

**Inspection Results**

The inspection fixture as built up employs a conventional lathe. The tappet follower can be a flat plate, roller, or curved shoe, and should be the same as the type normally used with the cam contour being inspected if accurate data are to be obtained for comparison with a theoretical curve. For purposes of magnifying errors appearing on the nose of the cam, a small roller follower may be used on a cam contour normally requiring a flat plate or large roller follower. In this instance, the wave forms will be of value for comparative purposes only in production testing and will have no direct relationship to theoretical curves.

At the adopted test speed of 226 rpm the maximum inertia load, when inspecting a high-acceleration cam, is about one pound. During testing a light oil (about SAE-10) is continually supplied to the cam lobe to eliminate any tendency of the tappet follower to chatter. Inadequate lubrication produces rough and nonrepetitive curves.

Actual inspection is generally visual, but the curves on the screen can be photographed for closer study wherever desirable. A typical complete set of curves as photographed for study of velocity and acceleration is shown in Fig. 3. The multiple curves shown are obtained by multiple exposure, one for each line or pattern across the film. The film may be projected onto graph paper and traced for accurate comparison with a theoretical design curve, as shown in Fig. 4.

**Engine Test Work**

It is frequently desirable to observe valve motion directly on an internal combustion engine at relatively high speeds. Due to the flexibility of the various component parts, to a possible surge of the spring and perhaps to false motion in the valve gear, the resulting valve motion departs measurably from the theoretical motion which the cam is designed to produce. The same electronic instrumentation used for camshaft inspection may be advantageously used to observe valve motion at high speeds.

Arrangement of the equipment on an engine with overhead valves is shown in Fig. 5. Observations may be made with the engine motorred with a dynamometer or under engine firing conditions. Typical valve lift and velocity curves obtained with the engine delivering power at 3,600 rpm are also shown.

Due to the increased frequency of operation on an actual engine, it is necessary to alter the integrating and differentiating networks to secure accurate results. For this type of work the networks shown in Fig. 5 are used.

Synchronization of the oscilloscope may be obtained by using the simplified magnetic synchronization trip shown in detail in Fig. 5. This device consists of a coil of fine wire wound on a steel core and mounted on a permanent magnet. The motion of a steel pin past the core disturbs the magnetic flux passing through the coil for a short time interval to generate sufficient voltage to give synchronization. The high speed of operation produces a rapid change in flux so that a sufficiently high voltage is produced and no additional voltage amplification is required in the electronic equipment.

The use of this type of electronic test equipment for inspection purposes will assure that more manufactured cam contours will be closer to the preferred design. Its use on engine test work will reveal to the engine designer exactly how the valve gear is performing in an engine. The results will be longer life to the component parts of the valve gear and improved engine performance.
Curtain-Rod F-M Antenna

Body forms part of tunable horizontal loop exhibiting nearly omnidirectional characteristics. Design is easy to manufacture, install and adjust and withstands rough handling on the road and in the shop.

The curtain-rod f-m antenna to be described is one component of a complete bus f-m receiver system which was developed for Transit Radio, Inc., Cincinnati, Ohio.

A satisfactory antenna for this application must meet the following requirements:

1. Receive horizontally-polarized waves.
2. The pattern in the horizontal plane should be reasonably omnidirectional.
3. A vswr on 50-ohm coaxial cable of 5 to 1 or better over a frequency band several times greater than the f-m channel width of 200 kc.
4. Mechanically strong to withstand the pressure of the large rotary brushes used to wash the bus, and to withstand the shocks caused by striking low-hanging tree branches during a run.
5. Easy to install, tune-up, and maintain by semi-skilled personnel.

Description

The antenna developed for this application is called a curtain-rod because of its physical appearance. Fig. 1 shows the antenna installed on the front of a bus between the windshield and destination window. It is a type of long, narrow, horizontal loop which is adaptable for mounting on the front or back of the bus. The loop is supported in the center by a metal U. This supporting U also serves as part of the tuned circuit that matches the balanced high impedance of the loop to the 50-ohm unbalanced coaxial cable which carries the signal to the receiver.

The antenna has five principal parts, four of which are shown in Fig. 2. The two long end elements are made of soft aluminum tubing which can easily be bent, flattened and drilled. The center U has a mounting base and connecting lugs and is cast of brass. The tuning capacitor which is mounted and connected between the top ends of the U, is a 7-to-45 µµf ceramic variable of the disc type. A Plexiglas cover for the center part of the U keeps rain, dust and tree branches away from the tuning capacitor and feed wires. An access hole is provided in the bottom of the cover so that the capacitor can be adjusted during routine maintenance without removing the cover. This hole is normally closed up with a metal snap-in button.

The cable that carries the signal from the antenna to the receiver is 50-ohm RG-58/U coaxial. It terminates at taps on the inner sides near the bottom of the U to provide a shunt-fed configuration.

Figure 3 shows how the optimum...
for Buses

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vswr and frequency bandwidth for 5-to-1 vswr of the antenna installation shown in Fig. 1 vary throughout the frequency band 88 to 108 mc. (It is a conventional specification for receiving antennas that the mis-match loss may be as much as 2.5 db, corresponding to a vswr of 5 to 1). These curves show that the antenna can be adjusted for a vswr of less than 3 to 1 at any frequency in the band and that the bandwidth is more than 2 mc. Actual experience with a number of bus installations has indicated that this bandwidth provides a safe margin for reliable operation.

The first horizontal-plane patterns were measured using an actual bus installation tuned to f-m station WMML on 94.7 mc. The bus was driven around in a small circle at a location in the middle of a level, clear field six miles from the station. The effective radiated power of the station was 4 kw and substantially line-of-sight propagation conditions prevailed. The strength of the input signal to the receiver was measured using a microammeter to indicate limiter-grid current for every 10-degree change of bus heading. The receiver meter had been previously calibrated in the laboratory with a signal generator. The measured pattern of receiver input signal voltage in millivolts versus bus heading is shown in Fig. 4. The strongest signal was received when the bus was headed toward the station but the extreme variation in the signal strength was only 7 db.

The same type of bus receiving antenna has also been used in several cities where the f-m station is still in the low band of 42-50 mc. In these cases, the antenna was modified by the addition of a 25-µf fixed capacitor in parallel with the variable tuning capacitor in the center U. The resulting antenna is not quite as well matched, but it still has a vswr of less than 5 to 1 throughout the band and gives very acceptable performance.

General Design Aspects

The length of the loop is nearly a half-wave and the loop is center-fed with a balanced structure. A lumped-circuit approximation helpful in understanding the antenna is shown in Fig. 5.

Each of the two end elements is approximately a quarter-wavelength long and during reception of a signal each element provides the center U with an induced loop voltage in series with a large resistance, R, and reactance, X. Voltage is the same from both elements and therefore a balanced voltage from a high-impedance source is applied across the top ends of the U. The U acts as a parallel L-C circuit balanced to ground; the base at the center of the U is actually grounded to the bus body.

The coaxial cable is tapped across the U near its base for best match to 50 ohms. The position of the tap varies with frequency, but a satisfactory compromise tap position can always be found. This location gives the vswr characteristics shown in Fig. 3.

More than a thousand of these antennas have been in service for several years without any major changes in the design. After the curtain-rod antenna had been developed it was learned that a 75-mc marker-beacon aircraft antenna having somewhat similar radiating elements was investigated by the Germans during World War II. 3

The author wishes to credit John B. Caraway, Jr. of Electronics Research, Inc. for several invaluable suggestions and Richard W. Anderson for performing some of the measurements reported here.

REFERENCES

(1) Car-Card Radio, ELECTRONICS, p 72, June 1948.

FIG. 2—Plan-view of antenna installation on front of bus

FIG. 3—Voltage-standing-wave ratio and bandwidth characteristics

FIG. 4—Reception pattern of bus installation

FIG. 5—Lumped circuit approximation of the antenna
GETTER MATERIALS

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Typical Ba flash getters for glass bulbs (upper row) and getter strip assemblies

The use of getter materials is based on the ability of certain solids to collect free gases by adsorption, absorption or occlusion. This effect is widely utilized in the field of electronics to shorten the exhaust period and to improve and maintain a high vacuum or the purity of an atmosphere of noble gases.

Bulk getters are sheets or wires of gas-absorbing metals, which usually are heated for this purpose by mounting them on hot electrodes of the tube. In some cases the heating is accomplished by a separate heating source.

Coating getters are generally applied to those electrodes of vacuum tubes, which during service are maintained continuously at temperatures between 200 and 1,200°C. Such getters usually consist of non-volatile metal powders that are situated upon the electrode surfaces.

In the case of flash gettering, chemically active, comparatively volatile metals—mostly metals of the alkaline earth group—are evaporated by heating their supports at the conclusion of the pumping process. The metal vapor before and during condensation reacts instantaneously with all other than noble gaseous residues and forms on all cold parts of the tube, particularly on the tube walls, the so-called getter mirror. This surface, because of its large area, is capable of binding chemically or physically gases that are liberated during the life of the tube. With respect to the mechanism of gettering and the action of gases getter materials may be divided into two groups: corrosion type and solution type. From this aspect, barium (Ba) is the typical example of chemical corrosion by gases and zirconium (Zr) an example of solution of gases in a metal. Corrosion takes place if the oxide film is porous and incoherent, thus not preventing further oxidation, which usually happens only if the volume of the oxide is smaller than that of the metal to be oxidized. In this case, the sorption of gas from the surrounding atmosphere can continue uninterruptedly. Oxides of the alkali and alkaline earth metals have less volume than the metal.

From a technical aspect the wide application of earth alkali metals for flashing getters in vacuum tubes is founded upon the fulfillment of the following requirements.

(1) During the standard degassing procedure at 400°C the getter should have low vapor pressure ($p < 10^{-2}$ mm Hg).

(2) The getter should be readily vaporized at its activation temperature. This temperature range must be high enough so that the getter may be readily degassed prior to the flashing; on the other hand, it must be sufficiently low to avoid the evaporating, melting or loosening of electrode metals. For nickel supports this establishes a temperature range of 600 to 1,000°C.

(3) After flashing, the getter deposit on the tube glass wall must have a negligibly low vapor pressure ($p < 10^{-4}$ mm Hg) assuming the operating temperature of the vacuum tube at 200°C.

(4) Between ambient and operating temperature the getter should be very active for all gases, especially oxygen. The oxide film created must be porous and incoherent in order that the gases may diffuse without hindrance into the interior of the getter mirror and may be absorbed also by getter molecules in the volume of the getter material.
for ELECTRON TUBES

The specific action and applicability of Ta, Cb, Zr, Th, Ti, Al, Mg, Ba and P as getters for vacuum tubes are shown. They can be formed as wires, sheets, tubes and tablets directly or indirectly heated; they may be powder coatings on hot electrodes; or they can be flashed.

(5) The chemical compounds should be stable in order that during operating temperature or electron bombardment the absorbed gases are not expelled. For gas-filled tubes, the absorbed residual gas should not be replaced during operation by the filling gas, for example—Hg-vapor in tubes.

The first requirement is satisfied by all earth alkali metals. As seen from Fig. 1, Mg is near the border line, and cannot be used in tubes with high operating temperature because of the danger of migration of Mg atoms. Requirement 2 is met by all earth alkali metals but not by aluminum. Requirement 3 is met by all earth alkali metals with the exception of magnesium. The fourth requirement, with emphasis on activity, is met by all earth alkali metals with the exception of magnesium and aluminum. In a similar manner requirement of an incoherent oxide layer is not met by magnesium and aluminum. Requirement 5 (stable reactions) is met by all earth alkali metals but only up to a temperature of 200°C (regarding the oxides created even up to higher temperatures).

The materials Sr, Ba and Ca, are the most suitable for flash getters in high-vacuum electron tubes. Concerning the replacement of absorbed gases by mercury vapor, however, all earth alkali metals fail with the exception of magnesium, which is the reason that the latter metal is used in mercury tubes.

There are few quantitative data that permit a comparison of the getter-efficiency of different metals for different gases. Table I shows such a comparison for flashed deposits of Al, Mg, Th, U, mischmetal and Ba and the gases O₂, H₂, N₂, and CO₂. It exhibits Ba as the most efficient getter among the metals investigated. The higher efficiency of diffuse deposits is due to their much larger surface, resulting from their finely divided state. This phenomenon, known as dispersal gettering is illustrated by the black Ba deposit.

The practical choice of the proper getter material is a function of factors other than efficiency alone. The broad use of high-efficiency flash getters requires considerations of insulation, interelectrode capacitance, contact potential and secondary emission of vacuum-tube electrodes and insulators, which often suggest their avoidance. On the other hand, Ba flash getters are preferred for oxide-coated cathodes because the Ba does not poison the cathodes and in some cases will improve the BaO cathodes. Judicious use of shields and proper positioning of the flash getters avoids most of their disadvantages.

It has been known for a long time that almost all metals (after thorough degassing) are capable of absorbing gases on their surfaces.

**Tantalum**

Certain metals are capable of incorporating gases, even noble gases, by solution in their bulk volume. The classical example is tantalum which, on account of this property, plays a predominant role in the construction of high-power transmitting tubes. After degassing in a high vacuum for several hours at a temperature of 1,600 to 2,000°C, tantalum is capable of absorbing gases in amounts up to several hundred times its own volume. The optimum gettering temperature for tantalum appears to be in the neighborhood of 1,000°C. At temperatures above 1,500°C, the gettering action is reversed. The maximum getter effect is secured, therefore, by dimensioning tantalum anodes so that during normal service the electrodes operate at red to yellow heat. Generally, the high price of tantalum sheets and wires limits the use of whole tantalum electrodes to particularly valuable tubes and suggests the coating of electrodes with tantalum powder. This is mostly performed by applying very fine tantalum powder on the surface of anode sheets in the finished assemblies. They are sintered together while simultaneously degassing these powders during the pumping operation by means of high-frequency heating or by electron bombardment. On account of the high degassing temperature required for tantalum, only molybdenum or tungsten is suitable as a base metal for tantalum powder. Tantalum should never be hydrogen-fired because of embrittlement.

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<th>Diffuse deposit</th>
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<td>202</td>
<td></td>
</tr>
<tr>
<td>Th</td>
<td>O₂</td>
<td>7.45</td>
<td>31.15</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>O₂</td>
<td>10.56</td>
<td>9.26</td>
<td></td>
</tr>
<tr>
<td>Mischmetal</td>
<td>O₂</td>
<td>21.2</td>
<td>50.9</td>
<td></td>
</tr>
<tr>
<td>Ba</td>
<td>O₂</td>
<td>15.2</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H₂</td>
<td>46.1</td>
<td>63.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N₂</td>
<td>3.18</td>
<td>16.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO₂</td>
<td>2.2</td>
<td>44.8</td>
<td></td>
</tr>
</tbody>
</table>

Getter efficiency is determined by the product of volume (l) liter) and pressure of gas cleaned up by 1 mg getter material. Diffuse deposits were obtained by flashing the getter in argon and consist of finely divided getter material.
and consequent destruction by this gas.

The main disadvantages of tantalum are the high material cost and the high temperature range required for proper degassing and subsequent gettering operation.

**Columbium**

During recent years columbium getter pellets have been introduced to the vacuum technique. These pellets are approximately three to five millimeters in diameter and one to three millimeters high, and consist of oxide-free columbium metal.

The getter pellets must occupy a position in the tube where they can be heated to a high temperature during exhaust by either high-frequency induction or electron bombardment. The position of the pellet must be such that the temperature is maintained by either radiation or electron bombardment at approximately 500 °C. This temperature is not critical but must be above 400 and less than 900 °C. A temperature of 1,650 °C is needed to outgas columbium pellets because at this temperature occluded and absorbed gases are expelled and columbium oxide is volatilized. A temperature lower than 1,650 °C will not accomplish this expulsion of columbium oxide. The outgassing time may vary from a period of five minutes to a somewhat longer time. The preferred manner for supporting the columbium getter pellet is to weld a molybdenum wire to it. The temperature of outgassing is too high for a nickel support but is in the proper range for molybdenum. Tungsten need not be used.

**Zirconium**

Zirconium has valuable gettering characteristics and has come into wide use during the past decade. It forms very stable solid solutions (or compounds) with such gases as O, N, CO and CO₂. Zirconium metal is cheaper than tantalum and requires somewhat lower operating temperatures. Zirconium is available either in solid metal form (sheets or wires) or it may be applied in the form of a powder to base metals (molybdenum) as described above. The proper outgassing temperature for zirconium lies between 1,000 and 1,700 °C, which is attained by either direct or indirect heating of the zirconium metal or of the base metal to which zirconium metal or zirconium powder has been applied. Wherever it is deemed inadvisable to heat the getter material to this temperature range, an outgassing temperature of 700 °C must be considered minimum for activating the surface of the zirconium getter. While zirconium is effective as a getter from about 400 °C on, it is most active at temperatures up to 1,600 °C if used, for example, on molybdenum and carbon anodes.

The solubility of H₂ in Zr at room temperature equals 1,500 times its own volume at 1 atmosphere. Sorption begins at 300 to 400 °C and is completed at 500 °C. As the temperature is increased, the metal frees H₂, but at 850 °C the H₂ is again taken up during transition from α to β Zr. Above 850 °C, H₂ is evolved. Sorption and desorption are reversible with decrease in temperature. Preliminary heating to a high temperature is a necessary condition for the sorption of H₂ at lower temperatures. During a rapid passage from a high temperature (above 1,200 °C) to room temperature, a large amount of H₂ is quickly taken up.

Oxygen as well as N₂, dissolve homogeneously in Zr. When a Zr rod covered with a thick white oxide layer is heated in vacuum, the metallic luster reappears. Water vapor is cleaned up between 200 to 250 °C. Care must be taken that a part of the Zr getter remains at a low temperature (approximately 400 °C) during operation in order to bind the H₂, while another part must assume much higher temperatures (approximately 800 °C) in order to absorb O₂, N₂ and other gases.

Zirconium metal in sheet form 0.002 to 0.005 inch thick is used on locations that can be properly outgassed and which operate in the temperature range indicated above.

Very often zirconium sheets are mounted to grid shields, cathode supports, and other structures, which during operation attain a temperature of 600 to 800 °C. In small tubes zirconium sheets, cylinders, or ribbons are used for cathode supports, grid supports and radiation shields. Zirconium wire of 0.005 to 0.020-inch diameter can be mounted for direct heating, being heated whenever absorption of gas is required, or it may be mounted for the same purpose by winding zirconium wire around Mo rods or other suitable structures.

Continuous gas absorbers such as that shown in Fig. 2 provide a support for the Zr wire and are operated from 350 to 1,700 °C, for example, in x-ray tubes in series or in parallel with the filament (the temperature being adjusted by proper length of the wire). They have also been used for shortening the degassing time of electrode systems during pumping. Using a

---

![FIG. 1—Vapor pressure of metals used as flashing-type getters. H₃ and Ni are included for comparison](image-url)
Zr wire spiral of fifteen turns on a 0.040-inch Mo mandrel, treated and outgassed for one hour at 1,700°C, a pressure of $5 \times 10^{-4}$ mm Hg was reached in ten minutes instead of thirty minutes with the high vacuum pump alone. This auxiliary pumping getter can be used repeatedly even though exposed to atmospheric pressure between pumping cycles, no additional outgassing between cycles being required. In every case the Zr absorber maintained a higher vacuum at a considerably higher effective pumping speed than the 20-liter-per-second high-vacuum pump.

A convenient way of using zirconium is to spray the tube parts with fine zirconium powder. Such powders, of particle size between 1 and 8 microns, may be suspended in a temporary binder such as nitrocellulose or amyl acetate. For high voltage tubes a permanent binder such as colloidal silicic acid has been used with success. Such a binder has the further advantage of not giving off gaseous products during outgassing and operation. The amount of binder is usually two to five percent. This mixture is sprayed on the electrode parts, which in turn are fired in vacuum in order to remove the binder or to convert the binder to a stable compound. Nickel electrodes (preheated at 1,000°C, operating at 200 to 500°C), molybdenum electrodes (preheated at 1,500°C in vacuum and operating at 800°C) and graphite electrodes can be satisfactorily coated with such mixtures. Quantitative data on the sorption of different gases at different temperatures by powdered Zr are shown in Table II. Other methods of applying zirconium powder to electrodes have been reported, such as a suspension mixture consisting of paraffin, naphthalene, xylene and methanol or deposition of zirconium powder by cataphoresis.

Zirconium hydride ($\text{ZrH}_2$) may also be applied to Mo, Ni, Fe or graphite anodes or grids as a paste, by spraying or cataphoretic precipitation, and reduced to pure Zr upon heating. This compound compared with pure Zr powder presents the advantage that at lower temperatures the zirconium is tied up and protected against oxidation or poisoning during seal-in and exhaust. Then as the temperature is raised, metallic zirconium is formed, liberating its hydrogen completely in vacuum at about 800°C. Thus, for coating on carbonized plates, which liberate much adsorbed gas during exhaust, zirconium hydride may be preferable to the pure metal since not only is the combined zirconium protected from the evolved gases but furthermore the hydrogen that it liberates at higher temperatures apparently reduces the last traces of adsorbed oxygen in the carbon layer.

Zirconium has been used successfully in high-power transmitting tubes, especially tubes having thoriated tungsten filaments, small microwave tubes and gaseous discharge tubes. Zirconium is inert to mercury vapor.

Stable solutions or compounds of Zr are formed with most gases including water vapor, with the exception of hydrogen.

The chief disadvantage of zirconium as a getter is that the optimum temperature for the sorption of hydrogen is too low for the effective cleanup of oxygen, nitrogen and the oxides of carbon. If, therefore, the zirconium-coated part is to operate at a temperature much in excess of 300°C, a supplementary lower temperature Zr getter or a getter of the barium or barium-magnesium type should be added to absorb the hydrogen. Whether this precaution is necessary or not depends upon the tube and the amount of water vapor or pure hydrogen found within it.

### Thorium

During World War II, thorium, thorium alloys and mixtures of these with other getter materials were developed in Germany for use in vacuum tubes. Thorium metal is manufactured by reduction of ThO$_2$ with Ca. Powdered Th is very pyrophoric; it is inflammable by mere friction. Electrode parts were coated with thorium powder by cataphoresis and heated for two to three hours in a vacuum furnace. For wires the coating was 5 to 10 microns thick and for sheets 1 to 2.5 mg per sq cm. The heating temperature is about 800 to 1,000°C for nickel and iron and 1,500 to 1,600°C for graphite electrodes. Considerable gas absorption is reported to occur around 200°C but especially in the range from 400 to 500°C. This getter is therefore suitable for power tubes and very small tubes with high anode temperatures. If the anode is covered with thorium powder its surface finish is rough, resulting in increased emissivity by blackening.

One alloy of thorium is the getter called Ceto, which comprises a 20-percent mischmetal (chiefly cerium) and 80 percent thorium. This powder mixture is sintered at approximately 1,000°C, and the bars are milled to powder again. It is very inflammable. Ceto getter powder is transformed with amyl acetate into a paste that is applied to the tube electrodes in the amount of 15 to 25 mg powder per sq cm and then sintered upon the base metal in a vacuum furnace. The degassing temperature of the Ceto getter is 800°C and a marked getter action is exhibited from 80 to 130°C up, with an absorption maximum at 200 to 500°C.

Ceto getter material has a lower secondary emission than barium. It is used when it is desired to avoid or to reduce secondary emissions.

### Table II—Sorption of Gases by Powdered Zirconium

<table>
<thead>
<tr>
<th>Gas</th>
<th>Temp C</th>
<th>Gas Sorbed (cm$^3$ x mm Hg per mg Zr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O$_2$</td>
<td>25</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>1.99</td>
</tr>
<tr>
<td>N$_2$</td>
<td>500</td>
<td>0.11-1.0</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>1.46</td>
</tr>
<tr>
<td>CO</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>3.65</td>
</tr>
<tr>
<td>C$_2$H$_4$</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>3.04</td>
</tr>
<tr>
<td>H$_2$</td>
<td>25</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>13.33</td>
</tr>
</tbody>
</table>
sion that might arise from the use of Ba. It cannot be used above 600°C. Ceto bridges the gap between the low-temperature flashing getter such as Ba and the high-temperature non-volatile types (Th, Ta and Zr.). Pure thorium or compounds of Th and Zr are highly pyrophoric.

**Titanium**

A recent addition to bulk getter materials is titanium, which can be used either as bulk or as coating getter. It is not pyrophoric and its getter properties are good, besides being easy to form and machine. Blackening of the parts can be obtained by a short heating in air. At present titanium sheet is more expensive than zirconium per unit of gas absorbed.

**Aluminum**

Aluminum in its pure state is not used as a flash-getter, chiefly because its vapor pressure is too low (see Fig. 1). It vaporizes sufficiently only above 1,300°C, which is much too high for the conventional base metals like Ni. On the other hand, aluminum plated on Fe to a thickness of about 15 microns shows a considerable coating-getter effect for traces of O, being bound by the carbon content of Fe electrode and released only slowly during the life of the tube. After heating at 700 to 800°C in vacuum, the aluminum forms a black compound with the Fe base (FeAl, or FeAl4). This blackening increases the total emissivity to a level that is equal to or greater than that of carbonized Ni anodes. Such Al-plated sheet-iron has been widely used in Europe for anodes in receiving and amplifier tubes with oxide-coated cathodes.

The trade name for sheet iron plated with aluminum on both sides is P2-iron; plated with Al on one side and with Ni on the other—PN-iron.

**Magnesium**

Pure magnesium possesses many desirable properties for a getter material, such as availability in suitable forms, and being comparatively stable and volatile under vacuum at convenient temperatures around 500°C. Unfortunately, the gettering power of magnesium is not high because most gases are only physically absorbed. As a result, magnesium by itself is not used in high-vacuum tubes. The only evidence of its use is in Hg-vapor-filled rectifiers and in certain types as a grid coating powder to reduce secondary emission.

In order to obtain a material of greater stability and safety in use than pure magnesium, the so-called Formier getter was developed. It consists of aluminum-magnesium alloy powder (55 percent Al, 45 percent Mg) which is applied suspended in a nitrocellulose binder and applied to tube parts as a paint. On account of the limited gettering powers of magnesium, Formier is used only when other types of getters with higher evaporation temperatures must avoided. Magnesium getters are difficult to degas, have little gas absorption up to temperatures of 175°C and absorb only oxygen. High vacuum pressure precludes use in small tubes and at high operating temperatures.

**Barium**

The active ingredient of most flash getters is barium, which is used in combination with aluminum, magnesium, tantalum, thorium, strontium or calcium. The getter is attached to the electrodes in the form of a pellet, or more frequently, to a special metallic support within the tube as shown in the top row of the accompanying photograph. It is mounted in such positions as to insure that the vapor stream produced is not splashed against such parts as the stem or the insulated lead-in wires. Shielding screens of metal, mica or ceramic materials are often provided to prevent this. The getter pellet must be attached to parts that during the pumping process may be readily heated to the evaporation temperature of the getter. This heating is performed by electron bombardment or, more frequently, by high-frequency induction from coils arranged outside the tube.

Flash getters of pure barium have the disadvantage that the unprotected barium reacts at room temperature with oxygen or with water vapor, thereby becoming inactive. This condition may be prevented by using: a protective layer or casing, alloys of Ba that are inert at room temperature or by generating the gettering material in the vacuum tube by a chemical reaction between stable Ba compounds and deoxidizing agents to form a reaction-type getter. Alloys of barium with magnesium and aluminum are relatively stable at room temperature and yield pure barium upon dispersal or flashing of the getter. The percentage of metals in standard alloys for getter tablets are: Ba 25, Mg 55, Al 20; Ba 37, Mg 37, Al 26; Ba 43, Mg 20, Al 37 (known by the trade name Kemet). The tablets are mounted on nickel flags of various shapes.

Barium-magnesium alloys yield very little Ba metal in the flashing and are, therefore, seldom used in modern high-vacuum tubes. Ba-Al getters provide much larger amounts of Ba metal, which accounts for their wider use. A common disadvantage of both types of alloys is their rapid rate of deterioration upon exposure to air and the necessity of vacuum packing.

Another commercial assembly is shown in Fig. 3. Other types comprise short pieces of iron, nickel and copper-clad barium wires to be mounted on a support of Ni-sheet, which can be high-frequency flashed at 900 to 1,100°C. Trade names of these materials are Feba, Niba and Cuba.

Several x-ray tubes of European

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**FIG. 3—Typical Kemet KIC getter mountings:** A is nickel h-f induction loop. B getter strip. C iron sheath. D weakened zone to allow evaporation and E is 0.3 to 24-mg barium filling.

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make use iron-clad barium (Feba) getter made in wire form, 2 mm diameter by 15 mm long. The getter is mounted within a miniature oven consisting of a ceramic tube into which the getter just fits. A tungsten spiral heater is wound on the outside of the ceramic tube. Care must be taken to avoid the possibility of migration of the barium to active tube elements. After sealing off the tube, the getter is flashed by heating the spiral.

Examples of the reaction type Ba getters are the reduction of BaO by Al to Ba (Alba getter) and of BaCO₃ or barium berylliate by Ta to Ba. In the case of BaCO₃, a tantalum wire heater is coated with a mixture of BaCO₃ and SrCO₃ (SrCO₃ prevents fusing of BaCO₃). At 800 to 1,100 °C the carbonates dissociate to oxides and at 1,300 °C the oxides react with Ta to form metallic Ba, whereby 40 percent of the theoretical Ba yield is obtained in the so-called Batalum process. Also barium berylliate (BaBeO₃) is stable in air and is used in a directly heated getter, shown in Fig. 4, formed in the shape of a trough from a 0.040 × 0.001 in. Ta ribbon, which holds approximately 2.5 mg of Ba and gives a Ba yield of 60 percent.

Another flashing-reaction-type getter is the so-called Bato getter, which is prepared by mixing an aluminum-barium alloy with iron oxide and thorium powder. Its purpose is to provide a source of heat in the getter pellet and in so doing aims at flashing Ba metal at a relatively low getter flag temperature. The source for the Ba is the Ba-Al alloy and the latent heat so derived forms an exothermic reaction between iron oxide and metallic thorium. The powder is formed into tablets, which are pressed into nickel cups and attached to special supporting members within the tube. Since it is important to store the Bato getter in a dry atmosphere, the getter flags are usually sealed into evacuated ampoules or cans. After the pumping process, the getter is evaporated by high-frequency.

Flash getters are outgassed at temperatures between 600 and 700 °C, usually by r-f heating from the outside of the tube, and flashed at temperatures between 900 and 1,300 °C. The barium vapor condenses on the cold surface opposite the getter material, usually on the envelope of the tube. The appearance of the condensed getter deposit depends upon the vapor pressure in the tube at the time of flashing. If the getter is vaporized very slowly, the first barium atoms evaporated will absorb the gas present so that the remaining getter is deposited in a very high vacuum, exhibiting a shining mirror. If flashing is done very rapidly, however, the getter deposits in a rather high vapor pressure and the getter mirror will be discolored due to dispersion of the Ba. If vaporization is carried out in the inert atmosphere of a rare gas the condensed deposit will be black, resulting in a dispersal getter. This condition does not mean that the getter is contaminated, but merely that the deposit is finely divided and therefore absorbs light. Such deposits exhibit higher efficiency than the

![FIG. 4—Arrows indicate direction of barium metal evaporation from barium berylliate in tantalum trough](image)

Table III—Outgassing, Flashing and Operating Temperatures of Typical Getters

<table>
<thead>
<tr>
<th>Material</th>
<th>Ta</th>
<th>Ch</th>
<th>Zr</th>
<th>Th</th>
<th>Ceto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of Application</td>
<td>coating</td>
<td>coating</td>
<td>coating</td>
<td>coating</td>
<td>coating</td>
</tr>
<tr>
<td>Form of Getter</td>
<td>sheet</td>
<td>pellets</td>
<td>sheet</td>
<td>powder</td>
<td>powder</td>
</tr>
<tr>
<td>Outgassing Preheating Temperature (deg C.)</td>
<td>800-1,300</td>
<td>1,500</td>
<td>700-1,300</td>
<td>for metal</td>
<td>300-1,200</td>
</tr>
<tr>
<td>Flashing Temperature (deg C.)</td>
<td>500</td>
<td>no ref</td>
<td>900-1,300</td>
<td>200-200</td>
<td>max</td>
</tr>
<tr>
<td>Operating Temperature (deg C.)</td>
<td>700-1,200</td>
<td>300</td>
<td>200-200</td>
<td>200-500</td>
<td></td>
</tr>
<tr>
<td>Applications</td>
<td>D, E, M</td>
<td>D, E</td>
<td>C, D, E</td>
<td>G, H, I</td>
<td>A, F</td>
</tr>
</tbody>
</table>

**Ba And Ba Compounds**
- Mg
- Al-Mg

**Reaction-Type Getters**
- Bato
- Batalum
- Ba-berylliate

**Phosphorus**
- flash
- powder evaporation
- no ref

**Ba And Ba Compounds**
- ribbon
- wire
- point

**Flash Getter Materials**
- H
- I

**Operating**
- 1,200-1,300
- 1,300
- 200-200
- 200-1,000

**Applications**
- D, E, M

**N**
- Tubes with thoriated cathodes
**O**
- Inert discharge lamps
**P**
- Vacuum tubes in which neither flashing getters nor the high temperatures necessary for Ta and Zr may be used.
Bright phosphorus x-ray, by In envelope. Such getters may provide a high operating voltage of several getters or several getter pellets are employed.

Flash getters have the disadvantage that during flashing metallic vapor is produced, which may settle on insulating parts or build up a conducting layer on the glass envelope. Such layers may become charged during operation or represent interelectrode capacitance. Usually flash getters are inadvisable in high voltage tubes or in microwave tubes, the latter type having very close spacing and only short insulating surfaces. It should also be considered that the opaque mirror interferes with the cooling of electrodes by radiation. In high-voltage types transmitting a 20-30 x-ray tubes fast stray electrons may hit the mirror and evaporate sufficient getter material to cause a gas discharge followed by a short circuit and destruction of the tube.

Phosphorus

Phosphorus has a comparatively high vapor pressure (indicated in Fig. 1) and for this reason it is not used in radio transmitting, x-ray, or other high-vacuum discharge tubes. Inexpensive and simple to handle, it is used for high-vacuum and gas-filled lamps, especially for types of below 60 watts with voltages of 90 to 250 volts.

The outgassing, flashing and operating temperatures of typical phosphorus getters are given in Table III.

The authors wish to extend thanks to E. B. Steinberg (Remington-Rand) and E. A. Lederer (RCA) for assistance and suggestions in the preparation of this manuscript.

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Aircraft Ignition Tester

One set of spark plugs in an engine equipped with a dual ignition system is used as ionization detector to determine if the active set is firing properly. The drop in potential across the detector plug is sensed by an amplifier and neon lamp indicator for each cylinder to give a dynamic indication on the ground.

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Operation of the ignition tester to be described depends upon the fact that an aircraft dual-ignition system includes two sets of spark plugs. Each cylinder has two plugs, connected to associated magnetos by a cable harness as shown in Fig. 1. When the engine is operating on one of the magnetos, the spark plugs of the other magneto system can be used as detector plugs to determine if the other spark plug in the same cylinder is firing properly.

Testing is accomplished by applying a fairly high voltage across the detector plug. When flame strikes the electrodes as the cylinder fires, ionization conductivity of the combustion gases permits current to flow and the potential across the detector plug drops.

This drop in potential across the detector plug is used to flash a neon lamp by means of an electronic circuit.

The basic circuit of the ignition tester is shown in Fig. 2. A potential of about 500 volts is applied to the detector plug through \( R_3 \). The same voltage also charges \( C_1 \) through \( R_1 \) and \( R_2 \). The grid of \( V_1 \) is normally positive, grid current being limited by \( R_2 \). Neon lamp \( V_2 \) performs the double duty of voltage regulator and voltage level indicator.

The use of a spark plug as a detector of ionization has previously been used in studies of propagation of flames in cylinders. When an active plug fires, the combustion flame at the detector plug greatly reduces the dielectric strength of the gap. When the gap of the detector plug becomes sufficiently conductive, the charged capacitor \( C_1 \) discharges through the detector plug. This discharge charges \( C_1 \) in opposition to its normal polarity and makes the grid of \( V_3 \) negative.

A typical oscillogram of this variation in grid voltage, measured at the junction of \( C_1 \) and \( C_2 \), is illustrated in Fig. 3. It will be noted that the grid voltage is driven from a positive value to a much greater negative value.

Swinging the grid of \( V_3 \) negative cuts off this triode with the result that its plate potential becomes much more positive, making the grid of \( V_3 \) positive. Tube \( V_3 \) is normally biased to cutoff, so the positive swing causes \( V_3 \) to conduct and to light the neon indicator lamp \( V_3 \). Flashing of \( V_3 \) indicates that the live spark plug has fired the cylinder’s combustion charge.

After the voltage discharge through the detector plug, the grid voltage of \( V_1 \) relaxes toward its quiescent positive bias illustrated in Fig. 3, so that \( V_1 \) becomes conducting. It allows \( V_1 \) to return to its normally nonconducting state until the next ignition flame is detected by the detector plug. By providing suitable voltages across the detector plug and to the grid of \( V_3 \), even a weak detection signal, owing to a very lean mixture, can.

* Formerly Curtiss-Wright Corp.
be relied upon to flash the indicating lamp $V_s$ brightly.

**Bias Tube**

The unusual location of the neon indicator lamp $V_s$ in the plate circuit of triode $V$, may be noted since the cathode is isolated from ground except during the conduction period of the lamp $V_s$. By this means, a negative biasing battery or other inconvenient biasing method is avoided. Cutoff bias voltage is developed automatically by cathode emission and by electron collection by the plate. The cathode, being isolated from ground by the neon lamp, will raise itself to a positive potential by loss of electrons. With the grid grounded through $R_s$, cutoff bias is obtained that keeps lamp $V_s$ dark until the positive grid signal is transmitted through capacitor $C_s$.

In practical applications a separate electronic detector circuit is used for each cylinder. For a nine-cylinder engine, nine detector circuits with a total of nine firing indicator lamps and nine dual-triode tubes together with a power supply are used. This arrangement makes it possible to check all nine cylinders at once.

To connect such an ignition tester to an aircraft engine, disconnect junction blocks must be located in an accessible position somewhere along the high tension leads between the distributor and the ring manifold of the harness. In Fig. 1, the continuous ring manifold is shown with the disconnect blocks located on top of this manifold in front of the engine. To attach the tester, one disconnect is opened and the tester cable is plugged into the manifold block. The plug from the magneto has all contacts grounded for protection.

For a nine-cylinder engine, nine individually shielded wires are connected to the tester from the receptacle on the ignition harness. Shielded leads are preferred in order to prevent crosstalk between the test leads in the cable to the tester. If unshielded leads are used, the mutual capacitance between leads permits induction of the firing signal from one lead to all the others. Such capacitance causes false flashing of the indicator lamps and greatly dissipates the strength of the initiating signal.

Another difficulty encountered was the severe interference from the mutual capacitance between the live ignition leads and the test ignition leads in the same harness. Reduction of interference voltage is accomplished by the capacitor divider action of the comparatively large capacitance to ground of the test leads in the 20-foot cable connection to the tester. Further elimination of interference is accomplished by the integrator circuit defined by $R_s$ and $C_s$. Tolerance of residual interference is made possible by operation of triode $V_s$ with positive bias that is too high for any negative interference peak to overcome.

**Using the Tester**

To test the ignition system of an aircraft engine, the engine may be run first on magneto 1. In this case, magneto 2 is cut out and the tester cable is connected to the receptacle at the disconnect block between the magneto and ignition harness in the circuit of magneto 2. With the engine running, firing of each cylinder is indicated by the flashing of its respective neon indicator lamp. The indicator lamp indicates definitely whether the associated cylinder is or is not firing, even if there is only occasional missing. The

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*Underchassis views of the tester. Connection to the individual test plugs is made through the multiconductor plug shown at left.*

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**Spark Plug Faults Are Elusive**

A plug that acts erratically in an engine when hot may test good when removed. Plugs that work perfectly under cruising conditions may go bad under takeoff conditions of higher compression and temperature. Many a crash has occurred that could have been avoided if ignition had been checked under load on the ground.

A conventional preventative is routine replacement of all spark plugs. However, it takes twelve man-hours to do the job on an 18-cylinder engine—with no assurance that new troubles have not been introduced. The ignition fault finder described in this article may go a long way toward improving maintenance.
dication is simply the failure of the neon lamp to flash repeatedly so that an experienced operator is not required to interpret the lamp indications.

The ignition trouble is accordingly localized in the particular circuit which fails to fire the cylinder charge and in most cases the trouble can be cleared by replacement of the spark plug. If after such replacement, trouble still exists in this particular circuit, a standard harness and magneto tester may be used to locate the trouble in this circuit.

As a matter of convenience, the tester may be provided with a so-called memory switch (S, of Fig. 2) for each indicator circuit. If an indicator lamp shows faulty ignition, the memory switch may be closed so that the lamp will remain lighted after the ignition testing is completed.

Tests have shown that the detector spark plug need not itself be in perfect condition for detecting proper firing of the active plug on test. It has been found that fouled spark plugs will serve as ignition detectors until they are practically

FIG. 1—Simplified detail of conventional ignition harness and method of attaching tester

FIG. 2—Schematic of the test circuit. A similar channel is required for each cylinder

FIG. 3—Oscillogram of the voltage at the grid of tube V1 shorted by a bridge of carbon across the electrodes of the spark plug. Even in case the testing apparatus falsely indicates faulty ignition of the active spark plug due to the detector plug being very badly fouled, the tester will still definitely indicate faulty ignition in that cylinder since the badly fouled plug would in this case fail to give satisfactory ignition.

Unique Performance

During a test demonstration of the ignition tester on a Wright G-200 engine, an indication of intermittent ignition in a cylinder where a new spark plug has been installed was indicated. Examination showed a mechanic's failure to make a proper connection to that spark plug. No other existing type of tester could have found this trouble, nor could a complete replacement of an entire set of spark plugs preclude recurrence of the same trouble. The action of some questionable spark plugs was to go dead for a second or two, repeating the trouble after an interval of a few seconds to half a minute. Synchronized with the indication of the tester, there was an unmistakable change in sound and vibration of the engine. This type of an intermittently bad spark plug usually tests good on all other testers.

The presently used ignition harnesses are usually not equipped with disconnect blocks that would permit the ignition tester to be readily attached. Manufacturers have indicated a willingness to produce new harnesses with disconnects. Although this type has been developed and is being tested by airlines and engine manufacturers, present applications are confined largely to military uses.

The photograph shows an experimental model tester equipped with nine separate channels so that all cylinders of a nine-cylinder engine may be tested simultaneously. A type 6SN7GT dual-triode is used in each channel. Power is supplied from a vibrator pack and its associated rectifier tube since this particular model is intended for portable operation at an airport. The dual voltage output from the vibrator is obtained with a synchronous vibrator in addition to the novel use of a full-wave rectifier tube across the secondary of the vibrator transformer. The nine neon indicator lamps are visible through the openings in the front panel. The neon lamp to the far right is the voltage regulator V, referred to earlier in this paper. The glowing of this lamp indicates that the voltage applied from the power supply is sufficient for reliable operation of the ignition tester.

Test facilities for this development of the Curtiss-Wright Corporation Development Division were provided by the Wright Aeronautical Corporation ignition service and engineering departments, and by the Army School in Paterson, New Jersey. Grateful acknowledgment is also expressed for the helpful cooperation of A. C. Winter, Tony Munsell and J. G. Smith.
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VIDEO RECORDING, the transcription of televised material onto motion picture film from a cathode-ray tube, is an essential medium for long-distance network television. Used with existing relay facilities, video recording enables program presentation at the same hour in different time zones. In the absence of relay facilities, it provides the only means for network distribution of key station programs.

Current practice is to record on 16-mm film, at the motion picture standard rate of 24 frames per second. The recording camera is driven by a synchronous motor, operating from the local power line, so that the film exposure rate is synchronized to the local power line frequency. The television picture rate, on the other hand, is necessarily synchronized to the power line frequency at the point of origin. If the camera has a conventional mechanical shutter, frequency difference between power lines causes recording difficulties in distant program pickup.

A new recording system, using an electronic shutter timed by electronic counting circuits, is entirely independent of the synchronizing frequency at the point of program origin. The equipment is self-contained in a single console. It includes picture and sound pickup circuits, the recording cathode-ray tube, a direct-reading video level monitor, a camera and a sound head.

The mechanical shutter of a conventional motion-picture camera performs the cyclic tasks of starting, stopping and timing each film exposure. The electronic shutter is an assemblage of electronic circuit blocks which performs these same tasks. It differs from a mechanical shutter in the following respects:

The exposure is started and stopped by successively applying and blanking the picture on the face of the cathode-ray tube, rather than by intervention of a mechanical shutter blade.

The exposure is timed by counting the scanning lines which compose the television picture. Exposure of each film frame is terminated on completion of the 525th scanning line, regardless of whether or not the camera and the television synchronizing generator are in synchronism with each other. To achieve the same desirable objective with a mechanical shutter, two major variables must be controlled. These variables are the operating speed of the shutter and the angular blade width. The angular blade width is fixed in the camera design so that the time of shutter opening is 525 lines when the shutter is running at nominal operating speed. Departure from nominal speed during nonsynchronous operation causes line-count errors. During synchronous operation, momentary changes in power line frequency may cause line-count errors because of the inertia associated with the camera mechanism.

With either mechanical or electronic timing, the start of exposure must be properly phased in relation to the camera mechanism. Exposure should not start until film pulldown has been completed and the film has become stationary. With a mechanical shutter, this function is performed by the trailing edge of the shutter blade (or the leading edge of the shutter opening). With an electronic shutter, it is performed by a mechanical cycling disc which generates an electrical cycling pulse suitable for actuating the counting circuits.

The circuit blocks which compose
Independence of synchronizing frequency at the point of program origin is established by substitution of electronic circuits for the mechanical shutter of a motion-picture camera. Tubes are also employed for phosphor persistence compensation and gray-scale correction.

The scanning method commonly used with either a mechanical or electronic shutter is shown in Fig. 2. Since four film frames are to be exposed during the period of five television frames, one television frame must be dropped out of every five. By utilizing the interface feature of the television scan, the same result is obtained by dropping one-quarter frame out of every one and one-quarter. One complete field and two complementary portions of adjoining interlaced fields are photographed during a single shutter opening, the separate portions adding up to a single television frame.

Accurate shutter timing is essential for correct operation. The shutter not only blanks the picture during the film motion interval, but also times the exposure to allow exact completion of a single television picture on each film frame. It is this additional timing function that imposes the severe accuracy requirement. With correct shutter timing, the starting line of the first field and the ending line of the third field occupy adjoining positions in the raster. If the shutter remains open a trifle too long the film records several extra scanning lines, which appear on top of a completed frame as a bright horizontal strip.

Similarly, early shutter closure causes a dark horizontal strip. This strip, either light or dark, becomes an obvious exposure defect which is sometimes called a shutter bar. The region of the picture where shutter closure occurs is known as the join-up or splice.

These conventions apply to a positive print produced from a negative film. The light values reverse for a direct positive print.

It is characteristic of the scanning method that the join-ups of alternate frames have different positions. The two join-up locations are separated from each other by one-half the picture height. In Fig. 2, the intersections of the dotted lines with the vertical saw-tooths indicate the join-ups. The phasing chosen places one join-up near the top of the first and third frames, and the other join-up near the bottom of the second and fourth frames. One join-up can be removed from the picture area by phasing the camera to place the join-up at the raster edge, but the other join-up lies within the picture area. The join-up locations remain stationary when the television and camera rates are synchronized to each other. Otherwise, they travel up or down, depending on the difference between rates. An invisible join-up is a necessity in either case, and shutter timing must be correspondingly accurate. As an illustration of the degree of accuracy required, it may be noted that the edge of a mechanical shutter blade is hand-finished to almost micron dimensions in order to produce a satisfactory join-up. Even with this degree of accuracy, changes in the cyclic time base during nonsynchronous operation cause a shutter bar effect.

In the equipment illustrated, a shutter gate generator, rather than a timing circuit alone, blanks the cathode-ray tube during a portion of the film cycle. The phasing and duration of the shutter gate are established by several associated electronic circuits. One of these circuits opens the gate and starts the timing action as soon as pull-down of the preceding exposed frame has been completed. Another circuit times the exposure. A third circuit closes the gate. This combination of circuits forms an electronic shutter which replaces the

![Diagram](image-url)
conventional mechanical shutter and affords greater inherent accuracy. The electronic shutter in the camera described has an inherent timing accuracy of better than one percent of a single horizontal line, or 0.5 microsecond, in either synchronous or nonsynchronous operation. The join-up reduces to a small line break in the unused margin of the raster, outside the picture area.

Since each television frame contains exactly 525 horizontal scanning lines, counting circuits may be used to time the film exposure. The counting circuits blank the recording cathode-ray tube when the correct number of horizontal lines has been scanned. Film exposure may start at any horizontal scanning line. Once started, the exposure continues to completion of the television frame, and then stops until triggered by a cycling pulse. In the camera, film pulldown starts after the exposure stops. On completion of pulldown, when the film has become stationary, the camera generates the cycling pulse and starts a new cycle.

Referring to Fig. 1, the cycling pulse, after amplification, actuates the start coincidence circuit. The pulse does not initiate the actual exposure, but merely cocks the circuit. A single horizontal synchronizing pulse then trips the circuit. This same synchronizing pulse, which may lie anywhere in the scanning cycle, becomes the start pulse which opens the shutter gate. Photography of the first scanning line commences with this pulse and continues as long as the shutter gate is open, the duration of the shutter gate opening being determined entirely by the timing gate.

The timing gate resembles the shutter gate, but the starting edge is intentionally delayed so that the gate opens during the first scanning line, after passage of the zero pulse. With the timing gate open, each pulse following the start pulse trips an appropriate stage in the binary counter circuit until the 524th pulse trips the 10th stage. This, in turn, actuates the stop coincidence circuit, effectively cocking the circuit. The 525th horizontal synchronizing pulse then trips the circuit, closing both the shutter gate and the timing gate. The gates remain closed during the blanking interval. At the conclusion of this interval, the camera generates a new cycling pulse, exposure starts and the operation repeats itself.

**Start Coincidence Circuit**

Figure 3 shows the start coincidence circuit. Under static conditions, triode *V*₁₆ is strongly conducting and *V*₂₄ is biased to cutoff.

The negative cycling pulse from the camera passes through diode *V*₂₄ and arrives at the grid of *V*₂₅ as a strong negative pulse, sufficiently large to stop conduction in this triode section. The voltage at the plate of *V*₂₅ goes positive, carrying the grid of *V*₂₅ with it. Conduction thus transfers to *V*₂₅. Meanwhile, the negative charge on *V*₂₃ grid starts leaking off through the 1-meg resistor.

The time constant in the grid circuit is such that *V*₂₃ grid can remain negative during the period of several horizontal lines. (This is the cocking action illustrated in Fig. 1.) While *V*₂₄ is conducting, the horizontal sync pulses are amplified in *V*₂₄ and appear as positive pulses on *V*₂₃ grid. Within the time of a few scanning lines, the negative potential on *V*₂₃ grid becomes so small that a particular pulse in the string of horizontalsync pulses overrides the negative potential on the grid of *V*₂₃. This is the zero pulse, illustrated in Fig. 1, which causes transfer of conduction to *V*₂₅. The voltage at the plate of *V*₂₅ falls abruptly from +150 volts to almost ground potential, giving rise to a large negative pulse which becomes the start pulse.

The stop coincidence circuit is shown in Fig. 4. It is similar to the start coincidence circuit, except for the use of direct coupling to *V*₂₄ grid. The 524 count (Fig. 1) from the 10-stage binary counter replaces the cycling pulse as one of the inputs. The other input, the string of horizontal sync pulses, remains the same. The output is the stop pulse. The stop coincidence circuit contributes the 525 count.

**Shutter Gate Circuit**

The heart of the shutter gate generator is shown in Fig. 5. The circuit is a symmetrical version of the start coincidence circuit, and may be recognized as a form of the scale-of-two counter. It has two stable positions, characterized by conduction of one or the other of the two triodes. If triode *V*₂₅ is conducting, a negative pulse applied through diode *V*₂₃ transfers conduction to triode *V*₁₆. Conversely, if triode *V*₂₄ is conducting a negative pulse applied through diode *V*₂₃ transfers conduction to triode *V*₂₃.

The counter stages also employ the same basic circuit. Ten counter stages are used, but only the first and last of these stages are shown in Fig. 6. The circuit configuration within each stage is identical. The circuit is known as the Higinbotham counter circuit.

Tube *V*₅ of the counter group inverts incoming positive horizontal pulses, providing the negative pulses required by the design of the counter circuit.

The negative sync pulses reach

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**FIG. 2—Time relationships between television picture scan and film exposures**
the first counter stage, \( V_m \), through a 100-\( \mu \)F capacitor and the pair of diodes in \( V_r \). The counter stage has has two stable conditions, depending on whether the \( A \) or \( B \) triode section is conducting. Each successive pulse transfers conduction from one triode section to the other. Whenever conduction transfers from the \( A \) triode section to the \( B \) triode section, a 140-volt negative pulse is produced at the plate of the \( B \) triode section. This negative pulse reaches the next counter stage through another 100-\( \mu \)F capacitor and another pair of diodes. The action continues to the tenth stage.

Each counter stage contains two diode sections, only one of which is effective during any one pulse application. The plate of the other diode section stands at a negative potential with respect to its cathode, and hence the diode section does not conduct. Conduction transfers from one diode section to the other as the counter operates.

**Counter Operation**

Assume each stage in the counter is on when its \( A \) triode section is conducting, or off when its \( A \) triode section is nonconducting. The stage produces a pulse when it goes from on to off. It does not produce a pulse in going from off to on. The stage goes through a single reversal on receipt of a pulse from the preceding stage.

Suppose, then, that all stages are on as an initial condition. A single pulse entering the first stage trips all stages simultaneously, including the last stage. As the last stage swings from on to off it generates an output pulse. In effect, the circuit has counted one.

Suppose, instead, that all stages are off as an initial condition. The first incoming horizontal pulse swings the first stage on. The second incoming pulse swings the first stage off; and the resulting counter pulse swings the second stage on. The second stage thus requires two incoming pulses for a single reversal. Similarly, the third stage requires 4 incoming pulses, and so on. The tenth stage swings from on to off, and generates an output pulse, only after 1,024 incoming horizontal pulses have been counted.

By turning certain stages on and the other stages off as an initial condition, any number from 1 to 1,024 can be counted. The 525 count imposed by current television standards is just beyond the limit of a 9-stage counter, and hence ten stages are used. The ten binary register switches are set to count 524 incoming pulses during each counter cycle. The 525 count is contributed by a separate stage associated with the stop coincidence circuit. In this way, the final critical count in each cycle is obtained directly from the associated horizontal pulse, with a minimum of intervening circuit elements.

The timing gate opens during the first scanning line, and remains open during the exposure cycle. Positive polarity corresponds to closed shutter. When the positive timing gate is applied to \( V_m \) grid, the triode conducts heavily and the voltage at the plate falls to almost ground potential. This allows conduction through the reset diodes \( V_r \) to \( V_m \) and the binary register switches. All counter stages are thus reset to their preselected on or off initial conditions during the blanking interval. The reset diodes do not conduct during the exposure interval, and hence do not affect the counter action.

A full frame of 525 lines is scanned during the exposure interval. One quarter frame is then dropped during the blanking interval to effect the 5:4 frame rate conversion. Under synchronous conditions, the average blanking interval covers 131.25 lines. However, since the counting circuits do not recognize fractional lines, the actual number of lines dropped during successive blanking intervals is 131, 131, 132, 131, 131, 131, 132 and so on. The difference on the fourth count is caused by an accumulation of fractional-line increments to the point where they start the blanking interval a whole line earlier. Each picture, meanwhile, scans to completion.

On the fourth count, the scan merely starts and ends one line higher. Since the beginning of the blanking interval is tied to the end of the picture, while the end of the blanking interval is tied to the cyclic rate of the camera, the blanking interval is not subject to rigid cyclic control. It can shrink several lines, or increase by any necessary amount. Because of this flexibility, the camera need not be locked to the frequency of the television signal. A full frame of 525 lines is photographed during each locally synchronous exposure cycle, and any short or over lines are dropped out during the blanking interval.

**Camera Construction**

In the camera, the most noticeable differences are the absence of the conventional mechanical shutter and the substitution of a cycling disc, outside of the picture light path, which generates the cycling pulse. This disc rotates at a constant speed of 24 turns per second (1,440 rpm) and passes a single light pulse during each revolution. It is phased so that the light pulse follows immediately after completion of film pull down. A Phototube with associated amplifying and pulse shaping circuits translates the light pulse into the electrical cycling pulse.

Figure 7 shows the amplifying circuitry.
and pulse-shaping circuits. Triode $V_{m}$ and $V_{s}$ are a two-stage amplifier and $V_{s}$ is a gas tetrode used as a pulse regenerator. It is biased to cutoff in the absence of an input pulse. A positive pulse applied to the grid fires the tube and produces a single negative-going pulse at the plate. This pulse is fed to the start coincidence circuit.

Film pulldown must be accomplished in a relatively short time. The blanking interval of 1/120 second establishes the maximum time allowance for film pulldown, but only a portion of this interval may be utilized. The film must remain stationary during the initial portion of the blanking interval to allow for phosphor persistence effects in the recording cathode-ray tube.

Rate changes encountered in nonsynchronous operation serve to further shorten the allowable pulldown time. During periods of increased camera rate or decreased television rate the end of the television frame intrudes on the beginning of the nominal blanking interval, and the start of film pulldown must be correspondingly delayed.

The camera uses a 3-to-1 skip movement in the intermittent mechanism. In effect, the mechanism operates at triple the normal speed and would pull the film at the rate of 72 frames per second if not for the fact that two out of three pulldown cycles are skipped. The film travels at normal rate of 24 frames per second, but pulldown is completed in $\frac{3}{4}$ the normal time. With this fast action, pulldown can begin late in the blanking interval and can be completed before the next film exposure starts.

**Practical Design Factors**

It has been found that vibration, even in a small degree, may betray the location of the picture join-up. The subject for photography is a moving spot which traces successive patterns of evenly spaced lines. Vibration during film exposure displaces some lines with respect to others, causing line pairing and coarse line structure over portions of the film. Differences in line structure become particularly apparent at the join-up.

The effectiveness of vibration reduction measures employed can be gaged from the fact that close inspection of a recorded picture, projected on a 6 by 8-foot screen, reveals no evidence of vibration effects on either side of the join-up.

The deflection yoke design necessarily involves a compromise between good focus and low distortion. Perfect focus over the entire field can be attained at the expense of linearity, by accepting a certain amount of pincushion distortion. The approach used in this design was to strive for perfect focus over the field and to compensate for nonlinearity by optical means. As a result, the scanning lines are clearly resolved over the entire tube face, while the departure from linearity at any part of the picture does not exceed the width of two scanning lines. The recorded film original shows definite scanning line resolution in regions of low or medium density, at the corners as well as in the center.

A P11 phosphor is used in the recording cathode-ray tube. The major component of this phosphor's light output is in the blue region of the spectrum, where video recording films are most sensitive. This phosphor has a desirably high decay rate, the persistence illumination dropping to a very small percentage of initial illumination within the scanning time of a few lines.

Persistence illumination preserves each line for photographic exposure during an interval after scanning, and supplies an appreciable additional light contribution in relation to initial illumination. If the last line scanned in each frame is to contribute its full share of persistence illumination before film pulldown starts, the phosphor decay rate must be very high.

The P11 phosphor is almost entirely satisfactory in this respect, but has one shortcoming which seems to be common to all presently available phosphors. Complete extinction of low-level illumination requires several seconds. Residual illumination from this source causes a brightness difference between the first and last lines. Although the magnitude of the effect is small, the brightness difference can be quite apparent because these lines are adjacent in the recorded picture, and because the high contrast of the photographic film emphasizes any brightness difference.

Compensation is effected quite simply by using a sawtooth waveform which decreases the bias on the cathode-ray tube (increases brightness) as the exposure proceeds. The peak amplitude of the compensating sawtooth waveform is adjustable to meet different tube characteristics. The adjustment need be made only when a new tube is installed, and need not be repeated during the life of the tube.

**Power-Law Amplifier**

Gray scale rendition is improved by use of a power-law amplifier, a device which was originally developed for video recording, but which now offers promise...
of general application wherever gray-scale correction is required.

The gray scale of the reproduced picture depends on the overall transfer characteristic of the system elements intervening between the scene and the picture. The transfer characteristic can often be expressed in terms of the exponent of a power-law relation, the exponent being analogous to the familiar gamma of the photographic art.

A gamma greater than unity indicates compression of the blacks and expansion of the whites; lower than unity indicates the converse effect. A very high exponent is associated with a harsh or contrasty picture; a very low exponent is associated with a flat or washed-out picture. A gamma of about 1.5 at the screen is considered to be most pleasing for motion-picture exhibition by direct projection.

Current television practice results in an exponent greater than unity, principally because of the individual transfer characteristics of the light-to-signal and signal-to-light transducers. Direct studio pickup involves only a single pair of transducers, namely, the pickup tube in the camera and the cathode-ray tube in the receiver. The resulting transfer characteristic is quite acceptable. The video recording process introduces two additional transducers, as well as the film on which the recording is made, and the cumulative effect may be far from acceptable.

Assume that a linear transfer characteristic (exponent of 1 in the reproduced picture) is the desired objective, and that the overall system response is such as to result in an exponent of 2. An amplifier is inserted in the video line and is adjusted to provide a transfer characteristic which follows a 0.5-power-law relation between its own input and output. Prior to correction, the brightness of the reproduced picture follows the square of the scene brightness. The video signal is modified by insertion of the amplifier, the amplifier output signal following the square root of the input signal. With this correction, the brightness of the reproduced picture is linearly related to the scene brightness.

The heart of the amplifier is a germanium crystal diode. The resistance of the diode varies with the crystal current. One portion of the resistance-versus-current characteristic can be closely approximated by the relation, \( R = KI^{2} \), where \( K \) is a proportionality constant and \( R \) and \( I \) are crystal resistance and current, respectively. The amplifier circuit which utilizes this characteristic is shown in Fig. 8.

The first 12AT7 operates as a cathode follower and delivers a voltage replica of the video waveform at point A. Video black level is at ground potential; video white level is at approximately 0.3 volt positive. The cathode load on this first tube is an essentially constant resistance. The crystal resistance, even at maximum value, is negligibly low in relation to the resistor in series with it. The cathode follower can therefore be regarded as a low-impedance source feeding a constant-resistance load. The load consists of two voltage dividers having significantly different characteristics.

The voltage divider composed of \( R \) and the germanium crystal diode delivers its voltage output at point B. Because of the relatively high constant resistance of the resistor, and the negligibly low resistance of the crystal diode, the current through the crystal diode is a replica of the video waveform. The voltage across the diode is, however, influenced by the crystal resistance characteristic. The voltage at point B is thus a power function (exponent = 0.5) of the voltage at point A.

The voltage divider composed of \( R \) and \( R_{c} \) delivers its voltage output at point C. The voltage at this point is a linear function (or a power law of unity exponent) of the voltage at point A. The potentiometer arm is set for equal white level voltages at points B and C.

Both voltage outputs are applied to the second 12AT7. Each half of this second tube functions as a cathode follower. Video output voltage can be obtained from point D, E, or from any intermediate point F. Point D provides maximum correction, point E provides minimum correction, and point F provides any intermediate value of correction.

**Sound**

The sound portion of the equipment is planned for direct positive variable density sound-on-film recording, using a recording system developed by J. A. Maurer, Inc.

The positive film stocks used in video recording are relatively insensitive in comparison to the negative film stocks which are normally used in motion picture photography. Considerably more light is required if the optimum density range of the film is to be utilized. The sound recording system uses larger than normal optical apertures to allow an approximately fourfold increase in illumination level.

A precisely-shaped mask compensates for the nonlinearity of the light-transmission-versus-exposure characteristic of the film.

**Bibliography**


Transistor characteristics are determined quickly and accurately by a-c test apparatus. Circuit design information is furnished as well as operational test results. Includes provision for electrically forming transistors.

VOLTAGE GAIN, current gain and input impedance of transistors for various emitter biases and collector load resistances are determined quickly and conveniently by the transistor testing apparatus shown in the photograph. Since no general set of curves can describe each transistor, this tester furnishes specific design information as well as operational test data.

The equipment has a built-in circuit to modify the electrical characteristics of a transistor and an oscilloscope for visual inspection of its diode characteristics.

Figure 1 is a block diagram of the circuit. The transistor is connected in the conventional manner with 500 ohms in the emitter circuit and a 400 to 42,000-ohm variable resistor in the collector circuit. The emitter bias is supplied by a center-tapped voltage divider so that either positive or negative d-c voltage may be applied. The collector is supplied 60-cycle a-c voltage through the isolation transformer $T$. A crystal-diode rectifier $D$, in series with the collector probe, is connected in opposition to the direction of rectification of the collector probe itself. When not shorted out by $S_2$, it will have the positive half-cycle voltage of the 60-cycle supply developed across it, permitting the collector probe to be swept in negative polarity only. With $S_e$ closed, the magnitude of the forward current in the collector may be varied by the variable resistor in series with $S_e$. The negative peak value of the 60-cycle collector current is read on $M_e$ as the 20-µf capacitor shown in Fig. 3 charges through diode $D'$. Switch $S_e$ selects the proper series resistance to read either 10 or 20 ma full.
scale. The peak collector voltage may be read directly from the trace on the calibrated oscilloscope screen.

Voltage Gain

Voltage gain of the transistor is measured at 10 kc by applying the output of the 10-kc oscillator to the emitter through the linear attenuator and comparing the 10-kc voltage developed across the load resistor with the direct output of the oscillator. Voltage comparison is made by means of the peak voltmeter and \( S_n \), as shown in Fig. 1. If the linear attenuator is adjusted so that the two voltages are equal, the voltage drop in the linear attenuator is balanced by the gain of the transistor, and the reading of the attenuator equals the voltage gain of the transistor. The 60-cycle sweep voltage is filtered from the input to the peak voltmeter so error will not be introduced.

A similar method is employed to measure current gain. The relationship of collector and emitter currents is determined by comparing voltage drops across resistances selected by step switches \( S_s \) and \( S_n \). These signals cannot be fed directly into the peak voltmeter but first must be amplified as shown in Fig. 4A. Step potentiometer \( S_s \) (Fig. 1) is adjusted to pick up the same value of 10-kc voltage as appears across the resistance selected by \( S_n \). The current gain can be read directly from the setting of the step potentiometer. The decimal point is determined by \( S_n \).

The input impedance may be found by measuring the voltage and current gains at a known value of load resistance, since the voltage gain is equal to the current gain multiplied by the ratio of load resistance to input impedance.

The collector volt-ampere characteristic is shown on the oscilloscope with the voltage across the collector on the horizontal plates and the voltage across the load resistor on the vertical plates. The 10-kc voltage amplitude is negligible compared to the 60-cycle sweep voltage so the trace is not broadened appreciably if voltage gain measurement is made while the collector characteristic is being examined. Figure 2A shows a typical characteristic. Figure 2B gives typical bias values of collector current and voltage.

Short-circuit current gain \( a_c \) may be measured by adjusting the load resistance to equal the a-c resistance of the collector-characteristic line at the desired operating point, measuring the current gain and doubling it. The collector characteristic on the oscilloscope may be used to adjust the load resistance to this value. The load resistance is varied until the voltage drop across the load is equal to the voltage drop across the transistor. To facilitate this adjustment, a diagonal line is ruled on the oscilloscope screen at the proper angle and the collector characteristic trace is made parallel to this line by varying the load resistance.

Forming Circuit

To form the collector probe of the transistor a second 60-cycle sweep voltage of large magnitude is applied momentarily to the transformer in the collector circuit. The duration of this forming pulse is determined by the timing circuit through \( R_{E}L \). The ratio of forward to backward current in the collector is controlled during the forming pulse in the same manner as for the sweep. A range of forming pulse lengths from 20 cycles to one cycle is available. The forming pulse is applied by pressing the
push-button switch $S$, shown in Fig. 3, and the effect of forming may be observed immediately on the oscilloscope and peak voltmeter. Figure 2C is a photograph of the back-voltage breakdown of a crystal induced by a forming pulse.

The timing circuit shown in Fig. 3 controls the length of time of application of the forming voltage. It consists of a capacitor discharging through the winding of the relay, initiating a voltage pulse in the collector circuit. The relay is in parallel with a variable resistor so that the time of capacitor discharge can be varied. One of two capacitors can be selected with $S$, and these capacitors are charged through resistors large enough to ensure that $R_E$, cannot be activated more often than once in 5 seconds to prevent overloading.

**Peak Voltmeter**

The peak voltmeter is one of two systems used to measure voltage and current gain. The output voltage of the 10-kc sine-wave oscillator is compared by the peak voltmeter with the same 10-kc signal after passing through the linear attenuator and transistor. Voltage gain is measured by balancing the gain of the transistor against the drop in the linear attenuator. A peak value voltmeter is necessary because the modulated form of the wave varies with transistor characteristics.

Circuit illustrated in Fig. 4B consists of a filter for 60 cycles, two-stage amplifier, series rectifier, storage capacitor $C_6$, and a low-current voltage-measuring circuit. The incoming signal passes through a network consisting of $C_6$ and a parallel L-C circuit. The L-C circuit is tuned to 10 kc for maximum impedance to ground. The high reactance of $C_6$ in combination with the low reactance of the L-C circuit at 60 cycles forms a 60-cycle filter. The 10-kc signal is then amplified 150 times in two stages to provide sufficient amplitude for linear operation of the 6AL5 rectifier. Capacitor $C_6$ charges through the 6AL5 to peak value of the signal.

The 12AX7 monitors this voltage, and the reading of $M_1$ is proportional to it. Potentiometer $R_4$ is a zero set for $M_1$, a 70,000-ohm unit controls its sensitivity.

**Direct Gain Reading**

The absolute magnitude of the voltages is unimportant. Meter $M_1$ is set on the direct 10-kc signal, then switched to the modulated 10-kc signal of the transistor output. The attenuation is varied until the meter reads the value previously set. The attenuator then gives voltage gain directly.

The second method of measuring voltage gain is to apply the output of the peak-voltmeter amplifier to the vertical plates of the oscilloscope and compare the height of the two 10-kc signals.

The use of the peak voltmeter to make current-gain measurements is essentially the same as described above for the voltage-gain measurements. Either $M_1$ or the oscilloscope may be used to indicate a balance between the signals originating across the step potentiometers $S_a$ and $S_b$, shown in Fig. 3.

By use of selector switches $S_a$, $S_b$, and $S_c$ (Fig. 1) diode characteristics, the voltage-comparison test or the current-comparison test may be viewed on the oscilloscope. The horizontal input for the voltage- and current-comparison tests is a 60-cycle variable sweep voltage. The two methods of measuring voltage or current gain will work simultaneously. When the diode characteristic is on the scope, the peak
voltmeter alone will register balance.

The 10-kc attenuator in Fig. 5 consists of two 10-step potentiometers in series. The first adds 300 ohms resistance in each step. The second adds 30 ohms per step.

The output of the attenuator is always taken across the 30-ohm resistor, $R_a$. When the attenuator is on position 1, the 30 ohms is in parallel with the secondary of the transformer and may load the oscillator amplifier to some degree depending on the secondary impedance. This does not create an error in the measurements since all tests are of a comparison nature. Above position 3 this effect disappears. Increasing the attenuator from position 1 to position 2 drops the voltage across the output resistor by one-half. The next step drops the voltage by one-third. These fractions represent the ratio of the attenuator-output voltage to input voltage, therefore the step-position numbers indicate directly the voltage factor by which the 10-kc oscillator output is attenuated. When this attenuation is balanced by the gain of the transistor, the numbers read directly the voltage gain of the transistor.

Current Gain Measurement

The method of measuring current gain makes use of extremely small signals compared to those used in voltage-gain measurement. These signals are amplified by the circuit shown in Fig. 4A. Since the amplitude of the 60-cycle current in the collector circuit is large, and only the 10-kc current is to be measured, a 60-cycle filter is added ahead of the preamplifier to prevent saturation by 60 cycles. A twin-T filter was chosen because it is possible to tune such a circuit to cancel out one frequency completely. The twin-T circuit's relatively low input impedance is no disadvantage since the original signal appears across a resistance of the order of 10 ohms. Following the preamplifier, there are terminals for an external oscilloscope, which are used if current and voltage gains are read simultaneously.

The signal used to measure current gain is so small that any stray signals caused by inter-winding capacitance in the oscillator output transformer will add a constant factor to the readings. This effect is minimized with the addition of the second transformer by permitting grounding of the secondary of the first output transformer.

Oscilloscope

Through switches $S_1, S_2$, and $S_3$, the scope shown in Fig. 6 becomes multipurpose. The circuit consists of a 2,000-volt power supply, a potential-dividing system, centering controls for the scope traces and a system of calibrating the horizontal and vertical scope traces in volts as illustrated in Fig. 6. Horizontal and vertical deflections are varied simultaneously by varying the second-anode voltage, thus maintaining a vertical-to-horizontal deflection ratio of 7 to 10. The voltage is usually set so the horizontal sweep is 7 volts per division. The vertical calibration is 10 volts per division.

Oscillator

The Colpitts oscillator shown in Fig. 5 is tuned to 10 kc. The signal is amplified and fed to the linear attenuator and the peak voltmeter. The oscillator has proved stable in both amplitude and frequency. Binding posts on the front panel are provided for an external oscillator should measurements at another frequency be required.

This apparatus has been used in production of transistors to check the semiconductor ingots before cutting, to select the best pieces after cutting, to check the best probe adjustment, to form electrically the finished transistor, and to grade the final product. It has also been used to pick the best transistor for a given circuit application, and to give the information necessary for a proper choice of other circuit components. It has been used to check periodically the characteristics of transistors when in use, and to carry out experiments on transistors in statistical quantities.

Reference

Selective Mixing Amplifier
For Aircraft

Unit combines ten channels of communication and navigation audio information in any combination, selected separately by pilot and copilot, without mutual interference between used and unused channels. Fail-safe arrangement insures reliable operation.

By PAUL B. KING, Jr.
Aircraft Radio Corporation
Boonton, New Jersey

The amplifier to be described provides a means of integrating almost any composite installation into a highly efficient and practical system. Because all audio signals pass through this amplifier it has necessarily been made fail-safe. That is, in the event of partial or complete failure, it is easily disconnected from the circuit by the pilot or copilot in such a way that service is uninterrupted. Isolation of the two circuits is such that there is no crosstalk. Sufficient output power is available to drive small cabin speakers, thus eliminating the fatigue of wearing headphones. Since the amplifier is optional equipment, it has been designed to be added to existing installations.

The F-11 isolation amplifier is capable of handling ten audio input circuits. Two of these circuits are divided in such a way that the outputs of two receivers can be terminated in two range-voice filters. Pilot and copilot can then independently select any combination of range, voice or both filter outputs without mutual interference. A typical assignment of audio circuits to the various channels is as follows:

<table>
<thead>
<tr>
<th>Channel Number</th>
<th>Audio Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ADF receiver</td>
</tr>
<tr>
<td>2</td>
<td>Range-Voice-Both</td>
</tr>
<tr>
<td>3</td>
<td>L-F range receiver</td>
</tr>
<tr>
<td>4</td>
<td>Range-Voice-Both</td>
</tr>
<tr>
<td>5</td>
<td>ADF receiver</td>
</tr>
<tr>
<td>6</td>
<td>Broadcast receiver</td>
</tr>
<tr>
<td>7</td>
<td>VHF navigation receiver</td>
</tr>
<tr>
<td>8</td>
<td>VHF communication receiver</td>
</tr>
<tr>
<td>9</td>
<td>Marker beacon receiver</td>
</tr>
<tr>
<td>10</td>
<td>H-F transmitter sidetone</td>
</tr>
<tr>
<td>11</td>
<td>VHF transmitter sidetone</td>
</tr>
<tr>
<td>12</td>
<td>Intercom</td>
</tr>
</tbody>
</table>

The photographs show the complete unit and the under side of the chassis, base removed. Connections are made by means of multiwire ceramic-insulated connectors plugged into receptacles mounted on the front plate.

Basic Circuit

The basic isolation circuit is shown in Fig. 1. For simplicity only two of the ten circuits are drawn in detail. Each input channel provides a 500-ohm load for the circuit connected to it. As shown, the pilot is connected to channel 1, while the copilot is connected to channels 1 and 2. In the case of the pilot, the desired signal from channel 1...
passes through the closed switch, a 300,000-ohm isolating resistor and thence to the grid of his isolation-amplifier tube. Because the nine other isolating resistors connected to this grid are grounded, the desired signal suffers a reduction of only 20 db.

The signal from channel 2, to which the copilot is also listening, reaches the grid of the pilot's amplifier by the path indicated. It can be seen that it undergoes the following losses: (1) to copilot's amplifier grid -20 db, (2) to circuit 1 input load -56 db, and (3) to pilot's amplifier grid -20 db. The undesired signal level is therefore 96 db below the input level or 76 db below the level of the desired signal at the grid of the pilot's amplifier. Actually common ground currents and cross coupling reduce this to about 60 db.

All audio switching is done by relays. The selector relays are located in the bottom portion of the chassis along the sides. The arrangement can be seen in the bottom-view photograph. Relays permit short unshielded leads between receivers and amplifier. All wiring between amplifier and cockpit is d-c and high-level low-impedance audio. These wires are not subject to cross coupling or noise pick-up.

Operation

Figure 2 shows a modification of the basic circuit to provide a means of bypassing the amplifier in the event of component failure. The two relays are connected in the common lead of the input load resistors. When energized this lead is grounded and operation is as described above. The relay coils are connected directly to the primary power circuit. When this circuit is broken by fuse failure or manual switching, the relays open and connect the common lead of the input load resistors directly to the output circuit. The loss introduced in each receiver line by the load resistors and shunting effect of other receivers is about 10 db. This loss, although noticeable, is not sufficient to impair operation of the system and the receivers can be shared by pilot and copilot as before installation of the amplifier.

Figure 3 shows a method of using a range-voice filter in one channel. The filter is the receiver load. The input load resistors are now divided and brought to separate pins of the input receptacle. These pins are connected to the arms of pilot and copilot filter switches. The pilot and copilot can now connect their input circuits to filter output range, voice or both. No crosstalk will result if both users are connected to the same circuit but there will be a noticeable reduction in output (3 db). If this cannot be tolerated, the use of separate filters is recommended.

It is desirable to cut off or mute all incoming signals during transmission. Isolated muting circuits are desirable because the speaker only requires perfect quiet. The use of selector relays makes possible receiver muting as desired. Figure 4 shows the muting circuit.

The selector relay circuits are energized by completing their coil circuits to ground by means of individual selector switches. Any circuit or group of circuits may be muted by breaking the common ground lead of the corresponding selector switches. This is easily done by the muting relay which is operated by the microphone key circuit when the button is pressed to talk. Muting relays are usually located in the control boxes.

Installation

A complete installation permits independent selection of 1 to 10 audio channels by pilot and copilot, independent choice of range-voice filters on two circuits and independent muting of receivers, also choice of speaker or headphone operation. The design of the amplifier unit is such that an input signal of 300 mw will produce 3 watts output for loudspeaker operation.

At this time it is felt that the 10-channel amplifier is adequate for most needs. Another such unit can be added as the number of channels increases. Thus pilot, copilot, radio operator and flight engineer can listen to any combination of the 10 facilities without mutual interference.
**Precision Phasemeter**

Phase difference measurements accurate to 0.1 degree are obtained by the precision phase meter shown in the photograph.

Phase comparison is accomplished by a detector bridge consisting of four 5647 diodes arranged as a ring modulator. Phase difference is read directly from a decade voltage divider which controls the amount of quadrature voltage added to a reference signal.

The instrument is self-calibrating and provides sense information to remove 180-degree ambiguity. Figure 1 shows a block diagram of the phasemeter.

Some proposed applications of the instrument are in testing polyphase systems, goniometers, single-sideband band phase systems, and feedback amplifiers. It may also be used in filter, transformer and network design and in measurement of residual L and C in resistor units.

**Basic Method**

The method developed by J. R. Ragazzini and L. A. Zadeh forms the basis for design of the precision phase meter. It can be classified as a phase comparison method. The phase meter is seen in the simplified block diagram of Fig. 2 to consist of two signal channels terminating in a phase detector, which need only indicate approximate phase quadrature between its input signals. Two phase shifters, one calibrated and the other uncalibrated, are inserted in series with one or the other channel. Either phase shifter can modify the phase difference between signals at the phase-detector input as compared with those at the phase meter input.

The phase meter is calibrated by applying a single test signal to both input terminals, and setting the calibrated phase shifter to zero. The uncalibrated phase shifter is adjusted so that the phase detector indicates a condition of balance. To measure phase difference, the input terminals of the two channels are separated and connected to the two signals whose phase difference is sought. The phase detector will then show a condition of unbalance. The indication of balance is restored by adjustment of the calibrated phase shifter.

The operation of the calibrated phase shifter is shown in Fig. 3A, B, and C. In Fig. 3B the input signal \( E_\angle 0^\circ \) is shown. Added to this signal in exact quadrature is a vector \( E_\sigma \), \( \tan \theta \). The resultant \( E_r \) is phase-displaced by an angle \( \theta \) from the original vector. In Fig. 3A is shown the method of producing vector \( E_\sigma \), \( \tan \theta \). The amplifier of gain \( A \) has capacitive reactance \( X \) bridged from input to output. It can be shown that for \( R = X \), the overall gain is unity and the phase shift is closely equal to 90 degrees. The error in quadrature is approximately \( 1/A \) radians. For values of \( R \) unequal to \( X \) due to frequency variations, the accuracy of the quadrature relationship is essentially maintained with the output amplitude varying directly with frequency. The output divider can then be calibrated in terms of \( \tan \theta \).

For the condition \( R = X \), all values of calibrated phase shift up to 45 degrees may be obtained by properly adding the two voltages. An additional 45 degrees can be obtained by merely switching the divider to the \( E_\angle 0^\circ \) vector before summation. The vector diagram of this relationship is shown in Fig. 3C. It can be seen that phase angle calibration is independent of frequency provided the \( R = X \) condition is maintained throughout the band. Similar results are obtained if \( R \) and \( X \) are interchanged. The circuit shown is the preferred arrangement since it displays an integrating characteristic to harmonics. It does however tend to accentuate low-frequency noise which is controlled by R-C cutoff filters in the band switching.

The condition of \( R = X \) or unity gain requires adjustment of \( R \) for each frequency of measurement. The balance voltmeter used for this purpose is shown in Fig. 4A. The input and output signals of the 90-degree amplifier are fed to a pair of stable feedback amplifiers which in turn feed a pair of full-wave averaging rectifiers. The d-c output of these rectifiers is applied to a microammeter through a pair of self-protecting cathode followers. The two inputs are connected to the same signal source to establish amplitude equality. The gain of one amplifier is adjusted to obtain a

**Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>30 to 20,000 cps</td>
</tr>
<tr>
<td>Phase Range</td>
<td>-0 to 360 degrees</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.1 degree absolute</td>
</tr>
<tr>
<td></td>
<td>(0.01 degree for incremental angles up to two degrees)</td>
</tr>
<tr>
<td>Signal Level</td>
<td>0.5 to 10 volts rms</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>10 megohms</td>
</tr>
<tr>
<td>Display</td>
<td>decade null system</td>
</tr>
<tr>
<td>Power Supply</td>
<td>105-125 volts rms, 50/60 cps</td>
</tr>
<tr>
<td>Size</td>
<td>19 3/4&quot; wide × 16 1/4&quot; deep × 25&quot; high</td>
</tr>
<tr>
<td>Weight</td>
<td>110 pounds including walnut cabinet</td>
</tr>
</tbody>
</table>

By J. Kritz
Senior Engineer
W. L. Magoon Corp.
New York, N. Y.
for Audio Frequencies

One-tenth degree accuracy is obtained in phase-difference measurements between two sinusoidal voltages. Problems in design of a commercial instrument to this accuracy are discussed. Self-calibration procedure is outlined.

balance reading on the zero-center microammeter. The inputs are then connected to the 90-degree amplifier with the meter serving as indicator for the balance condition. The required sensitivity of one part in 3,000 is obtained with amplifier gains of approximately 250. A schematic diagram of the balance voltmeter circuit is shown in Fig. 5.

Method of Display

The mechanical calibration of a continuously variable potentiometer is not feasible for a dynamic range of 360 degrees with 0.1-degree accuracy and a sensitivity of discernment of 0.01 degree. A combination of 23 precision fixed resistors is used to obtain 2-degree intervals. These intervals are chosen by means of two switches, the first selecting any 10-degree value from 0 to 80 degrees, the second selecting any of five additional two-degree intervals. The transition around the 45-degree point is accomplished automatically as the tens or units dial is rotated. The interpolation of the remaining 2-degree interval is provided by the phase comparator.

The phase comparator must have a sensitivity sufficient to resolve phase deviations of the order of 0.01 degree. It must be capable of measuring such incremental angles accurately over a range of two degrees. The comparator is shown in block form in Fig. 4B. It is an application of the classical wattmeter circuit or ring modulator. The d-c output current measured by the zero center microammeter balances when a 90-degree phase difference exists between the two channel voltages. The d-c current is a function of the signal amplitudes and the cosine of the phase-difference angle.

For plus or minus one-degree deviation from the balance condition, the d-c current is linear to within $5 \times 10^{-4}$ degree, so that linear scale calibration is adequate for this interval. A deviation of plus or minus ten degrees departs from linearity by approximately 0.05 degree. This is applied in obtaining coarser phase measurements with greater rapidity by shunting the meter to obtain a plus or minus ten-degree scale.

Amplitude inaccuracy is virtually eliminated by setting the levels on the phase-detector bridge to prescribed values. Misadjustment of more than ten percent of both levels is required before impairing the 0.1-degree accuracy with the meter at full scale.

Analysis of the ring modulator disclosed that at discrete operating level ratios various orders of odd harmonics in one channel would be rendered ineffective in producing errors. Since the bridge is insensitive to even-order harmonics, levels were designed for cancelling third-harmonic effect in channel 2. The 90-degree amplifier is integrating in character and is therefore used

FIG. 2—Simplified block diagram illustrates phase-comparison method of measurement

FIG. 1—Block diagram shows path of input signals to phase-detector bridge. Divider gives phase-difference reading.
for feeding channel 1. The result is to preserve meter accuracy in the presence of harmonics.

**Sensing Circuit**

The 90-degree amplifier and dividers are capable only of calibrated phase shift over 90 degrees. An additional 90-degree shift is obtained by interchanging the positions of the calibrated phase shifter and the uncalibrated phase shifter shown in Fig. 1. The phase comparator is however, ambiguous about 180-degree points. A sensing circuit consisting of a low-level wattmeter 90 degrees out of phase is used to indicate the quadrant. While a value between zero and 90 degrees is read on the phase meter, a switch position indicates polarity and the sense meter indicates whether or not 180 degrees must be added.

**Developmental Problems**

For 0.1-degree accuracy, it is necessary to limit individual known error effects to a maximum of 0.01 degree. The gain of the 90-degree amplifier contributes an error effect approximately equal to 1/4 radian. Therefore high orders of gain must be achieved in the presence of a 0.7 feedback ratio at 45 degrees at operating frequency. The schematic of the 90-degree amplifier is shown in Fig. 6.

Stray capacitance across \( R \) (Fig. 3A) contributes error in the form \( R/X \) radians while leakage resistance across \( X \) contributes \( X/R \) radians. This complicates amplifier design in that a low operating-impedance level is required to minimize these errors. An amplifier with a cathode-follower output working at an impedance level of about 1,000 ohms is employed. The amplifier gain is 4,000 over the frequency band, with amplitude-phase characteristics outside the operating band controlled to insure stability. High quality polyethylene capacitors with \( Q \)'s of the order of 5,000 are used.

Resistor \( R \) must be capable of stable adjustment to one part in 3,000 to achieve a settable maximum of 0.01 degree at 45 degrees. Three series controls are used to adjust \( R \): a coarse-control 31-position attenuator, a medium-control 31-position attenuator and a smooth low-resistance rheostat for fine control. The coarse control is calibrated in frequency to permit easy, rapid adjustment with the balance voltmeter.

Adding two signals with phase accuracy better than 0.01 degree and amplitude accuracy of one part in 3,000 is accomplished by two feed-back amplifiers with low-impedance cathode-follower outputs that feed a pair of precision-balanced 5,000-ohm resistors whose center tap is fed to the high-impedance input of the subsequent amplifier stages. Thus the effects of vacuum-tube variations and of component aging are virtually eliminated. Figure 7 shows the circuit of one of the amplifiers.

Vacuum diodes are used in the phase-detector bridge because of the linearity and consistency of diode characteristics even with heavy loading. Since contact potential and diode characteristics are critically dependent upon heater potential and vibration, stability is achieved through use of subminiature ruggedized diodes (type 5647) suspended in a sealed potted container. The heater supply is current regulated.

The output stage is a push-pull Class-A amplifier with 30-db feedback, driven by direct-coupled cathode followers to eliminate phase-shift variations at low frequencies due to small grid conduction. The output-level meters are specially designed rectifier types flat to within \( 1/2 \) db from 30 to 20,000 cps.

Due to the low operating impedance levels used throughout the design, common coupling at high frequencies presents little difficulty. Elimination of coupling at low frequencies through the common impedance of the power supply requires three separate anode sources. Their self impedances are kept below one ohm and their transfer impedances below 0.01 ohm with a combination of L-C filtering and electronic regulation. A schematic of the channel-1 output amplifier
and uncalibrated phase shifter is shown in Fig. 8.

**Test Methods**

To determine performance characteristics within the specified tolerance, a test method capable of divulging 0.01-degree error is necessary. Such orders of accuracy are unobtainable in any primary standard. The use of accurately calibrated phase shifts created by resistive-reactive networks and carefully measured frequencies is unsuitable. In the most favorable case of a single 45-degree R-C network, calibration accuracies suitable at one frequency only are of the order of 1.75 parts per 10,000. This assumes basic calibration equipment of such complexity as is available only at the Bureau of Standards. The method employed uses the instrument itself to divulge its own error.

A phase standard of zero degrees implies connection to the same signal source. In addition, two variable uncalibrated phase shifters of the following characteristics are necessary. Input and output impedances must be sufficiently high and low respectively that less than 0.01-degree change is effected by loading one input on another output. The output impedance must be sufficiently low that less than 0.01-degree change is effected by loading the output with the input impedance of the phase meter.

Design of such phase shifters is readily realizable. Cathode-follower input and output stages of conventional 12AT7-type miniature triodes provide sufficient isolation. The test procedure is as follows:

With the input terminals tied to a common source, the phase meter is adjusted to its calibrating position of zero degrees. It is then connected to measure the shift of one phase shifter which is adjusted to give an exact reading of 180 degrees on the phase meter. The first phase shifter is removed, and the remaining phase shifter is similarly adjusted. The phase meter is then connected to measure the phase shift of the two shifters in tandem. For zero error in the original reading of 180 degrees, the sum should now read 360 or zero degrees. The deviation from zero degrees indicated by the phase meter is double the error at 180 degrees. This permits exact calibration of the true 180-degree point.

This procedure is then repeated with each phase shifter adjusted to 90 degrees as read on the phase meter. The deviation from the previously calibrated 180-degree point when connected in tandem is double the 90-degree error, and the true 90-degree position is evaluated. In this manner 45 degrees, 22.5 degrees, etc. may be checked.

By means of the two-degree steps, it can again be shown that eleven equal phase shifts as indi-
cated on the degree meter add to 22 degrees, and 22 such equal shifts add to 44 degrees, and 45 such steps add to 90 degrees. In this manner the entire region from -90 degrees to +90 degrees may be tested. The remaining angles of the complete 360 degrees can be checked by a similar process utilizing the 180-degree symmetry of the instrument.

Production Technique

For a large number of frequencies in the spectrum this complete test method is laborious and time consuming. Exhaustive tests on the prototype have borne out theoretical considerations of unobservable error at 180 degrees, and complete symmetry about 180-degree spaced values. Two-degree step tests to 46 degrees in addition to the cardinal points have proved sufficient to guarantee an instrument accuracy of 0.1 degree throughout the range, thus enabling a more rapid production technique. This technique tests the divider accuracy as a basic 45-degree calibrated phase shifter as well as the remaining circuitry which remains unaltered over the entire range.

Evaluation of Tests

The maximum error disclosed in type testing the prototype is 0.06 degree. This represents the maximum accumulation at various angles and frequencies of the calculated 0.01-degree errors in different circuits. Stability of zero calibration is such that measurements to full accuracy are possible after about 15 minutes of warm-up. Variation of vacuum tubes and components within the commercial tolerances shows no effect on performance. Evaluation of performance in terms of harmonic content of the signal source is in process and will soon be available. Preliminary observations indicate no error contributed by even-order harmonics and a tolerance of about one percent third within stated accuracy. Accuracy and calibration are not disturbed by insertion of filters in the input. Zero calibration may be set even if the filters are not matched.

Equipment Layout

The top row of instruments on the front panel is for indications of balance, channel level, and sense. Immediately below are the major degrees dials and meter. Below these dials, on the left are the three balance controls (R of Fig. 1), with calibrated controls for the uncalibrated phase shifter on the right. The contact potential balance dials and balance voltmeter controls are located in two panel recesses. These elements require infrequent adjustment and are removed from the operating area.

A photograph shows a rear view of the instrument removed from its cabinet. The lower deck is the power supply. Also shown is a top view from the rear with the dust cover removed from the switch box. The ganged degree switches and precision divider resistors can be seen. The first production model has been delivered to the Communication and Navigation Lab., Wright-Patterson Air Force Base, whose cooperation and stimulation aided the program considerably.

REFERENCE


October, 1950 — ELECTRONICS
A Fast Sweep Circuit

Designed for study of extremely short-duration phenomena, the oscilloscope described has a maximum sweep speed of 100 inches per microsecond, obtained from a single thyatron circuit. Three methods of calibration are employed

![Diagram](image)

**FIG. 1**—Stable delayed sweep is provided by modified raster scan

By N. L. Davis and R. E. White

Naval Research Laboratory Washington, D. C.

In atomic studies, the scintillation counter has assumed great importance. With these counters it is now possible to detect the incidence of single alpha or beta particles or single-gamma quanta upon certain types of crystals. When particles strike the crystal, minute fluorescent light flashes are produced.

The use of a multiplier phototube makes it possible to convert these tiny flashes to voltage pulse waveforms, a much more convenient form for recording and studying. The voltage waveforms produced are, however, of extremely short duration and the problem of displaying them in sufficient detail to allow accurate study and counting presents a considerable problem in design of high-speed oscilloscopes. In the field of digital computers there is an increasing requirement for high-speed operation. Such operation demands the use of short-duration pulses. For the observation of such pulse voltages, a fast-sweep oscilloscope is required.

For use in the type of problems mentioned an oscilloscope with the following characteristics has been developed: The frequency response is uniform to 256 megacycles. It is possible to observe either single traces or recurrent traces to a repetition rate of 5,000 cycles. The unit has a maximum sweep speed of 100 inches per microsecond (0.01 µsec per inch) with several sweep ranges reaching a maximum sweep length of 25 microseconds. A low-impedance keying pulse is provided for keying external circuits under examination. A variable delay between the external keying pulse and the oscilloscope is available which may be varied from 0 to greater than 5 µsec.

**Requirements**

The first three specifications place severe requirements on the cathode-ray tube and its circuitry. The tube must be capable of producing traces of very high brilliance, and the transit time of the electron beam through the deflection plates must be sufficiently low to permit the required frequency response. The performance of the cathode-ray tube on both of these factors is improved by the use of very high accelerating potentials.

Two DuMont CRT types are designed for high-speed oscilloscope applications. A few of the pertinent characteristics of these two tube types are compared in the accompanying box.

For the oscilloscope to be described, the 5RP-A satisfies the required brilliance and frequency limits and was used because of its immediate availability.

**Sweep Circuitry**

With an accelerating potential of 20,000 volts on the 5RP-A tube, a deflection sensitivity of approximately 0.005 inch per volt may be expected. For five inches deflection approximately 1,000 volts of sweep voltage is required. If the fastest sweep (100 inches per µsec) is considered, a voltage slope of 20,000 volts per µsec must be developed for a sweep wave form.

Two general methods of generating suitable sweep voltages were investigated: modified raster scan using vacuum tubes, and sweeps generated by hydrogen thyratrons.

The modified raster scan produces the presentation shown in Fig. 1. To develop this scan, a two-megacycle oscillator is keyed to provide either sine-wave sweeps or a series of linear sawtooth sweeps. The cathode-ray tube is then unblanked during the interval under investigation.
with the unblanking pulse, a small expansion sweep voltage is applied to the vertical deflection system so that several consecutive sweeps become distinguishable. This corresponds to a raster type of scan in that several sweeps may be made available at a given time.

One advantage of this type of sweep is that it provides stable delayed sweeps with no stable delay-pulse generation required. The time jitter of any sweep depends only upon the variation in the amplitude and frequency of the two-me basic oscillator.

The jitter in the delay of the unblanking pulse used in this system does not result in time jitter in the trace itself, but is seen as fluctuations in the end of the interval being examined. This method works quite satisfactorily for sweeps longer than 0.5 μsec. Above this speed, the generation of steep voltage slopes demands higher currents than can be conveniently obtained from vacuum tubes.

The rate of rise in volts per second of voltage across a capacitor is equal to the current divided by the capacitance.

\[
\text{amps (farads)} = \frac{\text{volts}}{\text{seconds}}
\]

If the sweeps are developed over the lowest possible capacitance consisting of the output capacitance of the sweep generator tube in parallel with wiring and cathode-ray tube capacitances, the current which must be handled becomes objectionably high to be handled by a vacuum tube. For example, given a minimum capacitance of 30 μf and a rate of rise of 20,000 volts per μsec, the current becomes 0.6 ampere.

In addition, the amount of cross coupling from one deflection plate to the next right-angle plate increases as the capacitance from plate to ground is lowered. This is due to the capacitance divider formed by the capacitance to ground and the plate-to-plate capacitance of the cathode-ray tube. If the capacitance from the deflection plate to ground is deliberately made as high as 100 μf to minimize cross-coupling effects, the current is increased to two amperes. This magnitude of current leads to the selection of a gas-filled tube such as the thyratron as a sweep generation source.

Several variations of the basic circuit for the development of CRT Characteristics

<table>
<thead>
<tr>
<th>Direct interelectrode</th>
<th>K1030 5RP-A capaci-</th>
</tr>
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<tbody>
<tr>
<td>capacitances</td>
<td>to D&lt;sub&gt;1&lt;/sub&gt; 0.52 1.8</td>
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<tr>
<td>Deflection plate</td>
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<td>Maximum ratings</td>
<td></td>
</tr>
<tr>
<td>Anode 2 to final in-</td>
<td>30,000 v 22,000 v</td>
</tr>
<tr>
<td>22,000 v tensifier</td>
<td></td>
</tr>
<tr>
<td>Typical deflection</td>
<td>128 140±20%</td>
</tr>
<tr>
<td>factor percent</td>
<td></td>
</tr>
</tbody>
</table>

sweeps through the use of a hydrogen thyratron are possible. Figure 2A shows one form such a circuit may take. The tube may be a 2D21, 2050, 3C45, 4C35 or others.

This circuit operates as follows: with the thyratron in an unfired condition, the pulse-forming network is charged to voltage E through resistance R<sub>n</sub>. When the trigger pulse is impressed upon the grid of the thyratron, the tube conducts and the voltage at the plate of the gas tube falls very rapidly to a voltage 20 to 50 volts above ground depending upon the tube used.

The charged line then discharges through the series circuit of Z, and the thyratron. This produces a negative square pulse across Z, of amplitude E/2 and length equal to twice the delay of the line, providing an unblanking pulse. The sharp drop at the plate is integrated by the RLC circuit to provide a substantially linear sweep voltage approximately equal to the supply voltage.

Associated with single-ended sweeps on electrostatic cathode-ray tubes there is an effect known as deflection defocusing which appears as progressive defocusing from start to end of the sweep. To correct this situation, two methods of producing balanced sweeps have been investigated. One method is illustrated by the circuit shown in Fig. 2B. The circuit is similar in operation to that previously described. When the thyratron is triggered, the cathode of the gas tube rises rapidly to a voltage V/2. In this way, C<sub>2</sub> charges to V/2 through L<sub>1</sub> and R<sub>1</sub> to provide a positive linear sweep approximately equal to V/2. Capacitor C discharges from V to V/2 to provide a negative sweep approximately equal to V/2. A positive square pulse of amplitude V/2 is developed across Z, so that an unblanking pulse may be obtained from the circuit.

Another method of obtaining balanced sweeps employs a transformer. In this circuit, Fig. 2C, the cathode of the gas tube is grounded, eliminating the necessity of filament chokes and the pulse transformer for keying purposes. Here the unblanking pulse is obtained across Z, and the sharp voltage step at the plate is capacitively coupled to the phase-inverting transformer. The voltage step is integrated from the secondary of the transformer to develop balanced sweeps. The linearity of these sweeps depends upon the frequency response of the transformer.

With the 5RP-A tube, deflection defocusing is not very serious and because of the possible simplification of circuitry, the single-ended sweep circuit shown in Fig. 2D is now used in this oscilloscope. The sharp voltage drop at the plate of the gas tube is integrated by L<sub>R</sub>C<sub>T</sub> to provide the sweep output.

The sharp voltage drop is also coupled by C<sub>B</sub>, a very small capacitor, to one of several tuned circuits.
in the grid circuit of the cathode-ray tube where a damped train of oscillations suitable for intensity markers is generated. The \( L, R, \) and \( C \) components produce a negative voltage pulse from which an unblanking pulse of sweep duration is formed.

**Delay**

When using an oscilloscope having high sweep speeds, the difficulty of maintaining the sweep in coincidence with the signal is considerable. To obtain a good presentation, the jitter should be kept less than one line width. This naturally applies to recurrent phenomena only since jitter from one sweep to the next is not recorded if individual sweeps are being photographed. Consider the case of the fastest sweep described, namely, 0.01 \( \mu \)sec per inch. Allowing for a spot size of 0.05 inch, this demands a jitter less than 500 \( \mu \)sec for recurrent sweeps.

To obtain coincidence of sweep and signal, means must be provided to delay the sweep over the interval being examined. In the past, some variation of the circuit shown in Fig. 3 has been used. In this circuit a pulse is developed and fed into a delay line. This pulse traveling along the delay line is picked off at two points. A pulse with one delay is used to initiate the action to be observed, and a pulse at a second delay is used to initiate the oscilloscope sweep. These delays are so chosen that the transient to be observed occurs in the desired portion of the oscilloscope sweep.

An investigation of the keying characteristic of thyatrons has shown that with a d-c heater supply, a keying pulse supplied from a low-impedance source can provide stable keying of a thyatron on a comparatively slow voltage slope. By decreasing the amplitude of this low-impedance pulse, the delay in firing the thyatron is increased.

Figure 4 shows a suitable source of low-impedance keying pulses. In this circuit two low-impedance pulses are obtained simultaneously from the same thyatron, thus assuring that no jitter exists between them. One pulse is used to trigger the thyatron sweep tube while the other is used to trigger the thyatron to be observed.

The values of \( L \) and \( C \) can be switched to furnish a rough adjustment of the delay in firing. For fine adjustment the amplitude of the keying pulse is changed by varying \( R \). By means of suitable adjustment, the sweep tube and the tube under observation can be keyed simultaneously.

With this general type of circuit negligible jitter delays to 10 \( \mu \)sec have been obtained. To do this the values of \( L \) and \( C \) are such as to produce an approximate half sine-wave pulse of length equal to 20 \( \mu \)sec. By suitable compensation within the gas-tube circuit as well as changes in the design of the thyatron the stable delay interval may be increased.

**Calibration**

The high-speed sweeps described were calibrated by several methods to find one accurate method suitable for both visual and photographic use.

Perhaps the most accurate method tried consists of using a crystal-controlled transmitter as a timing-wave source. The timing wave is applied to the vertical deflection plates and single-trace photographs taken. It has the disadvantage of not being synchronized with the sweeps and cannot be used to measure time directly when viewing recurrent phenomena.

A 120-mc oscillator was keyed and photographed, Fig. 5. This circuit is very stable and easily photographed since a considerable number of sweeps can be observed at one time.

A third method consists of ringing an inductance to produce a train of damped oscillations. This method is easiest to apply since a thyatron having high-current capabilities can be used for generating the oscillation. With the 3C45 the physical size of the tube appears to limit the frequency of oscillations to about 60 mc.

Figure 6 shows a 50-mc timing wave obtained from a ringing circuit superimposed on a 0.005 \( \mu \)sec pulse by alternate keying.

The oscilloscope is housed in a four-foot cabinet with component parts placed in three levels. The CRT gun and deflection section are enclosed in a mu-metal shield to prevent magnetic fields from influencing the beam. The front of the tube is maintained at the final intensifier voltage by means of a copper band encircling the tube. To prevent corona and provide physical support for the tube, a Lucite collar is fastened to the front panel and supports the front of the cathode-ray tube. A sheet of 1-inch Lucite protects the observer from the high voltage. The high-voltage bleeder for obtaining the proper voltages for the intensifier elements consists of half-watt 1.8-megohm resistors wound in a spiral groove cut into a polystyrene rod to minimize corona effects. The total resistance is 100 megohms so that a 200-microamperemeter may be used with the bleeder to read 20 kilovolts at full scale.

The limits on bandwidth and sweep speeds encountered in this oscilloscope are not a function of the circuitry. The frequency limitation is imposed by the cathode-ray tube and may be extended by a factor of four with use of the K1030 type tube. The available writing rate then becomes much greater and the circuitry may be extended to provide sweeps of much higher writing rates.

![FIG. 5—Trace of a 120-mc keyed oscillator with a sweep of 0.005-\( \mu \)sec per inch](image-url)
Calculating
UHF Field Intensities

Curves based upon accepted propagation concepts facilitate theoretical prediction of television field intensities between 470 and 890 mc until more experience is obtained. Data on nulls and maxima resulting from path differences are included to show their location in miles from the transmitter.

By FREDERICK W. SMITH
Radio and Allocations Engineering National Broadcasting Co.
New York, N. Y.

The recent allocations proposals by the FCC for commercial television broadcasting in the band from 470 to 890 mc have centered attention on propagation problems at these frequencies. In order to facilitate the prediction of theoretical ground-wave field intensities in this band, the group of charts presented here has been prepared.

The methods for the calculation of field intensities employed were originally proposed by Norton and have been conveniently summarized by Terman.

Field Near Transmitter

The equation for field intensities in the immediate vicinity of the transmitting antenna for the ultrahigh frequencies under consideration is given by Terman as

\[ E = \frac{2 E_0 P}{d} \sin \frac{2\pi h a}{\lambda} \]  

(1)

where \( E_0 \) is the reference field intensity produced at a distance \( d \) of one mile for an effective radiated power \( P \) of one kilowatt, and \( h \), \( a \) and \( \lambda \) are the heights of the transmitting and receiving antennas and the wavelength, respectively.

The reference field intensity selected by the FCC as an f-m and tv standard is that developed in the equatorial plane of a half-wave antenna under the conditions specified above, or 137.8 millivolts per meter. Such an antenna has a power gain of 1.641 when compared to an isotropic radiator.

Using this value for \( E_0 \) and substituting 186,200 miles per sec \( f \) or \( c/f \) for \( \lambda \), with \( h \) and \( a \) in feet and \( f \) in megacycles, Eq. 1 can be reduced to

\[ E = \frac{275,600}{d} P \sin \theta \text{ microvolts per meter} \]

where \( \theta = 6.92 \times 10^{-4} h a f/d \text{ degrees} \)  

(2)

It can be seen from Eq. 2 that for a fixed distance and receiving antenna height, a single value of field intensity will result for a given frequency-transmitting antenna height \( f h \) product. Thus, where Eq. 2 applies, a transmitting antenna height of 1,000 feet at 450 mc will produce the same field intensity as 500 feet at 900 mc, other factors being equal.

This relationship has been employed to simplify the construction of the field-intensity chart, which is similar in many respects to previous charts published by the FCC for field-intensity calculations in the vhf band. Here, the product \( f h \) serves as the independent variable, which permits the use of a single chart for the entire frequency band under consideration.

Phase Interference

Near the transmitting antenna, a series of oscillations will occur in the field intensity as a result of phase interference due to differing path lengths traversed by the space wave and ground-reflected wave components of the signal. This effect is indicated by the sine term of Eq. 2, which will oscillate between unity and zero in value as \( \theta \) reaches successive values of 90, 180, 270 degrees, and so on. The nulls and maxima thus produced will become much more frequent with decreasing distance. However, the latter will always be tangent to a curve along which the field intensity var-
FIG. 1—Theoretical ground-wave signal range for 470 to 890 mc

ELECTRONICS — October, 1950
ies inversely with distance. Such a curve can therefore serve as a guiding upper limit when the graph is used to secure a plot of $E$ as a function of $d$.

The approximate distances at which the above mentioned nulls occur for various $f h$ products can be estimated from the null lines that have been drawn for the first five nulls. These null points may be more exactly determined from the smaller graph, Fig. 2, which represents the distance to the various maximum and null points as a function of $f h$. The dotted lines adjacent to the first null line in Fig. 1 serve to indicate the points at which the field intensity curves will start to fall from and return to the inverse distance curve on either side of the first null, giving some idea of the behavior of the field-intensity curves in a null region.

As the transmission distance increases, nulls cease to appear, and field intensities will progressively diminish, varying as the inverse square of the distance when $\Theta$ has decreased to 20 degrees or less. This is seen in Eq. 2 where sin $\Theta$ may be replaced by $\Theta$ itself for the values of $\Theta$ just mentioned, causing $d$ to be squared in the denominator.

Equation 2 may be used with accuracy until $\Theta$ equals ten degrees, or until the radio line-of-sight horizon has been reached. Beyond these limits a different expression must be employed which provides field intensities in the diffraction region where the receiving antenna is below the line-of-sight. In order to obtain the continuous curves that appear in Fig. 1, smooth transition curves were drawn between the field strengths calculated for line-of-sight conditions and the field strengths calculated for the diffraction region.

It should also be noted that values shown in Fig. 1 for $f h$ products of 10° or more are approximate only.

**Diffraction Region Fields**

Field intensities in the diffraction region where the receiving antenna is below the line-of-sight are computed by means of an expression due to Norton and given by Terman  as:

$$E = F_1 F_2 E_{112}$$

where $E_{112}$ is the surface wave intensity at the point on the earth's surface below the receiving antenna as calculated from Eq. 10, par. 2 of the same reference, and $F_1$ and $F_2$ are the appropriate height factors for the transmitting and receiving antennas as given by Eq. 20, par. 3 of the source above.

It is apparent from Fig. 1, that in the diffraction region the frequency-height product relationship no longer holds, and as a result separate distance scales have been provided for 500 and 900 mc, with the addition of curves for 600, 700, and 800 mc at the 20, 30 and 40-mile points as an aid to interpolation.

**Prediction Vs Measurement**

Unfortunately, the theoretical calculation of field intensities at these frequencies fails to take into account various factors such as terrain irregularities, shadowing or phase differences in signals arriving at a given point by multipath propagation. Also neglected are effects important at larger distances such as fading, day-to-day variations due to changes in the refractive index of the atmosphere, and tropospheric reflections.

Initial uhf field measurement surveys in the New York\(^6\) and Washington\(^7\) areas have indicated that actual uhf field intensities observed are likely to be lower than those predicted theoretically. However, it is evident that much more investigation will be required before local deviations from the theoretical can be predicted with any accuracy.

**Using the Chart**

The field intensities developed at any distance up to forty miles for one kilowatt of effective radiated power may be read directly from the ordinate of Fig. 1 for any frequency-transmitting antenna height product along the abscissa. For example, an $f h$ product of 100,000 will produce approximately 54 millivolts per meter at a distance of four miles for an erp of one kw for all frequencies in the band, and at thirty miles, 255, 212, 170, 141 and 124 microvolts per meter for 500, 600, 700, 800 and 900 mc respectively.

For other values of $P$, the ordinate scales must be shifted in proportion to $P^1$ as is done when using the charts published by the FCC for the vhf bands.

Where Eq. 2 is valid, Fig. 1 may be compared directly with the FCC curves. Citing the same example, at a distance of four miles, 54 millivolts per meter will also be obtained from the FCC curves for 82 mc at 1,220 feet, 98 mc at 1,020 feet and 195 mc at 513 feet.

References

3. Reference 2, sec. 16, par. 3, Eq. 24 (b).
4. Reference 2, sec. 16, par. 2, Eq. 18.
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Cathode Follower Response

Chart gives permissible cathode-follower pulse drive at video frequencies in terms of low-frequency sinusoidal input. Video-frequency overloading and distortion in conventionally loaded circuits originate in output time constant.

By RALPH H. BAER
Chief Engineer
Wappler, Inc.
New York, N. Y.

Cathode followers frequently overload and distort on video signals when designed on the basis of low-frequency formulas. This behavior results from the effect of the time constant associated with the output impedance of the cathode follower and the load capacitance. The usual formula for the peak signal permissible is

\[ e_{\text{peak}} = \frac{E_p}{\mu} \left[ \frac{1 + \frac{R_k}{R_p} (\mu + 1)}{R_k + 2} \right] \]

(1)

which is readily calculated. Inspection of Eq. 1 shows that medium values of \( \mu \) (15-30) are desirable for maximum permissible input signal.

When a video signal with rise time \( t \) microseconds is applied to a cathode follower this permissible grid swing is reduced by a factor of

\[ \frac{1}{1 + \frac{R_k}{R_p} \left( \frac{1 - e^{-\frac{t}{T}}} {\frac{t}{T}} \right)} \]

(2)

where \( T \) is the time constant. Whenever \( T \) approaches the pulse rise time in order of magnitude, the reduction in permissible grid signal can no longer be neglected and the correction factor of Eq. 2 becomes essential.

The graph is a solution of Eq. 2; the following procedure applies when a pulse waveform of rise time \( t \) is to be handled without distortion where

\[ T = \frac{C_p R_k}{1 + 50 \mu R_k} \]

(a) Determine the value of \( R_k/R_p \) and \( t/T \). (b) On the graph, connect \( R_k/R_p \) with \( \mu \). (c) At the intersection of line A with the line drawn in step (b), read vertically up or down to the proper \( t/T \) curve. The solution is then obtained from the percent scale by reading horizontally to the left.

As an example, consider a tube with \( \mu = 40, R_p = 20,000 \) and a load impedance of \( R_k = 1,000 \) and \( C_p = 250 \mu F \) in parallel. From Eq. 1, \( e_{\text{peak}} = 5.6 \) volts for \( E_p = 150 \) volts. Suppose a video signal with rise time \( t = 0.42 \) \( \mu \text{sec} \) is handled by the cathode follower. Then \( T = 0.0834 \mu \text{sec} \) and \( t/T = 5 \). From the graph the permissible peak signal is seen to be 72.3 percent of \( e_{\text{peak}} \) at low frequencies, or 4 volts.
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TUBES AT WORK
Including INDUSTRIAL CONTROL
Edited by VIN ZELUFF

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Automatic Audio Level Alarm

By N. Hagmann
Station Engineer
Radio Station WJZ
Lodi, N. J.

One of the many things to which a broadcast station engineer must pay careful attention is program level and quality. Because rather large variations in level are not easily detected by ear, particularly if the engineer is occupied with other allied work, an automatic alarm system becomes a practical necessity. Such a device is particularly valuable when more than one transmitter carrying the same program material must be monitored.

The audio alarm used at this station is fed through a bridging transformer from the audio source to a 6K6 amplifier stage. This tube feeds into a cascaded diode rectifier, a type 6H6, that separates the diode load circuit from the control circuit. Load resistor \( R_a \) in the cathode of the 6H6 is used to adjust the level of audio to be rectified.

The plate of the same tube feeds the cathode of the second 6H6 section and acts as a d-c separation circuit. The plate of the second section charges a large capacitor that bleeds off through resistors \( R_a \) and \( R_c \) with \( R_c \) the controlling element. The grid of the 2050 is connected to the junction of \( R_a \), \( R_c \) and \( R_m \). The plate circuit of the 2050 contains the a-c alarm relay. A type 6E5 tuning-eye tube facilitates adjustments for proper level and time delays \( R_a \) and \( R_c \), respectively.

In operation, the 2050 gas tube is made conducting by the rectified signal on its grid stored by the 20-microfarad capacitor. This signal results from the charging effect of the audio input. The proper reference level is set by potentiometer \( R_m \) that effectively biases the gas tube. Failure of the audio signal, after an appropriate time delay set by \( R_a \), results in the relay being de-energized and closing the alarm circuit through its back contacts. A disabling switch in the alarm circuit is useful during symphonic or similar programs in which wide dynamic range is encountered.

The unit can be fed from either audio program lines or the output of an r-f monitor. In the latter case, failure of either the program or the carrier will be detected.

Low Frequency Generator

By W. G. Sheppard
Physical Research Unit
Boeing Airplane Co.
Seattle, Washington

The generation of sine waves by ordinary electronic means becomes increasingly difficult as the frequency is lowered below 10 cycles. The phase-shift circuit is generally used but elaborate care in design and construction is necessary to achieve satisfactory performance. Since a multivibrator is a more dependable low-frequency oscillator, operating down to almost any lowness, it was decided to use the output wave of a multivibrator and shape it into essentially a sine wave.

First a large square-wave voltage was generated by triggering an Eccles-Jordan flip-flop circuit from the multivibrator, this being easily done because the triggering signal can be applied to both grids. By incomplete integration, essentially a triangular wave is obtained. Since this wave contains no even harmonics and only 1/9 third and even less higher harmonics,

\[ Y = \frac{8}{\pi^2} E (\cos x + \frac{1}{9} \cos 3x + \frac{1}{25} \cos 5x + \ldots) \]

a simple filter system will reduce the harmonics to negligible value.

Such a sine-wave generator is most easily constructed for a single frequency and is not very well suited for continuously variable frequencies over a wide range because of the increasing attenuation of the filter as the frequency is raised. However, it is quite feasible to construct a unit covering a num-

FIG. 1—Diagram of the audio failure alarm. Potentiometer \( R_m \) sets the level at which the gas tube fires. \( R_a \) controls time delay between loss of audio and sounding of alarm, and \( R_c \) sets level of audio into the device.
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Precision omni-range equipment, of which the tower shown on the front cover is a part, has made possible significant increases in air terminal capacity. The new equipment, introduced by Sperry Gyroscope Co., operates in the 5,000-mc region. The photograph shows the microwave lens which performs a function similar to the Fresnel lighthouse lens. The sharp vertical pattern it forms increases accuracies to within one-half degree, by virtually eliminating ground reflections at all angles greater than approximately 45 degree above the horizontal. This represents an altitude of about 1,000 feet at the edge of the control zone. Thus the signal is free from ground reflections in the operating region.

Two filter circuits, C.R. and C.R., are so proportioned that the third harmonic is attenuated in each about three times as much as the fundamental, leaving about one or two percent third and practically no higher harmonics. For simplicity only three switch positions are shown in the diagram, but values are given in the table for 10 frequencies. These are the values actually used and differ somewhat from calculated values. The value of C. was chosen experimentally to give approximately the same voltage output for each frequency. The cathode circuit of V., contains a control allowing for further minor adjustments in output voltage. The output voltage, after being amplified by the 6A05 tube, is about 14 volts at the input to the attenuator.

Since the generator, as constructed, is used for calibration work, some method was necessary to make sure that the output voltage is approximately the same for each frequency. Since the frequency is too low for the use of a meter, a small cathode-ray tube is used as an amplitude indicator. The vertical and horizontal plates are tied together to increase the sensitivity of the tube. Since this causes the spot to move back and forth diagonally, the tube must be rotated 45 degrees to give a horizontal spot movement.

Blocking-Oscillator

Figure 1 shows the diagram of such a circuit as constructed for calibration purposes. Type 6J6 tubes are employed in the multivibrator and flip-flop circuits, the multivibrator receiving its plate supply from a regulated source for greater frequency stability. Capacitors C and R form the triangular wave and V is a cathode follower inserted to lower the impedance.

FIG. 1—Schematic of sine-wave generator producing frequencies from 0.2 to 100 cycles

(Continued on p 150)
"For practicing black magic, consort- 
ing with the devil, and spreading dan- 
gerous thoughts against the laws of man 
and nature, you are exiled forever!"

This was the import of the fateful words heard 
by Galileo Galilei, facing a court of inquisition in 
the 16th century. Scorned and ridiculed, the 
great mathematical and astronomical genius went 
to his exile an old and broken man; a brilliant, 
searching mind no longer permitted to probe the 
mysteries of the universe.

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such restriction. Analysis and proof are the tools 
employed in this enlightened era to obtain for 
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Ionosphere Winds Charted from Meteor Echoes

Ionospheric winds, 50 to 80 miles above the earth, have been measured by analyzing the drift of meteor ion trails.

Wind velocity, which may range from 30 to 125 mph, is determined by use of the Doppler effect. Doppler recordings have been made using a 23.1-mc c-w transmitter, the beat difference between the transmitted and reflected signals being used to determine wind velocity. In addition, a 17.3-mc pulse transmitter has been used for ranging on the ion trails.

Wind direction is determined through the use of a special meteor direction finder. Four vertical antennas are spaced about a vertical reflector as shown in the photograph. Each radiates through a single quadrant. The antenna pattern is swept electronically. Presentation involves sixteen vertical A-scan traces on a horizontal trace.

This research, carried on at Stanford University and financed by the Office of Naval Research, is expected to have useful applications both in the design of long-range guided missiles and in weather forecasting.

Irregularities Noted

Although each ion trail lasts only a second or two, the average motion of the upper atmosphere air mass is determined by averaging many measurements. In addition to this average motion, evidence of irregularity in the nature of the wind has been reported.

The meteoric ion trails are usually observed to drift at speeds of 200 mph, although the air mass as a whole moves several times more slowly. It is not yet clear whether these irregularities are the result of local turbulences or of separate layer-like winds blowing in different directions at different altitudes.

The measurements show that during July and August last year, the winds in the outer atmosphere were predominately from the south-south west, with some winds from the north, and a few weaker winds blowing west to east.

The bright flashes seen in the night sky by the naked eye are caused by particles of matter about the size of a small pea. Smaller, more numerous particles produce weaker flashes not visible to the human eye and are easily detected by electronic methods.

Continuous Readings

Radio equipment can detect these tiny meteors both day and night, so the ion trail method of wind measurement is potentially capable of giving continuous wind readings.

Thus far measurements have been made only during the early
Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

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Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.
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This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated directly in kilocycles or megacycles, with scalar conveniently divided for maximum readability. A vernier drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

2 Q-TUNING CAPACITANCE DIALS:
L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance directly in MMF, and (2) providing an effective inductance scale which also becomes direct reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from 4-3 MMF through zero to —3 MMF, accurate to ±0.1 MMF.

3 Q-VOLTMETER AND MULTIPLIER METER.
For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated directly in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1.5 in 0.1 steps, X2, and X2.5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermocouple element for maximum accuracy.

BOONTON RADIO CORPORATION
BOONTON—N.J.—U.S.A.

ELECTRONICS — October, 1950
morning hours when radio conditions are best. Improved equipment, which is just being put into service, is expected to extend the measurement schedule around the clock.

By a further extension of the technique it is believed, that winds at selected heights in the 55 to 80-mile altitude range may be measured.

The meteor drift method is the first to offer the possibility of continuously measuring winds at different altitudes. Other radio wind-measuring methods have recently been devised in the United States and England, but they depend on the regular ionosphere layers and so are restricted to specific heights. Wind measurements made during high-altitude rocket flights are expensive and restricted to a few minutes duration at the most.

Knowledge of the high altitude winds gives information as to the composition of the upper atmosphere. This information is of value to high-altitude aircraft designers in connection with airfoil design; and it is particularly useful to weather forecasters because weather predictions must be based on the most complete possible knowledge of the atmosphere.

Field tests carried out simultaneously with measurements at Stanford served to confirm the reality of the wind-drift effect and showed that the same meteor disturbances could be detected simultaneously at two locations as much as 50 miles apart. Valuable data on the composition of a given meteor trail at different points along its length was also obtained in these tests.

Metallized Paper Capacitors

By JOHN H. FISHER

Vice-President in Charge of Engineering

Astron Corporation, East Newark, N. J.

The conception of a metallized paper capacitor dates back to approximately 1900. However, developments at this early stage of the art were stymied mainly by the inability to obtain a uniform and continuous metal coating on thin paper. The basic principle was proven sound by Robert Bosch of Stuttgart, Germany during World War II when he developed a practical evaporation process for coating paper with a thin uniform film of zinc. The zinc is placed in a high-vacuum chamber and its temperature is raised to about 350 degrees C. The gaseous vapors given off then condense on the relatively cool paper surface in the chamber.

Under the right conditions of vacuum and temperature the result is a homogeneous metallic coating 50 millimicrons in thickness.

Bosch found zinc most suitable for his purpose because of its low vapor pressure of 10-7 mm Hg at 350 C, which gave him no refractory difficulties during the process. It was found, however, that zinc is somewhat limited for capacitor applications, chiefly because of its high power factor which limits it to d-c applications. It is also difficult to obtain a strong lead connection to the zinc-coated paper section of small capacitors.

A practical method was developed in England for the vaporization of aluminum on paper, using a vacuum of 3 to 4 microns and a temperature of 1,500 C. The thin uniform coating of aluminum permits use of a single-sheet dielectric and gives a small, compact and light-weight capacitor unit with revolutionary self-healing characteristics.

Prior to metallizing the paper is continuously coated on one side with a thin film of lacquer material consisting of a 10-percent solution by weight of cellulose acetate, to increase the dielectric strength and insulation resistance of the paper.

Selfhealing Action

Metallized paper capacitors can be subjected to intermittent overvoltages and surges without danger of failure. If surges are of short duration, the capacitors can safely stand surges of 2 to 2.1 times their operating voltage. As the temperature is increased the tendency to spark increases and the breakdown point of the capacitor is lowered. When the capacitor is overstressed, any incipient weakness in the dielectric is burned out. Actually the aluminum coating on the paper is melted by the spark discharge caused by the puncture, whereupon the molten metal is blown away from the hole by the arc, leaving a metal-free area around the puncture. The area thus made has a high surface resistance so that the overall insulation resistance of the capacitor is only slightly lowered. In most circuits, reduced in-

(Continued on p 214)
The tape goes 'round and 'round...
smoothly, swiftly—at higher winding machine speeds

It's Kodapak Sheet
...choice of leading electrical manufacturers for primary wire insulation

In general: Kodapak Sheet is available in various forms including Kodapak I Sheet, cellulose acetate, gauges up to 0.060"; Kodapak II Sheet, cellulose acetate butyrate, gauges up to 0.002". Of the two, the latter is preferred for many electrical applications because of its high dielectric strength, its superior resistance to moisture and oxidation.

Self-centered...Solvent-sealed. Wire wound with Kodapak tape is perfectly centered; thus permits over-all diameters to be held at a minimum. Also, when overcoating of braid is employed, lacquer and lacquer solvents tend to seal tape, forming a continuous waterproof tube around the wire.

Hard to harm it: Because it has excellent strength, stretch, and toughness characteristics, Kodapak Sheet is particularly suitable for use on winding machines. It serves well at high speeds without breaking. These same properties allow wire to be flexed or bent sharply without harming the insulation.

For further information, including other applications, write for free copy of the folder, "Kodapak Sheet for Electrical Uses."

Kodapak Sheet...for efficient insulation
NEW PRODUCTS
Edited by WILLIAM P. O'BRIEN

Radio and TV Equipment Vie With Nuclear Devices ... Improved Lab Gear and Testing Equipment Are Listed ... Twenty-Four Literature Items Are Reviewed

Impedance Measuring Device
FEDERAL TELECOMMUNICATION LABORATORIES, INC., 500 Washington Ave., Nutley 10, N. J. The 42A Impedometer is a compact device for the measurement of impedance in the frequency range from below 50 mc to above 500 mc. Below 500 mc its accuracy is ±5 percent. It consists of a short length of standard 18-in. 52-ohm coax line on which are mounted two directional couplers, a voltage probe and a capacitance plunger. To use the unit a signal generator is connected to one end of the line and the load to be measured is connected to the other end.

Ultrasonic F-M Receiver
RADIO ENGINEERING LABORATORIES, INC., 36-40 Thirty-Seven St., Long Island City 1, N. Y. The model 720 Remo receiver is particularly designed for f-m broadcast music in public places, such as restaurants and shopping centers. The audio output can either be muted or boosted by transmission from the broadcast station of a superaudible tone. Specifications are given in Article 10-31.

Sound Stretcher
KAY ELECTRIC Co., Maple Ave., Pine Brook, N. J., has announced the Sona-Stretcher, an instrument that lengthens the time scale of recorded sounds by a 2-to-1 ratio but does not alter the frequency distribution. It covers a sound frequency range of about 100 to 5,000 cycles. The instrument consists of three component parts: a stretching circuit and monitor amplifier; a turntable suitable for standard disc records, with variable reluctance pickup; and a monitor loudspeaker. It is useful in general studies in phonetics and language instruction.

Lab VTVM
THE HICKOR ELECTRICAL INSTRUMENT Co., 10527 Dupont Ave., Cleveland 8, Ohio. Model 209-A volt-ohm-capacitance milliammeter is especially designed for increased speed and range for tv engineers and technicians. It measures resistance as low as 0.1 ohm and capacitance of 1 µf. The unit has a new a-c range of 1,500 v and features flat frequency response to 300 mc. New literature is available covering full technical details.

Modulation Monitor
RADIO CORP. OF AMERICA, Camden, N. J. Type BW-66E amplitude modulation monitor provides continuous direct reading of modulation percentage in a-m transmitters operating in the 500 to 2,500-kc range. It will measure percentage of modulation on either positive or negative peaks, carrier shift when modulation is applied, and transmitter a-f response. It will also provide overmodulation indication and is useful in program level monitoring. The unit operates from a 75-ohm r-f transmission line, and can accommodate a range of r-f input powers from 0.35 watt to 6 watts. No tuning adjustments are required.

TV Stabilizing Amplifier
GENERAL ELECTRIC Co., Syracuse, N. Y. Type TV-16-B television stabilizing amplifier provides automatic correction of the sync and...
### 1. High pereance (performance compares favorably with that of the larger 6AL5)

### 2. Low heater current (150 mA); half as much as the 6AL5

### 3. Moderate cost

---

#### NEW TYPES

This chart gives you a glimpse of the characteristics of representative Raytheon Subminiature Tubes.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Remarks</th>
<th>Maximum Dimensions</th>
<th>Heatsink Lengths</th>
<th>Filament Volt.</th>
<th>Power Input</th>
<th>Output Power</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATER DIODES</td>
<td>High Mall Aclfeter</td>
<td>0.40x0.40</td>
<td>1.25</td>
<td>100</td>
<td>1200</td>
<td>7.5</td>
<td>500</td>
</tr>
<tr>
<td>CK792/CK586EX</td>
<td>Characteristic of 6ALS</td>
<td>0.40x0.50</td>
<td>1.5</td>
<td>150</td>
<td>1200</td>
<td>9</td>
<td>500</td>
</tr>
<tr>
<td>CK793/THX6K</td>
<td>Tube, UHF Oscillator, 16 watts at 500 ma</td>
<td>0.40x0.50</td>
<td>1.5</td>
<td>150</td>
<td>1200</td>
<td>9</td>
<td>500</td>
</tr>
<tr>
<td>CK796/CK586EX</td>
<td>Tube, excitation for one-half 6ALS</td>
<td>0.315</td>
<td>1.5</td>
<td>120</td>
<td>100</td>
<td>9</td>
<td>500</td>
</tr>
<tr>
<td>CK794/MMGK</td>
<td>Tube, High ma.</td>
<td>0.100</td>
<td>1.5</td>
<td>150</td>
<td>350</td>
<td>40</td>
<td>500</td>
</tr>
<tr>
<td>CK586</td>
<td>Characteristic of 6ALS</td>
<td>0.40x0.50</td>
<td>1.5</td>
<td>150</td>
<td>1200</td>
<td>7.5</td>
<td>500</td>
</tr>
<tr>
<td>CK5829/EX</td>
<td>Small 6ALS</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>120</td>
<td>150</td>
<td>7.5</td>
<td>500</td>
</tr>
</tbody>
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#### FILAMENT TYPES

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Remarks</th>
<th>Maximum Dimensions</th>
<th>Heatsink Lengths</th>
<th>Filament Volt.</th>
<th>Power Input</th>
<th>Output Power</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>146V</td>
<td>Shunted RF Porema</td>
<td>0.300x0.400</td>
<td>1.5</td>
<td>150</td>
<td>2000</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>SM1-32</td>
<td>Shunted RF Porema for pocket radio</td>
<td>0.300x0.400</td>
<td>1.5</td>
<td>150</td>
<td>2000</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>SM1-36</td>
<td>Output Porema for pocket radio</td>
<td>0.190x0.390</td>
<td>1.5</td>
<td>150</td>
<td>2000</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>SM1-42</td>
<td>Output Porema for pocket radio</td>
<td>0.290x0.390</td>
<td>1.5</td>
<td>150</td>
<td>2000</td>
<td>45</td>
<td>50</td>
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<tr>
<td>ST-20</td>
<td>Tube, Hapode for pocket radio</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>2000</td>
<td>45</td>
<td>50</td>
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<tr>
<td>M61</td>
<td>Gas Tube, DC Amplifier</td>
<td>0.210</td>
<td>1.0</td>
<td>1.4</td>
<td>2</td>
<td>120</td>
<td>6.0</td>
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<tr>
<td>CR514AX</td>
<td>Double Space Charge Porema Amplifier</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK177AK</td>
<td>Low microammeter voltage amplifier</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK224AK</td>
<td>Output Porema, 20 mA, filament</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
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<tr>
<td>CK564AK</td>
<td>Output Porema</td>
<td>0.234x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
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<tr>
<td>CK225AK</td>
<td>Output Porema, 15 mA, filament</td>
<td>0.234x0.385</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK226AK</td>
<td>Output Porema, 15 mA, filament</td>
<td>0.234x0.385</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK227AK</td>
<td>Output Porema, 15 mA, filament</td>
<td>0.234x0.385</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK229AK</td>
<td>Tube, Hapode for pocket radio</td>
<td>0.234x0.385</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK231AK</td>
<td>Output Porema</td>
<td>0.234x0.385</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
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<tr>
<td>CK335AK</td>
<td>Diode Porema</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>1.25</td>
<td>10</td>
<td>110</td>
<td>6.0</td>
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<tr>
<td>CK335AKA</td>
<td>HF Porema</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>1.25</td>
<td>10</td>
<td>110</td>
<td>6.0</td>
</tr>
<tr>
<td>CK371AX</td>
<td>10 mA, Shunted Diode Porema Tube</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK372AK</td>
<td>Tube, High-freq. Amplifier</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK364AKA</td>
<td>Unshunted Porema Control, RF Amplifier</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
</tr>
<tr>
<td>CK367EX</td>
<td>Output Porema</td>
<td>0.254x0.450</td>
<td>1.25</td>
<td>1.0</td>
<td>120</td>
<td>6.0</td>
<td>50</td>
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<tr>
<td>CK376/CK566EX</td>
<td>Tube, UHF Oscillator</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>CK377/CX606EX</td>
<td>Tube, UHF Oscillator</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>CK378/CX606EX</td>
<td>Tube, UHF Oscillator</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>CK379/CX606EX</td>
<td>Tube, UHF Oscillator</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>CK4477/CX607EX</td>
<td>Electron Tube, Triode, r.f., grid current</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
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<tr>
<td>CK593</td>
<td>High voltage rectifier</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
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<tr>
<td>CK611</td>
<td>High voltage rectifier</td>
<td>0.300x0.450</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>CR595</td>
<td>7.5 mA, Shunted Diode Porema Tube</td>
<td>0.254x0.385</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
</tbody>
</table>

#### VOLTAGE REGULATORS

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Remarks</th>
<th>Maximum Dimensions</th>
<th>Heatsink Lengths</th>
<th>Filament Volt.</th>
<th>Power Input</th>
<th>Output Power</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK793</td>
<td>Voltage regulator</td>
<td>0.400</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>CK795</td>
<td>Voltage regulator</td>
<td>0.400</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
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<tr>
<td>CK797</td>
<td>Voltage regulator</td>
<td>0.400</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
<td>60</td>
<td>150</td>
</tr>
</tbody>
</table>

#### RAYTHEON MANUFACTURING COMPANY

Special Tube Section - Newton 58, Massachusetts

Subminiature Tubes - Germanium Diodes and Triodes - Radiation Counter Tubes - Rugged, Long Life Tubes

ELECTRONICS - October, 1950

125
blanking portion of a tv signal. It features adjustable sync percentage, can remove noise and hum from the video signal will combine sync and video or separate sync and video, and automatically clips black and white spikes. The unit can increase the picture signal by up to 20 db.

Feed-Through Capacitors
CENTRALAB, 900 E. Keefe Ave., Milwaukee 1, Wis., now offers tiny ceramic feed-through capacitors designed for single-hole mounting where a capacitance ground to either chassis or shield is desired. They are available in 500, 1,000 and 1,500 µF. Voltage rating is 600 volts d-c working, 1,000 volts d-c flash test. Both ends of the terminals are hooked to facilitate soldering.

Miniature Plated Commutators
THE ELECTRO-TEC CORP., 53 Bergen Turnpike, Little Ferry, N. J., has pioneered the use of precious metal electroplating for fabrication of all size commutators and slipring assemblies. The miniature sections illustrated are firmly anchored to withstand high centrifugal force at up to 12,000 rpm. Commutator forms are stamped out of laminated linen base bakelite sheets with the laminations running parallel to the segment faces in order to utilize the strength of the linen base. By threading wire connections prior to plating, the wires and segments are bonded so as to be impervious to heat.

Sync Lock Unit
GENERAL ELECTRIC Co., Syracuse, N. Y. Type TV-30-A television sync lock unit allows remote picture signals to be treated and handled like local studio productions. Through its use local commercials, special effects or other local program material can be inserted into the remote picture without disturbance. This is accomplished by means of automatic synchronisation of the local sync generator with the remote sync signals.

TV Sweep Generator
KAY ELECTRIC Co., Maple Ave., Pine Brook, N. J., has announced the Switcha-Sweep, an all-electronic tv sweep generator with fundamental outputs on all channels as well as output in the i-f range. A rotary switch selects the desired channel, which is swept through a range of 15 mc. Sawtooth sweep eliminates phasing problems. Amplitude modulation of the sweep signal is less than 1 percent per megacycle. Both switched and continuously variable output attenuation is provided, with maximum outputs of about 0.5 volt on the 70-ohm unbalanced output and 1 volt on the 300-ohm balanced output.

Voltage-Regulated Power Supply
KEPCO LABORATORIES, INC., 149–14 41st Ave., Flushing, N. Y. Model 315 features one regulated B supply, one regulated C supply and one unregulated filament supply. The B supply is continuously variable from 0 to 300 v and delivers from 0 to 150 ma. The C supply is continuously variable from 0 to 150 v and delivers 5 ma. Ripple is less than 5 mv. The a-c output is 6.3 v, 5 amperes, center-tapped, unregulated.

Ore Detector Kit
ALLIED RADIO CORP., 833 W. Jackson Blvd., Chicago, Ill. The Scout radio-active ore detector, in addition to field survey work, may be used for (continued on p 242)
THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

RCA-5770
150 kw input
to 20 Mc.

RCA-5786
1.5 kw input
to 160 Mc.

RCA-5762
5.5 kw input
to 110 Mc.

RCA-5771
60 kw input
to 25 Mc.

RCA-5671
80 kw input
to 25 Mc.

RCA-5831
650 kw input

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

...with the economy of thoriated-tungsten filaments

THESE SIX improved RCA power tubes are "musts" for designers of industrial electronic heating equipment where design and operating economies alike are important considerations.

Ranging in power input from 1.5 to 650 kw, these types successfully utilize thoriated-tungsten filaments which offer marked savings in filament power and the cost of associated power equipment.

RCA-5671 utilizes an effective lightweight radiator while the 5762 and 5786 have radiators designed to permit use of less-expensive blowers than have been required previously for similar tubes. The new and revolutionary RCA-5831 super-power beam triode with internal water cooling, is tested at one million watts input, and handles with high efficiency an input of 650 kilowatts in continuous commercial service.

Air jackets for the 5671 and 5762, and water jackets for the 5770 and 5771, are available from RCA.

RCA Application Engineers are ready to consult with you on the application of these improved tubes and accessories to your specific designs. For complete technical information covering the types in which you are interested, write RCA, Commercial Engineering, Section J42R, Harrison, N. J.
NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

AIEE-IRE Electronic Instrumentation Conference

FINAL DATES for the third annual joint AIEE-IRE Conference on Electronic Instrumentation in Nuclear and Medicine have been set as October 23, 24, and 25, 1950. Location of this meeting which will feature technical papers and discussions on the various problems in instrumentation for the vital fields of nuclear and medical science, is the Park Sheraton Hotel, New York City.

More than 300 persons attended the highly successful three-day gathering last year at which papers were presented covering the non-nuclear phases of electronics in medicine, nucleonics in medicine, and nucleonic developments in industry and government.

Such great interest was evoked in the papers presented that they were compiled and published in the form of a consolidated pamphlet covering the proceedings of the conference and made available by the two organizations. This year's meeting will be held along the same lines and a similar type of publication is contemplated.

Prominent among the features of the conference is a special evening meeting during which a number of prominent authorities will discuss, "Effects of Atomic Weapons"—a government publication containing recently declassified information on the subject. They will explain various parts of the book in an effort to educate the technical man in the techniques of protection from atomic weapons so that he in turn can pass on the information.

Interesting and informative exhibits of instruments and related products will be displayed by leading companies in the field. Those attending the meeting will have an opportunity to see many of the devices (some in actual operation) that will be discussed in the technical papers.

Ford's Rouge Railroad Gets Radio System

INSTALLATION of a two-way radiotelephone communication system for direction of railroad traffic over the 105 miles of track in Ford Motor Co.'s Rouge plant will be completed within a year. The Rouge railroad, largest such industrial system in the world, is one of the first private lines to adopt this method for traffic direction. As of August, the special equipment had been installed in ten of the company's 19 diesel-electric locomotives.

Ford officials expect the radio control system to improve the railroad's overall efficiency, expedite the movement of freight cars in and out of the yards, and speed execution of all switching orders. It is the result of four years of experimentation with equipment and methods by the company's communications, railroad and plant security sections. A special control tower has been constructed to serve as the brain center for the system.

Audio Fair Program

THE THIRD ANNUAL AUDIO FAIR, sponsored by the Audio Engineering Society will be held from Oct. 26 to 28, 1950, at the Hotel Commodore, N. Y. The advance program of papers for the technical sessions is as follows:

**Thurs. Oct. 26**


**Fri. Oct. 27**

New Developments in Radio Tubes and Their Application to Audio Circuits, (speaker to be announced). A Consideration of Intensity-Loudness Function and Its Bearing Upon the Judgment of Tonal Range and Volume Level, by S. E. Stunte of U. S. Naval Medical Research Lab, New London, Conn. CBS Television Studio Intercommunication Facilities, by R. B. Monroe of CBS-TV. Report of the A.E.S. Standards Committee on Playback Characteristic (speaker to be announced). Free Field Audiometry, by R. Allison of...
Never Before Reproduction Like This!

The G-610 brings a totally new meaning to high fidelity sound reproduction. Not only does this new 3-channel system reproduce the widest frequency range ever attained by a loudspeaker, but it also sets new high standards with its incomparably smooth response characteristic and very low distortion. The result is clear, clean, life-like quality, with thrilling transport to the original such as you have never heard before. The G-610, complete with Speaker Unit and Crossover and Control network is priced at $365.00 list. Ask for Data Sheet 160.

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IRE Emporium Seminar

A number of prominent speakers were featured at the eleventh annual seminar of the Emporium Section of the Institute of Radio Engineers, held August 18 and 19 at Emporium, Pa.

Included as speakers for the technical sessions were Norman Pickering of the Pickering Co., Oceanside, N. Y., who discussed high-quality audio reproduction; C. Wesley Carnahan of the Sandia Corporation, Albuquerque, N. M., who spoke on the application of electronics to remote control devices; R. M. Bowie of Sylvania Electric Products Inc., Bayside, N. Y., who reported on color television; and F. M. Geyer of the Corning Glass Works, who discussed the electrical characteristics of glass.

ARINC Expands Pacific Communication Services

New equipment installed in Hawaii by the Mackay Radio and Telegraph Co., subsidiary of the American Cable and Radio System, will permit coverage of the entire Pacific area with both radiotelephone and radiotelegraph service to aircraft and base stations, thereby expediting the increased flow of air traffic to the Far East.

This rapid expansion in available communication services in this area has been carried out under the direction of Aeronautical Radio, Inc., or ARINC as it is commonly known, the organization established and supported by the air industry to operate radio communication stations wherever required.

Mackay, under terms of a contract with ARINC, broke ground for a large extension to its radio transmitter at Kailua, Hawaii, on June 21, and before the deadline date of August 1 had completed the installation of four multichannel transmitters and associated antennas. The new equipment was manufactured by Federal Telephone and Radio Corp., a subsidiary of the International Telephone and Telegraph Corp.

N. Y. Ferries Get Radar

All City of New York ferries operating between Manhattan and Staten Island will be radar-equipped by the end of the year. Contracts for double-ended installations of X-band General Electric radar navigators in the eight ferries now on the run have been received by the Marine Electric Corp. of Brooklyn, N. Y., distributors for G-E equipment.

Each craft will have two radar consoles, with a scope in each pilot house. Skippers of the ferries will receive training in the use of radar during their two-week installation layups.

Disaster Communications

Proposed rules for providing emergency radio communications have been formulated by the FCC. They provide for “disasters and other incidents involving loss of communications facilities normally available or demanding the temporary establishment of communications facilities beyond those normally available”.

The Disaster Communications Service would operate in the frequency band of 1,750-1,800 kilocycles. Any fixed, land or mobile station could qualify for participation in such emergency operation, including amateurs and commercial radio operators.

It is proposed that application for authorization to operate in the Disaster Communications Service for a radio station already licensed in a different service shall be submitted directly to the Commission. The application would detail the individual's eligibility and include a certified copy of the locally coordinated disaster communication plan.

In this proposal it is mandatory that a local network be set up under appropriate leadership with rules for self-government and operating procedure that will tend to assure an orderly and reasonably efficient service.

Radio Fall Meeting

Latest technical developments of radio and television equipment and components will be discussed at the annual Radio Fall Meeting sponsored by the IRE and RTMA engineering department, to be held at the Hotel Syracuse, Syracuse, N. Y., Oct. 30 to Nov. 1. Following is the tentative technical program:

Mon. Oct. 30

9:30 A.M.—General Session (Ralph R. Bacher, presiding)

A Broad Range Oscillator for Television Testing, by H. A. Finke and J. Ebert of Polytechnic Research and Development Corp.

Wideband Impedance Matching Between a Resonant Antenna and a Line, by H. A. Wheeler of Wheeler-Laboratories, Inc.

High Frequency Crystal Calibrator Design, by J. T. Minter of Measurements Corp.

The Determination of Amplifier Sensitivity

(Continued on page 282)

MEETINGS


SEPTEMBER 30-OCT. 2: Third Annual National Television & Electrical Living Show, Chicago Coliseum, Chicago, Ill.

OCT. 3-5: AIEE District No. 2 Meeting, Lord Baltimore Hotel, Baltimore, Md.

OCT. 16-20: 68th Semiannual Convention of SMPTE, Lake Placid Club, Lake Placid, N. Y.

OCT. 22-25: Third Annual Joint AIEE-IRE Conference on Electronic Instrumentation in Nucleonics and Medicine, Park Sheraton Hotel, New York City.

OCT. 23-27: AIEE Fall General Meeting, Skirvin Hotel, Oklahoma City, Okla.

OCT. 26-28: Second Audio Fair, sponsored by the Audio Engineering Society, Hotel New Yorker, New York City.

OCT. 30-NOV. 1: Radio Fall Meeting, sponsored jointly by IRE and RTMA engineering department, Hotel Syracuse, Syracuse, N. Y.

These Leaders look to SYLVANIA for dependable TV Picture Tubes

Admiral Emerson Meck PHILCO

Arvin FADA PILOT

Bendix Television Motorola SCOTT

Hoffman National Sentinel

Calber Industrial Television Olympic Silvertone

CONRAC TRAV-LER

CROSLEY Packard Bell

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- The trade-marks shown here identify the television leaders now choosing and using Sylvania TV Picture Tubes in their sets.

The reasons behind today’s acceptance of Sylvania tubes include greater clarity, consistent color, dependability, and longer life. Remember, your dealers as well as set owners recognize Sylvania as a symbol of distinction—a name associated with the very finest in radio and television.

For full descriptions and ratings of all Sylvania TV Picture Tubes, write today to Sylvania Electric Products Inc., Dept. R-2110, Emporium, Pa.

SYLVANIA ELEC TRIC

Radio Tubes; Television Picture Tubes, Electronic Products, Electronic Test Equipment, Fluorescent Tubes, Fixtures, Sign Tubing, Wiring Devices, Light Bulbs, Photolamps; Television Sets
NEW BOOKS

The Principles of Television Reception


This short book, by a well-known contributor to the British technical press, is unusual in that it treats the American and British television systems on an equal footing, and is one of the few sources of comparative data on receiver design in the two countries. Complete circuit diagrams of popular American and British receivers of the 1947 vintage are included.

The book opens with chapters on system standards, basic video signal theory and circuit operation. The following six chapters are devoted to detailed examination of typical receiver circuit functions. Chapters on aerial systems and test equipment are included. The final chapter gives an introduction to color television, describing the wideband field-sequential and simultaneous systems. Since the manuscript was prepared in 1947, no mention is made of the line-sequential or dot-sequential systems.

The treatment is non-mathematical in the text proper, but a mathematical appendix is included for those who wish to consult it. The book is not intended for design engineers, except as it reveals details of receiver practice (many of which are now unfortunately outmoded, such is the pace of TV design in both countries). The book is an excellent introduction to the subject, however, and is recommended to all who wish to compare British and American methods.—D. G. F.

Ralph 124C 41+


SHADES of Edward Bellamy, Jules Verne and all the more recent imaginative writers of science fiction! This book is a revival of one of the early classics of that peculiar brand of literature that is at once the dismay of those who don't like it and the bread and life of those who do. And to anyone in this field of electronics who has followed Hugo Gernsback through the years, (Continued on p 133)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles that ELECTRONICS has Published

Why not here?

DEAR SIRS:

I READ with much interest the paper by Dr. Brueckmann which appeared in the May 1950 issue of ELECTRONICS on an antenna for the regular broadcast band used on the broadcast station in Frankfort designed to push out the rapid fading zone and increase efficiency.

My special interest is due to the fact that in the late thirties, I spent some time on the theory of such an antenna and variations of it and also on an antenna fed at more than one point, whereby the current distribution along the antenna could be controlled accurately, so as to provide the desired radiation distribution in the vertical plane. On the basis of this work I applied for patents and was in due course granted patents No. 2,283,617, No. 2,283,618, No. 2,283,619. I had thought that the clear channel stations in the United States would have been interested to have had their service improved by such antennas, but no interest has been shown by them. I was therefore very interested to find that German broadcast stations have found this antenna worthwhile. Dr. Brueckmann has just written me that he believes another German station, located at Muhlacker, has a similar antenna under construction.

RAYMOND M. WILMOTTE, INC.
Consulting Engineers
Washington, D. C.

ELECTRONICS Quiz

AS PROMISED in July Crosstalk, here is the first installment of our electronics puzzle-quiz column. To start, we will publish one problem every month and its solution the following month, along with the next problem. Readers are encouraged to submit brain-teaser problems for this department. A payment of $5.00 will be made for each acceptable entry.

This month's problem is submitted by R. W. Johnson, China Lake, California.

What is the power dissipated by the plate resistor of a class A audio amplifier when both a sinusoidal and d-c component of plate current are present?

Answer will appear next month.

Neutralizing Bipolar I-F Stages

DEAR SIRS:

IN THE PAPER "Bipolar I-F Coils", appearing in the June 1950 issue of ELECTRONICS, it is stated that a

(Continued on p 290)
TECHNICAL BOOKS
Just Published!

HIGH-SPEED COMPUTING DEVICES
1. A fundamental book that gives you a clear picture of the various mathematical methods and physical mechanisms, including circuit diagrams, developed for use in automatic computations. Acquaints you with the general character of computing machines and outlines arithmetic techniques used in their operation. Points out variations used for large-scale machines; explains importance and nature of the relationship between a machine and its operator, and between machine capabilities and the required mathematical tools. Aids executives, mathematicians, and computers in deciding which computing system is most readily applicable to a given problem. Describes types of systems, physical components, methods, desk calculators, large-scale systems, data-conversion equipment, etc. By the staff of Engineering Research Associates, Inc., Edited by W. W. Stiller, Jr. 446 pages, 96 Illus. $6.50

STRUCTURAL PLASTICS
2. A compilation of selected information on the nature, properties, and utilization of structural plastics. Gives chemists, structural engineers, architects, aircraft designers, etc. practical know-how and theory on material fabrication and applications. Shows how to develop, design, and apply plastics for efficient structural use. Summarizes structural plastic research. Includes charts, graphs, and easy-in-con- suit data. By H. C. Engel, Consultant; C. H. Hems- king, U. S. Plywood Co., and H. K. Merriman, Glenn Martin Co. 301 pgs. 96 Illus. $1.50

RADIO ENGINEERING HANDBOOK
3. Brings you 1197 pages of design data, charts, tables, circuits, diagrams, and formulas; an invaluable aid in solving radio engineering problems quickly, easily, and accurately. Gives designers, engineers, and radio technicians principles, standards, and procedures for quick answers to routine and special assignments in radio, broadcasting, aircraft radio, television, etc. Fully revised for greater usefulness. New subjects include cavity magnetrons, radar and forum, sequential scanning, crystal converters, TV allocation, disk seal tubes. Jobs with training. Edited by Keith Hen- ney, 4th Ed. 1197 pgs. $10.00

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TECHNICAL BOOKS
How modern electronic devices work in industry today

WHAT the different types of vacuum tubes can do in specific installations.

SURVEY OF MODERN ELECTRONICS
By PAUL G. ANDRES
Illinois Institute of Technology

GIVES TESTED MATERIAL USED BY MANY MANUFACTURERS

Most books on electronics describe equipment used or produced by two or three companies. Survey of Modern Electronics gives you data and circuits used by nearly every manufacturer in the field. Based on the author's 18 years of engineering experience and 10 years of technological teaching, this new book employs industry technique and design to relate fundamental knowledge with technical details.

The main emphasis is placed on practical application. The book examines the basic principles of electronic tubes and explains their use in such devices as the automatic pilot and electronic measuring equipment. It covers tube applications such as those found in the proximity fuse, electronic electrocardiograph, radar, induction and dielectric heating, instrumentation, communication and control.

A generous number of illustrations—many supplied by manufacturers—help make this up-to-date survey accurate and complete. To examine this time-saving book without obligation, mail the coupon today.

Sept., 1950 522 pages 380 Illus. $5.75

APPROVAL COUPON

John Wiley & Sons, Inc., Dept E-950
440 Fourth Ave., New York 16, N. Y.

Please send me, on 10 days' approval, a copy of Andres' Survey of Modern Electronics. If I decide to keep the book I will remit $5.75 plus postage; otherwise I will return the book postpaid.

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Address...................
City..............Zone...State....
Employed by................
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Electrical Communication


This new edition of Professor Albert's useful text follows the general scheme of earlier editions—to provide a concise picture of all aspects of modern communication systems as means for transmitting and receiving intelligence in the form of coded voice or music over radio or wireless circuits.

In the first part of the new edition the author has grouped certain basic subject matter useful to any communication system: that is, acoustics and electroacoustic devices, lines, filters, cables and waveguides. Thereafter he deals with specific mechanisms.

There are chapters on telegraph...
Amphenol Now Produces Teflon in Eleven sizes

Electronics Engineers will want to keep this listing at hand for quick reference. If you do not wish to remove this chart from this publication, Amphenol will gladly send a reprint of the advertisement.

AMERICAN PHENOLIC CORPORATION, 1830 SOUTH 54TH AVENUE • CHICAGO 50, ILLINOIS
For low-level d-c measurements
Use these new, triple-purpose
D-C INDIcATING AMPLIFIERS

stabilized for zero and gain

Voltage-balance feedback (above) and current-balance feedback stabilize gain... provide virtual null balance.

USE AS
• DIRECT-READING MICROVOLTmETER
• OR MICRO-MICROAMPERe UNIT
• RECORDER PREAMPLIFIER
• NULL DETECTOR

These new instruments are not only D-C Indicating Amplifiers but are stable, accurate measuring instruments as well. You can use them in measurements with thermocouples, strain gages, bolometers ... bridge and potentiometer circuits ... ionization, leakage, and phototube currents ... almost any measurement of extremely small direct current or voltage.

Through a combination of a-c amplification and unique balanced feedback network, zero and gain stability are designed right into the instrument. Trimmer controls are designed out—eliminated.

Actually three instruments in one, these amplifiers can be used as—

Direct-reading instruments ... At the turn of a scale-multiplier knob, you simply select the range in which you want to work.

Recorder preamplifiers ... with broad flexibility. For instance, one or two degrees of temperature difference can be spread across an entire Speedomax recorder scale.

Null detectors ... more sensitive than most reflecting galvanometers, yet with full scale response time of only 2 to 3 seconds. Leveling is unnecessary. There's no worry about shock or vibration. At the turn of a range knob, you have available a wide choice of sensitivities. External shunts are not required. And when using non-linear response, not only does the instrument stay on scale at extreme unbalance; sensitivity increases automatically as the null point is approached. For details, write to Leeds & Northrup Co., 4979 Stenton Ave., Phila. 44, Pa.
Fast and Reliable TV Receiver Testing—makes this scope particularly useful in head-end position work. Unsurpassed for stability and fine trace... excellent definition... no bounce when shifting bands. Where the sweep generator does not have a baseline, measurements can be taken on the DC amplifier. Delivers maximum sensitivity without sacrifice of frequency response. Low capacity input probe is provided for trouble shooting.

In Broadcast Stations, It Pin-points Trouble—helps you stay on the air with maximum performance. Use it to check hum, noise, distortion, modulation, phase relationships; measure gain and sweep generator output; isolate defective components; determine frequency response of audio circuits.

In Laboratories, It’s Versatile—Fits many applications where waveform study is essential. Built-in voltage calibrator permits calibration of the scope for voltage measurements. Gives you wide frequency response without recourse to peaked amplifier coupling circuits. Straight resistance coupling is used, and the scope can be employed on frequencies up to 3 mc. Excellent transient response within the frequency range of the instrument.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Frequency Response</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Amplifier</td>
<td>Vertical</td>
</tr>
<tr>
<td>AC — +0,—20% from 20 cycles to 500 kc (Square Wave response 60 to 40,000 cycles.)</td>
<td></td>
</tr>
<tr>
<td>DC — +0,—20% from 0 to 500 kc at full gain setting.</td>
<td></td>
</tr>
<tr>
<td>Probe — +0,—50% from 20 cycles to 1 megacycle with gradual reduction in response beyond 1 mc.</td>
<td></td>
</tr>
<tr>
<td>Sweep Range</td>
<td>1. AC Input — 0.015 volts RMS per inch</td>
</tr>
<tr>
<td>10 cycles to 100 kc in six overlapping ranges.</td>
<td>2. DC Input — 2.0 volts DC per inch</td>
</tr>
<tr>
<td></td>
<td>3. Probe — 20 volts RMS per inch</td>
</tr>
<tr>
<td></td>
<td>Horizontal — 0.4 RMS volts per inch</td>
</tr>
</tbody>
</table>

Calibrating Voltages

Seven AC voltages of power line frequency — 3, 1.5, 3, 15, 30, 150 and 300 volts with ± 1.5% accuracy.

October, 1950 — ELECTRONICS
STATIONS ★ FOR DEVELOPMENT LABORATORIES

UHF coverage

TEST EQUIPMENT

VARIABLE PERMEABILITY SWEEP GENERATOR—ST-4A
Completely Electronic. No Moving Parts. Using an exceptionally wide linear sweep, this instrument is ideal for television receiver maintenance, TV production and development laboratories, wide band amplifier study, and transmission line impedance measurements. The front panel is slotted, permitting the equipment to be removed and mounted in a standard 19-inch relay rack. A new Balanced Output Adaptor (Type ST-8A), also available, provides balanced 300 ohm output from the sweep generator.

SPECIFICATIONS
Frequency Range: Continuously variable from 4 to 110 mc and 170 to 220 mc. Can be used through 900 mc on harmonic operation.
Sweep Width: Linear from 500 kc to greater than 15 mc.
Output Voltage: Greater than 0.1 volts from 4 to 110 mc. Greater than 0.5 volts from 170 to 220 mc.
Output: Single-ended or balanced 300 ohm output.

MARKER GENERATOR TYPE ST-5A
Functions as a crystal referenced calibrator from 10 mc to 300 mc. When used with the G-E sweep generator, it provides a multiple of markers spaced 1.5 or 4.5 mc apart... or can be used to supply a marker or markers at any frequency from 10 mc to 900 mc.

SPECIFICATIONS
Picture Carrier Oscillator: 15 position rotary selector switch selects 12 crystal-controlled frequencies plus 3 tuneable ranges covering intermediate frequencies.
Channel Crystal Accuracy... .02%
IF Ranges: 3 Bands—20 to 27 mc; 27 to 37 mc; 37 to 50 mc Accuracy: dial hand calibrated, crystal calibrator ±.05%.
Crystal Modulator: Provides audio and intermediate frequency locations simultaneously with picture carrier.
Crystal Accuracy: 4.5 mcs ±.05% 1.5 mcs ±.15%.

ILLUSTRATED BULLETINS
Complete information will be furnished on any of the General Electric test instruments listed here. Check those you are interested in... then fill in and mail the coupon today.

TV Scope ST-2A
Sweep Generator ST-4A
Marker Generator ST-5A
Balanced Output Adaptor ST-8A
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Distortion and Noise Analyzer YDA-1
Square Wave Generator
Industrial Scope YNA-4

General Electric Company, Section 4100 Electronics Park, Syracuse, New York
Please send me further information on products checked at left.

NAME............................................................
COMPANY...........................................................
ADDRESS..........................................................
CITY.........................................................STATE...
tion of even the most elaborate installations.

Many of the techniques discussed are recognized as having been in existence for quite some time. However, their value is not lessened by their age in this case.

One possible shortcoming of the book is the lack of down-to-earth what-tube-do-I-use and what-value-of-resistor information that is so important to many engineers and technicians. Both British and American light-sensitive devices are discussed.—J. F.

Better Television Reception
BY WOODROW SMITH AND R. L. DAWLEY. Editors and Engineers Ltd., Santa Barbara, Calif., 141 pages paper-covered, $2.50.

SPECIFIC recommendations are given for the best method, the best antenna and the best accessories for improving vhf television reception in fringe and low-signal locations. Techniques presented apply to difficult nearby locations behind hills or in canyons, as well as locations far beyond line-of-sight paths from transmitters. Emphasis is on practical rule-of-thumb data, with theory included only to give a general idea of the considerations involved.

Of particular interest technically is the second chapter, dealing with propagation phenomena. Subjects covered here include bending or diffraction of tv signals, picking up of ground reflection after diffraction, explanation of focusing by diffraction to give a strong-signal region directly behind a large rounded-top hill, focusing by reflection where a hill of gradually increasing slope approaches a section of a parabola, utilizing focused ground reflections and reflections from large objects, elimination of ghosts, use of ghosts, analysis of conditions leading to fading and flutter, intelligent use of boosters, and realignment of video i-f amplifiers in receivers for reception of very weak signals.

Other chapters, equally detailed, cover receiving antennas, transmission lines, mast installation and interference problems. Examples of practical data are the recom-
Businessmen call it reputation... accountants refer to it as goodwill... production men think of it as reliability. Reliability has a dollar-and-cents value entirely apart from the quality and price of the capacitors you buy.

That is why so many leading radio equipment manufacturers insist on C-D capacitors. They know that C-D's extensive manufacturing facilities, reliable service, dependable quality are features that cannot be measured in dollars and cents. Typical of this C-D reliability is the:

"Blue Beaver"* Electrolytic

- Special formation process—developed by C-D engineers after years of research—insures low leakage; good performance at high temperatures; long life at high voltages.
- Low contact resistance between anode and lead wires and negative lead to can, by unique assembly procedure. Contact resistance checked on Kelvin bridges and maintained at low value.
- Special separator material prevents breakdowns under most adverse conditions.
- A positive acting diaphragm vent—developed in C-D labs—insures proper venting when needed.
- Special insulator around positive lead eliminates shorts to can.
- Extreme care in assembly to eliminate all contamination plus the finest raw materials obtainable insure a unit free from corrosion.

For details on these and other C-D electrolytics write for catalog. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K10, South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind., and subsidiary, The Radiant Corp., Cleveland, Ohio.

C-D Best by Field Test!

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ELECTRONICS — October, 1950
NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strawger" type mounting.

COIL POWER: From 40 milliwatts to 7 watts D.C.

CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 ampere contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS: 1 1/8" HIGH, 2 1/2" LONG, 1 1/2" WIDE

These are the dimensions for the 6 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

SK RELAY

MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliwatts to 4.5 watts D.C.

CONTACTS: Same as "LK".

DIMENSIONS: 1 1/2" HIGH, 1 1/4" LONG, 3 1/2" WIDE.

These are the dimensions for the 4 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS.

PLUG-IN MOUNTING—SPECIAL.

SK, HERMETICALLY SEALED

AL-132

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Conventional Way: This design died on the drawing boards, because the Deublin Company, Northbrook, Ill., found the simplified design, using Truarc Rings, superior and more economical.

HOW $2.41 WAS SAVED

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td>Materials saved</td>
<td>5.79</td>
</tr>
<tr>
<td>Eliminated bearing lock nut and washer</td>
<td>1.18</td>
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<tr>
<td>Machine operations eliminated</td>
<td>.97</td>
</tr>
<tr>
<td>Decreased wall thickness of housing</td>
<td></td>
</tr>
<tr>
<td>Eliminated bearing lock nut and washer</td>
<td></td>
</tr>
<tr>
<td>Locate cap on arbor, and chase threads</td>
<td>.39</td>
</tr>
<tr>
<td>Drill spanner wrench holes</td>
<td>.28</td>
</tr>
<tr>
<td>Cut thread on rotor for lock nut</td>
<td>.09</td>
</tr>
<tr>
<td>Mill slot in thread for tang on lock washer</td>
<td>.18</td>
</tr>
<tr>
<td>Drill spanner wrench holes in rotor</td>
<td>1.14</td>
</tr>
<tr>
<td>Assembly operations eliminated</td>
<td></td>
</tr>
<tr>
<td>Install lock washer, tighten lock nut, bend lug</td>
<td>.20</td>
</tr>
<tr>
<td>Assemble cap into housing</td>
<td>.10</td>
</tr>
<tr>
<td>TOTAL SAVINGS</td>
<td>$2.41</td>
</tr>
</tbody>
</table>

THE Deublin Union—a rotating joint for steam, air, or water—is simple, rugged, easy to service. 4 Waldes Truarc Rings hold entire unit together, permit simplified design, cut unit cost $2.41.

Improve and simplify your own product design with Truarc Rings, and you too will cut costs. Whereever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there’s a Waldes Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision engineered. Quick and easy to assemble, disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

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Please send the new catalog on Waldes Truarc Retaining Rings.

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Title:__________________________________________

Company:_______________________________________

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Please send the new catalog on Waldes Truarc Retaining Rings.
because the opposed windings are on a special flatted core

It's a Ward Leonard exclusive—a non-inductive resistor with Ayrton-Perry winding around a core that's flatted on opposite sides. Purpose of the flats? To make sure the crossings of the two windings are exactly 180° apart—thus reducing inductance and distributed capacitance to an absolute minimum.

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NEW BOOKS

The Radio Manual


It is safe to say that this volume represents a comprehensive study of the entire field of radio communication. The field is broad and its subdivisions are diversified, but the authors seem to have had the skill, experience and initiative to weigh each phase and to collect and record a good balance of general information.

This fourth edition is a completely rewritten and reworked version of its already famous predecessors. Entirely new chapters have been added on such subjects as f-m systems, propagation, antennas and emergency equipment, and there is an especially comprehensive chapter on television. The other chapters have been revised to include the latest developments in studio and transmitter techniques. The last three chapters list the latest regulations governing radio and allied arts.

In dealing with a subject, pieces of actual equipment are discussed. Complete circuits of typical transmitters are explained in detail. Mobile and marine installations are thoroughly treated. Also included are chapters on up-to-date direction-finding and test equipment.

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NEW BOOKS (continued)

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High Power Pulse Transformer Design and Development. Section of report by Armour Research Foundation for Bureau of Ships, 229 pages, $8 in microfiche or $8.75 in photostatic, from Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D.C. Intended to minimize use of skilled highly trained design talent. Gives theory of pulse transformers, details of Armour interleaved winding design and places primary and secondary conductors in a single layer, and steps in electrical and mechanical design procedure for development to meet specific requirements.


Resistance Welding—Designing, Tooling, and Applications. By Wallace A. Stanley. Progressive Welder Co., Detroit. McGraw-Hill Book Co., New York, 1950, 229 pages, $7.50. Background or basic information on resistance welding characteristics of standard equipment, design considerations for products to be assembled by resistance spot, projection, seam or flash butt welding, evaluation of weld quality, practical data on getting the most out of resistance-welding equipment, and time-saving techniques. Highly practical book for engineers as well as production men, of real value to electronic engineers who work with welders even though-by intent-the author has ignored the subject of electronic welding controls.
Inside Information on the Inside of a Tube

The public-at-large does not know, as you do, that within nearly every electronic or television tube are other tubes. Or that these other tubes—of metal—can be as troublesome as they are tiny.

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Or LOCKSEAM...? Produced directly from thin nickel alloy strip stock, .040" to .100" O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, headed or plain.

52,600 Seamless Nickel Cathodes standing on end compared with a ruler, and an ordinary pin under a lens.

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INSULATING SPLICE of high voltage lead to picture tube neatly, quickly with “Scotch” No. 33 Electrical Tape.

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More and more TV repairmen are saving money on service contracts with “Scotch” No. 33 Electrical Tape. This plastic-backed tape provides safe, snug protection for all wiring. Makes it easier to splice leads than to replace them! Difficult soldering is eliminated. Repair time is cut as much as 50%.

And customers are happier, too! Plastic tape in TV sets helps eliminate “snow” and “ghosts,” improves signal-to-noise ratio.

Try “Scotch” No. 33 Electrical Tape on your next insulating job. Write Dept. ES-105 for complete information.

Quick facts about “Scotch” No. 33 Electrical Tape

- THIN CALIPER—only .007 inch thick, makes a neat wrap.
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ELECTRONICS — October, 1950
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A tough, horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, light weight. Sheets, Rods, Tubes, Special Shapes.

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National Research and Engineering Service are available to you, without obligation—to help you solve your specific development problem. Write us—

TUBES AT WORK
(continued from p 118)

FIG. 1—Positive-grid blocking oscillator provides oscilloscope time base

inherently a good sawtooth, its shape unaffected by changes in circuit constants and voltages; frequency is substantially independent of plate supply; and sawtooth amplitude is independent of frequency.

Referring to Fig. 1, one half of a double triode is connected as a blocking oscillator, with the grid resistor returned to a high positive potential, conveniently the B+ supply. This bias linearizes the sawtooth voltage by making the total voltage across the grid or charging resistor large compared to the incremental voltage. Part of the grid resistor, Rg, is variable as fine-frequency adjustment. Coarse-frequency control is effected by switching capacitors at Cc.

The oscillator coil is not at all critical in design. Circuit in Fig. 1 uses two close-coupled windings of about 20 turns of No. 30 wire on a 3/8-inch form. Best results are obtained when both grid and plate coils are the same size with no tuning capacitors connected across them. Sawtooth amplitude increases with the Q of the coil, and is higher with low-mu tubes than with high-mu. The r-f frequency of oscillation is relatively unimportant. No attempt was made to design for "snap" operation, in which the discharge of the grid capacitor is effected in a single cycle of oscillation.

Synchronization

The other triode V2 is used for the purpose of sync injection, and is connected as a cathode follower. The 200-µuf capacitor across the cathode resistor provides r-f bypassing. If very high sweep frequencies are not desired, a capacitor of 22 µuf or so from the grid of V2 to ground will help improve
Because of its amazingly high load-input ratio, the No. 5000 relay operates at 115 volts 60 cycles on only 0.007 ampere—a fraction of the current consumed by any other type of mercury relay!

It is ideally suited for use in electronic tube circuits where the output of the tube is limited. With its low amperage operating the coil, the contacts will handle 5 amperes at the same voltage—and tests indicate the No. 5000's life to be over 30 million operations!

It can be used as a pilot relay operating from a very sensitive thermo-regulator—serves equally well for high and low temperature control—and functions perfectly with either mercury-and-glass or bi-metal regulators.

**Every ADLAKE Mercury Relay offers these advantages:**

- Hermetically sealed—(dust, dirt, moisture, oxidation and temperature changes can't interfere with operation)
- Silent and chatterless
- Requires no maintenance
- Absolutely safe

FOR FULL INFORMATION on this sensational relay, write The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

Manufacturers of
Hermetically Sealed Mercury Relays for Timing;
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25 MC

NM - 20A

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Commercial equivalent of T5-587 U.
Sensitivity as two-terminal voltmeter, (95 ohms balanced) 2 microvolts 15-125 MC, 5 microvolts 88-400 MC. Field intensity measurements using calibrated dipole. Frequency range includes FM and TV Bands.

Commercial equivalent of AN/URM-6.
A new achievement in sensitivity! Field intensity measurements, 1 microvolt-per-meter using rod; 10 microvolts-per-meter using shielded directive loop. As two-terminal voltmeter, 1 microvolt.

Commercial equivalent of AN/URM-17.
Sensitivity as two-terminal voltmeter, (50-ohm coaxial input) 10 microvolts. Field intensity measurements using calibrated dipole. Frequency range includes Citizens Band and UHF color TV Band.

Since 1944 Stoddart RI-FI* instruments have established the standard for superior quality and unexcelled performance. These instruments fully comply with test equipment requirements of such radio interference specifications as JAN-I-225, ASA C63.2, 1664 (SHIPS), AN-I-240, AN-I-42, AN-I-270, AN-I-40 and others. Many of these specifications were written or revised to the standards of performance demonstrated in Stoddart equipment.

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*Radio Interference and Field Intensity.

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Your inquiries will receive prompt attention. Since these components are usually tailored to individual jobs, please include with your inquiry, functional requirements and any physical limitations. Write to Apparatus Dept., 42-328A, General Electric Co., Pittsfield, Mass.
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THE NEW SHURE "VERTICAL DRIVE" CRYSTAL PICKUP CARTRIDGES

Big things often come in little packages... So it is with the superlative new Shure "Vertical Drive" Crystal Cartridges. They reproduce all the recorded music on the new fine-groove recordings—a reproduction that meets the strict requirements of high compliance and full fidelity. The "Vertical Drive" cartridges are requisite for the critical listener—the lover of fine music. They are especially recommended for those applications where true fidelity is essential.

**W 23A** for standard width-groove records.**W 22AB** for both standard and fine-groove records.

Unusually highly compliant, these "Vertical Drive" Cartridges will faithfully track standard records with a force of only 6 grams—micro-groove records with a force of only 5 grams (an added protection for treasured recordings). Will fit standard or special mountings. Have more than adequate output for the average audio stage.

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Microphones and Acoustic Devices
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TUBES AT WORK (continued)

the isolation of the sync source from retrace pulses.

The sync voltage required is higher than with gas triodes, but is not excessive. Less sync input is required at lower plate-supply voltages. Otherwise the plate voltage makes no difference except in the amplitude of the output wave. Voltages from 75 to 300 have been found satisfactory.

Trials with plate-blocked oscillators indicate that they are remarkably free of high-frequency limitations. Their inherent defect is that blocking action is proper only over a comparatively small range of charging resistance—not over 2 to 1. The best tube is a medium-mu triode with a high ratio of mutual conductance to plate current at low values of plate current.

**BIBLIOGRAPHY**

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Chang, Series Sawtooth Oscillator, ELECTRONICS, p 178, Aug. 1950.

Coaxial Feed System for Antennas

**BY JOHN F. CLEMENS**

Project Engineer
Electronics Research Inc.
Evansville, Ind.

Coaxial cable may be used to feed balanced horizontal antennas without interference, noise pickup or power loss due to unbalanced currents in the outer shield. The familiar delta match is used. The outer shield is bonded to the center of the antenna while a shorted section of cable resonates with the inductive reactance of the system.

Coaxial cable has advantages over unshielded or open-wire line in almost every transmission-line application. Generally speaking, attenuation is lower, making it particularly desirable when the line must be relatively long. For receiving applications the low noise pickup...
The shortest distance between guessing and knowing

Fast-moving machines are hard to study under actual working conditions. But with high speed movies you can slow down fast action to a pace the eye can follow.

With the Kodak High Speed Camera you can take pictures of your problem (up to 3200 a second on regular 16mm movie film). Then you can see the operation clearly—enlarged on the projection screen—slowed down 200 times! You can see the reasons for excessive wear, faulty operation, noise, vibration, or early failure. What you see can point the way to better design, better methods, better performance.

High speed photography is not difficult, and its cost is small compared with the savings it makes possible. For more information, write for the booklet “Magnifying Time” or for loan of the 16mm demonstration film made with the Kodak High Speed Camera.

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High-Speed Movies

... another important function of photography
easy
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On a nice clear day finding an iceberg is pretty easy even though nine-tenths of its hulk remains below the surface.

But some other sea prowling isn’t this simple. Locating submarines or sunken objects, charting the ocean floor or “seeing” the shape of the channel beneath calls for the use of intricate electronic devices.

Edo has been a leader in the research and development of depth-finding instruments and sonar equipment with which to find out much more easily and clearly what’s below.

Already, Edo equipment, designed and manufactured for the United States Navy, is making possible new accuracy in underwater detection techniques.

UNDER-WATER “EYES”

Edo has developed and manufactured for the U. S. Navy a new sonar device which makes it possible to see the shape of the ocean floor both below and to either side of a ship.

Known as the Contour Bottom Scanner, the instrument gives a continuous picture of the bottom’s profile on a cathode ray tube. It has many potential uses for navigating in shallow waters and locating sunken objects.

The C. B. S. is but one of a wide variety of electronic devices developed and perfected by Edo’s highly qualified electronics engineers who have behind them Edo’s twenty-five years of diversified experience in engineering, precision manufacturing, research and development.

For a complete picture of Edo’s activities, you’ll enjoy reading our recently published Twenty-Fifth Anniversary booklet. Write Dept. ES-4, Edo Corporation, College Point, N. Y. for your copy today.

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The above graph shows, strikingly, the dollars and cents savings possible with Rectox Selenium Rectifiers.

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An exclusive Westinghouse process of manufacture assures lowest rate of forward aging and constant, uniform cell performance.

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* In a bridge circuit, total savings are the product of: the cells saved in series (due to 24 volts d-c per cell) times 4 (the number of arms in the bridge) times the number of cells in parallel in each bridge arm. For example: A 4-5-3 connection cut to 4-4-3 by use of one fewer cell in series per arm means 1 saved x 4 x 3 or 12 total cells saved.

Westinghouse Rectox Rectifiers & Chargers for ALL INDUSTRIES
of coaxial cable is a definite advantage. For this reason it is especially suitable for television receiving antenna leads. Coax is entirely free from weather effects while the ribbon type of line is usually affected by rain and moisture, often deteriorating rapidly from exposure in coastal regions.

No Split Element

A system of coaxial-cable feed for balanced horizontal antennas should find wide application to television and f-m receiving antennas and transmitting antennas such as parasitic beams. The system described has a feature of prime importance in these applications: splitting the driven element is unnecessary. A feed system which necessitates breaking the antenna is difficult to fabricate since insulating materials of sufficient strength and electrical quality are not available for large self-supporting structures.

A serious problem in applying coaxial feed to a balanced antenna is that of eliminating unbalanced or antenna currents from the outer shield. If present, such currents cause loss of the normal antenna pattern and the low noise pickup feature of coaxial cable. In transmitting, currents on the outer shield may cause feedback, interference or power loss.

The system described achieves balanced feedline currents as determined by test. In general, a symmetrical system can be relied upon for absence of unbalance effects. The diagram of the system, Fig. 1, discloses almost perfect symmetry.

Delta Match

The impedance between two symmetrically located points on an antenna rises from zero when the points are adjacent, to a very high value when the points are at opposite ends of the antenna. Therefore, in any type of resonant antenna, it is possible to select two points between which the resistive component of impedance is equal to the characteristic impedance of the transmission line. This is the basis for the familiar delta match.

The impedance between two driving points is not purely resistive;
Insulate all these parts with tough TEFiON tape

New Du Pont plastic offers unusual combination of electrical, mechanical and thermal properties for:

- Slot Liners
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**MECHANICAL.** "Teflon" tetrafluoroethylene resin is extremely tough—withstanding considerable abuse in assembly and in use. Doesn’t deteriorate with time. In applying, it’s easy to handle, smooth, conforms well to corners and odd shapes—is adaptable to automatic operations.

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ELECTRONICS — October, 1950
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The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

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**ENDURES HEAT** — Temflex 105 is Underwriters' Laboratories approved for continuous operation at 105°C!

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The actual impedance may always be represented by an equivalent series circuit of resistance and reactance. Prediction of the actual input impedance between two driving points is difficult in a parasitic array although approximate formulas are available for the half-wave dipole.

The driving points must be chosen empirically to satisfy the requirement of an equivalent series resistive component equal to the characteristic impedance of the transmission line. Once these points have been determined, the series reactive component of the impedance may be calculated.

**Shield Bonded**

Assume that two symmetrically-located driving points have been located on the antenna. If the shield of a coaxial cable is connected to the center of the antenna, no antenna current will flow into the cable since the voltage at the center of the antenna is negligible. The cable may also be run along the antenna since it will act merely to increase its effective diameter. If protrusion of the inner conductor is negligible, no current will flow in the cable. Accordingly, it may be extended to one of the driving points. The shield should be well bonded to the antenna at this point.

The center conductor of the cable is looped past the center of the antenna to the opposite driving point. The coax sees a load resistance paralleled by the inductance of the length of the antenna element between driving points, and in series with the inductance of the ex-
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   The 72-inch-high standard relay rack is completely wired at the factory. Just install the antenna, plug the station into any standard electrical outlet, and it's ready for operation.

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   All adjustments are made from front panels. Plug and receptacle connections permit instant removal of all components. Simple circuits minimize the number and types of tubes, require no special training or test equipment.

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One OF A LINE....

Guardian Control units—tiny A.C. relays to heavy-duty D.C. Solenoid contactors—are available in a wide range of specifications and mountings. One of a line of hermetically sealed relays is shown above with the A.N. Connector type container. Other hermetic seal containers incorporate the Octal Plug, Screw and Lug Header terminals. We invite you—get your cost-free copy of Guardian’s Hermetically Sealed Relay Catalog now.

Series 220 operates as an A.C. Relay capable of breaking currents up to 20 amps. at 230 v., 60 c., A.C., non-inductive load. Contacts are same alloy used in Guardian Solenoid Contactors, specially compounded to withstand high loads. Dual contacts reduce arcing to a minimum. Standard hermetically sealed unit weighs 6.2 ounces. Highly insulated. Compact. Low priced.

Write—ASK US TO MAKE SPECIFIC RECOMMENDATIONS. NO OBLIGATION.

GUARDIAN ELECTRIC
1675-L W. WALNUT STREET
CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

ELECTRONICS — October, 1950
DIRECT WRITING RECORDERS

Records are produced by a heated writing stylus in contact with heat sensitive paper. The paper is pulled over a sharp edge in the paper drive mechanism (standard speed 25 mm/sec., slower available) and the stylus wipes along this edge as it swings, thus producing records in true rectangular coordinates. The writing arm is driven by a D'Arsonval moving coil Galvanometer with an extremely high torque movement (200,000 dynes cm per cm deflection).

This recorder assembly may be obtained in base chassis form, as illustrated (51-606) with or without built-in timer, or, with the addition of a stylus heating transformer, temperature controls, and control panel (127) or, with the entire assembly, controls and control panel enclosed in a mahogany carrying case (127C). Complete catalog available, see below.

INSTRUMENT AMPLIFIERS

A general purpose, A.C. operated driver amplifier for use with model 127 Recorder, comprising three direct coupled push-pull stages. Maximum sensitivity 50 mV per cm, minimum sensitivity 5 mV per cm, with four intermediate ranges. Balanced input terminals available with impedances of 5 megohms to ground. Complete information in catalog shown below.

AMPLIFIER-RECORDERS

Model shown at right is a single channel unit comprising above Amplifier 126 and Recorder 127, contained in one mahogany carrying case, and designed for use in the industrial field as a direct writing vacuum tube recording voltmeter capable of reproducing any electrical phenomena from the order of a few millivolts to more than 200 volts. More complete data in catalog shown below.

At lower right is a typical "Poly-Viso" multiple channel direct writing Recorder and Amplifier in console. Numerous combinations of this recorder and associated amplifiers and accessories are available. The Multi-channel Recorder (Model 165) provides for the simultaneous registration of up to four input phenomena, using the same principles and method as for the Recorder Assembly above. In addition, the "Poly-Viso" Recorder provides a selection of eight paper speeds: 50, 25, 15, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec., and for the use of 4, 2, or 1 channel recording Permapaper. The Amplifier equipment is housed in a rack which has space for four individual driver amplifiers (electrically identical to model 126, above) and one 4-channel preamplifier.

For complete catalog giving tables of constants, sizes, weights, illustrations, general description, and prices, address:

SANBORN COMPANY
Industrial Division
CAMBRIDGE 39, MASS.

TUBES AT WORK

(continued)

tended center conductor. The inductance of both antennas and center conductor can be determined from

\[
L = 0.00508 \left( \frac{2.303 \log \frac{4a}{d} - 0.75}{a} \right)
\]

where \(a\) and \(d\) represent length and diameter of each conductor in inches, and \(L\) is given in \(\mu\)h.

The actual equivalent circuit is shown in Fig. 2A where \(R_e\) is unknown while \(L_o\), the inductance of the length of antenna between driving points, has been calculated.

The inductance of the extended center conductor, \(L_o\), may likewise be calculated. In Fig. 2B the parallel circuit of \(R_e\) and \(L_o\) has been replaced by the series equivalent \(R_s\) and \(L_s\). In this case, \(R_s\) is the characteristic impedance of the line. Inductance \(L_s\) may be calculated from

\[
X_s = \frac{X^2 + R_s^2}{X_s}
\]

\[
R_s = \frac{X^2 + R_s^2}{R_s}
\]

\[
X_s = \frac{X + \sqrt{X^2 - 4R_s^2}}{2}
\]

Resistance \(R_s\) may be determined likewise if desired.

**Resonating Load**

Once \(X\) has been determined the next step is to combine it with the reactance of \(L_s\) and insert a capacitance, \(C\), of such a value to resonate

FIG. 2—Equivalent circuits of coaxial lead system show effect of shunted line and distributed inductance
The DAVEN Type 35-A, Distortion and Noise Meter, is a new, skillfully engineered instrument that provides a rapid, accurate means of measuring distortion, noise and hum level in audio frequency equipment.

Of particular importance is the fact that there is no balancing or laborious time consuming tuning required to make measurements. The user need only push a button and the unit is automatically balanced. This is accomplished by the use of a series of 8 fixed band rejection filters covering the range 50 cycles to 15 Kc., followed by a stable, high quality, wide range (50 cycles to 45 Kc.), high gain amplifier. There are no tube circuits or other sources of inherent distortions, making it possible to measure low levels of distortion accurately over a wide level range.

**SPECIFICATIONS**

**RESIDUAL DISTORTION:** No tube circuits or non-linear devices between input of set and filter input.

**DISTORTION MEASUREMENTS:** Filters provided for 50, 100, 400, 1000 cycles, 5 Kc, 7.5 Kc, 10 Kc, and 15 Kc with cut off of −70 db. Distortion measurements to 0.1% full scale meter deflection with zero level input.

**NOISE MEASUREMENTS:** With zero db input, limit is −80 db. At +40 input, limit is −115 db below input.

**AMPLIFIER FREQUENCY RANGE:** 50 cycles to 45 Kc.

**ACCURACY:** Filters are down 70 db at fundamental frequencies, and within ±0.5 db of flat response at the second harmonic. Absolute accuracy of measurement can be depended upon to be within ±5%.

**RESIDUAL NOISE LEVEL:** Below −80 db at gain control full on. Multiple gain control employed so that residual noise drops to −90 db when gain control is set at −30, −100 db when gain control is set at −20, etc.
Since Carboloy Company, Inc., pioneered cemented carbides in 1928, research and development have continued to occupy a major role in the Carboloy program. We welcome the challenge of new fields provided by latest additions to the Carboloy Company family of special metals.

LOOK to CARBOLOY CO., INC.
for the finest in special metals

CARBIDES • ALNICO • HEVIMET
NEW INTERLEAVE COIL WINDER IS FULLY AUTOMATIC

Universal's new high speed automatic No. 107 winder produces accurately-wound paper-insulated or acetate-insulated coils at a very high rate of output.

Automatic feeding Single or laminated insulating sheets are fed into the machine automatically. Rate of feed, with either paper or acetate, can be as high as 25 inserts per minute.

Thus, on a coil containing 100 wire turns per layer, the machine can be operated at winding speeds up to and including 2500 rpm.

An entirely new type of delivery shelf has been designed to provide high accuracy. It imparts a uniform backward pull on the paper as it is fed into the coil, resulting in windings of highest possible density.

This delivery shelf will handle insulating papers, either “Kraft” or “Glassine,” from .0006 in. to .003 in. in thickness, and where the machine is equipped with devices for removing static, acetate sheet is handled at high winding rates.

The machine utilizes a single width of insulating paper, and this can be 24 in. or up to 25 in. maximum if required.

Accurate wire control Wire sizes accommodated range between No. 19 and No. 42 (B&amp;S). The creel stand is independently mounted, and holds up to 30 wire spools at a time.

The wire spool spindle is of the latest design, with solid construction. The braking device is mounted on the rear of the machine to give better balance between the wire spools and the higher winding speed.

Efficient winding A quick return of the wire guides is assured at the end of each wire layer, and thus there is no possibility of crossed turns due to delayed return, particularly where wear develops.

The same efficient traverse mechanism used in the Universal No. 105 Coil Winder has been adopted for the No. 107. No changes in cam are necessary for various lengths of wire layer.

Special attachments These include an auxiliary “space-wind” traverse for spacing the first and last layers of high-tension coils. A special “mid-tap” attachment permits shifting the wire guides at the end of a wire layer for “tap” location or to arrange for starting and finishing leads.

Where required, a “dual-counter” is available so that the machine will stop automatically for the removal of a mid-tap.

The new No. 107 Coil Winder has already demonstrated, in preliminary installations in plants of several prominent electrical manufacturing firms, its ability to turn out coils of the highest quality.

UNIVERSAL WINDING COMPANY
P. O. Box 1605 Providence 1, R. I.

FOR WINDING COILS IN QUANTITY
ACCURATELY . . . AUTOMATICALLY
USE UNIVERSAL WINDING MACHINES

ELECTRONICS — October, 1950
BALLANTINE
STILL THE FINEST
in
ELECTRONIC VOLTMETERS

Ballantine pioneered circuitry and manufacturing integrity assures the maximum in
SENSITIVITY • ACCURACY • STABILITY

- All models have a single easy-to-read logarithmic voltage scale and a uniform DB scale.
- The logarithmic scale assures the same accuracy at all points on the scale.
- Multipliers, decade amplifiers and shunts also available to extend range and usefulness of voltmeters.
- Each model may also be used as a wide-band amplifier.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>FREQUENCY RANGE</th>
<th>VOLTAGE RANGE</th>
<th>INPUT IMPEDANCE</th>
<th>ACCURACY</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>10 to 150,000 cycles</td>
<td>1 millivolt to 100 volts</td>
<td>1.7 meg, shunted by 30 mfd</td>
<td>3% up to 100 KC, 3% above 100 KC</td>
<td>$200.00</td>
</tr>
<tr>
<td>304</td>
<td>30 cycles to 3.5 megacycles</td>
<td>1 millivolt to 100 volts</td>
<td>1 meg shunted by 9 mfd, on low range</td>
<td>3% except 5% for frequencies under 100 cycles and over 3 megacycles and for voltages over 1 volt</td>
<td>$225.00</td>
</tr>
<tr>
<td>305</td>
<td>Measures peak values of pulses as short as 3 microseconds with a repetition rate as low as 20 per sec. Also measures peak values for sine waves from 10 to 150,000 cps.</td>
<td>1 millivolt to 1000 volts Peak to Peak</td>
<td>2.2 mgs shunted by 8 mfd, on high ranges and 15 mfd, on low range</td>
<td>3% on sine waves 5% on pulses</td>
<td>$280.00</td>
</tr>
<tr>
<td>310</td>
<td>10 cycles to 2 megacycles</td>
<td>100 microvolts to 100 volts</td>
<td>Same as Model 305</td>
<td>3% below 500 KC 3% above 500 KC</td>
<td>$225.00</td>
</tr>
</tbody>
</table>

For further information, write for catalog.

BALLANTINE LABORATORIES, INC.
100 FANNY ROAD, BOONTON, N. J.

TUBES AT WORK (continued)

the total inductive reactance as shown in Fig. 2C. A capacitor of capacitance \( C \) may be inserted in the center conductor anywhere along its length to obtain an impedance match.

Usually a capacitor is not used because of weather effects. Instead, a length of cable may be used to present the same capacitive reactance. Although a length of either open or shorted cable may be used, the shorted cable is preferable because of its lower loss. If a shorted cable is used the proper electrical length may be computed from

\[
X = -\frac{j Z_0 \tan \theta}{f}
\]

(5)

where \( X \) is the desired capacitive reactance. The electrical angle \( \theta \) may be converted to inches from

\[
D = \frac{(32 \theta) (v_p)}{f}
\]

(6)

where \( \theta \) is expressed in degrees, \( f \) in megacycles and \( v_p \), the propagation velocity, as a fraction.

The matching section and antenna may be bonded along their mutual length without altering the performance of either.

Allowable Mismatch

The fact that the antenna inductance, \( L_a \), shunts the resistive component, \( R_n \), permits the system to be used when the radiation resistance exceeds the characteristic impedance of the line. A 50-ohm coaxial cable may thus be matched to a free-space dipole having a radiation resistance of 73 ohms.

The cable may be fed inside a tubular antenna element with the center conductor emerging through a hole at one driving point and re-entering the antenna tube at the other driving point.

Experimental Antennas

A test of the system was first made at 300 mc with a close-spaced three-element parasitic array. Instead of the capacitive line section, a small variable capacitor was used. A standing wave ratio of less than 1.5 to 1 was readily obtained. Antenna elements were 3/16 silver-plated brass rods and the feed line was RG-58/U.

The system was next tested on a scaled-up version of the three-element antenna at 29 mc. Spacing
FOR ARMED SERVICES COMPONENT REQUIREMENTS—1N69 AND 1N70

GENERAL ELECTRIC germanium diodes must meet the most rigid specifications, yet volume production continues to drive their prices steadily downward. Compare new G-E prices with all others... then check the following reasons for this ever-widening acceptance among electronics designers, engineers, and equipment makers:

Dual Mounting—For Convenience—Versatile G-E diodes can be mounted two ways: clip them into place by means of their husky, non-oxidizing nickel pin terminals... or use each diode's well-tinned, copper-clad steel leads to solder it into the circuit. These leads are strong and flexible, conduct less heat than ordinary types, and thus prevent damage during soldering.

Platinum Whisker—For Strength—To assure stability and long life, the G-E diode's pigtail whisker is of platinum, which, unlike tungsten, can be strongly welded to germanium.

Moisture Resistant Insulating Case—For Protection—A special insulating case of milled, mineral-filled phenolic protects this unique welded contact. The case is also tapered to assure correct polarity mounting. These diodes are so easy to handle—you can install 'em in the dark!

Looking For A Long Life Diode? We've got 'em! The complete G-E line includes four general purpose diodes, two JAN types, two TV types (more than half a million of these have already been supplied to TV receiver manufacturers), one u-h-f model and the high quality quad of four balanced diodes. For product and application engineering service, inquire at the G-E electronics office near you, or write: General Electric Company, Electronics Park, Syracuse, N.Y.

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NEW DIODE HANDBOOK
Now in 2nd Printing! Here are 68 pages of facts on characteristics, advantages, and circuitry of diodes. Charts, curves, diagrams, typical applications. Leatherette bound, loose-leaf style. Supplementary sheets furnished free as published. Worth many times its modest price of $1.25. Send check or money order to: General Electric Company, Section 4100 Electronics Park, Syracuse, New York.
No matter what your panel instrument problem is, Simpson Electric Company engineers will be glad to help you solve it. Every day they are confronted with individual design problems.

Behind every Simpson instrument is a world-wide reputation for quality. Simpson movements have greater ruggedness and accuracy, because of the full bridge-type construction and soft iron pole pieces.

When Simpson helps you with your problem, you benefit from this world-wide reputation and the years of experience of Simpson engineers.

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SIMPSON ELECTRIC COMPANY
5200-18 WEST KINZIE STREET, CHICAGO 44, ILLINOIS
IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO
PUBLIC demand for bigger and better television at low price has brought manufacturers face to face with new problems in reducing weight and holding down set cost. And, like so many other industries, television has turned to Stainless Steel to solve this problem.

A new grade of U·S·S Stainless Steel, known as U·S·S 17-TV, has been developed especially for this television application. Having an appropriate coefficient of expansion, it permits fusing of the faceplate and neck to the metal cone with a strong air-tight seal.

By using U·S·S 17-TV instead of glass for the conical section of the picture tube, you can cut the weight of this key part over one-third. The result is important savings in handling, shipping and packing costs. The tube can be shipped installed in the receiver with little danger of damage in transit.

In addition to its light weight, other inherent advantages of Stainless make important contributions here. Its strength enables the tube to withstand extreme pressures and reduces breakage hazards. Because glass area is held to a minimum, and because of the protection provided by the Stainless Steel cone, hazards of implosion are minimized—in tube manufacture, in installation and in service. The U·S·S 17-TV cone permits the use of a flawless, smooth glass face, thus resulting in cleaner, and sharper pictures.

Whether you manufacture or use cathode ray tubes, investigate the possibilities of U·S·S 17-TV Stainless Steel, developed especially for the television industry. Like all other grades of U·S·S Stainless, it is made to give you the finest possible performance.

U·S·S STAINLESS STEEL

U·S·S STAINLESS STEEL

ELECTRONICS — October, 1950
COTO-COIL Windings

Can Provide the Answer

Through two world wars and intervening years of peace, Coto-Coil has earned a reputation for windings which conform to specifications with great exactness. Windings which will function under many and severe operating conditions.

We offer engineering ability with a wealth of experience. Our methods are modern... our equipment of latest design.

Coil winding is our business. That's all we have to sell. We'd like to serve you and shall be glad to quote.

TUBES AT WORK

(continued)

from antenna to director was 0.1 wavelength and from antenna to reflector, 0.15 wavelength. The antenna was 194 inches long, the reflector, 204 inches, and the director, 184 inches. All elements were 1 inch in diameter.

With a series variable capacitor and a Micro-Match, two feed points were located 20 inches each side of center. Type RG-8/U cable was then connected as described. The cross lead was formed by 42 inches of center conductor from which the shield had been removed. The cross lead was allowed to sag about three inches from the center of the antenna. The driven element is diagrammed in Fig. 1.

The inductance of 42 inches of wire with a cross-sectional area approximately equivalent to number 14 wire from Eq. 1 is 1.52 µh. The inductance of the antenna, \( L_a \), is 0.862 µh. Reactance \( X_a \) is therefore 158 ohms at 29 mc. Reactance \( X_i \) from Eq. 4 is 19 ohms. Reactance \( X_i \) is 277 ohms, making the total inductive reactance 296 ohms.

The capacitive reactance required for resonance is 296 ohms. This capacitive reactance was obtained by a 72-inch length of RG-8/U, shorted at one end, as calculated by Eq. 5.

First tests on the antenna were made with the shield of the capacitive shorted section and the driving cable bonded to the antenna and to the metal supporting pole throughout their mutual lengths. On a second antenna the shields were bonded to the antenna at the driving points where the vinyl jacket was removed from the cable but the remainder of the cable was left with the insulation on and merely taped along the antenna and supporting pole. No difference in performance was detectable in the two systems.

Standing-Wave Ratio

The antenna was mounted one wavelength above ground and tested with a Jones Micro-Match. The standing-wave ratio was measured as 1/1 at 29 mc, the resonant frequency of the antenna, rising to approximately 1.5/1 at 28.5 and 30.0 mc.

A question arises as to the desirability of a resonant system for im-
Your First Choice for Selenium Rectifiers

Federal

To meet the most exacting requirements for MILITARY END-USE EQUIPMENT

Federal introduced the Selenium Rectifier in this country and has since been FIRST IN

- Experience
- Development
- Production
- Performance
- Dependability

Federal Selenium Rectifier stacks are available as components, and in sub-assemblies and complete assemblies.

As America's oldest and largest manufacturer of Selenium Rectifiers, Federal has had unrivaled experience in developing and building Selenium Rectifiers to meet an almost unlimited range of specifications. Millions of Federal Selenium Rectifiers are serving with efficiency, dependability and economy in countless applications... from aircraft to submarines and from subminiature special equipment to heavy duty power supplies.

This Federal background of leadership in the field of Selenium Rectifiers has never been of greater importance than it is today. It is your assurance of obtaining Selenium Rectifiers that adhere to the most rigid requirements for military end-use equipment.

Federal engineers, with their wealth of experience in rectifier design and application, will assist you in determining the proper Selenium Rectifier to meet your power conversion requirements. Address your inquiries to Department F-213.
Mr. Guy W. Probst

That's what Guy W. Probst, owner of the Lockhaven Electric Repair Co., Lockhaven, Pa., says about General Electric's 9574. Here is his statement:

"G-E all-purpose insulating varnish 9574 gives you a cover coat you can see and that fills up between the Formex wires. I've had very good success with it on armatures up to 2000 RPM. On formed coils I can bake before forming and the turns don't come apart when you pull the coil. I've had no trouble with sludging, and all my work is hot dipped. I find that I only use about half as much 1201 Glyptal as a cover coat on 9574 as I had to use over the varnish I had been using, and I get higher gloss and better bonding when 1201 is used over 9574."

*G-E 9574 gives excellent results on all types of coils except extra-high-speed armatures. It is one of G-E's complete line of electrical insulating materials, including adhesives, wedges, cements, compounds, cords and twines, sleeving, wire enamels, mica, papers and fibers, pernigals, tapes, tubing, varnished cloths, varnishes.

SEND FOR BULLETIN!

If you haven't yet tried G-E 9574, get in touch with your local G-E Distributor, or write for our new bulletin to Section K-2, Chemical Department, General Electric Company, Pittsfield, Mass.
Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants ... even where the total population is Zero.

AEROCOM'S

Dual Automatic Package-Type Radio Beacon

for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters, one AK-3B keyer, one ACA automatic transfer, and an antenna tuner. (Power needed 110 volt or 220 volt - 50/60 cycles)

Frequency range 200 - 415 Kcs: self-contained P. A. coil covers entire range; 1"plug-in" crystal oscillator coil covers 200 - 290 Kcs., other 290 - 415 Kcs. (Self-excited oscillator coils covering same ranges are available). High level plate modulation of final amplifier is used, giving 35% tone modulation in 100 watt transmitter and 35 - 50% in 50 watt model. Microphone P-T Switch when depressed interrupts tone, permitting voice operation.

Using 866A rectifiers, unit can be operated in air temperature range 0°c to +45°c; using 3B25 rectifiers, -35°c to +45°c; humidity up to 95%.

Aerocom's Automatic Transfer unit will place the "stand-by" transmitter in operation when main transmitter suffers loss (or low level) of carrier power or modulation. The characteristics of the keyed call letters are so modified on "stand-by" that a distant monitoring station can determine whether the main or "stand-by" transmitter is operating.

Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs. Engineering data on this unit and other Aerocom communications products are available on request.

CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT
pedance matching such as the length of coaxial cable used to produce capacitive reactance. Reference to Fig. 2C shows that the series resonant circuit includes a resistance of 51.5 ohms. The total series inductive reactance has been calculated as 296 ohms. Thus, the Q of the series circuit is 5.75. Obviously, the feed system is a wide-band device compared to the three-element parasitic array on which it is used.

The 29-mc beam antenna was next checked for line current balance. The pattern of the antenna was first measured with a field-strength meter. Maximum radiation was found to be perpendicular to the antenna elements. An unbalanced antenna will usually show an altered pattern with the maxima occurring slightly off center. The field-strength meter was then positioned a fixed distance from each antenna-element tip in turn and the deflection of the meter was found to be the same in each case. This test indicates that the voltage at each antenna tip is the same. Small incandescent bulbs hung from each end of the antenna showed the same brilliance.

Further Tests

Next, the center conductor was broken close to the first driving point where the conductor emerged from the shield. A receiver connected to the line was now completely dead. The absence of pickup showed that the cable had no signal pickup of its own. Type RG-8/U cable may be used to carry transmitter outputs of two kw or so with the line matched. A standing wave exists in the capacitive shorted line section. Therefore care must be used to select a line of sufficient insulation capacity. For a one-kilowatt transmitter the line current which must flow through the matching section is 4.41 amperes.

The voltage drop across the capacitive section of coax is 1,310 volts. This voltage appears between the inner conductor and the shield of the capacitive matching section at the point where the inner conductor enters the shield. Since RG-8/U has a maximum voltage rating of 4,000 volts rms, it should
In this panel are illustrated standard models of HELIPOT multi-turn and single-turn precision potentiometers—available in a wide range of resistances and accuracies to fulfill the needs of nearly any potentiometer application. The Beckman DUODIAL is furnished in two designs and four turns-ratios, to add to the usefulness of the HELIPOT by permitting easy and rapid reading or adjustment.

MODELS A, B, & C HELIPOTS

A-10 turns, 46° coil, 1-13/16" dia., 5 watts—resistances from 10 to 300,000 ohms.
B-15 turns, 140° coil, 3-5/16" dia., 10 watts—resistances from 50 to 500,000 ohms.
C-3 turns, 13-1/2° coil, 1-13/16" dia., 3 watts—resistances from 5 to 30,000 ohms.

MODELS D AND E HELIPOTS

D—25 turns, 224° coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 273° coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.

LABORATORY MODEL HELIPOT

The ideal resistance unit for use in laboratory and experimental applications. Also helpful in calibrating and checking test equipment. Combines high accuracy and wide range of 10-turn HELIPOT with precision adjustability of DUODIAL. Available in eight stock resistance values from 100 to 100,000 ohms, and other values on special order.

MODELS R AND W DUODIALS

Each model available in standard turns-ratios of 10, 15, 25, and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.

R—2" diameter, exclusive of index.
W—4-3/4" diameter, exclusive of index. Features finger hole in knob to speed rotation.

For many years The Helipot Corporation has been a leader in the development of advanced types of potentiometers. It pioneered the helical potentiometer—the potentiometer now so widely used in computer circuits, radar equipment, aviation devices and other military and industrial applications. It pioneered the DUODIAL—the turns-indicating dial that greatly simplifies the control of multiple-turn potentiometers and other similar devices. And it has also pioneered in the development of many other unique potentiometric advancements where highest skill coupled with ability to mass-produce to close tolerances have been imperative.

In order to meet rigid government specifications on these developments—and as the same for all its precision potentiometers—The Helipot Corporation has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001" diameter. These winding machines are further supplemented by special testing facilities and potentiometer “know-how” unsurpassed in the industry.

So if you have a problem requiring precision potentiometers your best bet is to bring it to The Helipot Corporation. A call or letter outlining your problem will receive immediate attention!

THE HELIPO T CORPORATION, SOUTH PASADENA 2, CALIFORNIA

For Precision Potentiometers come to Helipot

The versatility of the potentiometer designs illustrated above permit a wide variety of modulations and features, including double shaft extensions, changing double shaft extensions, adding ganged assemblies, adding additional winding installations, chemical polarity, high and low temperature operation, and close tolerances on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.

3-GANGED MODEL A HELIPOT AND DOUBLE SHAFT MODEL B HELIPOT
All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment. The Model F, and the A, B, and C HELIPOTS are available in multiple assemblies, ganged at the factory on common shafts, for the control of associated circuits.

MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 60 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 18 additional taps on the middle two sections. Such taps permit use of paddling resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.
Maximum Reliability Every Time
with AIRPAX CHOPPERS

now... the A586

60 CYCLE CHOPPER
Precision engineered for reliability...
for amplification of low level DC signals... The A586 is supplied hermetically sealed... almost unaffected by shock, vibration, temperature extremes.

Moisture-Resistant Electrical Connectors

No question about it... JOY plugs and sockets are today's outstanding electrical connector value! Molded as one-piece Neoprene units and factory vulcanized to cords, they won't crack or shatter under hard blows — are surprisingly immune to climatic changes — and are trim, safe and easy to handle. Whenever advantageous, JOY Connectors are equipped with the famous MINES "Water-Sealing" face. Cutaway illustration in circle shows how close fitting segments on mating Male and Female plugs positively "Seal-out" dirt and moisture by enclosing contacts in a resilient rubber housing. Ask for a complete description on this and other advantages that only JOY Connectors provide.

A wide variety of sizes, shapes and pin combinations are available to meet the portable power requirements of TV, FM, AM or PA Circuits. Illustrations show JOY'S No. 2C166M Portable Male Plug and No. 2C166F Portable Female.

MOISTURE-RESISTANT ELECTRICAL CONNECTORS

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October, 1950 — ELECTRONICS
Saving energy for better low-cost telephone service

In the waveguides which conduct microwaves to and from the antennas of radio relay systems, current is concentrated in a surface layer less than 1/10,000 inch thick, on the inner surface of the waveguide. When these surfaces conduct poorly, energy is lost.

To investigate, Bell radio scientists devised exact methods to explore this skin effect at microwave frequencies.

Scratches and corrosion, they found, increase losses by 50 per cent or more. Even silver plating, smooth to the eye, can more than double the losses of a polished metal. Very smooth conductors, like electropolished copper, are best. An inexpensive coat of clear lacquer preserves initial high conductivity for many months.

Energy saved inside a microwave station is available for use in the radio-relay path outside. So stations can sometimes be spaced farther apart, and there will always be more of a margin against fading. Here is another example of the practical value of research at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST
NEW SNAP-Acting
STEVEN'S THERMOSTATS

- narrow differentials, as low as 5°F
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Now — for the first time — small, snap-acting thermostats in adjustable, non-adjustable or manual reset styles are available to manufacturers of devices requiring sensitive, precise control of high-wattage heater loads.

These new Stevens thermostats feature an electrically independent bi-metal element in close contact with mounting base. Thus, thermostat closely follows temperature of controlled device and bi-metal responds rapidly to temperature changes. Contact pressure is positive until the actual instant the contacts snap open.

Interchangeable with Stevens Type S units, the new Stevens thermostats insure satisfactory performance for your appliances and industrial apparatus. Always specify Stevens thermostats — they perform better... last longer.

A-3106

STEVENS manufacturing company, inc.
MANSFIELD, OHIO

TUBES AT WORK (continued)

be adequate for transmitter powers of well over one kilowatt.

REFERENCES


British Developments in Instrumentation

BY JOHN H. JUPE
Middlesex, England

A review of recent developments in Britain discloses some novel applications of electron tubes at work, particularly in the field of scientific instrumentation.

It is sometimes required to know the size of carbon particles in luminous flames. A particle size meter has been developed by the British Iron and Steel Research Association to do this efficiently.

The instrument uses an interrupted parallel beam of ultraviolet light which is allowed to impinge on the region of the flame under examination. The cloud of luminous carbon particles in the flame will scatter the ultraviolet light which is then detected by a multiplier-type photoelectric cell and a-c amplifier. A small monochromator is interposed to select the light falling onto the photocell. By making the wavelength of the light comparable with the size of the particles, the character of the scattering is very dependent on the size, which can thus be measured in terms of the amplified photocell current.

Midget Magnetometer

It has been known for a long time that if the metal germanium is prepared with a sufficient degree of purity it exhibits a pronounced Hall effect, its electrical resistance is a measure of the magnetic field in which the metal is placed. This effect has now been used as a basis of simple, self-contained instru-
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10 to 10,000,000 MEGOHMS

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It gives details of both the Standard and High Value Resistors, including construction, characteristics, dimensions, etc. Copy with Price List mailed on request.

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What to expect from ATOM BOMB EXPLOSION

Here is a timely survey, prepared under the direction of the Los Alamos Scientific Laboratory, that presents the results to be expected from the detonation of atomic weapons. This book gives every technically interested person — municipal authorities, civil and utility engineers, etc.—an understanding of the effects of this enormous energy release when used as a weapon in war, as a basis for the development and administration of protective measures. It gives the principles and description of atomic explosions, and discusses physical damage (from air blast, ground, and underwater shock), radioactive contamination, and effects on personnel.

Commended by the Civil Defense Office, National Security Resources Board.

Just Out

THE EFFECTS OF ATOMIC WEAPONS

456 pages, $3.00

The book's detailed description of the physical phenomena associated with atomic explosions provides valuable basic data helpful in the preparation of practical plans for atomic war defense. To help you better understand the effects of these weapons, you are given vital information on thermal radiation and immediate effects — thermal ionization, radiation and the protection of personnel. You will also find an appendix on calculating the deflection of structures by blast wave, and pertinent information on the estimation of hazards from world-wide contamination. These predictions in this book represent the most nearly quantitative approach to atomic bomb phenomena which can be published at this time.

Examine the book 10 days FREE

Prepared for and in cooperation with the U. S. ATOMIC ENERGY COMMISSION and DEPARTMENT OF DEFENSE

October, 1950 — ELECTRONICS
Center, on black background, are the eight standard sizes of Arnold Tape-Wound Toroids. Around them are a number of other cores of special nature produced for individual needs.

**ARNOLD TAPE-WOUND TOROIDAL CORES**

**APPLICATIONS**
- MAGNETIC AMPLIFIERS
- PULSE TRANSFORMERS
- NON-LINEAR RETARD COILS
- and TRANSFORMERS
- PEAKING STRIPS, and many other specialized applications.

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Arnold Tape-Wound Toroids are available in eight sizes of standard cores—all furnished encased in molded nylon containers, and ranging in size from ½" to 2⅛" I.D., ⅛" to 3" O.D., and ⅛" to ½" high.

**RANGE OF TYPES**
These standard core sizes are available in each of the three magnetic materials named, made from either .004", .002", or .001" tape, as required.

**DELTAMAX 4-79 MO-PERMALLOY SUPERMALLOY***

In addition to the standard toroids described at left, Arnold Tape-Wound Cores are available in special sizes manufactured to meet your requirements—toroidal, rectangular or square. Toroidal cores are supplied in protective cases.

*Manufactured under licensing arrangements with Western Electric Company.

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**THE ARNOLD ENGINEERING COMPANY**
SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois
Audio fidelity of a television receiver is tested in the echo-free room built by General Electric Co. Ltd. of England.

ments for measuring and exploring magnetic fields.

A small flake of germanium \( \frac{3}{8} \times 0.016 \) -inch in thickness is mounted in a probe and is thus capable of being used to measure field strengths in very small gaps. This instrument has an overall range of 0 to 25,000 gauss, in three ranges and has a direct-reading microammeter indicator.

A recent pyrometer development for use at temperatures above 750°C consists of a back-silvered, heat-resisting glass hemisphere. This is so made that black-body radiation can pass out through a small unsilvered hole at the top of the hemisphere, while radiations of wavelength longer than 2.5 \( \mu \) are absorbed by the glass. This prevents reflected radiation from interfering with the heat loss from the surface. A calibrated photocell with a very quick response, an alkali-metal cell, is placed behind the unsilvered hole and the cell current will then be a measure of the true temperature of the surface under examination.

Echo-Free Room

A piece of equipment which has many uses in the electronic and other electrical fields, as well as in mechanical engineering, is an echo-free room.

Such a room has recently been installed by engineers of the General
compare the speed, economy, accuracy of product marking by **E-Z CODE**

**E-Z CODES** are applied with finger-tip pressure, without moistening. They stick permanently...will not pop, peel or curl even in extremes of heat and humidity...or when pulled through conduit. E-Z Codes provide the fastest, most accurate and inexpensive method of wire marking.

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**E-Z CODES** make even the most complicated wiring circuit an open book to even "green" employees. They eliminate the need for large inventories of colored wire and speed assembly time. They insure accuracy, eliminate mistakes and save costly service calls. E-Z Codes are the proved method of increasing production with new employees without error and mistakes.

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ELECTRONICS — October, 1950
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**TUBES AT WORK** (continued)

Electric Co., Ltd. of England.

The size of the room is about 18 x 13 x 13 feet, before lining, and the walls, floor and ceiling are covered with nearly 3,000 Fiberglass wedges, each 3 feet long. These wedges are not supported by the usual eggbox construction but are in a welded wire frame arranged so as to produce the minimum sound reflection.

The door, which is also covered with wedges, presented an unusual engineering problem. Although the door opening is only 21 feet wide the attached wedges are 31 feet deep overall and so the tips would become damaged if the door were to open and shut in the usual way. To remove this difficulty the hinges of the door are designed so that it moves at right angles to the wall of the room during the final stage of closing. This is done by guiding it in tracks at right angles to the wall.

Inside the room, two overhead tracks have been fitted at right angles to each other. Their purpose is to enable the microphone carriages to be moved. An important feature of these carriages is that they have automatic brakes which ensure that a microphone cannot move during tests.

Across the floor of the room is a trolley track ending in a turn-table. This enables heavy objects to be wheeled into the room on the track through the door, revolved on the turntable and suitably positioned in the room. Although the turntable is very useful for positioning equipment, it was included mainly for measuring the sound distribution round an object, for example, determining the polar response curve of a microphone. Means are provided for rotating the turntable from outside the room.

The floor of the room is lined with wedges and immediately above their tips is a wire mesh false floor which is virtually "transparent" to sound. When the greatest accuracy is required this mesh can be removed, together with most of the track and supporting posts.

Photoelectric Gages

Many branches of engineering have needs for the measurement of rapidly varying displacements.
Specifying GLENCO MINIATURE CERAMIC PLATE CAPACITORS

for minimum size
maximum dependability
convenient rectangular shape

GLENCO SUBMINIATURE CAPACITORS
FOR COUPLING AND BYPASS APPLICATIONS

<table>
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<tr>
<th>CBM MINIATURE 500 V. D.C.</th>
<th>SMCB MINIATURE 250 V. D.C.</th>
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<th>SMCB SUB MINIATURE 250 V. D.C.</th>
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<td>SINGLE PLATE</td>
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D=.120 D=.080 D=.120 D=.150 -.800

SPECIFICATIONS FOR CBM AND SMCB COUPLING AND BYPASS CAPACITORS
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ELECTRONICS—October, 1950

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Because its superiority is unchallenged, Signal Generator type TF 867 stands alone, in splendid isolation. Especially noteworthy are an expanded wide-view scale covering 15 kc/s to 30 Mc/s and a concentric terminating unit which, while showing exact circuit conditions on an animated diagram, is also a dummy aerial and impedance source of 750 or 130. Other facilities include crystal standardisation, freedom from unwanted frequency modulation, deep amplitude or carrier shift modulation and stabilized output control. Output is variable from 4V to 0.4µV and calibration indicates the true artificial signal e.m.f. irrespective of load.

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No chance to damage leads or play in incorrect position.
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GLOBAR brand ceramic resistors offer unusual and valuable characteristics for bettering circuit performance in radio, television and industrial applications. Manufactured to meet your exact specifications, these resistors assure extreme accuracy of operation. Precision methods of control and inspection in their manufacture provide maximum uniformity and dependability.

The accompanying table lists a few different types of resistors available. GLOBAR engineers will be glad to work with you in applying any of these or other types to your designs. In the meantime, obtain more complete information by writing for Bulletins R, GR-2 and GR-3. Address Dept. V-100, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CHARACTERISTICS</th>
<th>TYPICAL APPLICATIONS</th>
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<tbody>
<tr>
<td>A</td>
<td>Low negative voltage and temperature sensitivity.</td>
<td>General purpose resistor for radio receivers and transmitters.</td>
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<tr>
<td>B</td>
<td>Medium negative voltage and temperature sensitivity.</td>
<td>Instrument compensation, X-Ray equipment.</td>
</tr>
<tr>
<td>BNR</td>
<td>High negative voltage sensitivity.</td>
<td>Magnetic valves, Motor governors.</td>
</tr>
<tr>
<td>CX</td>
<td>Low negative voltage and low positive temperature sensitivity.</td>
<td>Radio transmitters for dummy antenna and parasitic suppressors.</td>
</tr>
<tr>
<td>F</td>
<td>High negative temperature sensitivity.</td>
<td>AC-DC radio receivers to prevent surge currents in tube and pilot light filaments.</td>
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</tbody>
</table>

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company.
or pressures and a new and interesting development in this field is a photoelectric pressure gage by C.A.V. Ltd and Ricardo and Co. Ltd.

The principle of the device is that displacements or pressure differences are utilized to modulate a beam of light falling on to a photocell and the resulting electrical changes are ultimately applied to an oscilloscope where they are translated into direct indications of the quantities concerned.

The gaging mechanism is housed in a hollow metal cylinder and is composed of a light source, a slit of variable width and a photocell. The light beam is arranged to be parallel to the axis of the cylinder, which has the lamp and cell on either side of it. The slit, which is horizontal, is interposed in the beam.

For pressure measurements the edge of the slit shutter is linked to a horizontal circular diaphragm fixed to the base of the gage and moving with it. Pressures to be measured are applied to the diaphragm from a pipe.

For displacement measurements a different operating mechanism is used. It consists of an adaptor unit carrying a push rod which moves the slit shutter. The slit is decreased by upward displacement of the rod, which is restored to its normal position by a spring.

When the equipment is in use the current through the photocell varies directly with the width of the slit, providing that this is over 4 mils. The current change never exceeds approximately 1.9µ amp and a change of this order corresponds to variation of the slit by about 5 mils.

Generally speaking, the gage is connected to a voltage amplifier which feeds the oscilloscope, the cell output being taken from a 100,000-ohm resistor. For applications involving vibration or other rapidly-varying effects, the frequency response of the gage is important and is limited by the photocell circuit, either the cell itself or the time constant of the output circuit, which is determined by the output resistance and any stray capacitance which is effectively connected in parallel with it.

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**Terminal Shaft Assembly**

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- **Patented Capillary Oiling System**
- **Terminal Shaft Assembly**
- **Sealed Gear Case Assembly**

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[ ] Please send new Catalog

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ELECTRONICS — October, 1950
SIZE AND WEIGHT Because they are designed for high operating temperatures, Hornet Transformers and Reactors have only about one-fourth the size and weight of Class A units of comparable rating.

VOLTAGE RATINGS Designs are available for RMS test voltages up to 10,000 volts at sea level, and up to 5,000 volts at 50,000 feet altitude. Power ratings from 2VA to 5KVA.

POWER FREQUENCIES These units are designed to operate on 380/1600 cps aircraft power supplies, 60 cps power supplies, and any other required power frequency.

AMBIENT TEMPERATURES Hornet Units can be designed for ambient temperatures up to 200 deg. C. Size for any given rating depends upon ambient temperature and required life.

LIFE EXPECTANCY Extensive tests indicate that the life expectancy of Hornet units at continuous winding temperatures of 200 deg. C. is over 50,000 hours.

MOISTURE RESISTANCE Since Hornet Transformers and Reactors contain only inorganic insulation, they are far more moisture resistant than conventional Class A insulated units.

EFFICIENCY Regulation and efficiency of Hornet Transformers compare favorably with Class A units.

SPECIFICATIONS Hornet Transformers meet the requirements of Government specifications covering this type of equipment.

Bulletin B300, containing full electrical and dimensional data on Hornet units, is now available. Write for it, or tell us your specifications for special units.

NEW YORK TRANSFORMER CO., INC.
ALPHA NEW JERSEY

TUBES AT WORK (continued)

and displacement types is done by applying known quantities and then noting the corresponding indications on the c-r tube. This method has the advantage that it can be applied quickly and it reduces to a minimum the errors which could arise owing to changes in the gage during the interval between calibrating instrument and using it.

Believed to be the first practical instrument of its kind for general use, an ionization voltage tester has been designed as a simple means of determining the threshold voltage at which ionization occurs in a dielectric. It should prove of considerable value in researches into insulating materials.

The instrument consists of two main circuits, the first containing a generator of direct voltage, continuously adjustable up to a maximum of 5 kv by means of a single control. The positive pole of the generator is taken, via an output terminal, to the material under test, which is series-connected to the second circuit, which forms the input of a detector-amplifier. Output from the amplifier is fed into a small loudspeaker and a cathode-ray indicator is included to denote the passage of current.

As the voltage across the sample is increased, a point is reached when ionization commences and is denoted by a popping sound in the loudspeaker. A volume control is provided to enable the sound to be adjusted to a convenient level, because the intensity and frequency of the sound increases as ionization progresses. Simultaneously the miniature c-r tube indicates direct-current flow.

The instrument has a wide range of uses, testing of cables, motors, insulation on wires, high-value resistors; also the detection of ionization in gas pockets in insulation or dielectrics.

New Photocells

Developments in the field of photo-conductive cells include a miniature lead-sulphide cell of small size and simple construction for use in applications where the cell will not be cooler; a new pattern coolable lead-sulphide cell incorporating numerous improvements including interchangeable de-

October, 1950 — ELECTRONICS
MITCHELL-RAND
Demonstrates Leadership!

Produces 2 new Wax Compounds for greater protection against extreme high heat and extreme low temperatures!

3760 High Melting Point Wax
for Impregnating and Dip Coating

3767-A Corona Suppressing Plastic
for Dip Coating

SPECIFICATIONS

3760 Impregnating and Dip Coating Wax Compound, was developed to meet the needs of applications which must resist flow at temperatures above the boiling point of water, and also which must resist cracking at temperatures below zero degrees F.

3760 with good electrical properties, resistance to bleeding at high temperatures, low application viscosity and high drip melting point, is recommended for moisture proofing coils, transformers, capacitors, etc.

TESTS—HIGH TEMPERATURE
Using paper tubular capacitor samples, the tubes were impregnated with, and the assembled units were flash dipped in 3760 coating, approximately 15 mils thick), the units were then subjected to oven tests at 220 F for 24 hours. No sagging or bleeding of the coating was evident.

TESTS—LOW TEMPERATURE
The same units were cold tested by being placed in a cold chamber at —40 F for a period of one hour. The units were then removed and permitted to return to room temperature. Inspection showed that this low temperature treatment caused no cracks in the coating of 3760... and the surface obtained by dip coating with 3760 showed good resistance to blocking at temperatures normally encountered in shipping.

Write for your laboratory test samples... free upon request.

MITCHELL-RAND INSULATION CO. Inc.
51 MURRAY STREET - CORTLANDT 7-9264 - NEW YORK 7, N. Y.

SCREW MACHINE PRODUCTS

Metal • Fibre STAMPINGS Phenolite • Plastic

Complete Fabrication Facilities Under One Roof

Exacting Specifications Met — Rigid Inspection System

WM. STEINEN MFG. CO.

Brueen Cor. Hamilton St. Newark 5, New Jersey

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You Can See Right Through Me

“There’s nothing dense about me — everyone sees through me! But I’m Micro-Weave Tracing Cloth and in my business transparency counts a lot. That’s one reason I’m so popular with draftsmen — they can see the finest, lightest lines with crystal clearness without eye strain. People say that I’m the nearest thing to clear glass in tracing cloth.”


THE HOLLISTON MILLS, INC.

NORWOOD, MASS.

NEW YORK PHILADELPHIA CHICAGO

* Micro-Weave is backed by Holliston’s 50 years of leadership and experience in developing special cloths for industry.

October, 1950 — ELECTRONICS
YOUR QUESTIONS...OUR ANSWERS

May bring a solution to your

D. C. AMPLIFICATION PROBLEMS!

The Microsen D. C. Amplifier is designed for stable, accurate, and economical amplification covering an exceptionally wide range of applications. These fields of application may suggest, duplicate, or offer a solution to your particular D. C. Amplification problem.

Simple, compact and portable, the Microsen D. C. Amplifier has three different ranges in a single model. The Microsen Balance, an electro mechanical feedback amplifier, combines the advantages of high torque to current input ratio with rugged, shock-resistant construction.

Available models include Voltage, Current and Potentiometer Type Amplifiers, Direct Current Converters, Direct Current Transformers, and engineered designs to meet special requirements.

Typical applications in the field of measurement include:

THERMOMETRY in combustion research, gas turbine development, thermocouple inspection, meteorology, distillation processes.

PHOTOMETRY in fluid flow and turbulence, polarimetry, physiology of blood and density.

GAS ANALYSIS in mixture control, efficiency of filters and detection of explosive mixtures.

ELECTRICAL BRIDGES in resistor inspection, moisture detection, conductivity measurements, vacuum gauging, transient stresses.

ELECTRONICS in tube development, vacuum gauging and wave guide studies.

ELECTROLYSIS in electrolytic plating, electrolytic process and production control.

Input elements include thermocouples, photo cells, pirani gauges, strain gauges and others. The instrument is used generally with a recorder. The output can also be applied to a suitable milliammeter indicator or to actuate automatic control relays or signal devices. Design advantages include accuracy, sensitivity, stability and high speed response.

Inquiries for modification within the useful scope of the Microsen D. C. Amplifier are invited. If possible, such inquiries should contain complete application specifications.

MANNING, MAXWELL & MOORE, INC.

250 East Main Street
Stratford, Conn.

We are interested in the Microsen D. C. Amplifier.
Application specifications and/or specific queries attached □
Please send bulletin describing the instrument

Name
Position
Company
Street Address
City and State

MICROSEN ELECTRICAL INSTRUMENTS

A Product of

MANNING, MAXWELL & MOORE, INC.

STRATFORD - CONNECTICUT

Makers of 'Microsen' Electrical and 'American' Industrial Instruments, 'Hancock' Valves, 'Ashcroft' Gauges, 'Consolidated' Safety and Relief Valves, Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.

201
services for use with liquid air, solid CO, or circulating water as constant-temperature coolants, and a window of special glass with good transmission even as far as the long wavelength limit of sensitivity attained at liquid air temperature (about 4µ); and an experimental lead-selenide cell with sensitivity (at liquid air temperature) to cover 5µ.

There has been investigation into the dependence of resistance and photosensitivity of lead-sulphide cells upon the surroundings with the cell maintained at temperatures down to that of liquid air. Screening the sensitive material from room-temperature radiation has been shown to give a ten-fold or more increase in resistance and also in sensitivity at temperatures near those of liquid air.

An instrument based on what is believed to be an entirely new principle in connection with the detection of smoke uses a sensitive "nose" which actuates an alarm as soon as the concentration of smoke reaches a predetermined value.

The nose contains an ionization chamber which is open to the atmosphere to be sampled. A source of radioactivity maintains the air within the chamber in an ionized condition and a potential applied across the chamber causes a small current to flow. Smoke particles entering the chamber produce a sharp variation in the current and this effect is used to actuate an electronic tube of the cold-cathode type. The alarm circuit follows conventional practice.

Modulated Photocell

In many photocell applications where the light falling on the cell is steady or only changing very slowly, it is necessary to chop the d-c signals generated so that they can be amplified by high-gain, stable a-c amplifiers. This difficulty has now been overcome by subjecting the photocell itself to an alternating magnetic field, which causes the output signal from the cell to appear as an a-c voltage, thus dispensing with mechanical aids for chopping d-c signals. Such an instrument can be made sensitive to a few microlumens and is therefore useful for the measurement of...
How to be sure you get the Best Capacitor

YOU CAN test the paper for density . . . thickness . . . porosity . . . power factor . . . chloride content . . . dielectric constant . . . dielectric strength.

And then test the foil for thickness . . . purity . . . softness of the anneal . . . freedom from oil . . . cleanliness of surface . . . absolute smoothness.

And then test the liquid dielectric for specific gravity . . . viscosity . . . power factor . . . color . . . acidity . . . flash point . . . dielectric strength . . . dielectric constant . . . insulation resistance . . . water content.

And after that, test every single finished capacitor for shorts, grounds, and opens at overvoltage between terminals and between terminals and case . . . and measure the capacitance of every single unit . . . and then check every single capacitor to see that it has a leak-proof hermetic seal.

OR YOU CAN buy General Electric capacitors . . . product of outstanding research and know-how . . . which have already passed every one of these tests

. . . on the materials when they were made,
. . . and again before they were used,
. . . and on the capacitors during manufacture,
. . . and then, finally, on every single capacitor before shipment.

For full information on types, ratings, dimensions, types of mounting, and prices of capacitors, address the nearest General Electric Sales Office or Apparatus Department, General Electric Company, Schenectady 5, N. Y.
for Toggle Switches
Type H-1267

for Push Buttons
Type H-2475

for Control Shafts
Type H-1268

NOW--FOR PENNIES--YOU CAN
SEAL OUT
FUMES, DIRT AND MOISTURE AT
SWITCHES AND CONTROL SHAFTS
WITH RFL SEALNUTS!

HERE’S WHY... MATERIALS: Cap and O-Ring of flexible, close-bugging, long-wearing Neoprene • Nut of weather-resistant, nickle-plated brass • TEMPERATURE RANGES: Standard Type (+100°C to −40°C), Low Temperature Type (+100°C to −50°C) • WEATHERING CHARACTERISTICS: Unaffected by sun or moisture, SEALNUTS keep their positive seals indefinitely • OPERATING LIFE: 10,000 cycles (minimum)

MOUNT AND SEAL YOUR SWITCHES WITH LOW-COST SEALNUTS
Write for illustrated literature, or send $2.00 for generous "Get-Acquainted Package", containing liberal assortment for control shaft, toggle and push button switches.

ZOPHAR
Waxes, Compounds and Emulsions

Materials for potting, dipping or impregnating all types of radio components or all kinds of electrical units. • Tropicalized fungus proofing waxes. • Waterproofing finishes for wire jackets. • Rubber finishes. • Inquiries and problems invited by our engineering and development laboratories.

Zophar Mills, Inc. has been known for its dependable service and uniformity of product since 1846.

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Since 1922

RADIO FREQUENCY LABORATORIES INC.
Beantown 1, New Jersey

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104 YEARS

GRAPHITE ANODE TUBES
CUT FREQUENCY DRIFT

Frequency drift is a major problem in modern precision electronic equipment. With Speer graphite anodes, frequency drift hits new lows!

Here’s why: Graphite anode tubes are non-warping. Tube characteristics will remain uniform. Interelectrode capacitances stay constant. Warping in other tube elements is inhibited. Power ratings are raised—as high as 200 to 300 percent. Thanks to their lower operating temperatures, graphite anode tubes have exceptionally long life... withstand hardest usage.

Whether they’re used in power, rectifier, or modulator vacuum tubes, Speer graphite anodes are instrumental in bringing increased efficiency to modern electronics. Rectifiers, FM and short wave transmitters, diathermy, and many other types of equipment give better service—thanks to the tube with the graphite anode.

October, 1950 — ELECTRONICS
Get more from your test equipment with RCA ACCESSORIES

NEW RCA High-Voltage Probes—
WG-289, WG-290
Extend dc voltage range of your instrument to 50 kv.

NOW... the RCA TV Isotap WP-25A—
A combination Isolation-
Autotransformer for Television Servicing

ONLY $9.95
Complete with resistor.
Suggested User Price.

The last word in high-voltage probes for measuring the voltage of TV power supplies and other high-voltage sources. Has six safety features, including anti-corona probe tip, completely insulated grip, and separate ground leads. Multipurpose resistors available to adapt probes for various circuitry. Practically all popular volt-ohm-meters. Provides high input resistance for accurate voltage readings without loading circuit. The WG-289 and WG-290 Probes are identical except for their connectors. The WG-289 has microphone-type connector; WG-290 has phone-tip connectors.

AVAILABLE FROM YOUR RCA TEST EQUIPMENT DISTRIBUTOR

RCA WG-263 CRYSTAL PROBE


RCA WG-275 DIODE PROBE

Designed to operate with RCA Volt-Ohmyst Electronic Meters WV-75A or WV-95A, for reading rms or peak-to-peak voltages at frequencies from 30 cycles to 250 Mc. The probe fits coaxial "T" connectors, and permits direct measurement of voltages in coaxial lines. Price: $30.00.


RCA WG-265 MINIATURE TESTPOINT ADAPTER

Makes your troubleshooting faster, easier, safer by making tube-base connections accessible on the tube side of the chassis. Pins on one end of the adapter fit a 7-pin miniature socket, and socket facilities on the opposite end accommodate all types of 7-pin miniature tubes. Tabs project for easy probe contact. Price $1.50.

RCA ISOTAP WP-24A FOR RADIO SERVICING

Eliminates shock hazard between ac/dc chassis and ground, speeds detection of receiver faults with high-low line tests, and facilitates testing at 117-volt design-center value. Has six-position primary switch and three secondary receptacles. Price: $8.95.

RCA WS-18A RACK-ADAPTER PANEL

For mounting any of the matched RCA Test Instruments in standard 19-inch relay racks. Dimensions, 10 1/4" high, 19" wide, 3" thick. Price: $9.50.
Tubes at Work (continued)

density of films, infrared radiation and similar applications.

A recent British patent has disclosed that a variable permittivity dielectric can be made from a mixture of barium and strontium titanates in the ratio of 95 to 5, permittivity increasing as an applied alternating voltage is increased. This property can be utilized in various ways in electronic circuits by making capacitors which are voltage-sensitive and can thus be used to secure automatic selectivity or frequency control.

For example, if the two circuits of an interstage coupling of the bandpass type are precisely in tune for a given signal level, the progressive detuning of the circuit as the signal increases above this level can be achieved by including one of these new capacitors in the circuit. The detuning will automatically widen the acceptance band of the filter and can be made to give constant selectivity.

Fifteen C-R Tube Camera

A development in the cathode-ray tube field is a fifteen-channel crt camera with fifteen 1-inch built-in tubes as an integral part of the unit. The tubes are mounted so that eight are on one side of the camera and seven on the other, with the screens of the tubes facing in the same direction as a pair of 3-inch f.2.9 lenses.

The latter are mounted at an angle of 36 degrees to each other and adjustable mirrors (one for each tube) are arranged in two batteries to reflect the traces on the fluorescent screens accurately along the axis of each lens. The traces are focused on a vertical zero line and the tubes are staggered to permit fifteen traces on a 70-mm film. Each trace is 7.5 mm wide, being reduced from one inch (25.4 mm) on the cathode ray screens and the dispositions on the film are such that the extremities of any of the traces belonging to the seven-tube group are on the midpoint of the neighboring traces of the eight-tube group.

Integral with the camera are two argon-filled discharge lamps which can be operated from an external circuit to give time marks on the film. One mark, in the form of a
now color tv for industry!

THE DU MONT TA-164A CLOSED CIRCUIT INDUSTRIAL COLOR TV SYSTEM

Now available! The Du Mont tried-and-proved industrial color television system in a complete, packaged, ready-to-operate form. Designed specifically for industrial applications, the new Du Mont TA-164A Industrial Color TV System provides bandwidth of 18 mc. and picture resolution of 525 lines. Full high-fidelity color from light pastels to deep colors.

Engineered to provide dependable day-in day-out service required by industry, research, medicine, merchandising and countless other fields. Compact, lightweight, portable units are joined by interconnecting cables utilizing the famous Du Mont "Jiffy" connectors assuring complete flexibility and the DuMont kind of dependability. May be plugged into power line anywhere. Operates on 110-volt 60-cycle AC.

ALLEN B. DU MONT LABORATORIES, INC.
Television Transmitter Division, Clifton, N.J.
DO YOU KNOW?

—that a PILOT LIGHT
CAN IMPROVE YOUR PRODUCT

... add attraction — safety — service?

Ask DIALCO

THIS MAY BE THE ONE
Designed for low cost NE-51 Neon
- Built-in Resistor  - Patented
- U/L Listed  - Rugged
Catalogue Number 521308 - 997
for 110 or 220 volts.

SAMPLES
for design purpose
NO CHARGE

NEK. Write for the
"HANDBOOK OF PILOT LIGHTS."
Write us on your design problems.

The DIAL LIGHT COMPANY of AMERICA
Foremost Manufacturer of Pilot Lights.
900 BROADWAY, NEW YORK 3, N. Y.  TELEPHONE SPRING 7-1300

dependable instruments

Fully Portable
Self Contained

Schematic showing how coil leads are brought out to separate contacts in the relay base, permitting differential operation.

HOW YOU CAN TAKE ADVANTAGE
OF THESE FEATURES

Sensitivity of this degree makes this relay well suited as a dependable circuit actuator for use directly with low output detectors, such as thermocouples, photo-cells, etc. It may be used for polarized or differential operation, as a null-seeking device, etc. Contacts SPST or SPDT, normally open or closed. Seated height, 2¾”; dia. 1½”; weight 68 grams; 7-pin small radio tube base.

Full information available. Write for Bulletin 3004-D.

October, 1950 — ELECTRONICS
For the Answer to Your Insulation Problem

Look Through this Line...

VARGLAS SILICONE. That's the insulating sleeving and tubing—pioneered by Varflex—that takes temperatures ranging from 500° F above to 85° F below in its efficient, resistant stride. Lead wire and treated cord too.

VARGLAS TUBING IMPREGNATED WITH GENERAL ELECTRIC PERMAFIL. Tough, flexible, heat-resistant—available in coils. Premium tubing at a reasonable price.

VARGLAS SLEEVING AND TUBING. Numerous types and grades—including synthetic treated, varnished, lacquered, saturated, litewall and others.

VARGLAS NON-FRAY SLEEVING. Three types—may be subjected to temperatures up to 1200° F—for applications where dielectric requirements are not primary.

VARFLO TUBING AND SLEEVING. New, low-priced—for applications where unusually high temperatures are not a factor. A real economy line, this.

VARFLEX COTTON TUBING AND SLEEVING. Varnish or lacquer im- pregnants—for applications where Fiberglas products are not required.

SYNTHOLVAR EXTRUDED PLASTIC TUBING. Low temperature flexibil- ity—high dielectric and tensile strength—made from a standard formulation of vinyl polymers.

SAMPLIES? All you want with our compliments. For free folder of our complete line, just clip and mail this coupon.

VARFLEX CORPORATION

MAKERS OF ELECTRICAL INSULATING TUBING AND SLEEVING

VARFLEX Corporation, 308 N. Jay St., Rome, N. Y.
Please send me information as well as free samples of your electrical Sleeving and Tubing.
I am particularly interested in samples suitable for...

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Company
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City Zone State
WIRES - MEASURED, CUT AND STRIPPED AUTOMATICALLY - FAST AT LOW COST

This IS WHAT YOU GET BY USING ARTOS AUTOMATIC MACHINES

1. CUT WIRES FROM 1" TO 60" IN LENGTH
2. STRIP UP TO FIVE INCHES
3. HANDLES WIRES FROM 26 GAUGE TO 000 GAUGE

Applications of Artos Machines throughout the automotive, radio, telephone, and electrical appliance industries have the economy-improving, efficiency-increasing values of fully automatic cutting, measuring, and stripping of wires. AND, terminals can also be put on one end, AUTOMATICALLY, IN THE SAME OPERATION!

Artos machines are available in a variety of models. There is probably one to meet your exact requirements, in either bench or floor models.

Make it a point to find out how Artos machines can improve your production. Write on company letterhead today for complete information.

ARTOS ENGINEERING CO.
DEPT. EL, 2739 S. TWENTY-EIGHTH STREET
MILWAUKEE 7, WISCONSIN

TUBES AT WORK (continued)

small dot on the edge, can represent a chosen time interval and the other, a thin line across the whole film, can indicate a recurrent external event.

One particularly interesting use has been in the construction of a fault recording unit for the British Electricity Authority. This apparatus is made to record the faults on power lines and by the use of auxiliary apparatus is arranged to be normally in a quiescent state. When a fault occurs, the camera motor is started and the crt beams switched on to record all waveforms. Then after the restoration of steady conditions, it closes down again and at the same time recording the date and time of the occurrence.

Low-Frequency Analyzer

For some time there has been a need for an instrument by which aircraft engines can have their vibration modes analyzed and the engine speed shown simultaneously. The difficulty has been that the range of frequencies to be examined is considerably below the range of wave analyzers which give automatic and continuous records.

A new British low-frequency analyzer is arranged to scan continuously the frequency range from 6 to 400 cps. Six modulator circuits are incorporated to cover the bands 6-12.5, 12.5-25, 25-50, 50-100, 100-200 and 200-400. Scan for the channel bands takes place in 1/25 second and to provide a continuous scan the modulator frequency for each band is varied over the octave once in 5 seconds. This results in the analysis being spread from a row of plain lines to a continuous area, the boundary of which gives the amplitude distribution of the complex wave.

To obtain a high degree of resolution it is best if the fifth and sixth bands are displayed downwards on the cathode ray tube, below the first and second bands.

In practical use, the luminous area on the screen, something like an a-c waveform in appearance, is not solid but is shown as a number of bands corresponding with the obviously limited number of frequencies present, the width of the bands being a measure of the variation of these frequencies with time.
New Booster Pump reduces
the exhaust cycle of rotary units

This tiny booster pump was specially designed to increase the efficiency of rotary exhaust units. It is able to produce a total pressure of 0.5 \( \mu \), or less, in one-half the time of other available equipment because it has high pumping speed in the right range of pressure. It is ideally small — only 2\( \frac{1}{4} \)" in diameter by 6" long. You'll have no trouble mounting it at each exhaust port on most rotary equipment.

Because of its speed, this new diffusion pump can cut your exhaust cycle. At the same time, it gives the higher vacuum needed in the production of better quality tubes. Write today for complete information.
INTERCHANGEABLE MOTORS FOR ALL TIMING APPLICATIONS
A.C. Synchronous and D.C. Governed or Variable Speed

Standardize your timing motors. The A.W. Haydon Co. is the only supplier of interchangeable A.C. Synchronous and D.C. Chronometric governed or variable speed motors for precision time keeping.

THE A.W. HAYDON COMPANY
235 North Elm Street, Waterbury 32, Connecticut
Design and Manufacture of Electrical Timing Devices

Make A. W. Haydon your primary motor source for —
A.C. — Synchronous
D.C. — Governed
D.C. — Variable Speed
TIMING MOTORS

EISLER Television Tube MACHINERY

- ECONOMICAL
- MODERN DESIGN
- PRODUCTION ENHANCING

EISLER's Electronic Equipment is especially Designed and Built to your exact requirements.
From 5" to huge 24" Television Tube

EISLER specializes in GLASS WORKING MACHINERY for the manufacture of: Cathode Ray; Radio Tubes (Standard, Miniature, Sub Miniature); Fluorescent Lamps; Glass Amoules; Vials; Incandescent Lamps.
* Consultation without any obligation on your part is cordially invited.

EISLER ENGINEERING CO., INC.
751 SOUTH 13th ST. • NEWARK 3, NEW JERSEY

Form to form
THEY'RE UNIFORM

PRECISION paper TUBES

Die-formed under heat and pressure, each Precision Paper Tube is exactly the same as every other Precision Paper Tube that is made to the same specifications. This form-to-form uniformity helps assure more accurately-wound coils. Moreover, Precision Paper Tubes are made of finest dielectric Kraft, Fish Paper, Cellulose Acetate or combinations. Better heat dissipation, greater moisture resistance, and lighter weight are the results.

Let us make up a FREE sample for you!

We make Precision Paper Tubes precisely to your specifications. Any length, any size, any shape — round, square, oval, rectangular.

Write today for new mandrel list of over 1,000 sizes.

PRECISION PAPER TUBE CO.

Also makers of Precision Coil Bobbins
2041 W. Charleston St., Chicago 47, Illinois
Plant #2
79 Chapel St., Hartford, Conn.
ANNOUNCING

A NEW INDUCTION MOTOR-GENERATOR

- The first of its kind to be included in the wide range of "Brain Block" components now available for private industry.

ARMA Type 1A400

- A precision unit for high performance instrumentation and control applications.

ITS TYPICAL CHARACTERISTICS INCLUDE:

MOTOR — With 115 volt, 400 cycle excitation on both main and control fields.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Stalled Power Input</th>
<th>Impedance</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16.5 watts max. per phase</td>
<td>210+j 380 ohms approx.</td>
<td>1.5 oz. min.</td>
</tr>
</tbody>
</table>

Running — No Load

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Power Input</th>
<th>Impedance</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 watts per phase approx.</td>
<td>160+j 530 ohms approx.</td>
<td>8500 R.P.M. min.</td>
</tr>
</tbody>
</table>

GENERATOR — With 115 ± 1 volt, 400 ± 0.1 cycle excitation.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Input current</th>
<th>Input power</th>
<th>Max. speed for specified performance</th>
<th>Output — Nominal</th>
<th>Output — Standardized at 25°C, 3600 R.P.M., 750 mmfd. load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.065 amp.</td>
<td>2.8 watts</td>
<td>6000 R.P.M.</td>
<td>0.1 volts per 100 R.P.M.</td>
<td></td>
</tr>
</tbody>
</table>

Magnitude 3.600 ± .05% volts

Phase Angle 10° ± 5° (lagging)

Max. Linearity Deviation

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Over range 0-4000</th>
<th>Over range 4000-6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude (in % specified max. speed)</td>
<td>0.04% (1.5 R.P.M. or 1.5 m.v.)</td>
<td>0.15% (8.5 R.P.M. or 8.5 m.v.)</td>
</tr>
</tbody>
</table>

Quadrature

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Over range 0-4000</th>
<th>Over range 4000-6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over range 0-4000</td>
<td>1.0 m.v.</td>
<td>5.0 m.v.</td>
</tr>
<tr>
<td>Effect of ambient temperature change from 15° to 70° C.</td>
<td>approx. 0.07% max.</td>
<td>approx. 0.5 min. per degree</td>
</tr>
</tbody>
</table>

Variation in magnitude approx. 0.07% max.

Variation of phase angle approx. 0.5 min. per degree

Zero Speed-Residuals

In-phase: approx. 3 m.v. max.

Quadrature: approx. 3 m.v. max.

Harmonics: approx. 7 m.v. max.

PHYSICAL CHARACTERISTICS

- Type 1A400 and Resistor Unit

ARMA CORPORATION

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SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA ELECTRICAL RESOLVERS* ARMA SYNCHROS ARMA INDUCTION MOTORS ARMA INDUCTION GENERATORS ARMA MECHANICAL DIFFERENTIALS ARMA ALTERNATING VOLTAGE COMPARATOR COMPUTING MECHANISMS INDUSTRIAL CONTROLS STABILIZATION DEVICES NAVAIGATIONAL EQUIPMENT LIMITRON AUTOMATIC INSPECTION SYSTEM

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A signal from the brain and a man ducks, blinking his eyelashes. A huge bomber takes a load under various static and dynamic conditions and a multitude of strain lines take different characteristics. Electricity passes through electronic apparatus and emanates with different voltage, current, and phase relationships.

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RPC Resistors are high quality units designed to meet the most stringent requirements. They are widely used in large quantities by laboratories, instrument manufacturers, and the Armed Forces and their suppliers. Sizes available are in accordance with JAN-R-93, RB10 to RB14. Terminals may be wire leads if required. Resistance tolerance to 0.02% is available. All resistors are wound with special low temperature coefficient alloy wire at no additional cost. Quick delivery is a feature of our service to you. Write today for catalog.

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OF COURSE NOT! Literally, their normal body temperature is 98.6—the same as laborers, engineers or any other group of people. And, figuratively, they’re no more, or no less, cold-blooded—as a group.

We all know unreasonable generalizations can be dangerously false. Common sense and on-the-job experience show us the value of dealing specifically with ideas, problems—and people.

Let’s not make the big—and costly—mistake, then, of generalizing on religious or racial groups. Adopt and carry out these common sense principles:

1. Accept—or reject—people on their individual worth.

2. Don’t listen to or spread rumors against a race or a religion.

3. Speak up, wherever we are, against prejudice. Work for understanding.

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FOR HIGH-SPEED PULSE WORK
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This new Browning instrument incorporates the important circuit features requisite for intensive laboratory application in research and development work.

Browning
WIDE-BAND OSCILLOSYNCHROSCOPE
MODEL OJ-17

'Scope, synchronizer, high-voltage power supply, low-voltage power supply, and control panel are mounted in a vertical rack cabinet on casters. Provision is made for installation of a Fairchild Oscillo-record camera when photographic records of 'scope traces are desired.

CIRCUIT FEATURES

- Vertical amplifier: band width flat to 16 mc; response extends beyond 30 mc; maximum deflection sensitivity .05 volts/inch; video delay circuit; 0.2 micro-second delay.
- CH Tube: Type 5 RP or 5 XP; anode voltage variable 10-20 KV.
- Driven Sweep: variable .05-500 micro-seconds per in.
- Sawtooth Sweep: 5-500,000 c.p.s.
- Trigger Generator: output of 100 volts from 500 ohms, running rate 20,000 c.p.s.
- Markers: internal blanking or deflection type: 0.1, 1, 10, 100 micro-second intervals.
- Beam Intensity Modulation: external connection to grid.
- Variable Delay Circuit: provides positive and negative delayed output triggers. Delays sweep from external sync. or internal trigger generator. Continuously variable to 2000 micro-seconds by means of directly calibrated dial.
- Voltage Calibration Circuit: for measurement of input signals by substitution voltages in form of 60-cycle square waves.

THE ELECTRON ART
(continued)

rections up to 500 cps, motor starting up to 500 cps, and noise suppression systems. They are not recommended for photoflash work, coupling circuits and timing circuits requiring constant R-C curves.

Insulation Resistance

In general, the insulation resistance of metallized paper capacitors is lower than that of the foil and paper types. To a large extent, this is due to the fact that the working stresses employed are considerably higher, since advantage is taken of the selfhealing feature. Therefore the insulation resistance cannot be considered as a criterion of quality in the same sense as applied to the foil paper capacitor. In voltage ratings up to and including 200 volts d-c, metallized capacitors have an insulation resistance value of 500 megohms per µf. On higher voltage ratings the insulation resistance is 1,000 megohms per µf.

The insulation resistance and the selfhealing voltage are to a large extent interrelated and the result of these two properties. During the selfhealing cycle the surface resistance around the puncture reaches a definite value, so that with selfhealing there is a gradual reduction in the insulating resistance. The value of this resistance depends on the number of selfhealing cycles, as all of the punctured areas are in parallel.

Capacitance and Power Factor

As temperature is increased, there is a decrease of insulation resistance. This is a general phenomenon with impregnated paper, hence is not exclusive in metallized paper capacitors. Typical capacitance, power factor and insulation resistance characteristics are given in Fig. 1. Variations here are similar to those obtained with the conventional paper-impregnated capacitors. It will be noted that the mineral oil impregnated capacitors have a flatter curve than the mineral wax type and should be used in circuits demanding high capacitance stability. The mineral wax impregnated capacitor shows a definite decrease in capacitance with an increase in temperature. The decrease in capacitance with
Shooting a bird...

IN THE AIR AGE

THIS IS "shooting a bird" at the U.S. Naval Air Missile Test Center, Point Mugu, California.

The "shoot" is the launching of a missile, while the "bird", in this particular case, is the Fairchild CTV-N-9a guided missile.

In a matter of seconds the missile is hurled high into the atmosphere with a deafening roar, propelled by its reaction type motors and auxiliary booster. Separation of the booster occurs as the missile speeds higher and higher into space, stabilized and controlled by the "intelligence" of its electronic guidance systems.

Soon the launching crews and ground observers no longer see the missile... but its path is being carefully plotted as it hurls toward its target... now under its own homing control.

This "shooting a bird" is but one phase of the Lark project. It is an operation requiring split-hair timing and perfect coordination. It is the result of teamwork between the Bureau of Aeronautics, Navy Department, the Naval Research Laboratory and Fairchild engineers and represents a combination of the best in aerodynamic design, electronic controls and precision manufacturing.

Here is another example of a Fairchild first and of "shooting a bird"... in the Air Age.
KING-SEELEY CORPORATION designed this Progressive-made terminal to permit the housing of its oil pressure unit to "breathe" — a feature that insures the presence of atmospheric conditions inside the housing and, consequently, accurate pressure registration.

Progressive was called in to make the terminal for two reasons. We have the engineering and production skills to make the part, in all its tricky detail, according to specification. And, secondly, we do a precise job at a cost that makes it worthwhile to do business with us.

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THE ELECTRON ART

(continued)

FIG. 2—Voltage derating curves for metallized capacitors operated above rated temperatures

temperature is caused by the physical change in the wax as it goes from the solid to the liquid phase; this results in a decrease of the impregnant dielectric constant.

The negative temperature coefficient of these units can be made use of in certain applications. This capacitance change is of no importance in the majority of applications. As a matter of fact, a mineral wax capacitor should be given preference because of its higher breakdown voltage except in those cases requiring a flat capacitance curve.

Operating Characteristics

Due to their selfhealing characteristics, metallized paper capacitors can be operated at higher temperatures than conventional paper-impregnated capacitors without danger of breakdown. The ultimate breakdown of the metallized paper capacitor is determined by the thickness of the lacquer coating and impregnated paper dielectric and is usually two to three times the rated working voltage.

As temperatures are increased, it becomes necessary for safe operation to reduce the voltage impressed across the capacitor. The amount of derating necessary for safe continuous operation on or above rated working temperatures is given in Fig. 2. In intermittent service the amount of derating is decreased proportionally.

Life Tests

Metallized paper capacitors should be life-tested at their permissible operating voltage and maximum operating temperature, as given in Fig. 2. A suitable resistor, preferably 1,000 ohms, should be connected in series with each test specimen in order to limit
A New, Low Cost, Portable POLARISCOPE for Dynamic Stress Analysis

UNTIL now the apparatus required for either visual or photographic observation of photoelastic stress, either static or dynamic, has been cumbersome, expensive, excessively bulky and very heavy.

Through use of the G-R STROBOLUTE as a very high-intensity light source for photography, all of these objections have been overcome. Formerly, photographic exposures ran into minutes; the bench set-up accordingly had to be carefully designed to minimize vibration in its many parts. The new G-R Polariscope consists of an assembly of comparatively light rods, supports and disc mounts, this lightness being possible through the extremely short 40-microsecond exposure provided by the STROBOLUTE.

This new Polariscope includes in its many features:
- An unusually large field — 8 inches in diameter
- Very simple means for making instantaneous photographs of dynamic stresses . . . requires only a standard camera with an f/4.5 lens
- Time exposures no longer necessary . . . the STROBOLUTE flashes in 40 microseconds
- The 40-microsecond flash stops motion for dynamic stress patterns
- Unusually short wave length light . . . very high sensitivity
- Complete portability . . . weighs only 32 pounds . . . quickly assembled and disassembled . . . ideal for lectures and other demonstrations
- Easily removed quarter plates and polarizers
- Simplified replacement of damaged elements . . . snap-in assembly
- Convenient to use . . . horizontal and vertical adjustments over wide ranges . . . simpler than an optical bench
- Very low cost

TYPE 1534-A POLARISCOPE . . . $490.00

The Type 1532-A STROBOLUTE in place, with its power supply at the right. One knurled nut readily removes the STROBOLUTE lamp for substitution of the standard incandescent lamp for visual observation. Type 1532-A STROBOLUTE, complete and ready to use, $225.00

SPECIFICATIONS
A Type 1534-P6 Incandescent Lamp Housing
B Type 1534-P2 Diffuser
C Type 1534-P1 Polarizer
D Type 1534-P3 Strain Bridge for Sample
E Type 1534-P1 Analyzer
F Type 1534-P5 Filter
G Type 1534-P4 Camera Bridge (Camera not supplied)
H Type 1534-P7 Shafts (furnished 36-inches long)

Accessories Required for Photography
A G-R Type 1532-A STROBOLUTE Standard camera, preferably with ground glass focusing, with f/4.5 or faster lens
Wratten No. 75 front-of-lens filter, recommended to reduce effects of normal room lighting
Hermetically Sealed Transformers

A Complete Range of Hermetically Sealed Units
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Have the full details at your finger-tips on CHICAGO'S New Equipment Line—covering all JAN-T-27 units as well as famous Sealed-in-Steel transformers engineered for every application and geared to today's circuit requirements. Write for your free copy of this important catalog today, or get it from your distributor.

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THE ELECTRON ART
(continued)

FIG. 3—Variation of capacitance and power factor with hours of operation for all d-c voltage ratings of metallized units up to and including 600 volts

the energy discharged by paralleled test specimens through a capacitor going through a selfhealing cycle. If this precaution is not taken there will be an abnormal decrease in the insulation resistance due to carbonization of the dielectric.

Metallized paper capacitors can be operated on a-c as well as d-c, can be operated at high temperatures without any serious changes in capacitance or power factor, and are practically immune to breakdown. This does not mean that their life is infinite, but rather that when metallized paper capacitors are used in a circuit there will be no early failures and the life span of the equipment will be increased. Examples of life test curves are given in Fig. 3.

Accelerated life tests can be run at 1.25 times the permissible operating voltage and maximum operating temperature, but under this test there will be a greater decrease in the insulation resistance than normally would be expected.

British Cineradiograph Apparatus

BY J. H. JUPE
Enfield, Middlesex England

An advanced type of high-voltage cineradiography apparatus has recently been put in production in Britain, by Watson and Sons, which is associated with the General Electric Co. Ltd.

The new equipment incorporates several improvements over its predecessor, which was designed to take cineradiographs by the indirect method (photography of a fluorescent screen) on 16-mm movie film. A 10-kw stationary-anode x-ray tube was used and in order to minimize the exposure of
THE NEW
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The crown jewel of dynamic microphones. See it, handle it — use it on highest quality recording, public address or broadcast work. New beauty, new styling, new utility and new performance make the Turner Aristocrat the finest of the fine. Use it anywhere, indoors or out — in hand, on stand, suspended, or concealed in stage settings. The Aristocrat is quickly and easily detached from ball swivel coupler for hand use. Non-directional polar pattern picks up sound from any direction. Equally effective for individual or group pickups with wide range, high fidelity reproduction of voice or music. Its high output dynamic generator requires no closely associated auxiliary equipment for outstanding results. Built of finest materials with flawless workmanship, each unit is laboratory calibrated to insure specification standards. Write for complete details.

SPECIFICATIONS:
FREQUENCY RESPONSE: 50 to 15,000 c.p.s. flat within ± 2½db.
OUTPUT LEVEL: 56 db below 1 volt/dyne/sq. cm.
IMPEDANCE: 1,5, 200, 500 ohms or high impedance.
POLAR PATTERN: Essentially non-directional in any position.
MOUNTING: Ball and swivel type, tilts in any direction. Standard ½” — 27 thread.
CABLE: 20 ft., high quality rubber covered, two conductor shielded cable with Cannon quick-disconnect plug.

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ELECTRONICS — October, 1950
FIELD CAMERA CHAIN
Model CV-2

OUTSTANDING FEATURES
1. Extremely sensitive at low light levels.
2. Picture resolution greater than 500 lines.
3. Four lens turret with synchronized switching.
4. Electronic View Finder.
5. Communication Channel.
6. Portable Camera Control Unit meets all requirements of programming and monitoring.
7. Portable Power Unit adjustable for all operating conditions and completely metered.

WHERE USED
Polarad's Model CV-2, Field Television Camera Chain is used both indoors and outdoors for picking up programs. Excellent picture quality and resolution are obtained even under difficult and unpredictable lighting conditions.

DESCRIPTION
Polarad's Television Camera Chain, Model CV-2, consists of:
- Field Camera Unit
- Camera Unit
- Camera Control Unit
- Power Unit
- Electronic View Finder
- Camera Tripod

This ruggedly constructed camera chain is weatherized for all possible operating conditions.

- Compactness and lightweight suitcase type construction of the component parts insure portability. The camera unit is supported on a special scanning mount and tripod which provides excellent maneuverability in covering a scene over a wide angle. The electronic viewfinder plug into the camera and is detachable from it. A removable four lens turret with interlocking switches provides means for changing scenes rapidly without circuit transients.
- The Camera Unit is connected to the portable Camera Control Unit by a single special camera cable. The Camera Control Unit provides the major electrical adjustments of the camera. It monitors the picture and waveform of the output signal by means of a built-in oscilloscope and picture monitors.
- The Power Unit is adjustable for varying A-C line conditions and provides metering for the system. All power requirements for the Camera Chain are provided from this unit.

Polarad's Field Camera Chain, Model CV-2, is adaptable to and can operate with existing equipment.

British cineradiograph apparatus. X-ray tube is in housing at patient's right. Fluorescent screen and 35-mm camera are on patient's left.

the patient to x-rays, the voltage applied to the tube was reduced by means of a mechanical synchronous switching device, during periods when the camera shutter was closed.

Although this apparatus was used for much useful work, its design had some serious limitations. The patient could only be photographed in the upright position, the equipment was cumbersome and had to be operated in complete darkness. This was due to the long focal length of the lens used, a Zeiss Biotar, specially designed for the work and with an aperture of F/0.85.

With the x-ray tube then available this aperture was the minimum which could practically be used and because of its small acceptance angle, a long focal length (58 mm to cover 16-mm film) was unavoidable. This necessitated the camera and fluorescent screen being on separate stands to secure the correct reduction ratio and so led to operating in darkness. Other disadvantages were, poor definition and grainy films arising from the need to use a highly sensitive emulsion.

The new equipment, which was shown at the International Congress of Radiology in London recently, is a vast improvement on the early instrument and uses a rotating-anode x-ray tube energized at 120 kv, 400 ma, in conjunc-
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Your present and future needs continuously dictate our Engineering Policy

THE MEGA-NODE

The Mega-Node was the first commercially available random noise source. It is extensively used for making noise figure measurements on TV receivers, radar IF strips and other receivers. It has also been used as a calibrating and effective noise bandwidth measuring equipment. Its frequency range is 5 to 220 mc, has noise outputs to 23.8 db above "Johnson" noise, and can be used either balanced or unbalanced into a variety of impedances. Its price is $295.00.

THE SONA-GRAPH

The Sona-Graph is the only instrument we know that presents Fourier analyses of very short time sections of audio energy. It is now at work in many universities, research laboratories, military and industrial organizations analyzing speech, communications signals and industrial noises. It is producing non-photographic three dimensional records of intensity vs. time and frequency as well as two dimensional records of intensity vs. frequency at selected times. It analyzes signals of very short duration over the frequency range of 80 to 8000 cps with resolutions of either 45 or 300 cps. Its price is $1795.00.

THE MICROWAVE MEGA-NODE

When the need arose for a standard random noise source in the microwave ranges we were ready with the Microwave Mega-Node. It covers frequencies from 240 to 12,400 mc. It is built in standard JAN waveguides over this frequency range, has low VSWR and provides standard source of 15.84 db above "Johnson" noise.

Power Supply: Provides voltages for starting and operating fluorescent lamp bulbs in Wave Guides

The price is $195.00 for each wave guide and $100.00 for each power supply. RG48/U, 49/U, and 52/U with one power supply is $600.

THE VIBRALYZER

A NEW use of the Sona-Graph principle. It is applicable to vibration and medical studies. Tentative specifications are as follows:

Frequency Ranges:
A 5 to 500 cps
B 15 to 1500 cps
C 44 to 4400 cps

Filter Bandwidths:
A 6 or 20 cps
B 60 or 600 cps
C 30 or 300 cps

Record Time:
A 20 seconds
B 6.6 seconds
C 2.4 seconds

Displays:
Number 1 INTENSITY vs. TIME and FREQUENCY
Number 2 INTENSITY vs. FREQUENCY at SELECTED TIMES
Note: INTENSITY may be recorded linear in db or voltage amplitude

The price of the Vibralyzer is $2500.00.

All prices are FOB factory. Prices 10% higher outside USA and Canada.

Send for detailed catalog covering all our equipment.
To get a gander at just a few of the latest products you want—

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**CINCH-JONES**—New "300" series plugs and sockets in deep bracket mountings. New "164" barrier strips.

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**IRC**—New type DGH and DCF precision resistors. BTS, BTA, BT2 and BW resistors; in all tolerances and values. New CLA and CL-I insulated chokes, readily identified with RMA color coding in microhenries.

**SUPERIOR ELECTRIC**—Powerstat variable transformers and automatic voltage regulators for every requirement.

**SYLVANIA**—All types of germanium crystals, new glow modulators, gas pressure tubes, TF and ATR tubes, strobochrons, thyatrons, flash tubes.

**ALLEN BRADLEY**—Potentiometers, and EB, GB, HB resistors in all tolerances and values.

*Prices and literature on these products available upon written request on your letterhead.

**THE ELECTRON ART**

(continued)

tion with a specially designed 35-mm cine camera fitted with a F/1.5 Taylor-Hobson lens of 4-cm focal length.

The high voltage generator has an electronic switching device which is arranged so that the high-voltage transformer and x-ray tube are only energized during the brief period when the camera shutter is open. By adopting this plan the x-ray dose which the patient receives is reduced to a minimum and the power dissipated in the x-ray tube itself is minimized, with the result that a higher loading can be achieved without risk of tube failure.

For use at extremely slow film speeds, those for viewing slow movements of the body, the x-ray exposure can be arranged to occupy any proportion of the shutter-open period. This is done by means of subsidiary timing control in the electronic contactor circuit.

If desired, the camera, timing and synchronizing equipment can be switched out of use and radiographs can then be made on large size films by the usual still-radiography technique. In this case the synchronous timer of the equipment will determine the length of exposure.

The entire apparatus has a power consumption of about 1 kw when idling and 20 kw (average) when exposures are being made.

**Single-Tube Audio Phasemeter**

By JOSEPH A. VANOUS

Engineering Division
Galvion Radio Company
Cedar Rapids, Iowa

A PHASEMETER is described, which is capable of measuring phase difference between two sinusoidal voltages from 300 cps to 100,000 cps. Angles from 1 to 180 degrees are measurable with an accuracy of better than 1 degree. No preliminary adjustments for frequency are necessary with this meter.

A unique property of the magnitude of the sum and differences of two alternating current voltages makes the operation of this phase-meter possible. In operation, the phasemeter is connected across the phase-shift network. After two
Modern Electronic Design Means Plug-In Unit Construction

ALDEN PLUG-IN BASES AND HOUSINGS

A whole series of bases and housings to meet your plug-in needs. From the miniature plug-in to the special 20-pin non-interchangeable, Alden plug-in bases can be standardized over a wide range of plug-in design. The Non-interchangeable Series, special for plug-in construction, is designed with suitable pin patterns that ensure positive isolation of critical voltages or currents. Strang, stubby pins and elimination of bosses on Alden bases correct the bugaboo of conventional octal or letoal design.

Open 20 pin plug-in assembly
Shielded 20 pin plug-in assembly
Shielded 11 pin plug-in assembly
Miniature 9 pin plug-in assembly

ALDEN BACK CONNECTORS

Here are back connectors that make possible slide-in chassis that go together and come apart easily. Generous bell mouthed entries and floating clip action provide wide seating tolerances - do away with critical chassis alignment problems. Wiring in colored back connectors instantly identifies each lead for circuit checks - makes wiring accessible for easy servicing. Can be mounted flaked or staked to meet any space requirements.

Mechanical units
Decode units
Miniature chassis

ALDEN SLIDE-IN LOCK-IN CHASSIS

Designed for quick, positive insertion and removal, aldren lock-in chassis utilizes bullet mamed dovets which pull in, lock, and eject chassis quickly and easily. Simple 1/2 twist of handles gives positive protection against shock stroke in any position. P/nle action of locking dovets eliminates critical short metal tolerances. Slide-in lock-in chassis are built for racks or as separate units, miniature or standard size.

Instrumentation
Electronic
Communication
Mobile

CAP-CAPTIVE CONVENIENCE SCREW

Concave surface of head and arced notch quickly center production tools on screw for rapid tightening against lockwasher. In the field, no special tools are necessary - arced slot in head is of such proportion that even a coin gives sufficient leverage to back it off lockwasher. Can readily be made captive, so it's ideal for holding detachable mechanical units, plug-in housings, miniature chassis.

Plug-in Units
Electrical Units
Electronic Units
Mechanical Units

ALDEN PLUG-IN UNIT CABLEING IS A MUST

For years cabling did not keep pace with the speed of electronic design - Manufacturers had to be satisfied with cables designed as an afterthought - cabling utilizing mangled connectors and wire, designed for a job, yes, but not designed for a specific job. In the past this poorly designed cabling has led to a multitude of time delays, excessive production cost and high service cost in the field.

With today's higher voltages, frequencies, and critical signals, more and more engineers are turning to Alden for the solution to their cabling problems because Alden's is the one place where specifically designed connectors and large stocks of wire are obtainable under the same roof.

Here is what Alden engineers can do for you - take your prototype model, engineer to your specific requirements unit cables incorporating Alden's 20 years of technical design and development of connectors and wire services - give you electronic and efficient cables of good appearance that are built as units - allow instant continuity checks and rapid replacement in the field.

Alden's series connectors enable the engineer to select, and know that he will get, the right connector for the job. For critical connections, Alden has special non-interchangeable connectors with plugs that can only mate with the correct socket and thereby absolutely prevent misrouting and the costly damage of burned out sets. All connectors used have forward connected, low resistance contacts which provide individual strain relief for each lead. Production design connector bodies with well-isolated clip and wire pockets provide 100% insulation. Less material - less space, features of Alden top conected contact connectors, allow Alden to design and manufacture a cable that is more compact and more easy to handle.

Wire is supplied from stock piles that include sizes and insulation of any type. It is ready to be formed, braided, banded, or shielded - in production quantities - as needed. By pooling wire requirements in flexible high-speed cable department, special tools, trained operators and minding of inventory, the most exciting schedules of customers can be met at production line cost.

For quotations, suggestions about design, submit your inquiries or blueprints - Alden engineers are always ready to work with you on cabling problems.

NA-ALD

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Numerous other Coil Winding and Taping Machines are illustrated in our complete Catalogue, a copy of which will be sent to interested executives on application.

The large illustration depicts the improved "Douglas" Fully Automatic Multi-Winder, specially developed for the high-speed production of large quantities of coils with or without paper interleaving. It will produce round, square or rectangular coils up to 6 inches each in length and up to 4½ inches diameter. As many as twelve smaller coils can be wound simultaneously within the total available winding length of 12 inches at headstock speeds of between 600 and 2,000 revolutions per minute.

The Automatic Coil Winder & Electrical Equipment Co., Ltd.
Winder House • Douglas Street • London • S.W.1 • England

THE ELECTRON ART
(continued)

FIG. 1—Basic circuit and vector diagrams showing basis for two-tube audio-frequency phase measuring device
calibrations, the sine or cosine of half of the phase angle is measured directly. The principal value of the inverse function is found in a table of trigonometric functions. Multiplying this value by 2 will produce the phase angle in degrees.

Principle of Operation
Several other types of phase meters employ cascaded amplifier-limiter stages which supply square waves to the indicating circuits. Circuit simplicity is achieved by making a comparison between two sinusoidal waves directly.

The phasemeter consists of two low-impedance generators connected by an impedance of 2Z. The voltage at the centertap of the connecting circuit is measured by an a-c voltmeter as shown in Fig. 1A. The voltage E1 is the voltage at generator 1, and E2 (cos \( \theta \) + j sin \( \theta \)) is the voltage at generator 2. The two voltages have the same magnitude but differ by an angle \( \theta \) which is the phase angle. Assuming the voltage \( E_o \) is measured by a high-impedance voltmeter drawing negligible current, the following equation can be written

\[
E_o = E_1 - E_2 \cos \theta - j E_2 \sin \theta = i (2Z)
\]

Substituting Eq. 1 for \( i \) in Eq. 2

\[
E_o = \frac{E_1 - E_2 \cos \theta + j E_2 \sin \theta}{2Z}
\]

Solving for the absolute magnitude
The NEWEST Development in Disc Ceramic Condensers!

RMC DISCAPS

ACTUAL SIZE

1/4” 3/16” 1/2”

The new C Series DISCAPS offer for the first time a disc type general purpose zero or negative temperature coefficient disc condenser ideally suited to coupling and tuned circuit applications.

C Series DISCAPS feature small size, low self inductance, higher working voltage (600 V.D.C.), low power factor, greater mechanical strength and faster production line handling. Their low cost, plus their inherent quality characteristics make C series DISCAPS attractive to all manufacturers of high frequency equipment. Type C Series DISCAPS are available in a variety of capacities and tolerances with ratings up to 6000 W.V.

Are You Using the Now Famous Type B-GMV By-Pass Series Discaps?

Approved by leading makers of TV sets and tuners, RMC Type B-GMV DISCAPS are now available in the following capacities: .001, .0015, .002, .005, .01, 2x.001, 2x.0015, 2x.002, 2x.004, 2x.005 MFD; also Bi-element shielded section 2x.0015, 2x.005 and 2x.01 MFD. They feature small size and low self inductance and exceed GMV capacity at 85°C with 250 applied D.C.V. Capacity change between room temperature and 65°C is only +18% to -0%.

Every DISCAP is 100% Tested for Capacity, Leakage Resistance and Breakdown.

RMC production checks eliminate costly service failures. Because RMC produces the complete condenser, even to the processing of the dielectric element itself, it is possible to exercise the finest quality control. Yes, DISCAPS are definitely better!

C Series NPO and NTC General Purpose Low Capacity

CONDENSERS

<table>
<thead>
<tr>
<th>Type</th>
<th>CAP. MMF 1/4 Body Dia.</th>
<th>CAP. MMF 1/4 Body Dia.</th>
<th>CAP. MMF 1/2 Body Dia.</th>
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</thead>
<tbody>
<tr>
<td>NPO</td>
<td>5-15</td>
<td>16-30</td>
<td></td>
</tr>
<tr>
<td>N750</td>
<td>5-25</td>
<td>26-50</td>
<td>51-150</td>
</tr>
</tbody>
</table>

Available Tolerances: ±5%, ±10%, ±20%

SEND FOR SAMPLES AND TECHNICAL DATA

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GENERAL OFFICE: 1708 Belmont Ave., Chicago 13, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

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ELECTRONICS — October, 1950

229
Maximum Wattage Dissipation for Size

This compact, rugged type M 25 watt rheostat offers exceptional heat dissipation. An exclusive Hardwick, Hindle feature is the lock tab which prevents deformation of the contact arm due to rough handling. Its steel stop pin will withstand over 40 inch pounds torque.

The resistance element is wound on a pure mica strip, embedded in vitreous enamel and sealed in a ceramic base—thus bonding inseparably the winding and base.

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**SOME OF OUR SPECIALTIES**

<table>
<thead>
<tr>
<th><strong>&quot;SURCO&quot; A-10 FOR (105°C) HOOK-UP WIRE</strong></th>
<th><strong>MINIATURE WIRE &amp; CABLE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A-10 is an unusually high grade vinyl insulating compound developed in our own laboratories for a better hook-up wire. It has excellent resistance to deformation, soldering, high temperature, low temperature and aging; high electrical properties; Underwriters Lab. approved for continuous operation to 105°C without fibrous covering.</td>
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<tr>
<th><strong>JAN-C-76 HOOK-UP WIRE</strong></th>
<th><strong>SURFLON (200°C) HOOK-UP WIRE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval includes all types (WL-SRIR-SRHV-SRRF) in all sizes. WL available with nylon jacket or glass braid. SRIR-SRHV-SRRF available with primary insulation only or with the addition of a glass braided covering. All standard colors including &quot;Spiralon&quot; spiral striping.</td>
<td>&quot;Surflon&quot; (tetrafluoroethylene) insulation is extremely stable and capable of operation at 200°C for long periods with no appreciable decomposition. Non-inflammable. High resistance to chemicals; has no known solvent. Volume and surface resistivity very high. Surflon's electrical losses are exceptionally low, which adapts it for use on high frequency applications over a wide range of temperatures. Now available in hook-up wire sizes.</td>
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<tr>
<th><strong>MULTI CONDUCTOR CABLES</strong></th>
<th><strong>&quot;SURCO&quot; TUBING</strong></th>
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<tbody>
<tr>
<td>&quot;Surprenant&quot; manufactures an extensive line of multi conductor cables for a variety of applications with conductor sizes from No. 32 AWG stranded and larger, with or without nylon jacket or shielding. Our &quot;Spiralon&quot; color coding system permits easy identification even when hundreds of conductors are involved. Our designs and close tolerances permit unusually small overall diameters.</td>
<td>&quot;Surco&quot; vinyl tubing is available in special formulations for particular applications, such as, low temperature (-45°C), high temperature (105°C), U.L. approved, high dielectric strength, extreme flexibility and colors, as well as, standard compounds which are carried in stock in regular sizes. Polyethylene and nylon tubing are also available and are carried in stock in natural color, in limited sizes.</td>
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<tr>
<th><strong>COAXIAL CABLES</strong></th>
<th><strong>&quot;SPIRALON&quot;</strong></th>
</tr>
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<tbody>
<tr>
<td>&quot;Surco&quot; coaxial cables include a wide variety of types, such as, low capacity, extra flexibility, small diameter, microphone and 2 conductor. Many approved and conform to Jan-C-17A. Many special designs. If you have a coaxial cable problem consult us.</td>
<td>&quot;Surco&quot; &quot;Spiralon&quot; color coding is available on all vinyl and polyethylene insulated wire, with or without nylon jackets. One, two or three color stripes are available in the standard Nema colors. Solid color insulation is available in the 10 Nema standard colors.</td>
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<tr>
<th><strong>NEW, IMPROVED AIRCRAFT WIRE</strong></th>
<th><strong>EXTRUDED NYLON STRIPS &amp; SHAPES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nylon jacket over polyvinyl chloride for greater resistance to abrasion, fungus, moisture, hydraulic and other oils. Higher operating temperatures and better electrical properties approved under ANJC-48A. &quot;Surprenant&quot; manufactures aircraft wire to more rigid requirements, for newest developments contact us.</td>
<td>Nylon flat strip for punch press operations, as well as, extruded shapes, tubes and rods are now available. Surprenant experience in the nylon extrusion field can help you solve your problems.</td>
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*ELECTRONICS — October, 1950* 231
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ors are identical in value to provide a center-tap. The reactances of the blocking capacitors are also equal to produce an equal impedance both sides of center-tap. Reference to the derivation will reveal this as an initial condition.

Cathode followers were employed to provide an impedance transformation from a high input impedance to a low output impedance. It is desirable to have a high input impedance to prevent the loading of the measured network, and to prevent any additional phase shift by this loading. A low output impedance allows calibration of the voltmeter without excessive cycling.

A 180-degree phase reversal for measurement of the sine of $\theta/2$ is accomplished by obtaining the output from the plate of $V_1$. The switch labeled SINE-COSINE performs this operation.

The input to each tube consists of a blocking capacitor and a grid-leak resistor. Identical components are used to prevent a phase difference at the grids in addition to that being measured while measuring the cosine of $\theta/2$. When the output of $V_1$ is taken from the plate for the measurement of the sine of $\theta/2$, the reactance of the filter capacitor becomes significant at the low frequencies, and creates a spurious phase shift. This unwanted phase shift is canceled by introducing an opposite phase shift at the grid of $V_2$ by decreasing the reactance of the R-C circuit.

The rate of change of the sine function with respect to the angle is greater for small angles. Therefore, to obtain maximum reading accuracy, the sine of $\theta/2$ is used for phase angles from 0 to 90 degrees. The cosine of $\theta/2$ position is used for angles between 90 and 180 degrees where the rate of change of the cosine function is greatest.

The phasemeter is used in conjunction with an audio oscillator as shown in Fig. 3. A 3-way calibration switch is used with the a-c voltmeter to allow the calibration of the tube outputs. The cathode resistor of $V_1$ is a potentiometer for adjusting the voltage to one volt. The cathode and plate output voltages of $V_1$ are calibrated by means of the audio oscillator attenuator control. This procedure eliminates
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S.S. White engineers are ready to cooperate in working out details of any flexible shaft application. There's no obligation.

FIG. 3—In practice, the phasemeter is connected as shown here.

The phasemeter was first tested for inherent phase shift over the frequency range. The two inputs were connected together to an audio oscillator, and readings of sine $\theta/2$ versus frequency were taken. Under ideal conditions, the voltmeter reading will be zero, indicating zero phase shift, but a residual voltage caused by power supply ripple will normally be measured. This voltage amounted to 0.008 volts over the band, and, if considered a phase shift, equals approximately 1 degree. This is the smallest angle that can be measured.

The phasemeter was tested for accuracy by comparing measured phase shifts against calculated phase shifts of a R-C circuit. Values of capacitance and resistance obtained from an impedance bridge were used in the computations. The voltage across the resistance with reference to that across the series combination was first taken across the band. The voltage across the capacitor was then measured using the same reference. The error in the measured angles averaged 0.5 degrees.

Great differences in input voltages should be avoided. For greatest accuracy, both inputs should be approximately 1.7 volts corresponding to an output of one volt. The accuracy will then be within 1 degree from 1 to 180 degrees. If the input to $V_s$ is between 5 and 10 volts, then the 1-degree accuracy is maintained only from approximately 10 to 180 degrees. Excessive distortion creates harmonic voltages which predominate for small angles, and leads to an increasingly large error as the phase angle approaches 1 degree. Computation of the error due to the power supply ripple revealed it to
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Whether you need a certain characteristic, or a combination of several performance features in your specific capacitor application, you can safely specify these Sangamo Transmitting Micas for all types of military radio and electronic equipment for two reasons—first, because Sangamo Micas are service-proved by 27 years of satisfactory performance; second, they are built to meet all standards set by Joint Army and Navy Specifications JAN-C-5. They are engineered to assure high current carrying ability, to hold losses to a minimum, and to provide maximum safety.

Type G Capacitors are designed for use in medium and high power, high voltage and high current circuits. They are ceramic encased and are frequently connected in gangs to handle heavy loads.

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THE ELECTRON ART

(continued)

be negligible for angles greater than 1 degree.

The writer wishes to express his appreciation to Harry L. Sandberg for his analyses and encouragement. The writer is also indebted to Clem Arnold for his suggestions and cooperation.

REFERENCES


NRL Microwave Interferometer

ALTHOUGH ORIGINALLY intended for measurement of wavelengths in the centimeter region, a microwave interferometer constructed at the Naval Research Laboratory on the basis of Michelson’s optical instrument has also proved useful in the rapid determination of the dielectric constants of materials in sheet form. It is particularly suitable for the study of laminated radome materials, of parallel-plate media of nominal dielectric constant less than one, and of metal-loaded artificial dielectric materials for microwave lenses—media which cannot readily be placed in a waveguide as required by other techniques.

In the Michelson interferometer, a beam of light is split by a half-reflecting mirror. One part of the beam is reflected from a fixed mirror, the other from a movable mirror. When the two beams are reunited, they form interference patterns. In the microwave modification, the interference is produced between a reference signal and...
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**Write for Recordings** made on this equipment for study by studios, advertisers, agencies.
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led through a waveguide and a signal reflected from a movable metal reflector and a fixed half-reflecting mirror. In this way, phase and amplitude of an essentially plane wave may be compared with that of a reference signal.

The instrument was developed by Radio Division One of the Naval Research Laboratory.

Ultrasonics Used In Seed Treatment

A DETAILED STUDY of the effects of high frequency sound radiation on hybrid corn is in progress at the U. S. Department of Agriculture Research Center at Beltsville, Maryland.

Using a high-intensity ultrasonic generator, government agronomists are trying to evaluate the effects of time and intensity of treatment on germination, flowering, growth and yield. Seeds exposed to the high intensity radiation have been planted recently in field test plots. The agronomists have their fingers crossed.

Based on previous experiments with other seeds they expect a faster germination, but also possible failure of some of the seeds to take root. The end object of the research, of course, is higher production.

The piezoelectric generator operates on four fixed frequencies. It is essentially a radio-frequency generator modified to match the electrical impedance of a transducer through a coaxial cable. The complete equipment is housed in a battery jar containing about 12 liters of transformer oil.

To get a constant indication of the radio-frequency volt-amperes in the high-frequency line to the transducer, a radio-frequency ammeter and a vacuum-tube voltmeter have been added.

On the top of the battery jar is a copper shield, which has in the center a copper cup of about 3 inches in diameter and 3 inches deep. A 2-inch hole in the bottom of the cup is covered by a strip of copper less than 0.002 inch thick. The cup acts as a container for a

THE ELECTRON ART

October, 1950 — ELECTRONICS
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That's what this versatile interval timer by Haydon® says when its buzzer sounds off. This audible signal—at cycle completion—sounds continuously until manually turned off. The unit is driven by a dependable Haydon synchronous motor; is built to give constant, efficient service over thousands of cycles.

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A thermistor is placed in one arm of a bridge circuit whose other arms are usually 200 ohms each. A given amount of d-c current is passed through the bridge and an adjustable a-c voltage is connected and varied until the bridge is balanced. When r-f power is applied to the thermistor, the d-c current is automatically reduced until the bridge is again balanced. Thus with the bridge balanced, the change in d-c power in the thermistor is equal to the r-f power. A meter circuit is arranged to read this change directly.

Although this instrument was first intended for use in power monitoring work, other uses for it have arisen, such as that of checking signal generator output. The instrument was developed in Radio Division Two of the Naval Research Laboratory.
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This business paper is a member of the Audit Bureau of Circulations because we want our advertisers to know what they get for their money when they advertise in these pages. Our A.B.C. report gives the facts. Ask for a copy and then study it.

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NEW PRODUCTS (continued from p 126)
school lab projects and for safety checks in radiation labs. The circuit features a G-M tube, built-in amplifier with CK522 AX subminiature tube, and regulated vibrator-type high-voltage power supply. Weight is 2½ pounds.
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The MB-150 is intended for use in plate tank circuits having an input up to 150 watts. It is ideal for a pair of 807's, 809's or a single 829 B. Net $16.75.

The MB-40L may be used in the grid circuits of tubes employing the MB-150L in the plate circuit. Will handle 40 watts if link is kept loaded. Net $9.90.

Address export inquiries to Export Div., Dept. E-1050

NATIONAL COMPANY, Inc.
MALDEN, MASSACHUSETTS

October, 1950 — ELECTRONICS
monic distortion (measured at 100, 400 and 5,000 cycles); with a 48-watt peak output. It features 3 microphone inputs (each convertible for use with a low-impedance mike by means of a plug-in transformer); 2 phono inputs with dual fader; true electronic mixing and fading on all 5 inputs; separate bass and treble tone controls. Frequency response is ±1 db, 40 to 20,000 cps. Output impedances are 4, 8, 16, 166 (70 volts), 250, 500 ohms.

**TV Amplifier**

SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 212TV amplifier, specifically designed for television use, is a single untuned amplifier having a bandwidth of 40 to 240 me and a gain of 20 db into a 72-ohm unbalanced load and 25 db into a 300-ohm balanced line. Transmission characteristic is ±2 db over the bandwidth and impedance is 200 ohms.

**Nine-Pin Miniature**

RADIO CORP. OF AMERICA, Harrison, N. J. The 5963 medium-mu twin triode of the 9-pin miniature type

---

**“Sound” Research Develops a BETTER PRODUCT!**

**Magnecord Tape Recordings**

Research departments have found a better way to take notes on electronic data and noise... They record the actual sounds on magnetic tape using Magnecord tape recorders exclusively.

Magnecorders are sturdy and give perfect reproduction under the most difficult conditions. Light-weight — one man can carry a Magnecord recorder anywhere!

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No other recorder offers such a wide frequency range at such a low price. Special models to fit your special needs for

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GANGED LINEAR AND NON-LINEAR POTENTIOMETERS

This three-gang precision potentiometer assembly is just one more example of Fairchild's answer to customers' special-application problems.

The assembly combines on a common shaft, two 736 non-linear potentiometers, specially wound to an empirical function, with a highly accurate (+1.5%) 747 linear unit. Ganging in this manner saves considerable space and virtually eliminates error accumulation such as would occur if each unit were operated on its own shaft.

Fairchild's Potentiometer Sample Laboratory engineers can help you in analyzing your special applications. Write complete details on your requirements to Dept. 140-11A1, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

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You can fill your contract needs in flat and lock washers at Garretts. We manufacture a complete line of high quality washers made to meet the most exacting specifications of the Army, Navy and Air Force. These product-proved washers include:

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- Ordnance BBX1
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For high quality and quick deliveries on the above washers, send your order to Garretts. We can supply them in regular steel, spring steel, stainless steel, brass, bronze, monel metal, aluminum, Alclad and copper as specified. We plate them with zinc, cadmium, nickel, brass, chrome... or they can be parkerized.

Garrett, as a manufacturer, offers you one source and quick deliveries on all types of small parts—flat washers, spring lock washers, stampings, springs, hose clamps, snap and retainer rings. Write for new folder of specifications for Armed Forces washers.

Manufactured by GEORGE K. GARRETT CO., Inc.
Philadelphia 34, Pa.

IN-RES-CO CATALOG

Included are complete descriptions and specifications on wire wound resistors of all types and sizes. Each is precision wound to close tolerance, and many feature special moisture-proofing to assure proper functioning under severest climatic conditions. INRESCO Resistors—available for IMMEDIATE DELIVERY—are supplied in standard or custom types to meet the most unusual design or operational requirements, and are offered at prices that benefit from mass production facilities. A copy of the new INRESCO catalog will be helpful; write for it today. Prices, samples and estimates promptly on other than standard resistors.

INSTRUMENT RESISTORS COMPANY
1036 COMMERCE AVE., UNION, N. J.

Wire Wound Resistors for Every Use in Electronics and Instrumentation

October, 1950 — ELECTRONICS
is especially designed for frequency-divider circuits in electronic computers, and other on-off control applications requiring long periods of operation under cutoff conditions. A bulletin giving complete technical data is available.

Rectangular TV Tube

GENERAL ELECTRIC CO., Syracuse, N. Y., is now producing the 17BP-4A, a 17-inch magnetic-focus-and-deflection tube with a neutral-density faceplate. It features an electron gun designed to be used with an external, single-field ion-trap magnet for the prevention of ion-spot blemish. An external conductive coating serves as a filter capacitor when grounded. Heater voltage is 6.3 v and heater current is 0.6 ampere ±10 percent.

Scaler

ATOMIC INSTRUMENT CO., 84 Massachusetts Ave., Boston 39, Mass. Model 1010 standard scaler is furnished optionally with a scale-of-100 or scale-of-256, and added scaling assemblies to make either a scale-of-1,000 or a scale-of-4,096 may be

TOROIDS

by B&W

...to your SPECIFICATIONS

Development of stabilized, high permeability cores of various types and grades, has greatly increased the applications of toroid coils in the low frequency range from 500 cycles to 200 KC. B&W toroids feature high inductance and high Q within a minimum of space and confined electrical field. These features assure the highest performance in many types of filters or networks.

Over fifteen years background in coil design and manufacture, plus the latest toroidal coil winding equipment, provides a combination that makes it possible for B&W to meet your most exacting requirements. B&W Toroidal Coils are available in open types, shielded, potted or hermetically sealed units in addition to complete filters or networks for specific applications. Our Engineering Department is ready to assist you with your problems in the application of toroids.

Write to Dept. EL-100

BARKER & WILLIAMSON, Inc.
237 Fairfield Avenue
Upper Darby, Pa.
COMMUNICATIONS TOWERS

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FUNGUS-PROOF

Nylon LACING CORD
resists mold and micro-organisms

- Intensive research in the laboratories of Heminway & Bartlett has resulted in the development of a fungus-proof Nylon Lacing Cord. This new cord — with its special synthetic resin coating — resists the growth of mold and micro-organisms, factors most often responsible for the deterioration of old type linen and cotton lacing cord and the subsequent corrosion and failure of electronic equipment.

Heminway & Bartlett's new special finish Nylon Lacing Cord retains the desirable malleability of wax and yet has a melting point of over 190°F. It is non-toxic to humans.

We'll be glad to send you full information and prices... no obligation, of course. Why not write us today!

THE HEMINWAY & BARTLETT MFG. CO.
500 Fifth Avenue, New York 18, N. Y.

Branches: 617 Johnston Building, Charlotte 2, North Carolina; 222 West Adams Street, Chicago 6, Illinois; 77 S. Main Street, Gloversville, New York; 716-32 N. 18th Street, St. Louis, Missouri.

VSWR and RF WATTMETER

SPECIFICATIONS

- Frequency Range: 50 to over 1000 Mc.
- Impedance: 31.5 or 72 ohms
- Connectors: Standard connectors supplied are type N to accept UG-21/U attached to RG-8/U and RG-9/U cable. The instrument is supplied on request, with UHF type connectors to accept RG-21/U attached to RG-8/U and RG-9/U cable.
- Adapters are available for attaching to 5/8 inch 51.5 ohm coaxial line.

- Power Ranges:
  - Model MM 560: 0 to 4 watts
  - Model MM 561: 0 to 10 watts
  - Model MM 562: 0 to 20 watts
  - Model MM 563: 0 to 200 watts
  - Model MM 564: 0 to 2000 watts

- Accuracy: Plus or minus 5% of full scale for RF power.
- Reflection Coefficient: Less than 0.01.

MM 560 SERIES
Provides instant assurance of proper functioning of entire RF portion of transmitter, antenna, and transmission line.

This new MicroMatch reads directly the incident power, reflected power, net power to load, and VSWR of the load. Complete $97.00.

M. C. JONES ELECTRONICS CO.
BRISTOL, CONNECTICUT

Distributed Outside of Continental U.S.A. by RCA International Div., N. Y., N. Y., U. S. A.

October, 1950 — ELECTRONICS
specified. The standard unit features a resolving time of less than 5 µsec. Inputs are as follows: G-M probe with 0.25-v sensitivity and external preamplifier; an adjustable pulse height discriminator; a 2,500-v line and load-regulated h-v supply.

Inert-Gas Thyatron
WESTINGHOUSE ELECTRIC CORP., Bloomfield, N. J. A new grid-controlled, inert-gas rectifier, the type WL-5796 thyatron, is a three-electrode, temperature-free tube designed for industrial control and ignitor firing service. Maximum peak anode voltage, both inverse and forward, is 1,500. Maximum negative control grid voltage before conduction is 250; after conduction, 10. The tube can be used in polyphase rectifiers on inductive loads with very small or no cushioning circuits. Cathode voltage is 2.5 and cathode heating time is 10 seconds.

Double-Pulse Generator
BERKELEY SCIENTIFIC Co., 6th and Nevin Sts., Richmond, Calif. Model 902 double-pulse generator pro-
Kahle ENGINEERING CO.
1309 Seventh Street, North Bergen, New Jersey

Kahle are specialists in custom-built, ultra-precision ELECTRON TUBE MACHINERY.

Kahle custom-builds machines to make the exact tubes you require—from big 20-inchers to tiny sub-miniature—from laboratory types to those for high-speed production. Kahle puts each unit through exhaustive trial runs in our plant to assure trouble-free operation in yours.

Making cold metal go exactly where it's wanted by cold heading frequently requires specialized skills. Take this steel acorn-head screw, for instance. Ordinary cold heading just can't displace such a large amount of metal in the head on such a small threaded section.

Scovill makes a specialty of "tough" cold heading jobs—has the engineers, toolmakers and operators to turn out parts like these to close tolerances, with better finish, at low cost. Send your sample or blueprint for further information.

Kahle CUSTOM-BUILDS machines to make the exact tubes you require—from big 20-inchers to tiny sub-miniature—from laboratory types to those for high-speed production. Kahle puts each unit through exhaustive trial runs in our plant to assure trouble-free operation in yours.

Consultations invited
Send for our new catalog

Coil-Proved

PARAMOUNT Paper Tubes facilitate coil winding—insure coil accuracy and stability. Proved by use, they have become standard with leading manufacturers of electrical, radio and electronic products. Here you are sure to obtain the exact size and shape you need for coil forms and other uses... from stock arbors, or specially engineered to your specifications. Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Also Shellac Bonded Kraft Paper Tubes for absolute moisture resistance.

PARAMOUNT Paper Tube Corp.
616 Lafayette St., Fort Wayne, Ind.
Manufacturers of Paper Tubing for the Electrical Industry

"Guide to the Profitable Use of Cold Heading"—Bulletin No. 2 describes the advantages and limitations of this process for the designer. It's free for the asking.

Recessed Head Screws • Sears Tapless Screws • Standard Machine Screws • Special Cold Headed Parts

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October, 1950 — ELECTRONICS
duces two pulses individually controllable in width, amplitude and time relation to each other. Pulse amplitude is individually adjustable from 0 to 50 and 0 to \(-200\) v. Pulse rise time is 0.05 \(\mu\)sec, decay time 0.10 \(\mu\)sec, and duration is individually adjustable from 0.15 to 1.5 \(\mu\)sec. Spacing between the two pulses is continuously variable in two ranges, \(-0.5\) to \(+3\) \(\mu\)sec. Output impedance is approximately 400 ohms; maximum output voltage, \(-200\) v. Overall accuracy of control calibrations is \(\pm 5\) percent over the entire range.

**Selenium Rectifier**

**BRADLEY LABORATORIES**, 82 Meadow St., New Haven, Conn., has introduced a new low-current selenium rectifier which features a special plate for use on direct currents in the microampere range. It was developed to provide a highly efficient selenium rectifier for very low current requirements in special equipment such as Geiger counters and c-r equipment. Model number is SE8LA. Rated up to 6,000 v peak inverse, connection series may be used for higher voltages.

**Matching Transformer**

**BRACH MFG. CORP.**, 200 Central Ave., Newark, N. J., has developed a 75 to 300-ohm matching trans...
MORE OUTPUT... LOWER COSTS... from EXCLUSIVE SPEED FEATURE. Universal motors permit variable speeds without changing belts and pulleys. Coil design permitting, speeds as high as 7500 RPM are not uncommon.

- PORTABILITY. Conveniently carried from place to place. Machines come mounted on bases to constitute one complete unit.

- MIGHTIER ORIGINAL COST. The same investment buys more GEO. STEVENS machines than any other coil winding machines.

- LONG LIFE. Most of the original GEO. STEVENS machines bought 14 years ago are still operating daily at full capacity.

- MIGHTIER FASTER CHANGING OF SET-UPS than any other general purpose coil winding machine. Quickly changed gears and cams save time between jobs.

- VERY LOW MAINTENANCE. Replacement parts are inexpensive, can be replaced in minutes, and are stocked for "same day" shipment, thus saving valuable production time.

- EASIEST TO OPERATE. In one hour, any girl can learn to operate a GEO. STEVENS machine.

Transformer winder Model 37S multiple winds power, audio, automotive, fluorescent ballast and similar types of coils. Winds wire from No. 18 B&S to 46 B&S up to 5" O.D. Maximum economy is possible by using mandrels up to 30" long. Thirty or more coils may be wound at one time. All turns are accurately registered by Model 50 or 51 6" full vision clock face Dial Counter. Set-ups can be changed in less than 5 minutes. A gear chart is furnished to quickly determine wire spacing.

No loss of turns (an exclusive feature) and accurate margins are assured by a screw feed traverse and an electrically controlled clutch. Highly polished wire guide rollers are ball-bearing mounted for free running. Traverse is quickly adjusted from 1/8" to 6".

Paper feed: A tilting table for pre-cut paper is furnished making paper feed simple and fast, or a new roll paper feed for extra economy is available at a small additional cost.

Motor equipment: - Variable speed, uniform torque 1/2 H.P. motor with foot treadle control.

Tension equipment: - 12 T-1 tensions and spool rack. Tensions will handle 6" spools.

Mounting: - Ground steel channel base ensures rigidity and permanent alignment. Machine is shipped mounted on bench ready for use.

There is a GEO. STEVENS machine for every coil winding need. Machines that wind ANY kind of coil are available for laboratory or production line... Send in a sample of your coil or a print to determine which model best fits your needs. Special designs can be made for special applications. Write for further information today.

World's Largest Manufacturer of Coil Winding Machines

GEO. STEVENS MFG. CO., INC. Pulaski Road at Peterson Chicago 30, Illinois

NEW PRODUCTS (continued)

former with high-pass filter action. It is designed to be a perfect termination at channels 2 to 13 but offers a serious mismatch to diathermy and short-wave interference transmissions in the i-f band. A coaxial fitting is provided to make a low-loss connection to RG59/U. The transformer has negligible loss over the complete tv band and a voltage gain of 2 to 1.

VHF Transmitter

Plessey Co. Ltd., Ilford, Essex, England. Type PT 15, a 50-watt vhf transmitter, has a wide field of application in providing radiotelephony communication wherever a compact fixed-station transmitter with a carrier power output of this order is required. Covering the 118 to 132-mc frequency band, the crystal-controlled operational frequency can be varied by insertion of the appropriate crystal.

Preamplifier

Pickering and Co., 309 Woods Ave., Oceanside, N.Y., has announced the model 230H. compact, small size preamplifier to equalize low frequencies and provide neces-
TUNGSTEN and MOLYBDENUM GRID WIRE

Made to meet your specifications... for gold content, diameter and other requirements.

Write for details and list of products.

THE GAMEWELL COMPANY
Newton Upper Falls 64, Massachusetts

PRECISION POTENTIOMETERS

The linear Type RL-275 illustrated is one of a series ranging from 1/4" to 5" in diameter, with resistance ranges of 80 ohms to 500,000 ohms.

GAMEWELL Potentiometers are precision instruments in every respect. They feature extremely close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life—far in excess of 1,000,000 cycles of operation.

All types will operate within specified limits of performance at temperatures -55°C to +55°C, 95% relative humidity at altitudes up to 50,000 feet. Corrosion resistant materials are used throughout and all insulating parts are fungicided. Our potentiometers meet AN-E-19 specifications.

We invite your inquiries and will gladly study and quote on special requirements.

Write for Bulletin F-68.

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SPECIFICATIONS\r\n
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SINCE 1901

SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

ELECTRONICS — October, 1950

253
Base your TV designs on RCA performance-proved deflection components

RCA TV Components reflect RCA's vast experience in TV design...and incorporate the most advanced engineering features. RCA TV components are unequaled for wide-angle deflection systems.

All RCA television components are "originals," with electrical and mechanical specifications rigidly held to co-ordinated circuit and tube requirements. They are "performance proved" and they are competitively priced.

RCA Application Engineers are ready to work with you in the adaptation of RCA television components to your specific designs. For further information write or phone RCA, Commercial Engineering, Section J428, Harrison, N. J., or your nearest RCA field office.

(EAST) Harrison 6-8000, 415 S. 5th St., Harrison, N. J.
(MIDWEST) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill.
(WEST) Trinity 5641, 420 S. San Pedro St., Los Angeles, Calif.

ULF Band-Pass Filter
KROHN-HITE INSTRUMENT Co., 580 Massachusetts Ave., Cambridge 39, Mass., has produced the model 330-A ultralow-frequency band-pass
IT'S here...

IT'S news...

IT'S WORTH STOPPING TO SEE!

Maybe Industry doesn't maintain show windows on Fifth Avenue or State Street or Wilshire Boulevard like America's great department stores. But your industry has a mighty effective show window... and this is it... this magazine.

In these advertising pages alert manufacturers show their wares. Here you will find up-to-the-minute news about products and services designed to help you do your job better, quicker, and cheaper.

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McGRAW-HILL PUBLICATIONS

ANNouncing New Model 1401
Plays 10½" Reels!

$345.00

Complete, for console installation with single or dual track heads:

Concertone

The professional quality tape recorder you have been waiting for! NAB standards; triodes throughout; 40-15000 cycles at 15", 40-9000 cycles at 7½". Three motors; flutter less than 0.1%; signal-to-noise better than 50 db. Three heads for simultaneous erase, record, playback. Quick change from single to dual track. Write for booklet.

FISHER RADIO CORPORATION - DISTRIBUTORS - 37 E. 47th St., N. Y.

Small Parts
Cost less when made by Multi-Swage

The economy way to get a million small parts similar to these—

Examine the tubular metal parts shown here twice size. If you use anything similar... in quantities of over a million... important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's Multi-Swage Process has long been known as the most economical method of making electronic contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities.

WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,
Tr. Mark 88 Mountain Grove St., Bridgeport 5, Conn.
The HK A-4920 frequency shift receiving terminal is a new development of Heintz & Kaufman which provides reliable radio-printer operation on extremely weak signals together with frequency stability normally obtainable only from far more costly equipment.

The terminal is used with two space antennas for diversity reception, and it will directly actuate a radio-printer or other d-c operated devices such as a multiplex keyer.

**FEATURES**

The terminal consists of two A-4921 crystal-controlled receivers and one A-4922 F-S converter. It has a range of operation from 2 to 24 megacycles with transmitter shifts nominally between 500 and 1000 c.p.s. at keying speeds up to 150 dot cycles.

**SENSITIVITY:** 1 microvolt or better for a 12 db. signal-to-noise ratio.

**SELECTIVITY:** An undesired signal only 1.5 kc. from the desired signal is discriminated by 60 db. Image rejection is 60 db. down or better throughout the input signal range.

**STABILITY:** When recommended crystals are used, the stability of the terminal will permit operation over a 24 hour period without manual adjustment under the following conditions and with an output signal bias distortion not in excess of 10%:

Ambient temperature variations between plus 10 and 50 degrees C. Line voltage varying from 105 to 125 volts. Signal input level variation (to receivers) from 1 microvolt to 1 volt. Input signal frequency variation (as from transmitter drift) of plus or minus 100 c.p.s.

**GENERAL:**

Visual and aural tuning system. Visual observation of signal conditions in each channel. Electronic selection of the best signal in each channel on a signal-to-noise basis.

For detailed electrical and performance specifications covering the new A-4920 terminal write or wire

NEW PRODUCTS

**Versatile VTVM**

**Chicago Industrial Instrument Co., 536 W. Elm St., Chicago 10, Ill.** The Multitester illustrated is a vtvm featuring 7 ranges of a-c and d-c volts to 5,000; 0 to a billion ohms in 6 ranges; a capacitance scale from 50 µµf to 5,000 µf and 0 to 500 ma in 4 ranges. Price is $39.00 and a descriptive folder is available.

**SWR Bridge**

**James Miller Mfg. Co., Inc., Malden, Mass.** Catalog number 90671 standing-wave-ratio bridge is of the resistance type and is...
make sure your crystals are made by Standard Piezo.

For years, our Crystals have been standard as original equipment with leading manufacturers and for replacement purposes by large operators of mobile equipment.

Precise, accurate, Standard Piezo Crystals are available for ALL types of mobile communication equipment.

Request catalog E for complete details.

Are You An

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or ELECTRICAL?

... then here's a CAREER opportunity you can't afford to overlook

If you're an engineer, and a good one; if you are interested in a position of prime responsibility that will pay you remarkably well; if you are eager for an employment opportunity that will associate you with a team of top flight engineers, physicists and production experts; if you are interested in a career job on the engineering staff of one of America's foremost manufacturers of radar equipment... then write or wire Mr. William F. Gates, Dalmo Victor Company, San Carlos, California for an interview appointment.

Dalmo Victor will assist new employees find suitable housing. San Carlos in the Peninsula area just south of San Francisco, is one of the nation's finest residential districts.

Building equipment to test products under conditions of high and low temperature, high altitude and relative humidity is Bowser's business. Because Bowser units can simulate all conditions found on or over the earth, such tough Gov't. specs as USAF 41065-B can be taken in stride. All Bowser units are self-contained and will maintain preset conditions automatically.

Why don't you take advantage of Bowser's long experience? Mail the coupon now!
Leading Manufacturers* Specify
COMMUNICATION ACCESSORIES
TOROIDAL COMPONENTS

CREMENTED COILS
Toroids close-tolerance adjusted to your specifications. Coils are heat cycled to maintain accuracy even in toughest service conditions. Toroids have low T/C characteristics, extremely low magnetic pickup and external field. Coils may be supplied with balanced windings, also can be toped, or have multiple winding for tight coupled impedance transformation.

PLASTIC COATED TOROIDS
Another C A C First. Our most progressive customers specify thermo-setting plastic coating for their coils, transformers, and tuned circuits. This tough resilient covering protects the coils and seals out moisture. Just another reason why the people who use toroids year after year specify C A C Toroidal Components.

CASED TOROIDS AND FILTERS
Rugged steel cases, construction meeting military specifications. Coils giving highest Q per unit volume and special capacitors provide sharper and more stable filters with a compactness never before possible. A special design for your every requirement.

Radio Beacon
AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC., 3090 Douglas Road, Miami 33, Fla., has developed the package-type dual automatic beacon transmitter illustrated. Each unit consists of two 100-watt transmitters (or two 50-watt transmitters), automatic keyer, an automatic transfer unit, and an antenna tuner housed in two standard rack cabinets, especially designed for unattended service.

Oscillosynchoscope
BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass., an-

* Names on request...

Send for this FREE booklet today...

COMMUNICATION ACCESSORIES
Company
HICKMAN MILLS, MISSOURI

NEW PRODUCTS (continued)
intended for use with cox lines of either 52 or 75-ohm type. The unit measures 4 1/2 in. x 2 1/2 in. x 1 1/4 in. It will work with any low-range d-c instrument and makes possible an inexpensive means for making measurements of the type necessary with all modern transmitter installations.
ELECTRONICS TECHNICIANS
for
RADAR, COMMUNICATIONS, TELEVISION RECEIVERS

Needed By
RCA SERVICE COMPANY, INC.
A Radio Corporation of America Subsidiary for U. S. and Overseas

REQUIREMENTS:
• Good Character
• Training in Installation or Maintenance of Radar, Communications or Television
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Qualified Candidates will be Interviewed Promptly.

COMPENSATION:
Up to $7,000.00 a year to start
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Qualified technicians seeking connection with leading company having permanent program for installation and service of military equipment, AM, FM, TV transmitters and receivers, and electronic devices, such as electron microscopes, mobile and microwave communications, theatre TV, write full history to:

RCA SERVICE CO., Inc.
Camden 2, New Jersey

BUILDING BLOCK DESIGN!
Successors to the famous 140 series amplifiers, the new ALTEC 1400 series is the most versatile amplifying, preamplifying, mixing group ever designed. Building block design permits combinations to provide 2 to 12 mixing input channels—preamplifiers that can be mounted on the power amplifier chassis or externally—mixing controls that can be mounted remotely from all other apparatus—output at line level, when required, or 35 to 75 watts. Thorough mechanical and electronic design and outstanding quality make the new ALTEC 1400 series perfect for every speech input and public address requirement.

AMPERITE CO., Inc., 561 Broadway, New York 12, N. Y.
In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto
Perhaps an Almo-Pinion will help you!

(Especially When they're FREE!)

If you want the best equipment—or the lowest priced equipment—to do an electronic job, you can save time and money with a FREE Almo-pinion.

1. Almo provides a one-source call for all the top lines. You get the impartial opinion of men who know all the competitive makes intimately.

2. You buy at the same factory prices—and get lots of added responsible service FREE.

3. You save time. Just a single call, wire, or letter will help you get the best solution to your particular problem. (Or we'll send you all the statistical data on all the competitive makes if you wish).

4. If you need electronic parts or equipment, ask for a FREE Almo-pinion. See for yourself how you can save time and money. Please address your request to Mr. Smith, Industrial Electronics Department.

Almo Radio Company
509 Arch Street, Philadelphia 6, Pa. 4 Stores to Serve You

Wilmington, Del. Atlantic City, N. J. West Phila.
6th & Orange Sts. 4401 Ventnor Ave. 6205 Market St.

NEW PRODUCTS (continued)

announces the model OJ-17 oscilloscroscope for laboratory use. The high-gain vertical amplifier has a response flat from 5 cycles to 16 mc, extending beyond 50 mc, including the use of a 0.2-µsec signal delay line. Two completely separate sweep systems permit accurate display of repetitive phenomena with recurrence rates as high as 10 mc, or transient and recurrent pulses as short as 0.5 µsec. Accurate time measurements may be made by use of 0.1, 1.0, 10 and 100-µsec timing markers. One compartment of the five-unit cabinet is provided for permanent installation of an Oscillo-Record camera.

Sensitive Relay

Assembly Products, Inc., Chagrin Falls, Ohio. Series 1816 is a sensitive relay with heavy-duty ratings. The coil is 15,000 ohms and operates on 5 ma d-c. Contacts are snap action and will handle 15 amperes, 115 v or 7.5 amperes, 220 v a-c. Designed for high differential between pull in and drop out the relay is normally high speed in action. Contacts are spdt or dpdt.

Random Noise Generators

Kay Electric Co., Maple Ave., Pine Brook, N. J., announces the microwave Mega-Nodes, a series of...
"But you can't buy that kind of a motor..."

How many times have you heard somebody say something like that about motors, pumps, compressors or whatever-you? And how many times have you heard somebody else say, "Oh yes you can! I saw just what we need in Blank Company's ad yesterday."

Advertising pages in this magazine are packed with news about your business. They contain information about products and services designed to help you do your job quicker, better and cheaper. To be well-informed about the latest developments in your business, your industry... and to stay well-informed... read all the ads too.

McGRAW-HILL PUBLICATIONS

THE NEW "Economy" OSCILLOGRAPH

Long the world's most popular oscillograph, the Type S-14 has been redesigned and improved to meet exacting demands of modern research. The NEW Type S-14C 'Economy' Oscillograph is the simplest to operate and maintain, and the most versatile in application. No research or testing laboratory is complete without it.

- Wide range of galvanometer types and characteristics. Natural frequencies to 10,000 cps; sensitivities to 50,000 mm per mv; single and polyphase watts.
- Precision optical system for very high writing speeds and high-quality records.
- Continuous-drive magazine for records to 100 or 200 feet long.
- Wide range of record speeds. Any of 9 speeds available by shifting single external belt. Standard speeds: 40, 20, 10, 4, 2, 1, 0.4, 0.2 and 0.1 in./sec.
- Internal motor and gear reducer shock mounted and vibrationless.
- Light-socket operation.
- Daylight loading and unloading.
- Automatic transiend recording attachments.
- Complete list of accessories for extreme versatility.

FOR FURTHER INFORMATION WRITE FOR BULLETIN 2D1-G

Hathaway Instrument Company
1315 So. Clarkson Street, Denver 10, Colorado
MINIATURES AND SUBMINIATURES

The MRB-3 miniature dynamic receiver and microphone has excellent wide-range frequency response characteristics, maintained flat by the Patented Permoflux acoustical damping method. Utilizes a self-formed voice coil. Sensitivity—115 db in 6 cc coupler with 1 m.w. input. Overall diameter 1"—height 13/8". Can be supplied with miniature input or output transformers in any impedance.

T1 and T2 Transformers — and Chokes — These subminiature units provide power efficiency from 80-90% with high voltage breakdown characteristics and extremely low susceptibility to electrolytic deterioration. Frequency response is ±2 db from 100 to 6000 Mc, impedances up to 200,000 ohms and windings with inductive reactances up to one megohm. Ideal for use with Permoflux microphone receiver units and headsets.

Low-Frequency Coils

UNITED TRANSFORMER CO., 150 Varick St., New York 13, N. Y., have developed a line of Hi-Q coils for subaudio frequencies. These coils have high Q and stable characteristics for frequencies from 0.1 to 10 cycles. A typical unit provides an inductance of 300,000 henrys with Q of 10 at 0.15 cycle and Q of 30 at 0.5 cycle. It is designed for a 1-volt a-c, 0.1-ma d-c circuit.

Regulated Power Supplies

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced two new regulated power supplies for tv station

NEW PRODUCTS

random noise generators designed to produce a known output noise in the frequency range of 2,600 to 12,400 mc. The following waveguide sizes are available: RG48/U, RG49 U, RG50/U, RG51 U, RG52/U. Over the operating range, the vswr of each generator is less than 1.1, with the exception of the RG50 U guide whose vswr goes to 1.19 over about 20 percent of the frequency range. Noise output of each generator is 15.84 db above thermal noise at a waveguide temperature of 32 C.
when you use the Audax POLYPHASE... ONE single unit plays ALL your records SUPERBLY... and at less than the cost of ordinary magnetic pick-ups

"The Standard by which Others Are Judged, and Failed"

MEMO TO DESIGNERS

THE PATH OF MOST RESISTANCE FOR ELECTRICITY IS THE PATH OF LEAST RESISTANCE for your PURCHASING AGENT

We’re Talking About

JELLIFF ALLOY 1000

This new resistance wire is almost too good to be true. Not only is the Resistivity 1000 ohms/cm (48% higher than that of the widely-used nickel-chromiums), but it also has such outstanding mechanical and electrical properties that it can easily replace several other alloys now being used in the smaller gages for precision resistors.

This means simplified procurement, stock and inventory procedures — more compact precision resistors — lower cost and longer life for the finished product.

For the full story of Alloy 1000, write for Bulletin 17

THE PATH OF MOST RESISTANCE FOR ELECTRICITY IS THE PATH OF LEAST RESISTANCE for your PURCHASING AGENT

PHOTOELECTRIC TOWER LIGHTING CONTROL

Turn-on 34 ft.-candles—off at 55 ft.-candles—independent of time of day or weather conditions. Low first cost—negligible maintenance. 3000 watts contact capacity. Over 20,000 in use for tower and street lighting. Complete details available — ask for Bulletin 63305.

NEW! OCTAL PLUG-IN WAFERS

Now available in production quantities, E-I Series OBS Plug-in Wafers feature several important new developments. Hollow keys are form fitting and a new hermetic sealing technique makes the seal practically indestructible, even when the pins are bent. The entire assembly is extremely rigid. For complete data, call or write for the E-I illustrated brochure.

Hermetic Sealing Components

E-I ELECTRICAL INDUSTRIES INCORPORATED

44 SUMMER AVENUE NEWARK 4, N. J.
Experience, hard and practical, is the reason why Tenney can build test chambers to meet the toughest industrial and government specifications. Standard Tenney units accurately control mildew resistance, altitude, explosion-proof, liquid immersion and other tests. Basic systems can be combined for complex conditions. Tenney program control assures absolute fidelity in changing times and conditions; electronic controllers provide high precision regulation. For literature and further information, write to Tenney Engineering, Inc., Dept. A 26 Avenue B, Newark 5, New Jersey.

Remote-Cutoff Beam Pentode

RADIO CORP. OF AMERICA, Harrison, N. J. Type 5890 is a low-current beam pentode of the remote-cutoff type intended particularly for the voltage regulation of h-v d-c power supplies. It has a maximum d-c plate-voltage rating of 30,000 v, a maximum d-c plate-current rating of 500 µa, and a maximum plate-dissipation rating of 10 watts. The h-v insulation required for its intended service is obtained by the use of a double-ended structure using a suitably designed electron gun consisting of a thermionic cathode and three grids. The plate connection is made to a small cap at the end of the bulb.

Sweep and Marker Generator

KAY ELECTRIC Co., Maple Ave., Pine Brook, N. J. Model RFP Marka-Sweep is an all-electronic sweep and marker generator espe-
QUAKER CITY GEAR WORKS
1910 N. FRONT ST.
PHILADELPHIA 22, PA.

SPECIALISTS IN ELECTRONIC GEARS

VULCAN ELECTRIC HEATING UNITS
FINNED STRIP
For use in blow- or type electric unit heaters, as ovens or space heaters in dryers, pump rooms, switch towers, etc.

From 10 1/2" to 42 1/2" overall.
500 watts to 2000 watts.
for 115 and 230 volts.
Steel sheath and fins (rust resisting)

For use where sheath temperature will not exceed 750° F.

HEART OF A TIP JACK...
IS THE SPRING CONTACT
Johnson Design, Materials
Mean Longer Life, Better Service

Next time you need Tip Jacks, remember the two important advantages JOHNSON Tip Jacks offer.

First, contact in the JOHNSON Tip Jack is made along the entire length of the phone tip or test prod, and remains unchanged despite insertion of oversized tip, excessive binding forces or long use. Second, JOHNSON uses heat treated berylium copper contacts which remain smooth acting, have low resistance and retain high spring tension.

Although other Tip Jacks may look like those made by JOHNSON, only JOHNSON offers you heat treated berylium copper contacts of this unique design.

The insulated style with strong molded Plaskon head, (illustrated) is available in ten attractive colors. They are also available without head for mounting directly in equipment, as well as in a variety of other types. In all of them JOHNSON machined parts are of highest quality, with close fitting threads, smooth finish, plated to comply with any specifications.

JOHNSON makes many other jacks and plugs, such as "banana" styles for military or commercial applications, as well as plug and jack board assemblies, connectors, etc. Manufacturers are invited to write for free samples and catalog information.

JOHNSON...a famous name in Radio!
E. F. JOHNSON CO., WASECA, MINNESOTA

VULCAN
ELECTRIC COMPANY
DANVERS 10 MASS.

SPECIALISTS IN ELECTRONIC GEARS

VULCAN ELECTRIC HEATING UNITS
FINNED STRIP
For use in blow- or type electric unit heaters, as ovens or space heaters in dryers, pump rooms, switch towers, etc.

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JOHNSON...a famous name in Radio!
E. F. JOHNSON CO., WASECA, MINNESOTA

SPECIALISTS IN ELECTRONIC GEARS

VULCAN ELECTRIC HEATING UNITS
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For use in blow- or type electric unit heaters, as ovens or space heaters in dryers, pump rooms, switch towers, etc.

From 10 1/2" to 42 1/2" overall.
500 watts to 2000 watts.
for 115 and 230 volts.
Steel sheath and fins (rust resisting)

For use where sheath temperature will not exceed 750° F.
SQUARE WAVE GENERATOR—Model SG5  An inexpensive step frequency type square wave generator for accurate high speed testing of response characteristics of wide band amplifiers, wide band oscilloscopes, television video amplifiers, etc.

**FEATURES**
1. Five fixed output frequencies of 50, 1000, 10,000, 100,000 and 500,000 P.P.S.
2. Individual calibration control for each frequency.
3. Rise time 0.5 microseconds.
4. Output voltage 0.8 to 8 volts peak to peak.
5. Small, compact, portable—completely AC operated.

**SIZE** 9" x 11" x 11 1/2"  **WEIGHT** 20 lbs.

INSULATION RESISTANCE TESTER—Model M05  A small compact portable battery operated insulation resistance tester employing a high quality vibrator power supply as a source of high potential. Operates completely from two small self contained 1 1/2 volt batteries. Total current drain only 15 milliamperes.

**FEATURES**
2. Meter—4½” rectangular type with 3½” scale length.
4. Provided with leather strap for carrying.
5. Operates completely from two self contained scale volt dry batteries.

**SIZE** 5” x 3½” x 6”  **WEIGHT** 2 lbs.

AUDIO OSCILLATOR—Model TE200K

Frequency Coverage — 20 cycles to 200,000 cycles in four ranges.
Frequency Dial — 6” diameter, direct reading, with planetary drive.
Output Voltage — 10 Volts maximum.
Calibration Accuracy ± 2% of dial setting indication.
Distortion — 3½% or less across standard load at any frequency setting and at any output voltage up to maximum.
Hum Level — Minus 50 DB or better.
Standard Load — 1000 ohm resistive.
Frequency Response — 1 DB from 20 to 200,000 C.P.S.
Drift — 3% or better.

**SPECIAL FEATURES**
1. Electronically regulated power supply for stable operation under varying line voltage conditions.
2. No electrolytic capacitors are used.
3. Designed for stable continuous operation under the most adverse conditions.
4. Mounts in standard relay rack or table cabinet.

We maintain a fully equipped laboratory embracing the finest in modern high quality test instruments—complete facilities for testing every type of equipment manufactured—facilities for testing temperature and humidity tests from —80°F to +165°F and humidities up to 95%.

Take advantage of our 15 years of experience in the Specialized Electronics Field. We are one of the oldest commercial manufacturers of Nucleonic Instruments and Capacity Operated Electronic Burglar Alarms.

15,000 SQ. FEET OF FLOOR SPACE AND A MODERN, FULLY EQUIPPED PLANT TO SERVE YOU

FOR FURTHER DETAILS WRITE  EL-TRONICS, INC. 2649 N. HOWARD ST. PHILADELPHIA 33, PA.

NEW PRODUCTS (continued)

Specially suitable for production alignment of tv tuners and overall alignment of complete receivers. A 12-position channel switch selects extremely narrow pin-type crystal-positioned picture and sound carrier markers as well as the desired 15-mc wide swept oscillator output. Sweep outputs are from maxima of approximately 0.5 v for the 70-ohm unbalanced output and 1.0 v for the 300-ohm balanced output down to minima suitable for aligning the most sensitive receivers.

Transmitting Tube

GENERAL ELECTRIC Co., Syracuse, N. Y. Type GL-5680 transmitting tube is designed for use as a power amplifier in transmitters for long-range navigation. The tube is forced-air cooled and may be operated at maximum ratings at frequencies as high as 5 mc. In pulsed r-f power-amplifier service it can deliver a peak power output of 90,000 watts at 15,000 volts under typical operating conditions.

V.T Multimeter

MILLIVAC INSTRUMENTS, Box 3072, New Haven, Conn. Type MV-T3B
ANNOUNCING the
RAWSON-LUSH
Rotating-Coil
GAUSS METER

Tiny coil (approx 3mm diameter) rotates in the magnetic field to be measured. The voltage generated is rectified in a synchronous rectifier and deflects a Rawson high sensitivity voltmeter with scale calibrated in kilogausses.

FEATURES
1) Simple operating principles, simple to maintain.
2) Compact and portable, just one meter and the long probe unit.
3) Ranges 0.4/1.2/4/12/40/120 kilogausses, all on one instrument.
4) Practically point measurement of field.
5) Can be inserted in any gap wider than 1/4", and will reach the center of 37" diameter gap. Coil protected by stationary outer tubing.
6) Measures direction of field as well as intensity.
7) Guaranteed accuracy Iwo or better.
8) Low price $325 complete with meter.

RAWSON ELECTRICAL INSTRUMENT COMPANY
111 Potter St. Cambridge, Mass.

STANSCROR
TRANSFORMERS

Specified as original components by the biggest radio and TV set makers in the industry. They have to be good!

WRITE. inquiries promptly answered

STANDARD TRANSFORMER CORPORATION
3578 ELSTON AVENUE, CHICAGO 18, ILLINOIS

Lavite STEATITE CERAMIC

Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications — high compressive and dielectric strength, low moisture absorption and resistivity to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

Complete details on request.

D. M. STEWARD MFG. COMPANY
Main Office & Works: Chattanooga, Tenn.
Needham, Mass. • Chicago • Los Angeles
New York • Philadelphia

add REAL TENSION CONTROL to COIL WINDING OPERATIONS

INSTALL
PAMARCO
Wire DeReeling Tensions on Your Present Machines!

Pammarc DeReeling Tensions increase the efficiency of coil winding departments in two important ways. Production quantity is increased because each machine accommodates more coils and can work at higher winding speeds. Production quality is improved because Pamarco free-running action practically eliminates wire breakage and shorted turns. No special skill or tools are required to operate Pamarco-equipped winding machines. Simple thumb screw can be set instantly for any wire gauge. For all the facts on money-saving Pamarco DeReelers, just call or write. Complete data will reach you promptly!

Manufactured Exclusively by
PAPER MACHINERY & RESEARCH INC
1014 OAK ST., ROSELLE, NEW JERSEY

WINDING DEVICES FOR TEXTILES AND ELECTRONICS
New radiation instruments in the modern tempo

The New Roentgen Rate Meter

The new Roentgen Ratemeter has been designed to indicate rate of beam intensity in roentgens per minute. Two probe selections are offered, each to cover four ranges of intensity, one 3-10-30-100, the other 30-100-300-1000 r per minute and both may be used interchangeably with the same meter. Calibrated in the international r, the instrument provides a means to make accurate and quick determinations of beam intensity for many laboratory applications.

The New Model 389 Thyac Survey Meter

A stable and versatile beta gamma survey meter incorporating new features and advantages in a portable instrument. The design provides compact, light weight, waterproof construction which meets severe military ruggedness and corrosion resistant requirements. It adapts itself for sensitive exacting laboratory measurements as well as for field measurements.

100 and 200 r hi-intensity chambers used with Model 392 charger

The Model 506 pocket ionization chamber is designed to meet the need for a compact dependable chamber for measurement of radiation in the 100 r and 200 r ranges. These chambers offer accurate readings of high intensity at energy responses of 40 KV and above, reliable for high dosage and are tamper proof.

The Victoreen Instrument Co.

5806 Hough Avenue • Cleveland 3, Ohio

NEW PRODUCTS

(continued)
The Green Engraver offers great speed and convenience. Quickly cuts up to four lines of letters from 3/64" to 1" on curved or flat surfaces whether made of metal, plastics or wood... operates by merely tracing master copy—anyone can do an expert job. Special attachments and engineering service available for production work. Just the thing for radio, electronic apparatus and instrument manufacturers.

*Price does not include mover type and special work holding fixtures.

GREEN INSTRUMENT CO.
363 Putnam Ave.
Cambridge, Mass.

JONES SHIELDED TYPE PLUGS & SOCKETS

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS, SUPPLIED IN 3 AND 2 CONTACT TYPES:
101 Series can be furnished with ¼", ⅛", ⅜", ¼", ½", or ¼" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation and sockets have bakelite. Quality construction. Fine finish. Assembly meets Navy specifications.

For full details and engineering data ask for Jones Catalog No. 17.

JONES MEANS Proven Quality

TITEFLEX, INC.
410 Frelinghuysen Ave., Newark 5, N. J.

It's a Fact...

Ground miniature bearings are obtainable and at NO EXTRA COST

The major development of the decade in anti-friction bearings made possible by
* Production skill and "know-how."
* The last word in machine tools and equipment.
* Precision grinding spindles of 100,000 rpm and more.

RESULT:
The smooth performance and accurate geometry of GROUND Bearings is now available in sizes as small as 1 mm (.040") bore x ½" O.D. with the millionths inch refinement of ABEC-7.

"The smaller the bearing the better it runs."

New Hampshire Micro Ball Bearings, Inc.
5 Main Street • Peterborough, New Hampshire

Microwave Transmission Problems
are a cinch with
Waveflex Waveguides

The WAVEFLEX waveguide incorporates all of the advantages of rigid waveguides while offering the additional feature of flexibility. Designers of radar, FM, and television transmission equipment have discovered that this combination of properties simplifies many of their design problems. WAVEFLEX waveguides offer lower attenuation loss, excellent impedance match, and extreme flexibility without loss of efficiency. They are made in accordance with joint Army-Navy specifications. Let us work with you in developing special waveguides for your special applications.

Literature on request
TITEFLEX, INC.
410 Frelinghuysen Ave., Newark 5, N. J.
New Miniature Insulated Terminals to help your miniaturization program

Featuring extremely small size combined with excellent dielectric properties, three new miniature insulated terminals are now available from CTC.

Designed to meet the requirements of the miniaturization programs now being carried out by manufacturers of electrical and electronic equipment, the terminals come in three lengths of dielectric and with voltage breakdown ratings up to 5,800 volts. In addition, they have an extremely low capacitance to ground.

The X1980XA is the smallest terminal, having an over-all height of only three-eights of an inch including lug. Insulators are grade L-5 ceramic, silicone impregnated for maximum resistance to moisture and fungi.

All terminals have hex-type mounting studs with 3/48 thread or .114" OD rivet style mounting. Mounting studs are cadmium plated, terminals are of bright-alloy plated brass.

Write for additional data.

C-R Oscillograph

Allen B. DuMont Laboratories, Inc., Clifton, N. J. Type 293 c-r oscillograph is designed for the impulse-testing of h-v transformers, insulators, lightning arresters, and other equipment designed to withstand surge potentials of great amplitude. Driven, logarithmic sweeps may be initiated from an external signal, internal signal, by manual pushbutton or from any point in the cycle of the 60-cycle line voltage. Sweep duration is adjustable in steps from 0.5 to 1,000 µsec. Bandwidth of both the X and Y axes is essentially uniform from d-c to 25 mc.

Literature

Coax Cable. Andrew Corp., 363 E. 75th St., Chicago, 19, Ill. Bulletin 39 treats type 738 ultralow-loss zero slip. It provides a stable, long-life, proportional clutch means that can deliver desired torques continuously for given levels of control current independent of slip-heat loss. Fractional horsepower units up to 1 hp are available for industrial work such as tension control, machine tool drives, dynamometers, and various duty cycles requiring continuous high-heat dissipation as well as synchronous driving upon demand.

NEW PRODUCTS (continued)
TEST TV TRANSMISSION and RECEPTION

Latest TELEQUIP

SYNC GENERATOR and MONOSCOPE

with Monoscope Picture Generators and Distribution Panel

Produces regular pictures used with TV transmitters. Gives synchronizing, driving and blanking signals for testing, research and development work, with monoscope controls and distribution signals for use at various points of testing.

Invaluable to manufacturers of TV receivers and broadcasting units for checking faults not likely to be observed by other methods. Can be used at transmitting stations as auxiliary unit. Available either in combination or as separate units.

Now used by Admiral, Motorola, Zenith, and many leading manufacturers of television equipment.

TELEQUIP RADIO COMPANY

2559 WEST 21ST STREET • CHICAGO 8, ILLINOIS

GRANT ELECTRONIC EQUIPMENT

SLIDES...

for Chassis, Consoles, and Racks

• a standard slide to meet any requirement
• slides to carry from 25 pounds to 2,000 pounds

Outstanding Advantages:

1. Continuous ball bearing motion.
2. Closely fitted slides eliminate chassis rattle.
3. Available with special locking device to lock slide in extended position and increase accessibility to all parts.
4. Allows 90 degree pivot for simplified servicing.

Consult with our engineering department on any slide problem
WRITE DEPT. E 10 FOR COMPLETE ILLUSTRATED INFORMATION

GRANT PULLEY & HARDWARE Co.

33-39J 57th STREET, WOODSIDE, L. I., N. Y.

Representatives in all major cities

The foremost name in Sliding Devices

ELECTRONICS — October, 1950

271
CONSTANT RESISTANCE
HIGH POWER RATING
TERMALINE
COAXIAL LOAD RESISTORS

51.5 ohms DC to 4000 mc—5 watts to 2500 watts

The constant resistance (Low VSWR) of the TERMALINE resistor make it the ideal dummy load and standard resistor at UHF and VHF. Design is such that normal resistance is put to work, producing a pure resistance over an extremely wide frequency range. Acting as a "bottomless pit" for RF energy, thousands of TERMALINE units are in daily use with high frequency transmitters.

SIX MODELS AVAILABLE

<table>
<thead>
<tr>
<th>Model</th>
<th>Cont. Power Rating</th>
<th>Input Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD-5F</td>
<td>5 watts</td>
<td>UG-218-U</td>
</tr>
<tr>
<td>BD-5M</td>
<td>5 watts</td>
<td>UG-218-U</td>
</tr>
<tr>
<td>BD-A</td>
<td>20 watts</td>
<td>UG-218-U</td>
</tr>
<tr>
<td>RI</td>
<td>50 watts</td>
<td>UG-218-U</td>
</tr>
<tr>
<td>B1B</td>
<td>80 watts</td>
<td>UG-218-U</td>
</tr>
<tr>
<td>B2C</td>
<td>500 watts</td>
<td>Adaptor to fit UG-218-U supplied.</td>
</tr>
</tbody>
</table>

Other adaptors or cable assemblies for any standard coaxial line available.

All TERMALINE units, except Model B2C, are self-cooled and require no auxiliary power. Substantial quantity discounts.

LITERATURE UPON REQUEST

NEW PRODUCTS

(cocontinued)

coaxial cable that is $\frac{3}{4}$ in. in diameter and semiflexible. Mechanical and electrical characteristics, impedance, power rating standing-wave ratio and a table of efficiency vs frequency are given. Several accessories are also described and illustrated; and a price list for all may be found in bulletin 58.


Reference Book. Harrison Radio Corp., 10 West Broadway, New York 7, N. Y. The Radio's Master is a 1,300-page hard-cover-bound reference book and buyer's guide for the electronics industry. It describes and illustrates the products of better than 90 percent of all manufacturers of electronic parts and equipment. Prices and specifications as well as an index are included. Copies will be sent free to any purchasing agent or chief engineer who writes on company letterhead.

Radiation-Detection Densitometer. Photovolt Corp., 23 Madison Ave., New York 16, N. Y. Bulletin 490 covers model 400-R radiation-detection densitometer which is self-contained and operates with barrier-layer photocell without amplification. The unit described is designed for the accurate measurement of density of dental-size x-ray films as employed in film badge systems for personnel monitoring in radioactivity laboratories and x-ray installations.

Receiving Tubes. Radio Corp. of America, Harrison, N. J. Form 1275-E is a 24-page booklet covering more than 450 receiving tubes and picture tubes including more than 50 new types. It provides quick and easy reference to the
ON THE JOB AT THE FAMOUS BELL "LABS"

In this modern home of telephone research—the Bell Telephone Laboratories, Murray Hill, N. J.—Ace Screen Rooms play an important part in assuring maximum shielding efficiency for numerous test and research procedures.

Better Attenuation

...AT NO GREATER COST!

Designed to exacting wartime laboratory standards, supplied in ready-built "knockdown" form for installation in a few hours, Ace Screen Rooms provide a minimum of 100 db. attenuation from 0.15 to 1000 mc. Total cost is no greater than that of "homemade" screen rooms of far lower efficiency. Numerous sizes are available and rooms can readily be moved or enlarged as required. Write, wire, or 'phone for details.

ACE ENGINEERING & MACHINE CO.
3642 N. Lawrence St.
Philadelphia 40, Pa.
REGent 9-1019

The Key to SUBMINIATURE TRANSFORMER PROBLEMS

DIMENSIONS: ...7/16" x 3/8" x 1/2"
WEIGHT: ...Less than 1/2 of an ounce
TYPES: ...input, interstage, output, reactor

Prompt Engineering Attention To Your Subminiature Problems

UNION ELECTRIC PRODUCTS CO.
24 EDISON PLACE
NEWARK 2, N. J.
NEW PRODUCTS (continued)

characteristics and socket connections for each tube type, as well as a classification chart which groups the tubes according to their family class, their functions, and their filament or heater voltages, and thus facilitates determination of the type designation of a tube for a desired purpose. Price is 10 cents.

Variable Transformers. The Superior Electric Co., Bristol, Conn., has released bulletin PS50 featuring the complete line of standard Powerstat variable transformers. Maximum display is given to product photographs, performance curves, graphs, wiring diagrams and similar descriptive illustrations. A complete rating chart occupying the back cover provides engineers and purchasing agents with a quick selector index.

Acoustic Apparatus. Audak Co., 500 Fifth AVE., New York 18, N. Y., announces its new 1950 catalog, a four-page brochure embracing its Polyphase model reproducers, also tuned ribbon and heavy duty pickups and cutting heads. All models are illustrated and list prices are given.

Contact Switches. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill., recently issued a bulletin dealing with a line of contact switches. Numerous line drawings and charts are employed to give information relative to sizes, designs and materials available in standard contact blades, lug adapters and insulating separators.

Radio and TV Catalog. General Mfg. Co., 919 Taylor Ave., Rockford, Ill. Catalog No. 154 features over 5,000 radio and television products and service aids. The 64 pages are well illustrated and prices of all items are included.


Sylvania Electric Products Inc.

Sylvania has been using Metex gaskets for over a year as conductive shields for their TR tubes used in radar and micro-wave ranging equipment.

To quote their experience: "We have found Metal Textile knitted wire gaskets excellent for conducting high frequency currents without boundary arcing. The gaskets are resilient, and yet do not deform too readily. Best of all, the material is inexpensive to assemble through soft soldering techniques."

The properties—electrical and physical—which make Metex Electronic Gaskets effective in this, and other demanding HF and UHF applications are due to their being made from knitted (not woven) wire mesh. The hinge-like action of the knitted mesh permits controlled resiliency of the finished gaskets. These can be die-formed to close dimensional tolerances, when required. There is practically no limit to the metal or alloy which can be used.

If the equipment you are manufacturing or designing requires a resilient conductive or shielding material, our engineers will welcome the opportunity of working with you. A letter, addressed to Mr. R. L. Hartwell, Executive Vice President and outlining your requirements, will receive immediate attention.

METAL TEXTILE CORPORATION
641 EAST FIRST AVE., ROSELLE, N. J.

For Only $650.

Never before a value like this new 2-KW bench model "Bombarder" or high frequency induction heater . . . for saving time and money in surface hardening, brazing, soldering, annealing and many other heat treating operations.

Simple . . . Easy to Operate . . . Economical Standardization of Unit Makes This New Low Price possible.

This compact induction heater saves space, yet performs with high efficiency. Operates from 220-volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. We will advise cycle required for your particular job. Cost, complete, only $650. Immediate delivery from stock.

Scientific Electric Electronic Heaters are made in the following range of Power: 1-2-3-1/2-3-1/2-10-12-1/2-15-18-25-40-60-80-100-250KW.

Scientific Electric Division of "S" CORRUGATED QUENCHED GAP CO. 107 Monroe St., Garfield, N. J.
World's Largest Stock of ELECTRONIC SUPPLIES

Components—Instruments—Ham Gear—

Increasing thousands of engineers, industrial plants, broadcast stations, and government agencies depend on NEWARK. Here is a fast and friendly service, competent technical help, lowest possible prices—EVERYTHING YOU NEED in one dependable and centrally located buying source.

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RAPID INSPECTION ON THE PRODUCTION LINE

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- STANDARD RANGE: 1 TO 20 CYCLES PER SECOND
- SINE WAVE
- MODULATED CARRIER
- 50 TO 800 CYCLES

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You Are Invited To Attend The Second Annual AUDIO FAIR
at the
Hotel New Yorker, New York City, October 26, 27, 28, 1950

The event of utmost interest and importance to Broadcast Engineers, Sound-on-Film Men, Public Address Men, Audio Hobbyists and Businessmen.

Presenting again, under one roof, an industry-wide display and demonstration of the latest and best of audio equipment, components and accessories.

FREE REGISTRATION BANQUET THURS.—OCT. 26 7:30 PM
Sponsored by the AUDIO engineering society in conjunction with it's ANNUAL MEETING AND CONVENTION

SMALL PARTS
Filaments, anodes, supports, springs, etc., for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to 1/2 inch. Any length up to 12 feet. LUXON fishing tackle accessories.

Inquiries will receive prompt attention.

ART WIRE AND STAMPING CO.
227 High St. Newark 2, N. J.
Precision Rod Cutting
at High Speed

with the New
DI-ACRO ROD PARTER

The DI-ACRO Rod Parter further increases the applications of “DIE-LESS DUPLICATING” as a cost-cutting, time-saving production technique so well established by DI-ACRO Precision Benders, Brakes and Shears. Do you require precision?—The DI-ACRO Rod Parter holds tolerance to .001” on duplicated cuts. The ends are square, and roundness is maintained.

Do you want speed?—The Rod Parter exceeds output of other methods with equal accuracy, on rods and bars up to 5”. Torrington Roller Bearings incorporated in an exclusive multiple leverage arrangement provide remarkable ease of operation in both heavy and light materials.

See Di-Acro Exhibit—BOOTH 1603
Nat’l Metal Exposition, Chicago, Oct. 23-27
or write for 40-page Catalog

NEW PRODUCTS (continued)

the electronic tube and its application to electronic calculators and business machines; the latter discusses commercial and technical applications of the company’s electronic calculating machines, and describes some of the work of the IBM technical computing bureau.

Photoelectric Colorimeter. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin 409 describes and illustrates the model 401 Lumetron photoelectric colorimeter, an instrument designed for accuracy, ease and speed of operation in colorimetric and turbidimetric analysis. The bulletin gives a list of applications, a price list and a list of available accessories and replacement parts.

Transformers and Related Components. Standard Transformer Corp., Elston, Kedzie and Addison, Chicago 18, Ill. The June 1950 edition of the company’s catalog of transformers and related components for radio, sound and industrial applications is available. This 20-page illustrated booklet lists complete electrical and physical specifications of more than 400 part numbers. Also included is a complete price list and handy charts. The company’s tv components are listed in a separate tv catalog and replacement guide, also available in a seventh edition.

Circuit Breakers. Heinemann Electric Co., Trenton 4, N. J. Equipment bulletin No. 3410 describes in 12 pages a line of fully magnetic nonthermal, nonenclosed, general purpose circuit breakers. Illustrations charts, diagrams, graphs and cutaway drawings portray these one-, two-, and three-pole breakers for general industrial use. Time overload curves and coil resistance curves are also included for convenience in selecting the breakers for specific needs. In addition to terminal construction, the following types of coils connections are described: series overload, calibrating tap, shunt trip and relay trip.

Solderless Connectors. Buchanan Electrical Products Corp., 1290
NEW Clipcord PC-4
Capacitance Comparator Checks, Grades and Sorts
Condensers of Every Type
— Paper, Mica, Oil Filled,
Ceramic, Electrolytic.

Now... UNSKILLED OPERATOR CAN
GRADE UP TO 8000 CAPACITORS DAILY!

The PC-4, companion to the well known
Automatic Resistance Comparator PR-4, is a
NEW high speed and extremely accurate
aid in the never ending battle for higher
quality and lower production costs. An un-
skilled operator can check, grade or sort
as many as 8000 capacitors of ANY TYPE,
daily, with an accuracy of 0.2%.
Ease of operation reduces inspection time to an
absolute minimum.

Completely self-contained, the PC-4 re-
quires no outside attachments other than
a Standard Capacitor against which the
"unknowns" are to be checked. Operates
on 110 Volts—60 cycle A.C. Range—100
mfd to 1000 mfd. Size 18" x 12" x 12".
Weight—approximately 35 lbs. For com-
plete details write for Catalog Sheet 4-E.

Clipcord
INSTRUMENT LABORATORY, INC.
1125 Bank Street
Cincinnati 14, Ohio

M AN U F A C T U R E R S  O F  R. F. C O I L S  A N D  E L E C T R O N I C  E Q U I P M E N T

H I G H V O L T A G E  P O W E R Supplies
Up to 250,000 volts
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SPECIAL INDUSTRIAL X RAY EQUIPMENT
FOR INSPECTION · GAGING · ANALYSIS...

We will Design, Engineer and Manufacture to your requirements.

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THOUSANDS OF
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ATLANTIC INDIA RUBBER WORKS, INC.
571 WEST POLK STREET · CHICAGO 7, ILLINOIS.
Write Dept. E for Complete Catalog #44—All Phones: HArrison 7-8290
Central Ave., Hillside, N. J. Bulletin 750 describes in four pages an improved line of connectors for solderless splicing and terminating of electrical wires. Illustrated descriptive data, installation instructions and ordering information are given. The pres-Sure tool is pictured in operation.

F-M Equipment. Collins Audio Products Co., Inc., P. O. Box 368, Westfield, N. J. Information on the T-20-A mobile receiver, the S-17-A Storecaster receiver and R-12-A industrial f-m tuner is found in a recent four-page folder. It tells how to increase the earning power of one's f-m station through use of bus radio, storecasting and industrial music. A price list is also available.

Tube-Base Reference. Radio Corp. of America, Harrison, N. J. The Triple Pindex, 2F366R, is a handy quick-reference guide to tube-base diagrams. Over 600 tube types are listed in both alphabetical and numerical sequence. Designed for workbench use, it measures 4 in. x 8 in. Price is 75 cents.

Measurements Notes. Measurements Corp., Boonton, N. J., announce the publication of the second issue of Measurements Notes. The purpose of the four-page brochure is to assist the industry in making measurements of receiver susceptibility to ignition interference.

Recorders and Amplifiers. Sanders Co., 39 Osborn St., Cambridge 39, Mass. A recent catalog folder contains a loose-leaf-perforated series of bulletins covering a line of direct-writing recorders and instrument amplifiers. Each unit is technically described and illustrated and a price list is included. As other, or newer, models become available, descriptive pages will be sent for inclusion in the folder.

Power Frequency Amplifier. Keithley Instruments, 1507 Warrensville Center Road, Cleveland 21, Ohio. An illustration, chief uses, features and specifications of the model 105 Meter Matcher are given. The small, compact, and well-engineered instrument has been redesigned to make it easier to handle and operate. It has a frequency range of 10 to 60,000 cycles, with a sensitivity of 1 microvolt at 10 cycles and an input impedance of 990 million ohms. The unit is housed in a sturdy metal case and is claimed to be rugged enough for field use.
**HEXACON BANTAM MODEL 30H**

- Weight: 5½ Ounces
- Watts: 40 or 60
- Tip Dia.: Both ⅛" and ¼" Tips furnished with each iron
- Price: $5.50

So light its weight is hardly noticeable. Outperforms any iron of equal size. Modern design makes it more comfortable and practical to use than a pencil iron. No transformer required. Write for complete catalog.

**Northern Radio Company, Inc.**

143-145 West 22nd Street
New York 11, N. Y.

Power Sources in Quality Communication Equipment

**The Variable Oscillator with CRYSTAL STABILITY**

High versatility, plus wide range, plus crystal stability and accuracy—that's the unbeatable combination for the best in diversity reception. You get all three with the Northern Radio VARIABLE MASTER OSCILLATOR. The HFO's stability is ± 20 cps/mc for ambient change of ± 25°C—matching that of any non-temperature controlled crystal. Its range is 2-32 mc continuous. Crystal check points, with 40 curves supplied, permit absolute frequency setting to ± 25 cps/mc. Three crystal-controlled frequencies provide fixed frequency reception. There's a LF crystal oscillator for BFO.

And, this unit also serves as an excellent transmitter exciter and laboratory measuring standard.

See the specifications on this outstanding model in the 1950 Electronics Buyers Guide. For complete data on the precision-built Northern Radio line, write today for your free latest Catalog E-2.

**CONTINENTAL CARBOMITE RESISTORS**

* JAN R-11 Approved
* Ratings, ½, 1 & 2 Watt
* Tolerance 5% & 10%
* Operate at 70° Amb

Ideal for service replacement, especially in television receivers. Available from stock through Continental Jobbers in cooperation with Allen-Bradley.

**CONTINENTAL CARBON Inc. CLEVELAND 11, OHIO**

For Precision Washers...For Precision Stampings...

**WHITEHEAD STAMPING CO.**

A preferred source of precision-made WASHERS and STAMPINGS. 46 years of experience and up-to-the-minute facilities, assure highest quality and service.

**WHITEHEAD STAMPING CO.**

1691 W. Lafayette Blvd.
Detroit 16, Michigan
may be found in a four-page folder. The unit described is a power frequency amplifier for greatly reducing the errors caused by measuring instrument loading of a circuit under test.

Portable D-C Recorder. Wallace & Tiernan, Belleville, N. J. Publication TP-18-A illustrates and describes a new portable d-c recorder, a direct writing recorder that is adjustable over a wide range. The unit described has a minimum full-scale range of 100 µa and a maximum full-scale range of 5,000 ma. It is particularly suited for laboratory use.

Antenna Catalog. Jerrold Electronics Corp., 121 N. Broad St., Philadelphia 7, Pa. A 12-page two-color catalog gives full information and shows diagrammatically how a Mul-TV system, including antenna, master control-amplifier unit and distribution outlets, is installed in a typical apartment house or store to provide perfect television reception on any number of television sets connected to the system.

Tube Selection Survey. Industrial Electronics, Inc., 8060 Wheeler St., Detroit 10, Mich., has available a survey form which will be sent to all companies that are interested in obtaining tubes that have superior life characteristics. The superior qualities are obtained by a preaging and selection process.

Resistors. Instrument Resistors Co., 1056 Commerce Ave., Union, N. J. A recent 28-page loose-leaf perforated folder covers a line of application-designed wire-wound resistors. Included are illustrations and specifications on each type.

Artificial Reverberation Generator. Tech Laboratories, Inc., Palisades Park, N. J., has available a single-sheet bulletin treating the type AF101 artificial reverberation generator. Technical specifications given include the unit's input impedance, input and output level, output impedance, controls, reverberation time and power requirements.
MASS PRODUCTION
FABRICATED SHEET
METAL PRODUCTS
YOUR OWN OR
GOVERNMENT SPECIFICATIONS

COMPLETE facilities under one roof for quality mass production—including welding, baking and finishing. Whistler and Wiedermann equipment for short runs. Tool and die engineering and designing. Completely conveyerized finishing facilities.

Large assortment of stock and special dies for the radio, television and electronic field. Production and engineering under the direction of a competent executive who has had over 36 years experience in sheet metal fabrication backed up by a substantial organization and personnel.

Chassis
Enclosures
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Spare Part Boxes to Army-Navy Specifications

Send your blueprints and requests for prompt attention and quotations.

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Precision MINIATURE SLIP RING Assemblies

and commutators for gyros, computers, resolvers, motors, selsyns

- Absolute minimum torque friction.
- Diameter ranges .050"—24.0".
- Minimum 1000 V.A.C. hi-pot between circuits.
- Hard silver plated to plastic base and wire to form rigid assembly that withstands up to 12,000 r.p.m.
- Supplied to your specifications at competitive prices.

ELECTROTEC Corporation
53 BERGEN TURNPIKE
LITTLE FERRY, N. J.

For uninterrupted production demand Dano trouble-free coils made up to your exact specifications. Avoid production holdups! Order now from Dano, makers of a wide variety of coils.

Also, Transformers Made To Order

THE DANO ELECTRIC CO.
MAIN ST., WINSTED, CONN.
Another Waterman POCKETSCOPE providing the optimum in oscilloscope flexibility for analyses of low-level electrical impulses. Identified by its hi-sensitivity and incredible portability, 5-14-A POCKETSCOPE now permits "on-the-spot" control, calibration and investigation of industrial electronic, medical and communications equipment. Direct coupling without peaking, used in the identical vertical and horizontal amplifiers, eliminates undesirable phase shifting. Designed for the engineer and constructed for rough handling, the HI-GAIN POCKETSCOPE serves as an invaluable precision tool for its owner.

Vertical and horizontal channels: 10 mv rms/sec. with response within ± 20% from 3C to 20KC and pulse rise of 1 mil. Non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude. Repetitive or trigger time-base, with linearization from 10ns to 50KC with ± 0.01% or trigger, Trace expansion filter graph screen. Mu metal shield. And a host of other features.

Waterman products CO., INC.
PHILADELPHIA 25, PA.
CABLE ADDRESS: POCKETSCOPE

WATERMAN PRODUCTS INCLUDE:

S-10-B GENERAL POCKETSCOPE
S-11-A INDUSTRIAL POCKETSCOPE
S-14-B WIDE-BAND POCKETSCOPE
S-15-A TWIN TUBE POCKETSCOPE
S-21-A LINEAR TIME BASE

Also RACKSCOPES, LINEAR AMPLIFIERS, RAYONIC® TUBES and other equipment

NEWS OF THE INDUSTRY
(continued from page 130)

activity. With the aid of the Noise Diode, by W. K. Squires of Sylvania Electronics Products Inc.

2:00 P.M.—Quality Control Session (J. R. Sherron, presiding)
The Control of Averages in Radio Tube Manufacture. A. K. Wright of Tung-Sol Lamp Works, Inc.

The Human Aspects of Engineering Quality into the Product, by C. Gartner of Allen B. DuMont Labs, Inc.

6:00 P.M.—Joint Session with Technology Club of Syracuse

Tues., Oct. 1

9:00 A.M.—Television Session (R. A. Hackworth, presiding)


The Application of a New Low-Noise Double Triode as an RF and IF Amplifier in Television Receivers, by R. M. Cohen of BCA.

Consideration of Optimum Use of Picture Tubes, by W. H. Whitley of Sylvania Electronics Products Inc.

Radio telephone Third

A NEW CLASS of license has been established to meet a need for non-technical radiotelephone operators who are to be employed by the telephone company. The latter can control the telephone operator at the station to operate and control the station.

Supplement No. 6 to the FCC Study Guide has been issued for those preparing for the new examination.

New Bureau

THE NEW Safety and Special Radio Services Bureau recently estab-
NOW!
ACME-MOLD COILS
Better than ever when molded and impregnated with the
New! AHCME MOLD COMPOUND

A PRACTICALLY 100% SOLIDS THERMOSETTING RESIN!

- Added toughness and abrasion resistance.
- Greatly increased resistance to moisture and humidity.
- Flame resistance.
- Perfect "moldability".
- Higher dielectric strength.
- Lower power losses.

ACME Wire
THE ACME WIRE CO.
NEW HAVEN, CONN.

INSULATING VARNISHES
ACME-MOLD COILS
MAGNET WIRE
VARNISHED INSULATIONS

Little-thought-of facts about capacitors
The short time breakdown voltage of a well-made D.C.
capacitor is not less than 5 to 6 times the actual working
voltage at 20°.

\[ E = 5 \times e_{\text{min}} \]
\[ E = \text{Breakdown voltage} \]
\[ e = \text{Rated d.c. working voltage} \]

INDUSTRIAL CAPACITORS are unvaryingly held to this
formula.

Designed for maximum safety and the smallest possible
volume, INDUSTRIAL CAPACITORS are the most widely
used capacitor in industrial applications.

WRITE TODAY FOR DETAILED CATALOG
INDUSTRIAL CONDENSER CORP.

WHAT MAKES A MAILING CLICK?
Advertising men agree ... the list is more than half
the story. McGraw-Hill Mailing Lists, used by leading
manufacturers and industrial service organizations,
direct your advertising and sales promotional efforts
to key purchasing power.

In view of present day difficulties in maintaining
your own mailing lists, this efficient personalized
service is particularly important in securing the com-
prehensive market coverage you need and want.

DIRECT MAIL DIVISION
330 West 42nd Street
New York 18, New York
lished by FCC is headed by Edwin L. White, Chief. He is charged with the unification of regulations for nonbroadcast, certain common carrier (including aeronautical) radio, ship and public coastal, public safety, amateur, land transportation, industrial and citizens radio services. His assistant is Lester W. Spillane.

Heading up the five divisions are: Marine, William N. Krebs; Aviation, John R. Evans; State-Local Government and Amateur, George K. Rollins; Industry and Commerce, Glen E. Nielsen; Authorization Analysis, Charles R. Weeks. The chief of the Enforcement unit is Marshall S. Orr.

Citizens Radio

FCC has amended its rules for the Citizens Radio Service to permit operation of such stations by any person so authorized by the station licensee as long as communication does not involve transmission of Morse code telegraphy.

BUSINESS NEWS

JOHN MECK INDUSTRIES, INC., tv receiver manufacturer, is now operating a new building providing 20,000 sq ft of additional production space at its main Plymouth, Ind., factory.

GOULD-NATIONAL BATTERIES, INC., recently became the new name of the National Battery Co., manufacturer of industrial storage batteries, when the stockholders of the latter firm approved the change proposed by the board of directors.

GENERAL ELECTRIC Co., Syracuse, N. Y., has bought the Illinois Cabinet Co. at Rockford, Ill., which will continue to produce its present line of wood products for tv home receivers.

PRODUCTION EQUIPMENT Co., 37 W. Main St., Oyster Bay, N. Y., is now functioning as two separate organizations. Production Tool & Fixture Co. will continue with the subcontract portion of the business producing aircraft and similar parts. Coil Winding Equipment
### FEATURES

1. Ball Bearing Micrometer spindle for absolute control of depth of cutter in all four ratios.
2. Accuracy of reproduction in four ratios due to excellent precision machining of pantograph arms.
3. Absolute accuracy in three-dimensional duplicating.
4. Many attachments available to increase versatility, such as extension arm, rapid self-centering vise, extension post for pantograph and copy carrier, hand engraving spindle and many more.
5. Copy and work right-side up and in view of operator.

**Catalog on Request**

**MICO INSTRUMENT CO.**

76E Trowbridge St. Cambridge 38, Mass.

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### NEW 400 CYCLE MINIATURE

**INDUCTION**

**MOTOR**

**PERFORMANCE CHARACTERISTICS**

- **Horsepower** : 1/50 HP
- **Voltage** : 200 Volts
- **Current** : 0.25 Amps.
- **Phase** : 3 Phase
- **Speed** : 10,000 RPM
- **Frequency** : 600 Cycles
- **Weight** : 10 oz.
- **Overall Dimensions** : 1 1/2" dia. x 1 1/2"

**ANOTHER EAD FIRST! This unit provides the highest possible HORSEPOWER OUTPUT PER UNIT WEIGHT AND VOLUME and is most valuable for use in aircraft applications and devices in confined areas.**

For further details write to **Department “B.”**

**EASTERN AIR DEVICES, INC.**

505 Dean Street

Brooklyn 17, N. Y.

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### MOVING?

If you are moving (or have moved), tell us about it, won't you? Your monthly copies of ELECTRONICS will not follow you unless we have your new address immediately. Make sure you don't miss a single important issue... and help us make the correction as speedily as possible by giving us your old address, too.

**ELECTRONICS CIRCULATION DEPT.**

330 W. 42nd St. New York 18, N. Y.
NEWS OF THE INDUSTRY (continued)

Co. will continue with the design and manufacture of equipment for the coil-winding industry.

TETRAD Co., Inc., 4921 Exposition Blvd., Los Angeles 16, Calif., is a recent entrant into the electronic components manufacturing field. It will specialize in the manufacture of miniature solenoid coils.

FIELDEN INSTRUMENT CORP., industrial control manufacturer, announces the occupation of new and larger office and factory space at 2920 North 4th St., Philadelphia 33, Pa. The name of the company has been changed from Fielden Electronics Inc.

GENERAL Electric Co., recently announced a three-million dollar expansion program for its receiving tube plants at Owenton, Ky., and Tell City, Ind., involving the addition of 134,000 sq ft of floor space and new tube making equipment.

BETA Electric Corp. has moved to new and larger quarters at 333 E. 108 St., New York 29, N. Y. The new premises will allow about five times as much production area as was formerly available and will allow for the manufacture of power supplies up to 400 kv.

LEAR, Inc. has acquired the balance of 9,600 sq ft of space in its main building in Grand Rapids, Mich., increasing the main plant area to 180,600 sq ft. The added space will be used to further increase production of such devices as automatic controls, servomechanisms, aircraft radio and other aircraft accessories.

ELECTRONCRAFT Corp. has been formed at Lakewood, Ohio, to manufacture electronic equipment under contract. Theodore C. Asad, 1578 Ridgewood Ave., is president of the firm.

NATIONAL Bureau of Standards, Washington 25, D. C., recently established the Office of Basic Instrumentation, to coordinate a program of evaluation and improvement of instruments for measuring basic physical quantities.

ATOMIC INSTRUMENT Co., manufacturers of nuclear research equip-

PFAISTIEHL STRAIN-SENSITIVE PICKUP is to OTHER PICKUPS

The difference between the quality of music obtainable from the new PFAISTIEHL STRAIN-SENSITIVE PICKUP and that from ordinary pickups is as great as the difference between good FM radio and AM radio reception.

There are good reasons why the PFAISTIEHL STRAIN-SENSITIVE PICKUP brings out the brilliance of truly great voices and orchestras . . . the latent music on your records that other methods of reproduction leave untouched.

- The PFAISTIEHL STRAIN-SENSITIVE PICKUP is an amplitude transducer with a CONSTANT RESISTANCE of about 250,000 ohms.
- Signal output is at a practically CONSTANT IMPEDANCE level.
- Excellent transient response.
- NO DISTORTION, phase shift or evidence of intermodulation apparent.
- LINEAR RESPONSE free from peaks or resonances.

Cartridges for micro groove (.001 tip radius) and standard groove (.0027 tip radius) are available along with a Quick Change Cartridge Holder.

Styli are tipped with famous PFAISTIEHL M47B Precious Metal Alloy which will wear to less than a .0003 tip in 100 play on standard records at proper pressure. Strain-Sensitive Elements equipped with Diamond styli are also available.

A special preamplifying circuit is necessary for operation of this new pickup. Four styles of preamplifiers with and without power supply and constant tine controls are available, and are engineered to provide the correct polarized current for the pickup element, and also to provide the first stages of signal gain.

Proof of the excellence of the PFAISTIEHL STRAIN-SENSITIVE PICKUP is apparent both in tests and in actual listening, when its wide range flat response is best demonstrated. Ask your radio supply man or use the handy coupon below to get complete FREE INFORMATION.

PFAISTIEHL CHEMICAL COMPANY
(Metallurgical Division)
104 Lake View Avenue • Waukegan, Illinois

Pfannstiehl Chemical Company (Metallurgical Division) | 104 Lake View Avenue, Waukegan, Illinois
Send me complete free information about the new PFANSTIEHL STRAIN-SENSITIVE PICKUP.

Name: ____________________________
Address: ___________________________
City, Zone & State: __________________
My Radio Supply House Is: _________

Address: ___________________________

TRIGGER-SWITCH CONTROL—Governs heat for light or heavy work. Saves power because no need to unplug gun between jobs.

SOLDERLITE—Spotlights the work. Lets you see what you’re doing at all times.

3-SECOND HEATING—No waiting, no wasted current. Saves hours and dollars each month.

LONGER REACH—Lets you get at any job with ease. Slides between wiring — into the tightest spots.

STREAMLINED—Compact and comfortable to hold. Pistol-balanced for fast precision soldering.


DUAL HEAT—Single heat 300 watts; dual heat 200-250 watts; 120 volts, 60 cycles.

See the new 250-watt Weller Soldering Gun today at your distributor — or write for bulletin direct.

SOLEERING GUIDE—Get your new copy of SOLDERING TIPS—revised, up-to-date and fully illustrated 20-page booklet of practical soldering suggestions. Price 10c at your distributor, or order direct.

WELLER ELECTRIC CORP.
806 Packer Street, Easton, Pa.

October, 1950 — ELECTRONICS
ment, have moved to new, larger, and more conveniently located quarters at 84 Massachusetts Ave., Cambridge 39, Mass.

The Fidelity Tube Corp. (formerly the Allied Video Corp.) has acquired 80,000 sq ft of space at 1000 Passaic Ave., East Newark, N. J., and has set up to make tv picture tubes. Full production goal is 1,800 per day.

PERSONNEL

Walter F. Kram, formerly engaged in CAA omidirectional range development work at Lavoie Laboratories, has joined the staff of Ballantine Laboratories, Inc., Boonton, N. J., as a senior engineer.

George D. Hulst, at one time engaged in development work on the proximity fuse, and until recently in the General Patent Department of the Research Division of Allen B. Du Mont Laboratories, Inc., has been promoted to manager of the Special Projects Laboratory of the Electronic Parts Division.

William J. Morlock has been promoted to assistant manager of the Commercial Equipment Division of the General Electric Co., Syracuse, N. Y.

Roger M. Daugherty, previously associated with Colonial Radio Division of the Sylvania Electric Products Corp. as manager of government sales and engineering and chief engineer, has been elected executive vice-president of J. H. Bunnell & Co., Brooklyn, N. Y., manufacturers of railroad and radio communication equipment.

Ralph R. Batcher, New York electronic consultant, recently succeeded L. C. F. Horle as chief engineer of the engineering department of the RTMA and manager of the

---

Try Remler for Service-Tested "Hard-to-Get" Components

**Custom Components**

Metal-plastic components designed and manufactured to order. Write for quotations specifying electrical and mechanical characteristics. Describe application. No obligation.

**REMLER TUBE SOCKETS**

• Standard for 30 years...
  The best in the industry

Heavy duty phenolic sockets with high current wiping action contacts...for industrial, transmitter and test applications. Rugged. Years of tube insertions and withdrawals do not impair contact effectiveness. Black phenolic is standard, low loss phenolic or alkyd on order.

Remler Company Ltd. 2101 Bryant St. San Francisco 10, Calif.

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**make your own Plug-In RELAYS COILS FILTERS**

with DESCO Plug-In Assemblies as basic housings


DESCO 'DG' 106 ASSEMBLY

**CENTER**—Discriminator Coil, used in low-frequency receiver by Herman Electronics Co.

DESCO 'DL' 151 ASSEMBLY

**RIGHT**—Toroidal Filter, Manufactured by Communications Accessories Co.

DESCO 'DG' 109 ASSEMBLY

We can furnish units with coils wound to your specifications

The DESCO Plug-In Assembly—a fitted aluminum shield can with octal-type plug connector in base. Available with and without coil forms or adjustable powdered iron tuning cores.

30 MODELS—1-3/4" and 2" square—2" to 4" high.

Write for literature and specifications.

**DIETZ DESIGN & MANUFACTURING COMPANY**

Inductance Specialists

Grandview, Missouri

Dwight 7216
RTMA Data Bureau, New York City.

V. K. Zworykin, Director of Electronic Research, RCA Laboratories Div., Princeton, N. J., was awarded the 1951 Medal of Honor by IRE.

Robert G. Scott, senior engineer for Allen B. DuMont Laboratories, Inc., has been named head of the company's Commercial Engineering Department.

Dundas P. Tucker, former director of electronics design and development for the Navy's Bureau of Ships, is the new director of the Naval Electronics Laboratory at Point Loma, San Diego, Calif.

J. Grayson Jones, former chief engineer of Conrac, Inc., Glendora, Calif., tv receiver manufacturers, has been elected vice-president of the company.

J. A. Hutcheson, director of research at Westinghouse Electric Corp., Pittsburgh, Pa., has been named chairman of the Committee on Ordnance, Research and Development Board.

Arthur Green, formerly vice-president and chief engineer of Thomas Electronics Inc., Passaic, N. J., is now vice-president and chief engineer of the new Fidelity Tube Corp., East Newark, N. J., tv picture tube manufacturers.

David B. Smith, vice-president of Philco Corp., has been named vice-director of the RTMA engineering department.

B. V. K. French has joined Allen B. DuMont Labs., Inc., East Paterson, N. J., as application engineer in the Electronic Parts Division.

E. H. Ullm, previously with Western Electric Co. as field engineer, and until recently sales engineer for the Electronics Division, Sylvania Electric Products Inc., has been appointed Sylvania's merchandising manager.

Harald Schutz, formerly electronics research specialist and consultant on microwave problems, now heads radio-frequency engineering in the electronics department of The Glenn L. Martin Co.
DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta, Chicago, Cleveland, Dallas
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Canada: Fiberglas Canada, Ltd., Toronto
Great Britain: Albright and Wilson, Ltd., London

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Westbury, L. I., N. Y., Westbury 7-1028

EL-TRONICS MANUFACTURING COMPANY
GARDEN CITY, N. Y.

ELECTRONICS—October, 1950

For more data on DC 4 Silicones
write Dept. J.
limitation of the use of bifilar coils is the fact that they preclude the use of usual methods of plate-screen neutralization. The reasoning indicated is that the screen is effectively grounded by the transformer secondary. This does not agree with observed experimental findings.

Consider the standard circuit of Fig. 1A. A balanced bridge circuit is obtained, and no feedback voltage appears between grid and ground due to driving voltage across $L$, when the following relationship is true: $C_{op}/C_{os} = C_p/C_s$.

This method applied to a bifilar stage is shown in Fig. 1B. The screen of the i-f amplifier tube will be close to, but not at, ground potential. Usually, $C_{op} < C_p$. The effect of $C_{op}$ will be to modify the effective driving voltage source of the equivalent bridge circuit. In first order terms, if transformer distributed capacitances are neglected, and $L = L_s = L$, and $k = 1$, the bridge circuit becomes that shown in Fig. 1C.

Neutralization is obtained when $C_{op}/C_{os} = C_p/C_s$. For identical conditions, $C_p$ is smaller than $C_s$. The bridge in the bifilar case will be more subject to unbalance due to tube wiring changes, and so on. Also, if $C_p$ is too small, Miller effect might prevent proper bridge balance conditions. Neutralization of bifilar i-f stages has been obtained, though, in development work conducted by associates of the writer.
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on pages 292, 293 & 294

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on pages 295-318

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Men qualified in any of the above are invited to send their resumes to:
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With good background in Vacuum Tubes and Govt. contracts. Must have good following in the industry and a record of ability. Must be free to travel. Established well-known firm. Send detailed Resume of experience. Interview will be held in New York area.

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will be accepted for the SEARCHLIGHT SECTION of the November issue of ELECTRONICS until September 29th.

Undisplayed rates: $1.20 per line, per insertion. (1/3 of this rate for Positions Wanted Ads).

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ELECTRONICS

330 W. 42nd St., N. Y., 18, N. Y.

October, 1950 — ELECTRONICS
None of the text is readable from the image provided.
SEARCHLIGHT

SONAR

Radar, a word that comes from the Greek "rados" meaning "ray," is a system of locating objects by means of transmitted electromagnetic waves. These waves are reflected from objects in their path and the system measures the time interval between transmission and reception of the reflected wave. Radar is a critical technology, used in a wide variety of applications, including aircraft navigation, military defense, and maritime traffic control.

**Radar and Sonar**

These devices are often confused, but they are actually quite different. Radar uses electromagnetic waves to detect objects, while sonar uses sound waves. Radar is used for long-range detection, while sonar is used for close-range detection. They are both used in many different applications, from navigation to military defense.

**The Must of the Month**

The must of the month is a set of 5 kW Radar and Sonar packages. These packages are designed for use in a variety of environments, from marine to airborne. They are used for navigation, target detection, and other applications.

**High Voltage Power Supply**

A high voltage power supply is a device used to generate high voltage electrical energy. These devices are used in a variety of applications, from electronic equipment to medical devices.

**FM Station**

The FM station is a radio station that broadcasts in the FM (Frequency Modulation) band. These stations are used to broadcast music, news, and other types of programming. They are often used to broadcast commercial programming, as well as public service programming.

**Communications Equipment Co.**

Communications Equipment Co. is a company that designs and manufactures communication equipment. They are known for their high-quality equipment, which is used in a variety of applications, from military to commercial.

**Radar and Sonar**

Radar is a technology used for detecting objects by emitting electromagnetic waves and measuring the time it takes for them to bounce back. Sonar, on the other hand, uses sound waves to detect objects in the water.

**Radar Equipment**

Radar equipment can be divided into two main categories: land-based and airborne. Land-based radar is used for applications such as navigation and military defense. Airborne radar is used for applications such as air traffic control and weather forecasting.

**Sonar Equipment**

Sonar equipment is used for detecting objects in the water. This can include anything from fish to submarines. Sonar can be used for a variety of applications, from fish finding to military defense.

**FM Station**

An FM station is a radio station that broadcasts in the FM band. These stations are used to broadcast music, news, and other types of programming. They are often used to broadcast commercial programming, as well as public service programming.

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**Notes:**

- Radar and Sonar
- The Must of the Month
- High Voltage Power Supply
- FM Station
- Communications Equipment Co.
### 3000 MC. BENCH TEST EQUIPMENT

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<th>Description</th>
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36938-2, Hayden Timing Motor, 110V, 60 cycle, 2.2 w., 1/45 r.p.m.
Price $3.00 ea.
Type 1600 Hayden Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake
Price $4.00 each
Type 1600 Hayden Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m.
Price $3.00 each
Type 1600 Hayden Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m.
Price $2.70 each
Type 1600 Hayden Timing Motor, 110 V., 60 cycle, 2.2 w., 1/15 r.p.m.
Price $2.70 each
Type 1600 Hayden Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gear.
Price $3.30 each
Type 1600 Hayden Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m.
Price $3.00 each
Barber-Cotman Control Motor, Type AYLC 5091, reversible 24 volts D.C., 7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle.
Price $6.50 each

Kollman Type 776-01 400 cycle 2 phase drop-up type, fixed phase voltage 29, variable phase 35V, maximum, frequency 400 cycle.
Price $10.50 each net.

Kollman Remote Indicating Compass Set
Transmitter part No. 679-01, indicator part No. 680k-06, 26 V., 400 cycle.
Price $12.50 each net.

Schwein Free & Rate Gyro type 45600. Consists of two 28 V., D.C. constant speed gyros. Size 8" x 4.25" x 4.25".
Price $15.00 ea.

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase.
Price $17.50 each gyro.

Sperry A5 Vertical Gyro, Part No. 644814, 115 V., 400 cycle, 3 phase.
Price $20.00 each gyro.

Sperry A5 Amplifier Rack Part No. 644890. Contains V. D.C. Constant Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltimeter.
Price $10.00 each gyro.

Sperry A5 Control Unit Part No. 644836.
Price $10.75 each gyro.

Sperry A5 Analog Follow-Up Amplifier Part No. 656030.
Price $5.50 each.

Minneapolis-Honeywell Type 8B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque.
Price $10.00 each.

D.C. MOTORS
5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. Price $4.50 each net.
A-1755, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps, 3600 r.p.m., 1/30 h.p. Built-in governor.
Price $6.25 each net.
C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps, 7000 r.p.m., 1/100 h.p.
Price $4.50 each net.
Jaeger Watch Co., Type 44-K-2 Contact Motor, Operates on 3 to 4.5 volts D.C. Makes one count per second.
Price $2.00 each.
General Electric Type SBA15AJ52C, 27 V., D.C., 0.65 amps, 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible.
Price $5.00 each net.
General Electric Type SBA15AJ37C, 27 V., D.C., 0.5 amps, 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible.
Price $6.50 each net.

JACKSONVILLE-MAGNEYSYN COMPASS SET
Pioneer Type ANS730-2 Indicator and ANS730-3 Transmitter 26 V., 400 cycle.
Price $40.00 per set new sealed boxes.

Kollsman Type 776-01 400 cycle 2 phase drop-up type, fixed phase voltage 29, variable phase 35V, maximum, frequency 400 cycle.
Price $10.50 each net.

GENERAL ELECTRIC D. C. SELGYS
8TJ9-PDN Transmitter, 24 V.
Price $3.75 each net.
8TJ9-PAB Transmitter 24 V.
Price $6.75 each net.
8DJ1-PCY Indicator, 24 V. D.C. marked —10° to +65°
Price $4.50 each net.
8DJ1-PCY Indicator, 24 V. D.C. marked 0 to 360°
Price $7.50 each net.

AMPLIFIER
Pioneer Gyro Flux Gate Amplifier, Type 12076-1 A.
Price $17.50 ea. net, with tubes.
E. G. Servo Amplifier Type 2CV1C1, 115 V., 400 cycle, 0.09 ea.
Price $9.00 ea. net.
Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. Price $8.00

Write for Catalog NE100
U. S. Export License 2140

October, 1950 — ELECTRONICS
INVERTERS

Wincharger Corp. Inverter PU/16 type
MG 750, Input 24 V.D.C., 60 amps.
Output 115 V, 400 cycle, 1 phase,
6.5 amps. **Price $60.00 each net.**

153F, Holzter Cobot, Input 24
V.D.C. Output
115 V, 400
Cycle, 3 phase,
750 V.A. and
26 V., 400 cycle, 1 phase, 250 V.A.
Voltage and frequency regulated also
built in radio filter.
**Price $115.00 each net.**

149H, Holzter Cobot. Input 28 V, at 44
amps. Output 26 V, at 250 V.A., 400
cycle and 115 V, at 500 V.A., 400
cycle. **Price $40.00 each net.**

149F, Holzter Cobot. Input 28 V, at 36
amps. Output 26 V, at 250 V.A., 400
cycle and 115 V, at 500 V.A., 400
cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Out-
put 26 V, 400 cycle, 6 V.A.
**Price $22.50 each net.**

12117-2 Pioneer. Input 24 V.D.C.
Output 26 V, 400 cycle, 6 V.A.
**Price $20.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C.,
5 amps. Output 115 volts 400 cycle
single phase 45 watts.
**Price $100.00 each net.**

5D21NJ3A General Electric. Input 24
V.D.C. Output 115 V, 400 cycle at
485 V.A.
**Price $15.00 each net.**

PE 218, Ballentine. Input 28 V.D.C.,
at 90 amps. Output 115 V, 400 cycle
at 1.5 K.V.A.
**Price $50.00 each net.**

METERS

Weston Frequency Meter, Model 637,
350 to 450 cycles, 115 volts.
**Price $10.00 each net.**

Weston Voltmeter, Model 833, 0 to 130
volts, 400 cycle.
**Price $4.00 each net.**

Weston Voltmeter, Model 606, Type
204 P, 0 to 30 volts D. C.
**Price $4.25 each net.**

Weston Ammeter, Model 506, Type
S-61209, 20-0 100 amps. D. C.
**Price $7.50 each net with ext. shunt.**

Weston Ammeter, Type F1, Dwg. No.
116465, 0 to 150 amps. D. C.
**Price $6.00 each net.**

Westinghouse Ammeter, Type 1090-
D-120, 120-0-120 amp. D. C.
**Price $4.50 each net.**

Weston Model 545. Type 82PE Indi-
cator. Calibrated 0 to 3000 RPM,
234° size. Has built-in rectifier, 270°
meter movement.
**Price $15.00 each net.**

RECTIFIER POWER SUPPLY

General Electric, Input 230 V, 60 cycle
3 phase. Output 130 amps, at 28 V
D.C. Continuous duty, fan cooled, has
adjustable input taps. G.E. model No.
6RC146F. Size: Height 46", width
28", depth 173/4". **Price $200.00 each
net. New.**

PIONEER AUTOSYNs

AY1, 26 V, 400 cycle.
**Price $5.50 each net.**

AY14D, 26 V, 400 cycle, new with
calibration curve.
**Price $15.00 each net.**

AY20, 26 V, 400 cycle.
**Price $7.50 each net.**

AY5, 26V, 400 cycle. Has
hollow shaft.
**Price $7.50 ea. net.**

PRECISION AUTOSYNs

AY101D, new with
calibration curve.
**PRICE—WRITE OR CALL FOR
SPECIAL QUANTITY PRICES**

AY131D, new with calibration curve.
**Price $35.00 each net.**

AY201-2-A.
**Price $35.00 each net.**

PIONEER AUTOSYN

POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°,
26 V, 400 cycle.
**Price $15.50 each net.**

Type 6007-39. Dual. Dial graduated 0
to 360°, 26 V, 400 cycle.
**Price $30.00 each net.**

PIONEER TORQUE UNIT

Type 12602-1-A.
**Price $40.00 each net.**

Type 12606-1-A. Price $40.00 each net.

Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER

ASSEMBLY

Pioneer Magnetic Amplifier Assembly
Saturable Reactor type output trans-
former. Designed to supply one phase
of 400 cycle servomotor.
**Price $8.50 each net.**

PIONEER TORQUE UNIT

AMPLIFIER

Type 12073-1-A. 5 tube amplifier, Mag-
nesyn input, 115 V, 400 cycle.
**Price $17.50 each net with tubes.**

ALL PRICES,
F. O. B.
GREAT NECK,
N. Y.
**SEARCHLIGHT SECTION**

**MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.**

2.5 KVA MG SET.

2 KVA MG SET.

1.25 KVA MG SET.

DYNAMOTOR.

DYNAMOTOR.

DYNAMOTOR.

DYNAMOTOR.

INVERTER.

AMPLITUDE.

AMPLITUDE.

INVERTER.

INVERTER.

PE 218 INVERTER.

D. C. MOTOR.

SYNCHRO GENERATORS.

**S. G. RADAR EQUIPMENT**

**NAVY YARD SPARES FOR MODEL SG RAY**

**Consisting of the following:**

2. CRY-240M Recorder Power Unit for modulating generator.

2. CRY-230AHI Recorder Power Unit for Radar Receivers.

2. CRY-230AAI Modulation Generators.

2. CRY-230AHI Radar Receivers including B-50 Gain Controls for Range and Train Signals.

2. CRY-20AAN Signal Monitor.

1. Complete Transmitting R.F. equipment, including all required power supplies and Driving tube cavity associated equipment.


1. Complete Transmitting engine assembly including driving shears with their line. Modulating power supply, Type AN-149-A. Electrical Radiator and Drive Receiver Power Unit.

1. Complete set of equipment spare parts consisting of R.F. equipment, attenuators, inductors and capacitors, switches, interlocks, power supplies, links, relays, contacts, crystals, thermistors, R.F. insulation, capacitors, switches, test equipment, cables, resistors, etc., as listed in Navy Search Light Parts List W13885.

All above in new and unused condition packed in original metal space parts boxes.

**RADAR COMPONENTS**

CRP-230A1 Load Divider for use with S.G. Modulation generator.

CGS-230U Radar Type Receiver Adapter. 115V. 900 cy, 485 volts.

New stock type.

Nominal Type T-01, S-10-17, S-10-35 Radar Antenna Assembly.

Model 10-12. Base... $15.00

Model 10-81. Receiver... $24.50

**MODEL AN/APA-10 PANORAMIC ADAPTER**

**Provides 4 Types of Presentation:**

1. (Panoramic) 2. (Angular)

(3) Oscilloscopic

Designed for use with receiving equipment AN/AH-1, AN/AH-2, AN/AR-2, AN/AR-4, AN/AR-11 and any other series of receiving equipment.

New $69.50

1. **LINEAR SAWTOOTH POTENTIOMETER**

**W.E. KS-15138**

Low cost electronic conversion switch to convert 24 volts D.C. to 1 to 10 linear stepping output. Four operating positions between 100 units apart. Rates 100 units from zero to ten, linearity, nearest 10 units, and 90 volts between 100 units apart. Magnetical zero output at output voltage at output.

Brand new $5.50

**LAVOYR FREQ. METER PLAYE MICRO-WAVE**

375 to 725 MEC.

Model TV-127/3 is a compact, self-contained, precise (0 to 1 MEC) frequency meter which permits quick and accurate readings. Requires a standard 1.5 "A" and 90 "B" battery. Has 0-1 minute time scale. Contains specially constructed 114 "Q" resonator with a range of 3000 tuning dials and a 14"-5/8"-214" scale. Uses 382, 388 and 346 tubes. Tubes and precision content of all tubes. Low battery.

Brand new $69.50

**BAYHEDEN VOLTAGE REGULATOR**

Model 208-2400 VR. Input: 115V-208V, 60 cy, 1 Ph. Output: 115V-208V, 60 cy, 1 Ph, No. 20 Res. 40 °V. Overload protected. Regulator incorporated. Tapped internal...

Special... $14.75

**300 CYCLE TRANSFORMERS**

AUTO. 100 cy. G.E. Cat. No. 860184.

KVA: 345. $3.45


Output: 220V-240V, 50-60Hz, 5A-28A.

90°THYRATRON POWER 400-1600 cy. 100-150 cy, 50-60Hz, 500-1500W. Output: 220V-240V, 50-60Hz, 5A-28A.

THYATRON POWER 400-1600 cy. 100-150 cy, 50-60Hz, 500-1500W. Output: 220V-240V, 50-60Hz, 5A-28A.


Rectifier Power Supply.

Output: 125-250V, 0-1500W. New... $46.00

SOURCE: 125-250V, 0-1500W. New... $46.00

120V AC. $22.50

AMPLIDYNE-G. Type 5AMSINJ9A. Input: 115V-125V, 115-125V 7500 watts. Frequency 25000 cycles. New $46.00

AMPLIDYNE-G. Type 5AMSINJ9A. Input: 115V-125V, 115-125V 7500 watts. Frequency 25000 cycles. New $46.00

INVERTER - Power unit with Inverter-Receiver. Brand new... $46.00

**U.S. NAVY**

**SOUND POWERED BATTLE CRYSTAL**

Western Electric No. 4137-212. Type 6-120W. 10 In. (%0.01) rubber covered cable...

$26.50

**60 CYCLE TRANSFORMERS**

1.5 KVA STEPDOWN. G.E. Cat. No. 76011A.

Pri.: 115/230V Sec.: 214/75-7.5V...

57.5V. New $150.00

105% Overload protection...

500 M.F.D., 7.5KV 180°-90°...

$3.85

**PULSE TRANSFORMER**

PULSE. W.T.O. 0-12. Requires voltage peaks of 2500V from 100 ohm. Tested at 4000 Pulses per sec. 50-60Hz...

25 KV. New $200.00

**SWEEP GENERATOR CAPACITOR**

High speed leads for high frequency operation. All units are new...

$2.50

**PARABOLIDS**

Saxon Magnetics 100-150 lbs. Anodized, 150 lbs. deep. Mount with fixture for elevation and azimuth control on 10° 15° 20° 25°. Use with "A" style output shaft...

$6.75

All mechanized guaranteed immediately after purchase...

**All Prices Subject to Change Without Notice**

October, 1950 — ELECTRONICFR
SAVE on Miniature and Toggle Switches at WELLS

Miniature Switches

Toggle and Push Switches

Many More Types in Stock. Send Us Your Requirements.

JUST OUT: CATALOG H500 Manufacturers, Distributors and Amateurs write for the brand new Wells Electronic Catalog H500. Full of tremendous values in highest quality components.

Order directly from this ad or through your local parts jobber—

320 N. LA SALLE ST. DEPT. SL, CHICAGO 10, ILL.
SEARCHLIGHT SECTION

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Selenium Rectifiers

TRANSFORMERS—115V 60 CY
HI-VOLTAGE INSULATION

EQUIPMENT SPECIALS

FILTER CHOKES Hi V INS

RADIO HAM SHACK Inc.
189 GREENWICH STREET, NEW YORK, N.Y.

November, 1950 — ELECTRONICS
TEST EQUIPMENT

30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of APR-5 Receiver $65.00 less tubes


Tuning Units For APR-1 or APR-4 Receivers (can be used with any 30 mc amplifier):

TN-19, range 1000-2000 mc, tuned mixer cavity $150.00
TN-54, range 2000-4000 mc, tuned mixer cavity $150.00
TS-110 S Band Echo Box 2400-2700 mc, portable $110.00
TS-184 Echo Box and Attenuator for APS-13
TS-170 Test Oscillator for ARN-5
TS-226 Peak Power Meter for APS-13
TS-89 Voltage Divider for measuring high video pulses, ratios, 1:10 and 1:100, transmission flat within 2db 150 c.p.s. to 5 mc., with cable for attaching to oscilloscope.

Waveguide Below Cut-off Attenuator L-101-A U.H.F. Connectors at each end, calibration 30-100 db. $10.00
X Band Test Load, 50 watts, average power, 1/2" x 1/2" waveguide, Band load $35.00
HI POWER X BAND TEST LOAD, dissipates 280 watts of average power for 1/8" x 1/4" waveguide, VSWR less than 1.15 between 7 and 10 KMC $150.00
HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1/2" x 3" waveguide. Range 2500 to 3700 MC.
TS-45A/APM-3 Signal Generator, 9200-9600 mc, 110 V, 60-800 c.p.s.
TS-35/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, 8700-9500 mc.
X Band VSWR Test Set TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven travelng probe, matched termination and various adapters, carrying case.

Standard Signal Generator Measurements 65B, 100 kc to 30 mc, 1,000,000 microvolts, good working order. $400.00
S Band Mixer, tunable by means of slider type N connector for the R.F. and local oscillator input. U.H.F., connector for the I.F. output, variable oscillator injection. $30.00

X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.
S Band Spectrum Analyzer 2700-3400 Mc., similar to above.

ELECTRO IMPULSE LABORATORY

P. O. Box 250 Eatontown 3-0007 Red Bank, N. J.
### Reliance Specials

**WIRE WOUND PRECISION RESISTORS, 1% OR BETTER**

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<th>Type</th>
<th>Price ($)</th>
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**DIFFERENTIAL**

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**JONES BARRIER STRIPS**

| 403 in. | $1.01 |
| 806 in. | $1.01 |

**VERNIER DIAL**

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**METERS**

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**PRECISION CAPACITORS**

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**CAPACITORS**

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**CERAMIC MICA**

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**FUSE HOLDERS**

| 3AG Fuses | $1.01 |
| 4AG Fuses | $1.01 |

**NEEDLE BEARINGS**

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**POWER TRANSFORMER**

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**TIME DELAY RELAY**

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**DELAY NETWORK**

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### COAXIAL CABLES

**GUARANTEED!! NEW!!**

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**COAXIAL CABLE CONNECTORS**

**Angle Adapter**

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<th>Price Schedule</th>
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**Philco Power Cord**

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**OVERSEAS Packed**

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### RELIANCE MERCANTILE CO.

Arch St. Cor. Croskey  Phila. 3, Pa.  Telephone Rittenhouse 6-4927

---

**RELIANCE MERCANTILE CO.**

October, 1959 — ELECTRONICS
**IMMEDIATE DELIVERY**

**LOW PRICES**

**FULLY GUARANTEED**

---

### BROWN TELEPLOTTER RECEIVER

- **Model 791X1R**
- 115 volt 60 cycles
- Contains a pen driven by two balancing motors which writes on an arc of a transverse chart. Pen arm position is in terms of two coordinates supplied balancing motors thru two amplifiers. Originally intended for recording seasonal data or flat data from central point. See chart. Writes at one half scale on 3" chart. Discriminator input circuit designed to operate unit as an integral part of two or more similar units requiring the same type of recording. Sensitivity of pen motion is approximately .002 inch per scale division. Shipping weight 45 lb.

**Price $375.00**

### Aircraft Generator Eclipse NEA-3

- Output 115 VAC, 15.4 amperes 550 cycles at 2400 rpm. Also 28 VDC, 220 amps, stock #SA-250. Price $50.00 each.

### 400 Cycle Generators

- **Honeywell 1SA12005H-1**
- 100 cycle out of phase 115 v., 55 amp. Also a 28 v. output of 28 v. and 37.5 amps. Special at $115.00 each.

### C-1 Autopilot Amplifier

- Three-channel servo amplifier for use in C-1 Autopilot. 7 tubes stock No. 2SA-217. Price $25.00 each.

### Pioneer Servo Motor

- **Type 1506-13A**
- 50 cycle low inertia 72 V fixed phase 15 V max. variable phase stock #SA-287. Price $15.00 each.

### PRECISION AUTOSYN

- **Type AV-190 Control - Autosyn**
- Prices on Request

### SYNCHROS

- **Navy Types**
  - G, ICT, 5G, 5P, 5CT, 5DG, 5HCT, 5DP, 5HP, 5HS, 5HJ, 6DG, 7G, 7H, Prices on Request

### Compass Indicator

- **5-22**
- Compass Indicator 0-360°. 1 in. dia. 50 x .990 v. 600 cy. 0.37 12 0.60 cy. ideal position indicator stock #SA-284. Price $6.50 each.

### SWEEP GENERATOR CAPACITOR


### ALSO IN STOCK

- **C-1 AUTOPilot COMPONENTS**
- **GENERAL ELECTRIC D-C SELSYNS**
- **DC AND AC GENERATORS**

### 400 CYCLE AC BLOWERS

- **B, A.D. J-151-115 v. 100 cy. 52 cfm.**
- Westinghouse Type FL-115 v. 409 cy. 37 cfm.

### DC MOTORS

- **Hoynge 5604-U115 v. 150 mmf. 2400 FPM.**
- Stock 5601L1. Price $20.50 each.

### LEDS

- **Model 791X1R**
- 115 volt 60 cycles
- Contains a pen driven by two balancing motors which writes on an arc of a transverse chart. Pen arm position is in terms of two coordinates supplied balancing motors thru two amplifiers. Originally intended for recording seasonal data or flat data from central point. See chart. Writes at one half scale on 3" chart. Discriminator input circuit designed to operate unit as an integral part of two or more similar units requiring the same type of recording. Sensitivity of pen motion is approximately .002 inch per scale division. Shipping weight 45 lb.

**Price $375.00**

---

### INVERTERS

- **Windcutter PE-7/4:**
  - Input 115 VAC 120 cy.
  - Output 115 v. 110 cy. 6750 VA.

- **G.E. 5A231N/4**: (PE-118)
  - Input 28 VDC at 100 amps.
  - Output 115 v. 0.6 cy. 6750 VA.
  - Price $25.00 each.

### JACK AND HEINTZ STARTER

- **Daw. 6-350-R**
  - Aircraft engine starter.
  - Price $150.00 each.

### DC SERVO MOTOR

- **Elinco Type B-61**

### MAGNETIC AMPLIFIER ASSEMBLY

- **Serry 6602A**
  - Inductive type magnetic amplifier. Designed to supply one phase of 450-cycle servo control. Stock #SA-266. Price $65.00 each.

### FORD INST SERVO MOTOR

- **Model 791X1R**
- 115 volt 60 cycles
- Two low inertia motors, 15 watts output.
- BiOrd. #20575. Price $49.50 each.

---

**Servo-Iek**

Products Co.
4 Godwin Ave. Paterson, N. J.

**SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL**

**ELECTRONICS — October, 1950**
TUBE SPECIALS
BRAND NEW
FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITOR, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES.

QUOTATIONS UPON REQUEST

WESTINGHOUSE HYPERSONIC TRANSFORMER

Type 939-3240-150-68 Volts—100 Cycles 2 Phase—5 Watts—2650 RPM
Westinghouse Type D-1730.
Original Price $34.50—Our Price $8.22 each.

SOUND POWERED TELEPHONES

100% CEIRED—FREQUENTLY ORDERED

TERMS 20% DOWN—FULL PAYMENT IN 30 DAYS—IMPERIAL BONDS AVAILABLE ON REQUEST

FREE SHIPPPING ON ALL ORDERS OVER $50.00

MISCELLANEOUS EQUIPMENT

1D-6APX-4 Indicator ..... $29.50
274-5AP Receiver ..... $48.50
978APX 1 Receiver ..... $28.50
SCR-522 Transmitter ..... $48.50
RT-7AP/1 Transceiver ..... $35.50
FL-128 clock oscillator ..... $35.50
RS-3 remote control unit ..... $28.50
RT6-27/44 250 V transistor ..... $28.50
1B-1016-150-68 D. ..... $28.50
AIA Antenna—15 conical section ..... $28.50
AT-53 mini remote control ..... $28.50
AT-58 remote control unit ..... $28.50
RTA-1B 1/2 24 V. dynamotor ..... $28.50
1B-1016-150-68 D. ..... $28.50
AIA Antenna—15 conical section ..... $28.50
AT-53 mini remote control ..... $28.50
AT-58 remote control unit ..... $28.50
RTA-1B 1/2 24 V. dynamotor ..... $28.50
G. Type IP-1 portable current transformer ..... $2.50
AT-321 Antenna ..... $3.50
ASM-6 Radar equip. Complete ..... $6.75
DZ-2 loop antenna with switch ..... $14.30

MONTHLY BULLETINS
SEND IN YOUR NAME AND ADDRESS TO GET ON OUR MAILING LIST

All material brand new and fully guaranteed. Terms 20% cash, 10% down, balance C.O.D. unless noted. All prices F.O.B. our warehouse, Philadelphia, subject to change without notice.

SEARCHLIGHT

October 30, 1950 — ELECTRONICS
ELECTRONICS — October, 1950

SOLAR CONSTANT VOLTAGE TRANSFORMER
2 KVA, 17.4 Amps. Input 59-125 Volts, 60 Cycles, 110-125 Volts 60 cycles, 115 V, 125 V, 95 Y H, 75 Y W. Weight 225 Lbs. $157.50 each

RAYTHEON SWINGING CHOKER
Type 12. 10 Henries. 120 Max. 10 Ohms DC fully closed. High voltage installation equipment, conservatively rated. Weight 80 Lbs. $48.00 each.

THORDARSON PLATE TRANSFORMER
C.T. Type 11921. 2/0-230 v. 60 Cy. 12500 W. $295.00 each. 1.5 KVA 2300 W. 30 Cycles. D.C. 300 Volts, 3.5 Amperes, 3.50 Volts. Weight 240 Lbs. $365.00 each.
Portable VHF Communication Unit

Two-way radio telephone equipment designed for operation on between 152 and 162 megacycles. Adaptable for complete unit including rechargeable storage battery emergency use, a complete unit. Battery charger is extra at $19.95. This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal $95.50.

Mobile VHF Communication Unit

Adaptable for many mobile uses, this is a compact unit 315" x 8" x 15-1/2" operating on 152 to 162 megacycles. It is six volt powered direct from storage battery, and is complete with the time filter, and crystal, handset, control box, antenna and installation kit. Brand new ready to go. Extra 12" sub type antennae are available.

Condensers

<table>
<thead>
<tr>
<th>Condenser</th>
<th>Value</th>
<th>Price</th>
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<tr>
<td>2 mfd. 4000 VDC OIL FILLED</td>
<td>2.55</td>
<td>$29.50</td>
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<tr>
<td>1 mfd. 6000 VDC OIL FILLED</td>
<td>1.98</td>
<td>$19.95</td>
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<td>.05 mfd. 10000 VDC OIL FILLED</td>
<td>4.65</td>
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<td>.00025 mfd. 25000 VDC OIL FILLED</td>
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<tr>
<td>.01 mfd. 15000 VDC OIL FILLED</td>
<td>10 for 2.45</td>
<td>$29.50</td>
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<tr>
<td>2 mfd. 600 VDC OIL FILLED</td>
<td>2 for 4.30</td>
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<td>1 mfd. 600 VDC OIL FILLED</td>
<td>2.10</td>
<td>$19.95</td>
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<tr>
<td>.01 mfd. x 1-1200 VDC OIL FILLED</td>
<td>5 for 2.00</td>
<td>$29.50</td>
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<tr>
<td>50 mfd.-5KV-5 Amp. Vacuum Cond.</td>
<td>9.19</td>
<td>$19.95</td>
</tr>
</tbody>
</table>

T-85/APTS UHF TRANSMITTER

Operating over a frequency range of 300 to 1400 MHz with a nominal output of from 10 to 20 watts. Has a 110 V 60 CPS filament transformer; blower; leaker wire test frequency set, and 8 tubes. Price $29.95. New in its original box with Operating Instruction Manual.

Frequency Meter BC-771

Frequency Meter BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-968 and Radio Receiver BC-676. It is a separate unit. It is assembled by means of solderless air tight connectors. Price $29.95. The entire BC 100 as described above— all brand new—complete. Technical Manual TM-11-1133B is furnished with the complete set. Price $595.00 FOB Warehouse.

Oven M-348

is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110 VAC 60 Cycles. Price $395.00

Radio Equipment R. C.-100-B

This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.

Radio equipment RC-100-B consists of Cabinet CK-118 in which are mounted Transmitter BC-768, Keying unit BC-770, Radio Receiver BC-676, Rectifier RA-52, Wave Trap FL-35, wiring and Blower. Additional equipment consists of Antenna Unit AN-828; Transmission line MC-377, air compressor M-349, Oven M-348, control box BC-773, Amplifier BC-676B and associated cords and hardware. Primary requirements are 110 to 120 volts, 50 to 60 cycle for the entire unit and accessories.

Cabinet CK-118 is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet. Transmitter BC-768 is designed to transmit RF pulsed signals at 470 megacycles with the use of two type 135 Tubes operating in push-pull with resonant grid, plate and filament lines. Keying unit BC-770 furnishes the pulses of the Transmitter. Receiver BC-768 was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation. Rectifier RA-52 produces the high voltage. An 0.15 kilovolt DC Meter is connected across the output of the filter to measure the voltage fed to the transmitter BC-768, while an 0.05 milliammeter is connected to the ground return to measure the average current through the set. Antenna AN-828 consists of 24 vertically polarised, half wave radiating elements, a reflecting screen, open-wave transmission line sections and a concentric-line terminating section or elevator. Wave trap FL-35 is used to separate received and transmitted signals. Transmission line MC-377 is of 1/4 inch air-diodelectric, 70 ohm concentric line type and is assembled by means of solderless air tight connectors. Control Box BC-773 contains necessary controls for operation. Amplifier BC-676B is used to amplify the output of Receiver BC-768 for suitable oscilloscope presentation.
SOME MONTHS AGO we mailed a letter to all our customers and potential customers about resistors—sorry cannot mention the name.

The letter tells the story about resistors — - - a true story — - - . We know we cannot fill all orders for resistors from stock. We also regret that the difficulty in getting these resistors increases prices so much that we often refuse to buy these components.

Although we are a small company we promise to do everything possible to the end that this shortage shall not affect your production schedules. We do not use excuses but we do tell all the true facts about our delivery potential.

We thank all of you for confidence expressed in hundreds of orders coming daily and we promise to do all possible to fill these orders in the near future.

Please do not hesitate to mail us your orders—we will try to fill them all—altho there may be delays.

Thanking you for your very valued patronage, we are

Very sincerely yours,

[Signature]

Legri S Company Inc.
130 W. 102nd St.
New York 25, N. Y.
Gregory Grinn, President
WE HAVE ONE OF THE LARGEST STOCKS OF TUBE EQUIPMENT AVAILABLE!

WE HAVE 400-800 CYCLE TUBES!

THESE TUBES ARE IDEAL FOR AMATEUR RADIO, RADIO REPAIR, AND OTHER ELECTRONIC PROJECTS.

CONTINUE YOUR COLLECTION TODAY!

CABLE ADDRESS: COLLECT

C AND H SALES COMPANY

356 E. EAST PASADENA STATION PASADENA, B. CALIFORNIA

COMMERCIAL SIZE 3/4" SIZED, UNFILTERED "C" PAPER

312

NEW YORK'S RADIO TUBE EXCHANGE

312

SEARCHLIGHT SECTION

NEW YORK'S RADIO TUBE EXCHANGE

312

TELEVISION CAMERA

3350 LINE RESOLUTION. EASILY CONVERTED TO PRESENT RMA STANDARDS. CIRCUITS AVAILABLE WITH CAMERA. COMPLETE, LIKE NEW.

WE HAVE: APS-4 & APS-6 RADAR

WE ARE LOOKING FOR: ALL TYPES OF RADAR, GROUND AND AIRCRAFT RADIO EQUIP.

WE WANT: BC-348 ART-13

ARC-1 RTA-1B

MN 62 R5A/ARN7

BC-1000

TELL US WHAT YOU HAVE.

TELL US WHAT YOU NEED.

COLUMBIA ELECTRONICS LTD.

524 S. SAN PEDRO ST.

LOS ANGELES 13, CALIF.

CABLE ADDRESS: COLLECT

October, 1950 — ELECTRONICS
ELECTRONICS—October, 1950

SAN LÉNİON RECTIFIERS and ASSOCIATED COMPONENTS

SELENIUM RECTIFIERS and ASSOCIATED COMPONENTS

POWER SUPPLIES

GENERAL PURPOSE Low voltage DC power supplies, with variable outputs. Rugged—Dependable—precision control.

Features

- Long life
- Full wave selenium rectifiers
- Output Voltage Adjustable from zero to maximum
- 3 V Voltmeter and Ammeter 2% accuracy
- Replaces Control
- Instant Power—No Warm-Up Period
- Assembled and ready to operate
- For 115VAC 60 Cycles
- Dimensions 8 1/4 x 4 1/4 x 8 1/2

Write for descriptive bulletin GPA

Model Voltage Current Price
GPA110 0-12 VDC 10 Amps. $4 50
GPA210 0-12 VDC 15 Amps. $9 50
GPA215 0-12 VDC 25 Amps. $20 00

RECTIFIER CAPACITORS

All Primaries 115 VAC 50 60 Cycles

Type No. Volts Amps. Shpg. wt. Price
CP-1 1000 15 $ 40
CP-10 2000 15 $ 80
CP-50 5000 15 $ 100
CP-100 10000 15 $ 200
CP-500 50000 15 $ 500
CP-1000 100000 15 $ 1,000

RECTIFIER TRANSFORMERS

All Primaries 115 VAC 50 60 Cycles

Type No. Volts Amps. DC Res. Price
HYB1 04 $ 5 50
HYB1 06 $ 12 50

RECTIFIER CHOKES

Type No. H.v. Amps. DC Res. Price
HYB2 04 5 50 $ 2 75
HYB2 06 10 50 $ 3 75

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0-200 1 1/2" sq. G.E. DO 50 $ 6 00
0-1000 5 1/2" sq. G.E. DO 50 $ 10 00
0-5000 5 1/2" sq. G.E. DO 50 $ 15 00

R.F. MILLIAMMETERS

0-15 MA 7 1/2" Weston 430 $ 15 00
0-100 MA 7 1/2" Weston 430 $ 10 00

PRECISION PORTABLE INSTRUMENTS

Single or multi-range

D.C. Microammeters, from 6 to full scale thermo-couple milliammeters, from 1 ma. thermo-couple voltimeters.

Precision Electronic Instrument Co.
146 Grand Street
New York 13, N. Y.
OUTSTANDING VALUES

CATHODE RAY—X-RAY—TRANSMITTING
TUBE MANUFACTURING EQUIPMENT

- HIGH VACUUM MERCURY PUMP with "McLeod" gauge. Mercury diffusion pump electrically heated. Pressure switch controls operation of pump. Diffusion pump exhausts into a mechanical rotary vacuum pump. "McLeod" gauge measures vacuum to 0.1 micron.

- BOMBARDMENT EQUIPMENT
A grid controlled rectifier using two metal plates, which allows continuous and smooth control of anode current.

- OVEN CUBICLE with "Kromax" perimeter cono.

- HI POT TRANSFORMERS
GE, GE-259, etc. 410-1100/480-3200V.

- UNIVERSAL genset
Price $60.00/M

- UNIVERSAL general corp.

- BRAND NEW EQUIPMENT

<table>
<thead>
<tr>
<th>Nature of Equipment</th>
<th>Make</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>VCOC-1200 AC 20 HP 480</td>
<td>3-Phase</td>
<td>Contactor, 1200 amp, 3 poles, 240V</td>
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<tr>
<td>VCOC-1200 DC 20 HP</td>
<td>Single Phase</td>
<td>Contactor, 1200 amp, 240V</td>
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- TUBE MANUFACTURING EQUIPMENT

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- CABLE AND WIRE

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<td>VCOC-1200 DC 20 HP</td>
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- LABORATORY EQUIPMENT

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<tr>
<td>VCOC-1200 DC 20 HP</td>
<td>$395.00</td>
</tr>
</tbody>
</table>

- INQUIRIES FROM DECEMBER 31

COMCET ELECTRONICS SALES CO.
22 Washington St., Beacon, N. Y. 2-7663

- THE BEST IN ELECTRONIC SURPLUS

BC-610 Transmitters with 0-500 MA output, T-300 and T-400 Selective. All working. Wholesale prices; over 200 units. Complete with cables, etc. Inquire at $395.00 each.

- TELERAMA—TELECOMMUNICATIONS COM. 504 W. 27th St., N. Y. C. CABLE: TELERAMA, NEW YORK
A. C. VOLTMETERS

15 Volts, Westinghouse NA-35, 31/2" Round flush bakelite case (IAN type M614) $0.95
40 Volts, Westinghouse NA-33, 21/4" Round flush metal case, black scale luminous markings. (These were originally calibrated for 400 cycle use but have been adjusted for 60 cycle use) $0.95
40 Volts, Westinghouse NA-33, 21/4" Round flush metal case, black scale, luminous markings, calibrated for 400 cycles $0.95
40 Volts, Weston 517, 21/4" Round flush metal case, black scale, luminous markings, calibrated for 400 cycles $0.95
75 Volts, Weston 517, 2" Round flush metal case, ring-clamp type mounting, non-flanged $3.95
150 Volts, Weston 517, 21/2" Round flush metal case (IAN type M624W150ACV) $4.50
150 Volts, Tripplett 352-JF, 31/4" Round flush metal case $4.00
150 Volts, Tripplett 351-JP, 31/2" Round flush bakelite case $4.50
150/300 Volts, Dual Range, Tripplett 351-JP, 31/4" Round flush bakelite case with external series res. for 300 volts, calibrated 150, double scale indications for 300 volt use $5.50
300 Volts, Tripplett 333-2G, 31/2" Round flush metal case $6.00

ALL ITEMS ARE BRAND NEW-SURPLUS-GUARANTEED. All materials shipped from stock same day as order received, subject to prior sale.

A. C. AMMETERS

10 Amps, G.E. AO-35, 3" Square flush bakelite, expanded between 4 and 7 cycles. Scale calibrated 100 Amps for reading div. in 10, with calibr. for 500 cycles. @ $4.95
30 Amps, Tripplett 352-JP, 31/4" Round flush metal case $3.50
30 Amps, Tripplett 351-JP, 31/2" Round flush bakelite case $4.95
50 Amps, Westinghouse NA-35, 33/4" Round flush bakelite case 35 to 500 cycles $4.95
60/120 Amps, Dual Range, 32xc, 31/2" Round flush bakelite case, 5 Amp movement external current transformer $7.50

Volts, Weston 517, 300 Ampl. Volt, 5, 15, 30, 50, 75, 150. Simple wiring diagram furnished with meters or free on request

COST ONLY $7.50

RADIO FREQUENCY AMMETERS

120 Milliamps, Simpson 125, 31/2" Round flush bakelite, arbitrary linear scale calib. 0-10, with caption Output Units, complete with external thermometer $7.50
120 Milliamps, Tripplett, 21/2" Round flush metal case, arbitrary linear sc. calib. 0-100, black face, lum. markings, no cali., complete with external thermometer $7.50
1 Amp, General Electric DW-52, 21/4" Round flush metal case $3.50
1 Amp, General Electric DW-44, 21/2" Round flush bakelite case, black scale $3.50
1.5 Amp, Weston 507, 21/2" Round flush metal case (IAN type M620W025A) $11.00
1.5 Amp, Weston 507, 21/2" Round flush metal case, black scale $11.00
1.5 Amp, Westinghouse RT-35, 3" Square flush bakelite case $5.50
1.5 Amp, General Electric DW-52, 21/2" Round flush metal case $5.50

Volts, Weston 517, 300 Ampl. Volt, 5, 15, 30, 50, 75, 150. Simple wiring diagram furnished with meters or free on request

orders accepted from rated concerns, public institutions and agencies on open account, others please send 25% deposit, balance C.O.D. or check with order. All prices FOB our warehouse, N.Y.C.

ALVARADIO SUPPLY CO. "BUYS" by the CARLOAD

A Real Money-Saving Value!

FT 500/1,000 cycle, BNC plug-in, 5 V., 500 cycle, BNC plug-in, C/T @ 10 Amps $7.00
FT 100 cycle, Test 12 Volts D.C. Operating Uses 872A Tube or other tubes. Brand New $9.95
FT 100 cycle, Test 12 Volts D.C. Operating Uses 872A Tube or other tubes. Brand New $9.95
FT 100 cycle, Test 12 Volts D.C. Operating Uses 872A Tube or other tubes. Brand New $9.95

A Real Bargain Buy!

Amp, Weston 525, 41/2" Round flush metal case $2.50
Amp, Weston 525, 41/2" Round flush metal case $2.50
Amp, Weston 525, 41/2" Round flush metal case $2.50

A Real Bargain Buy!

WILLARD MIDGET 6V STORAGE BATTERY $2.49

3. amp hour rating
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WK

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3012  

SK

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NK

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#### TUBES

**TESTED—GUARANTEED**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Price per Unit</th>
<th>Price per Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 99</td>
<td>$1.98/100</td>
<td>$188</td>
</tr>
<tr>
<td>10 to 999</td>
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<td>$1400</td>
</tr>
<tr>
<td>1000 or more</td>
<td>$1.20/1000</td>
<td>$1200</td>
</tr>
</tbody>
</table>

*Write for Quantity Prices*

---

### PRECISION RESISTORS — 25 Million

**+TAB** Speculatives — We Ship Prices in Blocks

<table>
<thead>
<tr>
<th>Value</th>
<th>Resistance</th>
<th>Price</th>
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<tbody>
<tr>
<td>0.1 to 0.99 ohm</td>
<td>100 for $3.50</td>
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</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>100 for $4.50</td>
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</tr>
<tr>
<td>1 to 15 ohms</td>
<td>100 for $5.50</td>
<td></td>
</tr>
</tbody>
</table>

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*Image Computer Tubes III:

- Sensitivity: Standardized Design.
- Price: $25.00
- Compensation: up to 500000 Data Points

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<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 to 0.99 ohm</td>
<td>$10.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

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**Ship Prices In Blocks**

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### 35M FILM—Slow & Super Slow*...%

*Microfiche Microfilm...%

**Ship Prices In Blocks**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
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<tbody>
<tr>
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<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
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*Vacuum Precision HiVolt Resistors*

**Ship Prices In Blocks**

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### BLOWERS—

**Ship Prices In Blocks**

<table>
<thead>
<tr>
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<tbody>
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<td>0.1 to 0.99 ohm</td>
<td>$10.00/100</td>
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<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

*Vacuum Precision HiVolt Resistors*

**Ship Prices In Blocks**

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### PLATE TRANSFORMERS

**Ship Prices In Blocks**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 to 0.99 ohm</td>
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<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

*Vacuum Precision HiVolt Resistors*

**Ship Prices In Blocks**

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### RELAYS—FAMOUS MAKE

**Ship Prices In Blocks**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
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<tbody>
<tr>
<td>0.1 to 0.99 ohm</td>
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<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

*Vacuum Precision HiVolt Resistors*

**Ship Prices In Blocks**

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### HI-VOLT OIL

**Ship Prices In Blocks**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 to 0.99 ohm</td>
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</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

*Vacuum Precision HiVolt Resistors*

**Ship Prices In Blocks**

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### MICA XMITTING CNDRS—

**Ship Prices In Blocks**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
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<tbody>
<tr>
<td>0.1 to 0.99 ohm</td>
<td>$10.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

*Vacuum Precision HiVolt Resistors*

**Ship Prices In Blocks**

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### MODULATION & AUDIO FXMRS

**Ship Prices In Blocks**

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
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<tbody>
<tr>
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<tr>
<td>1 to 0.99 ohm</td>
<td>$20.00/100</td>
</tr>
<tr>
<td>1 to 0.99 ohm</td>
<td>$30.00/100</td>
</tr>
</tbody>
</table>

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**DEPT. 106**

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**THAT'S A BUY**

318

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Minimum Capacitance at Maximum Transconductance

Grid and Filament Connectors Available

Proven Life

CONSERVATIVELY RATED

TYPICAL TELEVISION OPERATION

(Two tubes in Push-Pull)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grounded Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (MC)</td>
<td>220</td>
</tr>
<tr>
<td>Band Width (MC)</td>
<td>14</td>
</tr>
<tr>
<td>D.C. Plate Voltage</td>
<td>4000</td>
</tr>
<tr>
<td>D.C. Grid Voltage</td>
<td></td>
</tr>
<tr>
<td>Synchronizing Level</td>
<td>-200</td>
</tr>
<tr>
<td>Black Level</td>
<td>-290</td>
</tr>
<tr>
<td>White Level</td>
<td>-550</td>
</tr>
<tr>
<td>Peak RF Grid Voltage (Grid to Grid)</td>
<td>1000</td>
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<tr>
<td>D.C. Plate Current (AMP)</td>
<td>2.5</td>
</tr>
<tr>
<td>Synchronizing Level</td>
<td>1.76</td>
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<tr>
<td>Black Level</td>
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<tr>
<td>D.C. Grid Current (MA)</td>
<td>400</td>
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<tr>
<td>Synchronizing Level</td>
<td>160</td>
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<tr>
<td>Black Level</td>
<td>1000</td>
</tr>
<tr>
<td>Driving Power (approx. watts)</td>
<td>1000</td>
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<tr>
<td>Power Output (KW)</td>
<td></td>
</tr>
<tr>
<td>Synchronizing Level</td>
<td>5+0.7</td>
</tr>
<tr>
<td>Black Level</td>
<td>3</td>
</tr>
</tbody>
</table>

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   Quality controls begin with the raw material and are followed through in every successive step of manufacture and assembly. That's why RCA tubes and components are consistently reliable.

8. **RCA Sales and Customers' Service**—
   A staff of seasonal sales representatives are within convenient reach. They're available when you want them. In addition, a staff at the Home Office devotes its time exclusively to expediting your orders.

9. **RCA District Offices**—
   RCA maintains three conveniently located district offices in Harrison, Chicago, and Los Angeles to serve equipment manufacturers. You can get prompt service from the office nearest you.

10. **RCA Distribution**—
    RCA maintains bulk tube and component stocks in three warehouses strategically located in Jersey City, Chicago, and Los Angeles for quick service.

11. **RCA Pricing**—
    Mass-production techniques and the RCA "Preferred Type Plan" have consistently operated to reduce manufacturing costs—which mean lower prices to you.

12. **RCA Engineering Leadership**—
    The vast resources of experience and ability that account for RCA's engineering leadership in tubes and components, are of direct benefit to RCA customers...a final reason why it pays to deal with RCA.

---

**Equipment Sales Field Representatives** at the RCA Sales Office nearest you:

<table>
<thead>
<tr>
<th>City and State</th>
<th>Telephone No.</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harrison, N. J.</td>
<td>Harrison 6-8000</td>
<td>415 S. 5th St.</td>
</tr>
<tr>
<td>Chicago, Ill.</td>
<td>Whithall 4-2900</td>
<td>589 E. Illinois St.</td>
</tr>
<tr>
<td>Los Angeles, Calif.</td>
<td>Madison 9-3671</td>
<td>420 S. San Pedro St.</td>
</tr>
</tbody>
</table>

**Orders and inquiries on orders:**

**Tubes:** RCA warehouse serving you:

<table>
<thead>
<tr>
<th>Location</th>
<th>Telephone No.</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago Warehouse, RCA</td>
<td>Harrison 6-8000</td>
<td>589 E. Illinois St.</td>
</tr>
<tr>
<td>Chicago, Ill.</td>
<td>Whithall 4-2900</td>
<td>415 S. 5th St.</td>
</tr>
<tr>
<td>Los Angeles Warehouse, RCA</td>
<td>Madison 9-3671</td>
<td>420 S. San Pedro St.</td>
</tr>
<tr>
<td>Los Angeles, Calif.</td>
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**ELECTRON TUBES AND COMPONENTS**

**HARRISON, N. J.**