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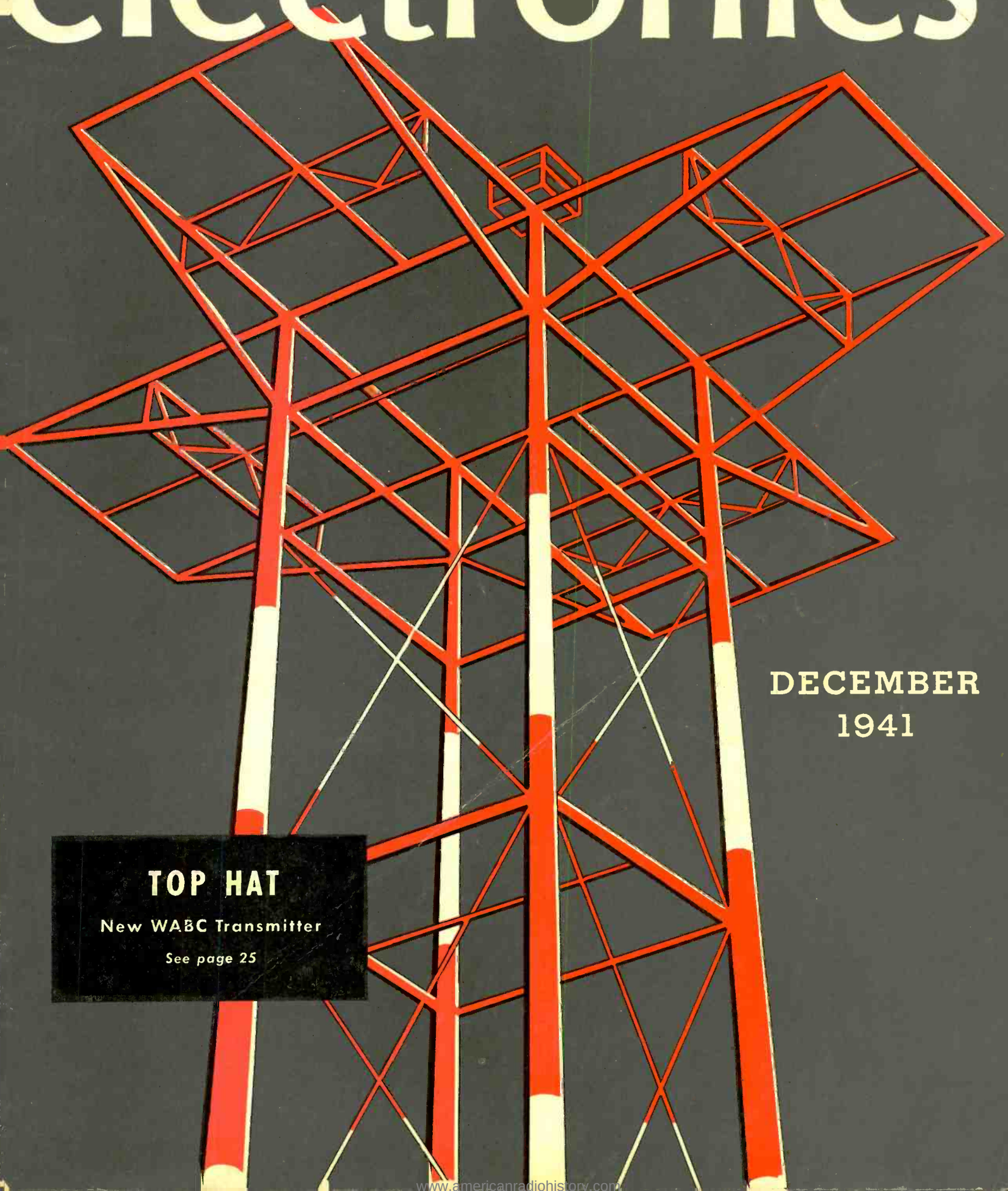
electronics



DECEMBER
1941

TOP HAT

New WABC Transmitter

See page 25

In a world at war

So that our next generation will not be born to a world of violence, shortages, rationing and sacrifice . . . a world wherein advancements are distorted into mechanics of destruction . . . a world in which peacetime economies are harnessed to the maintenance of colossal war machines . . . we pledge ourselves and our facilities.

Our nation is engaged in a great task of prepardness for our defense, and our products, transmitting and rectifying tubes, are employed in the establishment and maintenance of vital communications lines. These same tubes, which serve in our broadcasting stations to bring us laughter, music and culture; in research—and in electro-medical apparatus to alleviate suffering and disease; and in many industrial applications; must *NOW* serve in the protection of our shores. To this end, we cooperate willingly.

We must therefore ask your cooperation in anticipating essential, normal requirements so that we may continue to serve both you and our country to the best of our ability.

AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET • **BROOKLYN, NEW YORK**

A McGRAW-HILL PUBLICATION

electronics

CONTENTS—DECEMBER, 1941

DEPARTMENTS

ELECTRONICS, December, 1941. Vol. 14, No. 12. Published monthly, price 50c a copy. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation, 330 West 42nd Street, New York, N. Y.
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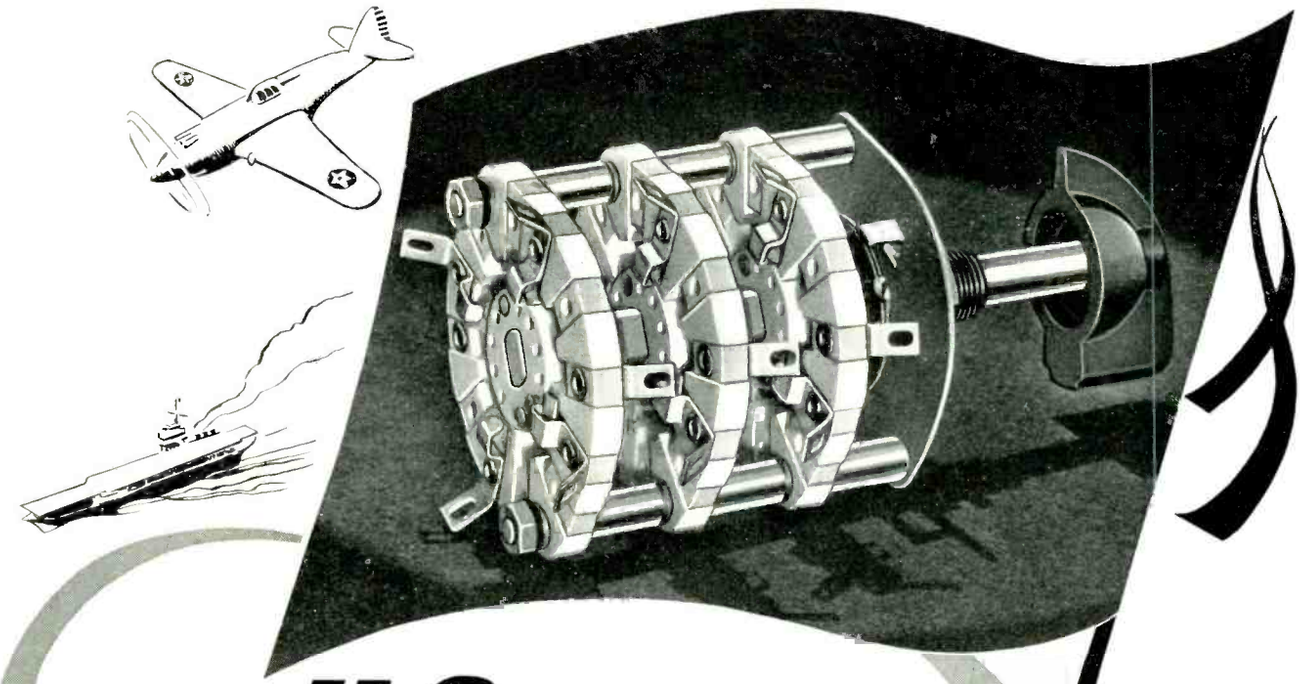
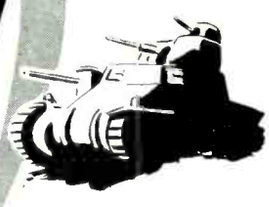


Rigid U.S. Tests Demand CENTRALAB Switches in Your Communication Systems



Don't hold up defense development! Centralab NOW offers a kit of parts of high grade Steatite Ceramic Switch Sections and necessary metal parts which will withstand the 200 hour Salt Spray Test, for the immediate construction in your own laboratory of efficient highest quality SELECTOR SWITCHES (over 200,000 electrical combinations available).

Whether it is the first "hand made" transmitter or receiver, or whether they are rolling off your production line; if you equip them with these CENTRALAB Selector Switches they will pass every test for they are "BUILT FOR ABUSE". For the first or thousandth unit . . . specify CENTRALAB SELECTOR SWITCHES.

Send for special bulletin on Selector Switches for Defense.

CENTRALAB · Division of Globe-Union Inc., Milwaukee, Wis.

Important Features of Centralab Selector Switches

1. High grade Steatite sections, vacuum wax impregnated.
2. Contacts, clips, eyelets and rivets heavily silver plated.
3. Complete index mechanism and operating shafts of stainless steel. All brass parts heavily nickel plated to withstand 200 hour salt spray test.
4. Standard indexing 30° and 90° between positions. Also available in 60° on special request.
5. Sections 3/16" thick. Mounting center of sections 1-9/16". Overall widest dimension 1-7/8".
6. Choice of 2 to 11 positions per section.
7. Kit consists of 61 Steatite Sections of various switching combinations, 36 indexes complete with hardware for assembling 1 to 6 sections per index.

DEFY ERASURE-GHOSTS
with this new tracing cloth

Here is a tracing cloth that holds erasure scars at a minimum—that won't show water marks or perspiration stains. Now you can have clean tracings, in pencil or ink, free from these untidy "ghosts" that reproduce on blueprints!

For PHOENIX is ghost-proofed by a remarkable new process that defies moisture and gives you an unusually durable working surface. You can use harder pencils with this improved cloth and get sharper lines with less tendency to smudge. Even 6H lines show clearly, and reproduce sharply! Erasing does not mar the drawing surface; erased areas take pencil smoothly—and ink without feathering. Its new white color and increased transparency give you excellent drawing contrast and produce strong blueprints.

Let PHOENIX prove its virtues on your own drawing board. See your K&E dealer, or write for a generous working sample and an illustrated brochure.

EST. 1867

KEUFFEL & ESSER CO.

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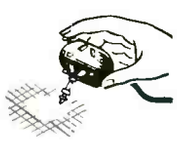
PHOENIX DEFIES MOISTURE GHOSTS

Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*

PHOENIX LESSENS SMUDGE GHOSTS

The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.



PHOENIX REDUCES ERASURE GHOSTS

Ordinary tracing cloths become scarred when erased... erased spots produce ghosts on blueprints.

PHOENIX has a durable drawing surface that reduces working scars to a minimum.

K&E

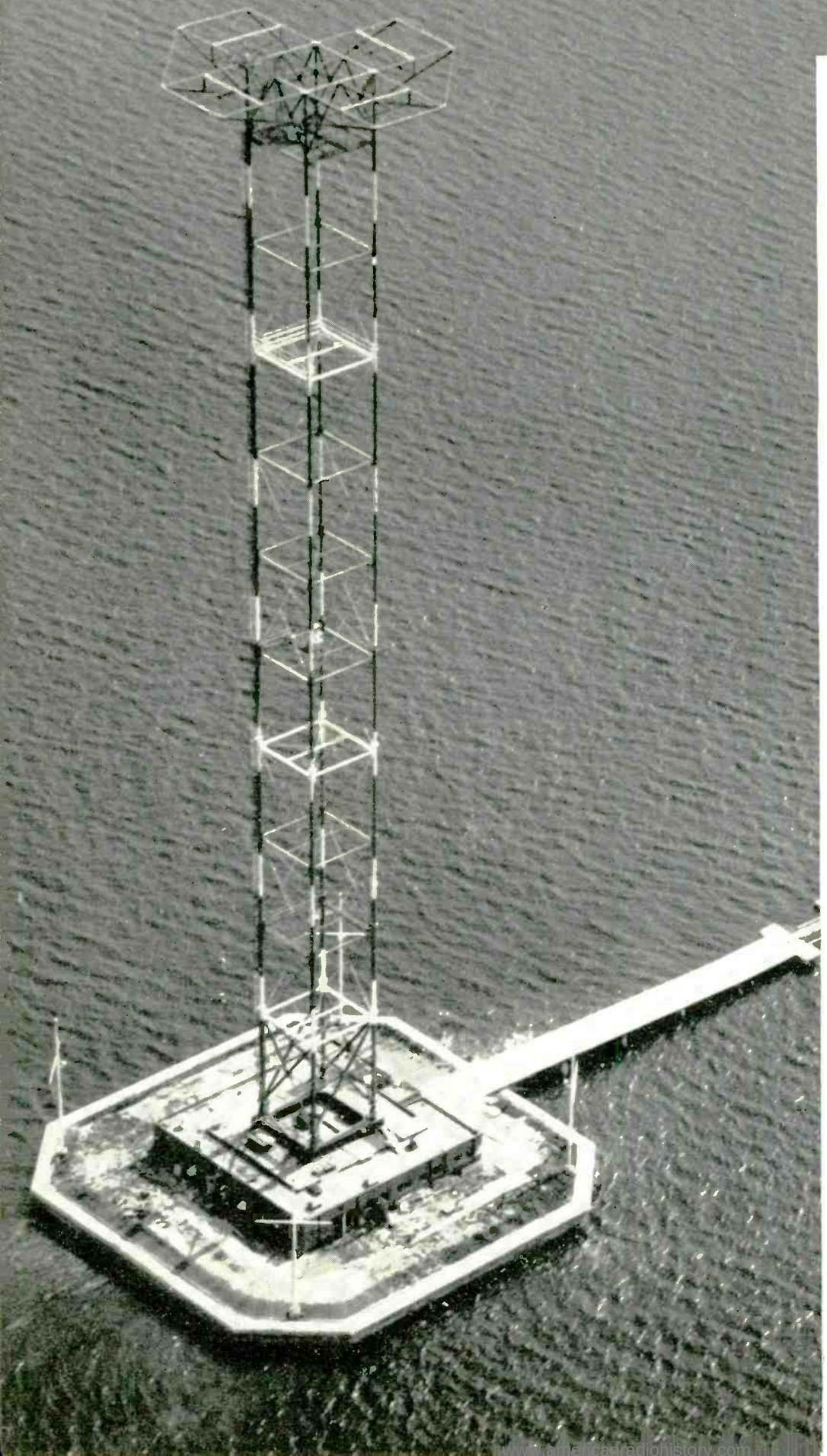
Phoenix

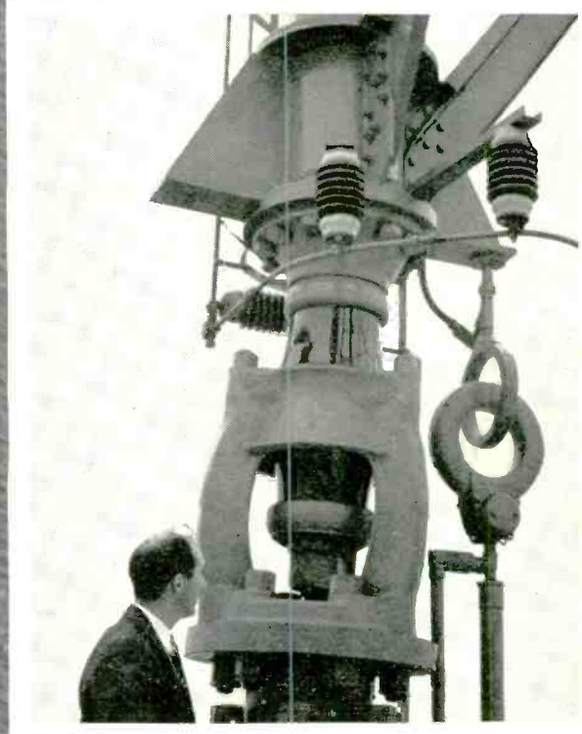
REG. U.S. PAT. OFF.

TRACING CLOTH

for pencil *and* ink

"Insulation by Lapp" f

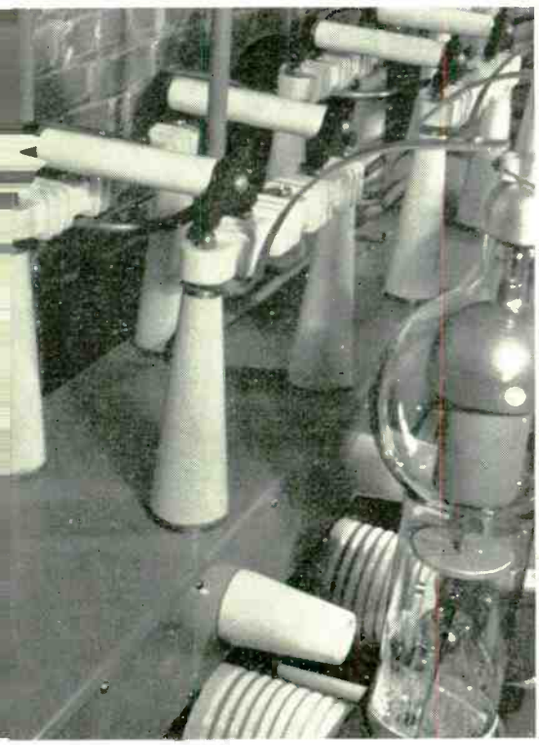




Each corner of the 410-foot antenna structure is sup ported by a Lapp push-pull tower-footing insulator. Now use of Lapp Fog-type Station Post insulators as stand-o for gas-filled high-frequency lead. Lapp tower footin insulators are available for all pipe masts, self-supporte towers and guyed radiators.

One of the WABC tower footing insulators before ship ment from the Lapp factory. These curved-side compre sion cones of high-voltage porcelain offer remarkab electrical and mechanical characteristics. This insulato was tested at 780,000 pounds in the Lapp laboratory. N Lapp footing insulator has ever failed in service.

the new voice of WABC

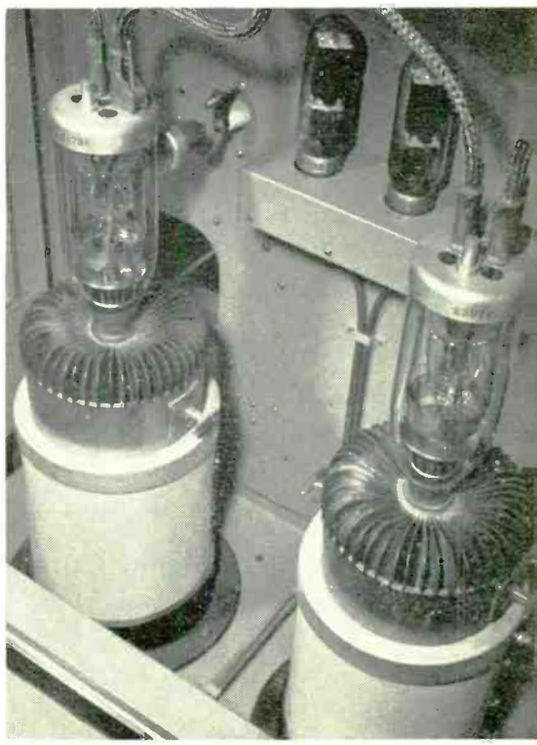


Stand-off insulators of Lapp electrical porcelain installed in the hand-switching system for the spare rectifier tubes at WABC 50 Kw transmitter.

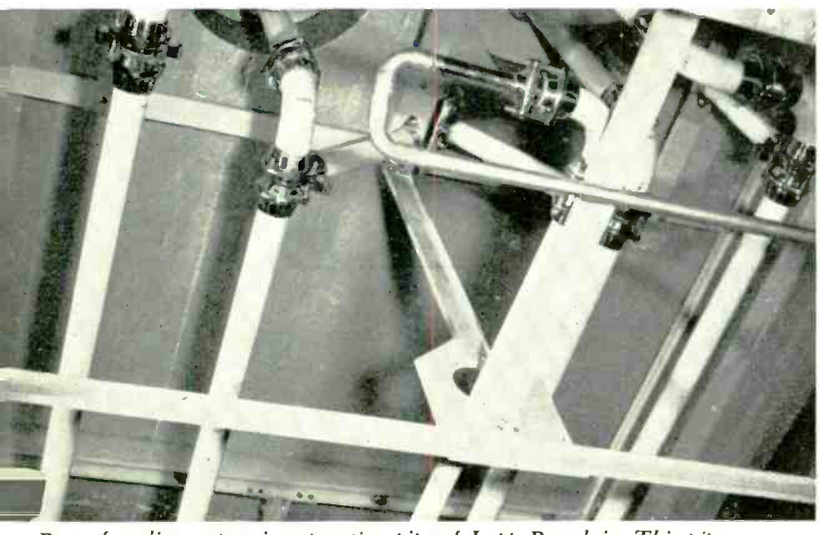
THE strong clear voice of WABC comes from the island location of the transmitter, from the up-to-the-minute engineering and design, and from the efficiency of equipment used.

Columbia engineers tell us, "The performance of Lapp equipment—insulators, condensers and porcelain pipe—is an important factor in the efficient and dependable operation of the transmitter."

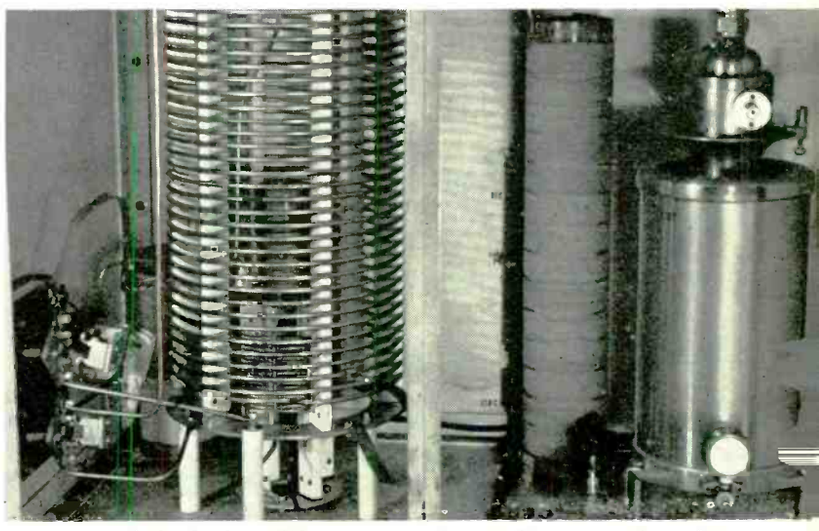
Lapp specialties for radio offer peak performance and operating security in the systems of modern transmitters. When you are considering installation of a new transmitter, or modernization of existing equipment, you can profitably investigate Lapp tower footing insulators, stand-off insulators, gas-filled condensers, porcelain pipe and water coils. Descriptive literature and specifications on request. Lapp Insulator Co., Inc., LeRoy, N. Y.



Air-cooled amplifier tube, mounted on support of Lapp Porcelain. Such pieces contribute to efficient operation of air-cooled systems.



Part of cooling system incorporating pipe of Lapp Porcelain. This pipe, non-porous and inactive chemically, eliminates sludging and need for cleaning; provides operation at peak level and low maintenance. Lapp pipe or porcelain water coils are used in all high-power water-cooled transmitters.

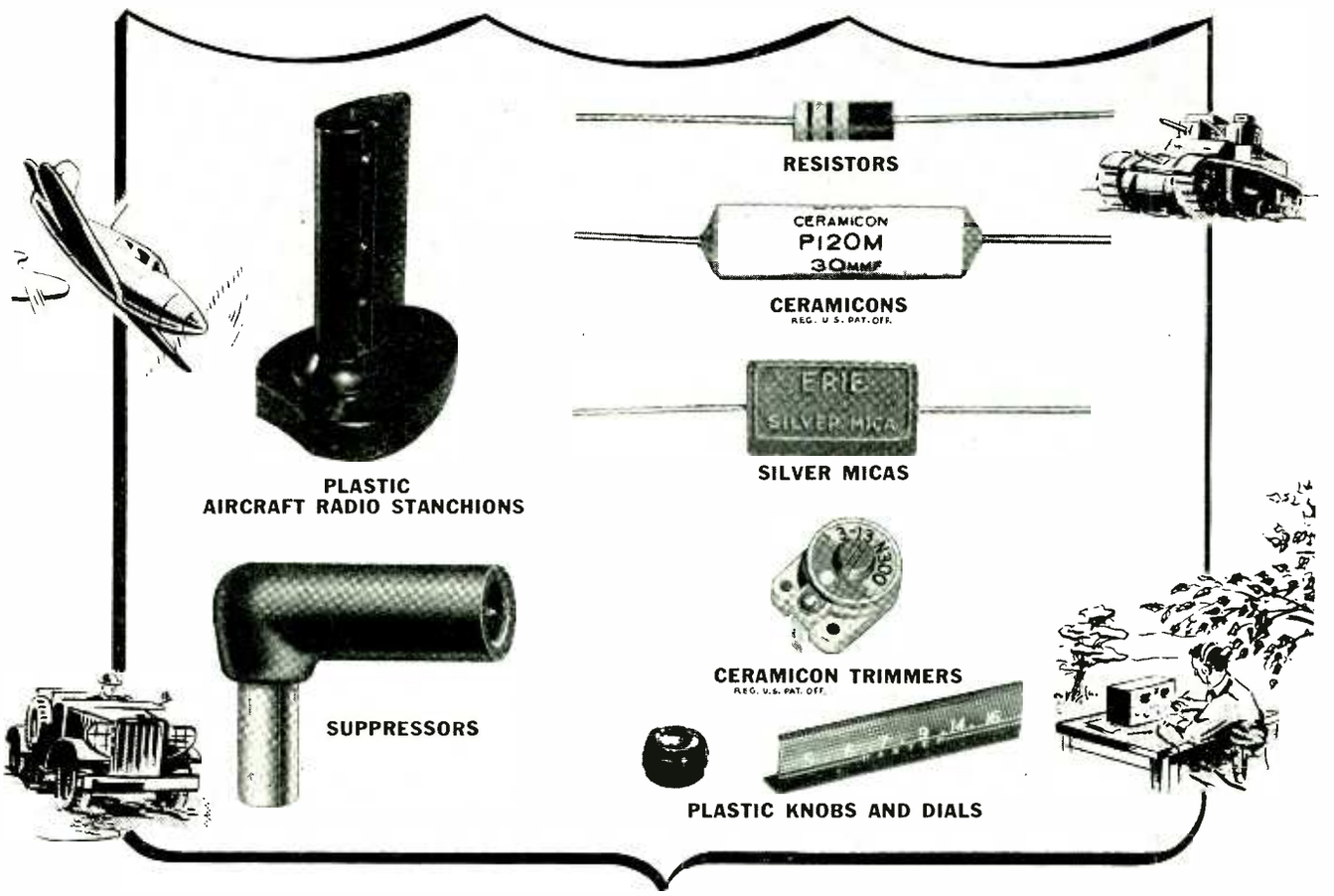


A part of the final amplifier stage in 5Kw auxiliary transmitter, Lapp gas-filled condenser, variable capacitance type, (at right) offers great economy of space, constant capacitance regardless of temperature change, zero loss, puncture-proof operation and the dependability of leak-proof construction.

for operating security specify **Lapp**

- TOWER FOOTING INSULATORS
- GAS-FILLED CONDENSERS
- PORCELAIN WATER COILS
- PORCELAIN PIPE
- STAND-OFF INSULATORS
- SPECIAL PORCELAIN PARTS . . . . . .

Erie Resistor CONTRIBUTES STABILITY and DEPENDABILITY to National Defense Electronic Equipment



HIGH Frequency electronic equipment used by all branches of the Army and Navy require components of exacting quality. The all-round excellent electrical characteristics of Erie Resistors fully meet all requirements for these services. Erie Ceramicons and Ceramicon Trimmers are being specified in large quantities for insuring frequency stability in transmitters and receivers. Similarly, Erie Silver-Mica Condensers, which have practically zero temperature coefficient, are used to prevent condenser capacity drift. Erie Suppressors are approved for U. S. mobile equipment for eliminating ignition interference with surrounding communication equipment.

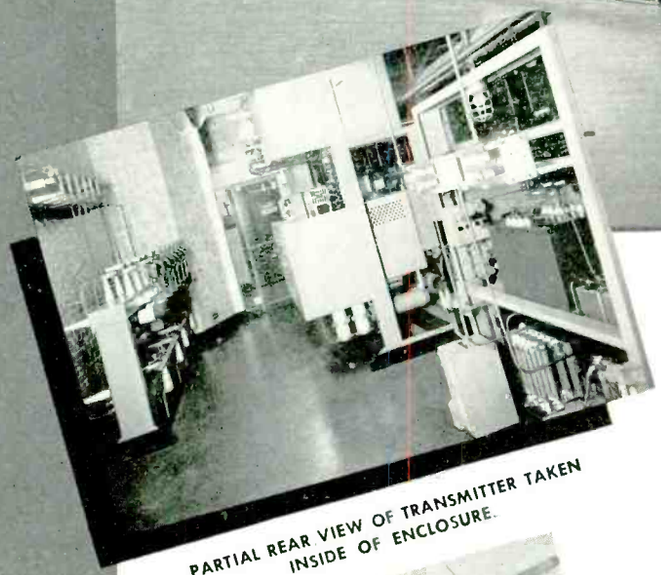
The Plastic Division of Erie Resistor is injection molding large aircraft radio mast stanchions for the Curtiss "Tomahawks" and the fast cannon-carrying Bell "Airacobras" being delivered to the R. A. F. Erie custom molded knobs and dials are being turned out in large quantities for radio equipment used on land, sea and in the air.

Complete details on these Erie Resistor products will be sent to interested engineers on request.

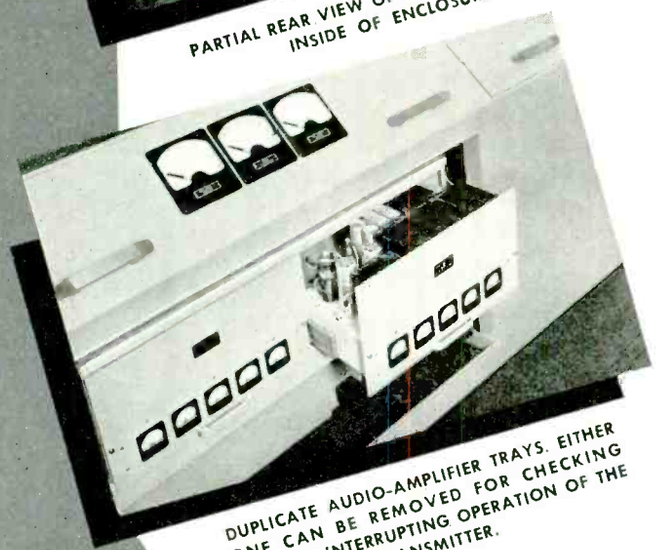
ERIE RESISTOR CORP., ERIE, PA. LONDON, ENGLAND · TORONTO, CANADA.

A Job Well Done!

CONTROL ROOM SHOWING FRONT PANEL ARRANGEMENT AND CONTROL DESK.



PARTIAL REAR VIEW OF TRANSMITTER TAKEN INSIDE OF ENCLOSURE.



DUPLICATE AUDIO-AMPLIFIER TRAYS. EITHER ONE CAN BE REMOVED FOR CHECKING WITHOUT INTERRUPTING OPERATION OF THE TRANSMITTER.

Another

FORWARD STEP IN BROADCASTING . . THE NEW WABC STATION

Transmitting Equipment by Federal Telegraph

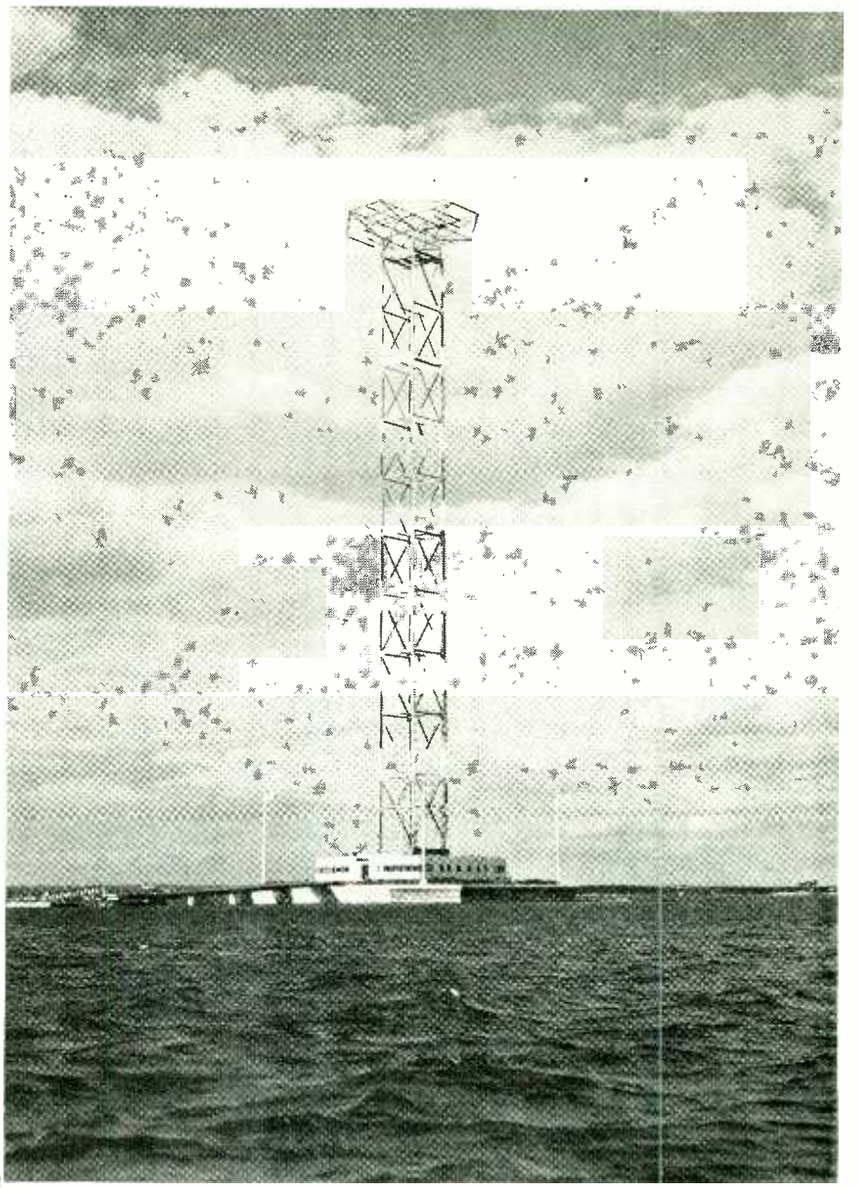
As manufacturers of the transmitting equipment for this great new broadcasting station, the Federal Telegraph unit of the International Telephone & Radio Manufacturing Corporation is proud to be associated with this magnificent project by the Columbia Broadcasting System, to bring to its millions of listeners quality and performance characteristics unsurpassed by any similar installation in the history of broadcasting.

International Telephone & Radio Manufacturing Corporation

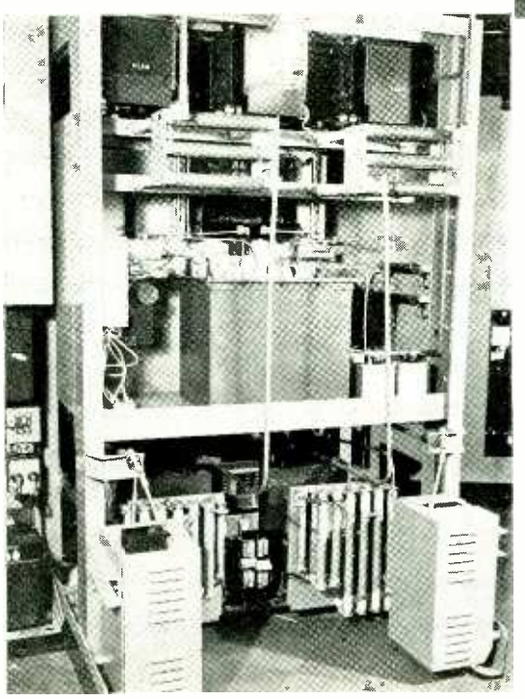
1000 Passaic Avenue • East Newark, N. J.

STATION W·A·B·C

COLUMBIA ISLAND NEW YORK



Rear view of a modulator unit showing Ward Leonard Resistors installed.



WE appreciate the confidence that the Columbia Broadcasting System and the Federal Telegraph Company have shown in our products by their use of Ward Leonard Vitrohm Resistors in the new Columbia Island station.

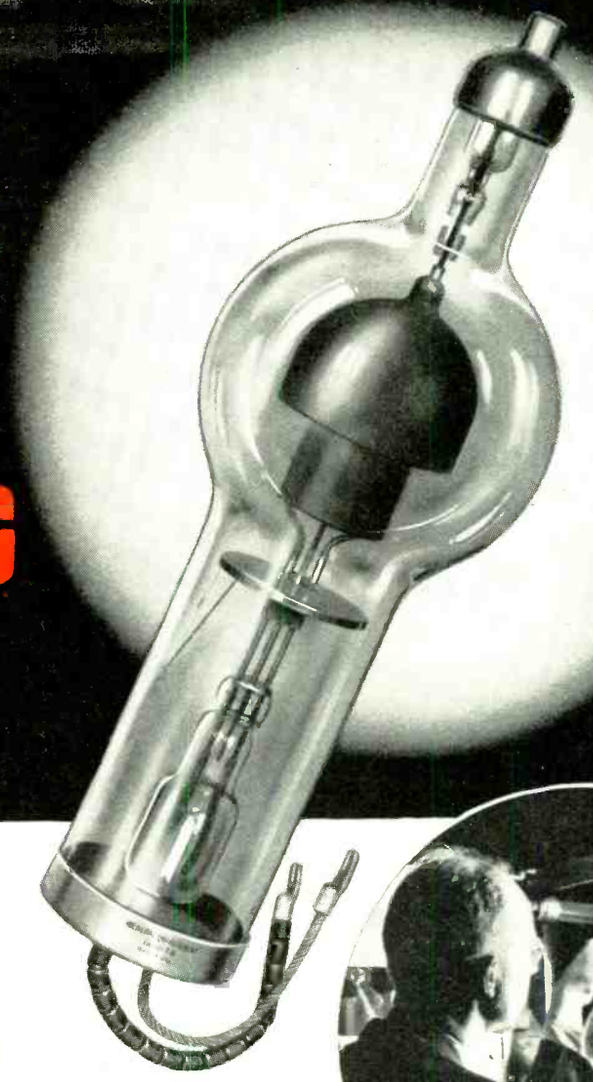
WARD LEONARD ELECTRIC COMPANY

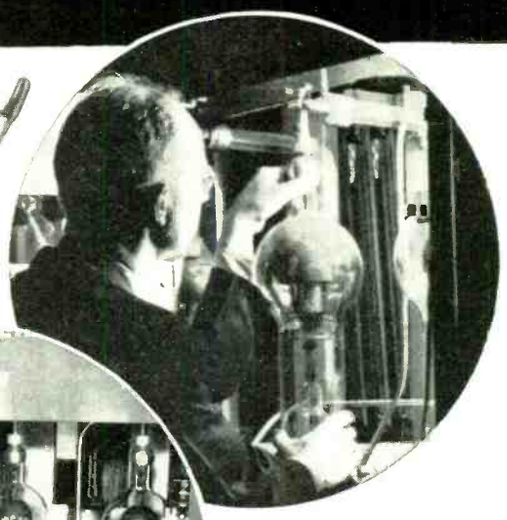
32 South Street, Mount Vernon, N. Y.

ELECTRIC CONTROL DEVICES SINCE 1892

Choose the PACE-SETTERS for BETTER BROADCASTING

G-E Tubes Mean Peak Efficiency

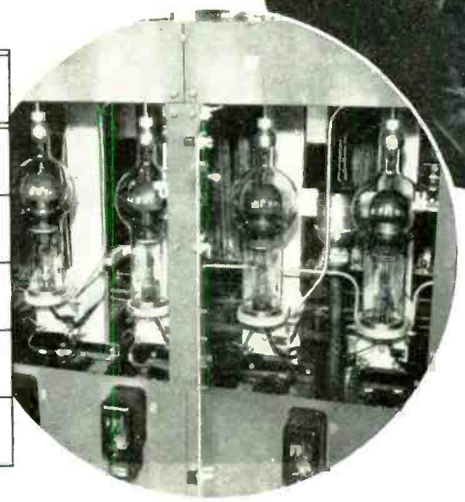




Here are a few ways GL-857B's meet your high-power, high-voltage rectifier requirements

CIRCUIT	MAXIMUM A-C INPUT VOLTS* (RMS)	APPROXIMATE D-C OUTPUT VOLTS TO FILTER	MAXIMUM D-C LOAD CURRENT AMPERES
SINGLE-PHASE FULL-WAVE (2 tubes)	7750	7000	20
SINGLE-PHASE FULL-WAVE (4 tubes)	15500 total	14000	20
THREE-PHASE HALF-WAVE	9000 per leg	10500	30
THREE-PHASE DOUBLE-Y PARALLEL	9000 per leg	10500	60
THREE-PHASE FULL-WAVE	9000 per leg	21000	30

*For maximum peak inverse voltage of 22,000 volts



THE exceptionally rigid filament structure in this tube assures long cathode life. Arcback has been greatly reduced. The low voltage drop and low power loss between electrodes—characteristics inherent in this type of tube—assure peak efficiency and great dependability.

The GL-857B was made possible by General Electric's pioneer work. After developing the hot-cathode mercury-vapor rectifier tube, G-E engineers built the first high-voltage mercury-vapor rectifiers, soon accepted as standard throughout the industry. They introduced the 857, and later this 857B.

When you sign your next tube order specify General Electric tubes—proved in the laboratory, checked at our own broadcast stations, and verified by the long list of satisfied users throughout the radio industry. For your requirements in standard broadcasting, FM, or television see your G-E representative first, or write General Electric, Radio and Television Department, Schenectady, N. Y.

GENERAL ELECTRIC

161-23-8850

DEPENDABILITY

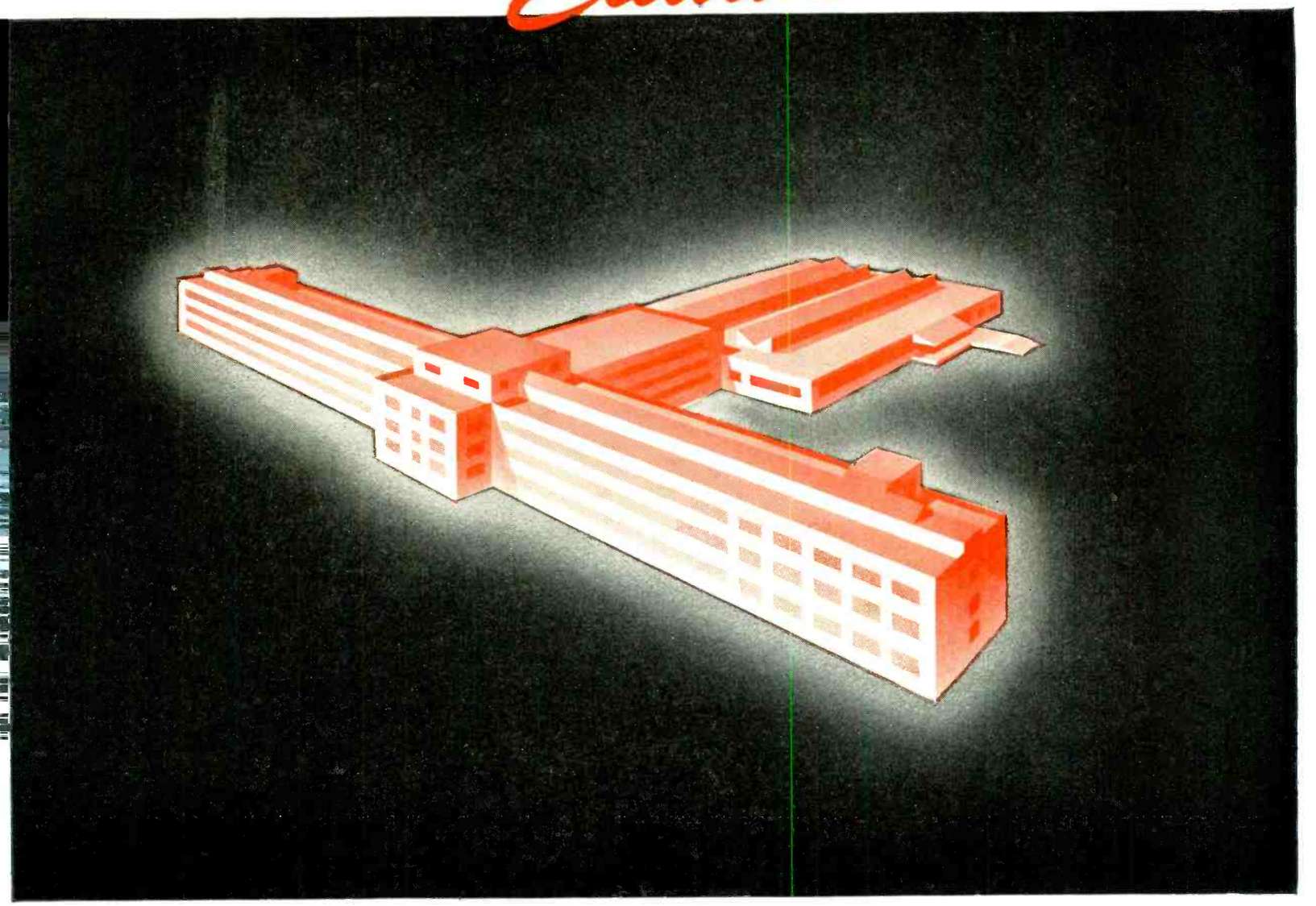
Diversity Receiver Installation at WABC

THE dependability of Super-Pro receivers is widely known among engineers in every branch of radio communications. That is why you will find Super-Pros used by leading broadcasting stations; press organizations; U. S. Signal Corps, and by many foreign governments. If it's a receiving problem you'll find the answer in a Super-Pro.

THE HAMMARLUND MANUFACTURING CO., INC.

424-438 West 33rd Street, New York, N. Y.

This is the House *Electrons* are Building



"Great oaks from little acorns grow"—In radio, great services from little electrons grow. Electrons—tiny bits of electricity—are corpuscles of science in the lifeblood of radio progress.

Electronics took wireless out of the spark gap and put it into the vacuum tube oscillator; it lifted radio off the cat-whisker of the crystal detector and placed it in the electron tube, acting as both detector and amplifier. Electronics gave wireless a voice—the radiophone, now called broadcasting.

Today in the Electronic Age, a new structure—RCA Laboratories—is being built on 260 acres at Princeton, N. J., planned to be the foremost radio research center in the world. Here in surroundings that inspire clear thinking and research, scientists of RCA Laboratories will seek new truths. They will develop new inventions and services for radio, for industry and for people everywhere, because Electronics is an ever-broadening field.

The main section of RCA Laboratories—the House that Electrons are Building—will be ready for occupancy in the Spring of 1942. And with its opening, a new gateway to the future of radio swings wide for the benefit of America and all the civilized world.

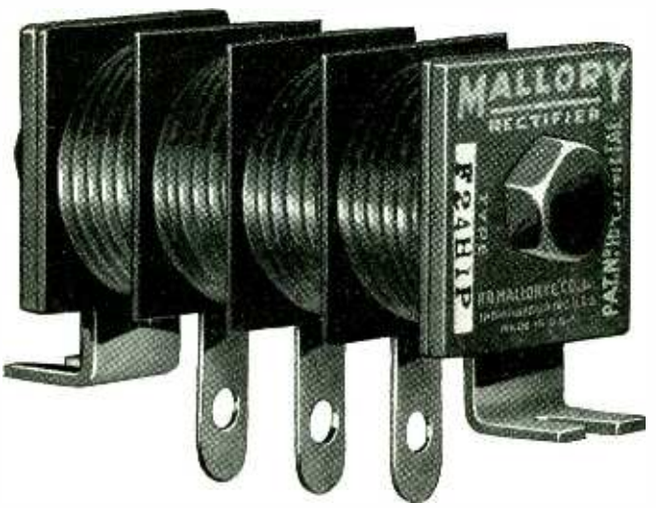
RCA LABORATORIES

A Service of the Radio Corporation of America

Other RCA Services: RCA Manufacturing Co., Inc. • Radiomarine Corporation of America • R. C. A. Communications, Inc. National Broadcasting Company, Inc. • RCA Institutes, Inc.

P. R. MALLORY & CO. Inc. MALLORY RECTIFIERS

Solve Many a Problem for Industry



In many industrial applications Mallory Magnesium-Copper Sulphide Rectifiers provide the economical dependable solution to the problem of obtaining low voltage direct current from a commercial alternating current source. These rectifiers are used for hundreds of services, such as

- The charging of automobile, airplane, electric truck, railroad and industrial storage batteries.
- The operation of magnetic separators, magnetic chucks, solenoids, generator and alternator fields, vibrating separators and chutes.
- The operation of arc devices in welding, motion picture projection arcs, theatre spot lights and milk irradiation arcs.
- Battery substitutes for—

Motion picture exciter lamps	Elevator mechanisms
Coin Machines	Laboratory equipment
Telephones	Burglar alarms
Telegraphs	Railway signal devices, etc.

- Electrochemical applications
  Electroplating (capacities to 5,000 amperes)
  Electrocleaning
  Electrolysis elimination

Let Mallory solve your rectification problems. Engineering service without obligation.

Send for this catalog
Mallory's catalog of approved precision products should be in every engineering source file. It saves time and money.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA
Cable Address—PELMALLO

CROSS TALK

▶ **HOKUM** . . . At the Fall Meeting of radio engineers at Rochester, reported on in detail elsewhere in this issue, much of great interest and value transpired. One of the things that inspired us with some hope for the radio receiver portion of the industry was in a talk by cost accountant Hulse of the General Electric company. Mr. Hulse did not talk long, but he had fresh and interesting approach. To the average radio engineer cost accounting must be about as interesting as radio engineering is to cost accountants—and yet Mr. Hulse's talk was interesting.

Among other things, he gave hope that much of the hokum which has plagued the radio industry would be eliminated as a result of a decreasing profit margin (not because of government control of prices but lack of control on wages) and decreased raw materials available. If this really comes about, sales departments must revise their chatter when oversized cabinets, oversized loud speakers, extra—and unused—tubes are eliminated from the average radio receiver. We hope the necessity of substituting real value for this hokum will not too seriously inconvenience the sales and advertising departments of many of our radio receiver companies.

There was much mention of the fact that the end of the war would see many changes in the communication setup due to advances in technique spurred on by the present situation. The fact that the post war days may see a severe depression with corresponding lack of spending cash in the pockets of the people, indicates that every technical advance made today should be earmarked as a potential stimulant for sales in the future.

Recognition that broadcasting provides the nation with a most essential means of keeping the people informed of important news events, points to the need for an annual production of about 7½ million home and auto receivers according to Dorman Israel. If the average life of a radio set is 8 years and if there are 60 millions in use, this annual production for replacement only is a subsistence level for the industry.

▶ **ELECTRONICS** . . . is happy to announce the addition to its editorial staff of W. W. MacDonald, a McGraw-Hill editor of some 15 years experience. Mr. MacDonald originally entering the field of communications as field engineer for one of the earliest mass-producers of radio receiving equipment, has seen the business of broadcasting grow up and settle down. Successively assistant editor, technical editor, associate editor, managing editor and for the last two and one-half years chief editor of *Radio Retailing*. "Mac" brings to ELECTRONICS his long experience with the distribution and service aspects of the radio industry. Amateur radio readers of ELECTRONICS will recognize him as W2TY since he has transmitters on nine amateur bands, beginning with 15-watts on ¾-meters and culminating with a 500-watter on 160 which burns up many an eardrum around Long Island.

Mr. MacDonald will devote his full time to investigating the growing field of applications of electronics to industrial problems.

▶ **SIGNALS** . . . During the current year, it is expected that the Materiel Branch of the Office of the Chief Signal Officer of the Army will buy from the radio industry more than a billion dollars worth of communication equipment. Of this vast sum, between 600 and 700 millions will go for radio apparatus; the rest for wire and wire communications. For a partial breakdown of where some of this money is to go, see this page for October 1941. It is hoped that an occasional progress report on contracts alloted and on deliveries made by the industry will be available here.

The mountains of communication equipment to be made available to the military will seriously curtail the production of radios for civilian needs both because of lack of raw materials and because of lack of man power and production facilities. In a good year the radio business might amount to a half-billion dollars at the prices manufacturers received for their products. Radio set and tube plants did not work full speed ahead all the year round and so some extra plant capacity has been available. The retail market is going to feel the lack of things to sell, however. Judging from present complaints of dealers that only the ability to get receivers limits sales, the pinch is already being felt.

Among the many products being made for the military services, the most subcontracting has gone on in the manufacture of radio sets, marine engines and electrical equipment. Here the figures are from 44 to 47 percent.

▶ **RESEARCH** . . . During 1941 1,008 American manufacturers will spend $117,490,000 for research according to the first survey of its kind just completed by Dr. Karl T. Compton, president of MIT and chairman of the Research Advisory Committee of the NAM. This is roughly 1.1 percent of gross sales. Only 8 percent of those surveyed indicated that their expenditures for research were less than in 1940; of the others, 49 percent increased their research budget and 42 percent had the same budget as the previous year.

THE GEIGER MUELLER TUBE

THE Geiger Mueller counter tube represents the most sensitive instrument known for the detection and measurement of radiations such as are emitted by radioactive substances, nuclear particles, x-rays, ultraviolet and ordinary light, and cosmic rays. To nuclear physicists it has been known as a very helpful laboratory instrument for nearly two decades. However, it is only recently that it has reached a stage of development which qualifies it to be added to the list of electronic instruments such as the cathode-ray tube, or the electronic vacuum tube. For, although simple in appearance, the construction of reliable Geiger Mueller tubes used to be more hazardous a game with unpredictable results, the main reason being that the mechanism of its operation was unknown.

After years of careful research and development nearly all the mysteries have given way to understanding, and the trial and error method of construction has turned into systematic and routine procedures capable of producing hundreds of tubes of equal characteristics. With the curtain of mystery rising, new applications extending from those in the laboratories of chemistry, biology, and medicine, to various industrial applications are being found in steadily increasing number.

Construction and Operation

The ordinary type of counter tube consists of a metal cylinder, and a thin tungsten wire extended along its axis, in a glass chamber containing a few centimeters (Hg) of pressure of a certain gas or gas mixture. Cylinder and wire serve as cathode and anode, respectively, in a circuit of the type shown in Fig. 1.

This relatively simple and very rugged instrument will supply a pulse of several hundred volts at A-B (Fig. 1) within a few microseconds from the time free electrons, or even a single free electron, are produced inside the cylinder. This pulse may then be used to operate or control any electrical or electromechanical device, as for instance a recorder which will count the number of such events taking place in the counter tube.

What tremendous amplification takes place in a Geiger Mueller tube can be realized by the fact that the presence of *one single electron* will unfailingly set off the counter mechanism to produce an electrical pulse sufficiently great to operate a relay tube without any further amplification.

A number of applications follow immediately from this feature of the Geiger Mueller tube as a detector for electrons, since the production of such electrons may be a consequence of various kinds of processes whose occurrence can thus be detected: ionization (corpuscular radiations), photoelectric and Compton effects (light rays, x-rays, γ-rays), or thermionic emission.

Under certain conditions, the counter tube can be made to supply pulses the amplitudes of which are directly proportional to the number of primary electrons formed in each event, so that this number may be determined by measuring the pulse size, thus supplying means for investigations regarding the nature of an unknown radiation, or the energy of a radiation, or the number of simultaneously occurring particles in every event. Working under such conditions, the tube is called a "proportional counter."

The Elementary Process in the Counter Tube Mechanism

A process similar to the one occurring in the electron multiplier developed by Zworykin takes place in the Geiger Mueller tube. The initial number of electrons is multiplied by giving them sufficient velocity (kinetic energy) to make possible the production of secondary electrons which join the initial ones on the path of further acceleration, this process repeating itself with the steadily increasing number of electrons.

While in the Zworykin tube the secondaries are produced by impact on a series of metal surfaces in a vacuum, in the Geiger Mueller tube the tremendous number of gas molecules in the tube supply the secondary electrons when the initial electrons have acquired such velocities that they ionize the molecules of the gas, and these ionization electrons

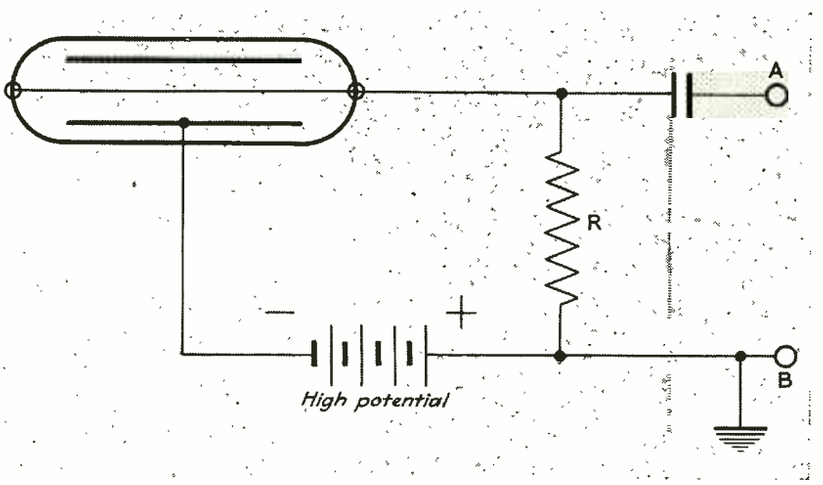


Fig. 1—Circuit of a Geiger Mueller tube. The voltage used is dependent upon the nature of the gas, the gas pressure and the geometry of the tube. A small counter tube like that at *A* in Fig. 4 contains a mixture of argon and oxygen (94 percent argon, 6 percent oxygen) at a total pressure of about 9 cm Hg, and has a Geiger threshold of about 800 volts. Other combinations have been employed, such as argon and ethyl-ether. Organic vapors, such as ethyl alcohol, are used in the "self-quenching" counters which seem destined to play an increasingly important role because of their clean cut mechanism

AN ELECTRONIC INSTRUMENT

By PAUL WEISZ,
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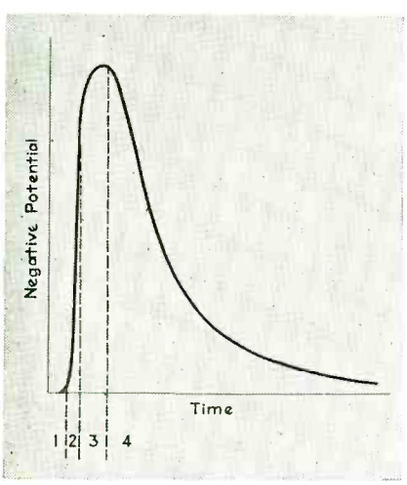
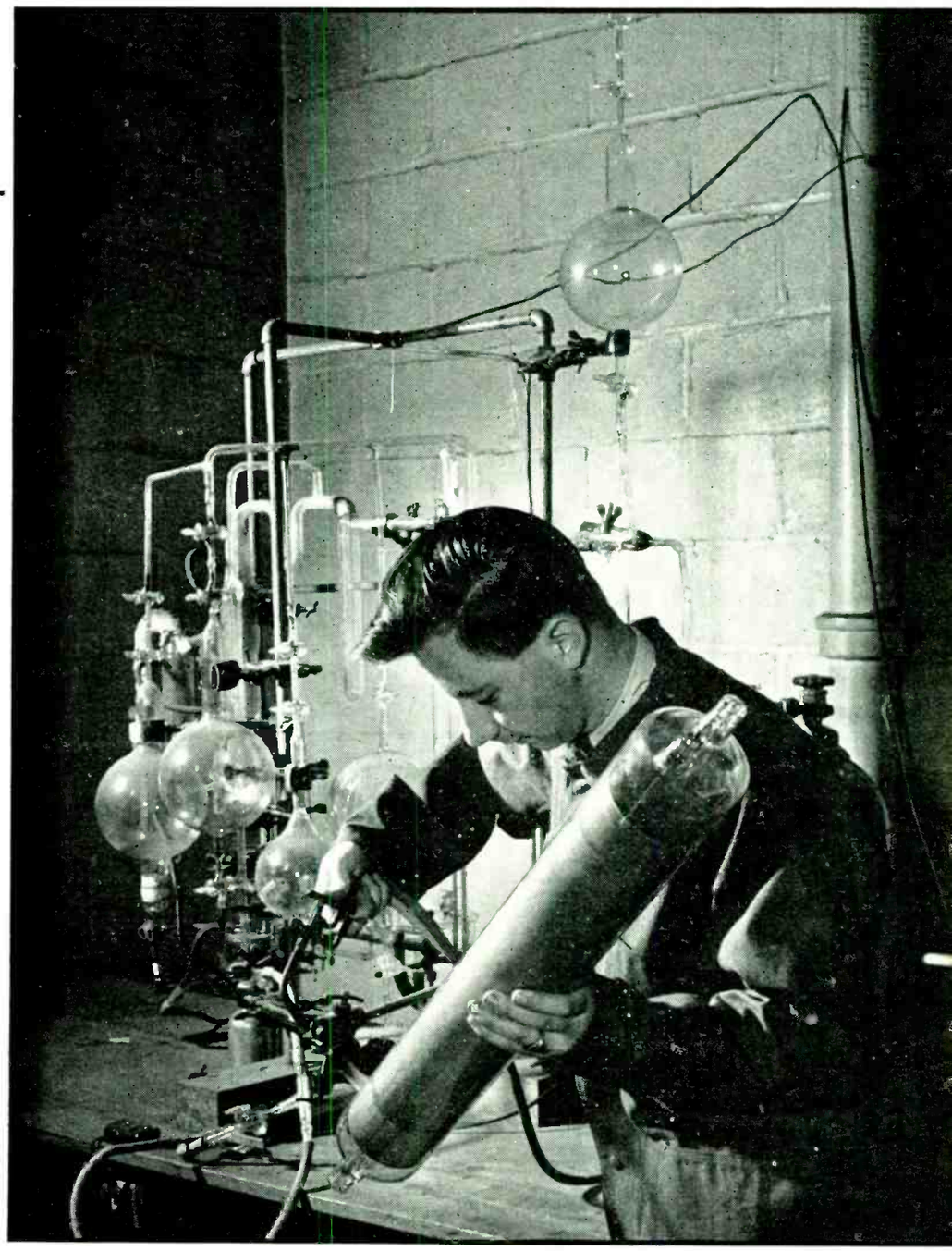
again join in on the action of further multiplication in the same manner, until a whole avalanche of electrons is formed which is attracted by the electrically positive wire and which will finally reach this electrode.

The electrical field conditions between the negative cylinder and positive wire are such that the main part of the multiplication process takes place in the immediate neighborhood (a few thousandths of an inch) of the wire.

Everywhere, however, where an electron is formed there is also a positively charged remainder of the molecule: the ion. These positive ions, which are attracted by the negative cylinder, are practically molecular in weight, and therefore travel very slowly compared with the velocity of the electrons. In fact, after all the electrons have reached the wire, the heavy ions have hardly moved away from their points of formation, that is from the vicinity of the wire, where they now form a sheath of positive space charge.

It is interesting that up to this instant, practically no potential variation has occurred on the wire, although the actual multiplication process, often called the "discharge," has taken place and has now definitely ended[1]. The positive





Mr. Weisz holding one of the larger counter tubes used by Drs. S. A. Korff and E. T. Clark for their measurements on neutrons in the cosmic radiation on Mount Evans, California in August 1941

Fig. 2 (Left)—Sketch of the shape of a pulse from a Geiger Mueller tube, during an entire process of operation

Region 1—The initial electrons have formed a whole electron avalanche which has reached the counter wire.

Region 2—The positive ion sheath moves out towards the cylinder, traversing a relatively small distance in the close neighborhood of the wire where the potential gradient is the greatest. Duration: A few microseconds.

Region 3—The positive ions travel the rest of the way to the cylinder and start to neutralize over the external leakage resistance R. Duration: a few tenths of a millisecond or less.

Region 4—The positive ions have all reached the cylinder and only the process of neutralization of the charges on cylinder and wire is going on, in the manner as any capacity represented by wire and cylinder would neutralize (discharge) its charges over a resistance R. Duration: Determined by R and the capacity of the system

ion charges have made the negative electron charges on the wire ineffective on account of their closeness to the oppositely charged electrons.

But the positive ions *are* moving out towards the negative cylinder, although much slower than the electrons have traveled, and thus during this motion, the negative charges on the wire become effective making the wire more negative. Due to the particular field distribution, this potential variation of the wire is greatest while the ions are moving out the very short distance through the immediate vicinity of the wire, and becomes less rapid while they travel the rest of the space to the cylinder.

When all ions have moved out and have reached the cylinder wall, the wire has acquired its maximum negative potential at which it would remain, had not a leakage resistance R (Fig. 1) been provided to carry away and neutralize the electrical charges at a rate determined by the rate of arrival of ions, the capacity of the wire system, and the dimensions of the leakage resistance, so that the potential difference between wire and cylinder will finally drop to its original value, in the manner of a small condenser discharging over a parallel leakage resistance according to the exponential law. Figure 2 shows the form of the entire potential variation, that is the shape of the counter pulse which we obtain at A-B as a result of an "event" in the counter tube.

This is the elementary discharge mechanism. It is not difficult to see that in this process, two initial electrons will at the end have produced twice as many electrons as a single initial electron, and, generally, the total charge produced, or the total pulse size, will be proportional to the number of electrons in the initial event which set off the counter mechanism.

The Additional Mechanism Above the Geiger Threshold

The counter tube may be operated in the described way as a proportional counter if the high potential applied to its electrodes has a value within a certain range of voltage indicated by "proportional counter action" in Fig. 3. This diagram also shows how the amplification factor, that is, the total multiplication, can be controlled within wide limits by means of the voltage applied. It also demonstrates that an amplification factor as high as several million can be obtained from the proportional counter.

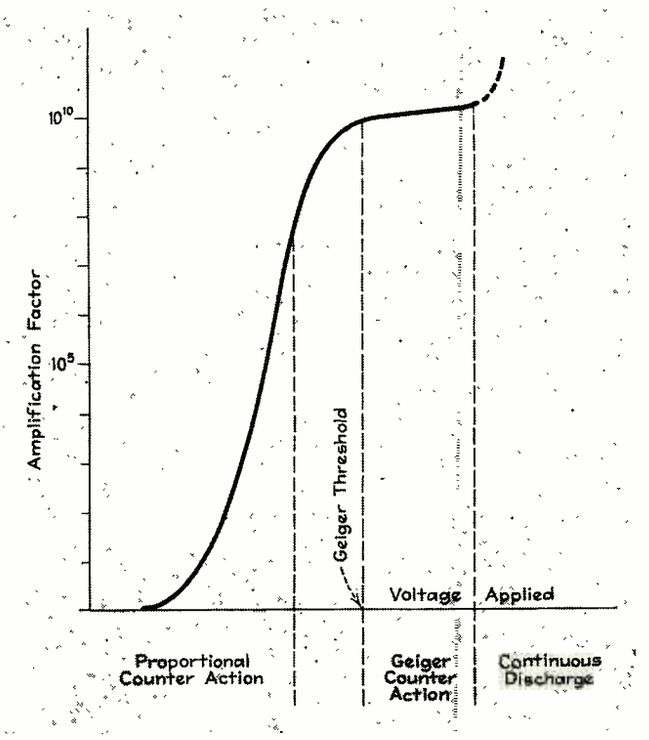


Fig. 3—The amplification factor of a Geiger Mueller tube at different voltages applied to its electrodes

If the potential applied to the tube electrodes is increased beyond the region indicated above, a new mechanism will set in, in addition to the elementary multiplication process, making it possible to obtain a total amplification up to some thousand millions (10^{10}).

This additional action in the tube is initiated by the same elementary process. However, the electrical field in the neighborhood of the wire is now not only sufficient to accelerate all electrons to energies enabling them to ionize molecules of the gas, but all electrons are now given such kinetic energies that they can produce excitation of the gas molecules followed by their emitting light quanta. These light quanta have a wavelength of the right dimensions to be qualified as ultraviolet light or soft x-rays, and as such will easily produce photo-electrons upon falling on other gas molecules, or on the surface of the cylinder if they are not absorbed before reaching it. These new photoelectrically produced secondary electrons also become parents of new multiplication electrons, and of new light quanta, which in turn produce photo-electrons again, and so on. Thus, these light quanta acting as carriers which travel with the velocity of light, finally spread the multiplication "disease" over the entire length of the tube.

This action would go on indefinitely. But again the positive ions, which are formed at the same tremendous rate as the electrons, play an important role. They, as a positive space charge sheath surrounding the wire, begin to screen the latter electrostatically more and more as their number increases, until the field in the region close to the wire is reduced so far that the electrons do not experience enough acceleration to produce quanta or even ionization secondaries. Then the discharge has ended, and now we obtain a voltage pulse produced by the migration of the great number of positive ions and the neutralization of charges over the external circuit in essentially the same manner as at the end of the elementary discharge process in the case of the proportional counter.

When the electrode potentials are increased beyond the region of proportional counter action (Fig. 3), the process of light quanta emission sets in, at first partially, and finally, at a voltage called the "Geiger threshold" the entire length of the counter becomes involved in the discharge mechanism. As this discharge mechanism is stopped only when the number of positive ions is such that the electric field at the wire is too weak to make quanta

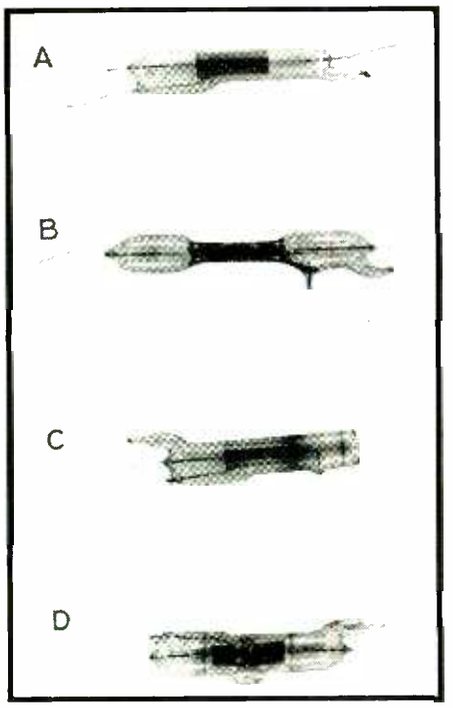


Fig. 4—Various types of Geiger Mueller tubes. Tubes designed by G. L. Locher and W. E. Ramsey

Fig. 5—Geiger Mueller tube with fluoride window for the measurement of very small light intensities in the ultraviolet. Tube designed by G. L. Locher

emission possible, and as this is some fixed number of ions, the final pulse size is now the same in every event, regardless of how many electrons initially set off the multiplication process. Therefore, there is no proportional counter action taking place, but at the expense of proportionality we have achieved a tremendous sensitivity and amplification factor.

It is understandable, of course, that the processes described would yield such extraordinarily great amplification above the Geiger threshold, for there the number of initial multiplication processes itself is quickly multiplied by the action of the light quanta.

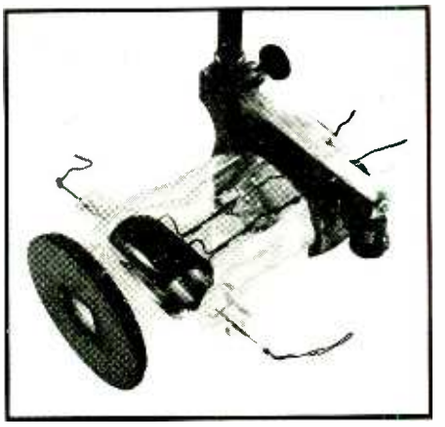
Types of Geiger Mueller Tubes

Efficiency considerations, the problems regarding penetrability of the various types of radiation, the different ways of formation of the first electrons, and background from undesired radiations, have lead to the development of various types of Geiger Mueller tubes for specific purposes.

The ordinary type of tube with metal cylinder and glass envelope (Fig. 4A) is most widely used in work with the γ-radiation from radium and other radioactive substances, with hard x-rays, and in cosmic-ray research, for these radiations are able to penetrate both the glass and the metal cylinder of the tube. Such tubes have been constructed to have cylinders less than one inch in length to as large as 25 by 3 inches and larger, as for instance for radioactivity measurements in oil bore-holes and the location of cement introduced into the bore-hole.

When soft x-rays or γ-radiation are dealt with which cannot penetrate the ordinary counter walls, the latter must either be constructed from material which the radiation can penetrate, or a window of such material must be provided where the rays can be shot into the tube.

In Fig. 4B, a tube is shown which



has no metal cylinder, but instead the cathode is formed by a thin layer of colloidal graphite painted on the inside surface of a glass tube which has been drawn out to have a thin wall.

The window type of counter is shown in Fig. 4C, and is particularly fit for work with α-rays and β-rays down to comparatively low energies. The window at one end of the tube is made by blowing a glass bubble onto the open end of the counter. Such glass windows have thicknesses down to as little as five ten-thousands inch. Such tubes may be used successfully in all applications employing weak radioactivity, in biological and biochemical tracer work.

Remembering that the formation of electrons by quantum radiation takes place through the photoelectric effect or Compton effect, the efficiency for the detection of soft x-rays, and for work with ultraviolet light can be greatly increased by allowing the radiation to fall on the metal cylinder wall inside the counter to produce photo-electrons there as well as in the relatively thin atmosphere of gas molecules. Thus, Fig. 4D shows a Gieger Mueller tube having a thin glass window at the side and a hole in the cylinder through which the radiation may fall on the opposite side of the interior counter cylinder wall.

By introduction of a photo-sensitive layer into a Geiger Mueller tube, it has also been possible to build extremely sensitive detectors for visible light, for instance for the measurement of the light intensity of stars. However, it is still difficult to build such tubes reliably, as it has been a delicate problem to compromise between the requirements for the proper working conditions as a counter tube, and at the same time maintaining the conditions necessary for the creation and preservation of photo-sensitive layers.

It is interesting that by means of a trick even neutrons, which since electrically neutral do neither ionize nor produce photo- or Compton electrons, have been made detectable by special Geiger Mueller tubes. Here, the fact that neutrons may enter nuclear processes with certain atoms resulting in the liberation of ionizing particles is utilized. For example, in a borontrifluoride gas atmosphere neutrons will interact with boron atoms leading to the ejection of α-particles which produce strong ionization. By filling Geiger Mueller tubes with this gas therefore, neutron intensities can be measured indirectly by measuring the number of counts resulting from α-particles produced in the tube by the neutrons.

Although this may sound as a fine laboratory experiment with little practical use, there really exist a number of applications of even the neutron counter, as the U.S. patent files reveal, where we find neutron sources and counters used in geological applications, and in industry employed for the testing of materials.

[1] We are here dealing with the simplest form of counter mechanism as it actually takes place in so-called "self-quenching counters."

A Versatile Oscilloscope

Flexible amplifier and sweep circuit arrangement for use with C-R tubes incorporates on a single panel, unity amplifier, provision for single sweep, spiral sweep arrangements, and a z-axis amplifier to modulate intensity of beam by varying bias on electro-optical tube

By W. E. GILSON

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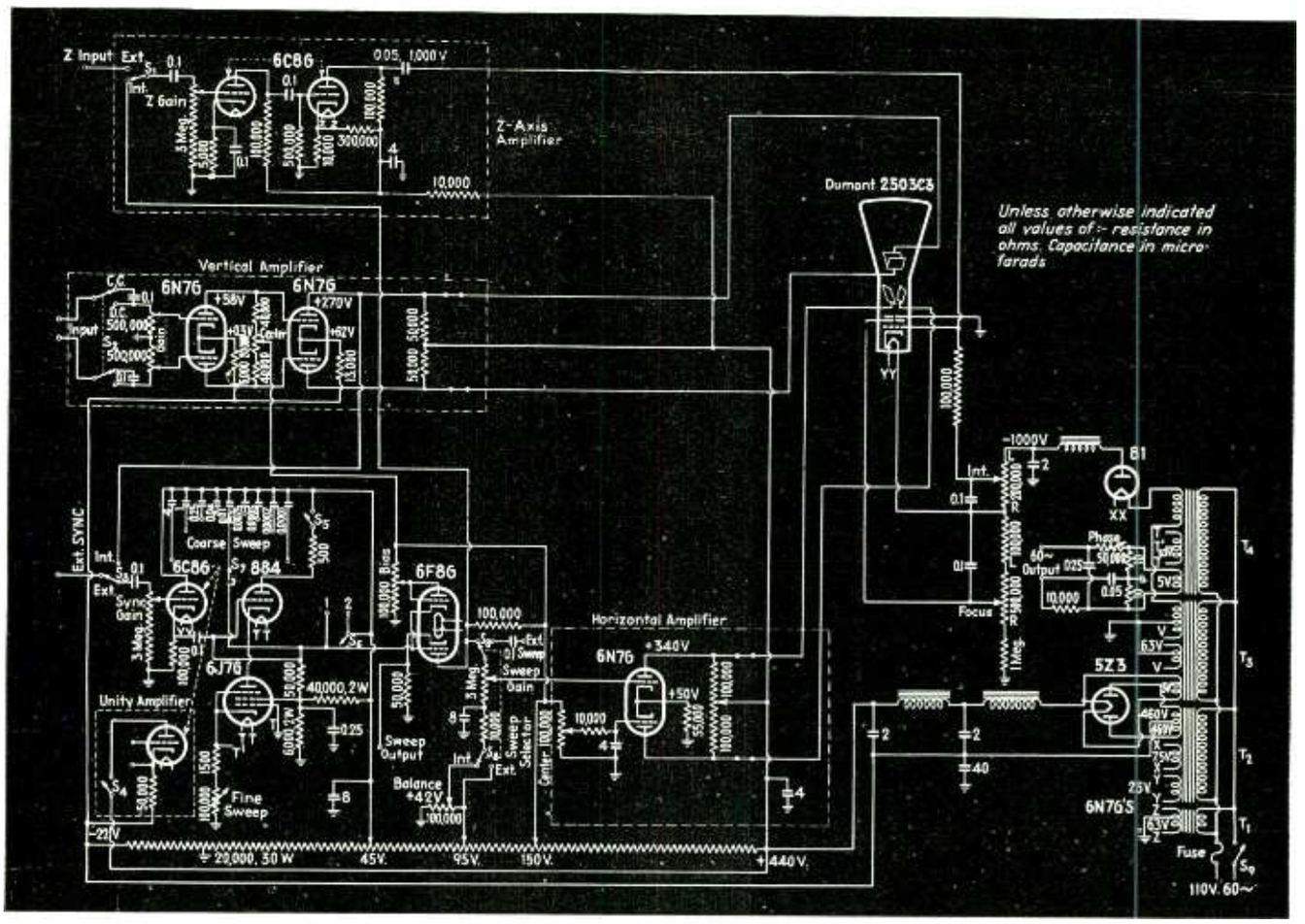
THE oscilloscope to be described was constructed because none of the commercial cathode-ray oscilloscopes included all of the features which seemed to be necessary or at least highly desirable, and in the past were found only in research equipment designed for special applications. The original features in the unit described here are the method of eliminating the influence of the amplitude control on the position of the spot in the direct coupled sweep circuit, and the inclusion of a unity amplifier for use in observing potential changes in circuits from which no current can be drawn without disturbing their operation.

As shown in Fig. 1, a direct coupled push-pull amplifier using two 6N7G tubes is used for the vertical deflection.[1] It has an amplification of 600, and is absolutely stable at full gain. The in-phase gain (the same signal applied to both grids) is extremely small, making it unusually free from 60 cycle per second pickup. Because of the inherent phase inverting characteristics of the circuit, the output is the same whether the signal is applied from grid to grid, or from one grid to ground.

As the circuit is push-pull there is no loss of amplification produced by the large cathode resistors, since there is no signal voltage across them. Another important advantage of the push-pull amplifier, besides its great stability to changes in plate and heater voltages, is its rela-

Fig. 1—Circuit diagram of oscilloscope and associated equipment. For simplicity in following some of the circuit details, the essential units are shown in dotted rectangles



tive indifference to a moderate amount of ripple in the plate supply voltage. This is of course applied to both plates equally, thus producing no deflection.

Provision is made for condenser coupling if desired by turning S_2. The two inputs are of value in observing the voltages between two points both of which are above ground, or as described later for mixing two signals.

The adjustment of the amplifier is very simple when carried out as follows: Variable 100,000-ohm resistors are placed in the cathode circuits of the tubes. The second 6N7G is removed. The centering control is adjusted to its midpoint by equalizing the plate voltages on the first 6N7G. The bias is adjusted by means of the 100,000-ohm variable cathode resistor until the voltage from the cathode to plate is slightly more than half of that from the cathode to the plate supply. The second 6N7G tube is now inserted and the same means used to adjust its bias. The variable cathode resistors are then replaced by equivalent fixed resistors, the values of which are determined by an ohmmeter or Wheatstone bridge. Almost any value of resistance may be obtained by proper selection from a group (a dozen or so) of commercial resistors which have a nominal value near to that desired.

The gain of the amplifier is very easily measured. One tenth volt input produces a plate-to-plate swing of 60 volts or more in the final stage, or a gain of 600.

The frequency response curve of the amplifier is illustrated in Fig. 3. No attempt has been made to compensate for the drop above 30 kc as such an extended response is not needed but if necessary compensation could be introduced without difficulty.

The vertical deflecting plates are connected to points on the rear terminal strip, so that direct connection may be made to them for radio frequency observations.

It has frequently been my experience that the use of an oscilloscope has been impossible in adjusting certain circuits, without disturbing their operation. For example, in a circuit just developed for delaying a single sweep from 0.1 to 5 seconds after a signal peak, and used in recording cardiac potentials, the connecting of a 500,000-ohm resistor from a certain condenser to ground changes circuit conditions considerably. For this reason it was considered desirable to include a unity amplifier for use in such circumstances and this may be connected in the circuit by closing S_1. A unity amplifier is one in which the load resistor is in the cathode circuit. It thus has extremely high inverse feedback, and the output at the cathode is in phase with the input and theoretically equal to it, but actually somewhat smaller. The cathode binding post is connected to one of the input binding posts, and the grid is connected to the point whose potential changes are to be observed.

The sweep circuit is direct coupled, making possible the use of sweep frequencies as low as desired. The longest travel time obtainable with the values shown is 9 seconds.

Assuming that the standard sweep generator[2], consisting of the 884 and 6J7G, is operating satisfactorily, the 6N7G feeding the horizontal deflecting plates is removed, the 100,000-ohm bias control is turned to its most negative point, and the sweep selector switch, S_3, is turned to internal sweep. The voltage at the plate of the 6F8G is measured at the end of the return trace, using the slowest sweep. The 100,000-ohm balance potentiometer, located under the chassis, is set to the same voltage. At this point there is no voltage across the sweep gain control, and changing the amplitude has no effect on the starting point of the sweep.

A 100,000-ohm variable resistor is placed in the cathode circuit of the 6N7G, the tube is inserted, and

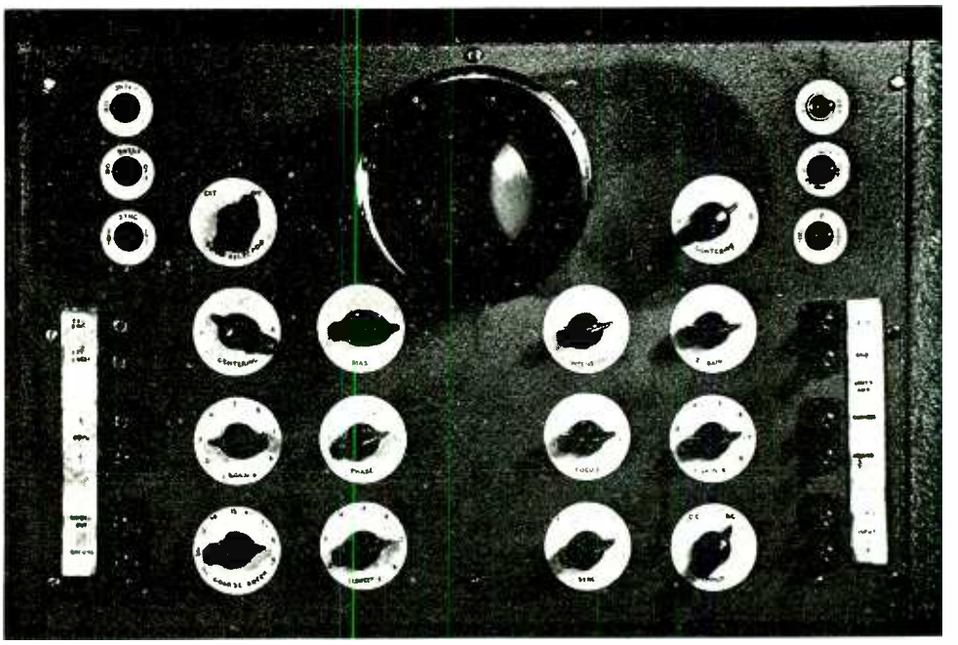


Fig. 2—Photograph of control panel of oscilloscope

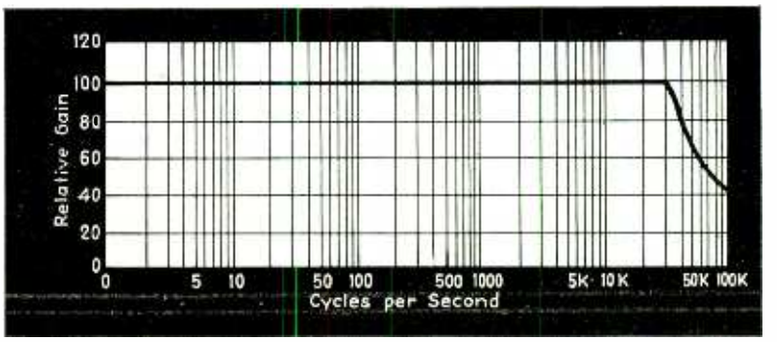


Fig. 3—Frequency response curve of direct-coupled amplifier

the bias adjusted so that the largest possible linear sweep is produced. The linearity is best judged by observing the shape of the sweep with another oscilloscope, but a fairly good idea of the linearity may be obtained by producing a sinusoidal vertical deflection and observing the evenness of spacing of the peaks. The variable resistor is replaced as described for the vertical amplifier. The linear output is more than sufficient to cover the screen.

The horizontal deflecting plates are connected to points on the rear terminal strip, so that direct connection may be made to them.

The sweep may be synchronized with a regularly recurrent signal by means of the synchronizing input. This is coupled through a unity amplifier, using a 6C8G, to the grid of the 884 gas tube, causing the latter to fire at a somewhat lower plate voltage than ordinarily and tending to synchronize the breakdown with the positive peaks of the signal. The synchronizing voltage may be obtained from a plate of the vertical deflection amplifier or from an external source by turning S_3.

The bias control of the 6F8G is used to produce a single sweep. The cathode of the diode to which the bias control is connected goes negative as the sweep condenser charges. If the bias control is set to a point more negative than the peak of the sweep, the diode has no effect. When the bias control is set to a point slightly more positive than the peak of the sweep, the cathode of the diode becomes slightly negative with respect to the plate, and the diode draws current preventing further charging of the condenser. The 884 gas tube will not break down unless its grid bias is reduced by a positive pulse applied through the synchronizing amplifier, which produces a single sweep. This pulse may be initiated by a signal peak, or by applying an impulse from a transient producing device a few milli-seconds before the transient is produced.

A single sweep may be produced manually by opening S_5, and then closing and opening S_6. This sweep occurs without time delay, as the condenser starts charging immediately. Points 1 and 2 are connections on the rear terminal strip, and may be connected to points on the transient producing device which are in contact until the transient is generated.

The external side of the sweep selector switch, S_8, is connected to such a point on the bleeder that the spot is near the center of the screen, when the sweep selector switch is turned to external sweep.

A 60 cycle per second output is provided from transformer T_4, two voltages to ground being available. The phase of one of them is variable. By connecting one of the outputs to the external sweep input a 60 cycle per second sweep is produced. This is useful for producing the familiar Lissajous figures. A somewhat less familiar figure, as useful as the cogwheel pattern obtained by modulation of the second anode voltage but more easily obtained, is the circular sweep. This is produced by connecting the other output post to one of the d-c amplifier grids and adjusting the relative amplitudes and phase until a circular sweep is produced. This separates the front and back halves of the Lissajous figure, as shown by a comparison of Figs. 4C and 4D. This is very useful for frequency determinations.

A spiral sweep is produced by superimposing a linear motion on the circular sweep. This is done by connecting the sweep output to one of the inputs of the d-c amplifier with the signal source, and leaving the connections otherwise as for a circular sweep.[4] This is shown in Fig. 4E.

The Z-axis amplifier is used to modulate the intensity of the beam by varying the grid voltage, producing dark areas in the trace on the negative peaks. This may be used to eliminate the return trace on the linear sweep, or to mark the circular sweep, Fig. 4F, or to produce timing marks on a signal with a linear sweep, Fig. 4G. Accurate timing is thus possible on a photograph of a single sweep.

Placement of parts is not critical, except that it is advisable to keep the transformers as far from the cathode ray tube as possible. It was found necessary to encase the tube in a 9-inch nipple of 3-inch iron pipe, as sufficient spacing was not possible on the chassis used.

It is recommended that anyone constructing an oscilloscope of this type use a 550-volt power supply, as this makes the adjustment of the various supply voltages even simpler.

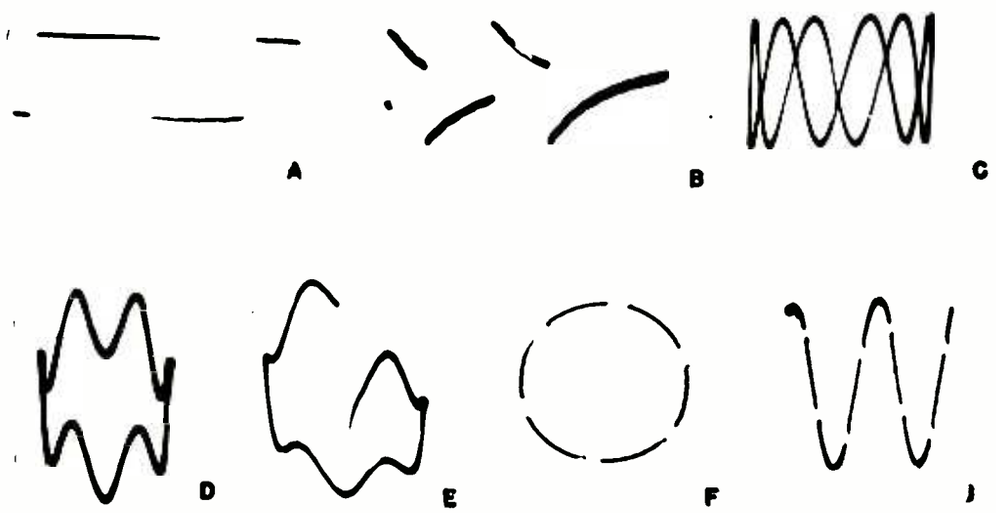


Fig. 4—Typical records obtained with the oscilloscope.
A. Square wave input, direct coupling
B. Square wave, condenser coupling
C. Lissajous figures, with 60 cps applied to horizontal plates and 360 cps applied to vertical deflecting plates
D. Circular trace of Lissajous figures shown at C, but with fore and aft separation
E. Spiral trace with 360 cps signal
F. Circular trace with 360 cycle intensity modulation which blanks out portion of the circumference
G. Linear sweep of 60 cps signal with 360 cps intensity modulation

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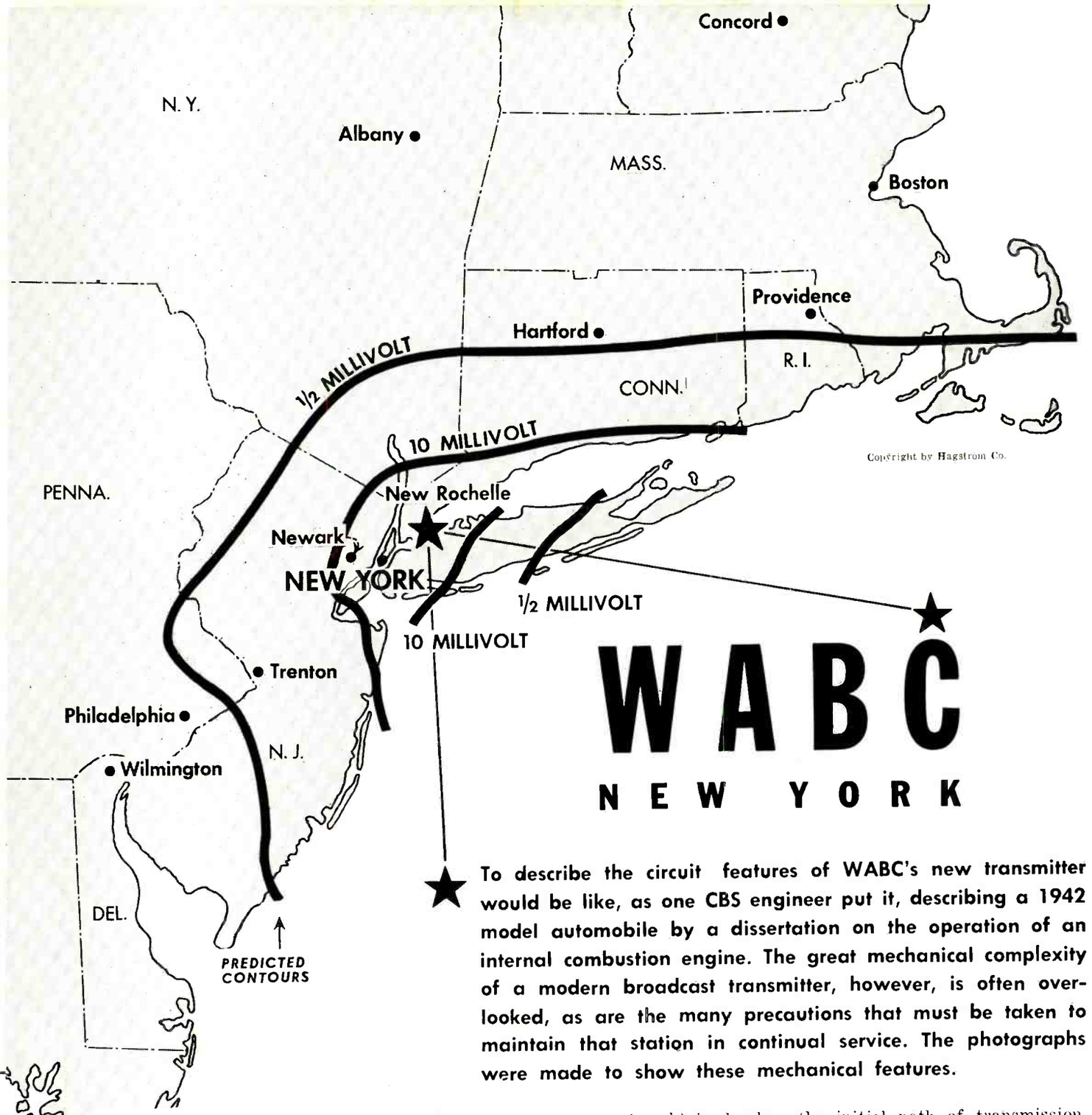
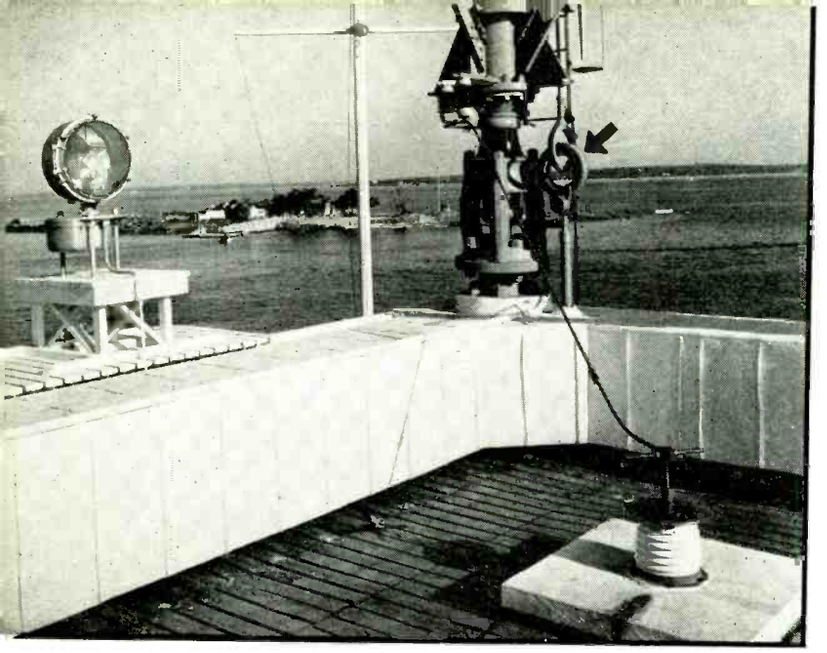


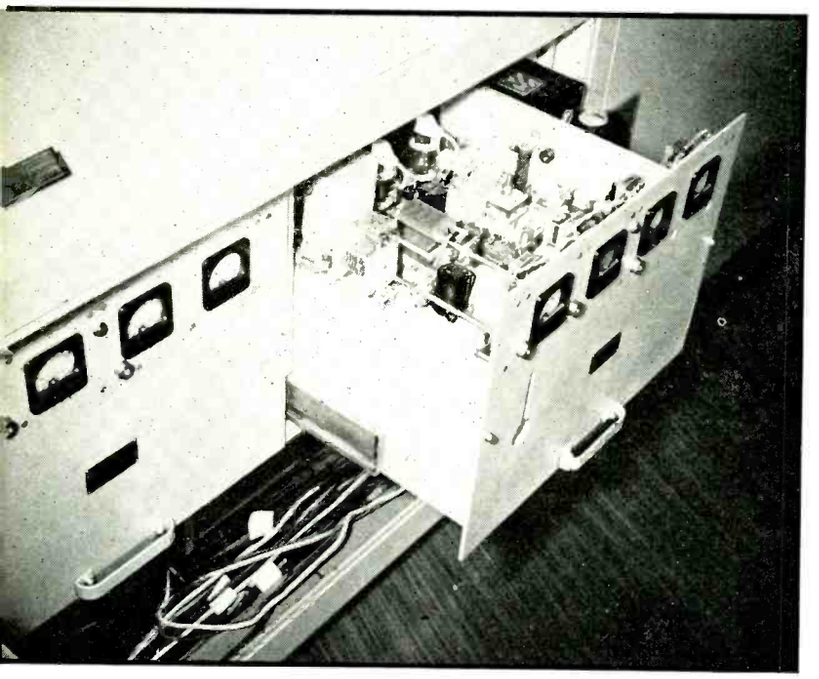
To describe the circuit features of WABC's new transmitter would be like, as one CBS engineer put it, describing a 1942 model automobile by a dissertation on the operation of an internal combustion engine. The great mechanical complexity of a modern broadcast transmitter, however, is often overlooked, as are the many precautions that must be taken to maintain that station in continual service. The photographs were made to show these mechanical features.

TO PARAPHRASE the famous formula for military success, the engineers of the Columbia Broadcasting System figured that they could capture a large portion of the large New York market by getting their programs into that area "loudest-est and best-est." The problem was doubly difficult because of the large area to be covered with primary service and the highly competitive situation among the local broadcast stations. The solution necessitated the construction of a new transmitter for WABC at a location from where the radiated signal would blanket the highly populated areas so strongly that good reception could be obtained with all but the poorest receivers, and in all locations but those having very bad local noise conditions. In this respect, from CBS's viewpoint, it was necessary to equal or beat the performance of competing stations.

Using the concept that the best transmission can be obtained when the initial path of transmission, that is, the first few miles from the transmitter, is over a ground material of high conductivity, CBS cast about for a small island surrounded by sea water, which has greater conductivity than any other ground material. A group of rocks in Long Island Sound projecting slightly above the water was selected as the site for the new transmitter. It was necessary to build a seawall 18 feet high and fill in an area 150 feet square. Because of the extremely small area available for construction the transmitter building and the antenna had to be constructed at the same spot. Externally, it appears that the tower is built atop the transmitter house, but actually the two are completely separate structures. The tower rests upon four concrete blocks which go down to bedrock. The lower portion of the tower consists of four concrete posts which pass through the building without coming in contact

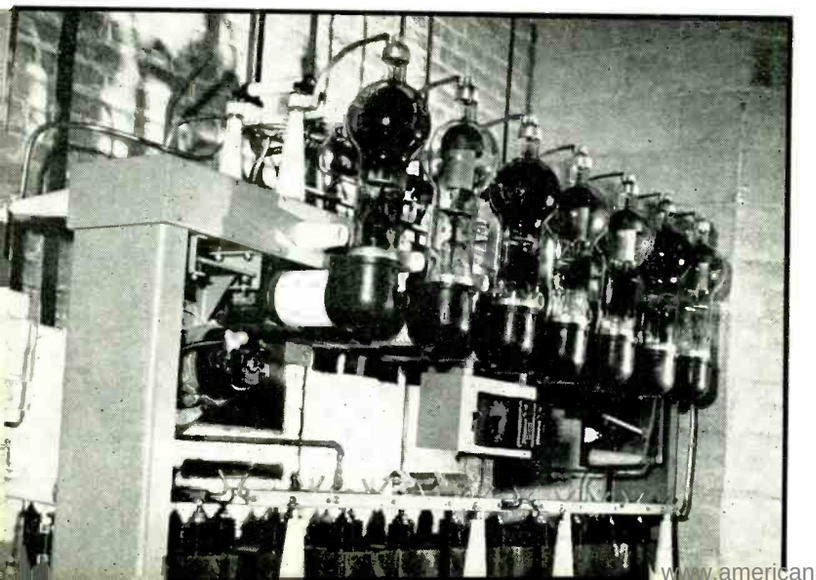


A corner of the antenna tower showing the antenna lead (right foreground), the ceramic insulator, the toroidal transformer (arrow) supplying the tower lights, and the photoelectrically controlled beacon



Crystal controlled oscillators which generate the 880-kc carrier. A spare oscillator is provided in the main and auxiliary transmitters

High voltage d-c power for the transmitter tube plates is supplied by this three-phase full-wave rectifier. Six F-357 tubes supply 12 amps at 12,000 volts. The seventh rectifier tube is ready for emergency use



with any part of it, although rubber baffles are used to keep rain and snow out.

The station itself consists of two complete transmitters, the main unit having a power rating of 50 kilowatts and an auxiliary unit rated at 5 kilowatts. Should anything happen to the 50-kw transmitter, the 5-kw unit could be put into emergency service immediately. In addition, the 5-kw unit can be used to drive the final stage of the 50-kw unit to further insure continuous operation at high level if trouble occurs in the low level stages of the main transmitter.

The observer is struck with the double keynote in the design of the new WABC. The first is the convenience of operation and maintenance of the transmitter and the other is the great precautions which have been taken to be sure that service can be continued regardless of almost any type of emergency. The program from the studio reaches the island by two different land and underwater routes. If these should fail, there is an f-m studio-transmitter link operating on 335 Mc. The f-m receiving antenna is located atop the tower and the signal is brought to ground potential by a quarter-wave transmission line in the basement of the building. Electric power is brought to the island by two cables coming out from the mainland over different paths. If both of these fail the station can be operated from a 94-kva generator driven by a gasoline engine. The duration of operation with the motor generator is limited only by the supply of gasoline and oil. The transmitter itself can be operated under several sets of conditions. All of the low-level equipment is duplicated so that in the case of failure of any one unit, the spare can be placed in operation without delay. If both units of the same stage fail, the 5-kw transmitter can be used in place of all the low level stages of the main transmitter. If the power output amplifier stage should fail, the station can remain on the air with reduced power using the smaller transmitter. Provisions have been made so that even if the tower should fall over, the station can continue to operate, with reduced power of course, by stringing up an emergency antenna on the four nautical looking flagpoles at the corners of the island.

The new station differs most from other broadcast stations, speaking of the transmitter itself, in that circuit elements are placed at the most favorable positions in the circuit and the controls are placed in the normal positions on the front panel. There are a large number of shafts with universal joints and gears connecting components with the controls. This method has the advantage of providing very short leads where they are necessary because the location of the coil or condenser is in no way dependent upon the position of the knob controlling it. Ingenuity in the mechanical design of the station has attained considerable flexibility in the electrical design with certainly no loss and probably with an increase in operating efficiency.

The Transmitter

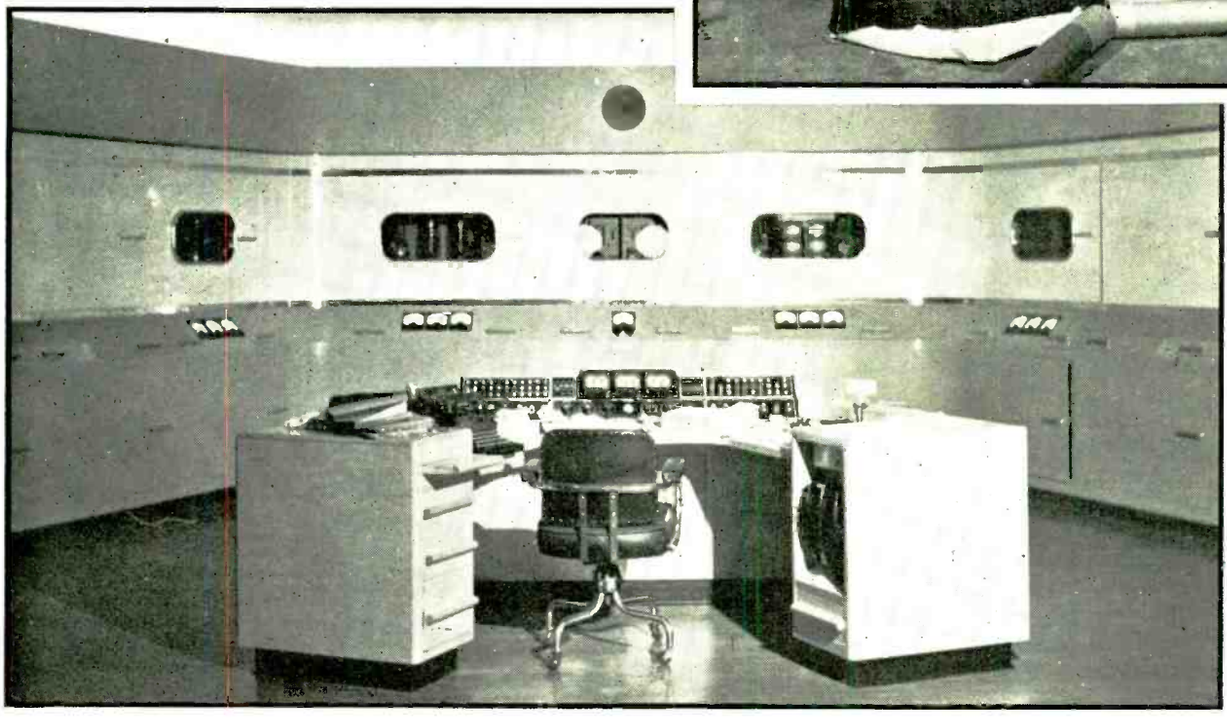
The transmitting equipment for the new station was manufactured by the Federal Telegraph Co., a subsidiary of the International Telephone and Telegraph Corp., according to specifications drawn up by

the engineering department of CBS. Two completely independent transmitters were built. The main transmitter is capable of delivering 50 kw at 100 percent modulation and the auxiliary transmitter will radiate 5 kw. Both transmitters use high level modulation, and for maximum flexibility the 5-kw unit uses air-cooled tubes to insure continued operation if the water cooling system should fail. Two type 124-A water-cooled tubes are used in the final r-f stage and two type 125-A water-cooled tubes are used in the high level modulator of the main transmitter. The two 124-A tubes have an anode dissipation rating of 40 kw each. They are capable of providing a 50-kw carrier signal and at 100 percent modulation they will deliver the necessary peak power of 200 kw. The filaments of all tubes in the station are operated on alternating current to avoid the added complication of providing rotating machinery for d-c power. The 5-kw unit uses two type 892-R air-cooled tubes in the final r-f stage and two 891-R air-cooled tubes in the modulator.

The Antenna System

The steel antenna tower rises 410 feet above sea level and is designed to remain upright in wind velocities up to 125 miles per hour, which is considerably

(Right) Circuit diagram of the complete broadcast station. The complexity of the main and auxiliary transmitters with the switching for emergency operation is indicated by the size of the blueprint



The control room is laid out for maximum convenience of operation. The meters on the main panels are large enough to be read from the desk. The main transmitter is behind the center panels and the adjoining panel at the left

greater than has ever been experienced in this area.

As is usual with broadcast antennas, the height is severely limited by the demands of safety for aircraft. Fortunately, the effective height of an antenna can be increased by a considerable amount by the use of top loading. Top loading consists of introducing near the top of the antenna a positive reactance which increases the current radiated from that portion of the antenna. By inserting various amounts of positive reactance in the antenna the radiation characteristic can be varied over a considerable range. There are various methods of inserting the reactance. The usual method is to place an inductance at the top of the antenna, but in this case it would involve a large mass high on the tower creating an undesirable wind load. Instead, top loading is ob-

tained by the transmission line method. A ⅞-inch copper pipe is hung parallel to and about a foot away from one of the four sections of the tower. At a distance from the top the pipe is shorted to the tower by a metallic connection. The top of the tower proper terminates at insulators on top of which is placed the "top hat," or upper portion of the radiator. The upper end of the ⅞-inch copper pipe is connected to the top hat to complete the antenna system.

The top loading system used operates as a quarter-wave transmission line which is shorted at some point. If it is shorted at one end it naturally presents a zero impedance looking into that end, and if shorted at the far end, it presents an infinite impedance, or an open circuit, looking into it as before. Any desired value of impedance can be obtained by shorting the transmission line at the proper point along its length. The value of positive reactance required to give the antenna system the desired characteristics was determined and from this was determined the proper point at which to short the ⅞-inch pipe part of the transmission line to the tower as explained above.

A dummy antenna of unusual design is provided to carry the load of a transmitter when it is not desired to radiate power. Either the 50-kw or the 5-kw transmitter may be connected to the dummy antenna for testing at any time. The conventionally designed dummy antenna is air cooled and requires considerable space to dissipate the heat generated. However, the unit at WABC is water cooled with a consequent great saving in space. It is contained in a cabinet about one foot square and about three feet high.

Emergency F-M Studio-Transmitter Program Link

An f-m radio studio-transmitter program link is in readiness for operation in case both land lines are forced out of service for any reason. The top of the studio building at 485 Madison Ave., New York City and the top of the antenna tower are within line of sight of each other and therefore the antennas for this service are mounted atop these structures. The lead-in of the receiving antenna is carried down from the top of the tower through the ⅞-inch copper pipe which is also used for top loading. This coaxial line is at high r-f potential and is not suited for connection to a radio receiver until the potential is brought down to almost ground potential. This is done by carrying the line through another copper pipe to form a quarter-wave co-coaxial line one end of which is at high r-f potential and the other at ground potential.

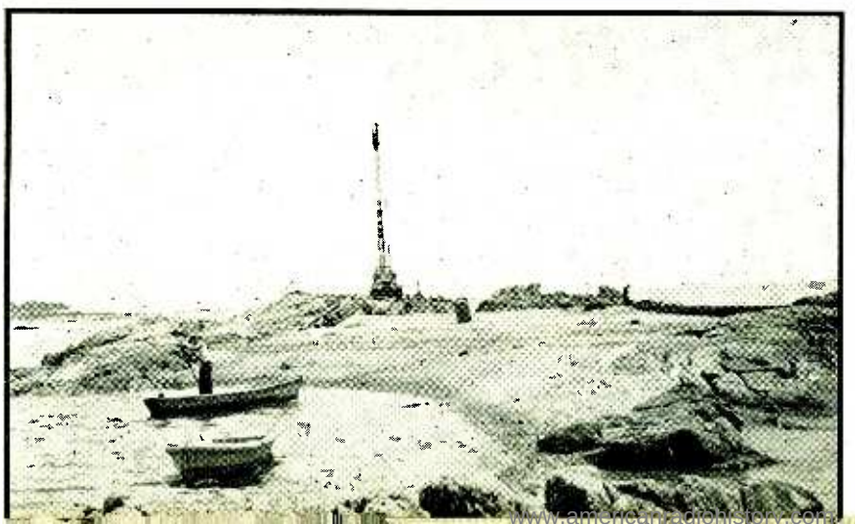
The ground system consists of a number of heavy copper cables which extend into the water far enough that the ends rest on the bottom six feet below mean low water. These cables are securely fastened to a sturdy bus which surrounds the sea wall at its base. At several points the bus is brought through the wall for connection to the transmitters and to the copper shielding of the transmitter building. The building is completely covered with copper sheeting except for door and window openings. This provides an exceptionally fine grounding system.

Duplication of Equipment and Switching Facilities

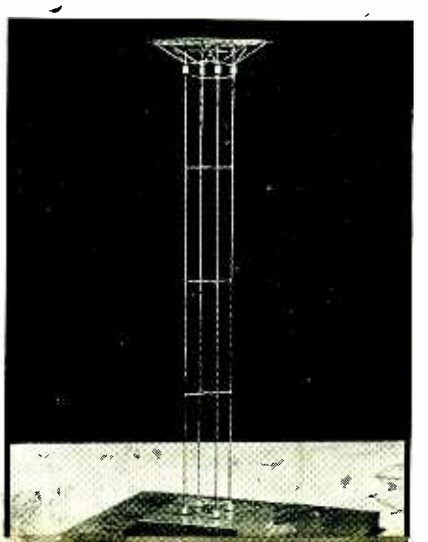
Each electrical circuit essential to the operation of the station is duplicated in some manner. First, there are three different program paths from the studio. There are two audio amplifiers for each transmitter up to the input of the modulator driver stages. Switching from one audio line to another, within a single transmitter, is accomplished by the push of a button. The crystal-controlled oscillator of each transmitter has a spare ready for service at all times except when it is out for inspection or repairs. The r-f amplifiers up to the input of the drivers for the final stages of both transmitters are duplicated and may be instantly replaced. In the rare case that all of the low-level equipment of the main transmitter should be out of service, the output stage of the auxiliary unit may be made to drive the final stage of the 50-kw unit. If the 50-kw final stage should go bad, the station can continue in operation with the 5-kw transmitter. In other words, every effort has been made to guard against failure of the station due to any set of conditions which can be foreseen.

The final precautionary touch of this island broadcasting station is that in case it is cut off from the mainland because of extremely severe weather conditions or for any other reason, complete living facilities are provided for at least six men. There are three bedrooms equipped with double deck beds as well as a complete equipment kitchen, dining room, and lounge. Men could live here for an indefinite period of time provided one of them has, in addition to his knowledge of how electrons chase each other around, a little down to earth acquaintance with the art of cookery.—C.W.

Appearance of the island as construction of the new transmitter was getting under way. It was almost entirely covered with water at high tide



This model was used in early tests to determine the proper antenna design



Report on 1941 Rochester Fall Meeting

Design and production of radio equipment for national defense absorb interest of engineers at 1941 IRE-RMA Rochester Fall Meeting. Topics discussed include improvements in bass output, skin effect, electron microscope, signal generators and receiver production

MORE than 500 radio engineers from the north-east quarter of the country with a representative or two from the west coast gathered in Rochester on November 10–12 inclusive for the thirteenth Rochester Fall Meeting of the IRE and RMA. That the meeting would live up to past performance was assured as the first flurries of snow of the year greeted out of town conventionites as they left their Pullmans early on Monday morning to descend upon the desk clerk at the Sagamore Hotel.

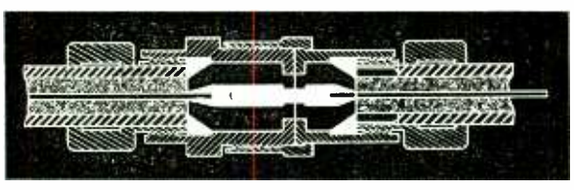
Seventeen technical papers were presented, twenty-five RMA committee meetings were held, and thirty exhibitors showed their newest products to the 520 engineers who gathered, while two additional firms were represented without exhibits. Emphasis this year centered around problems of the industry, especially as these are influenced by demands of national defense, and there was less emphasis on sales largely because production and lack of raw materials was the bottleneck this year in contrast with activities of preceeding years.

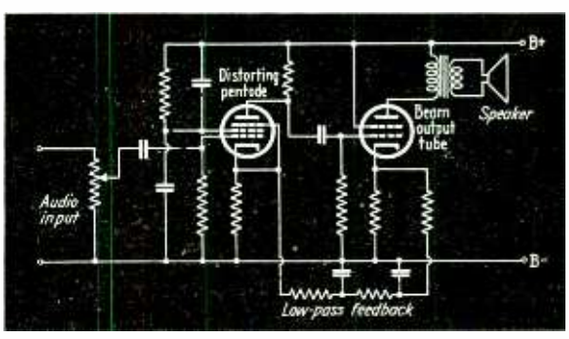
As usual, group lunches in the hotel were planned to keep the engineers together. For those who remained until the end or could not make train connections before late Wednesday evening, provision was made to attend a broadcast show, after which Mr. Ter Louw of the Eastman Kodak Company presented an interesting talk on "New Things in Photography". Among other matters pointed out was the need for technical men in the photographic field, men who know industrial applications of photography and engineering rather than portraiture and commercial photography.

The technical program was opened by Harner Selvage, consultant to the American Phenolic Corporation, who described recently developed flexible dielectric materials for coaxial cable in a talk, solid dielectric in coaxial cables. The new materials, which go by the names of Copolene S and Copolene B, are copolymers of polystyrene and polybutene respectively. The dielectric constants are 2.8 and 2.6; the power factors at 1 Mc are 0.001 and 0.0006 for Copolene S and Copolene B respectively. The latter material compares favorably with ordinary polystyrene (power factor of 0.0002 at 1 Mc.) Copolene B is the more flexible of the two and retains its flexibility down to low temperatures. Neither material can absorb water. Professor Selvage outlined the methods of measuring the characteristics of coaxial cable and described a connector which maintains a constant impedance between cables and hence minimizes reflections and losses. The flexible cables are particularly suited to aircraft installations, where vibration and bending may break the inner conductor of the beaded type of cable. The extremes of temperature encountered in aircraft applications also cause the beaded cable to collect moisture, whereas the filled cable is so constructed that moisture is completely excluded.

Speaking on the subject of synthetic bass in small receivers Frank Shepard, Jr. of the Revelation Patents Holding Corporation demonstrated a system of artificially enhancing the bass output of small receivers by introducing distortion in the low frequency region. Mr. Shepard described the input-output characteristics of the human ear, and showed that its electro-mechanical system inherently introduces a high degree of harmonic distortion, which is particularly pronounced at the

Constant impedance connector, below, for joining two ends of coaxial cable having solid dielectric. At right is shown a circuit for increasing the apparent bass output of small radio receivers





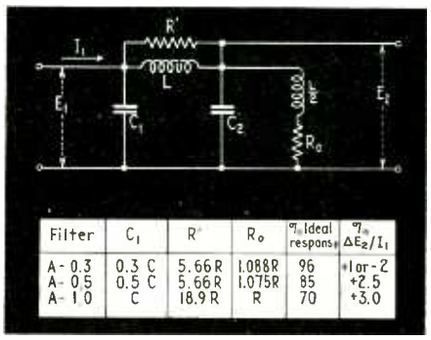
lower frequencies. Thus, if only the harmonics of a low-frequency tone are present, the fundamental being surpressed for example by the limitations of a small loudspeaker, the ear has most of the information which would be present if the fundamental were not surpressed. If the harmonics are emphasized, the apparent depth of the tone increases.

In practice a pentode tube is used to introduce the distortion. Regeneration between plate and grid is introduced through a filter circuit which limits the regeneration to the low frequencies, with corresponding high harmonic distortion in this range. The effect was demonstrated on several small receivers, using a beat-frequency oscillator and a phonograph record as sound sources. A marked increase in apparent bass output was apparent. In the discussion it was pointed out that the truly faithful reproduction is not obtained, since the ear introduces further distortion to the distorted output, but the net effect is nevertheless more pleasing when a small loudspeaker must be employed for reasons of economy.

Radio Engineering Economics

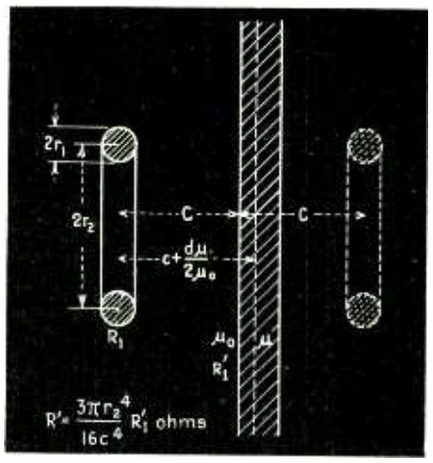
A departure from the usual run of papers was presented by E. L. Hulse, a member of the accountancy staff of the General Electric Company who spoke on "Some Aspects of Radio Engineering Economics". The talk was a lively commentary on the relationship of the sales department to the engineering department. The necessity of measuring engineering performance was illustrated, Mr. Hulse said, by the need of a device, which, if placed at the head of an engineer sitting with his feet on the desk, would reveal whether or not he was awake. Mr. Hulse pointed out that restrictions on materials would force a lot of the hokum out of engineering by making it essential to remove oversize components and unnecessary tubes which had been added at the insistence of the sales department. In the discussion H. A. Wheeler proposed that the IRE return the compliment conferred by this talk by sending a speaker to the next meeting of the American Society of Accountants.

Otto Schade and H. De Ryder of the RCA Manufacturing Company at Harrison described a high-performance video signal generator used



Filter	C_1	R'	R_o	% Ideal response	% $\Delta E_2/I_1$
A-0.3	0.3 C	5.66 R	1.088 R	96	+1 or -2
A-0.5	0.5 C	5.66 R	1.075 R	85	+2.5
A-1.0	C	18.9 R	R	70	+3.0

Design constants of video coupling network used in wideband circuits, as given by Otto Schade and H. De Ryder



Formula for r-f resistance of a ring near a shielding wall with diagram illustrating the conditions for which equation applies

in the testing of cathode-ray picture tubes. Since the video signal has to have considerably higher detail than the limiting resolution of the best picture tube to be tested, a video band from 20 cps to 10 Mc was chosen in the design. The signal source is a monoscope (static-picture) tube, which feeds into a high gain preamplifier with degraded high frequency response. The high frequencies are restored in a later stage, thus obtaining flat response with a minimum noise level. Several forms of circuits suitable for restoring the high frequencies were described. One circuit, employing a large cathode resistor and by-pass capacitor, produced a gain of 18 times, while delivering a uniform signal up to the 10 Mc limit. Several forms of coupling connection were described to obtain high gain over this wide range. The authors pointed out that a high degree of overshoot in reproducing a transient signal was occasioned by the use of a sharp cut-off filter, but that the use of a tuned circuit in the cathode of one of the stages could reduce this effect. Slides showing test chart images reproduced on this equipment were remarkable for their detail and absence of phase distortion. The equipment produces the necessary synchronizing and blanking pulses for testing picture tubes, although these pulses are not identical with the NTSC standards since it is not necessary to reproduce commercial-broadcast conditions in the circuits.

Skin Effect Simplified

H. A. Wheeler of the Hazeltine Service Corporation maintained his reputation for presenting valuable simplifications of difficult subjects in his paper "The Skin Effect and the Depth of Penetration". The accompanying chart shows the results in readily usable form. The depth of penetration D is the thickness of the layer at the surface of a conductor through which substantially all of the current passes. This quantity, once determined for the frequency and the conductor material, is the basis of the following rule: In shielding, attenuation of undesirable fields is increased as the depth of the layer of conductor is increased, until an attenuation of 8.7 db is obtained for a conducting layer equal to the depth of penetration. The other quantity shown on the chart is the surface resistivity R_1, which permits determining the a-c resistance of a conductor at any frequency. The a-c resistance is equal to the surface resistivity R_1 times the ratio of the length to the circumference of the conductor.

Mr. Wheeler also derived equations for the a-c resistance of parallel wire transmission lines. This resistance is given by

$$R = \frac{l R_1}{a\pi \sqrt{1 - (a/b)^2}}$$

where l is the length of the line, R_1 the surface resistivity of the conductor at the frequency of operation (taken from the chart), a is the radius of each conductor and b is one half the distance between the centers of the conductors, (a, b, and l in the same units).

Based on the equation above, as well as other formulas given at his talk, Mr. Wheeler stated his "incremental inductance rule" which is used for determining not only the effective resistance of a circuit, but also the added resistance caused by

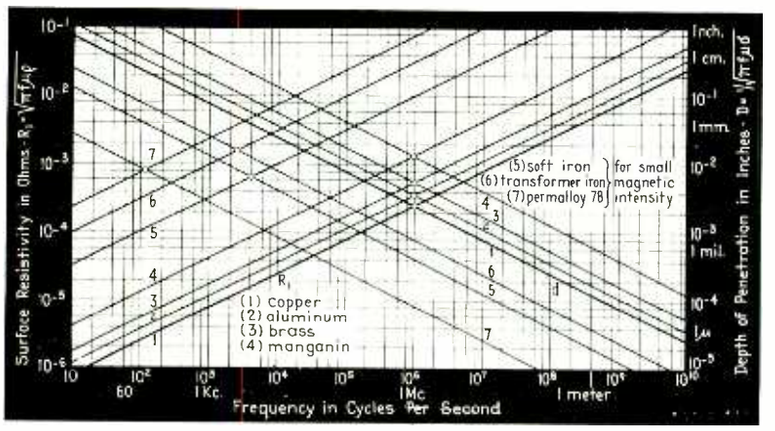
conductors in the neighborhood of the circuit. The inductance of the circuit is determined, from which the increase in resistance can then be calculated.

Super-Voltage Electron Microscope

One of the most interesting presentations at the Convention was that given by V. K. Zworykin, J. Hillier, and A. W. Vance of the RCA Manufacturing Company, Camden and entitled "A 300-Kilovolt Electron Microscope". The paper was delivered to a capacity audience by Mr. Hillier at the evening session. The earlier 60-kilovolt microscope, which had been described before the IRE in June 1940, was briefly reviewed. The reason for going to higher voltage was not to secure an increase in useful magnification, but rather to permit the examination of thicker specimens. The lower voltage model could not penetrate even thin layers of histological specimens, and its use was therefore limited to materials which could be applied in very thin layers to the collodion support. With the higher voltage however, specimens prepared for an optical microscope can be viewed in the electron microscope. The increased voltage causes the electrons to take straighter paths as they pass through the specimen, so higher fields in the magnetic lens system are required to restore the magnification as the voltage is increased. The highest useful magnification at present, beyond which no new detail is revealed, lies between 60,000 and 100,000 times. However, the total magnification from specimen to its projection on the screen before the audience ran as high as 4,000,000 times.

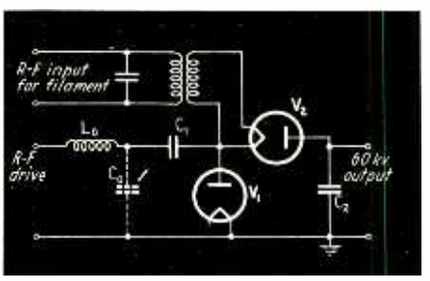
The problem of producing 300,000 volts for accelerating the electrons with sufficient stability to prevent defocusing was reviewed. A totally new design of the electron gun was necessary before the full voltage could be applied in damp weather. Also protection against the high voltage x-rays produced by the impact of the high speed electrons on the photographic plate was found to be essential. A large number of slides were shown to compare the detail available on a given specimen with the best optical microscope and that obtainable in the high voltage electron microscope.

The annual report of the RMA Director of Engineering was delivered by Dr. W. R. G. Baker who occupies that office. A review was given of the activities of the National Television Systems Committee which resulted in the adoption by the FCC of television operation standards and the consequent commercial operation of television stations. It was estimated that an expenditure on the part of the employers of the committee members of more than $50,000 was made. The activities of the RMA Materiel Bureau were also outlined. The members of this committee are at present very active in determining the requirements of the radio industry of various materials and the availability of these materials. Standardization of design of parts and of procedures are going forward at a rapid rate. It was emphasized by Dr. Baker that the committee is endeavoring to convince the governmental authorities that rather than limit the production to a given number of units, the industry should be given a certain amount of materials and be permitted to make as many units as it can. This procedure would be a challenge to the ingenuity of radio engineers to make more radio equipment from less materials.



Graphical study of skin effect, showing surface resistivity and depth of penetration in mks units for various metals and small magnetic intensity from a paper given by H. A. Wheeler

R-f filament and regulated high voltage supplies for the 60 kv electron microscope described by Zworykin, Hillier and Vance



Tube Noise

Noise in radio tubes and its origin in the manufacturing processes was discussed by Walter L. Krahl of Hygrade Sylvania Corp. Frequently noise is caused by momentary contact between two electrodes or an electrode and a piece of metal, such as a speck of nickel on a mica spacer or the getter. The major source of noise, because of electrodes shorting to each other, is the many small pieces of cotton or wool lint, largely from the clothing of the operators, which finds its way inside the tube envelope. During the exhausting and aging processes the tube structure becomes very hot in vacuum and the lint carbonizes to form a very good conducting medium. One of three things then happens: (1) the lint falls to the bottom of the tube where it does no harm, (2) it falls directly across two elements where it forms a short circuit, or (3) it falls in such a way that when the tube is struck with a light rubber or cork hammer, or when it vibrates, a momentary short circuit is caused to produce noise. In a test involving several hundred tubes and very severe noise testing conditions, rejected tubes were reduced from 90 percent for regular production tubes to 7 percent for tubes made with extreme and impractical precautions for preventing lint from entering the tubes. Also important as a cause of noise in tubes is the radiation of energy from one tube to a more

sensitive tube. Floating elements in the more sensitive tube become charged resulting in noise.

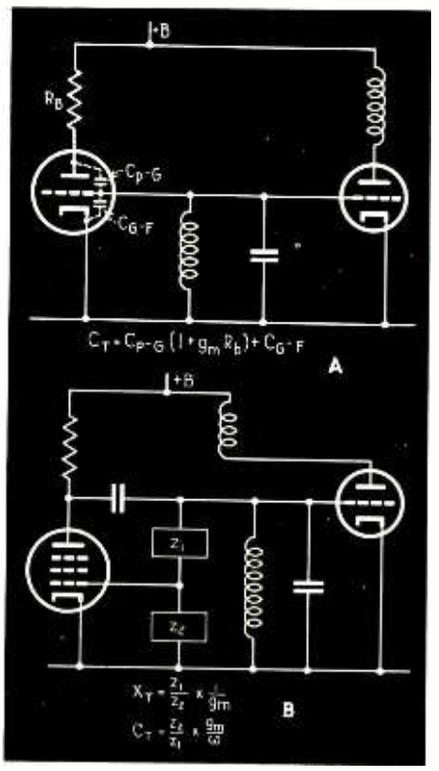
F-M Signal Generator Design

According to C. J. Franks of Boonton Radio Corp. the design of an f-m signal generator is a conflict between performance and cost. It should have better operating characteristics than the equipment it is to test and yet it should be reasonably low in cost. Consequently its circuit must be simple and the generator should contain as few tubes as possible. This immediately rules out phase modulation as a possible method of producing frequency-modulated signals because of the frequency multiplication required. Thus, the designer is limited to the use of a reactance tube for the generation of f-m signals. Mr. Franks discussed two types of reactance tube circuits, the grid connected circuit and the plate connected circuit which are shown in the accompanying diagram. It was decided to use the grid connected circuit, largely because of the low operating (or hot) losses associated with it.

It is highly desirable to operate this type of circuit at a single frequency. Therefore, a circuit with a mean frequency of 20 Mc is used in conjunction with a heterodyne oscillator. To cover the ranges from 1 to 10 Mc for intermediate frequencies and 41 to 50 Mc for carrier frequencies, the frequency range of the variable oscillator is from 21 to 30 Mc. This type of signal generator cannot be tested properly by the use of a vacuum tube voltmeter. Suitable tests require the use of another signal generator and a selective voltmeter which would be a radio receiver.

New Magnetic Materials

W. E. Ruder, of the General Electric Company, outlined some of the contributions which have been made in recent years to the improvement of magnetic materials which find extensive use in the radio field as core materials for transformers and as magnets for loud speakers. The benefits to be derived from cutting core pieces so as to take advantage of the unsymmetrical magnetization characteristics of the material, which are usually greater with the rolling grain than against this grain, the improvements due to carefully con-



Grid connected tube circuit (above) compared with plate connected reactance tube for the production of f-m signals, as discussed by C. J. Franks

trolled heat treatment, and particularly the improvements to be derived by appropriate magnetic treatment during the heat treatment of the magnetic materials were illustrated by means of slides and tables. All of these improvements have increased the effectiveness of magnetic materials and result in increased permeability with lower losses. Some discussion was also given to possible future developments which might be expected to come about as a result of increased activity on the part of metallurgists.

Problems encountered in the design and production of a signal generator covering the frequency range of from 50 to 400 Mc were outlined by John M. VanBeuren of the Measurements Corporation. Original plans for a signal generator for this high frequency range led to a realization that the techniques used in previous lower frequency models would, very likely, have to be drastically modified. Although certain problems which at first appeared to be quite simple were found to lead to unexpected difficulty, whereas in other cases, no trouble was experienced where it had been anticipated, the original point of view was determined to be well founded.

The signal generator described had a frequency range of from 50 to 400 Mc, a low impedance output, and provision of output signals of from 1 to 100,000 microvolts with switch arrangement of the resistance attenuator, and with extension up to 1 volt by external tap. The oscillator was a 954 acorn tube which, when used in a resonant line type of circuit produced a satisfactorily constant voltage at any frequency within the range of the instrument.

Most unusual feature of the instrument was the resonant line oscillator circuit, the frequency of which was varied by altering the length of the transmission line as well as by capacitive loading. To conserve physical space as well as to obtain the desired frequency range, the transmission line was made in the form of a loop which could be rotated about a central axis by means of the tuning drive shaft. The rotation of this disc also varied the capacitance of the loading condensers. Because of the large frequency range which was covered, it was found necessary to short-circuit the unused portions of the transmission line tuning circuit to prevent undesirable resonant circuits from being established. These short circuiting elements were provided by means of stationary jaws which made contact with the contact lugs on the rotatable transmission line. The tuning mechanism has a high ratio gear, and to conserve time of the operator, a motor driven mechanism is used to tune the circuit to the approximate frequency. Final adjustment of frequency is accomplished manually. The scale for the tuning dial has an overall length of about 5 feet, so that accurate tuning can be accomplished easily.

Iron Core Improvements

W. J. Polydoroff, consulting engineer of Chicago, gave a talk, illustrated with a series of slides, on "New Advances in Iron Cores" in which were outlined the advances which have been made in the past decade, on the improvements in iron core inductances and transformers for radio purposes. Whereas ten years ago, all emphasis was placed in the use of iron core coils for operation in the normal broadcast

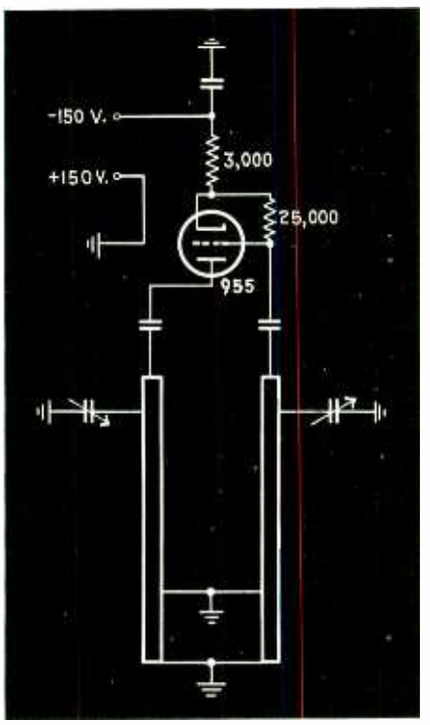
band, present day requirements utilize these coils in ultrahigh frequency bands as well. Reduction in size of the individual grains of the iron powder, resulting in greater uniformity and improved operation were outlined, and mention was made of the availability of domestic carbonyl iron which is at least equal to the quality of products which were formerly imported. The more important characteristics of carbonyl iron were also discussed.

Noise Meter Transients

C. M. Burrill of the RCA Manufacturing Co. opened the Thursday morning session with a discussion of "Some Observations Concerning the Transient Behavior of Radio Noise Meters". The transient characteristics of noise meters were discussed, with and without the use of automatic volume control circuits. It was shown that the transient characteristics of noise meters for measuring radio noise could not be completely specified in terms of transient response alone, as has been done in the past, since the transient response was dependent upon the noise range and the scale configuration for which the meter movement was designed. A method of analyzing the transient response characteristics of noise meters by a method of successive approximations was also given.

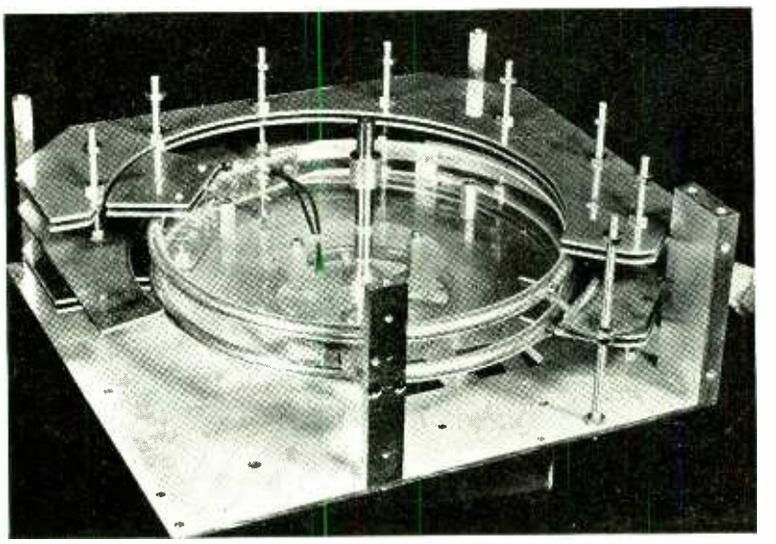
In prepared discussion which fol-

(*Continued on page* 85)



Circuit of connections for parallel conductor oscillator having range of from 50 to 400 Mc. as given by John M. Van Beuren

Constructional detail of 50-400 Mc. oscillator, showing loading condensers and shorting lugs on coiled parallel conductors



Change in Weight of Materials of Construction in Two 1942 Radio Receivers from 1940 Practice

		Loud Speaker	Variable Condenser & Perm. Tuner	Loop Antenna	Chassis	Brackets & Hardware	I-F Transformers	Other Coils	Hook-Up Wire & Line Cords	Electrolytic Condensers	Paper Condensers & Resistors	Tube Sockets	Controls	Cabinet & Knobs	Remainder and X	Total in pounds	Decrease	Increase
Iron and steel	1940	1.15	0.38		0.82	0.24	0.03			X		....	0.21	X	0.02	2.85		
	1942-A	1.28	0.68		X	0.15	0.04			X		0.03	0.26	X	0.02	2.46	0.39	
	1942-B	1.28	0.39		X	0.15	0.04			X		0.03	0.26	X	0.02	2.17	0.68	
Brass, Copper, Bronze	1940	0.24	X	0.08			0.03	X	0.06	X	0.04	0.03	0.05		0.01	0.54		
	1942-A	X	X	....			....	....	0.06	X	0.04	....	X		0.01	0.11	0.43	
	1942-B	X	X	....			....	....	0.06	X	0.04	....	X		0.01	0.11	0.43	
Aluminum	1940	....	0.10				0.05			0.014	0.026				....	0.19		
	1942-A	0.02	....				....			0.03	....				....	0.05	0.14	
	1942-B	0.02	....				....			0.03	....				....	0.05	0.14	
Tin	1940		X				X		X		X				0.06	0.06		
	1942-A		X				X		X		X				0.06	0.06	0	
	1942-B		X				X		X		X				0.06	0.06	0	
Lead	1940	....	X			....	X		X		X				0.04	0.04		
	1942-A		X			0.20	0.03		X		0.12				0.04	0.39		0.35
	1942-B		X			0.20	0.03		X		0.12				0.07	0.42		0.38
Nickel	1940	....					X								0.003	0.003		
	1942-A	0.03					X								0.003	0.033		0.03
	1942-B	0.03					X								0.003	0.033		0.03
Cobalt	1940	....														....		
	1942-A	0.05														0.05		0.05
	1942-B	0.05														0.05		0.05
Bakelite	1940	X	X				X					X		1.8	0.2	2.0		
	1942-A	X	X				X					X		....	0.2	0.2	1.8	
	1942-B	X	X				X					X		....	0.2	0.2	1.8	
Silver	1940			....			....	....								....		
	1942-A			0.08			0.02	0.01								0.11		0.11
	1942-B			....			0.02	0.03								0.05		0.05

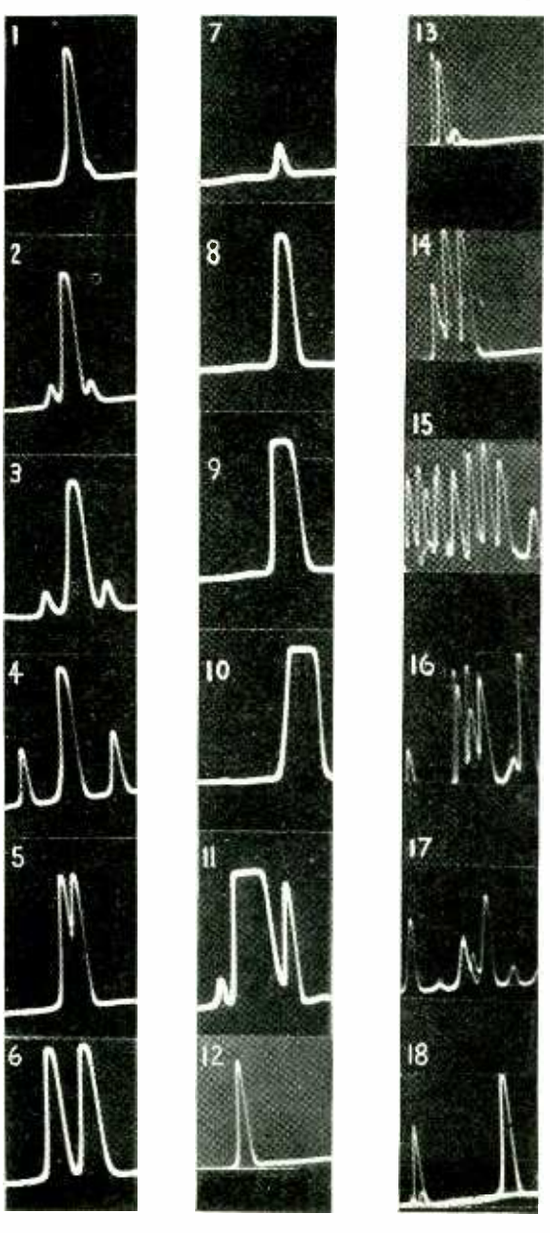
Panoramic Reception for Increased Receiving Efficiency

Efficiency of receiving stations can be improved if the operator is at all times aware of the activities of transmitters in the band to which he is listening. The Panoramic Spectroscope adapter informs him instantly when a new signal is radiated

CONTINUOUS indication of the presence of radio signals within plus or minus 50 kc of the tuned frequency of a receiver can be obtained by attaching to an ordinary superheterodyne an instrument making use of the panoramic method of reception. The indications appear as deflections on the screen of a cathode-ray tube and are such that the characteristics of any signal can easily be determined. This continuous indication can be extremely useful to a commercial or amateur operator to increase the efficiency with which he can operate his station. It provides him with an overall picture of traffic conditions of that portion of the spectrum which interests him and enables him to spot instantly any new signal which appears. With a little practice, the operator can interpret the indications so that he may know the approximate signal strength, whether or not the carrier is modulated and if it is modulated, the type of modulation.

The operation of panoramic radio reception was described in the June 1940 issue of ELECTRONICS and a brief review of its principles will suffice here. The panoramic receiver, or adapter unit which is attached to the plate of the converter in a conventional superheterodyne receiver, is continuously tuned through the selected portion of the band at the rate of 30 times per second. As each signal is tuned an audio voltage is impressed on the vertical plates of the cathode-ray tube. The horizontal sweep frequency is synchronized with the tuning sweep rate. The indication of each signal exists for but a very small part of a second, but because of the rapid scanning it appears as a continuous trace on the cathode-ray screen and because of the synchronization of the cathode-ray tube horizontal sweep frequency and the tuning sweep frequency the deflection remains stationary.

The adapter unit, attached to an ordinary superheterodyne receiver, operates in the following manner. The input to the adapter is obtained from the plate of the converter tube through a high resistance as shown in the diagram. The resistance is used so that the operation of the receiver is unaffected and so the operator can listen to the single signal to which the receiver is tuned. The first stage is an r-f amplifier whose passband is 100 kc wide with the mid-frequency equal to the intermediate frequency of the superheterodyne receiver. The characteristics of this stage are such that the overall response curve of the receiver r-f and converter stages and the adapter



Oscillograms showing how typical signals are indicated on the screen of the cathode-ray tube.

Sidebands vs sweepwidth

1. Carrier modulated at 3000 cps, 100-kc sweepwidth. The modulating frequency is too low for the sidebands to be resolved. The slightly irregularity near the base indicates their presence.
2. Same as No. 1, but with the sweepwidth reduced to 70 kc.
3. Same as No. 1 with sweepwidth reduced to 50 kc.
4. Carrier modulated at 15,000 cps, 100-kc sweepwidth.

Resolution vs Sweepwidth

5. Two carriers 5 kc apart, 100-kc sweepwidth.
6. Same as No. 5 with sweepwidth reduced to 50 kc.

Amplitude vs Signal Strength (100-kc Sweepwidth, fixed gain)

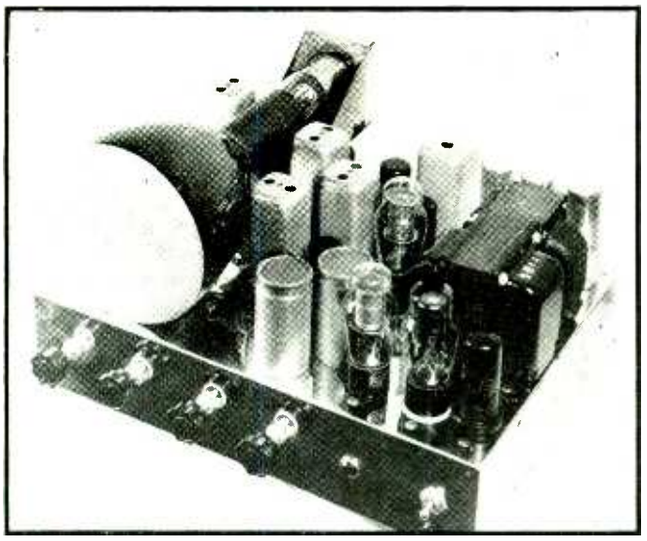
7. 10-microvolt signal.
8. 100-microvolt signal.
9. 1000-microvolt signal. Base widens and limiting action causes square top.
10. 10,000-microvolt signal.
11. 100,000-microvolt signal. The indication breaks up into three positions, the central portion flattened on top and two spurious harmonics.

F-M Signals

12. Unmodulated carrier.
13. Small degree of modulation.
14. Moderate degree of modulation.
15. Heavy modulation.

Typical Examples of Reception

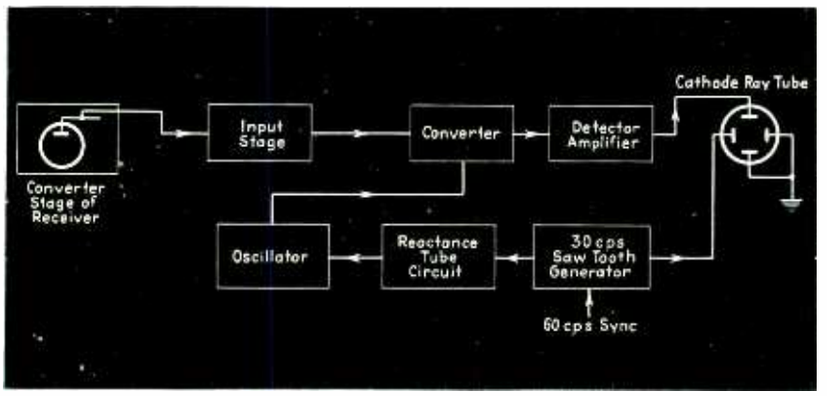
16. Amateur phone band at 14 Mc. Six modulated phone stations are indicated.
17. A portion of the standard broadcast band.
18. Three automatic telegraph stations. The rapid keying and relatively slow film exposure cause the deflection to be closed at the bottom.



Chassis of the adapter unit. Indications of the presence of radio signals appear on the screen of the cathode-ray tube when the unit is attached to a superheterodyne receiver

External view of the panoramic spectroscope adapter. A green screen is placed over the cathode-ray tube for increased visibility under strong light conditions

Block diagram of the panoramic adapter. The unit is tuned through the 100-kc band under inspection 30 times per second for indications of signals in the ether



r-f stage is nearly flat over the band in which the adapter must operate. To avoid too much complication the response curve is made flat for the medium frequency portions of the radio spectrum, with the low frequency end under-compensated and the high frequency end over-compensated. The output of the adapter r-f stage when it is fully compensated consists of all the signals within the 100-kc band which extends from 50 kc greater than the receiver tuned frequency to 50 kc less than the tuned frequency with the degree of overall amplification equal for all signals.

The purpose of the next portion of the circuit is to separate the signals so that each has a separate entity. The mass of signals is fed into the converter stage where they are mixed with the output of the oscillator. The frequency of the oscillator has a mean value 100 kc lower than the intermediate frequency of the receiver and varies 50 kc above and below the mean value. The converter is followed by an amplifier stage tuned sharply to 100 kc so that the signals are now spread out on a time basis as the frequency of the oscillator sweeps through its band. That is, the output of the oscillator heterodynes with the incoming signals and produces a 100-kc signal with only one signal at a time, and signals at frequencies of other than 100 kc with the remaining incoming signals. Because the next stage is sharply tuned to 100 kc, only that signal is passed. As the oscillator sweeps through its band heterodyne signals are passed through the circuit one after the other. The signals are then fed to a detector circuit and then fed to the oscilloscope.

A 30-cycle saw-tooth generator supplies the horizontal sweep for the oscilloscope and also the variation for the oscillator. Part of the output of the saw-tooth generator is fed to a reactance tube circuit which is connected through the proper phase shifting circuits so that it is part of the tuning element of the oscillator. This is a version of the reactance tube method of obtaining frequency modulated waves.

The sweepwidth, or the portion of the spectrum under examination, can be varied over a wide range with a maximum value of 100 kc. As the sweepwidth decreases, the deflections spread apart with the deflection corresponding to the audible signal remaining at the center. At a sweepwidth of 100 kc the resolution is about 3 kc and at 20 kc the resolution is 1.5 kc. The resolution is the difference in frequency of two signals at which two deflections are produced.

Interpretation of Results

Each type of signal has its own characteristics on the screen of the cathode-ray tube and can be easily identified. A constant unmodulated carrier appears as a steady deflection of fixed amplitude. An amplitude modulated carrier will appear as a deflection whose amplitude varies in accordance with the modulation. A constant tone produces periodic changes in the amplitude while voice or music modulation produces irregular changes. As

(*Continued on page 79*)

Flexible Sweep Circuit and Deflection Amplifier

FOR C-R OSCILLOGRAPHS

IN a previous article,* the author described a positioning method for cathode-ray oscillographs, utilizing a d-c push-pull deflection amplifier with d-c coupling from the amplifier to the deflection plates, and a variable d-c voltage superimposed upon the input to the deflection amplifier for position control. The advantages of this circuit are instantaneous positioning without electrical backlash, improved low-frequency response, and an increase of several hundred percent in the effective undistorted output of the deflection amplifier.

The sweep circuit described in this article employs the possibilities offered by such an arrangement to provide flexible single-sweep operation as well as generally improved performance at low sweep frequencies. A simplified deflection amplifier is also described. The sweep circuit used in conjunction with the amplifier is shown in Fig. 1.

The amplifier, as shown, consists of but one tube (7F7) and three resistors and it provides push-pull output with uniform response from d-c to beyond 20,000 cycles per second with a gain of more than 50. The outputs of the two triode sections are opposite in phase, and differ by less than 5 percent in amplitude.

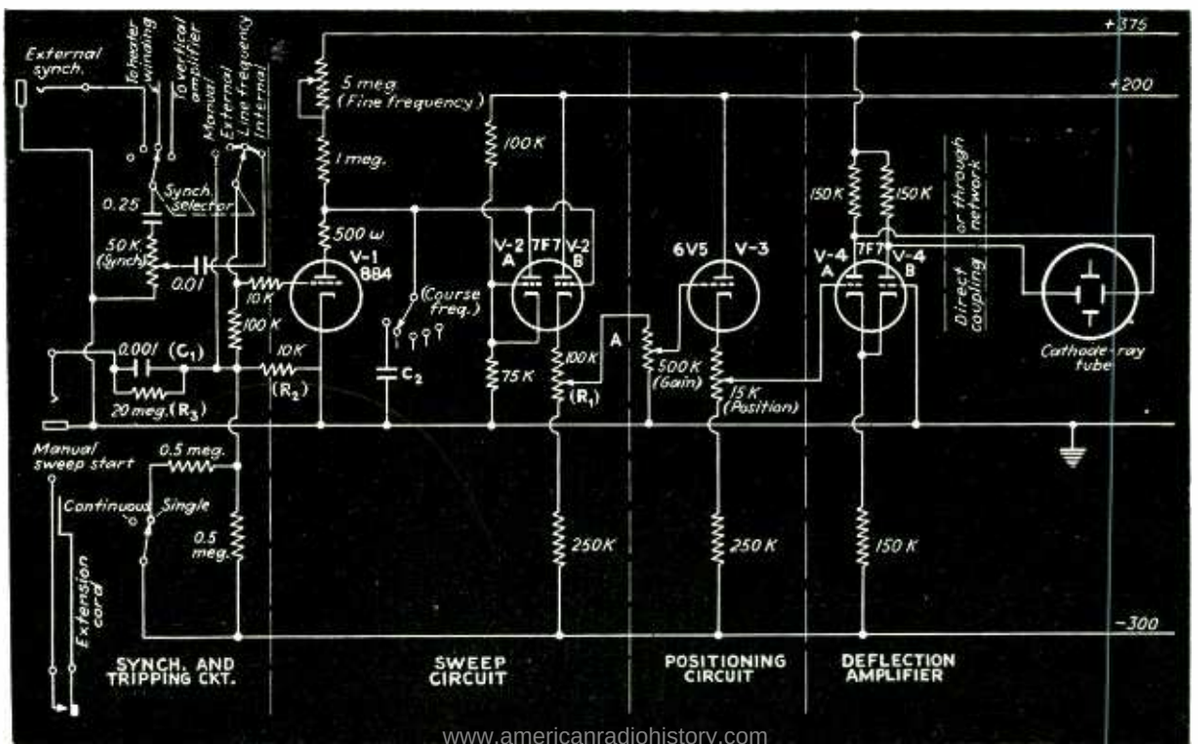
The sweep circuit is direct coupled throughout to provide flexible single-sweep operation, but it has been designed in such a way as to retain the desirable features of condenser coupled circuits, namely, independence of position and gain controls, and symmetrical expansion of the time-base line, with respect to its center, as the gain control is turned up.

To retain these features, it is necessary that the sawtooth voltage appearing at the top of the gain control (point A) be symmetrical with respect to ground. For recurrent sweep operation, this is easily accomplished by condenser coupling, but with such coupling, time must be allowed for the coupling-condenser charge to reach its new level, and the spot must be re-positioned to compensate for the change when the sawtooth oscillator is stopped preparatory to single-sweep operation. This can be particularly annoying where the circuit is designed for slow sweeps and hence has a long time-constant in the coupling circuit. Further, if several sweeps are tripped off within a short time, their positions will not coincide because of the charge built up on the coupling condenser.

In Fig. 1, the d-c component at A (referred to ground) will change much more rapidly than the sawtooth component as R_1 is adjusted. It is, therefore, possible to find a

* An Improved Cathode-Ray Oscilloscope Design, Wm. A. Geohegan, ELECTRONICS, November 1940.

Fig. 1—Wiring diagram of the simplified sweep circuit and deflection amplifier



A simplified sweep circuit and deflection amplifier is described which provides flexible single-sweep operation for cathode-ray oscilloscopes for frequencies up to 20 kc. The C-R tube is operated from a single tube balanced deflection amplifier of simplified design

By WILLIAM A. GEOHEGAN

Department of Anatory, Cornell University Medical College

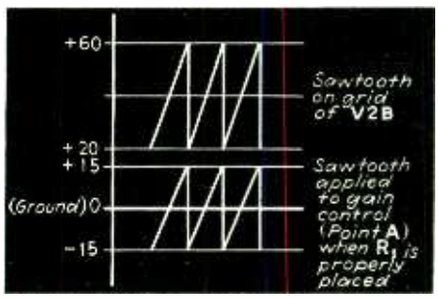


Fig. 2—Proper operation of the circuit makes it desirable that the sawtooth waveform be symmetrical with respect to ground potential. This can be accomplished by proper adjustment of R_1

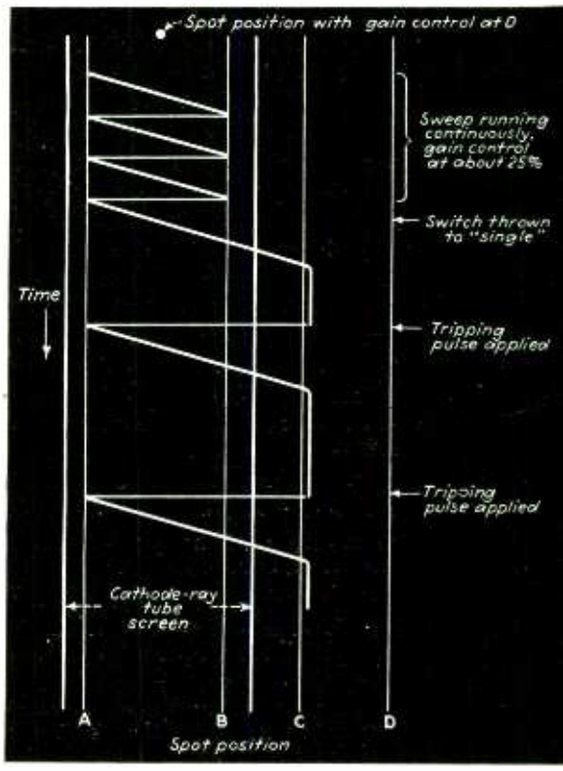


Fig. 3—Time trace of spot on screen of oscilloscope, and illustration of the mode of operation of the sweep circuit and deflection amplifier

point on R_1 at which the sawtooth wave is symmetrical about ground and is only slightly attenuated. With R_1 adjusted to this point, the sweep, running recurrently, will behave as though condenser coupled, but when the single-sweep feature is placed in operation it will assume its new conditions instantaneously with no adjustment of the positioning control and no annoying delay while the condensers build up to their new charge. Also, successive sweeps will coincide in position. Once adjusted, R_1 need not be adjusted further. It need not be a front-panel control.

The operation of the circuit may best be shown graphically as in Fig. 3. With the sweep running continuously, at an amplitude corresponding to that shown as *A-B*, it is necessary only to throw the lower switch of the synchronizing and tripping circuit to "single" to put the single-sweep feature into operation. When this is done, the spot continues the cycle in progress, but does not fly back when it reaches *B*, because the ionization potential of the 884 tube has been raised by the change in grid bias. The spot, therefore, continues off the screen toward *D*, the position which corresponds to the new ionization potential. It is prevented from reaching this point by the left triode section of the 7F7 of the sweep circuit which begins to draw current as soon as its plate becomes positive with respect to its cathode. The screen remains dark until a tripping pulse is applied, manually or through the synchronizing circuit, at which time the spot flies back to *A*, completes one excursion at the same transit speed, and then continues off the screen again to await another tripping pulse. Tripping pulses may be selected from any of the sources usually used for synchronization or, with the synchronization-selector switch in the "manual" position, the sweep may be tripped manually by means of a push button. When the button is pressed, the bias on the 884 is momentarily reduced while C_1 charges. The values of C_1, and R_1 are chosen so that the tripping pulse is of shorter duration than the shortest transit time for which the circuit is designed, and only one sweep will be tripped regardless of how long the button is held down. When the button is released, C_1 discharges through R_3 and the circuit is restored to normal. If C_1 discharges too rapidly, an unwanted tripping pulse may be generated due to contact bounce when the button is released. This is prevented by making R_3 very high.

Since the input resistance of the 7F7 (or V-2 B) is practically infinite, and d-c coupling is used throughout, the linearity of the time base line at low frequencies depends entirely upon the sawtooth oscillator. The linearity is good at 0.2 cycles per second using inexpensive condensers at C_2, and reasonably good linearity at even lower frequencies is undoubtedly possible with better condensers and other precautions against leakage. With the values shown, performance is satisfactory up to 10,000 sweeps per second. Performance at much higher frequencies, without impairment of low-frequency operation, is perfectly feasible with tubes of higher mutual conductance and with lowered impedances throughout.

New Books

Handbook of Broadcasting

By Waldo Abbot. *McGraw-Hill Book Co., New York, 1911 Second Edition. 422 pages, illustrated. Price $3.50.*

The revised second edition of this book on how to broadcast effectively incorporates changes and suggestions made by instructors in 50 universities where it has been used as a text, and by former students of the author who have gone into the field of broadcasting. For the benefit of those who are unacquainted with this work it may be pointed out that this is essentially a book for people engaged in the non-technical side of radio broadcasting. Such topics as radio speaking, radio pronunciation, articulation, the various types of programs, writing for radio, electrical transcriptions, microphone technique, sound effects, the radio day, and the law as it affects broadcasting are treated in great detail.

However, by no means should the strictly technical man in radio feel that this book is beneath his dignity to read. Some of the chapters tell how the electronic equipment which he designs and builds is used, and may well suggest revamping existing devices or even new types of equipment to meet the need of the broadcaster. Apart from this the book makes interesting reading by citing the mechanics of putting a program on the air. The section on sound effects is especially interesting.—E.E.G.

Fourier Series and Boundary Value Problems

Ruel V. Churchill. *Published by McGraw-Hill Book Co., Inc., New York,* 1941. 206 *pages, nine illustrations. Price* $2.50.

This text is a modern presentation of the application of generalized Fourier series to boundary value problems. Sources such as Courant-Hilbert, Byerly and Riemann-Weber are drawn on liberally, but the treatment makes use of all the later work done in this field. For instance, there are frequent warnings against accepting a solution until it has been shown to be both convergent and unique.

The treatment is entirely mathematical, but of the nearly 250 problems (with answers) some 40 percent relate directly to physical examples, mostly of the classical type involving homogeneous differential equations and boundary conditions. The author does not touch the field of forced oscillations, in which the equations and boundary conditions are usually non-homogeneous, and lead to complicated characteristic functions and values.

Fourier series receive the most thorough attention, with emphasis on the type of function which may be expanded. Together with the concept of orthonormal functions this leads to a concluding short presentation of expansions utilizing Bessel functions and Legendre polynomials.

Viewed as a whole this text is remarkably complete and should be a welcome reference book in any engineering library. Its especial appeal should be to the industrial mathematician, who will find it a convenient source of expansion as well as theoretical information. As a textbook it should be most valuable to the mathematical physicist although intended for the student of mathematics.—H.K.

Advanced Electrical Measurements

By Walter C. Michels, *D. Van Nostrand Co., New York, 1941. Second Edition. 350 pages, illustrated. Price $3.50.*

The first edition of this work appeared in 1932. Since then the rapid advances in electrical measurement technique have necessitated a complete revision of the text, and the author has done a fine job of compiling all the fundamental ideas of electrical measurements in a well organized book. Beginning with a dissertation on the precision of measurements and the preparation of suitable laboratory reports, the work covers such topics as: measurement of resistance, current, potential difference, quantity of electricity, and impedance; thermionic amplifiers, the measurement of their characteristics and their application in measuring instruments; and oscillators and oscillographs, and their use in measurements including transient studies. Electricity in gases, electrical vacuum measurements, electrical thermometry, radiation measurements and applications, and electrochemical measurements are also discussed.

The book presents its material in the usual form which has come to be accepted as standard for this type of work. The principles and theory underlying a particular measurement are given first. Then follow one or more experiments which not only illustrate the principles discussed, but also the established methods of measuring, or calibrating instruments. Finally, references for further information on the subject are listed at the end of each chapter. The MKS system of units is used in this book, and for convenience in transforming from this system to the cgs-electrostatic or the cgs-electromagnetic systems, a table listing these conversions is published in the appendix.

Since the book covers practically all phases of electrical measurements, and almost all of the instruments described are commercially available, it can well be recommended to the engineer as a guide to the solution of his measurement problem.—E.E.G.

Radio-Frequency Measurements by Bridge and Resonance Methods

By L. Hartshorn, *Principal Scientific Officer, The National Physical Laboratory. Published by John Wiley and Sons, Inc., New York, 1941. 6 by 9 inches, 265 pages, illustrated, price $4.50.*

Almost any electrical engineer can set up a bridge circuit, and with the aid of a few equations, can readily measure circuit parameters such as resistance, inductance, and capacities at low frequencies. However, attempting the same procedure at high frequencies may result in large errors. The subject matter of this book describes the proper, experimentally proven methods of accomplishing accurate measurements at radio frequencies.

The volume is divided into three parts. The first outlines the principles underlying r-f measurements. Circuit parameters, fundamentals of impedance measurement by resonance methods, screening, and the r-f bridge are covered in detail. The second part explains the apparatus used in r-f measurement. Generators, detectors, standards of capacitance, resistors, and standards of inductance are treated from a high frequency standpoint. Part three presents the methods of measuring capacitance, inductance, resistance, power factor, decrement, etc. by resonance and bridge methods. Ultrahigh frequency technique is also covered in this last section.

Many equations appear throughout the book, but none which the average engineer would find too difficult to understand. The various topics are treated qualitatively and quantitatively, derivations being included in many instances. The work is recommended for men engaged in the high frequency field who want a good source of practical methods of measurement. —E.E.G.

VECTOR COMPUTATIONS

By PAUL W. KLIPSCH *Houston, Texas*

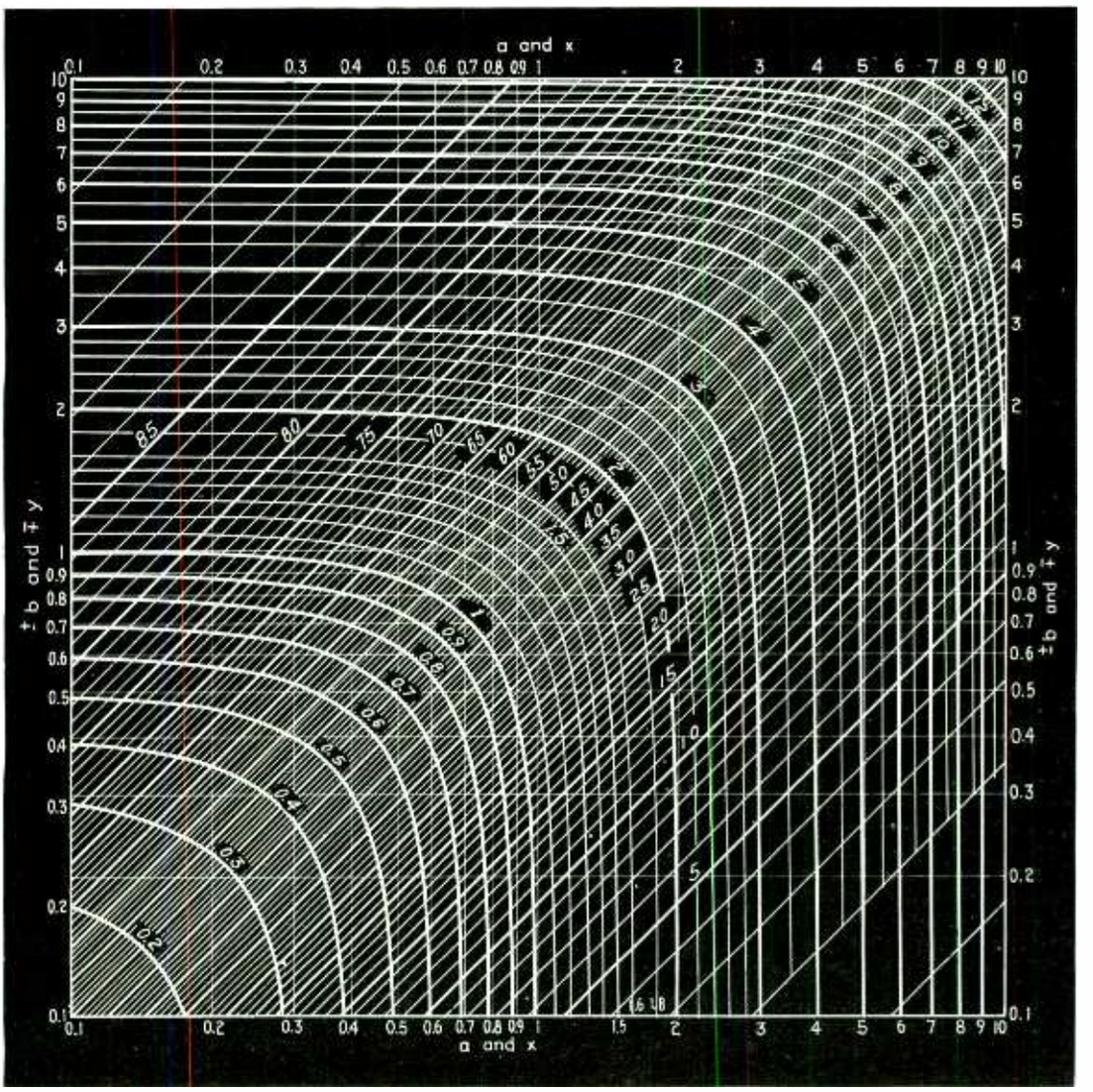


Fig. 1—Graph for converting between rectangular and polar coordinates to solve equations of the form $z = x + jy = a\angle b$. The x and y axes are logarithmically spaced, while the curves represent the argument a. The straight lines from lower right to upper left give the phase angle, b.

THE practical use of complex quantities in electrical engineering is almost as old as the profession itself. It is the purpose of this paper to offer two charts for performing two vector operations, namely transforming from rectangular to polar coordinates (or the reverse) and determining the reciprocal in rectangular coordinates.

The first of these operations, determining the vector sum or absolute value, together with the phase angle, can be done by means of a slide rule. A simple operation of unknown origin, the knowledge of which does not seem to be widespread despite its age will be presented here as an introduction to the subject.

Consider the problem of finding z in the equation

$$x + jy = z$$

The absolute value of z (written $|z|$) is readily found in two operations on a slide rule as follows: On the C and D scales take the ratio of x and y such that the ratio, greater than unity, appears on the D scale at the index mark on the slide. Opposite this ratio find its square on the A scale, add one, run the slide up to this new point, and under x or y, whichever is the smaller, on the C scale will be found $|z|$ on the D scale. For example, take $3 + j4$. Set 3 on the C scale opposite 4 on the D scale which places the slide index at 1.333 on the D scale and 1.778 on the A scale. Add 1 and run the slide index up to 2.778 on

the A scale. Under 3 on the C scale find the answer, 5, on the D scale. This is in effect a solution of the equation

$$|z| = (x^2+y^2)^{1/2} = y[(x/y)^2+1]^{1/2}.$$

Finding the phase angle involves the additional operation of determining the value of the impedance angle, $\angle z = \tan^{-1} y/x$

This method is as simple and fast as the same determination on the vector slide rule.

An alternative of the slide rule method is the use of the chart of Fig. 1 in which a transformation from rectangular to polar coordinates is performed in a single operation. The modulus and argument (absolute value and phase angle) can be found from the x and y components or the reverse operation can be performed. For example, locating the point (3, 4) on the rectangular system gives $|z| = 5$ on the curved coordinates and $\angle z = 53$ deg. on the diagonal coordinates.

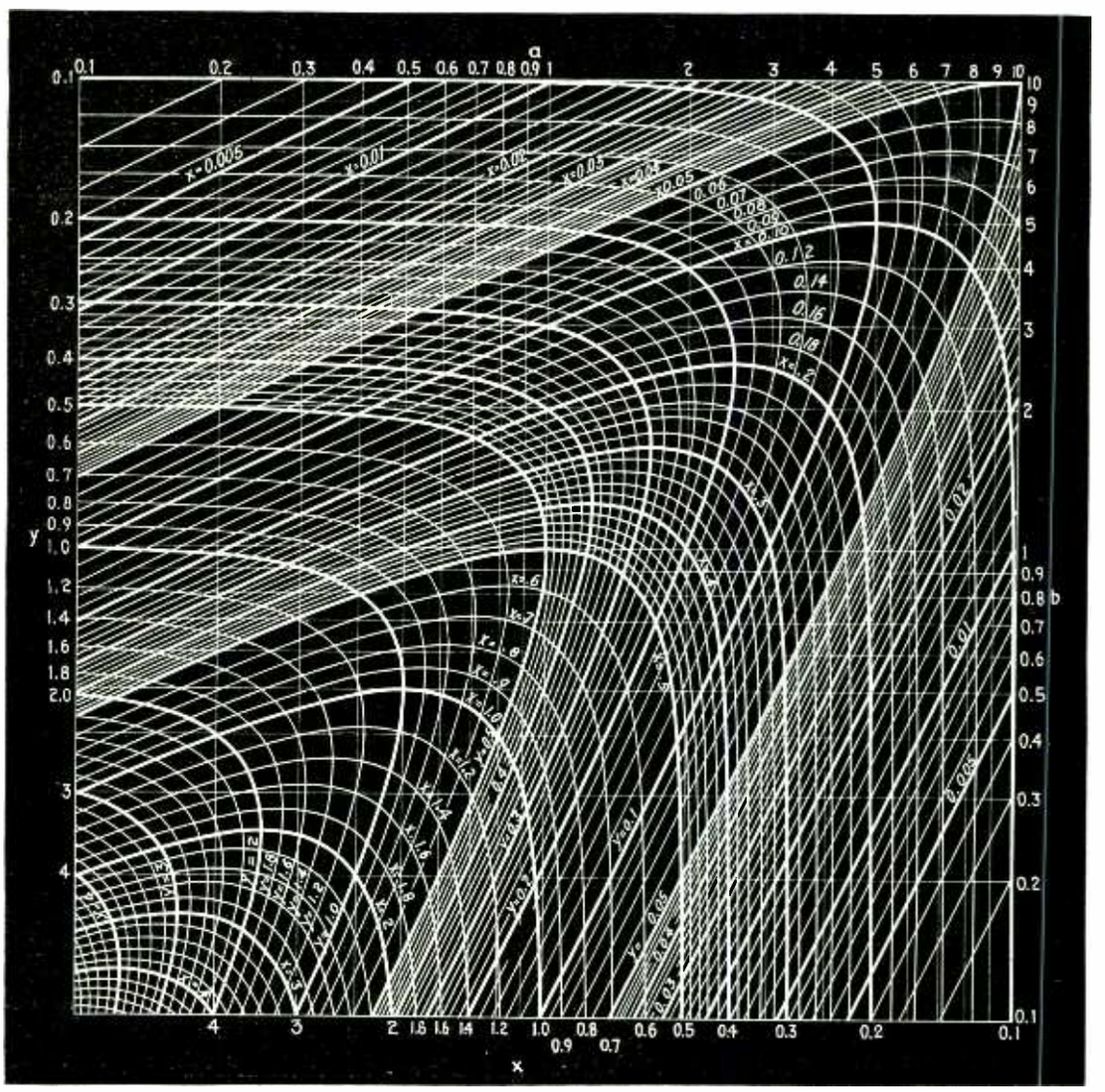
The second vector manipulation is that of finding the reciprocal. For a series of operations in solving a multimesh network, the multiplicity of slide rule steps becomes tedious, but the chart of Fig. 2 gives each reciprocal in a single operation. The vector reciprocal is the solution of the equation

$$x + jy = (a + jb)^{-1}$$

and the solution by means of the chart of Fig. 2 is simply that of looking up the numbers a and b on the rectangular system and then finding the coordinates of the same point (a, b) on the curvilinear system which are x and y, the sign of y being reversed with respect to the sign of b.

When the ratio of a to b lies outside the range 1/10 to 10 a simple approximation may be used, and when the numbers are otherwise off the chart a factor of ten or power of ten may be applied to the number to arrive at a value locatable on the chart, looking up the converted value on the chart and applying the same factor to the answer. To use the $3 + j4$ example again, the reciprocal is found to be $0.12 - j0.16$. As an example of a complex number outside the scale of the chart, take $30 + j40$. Using a factor 1/10, $(30 + j40)/10 = 3 + j4$ and the reciprocal is $(1/10) \times (0.12 - j0.16) = 0.012 - j0.016$. For the case in which the ratio of a to b is greater than 10, the chart is not needed to arrive at a close approximation. For example, let $a + jb = 3 + j40$. The reciprocal is $3/40^2 - j\ 1/40 = 3/1600 - j\ 1/40 = 0.00188 - j0.025$ within less than 1 percent, the true value being close to $0.00187 - j0.0249$.

Fig. 2—Graph for determining reciprocal of complex number. The reciprocal of $z = a + jb = 3 + j4$ on the a and b scales (top and right) is found to be $z^{-1} = x - jy = 0.12 - j0.16$ on the x and y scales (bottom and left)



TUBES AT WORK

New method of motion pictures requires novel illumination system of interest to electronic engineers. Expander and transcription control also described

OPTICAL METHOD FOR INCREASING DEPTH OF FIELD

A DISTINCTLY NEW and worthwhile contribution to optical practice and electronic illumination engineering which may very easily have possibilities for creating rather more than a minor revolution in motion picture and television procedure is described by Dr. Alfred N. Goldsmith in the January, 1942 issue of the *Journal of the Society of Motion Picture Engineers*. Dr. Goldsmith's vast experience in the photographic and radio fields is liberally drawn upon, as is easily apparent in his article, "The IR System: An Optical Method for Increasing Depth of Field."

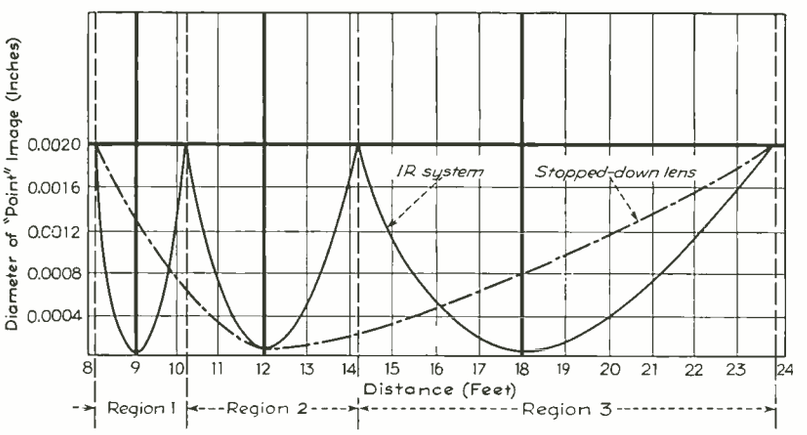
At first thought, a reader of ELECTRONICS might gain the impression that the article (which, incidentally, was delivered at the S.M.P.E. convention in October) deals so exclusively with optics and photography that it has but remote interest to electrical engineers. What makes Dr. Goldsmith's paper particularly suitable for mention in this department is that the photographic method outlined makes use of a new and novel sequential and regional lighting arrangement which gives illumination and electronic engineers plenty of opportunity to exercise their imagination and ingenuity to put the most appropriate tubes to work.

The first part of the paper outlines the limitations of current practice in the optical science by pointing out that the depth of field of a corrected lens system is determined by its focal length, its relative aperture, and the permissible diameter of the in-focus image of a point source. The limited depth of field in motion picture photography restricts freedom of action in large parts of the set, dictates a stylized, protracted, and costly studio procedure and affects dramatic value and audience appeal of monochrome or color pictures. The limitations of the ordinary optical system and practices have such severe limitations on the quality of the reproduced image, that many attempts, over a long period of years, have been made to increase the depth of field. Such previous attempts to increase the depth of field of an image have been scientifically unsound and unsuccessful in practice and have usually been accomplished, if at all, either by the decrease of the quality of the image, or by an appreciable reduction of the relative aperture of the system, thereby necessitating a vast increase in lighting to achieve a given effect on a film or television camera tube of specified sensitivity. These disadvantages are overcome in the IR (increased range) system.

Briefly the system described is based on a division of the set into optically appropriate regions, each region having identifiable illumination, with the identification and differential focusing at the camera of all regional images within a single exposure.

It is well known that for a given cir-

Fig. 1—Diameter of point-source image versus distance for IR System operation. For lens of focal length of 50 mm and f/2.3 stop



The improvements in depth of field which are possible with the IR system are evident in this illustration showing that objects from 8 to 18 feet from the lens are easily recorded in sharp focus by means of the new IR system

Photograph made with usual technique, and with lens focused on subject in foreground, a distance of 8 feet from the lens, and using a 50-mm, f/1.4 lens. Notice that background objects 18 feet from the lens are badly out of focus

VIBRATION *can be isolated*

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FROM the engineering point of view, all types of electronic apparatus, whether mobile or stationary, have widely different vibration conditions with which to cope. For the efficient isolation of electronic devices Lord manufactures several different styles of Bonded Rubber Mountings in hundreds of standard sizes for supporting loads from a few ounces up to 1500 pounds each. Their proved efficiency is due largely to the shear stress produced in the rubber by the imposed load and the special Lord process for bonding rubber to metal. Rubber mountings stressed in shear deflect more readily than when stressed in tension or compression. At the same time they are stable in all directions normal to the disturbing force.

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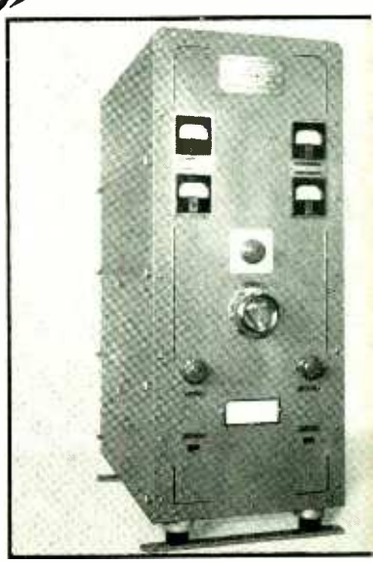
The basic engineering principles of vibration control are described in Lord Bulletin 104, which will be sent on request. Lord Vibration engineers have had considerable experience in solving many vibration problems in the radio, recording and industrial electronic fields, and are available to help with an efficient vibration control program for your equipment.



Heavy transmitters such as this Radio Marine Corp. of America unit are protected from shipboard vibration by four Lord Shear Type Mountings at the base and other Lord Mounts (not shown) used for lateral bracing.

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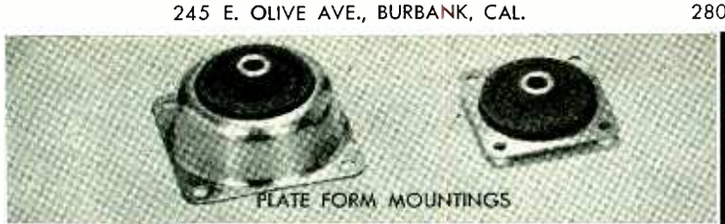

LORD
BONDED RUBBER
SHEAR TYPE
VIBRATION
MOUNTINGS

IT TAKES RUBBER IN SHEAR TO ABSORB VIBRATION

cle of confusion of the final image a lens of specified relative aperture and focal length has a definite depth of field, for which objects in this field may be considered in focus whereas objects nearer to, or farther from the camera are more or less out of focus and produce a blurred image. The depth of field not only depends upon the optical characteristics of the lens itself, but also depends upon the distance from the camera for which the lens is focused. For objects close to the camera, the depth of field will be relatively small, whereas for objects somewhat more distant, the depth of field may be increased perhaps several fold.

The IR system, which is suitable for motion picture and television work as well as for still photography, may be considered as a method of making multiple exposures on one frame of the single film in rapid succession, each successive exposure of which is made with a lens set for a different lens-object distance. Thus, several successive exposures are superimposed upon the same frame of film, but each partial exposure applies to a particular lens-object distance for whose depth of field (corresponding to a single region) all subjects photographed are in focus. By increasing the lens-object distances of the lens system for successive exposures in such a way that for one lens-object distance, the farthest plane in focus is the same as the nearest plane in focus for the next lens-object distance, the effect produced is one of vastly increased depth of field.

This may be explained in greater detail by means of Fig. 1, in which the lens is successively focused on objects 9, 12 and 18 ft. from the camera. The solid lines, representing the operation of the IR system, then will indicate the depth of field for each region. It is apparent that even for very small areas near the four cusps, images in sharp focus will be obtained for distances of from 8 to 24 feet. The dotted line for the lens stopped down shows the effect usually produced by ordinary optical systems if the aperture is decreased and the lens is focused so as to produce the same depth of field as that produced by the IR system. It is apparent that with the lens stopped down, only region two is in sharp focus whereas region one and region three are distinctly more out of focus than with the IR system. The stopped down lens has the further disadvantage of admitting considerably less light than the lens used in the IR system. In Fig. 1, three regions are shown, although it is obviously possible to limit the IR system to only two regions, or conversely, to expand it to more than three regions.

In order to obtain, in a relatively short period of time, a lens system which can be adjusted for several different lens-object distances, the author suggests the use of a differential focuser (abbreviated "diffo"), which may be defined as an optical element placed integrally in relation to an objective lens and capable of rapidly shifting

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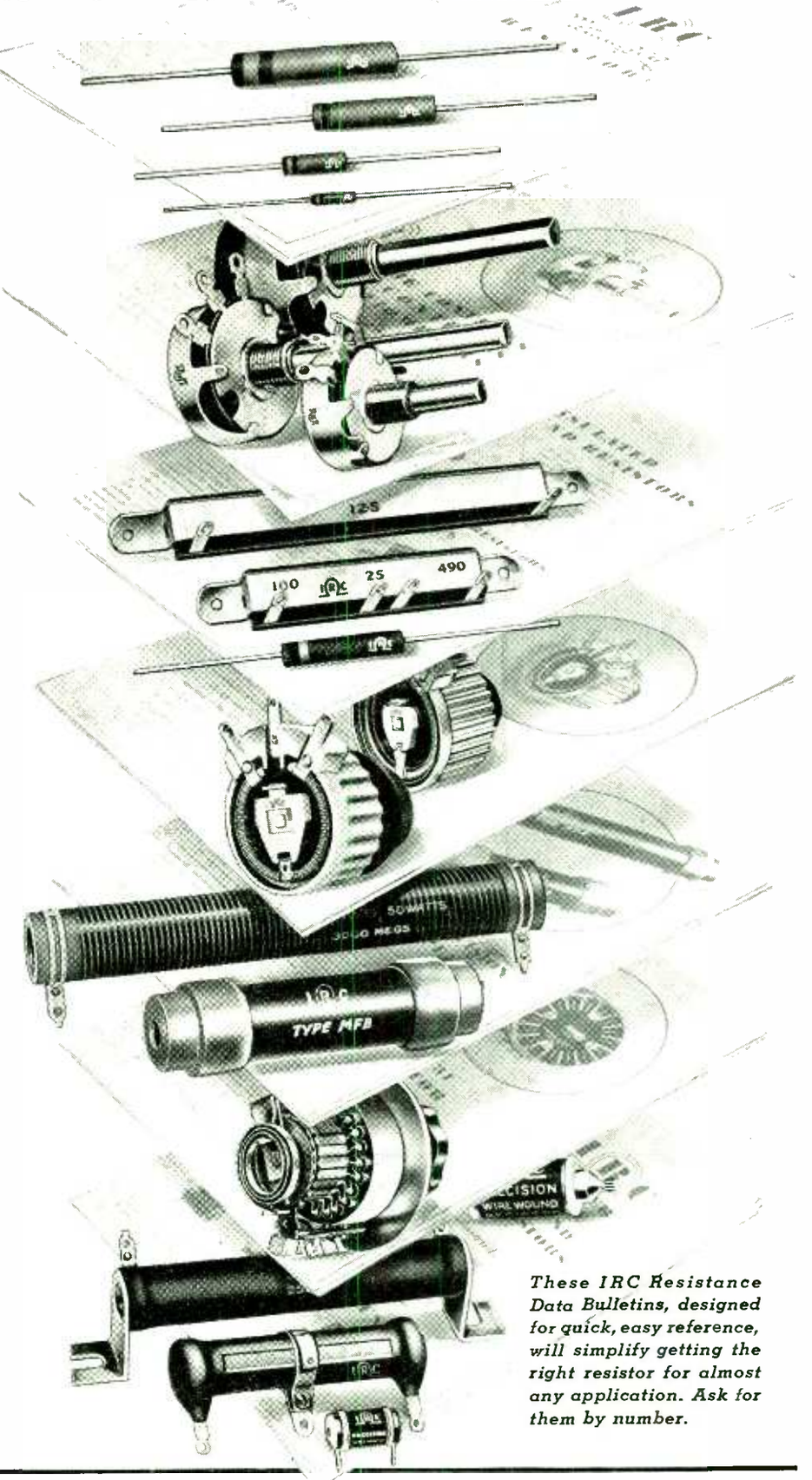

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the back focal plane thereof, according to a predetermined time schedule during a picture-making period, but without the introduction of perceptible aberrational errors in the conjoint optical system. As indicated in Fig. 2, this may be achieved by inserting a differential focusing plate in the path of the image-forming rays so that the new image will be displaced away from the lens by an amount depending upon the thickness of the parallel-plane diffo plate and its refractive index.

If an object at position O_1 in Fig. 2 forms an image on the photographic plate at I_1, an object at O_2, somewhat more removed from the lens, will form its image at I_2 in front of the plane of the photographic material. In order that the image of O_2 may be brought to the plane of the photographically sensitive material at I_1, it will be necessary either to refocus the lens by increasing the lens-image distance or, as indicated, to insert a plane diffo plate behind the lens. By employing a series of diffo plates which may be successively but rapidly placed in the path of the image forming ray, it is possible to alter the focal length of the optical system by discrete steps quite rapidly without rotating the lens barrel.

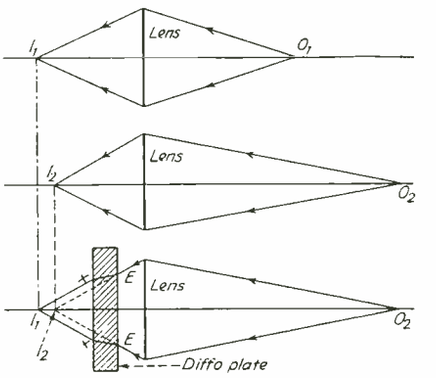
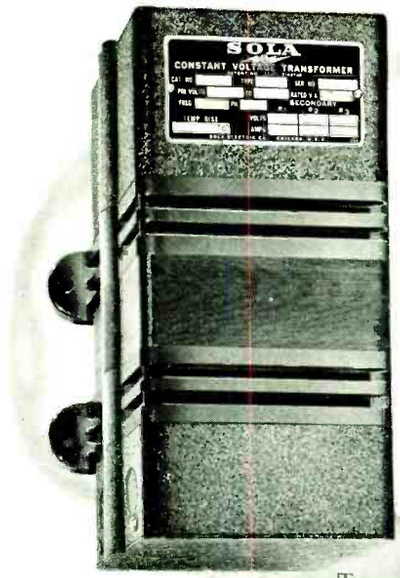


Fig. 2—Method of altering focus by use of diffo plate

Since each individual diffo plate, when combined with a lens, will produce images which may be regarded as being in focus for a different lens-object distance and since the total exposure is made up of several partial exposures, a new technique of illumination is required for optimum utilization of this optical system. The new technique utilizes what might be termed regional lighting, in which only that portion of the scene to be photographed (corresponding to a depth-of-field region) is illuminated for the particular lens-object distance which is focused on the film. Illumination for other regions of the set is brought into play successively as additional diffo plates enter the optical path. Thus, illumination is provided only for that region for which the lens is in focus. When another diffo plate is brought into the optical path of the lens, another region of the scene is illuminated, and so on. This requirement makes it necessary to provide a system of illumination which may be operated in a brief period of time and



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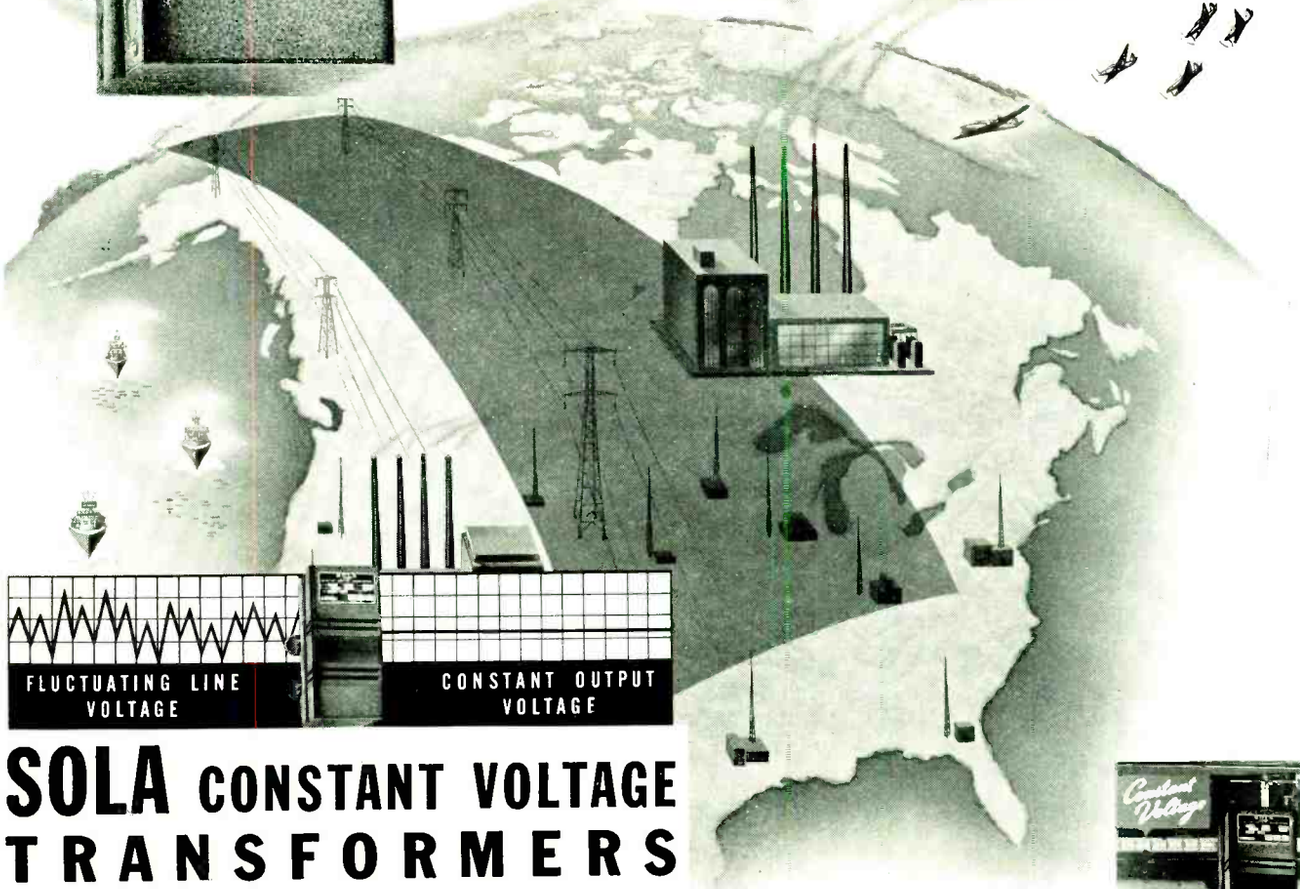

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which may be correctly synchronized with the operation of the diffo plates. This may be accomplished through the use of a completely separate system of illumination for each region, and by synchronizing the illumination with the operation of the diffo plate. To assure rapid operation, illumination is obtained from gaseous discharge rather than from incandescent lamps. Other considerations in the use of this regional type of illumination are that there shall be a relatively small percentage of "spillover" light from one region to the next and that there shall be reasonably good blending of light between the various regions. Experience has shown that the sharpness of photographic focus is not appreciably affected on important parts of each regional picture if the spillover does not exceed 3 percent.

Extensive work with the IR system has made clear that the method is not a mathematical abstraction or a precision geometrical system under usually desirable working conditions. It turns out to be a convenient method of operation with which liberties can be taken in practice, and which can be used with the same latitude and expression as any other photographic system. Illustrations made by the author showing depth of field with the usual system and that obtained with the IR system definitely indicate the superior depth-of-field obtainable with the new technique.

• • •

A Simple Expander

By Walter Bacon
Yorks, England

The system of contrast expansion described below employs simple apparatus, and can readily be fitted to an existing amplifier. It gives results which are good audibly and can also be shown to satisfy the theoretical conditions for correct expansion.

The basis of the method is to control feedback from the output transformer to an early stage of the amplifier by means of a small lamp. The resistance of such a lamp increases rapidly with the voltage applied to it. By a suitable circuit arrangement this can be used to decrease the amount of negative feedback applied as the output voltage increases. At low values of output feedback is considerable and the gain of the amplifier is much reduced, i.e., a small input signal will produce a much lower output than it would do were feedback not present.

At high output levels, on the other hand, the negative feedback is small or even zero. The gain of the amplifier is accordingly high. To a large input signal the amplifier acts as it would without the additional expansion and feedback circuit.

The system thus operates by reducing the level of soft passages while leaving the loud ones unchanged. The maximum output is still obtainable from the same input signal.

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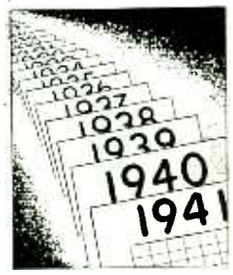

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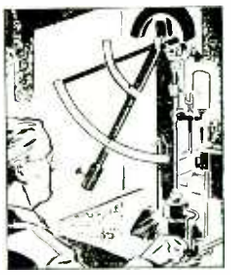

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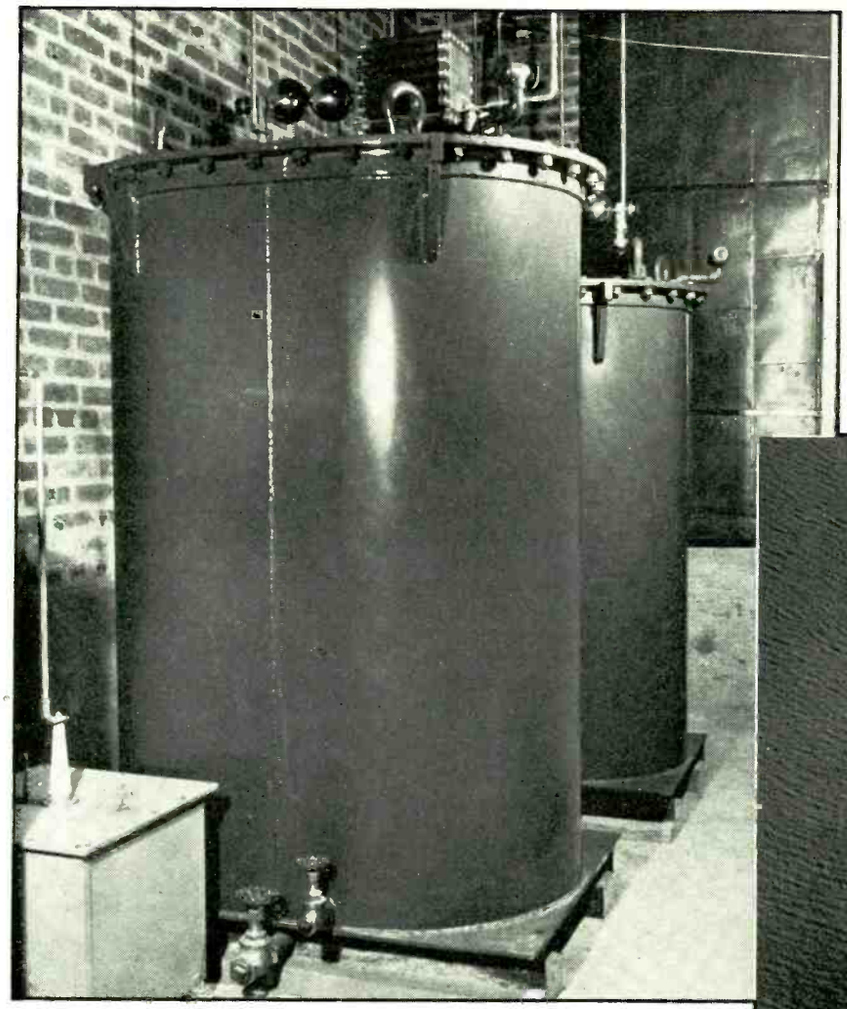

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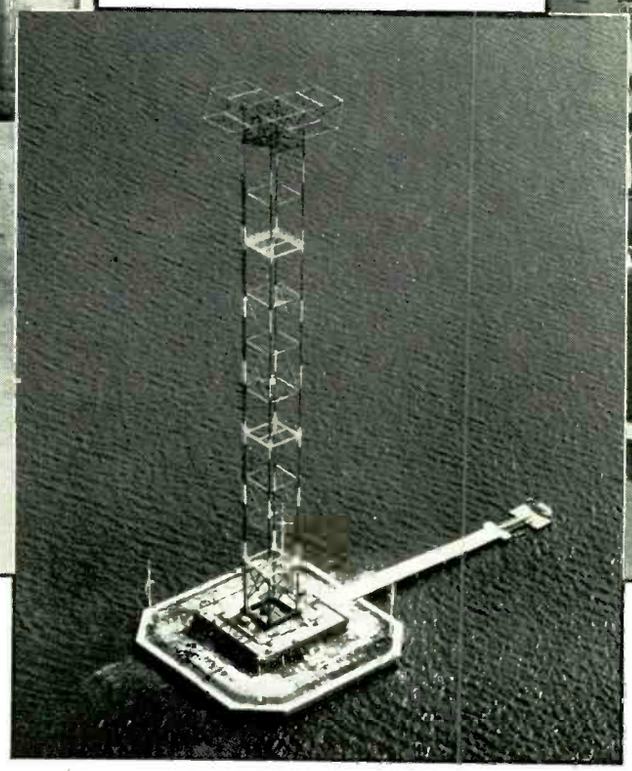

AmerTran Modulation Transformer and Reactor at the WABC 50 KW transmitter.

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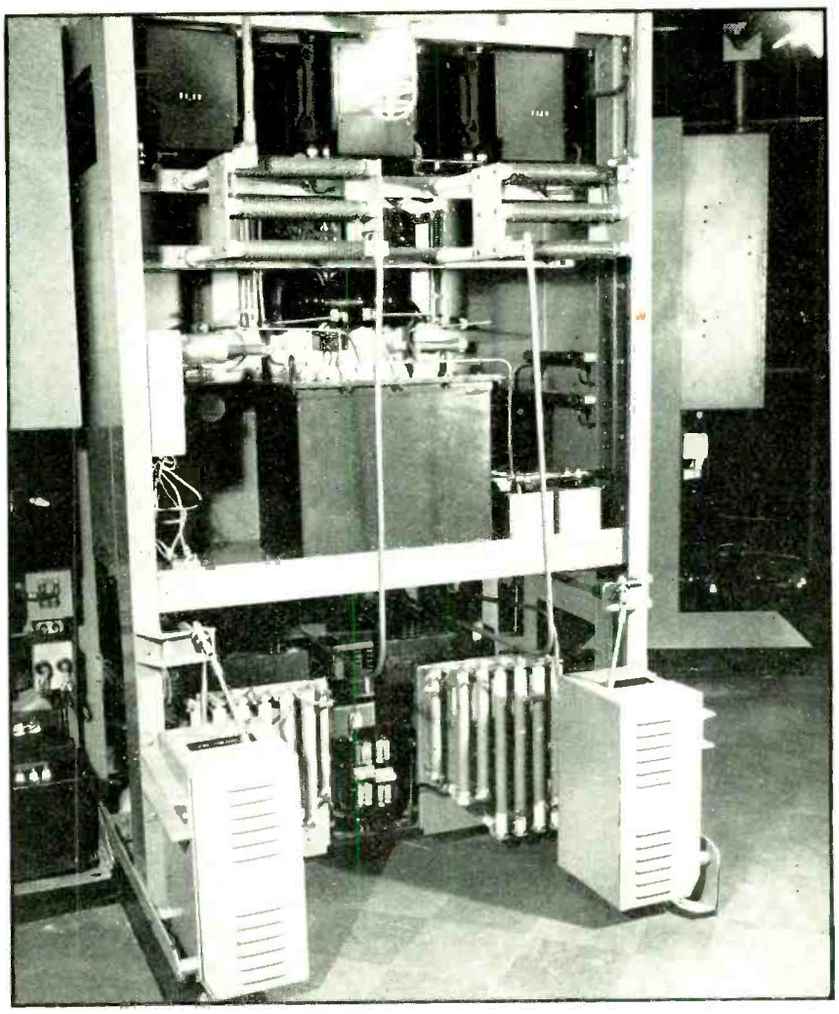
AmerTran Transformers used for the grid bias rectifier at WABC.



Rear view of Modulator. In center on rack is an AmerTran Interstage Transformer. On floor left and right, connected by gear-driven remote control are two AmerTran Transtats.

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The mechanism for obtaining this effect is shown in Fig. 1. The lamp L is placed in series with the resistance R_1 across a low impedance winding on the output transformer. A bridge circuit is completed by the resistances R_2 and R_3, also in series across the transformer.

A separate low impedance winding may be kept especially for expansion purposes, but if it is not desired to do this the bridge may generally be run in parallel with a low impedance speaker. It is essential, however, that neither side of the speaker be grounded.

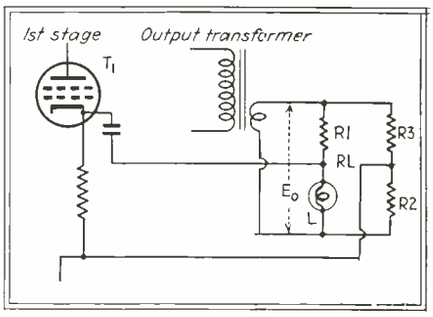


Fig. 1—Schematic wiring diagram of bridge circuit expander

It will be seen that a voltage whose magnitude depends on the value of R_L will be fed back from the output to the first tube T_1. Thus if R_L is zero, the voltage fed back is $E_o R_2/(R_2+R_3)$. As R_L increases, this feedback voltage decreases until when $R_L/R_1=R_2/R_3$ there is no feedback voltage at all.

Increase of output voltage from the amplifier will cause more current to pass through the lamp, the resistance of which will rise. This will cause the feedback to be cut down, increasing the gain of the amplifier. The output voltage will accordingly be further increased. Thus doubled input voltage will cause the output voltage to be much more than doubled so that the range of volume is being expanded.

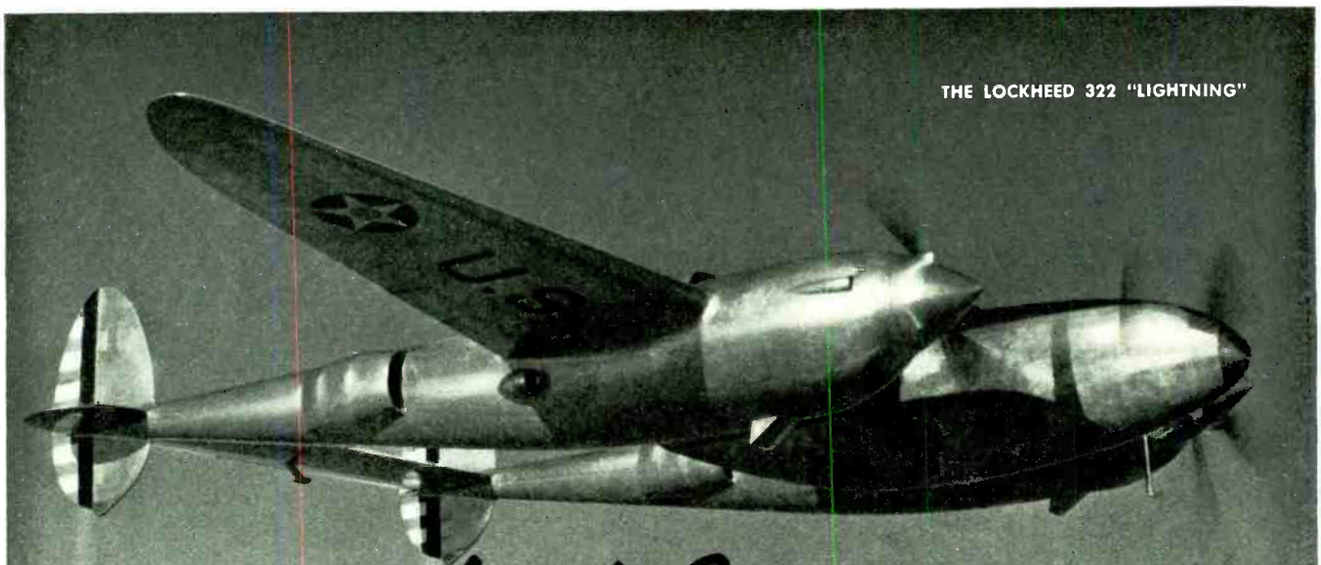
Should R_L ever exceed the value which makes $R_L/R_1=R_2/R_3$ feedback will change over from negative to positive. The amplifier will then go into uncontrollable oscillation. It is therefore necessary to arrange that R_L reaches this value only at the maximum possible output of the amplifier.

For successful operation of the system it is necessary to satisfy two sets of conditions:—(1) the expansion must be correct, yet (2) it must not cause the amplifier to be unstable. The condition for correct expansion is that a given db change of input shall cause a greater db change of output, but that the output-input ratio shall remain constant. From this may be deduced certain relations between amplification and output.

Let e_1 and e_2 represent the two values of input voltage.

a_1 and a_2 represent the corresponding amplifications of amplifier.

E_1, E_2 represent the corresponding output voltages.



THE LOCKHEED 322 "LIGHTNING"

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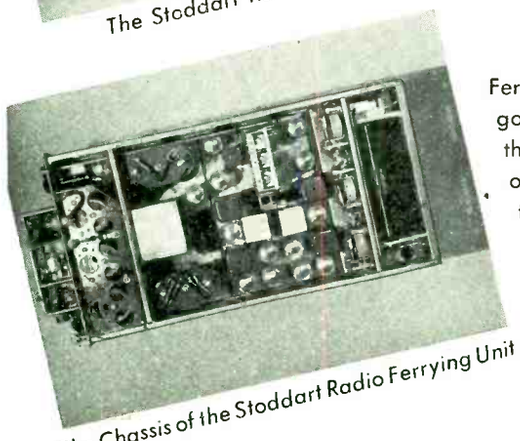
The Stoddart Radio Ferrying Unit



The Chassis of the Stoddart Radio Ferrying Unit

THE Lockheed 322 "Lightning," British version of the P-38 and the Hudson, a bomber, is equipped with Sylvania "Lock-In" Tubes for all ferrying equipment.

This is also true of the "Catalina" (PBY Flying Boats), built by Consolidated Aircraft. It was one of these latter ships which discovered the "Bismarck" and led to her destruction. . . . The radio ferrying equipment for both of these planes is produced by Stoddart Aircraft and Sylvania "Lock-Ins" are standard because they can take all the punishment that ferrying planes can give.

Ferrying equipment receives extremely hard abuse because the sets go into planes on the Pacific Coast for use across the country. Then they are removed and shipped back to the Coast to be installed in other planes. They must stand up because there is a minimum of time for the reinstallation and little if any for servicing.

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Then, expressed mathematically, the condition stated above is:—

$$\log_{10} E_2/E_1 = R \log_{10} e_2/e_1 \qquad (1)$$

where R is a constant. But we may also write $E_2 = a_2 e_2$ and $E_1 = a\ e_1$ or $e_2 = E_2/a_2$ and $e_1 = E_1/a_1$. Substituting these in Eq. (1)

$$\log \frac{E_2}{E_1} = R \log \frac{e_2}{e_1} = R \log \frac{E_2}{E_1} \cdot \frac{a_1}{a_2}$$

$$= \log \left(\frac{E_2\, a_1}{E_1\, a_2} \right)^R$$

Taking antilogs of each side,

$$E_2/E_1 = (E_2 a_1/E_1 a_2)^R$$

Collecting voltage terms together,

$$(a_1/a_2)^R = (E_2/E_1)^{1-R}$$

Raising each side to the power $-(1/R)$ (which inverts the L.H.S.),

$$a_2/a_1 = (E_2/E_1)^{-(1-R)/R}$$
$$= E_2{}^{(R-1)/R}/E_1{}^{(R-1)/R}$$

Hence $a_2 = a_1 E_2{}^{(R-1)/R}/E_1{}^{(R-1)/R}$

a_1 and E_1 are fixed datum values and since for correct contrast R must not change we may write:—

$$A = a_1\ E_1{}^{(R-1)/R}$$
$$K = (R-1)/R \qquad (2)$$

and hence

$$a_2 = A E_2{}^K \qquad (3)$$

which is a general expression for amplification in terms of output. Rearranging Eq. (2) to express R in terms of K,

$$R - 1 = KR$$
$$R = 1/1 - K \qquad (4)$$

It will thus be seen that as K is increased from zero (i.e. an ordinary non-expansion amplifier) the value of R is increased from unity until as K tends to 1, R tends to infinity. The criterion of stability is thus that K shall be less than one.

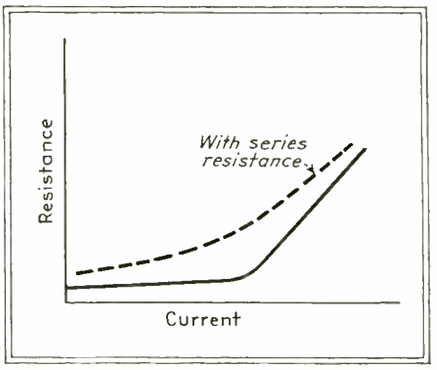


Fig. 2—Resistance-current curve for lamp with and without series resistance

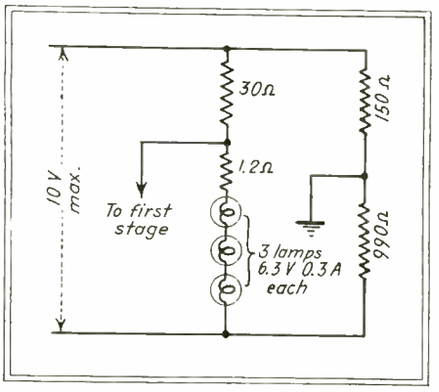


Fig. 3—Circuit constants of expander

Always NEW!

A radical plate design in 1936 greatly improved power capabilities and efficiency of 250T.

In 1941 further improvements and still greater efficiency.

VETERANS of many outstanding achievements in radio, yet there's no such thing as an OLD tube type at Eimac. Past achievements paved the way for present leadership in the field. Leadership made possible by "heads-up" developments in tube construction and performance capabilities. The plates in Eimac tubes today are not the same, by a long way, as those originally used. And yet basically they are the same. Note the pictures above. See one of the early models and the improvement in the modern design which represents greater efficiency. By such constant improvement, Eimac tubes are kept "always NEW"... always a step ahead of the needs of the industry. Each tube has behind it the successful years of its predecessors... radical departure from conventional in tube design... ability to perform without strain where many others have failed. Such is the Eimac 250T. Originally the Eimac 150T, it surprised the industry by performing so easily, the task of much larger tubes that, with slight modifications, its rated capabilities were boosted by more than 60%. The record today shows these comparatively small triodes being used in newer transmitters for jobs once thought impossible. Eimac tubes are like that, one and all. They are the only tubes on the market which carry unconditional guarantee against tube failures which result from gas released internally.

Follow the leaders to **Eimac TUBES**

Eitel-McCullough, Inc.
San Bruno, Calif.

EIMAC 250T

Plate Dissipation (normal)	*250 Watts*
Filament Voltage	*5 to 5.1 Volts*
Maximum Plate Voltage	*3000*
Power Output at 3000 volts on plate	*750 Watts*

EIMAC REPRESENTATIVES

California, Nevada
HERB BECKER, 1530 W. 104th St., Los Angeles, Cal.

N. Y., N. J., Penn., Md., Del., Dist. of Col., Maine, N. H. R. I., Conn., Mass.
ADOLPH SCHWARTZ, 262 Grayson [illegible], New

Wash., Ore., Idaho, Mont.
GENERAL SALES CO., Verner O. Jensen, 2605-07 Second Ave., Seattle, Wash.

Colo., Wyo., New Mexico, Arizona, Utah
RICHARD A. HYDE, 4253 Quitman St., Denver, Colo.

[illegible] Frazar & Co., Ltd., 301 Clay Street, San Francisco

Chicago, Illinois, Wisconsin
G. G. RYAN, 549 W. Washington Blvd., Chicago, Ill.

N. Caro., S. Caro., Georgia, Tenn., Flor., Ala., Miss.
JAMES MILLAR, 316 Ninth St. N. E., Atlanta, Georgia.

Texas, La., Okla., Ark.
J. EARL SMITH, 2821 Live Oak St., Dallas, Texas.

Ohio, Mich., Ky., Ind., Minn., Mo., Kan., Neb., Iowa
PEEL SALES ENGINEERING CO., E. R. Peel, 154 E. Erie St., Chicago, Ill.

The value of K is determined by the relative values of the resistances in the four arms of the bridge, and the way the lamp resistance varies.

It will be seen that the resistance-current curve for the lamp, solid line of Fig. 2, may be modified and given a more uniform rate of change by the addition of series resistance. A small resistance is included in series with the lamp therefore. The values adopted are shown in Fig. 3.

• • •

Errata

DR. EUGENE MITTELMANN has pointed out that the relationship between power absorption and area of electrodes is exponential rather than linear as stated on page 51 of the September issue. The proper relationship is given by the chart, "Design Chart for R-F Heat Treatment Generators."

Incidentally, the chart has been improved by addition of a power factor scale in the lower right corner under the scale of "Distance Between Each Side of Object and Electrode." While it is not feasible to republish this graph, those interested may add their own power factor scale, since this scale is logarithmically ruled. Values of 3, 24, and 54 percent power factor occur immediately under distances, D, of $\frac{1}{4}$, $1\frac{1}{2}$, and 3 inches, respectively.

With regard to his article, "Power Factor Meter" Alexander Bereskin points out an elusive decimal point in the second paragraph of the last column of page 42. The equation should have read, $(0.5 \times 100)/120 = 0.42$, instead of 42 percent.

• • •

A Transcription Control Box

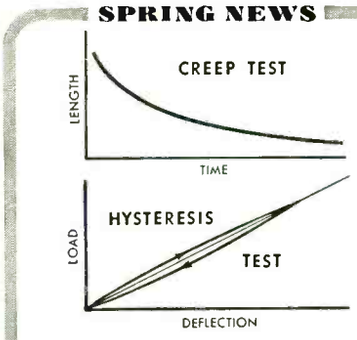
By E. L. MARVEN

WORC, Worcester, Mass.

BROADCASTING STATIONS GENERALLY use transcription playback equipment in groups of twos, but no particular equipment manufacturer, up to the time of writing, has seen fit to supply, as a regular stock item, a suitable control box for use in conjunction with a dual-turntable setup. The only steps taken in this direction by the large equipment manufacturers have been in connection with studio control console layouts, wherein provisions have been made for connection of two turntables. In stations in which the turntables are operated by the production or announcing personnel and the switching and control operations performed by studio technicians, this setup did not seem to be adequate. Consequently, steps were taken by the writer to design and construct a suitable transcription control box, based on our practical needs at WORC, which covers practically all phases of control in reproducing transcriptions for broadcasting purposes.

Springs get the CREEPS—This Measures Them

SPRING NEWS

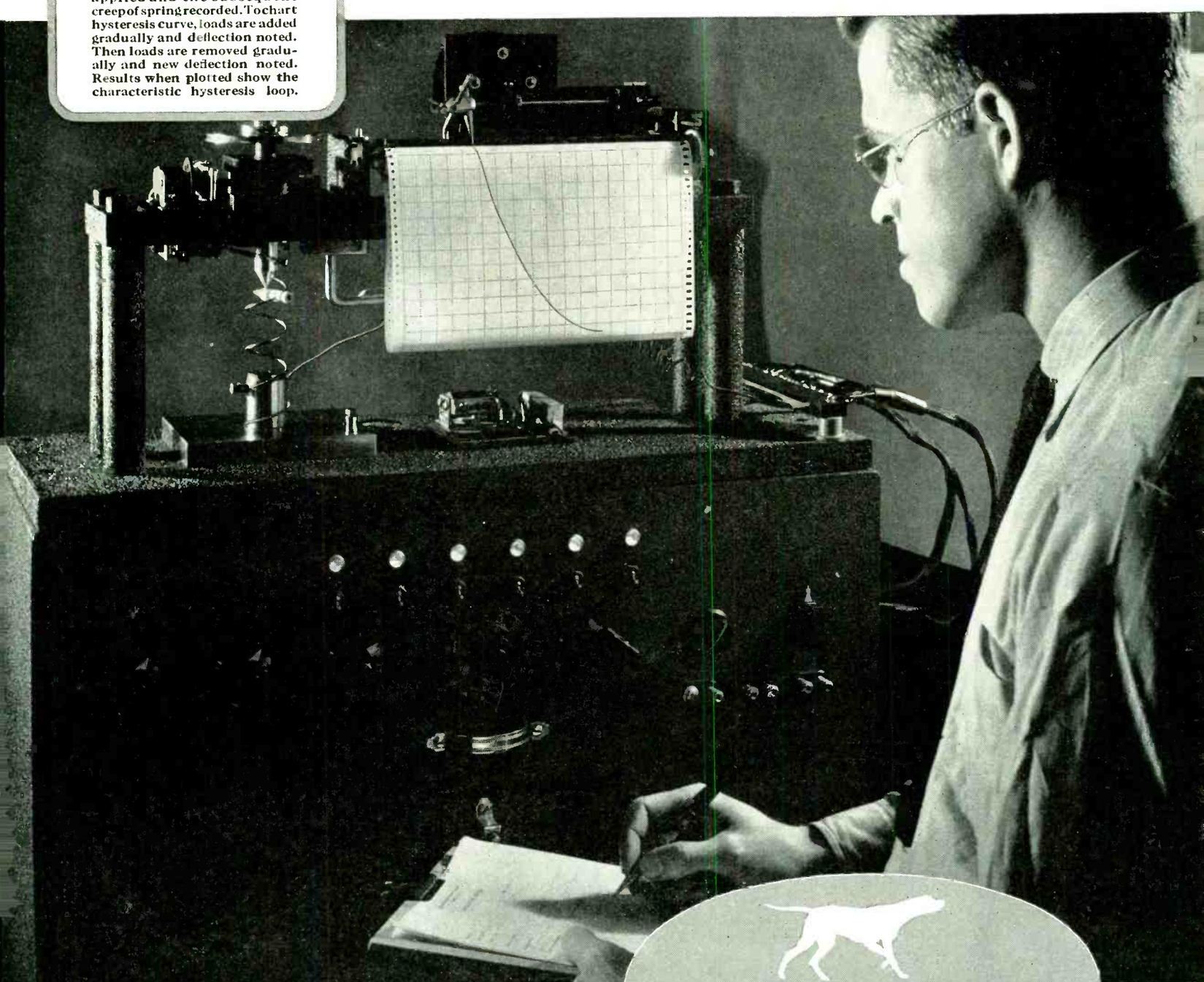


In the creep test a fixed load is applied and the subsequent creep of spring recorded. To chart hysteresis curve, loads are added gradually and deflection noted. Then loads are removed gradually and new deflection noted. Results when plotted show the characteristic hysteresis loop.

FOR A LONG TIME it has been known that a slow plastic flow takes place in metals subjected to a constant load at elevated temperatures. Engineers have a word for it. They call it "creep". Creep has a pretty important bearing on certain precision applications. And, since precision springs are Hunter's business, Hunter naturally wanted to find out all it could about the effects of creep on spring metals.

Thus an entirely new kind of automatic creep testing machine was evolved and built in the Hunter laboratories. This machine is a super-sensitive motion recorder which uses electronic detectors to shadow every micrometric change in length; enlarges them; then charts them plainly. More than that—*it even records its own errors automatically*—and presents for observation an accurate picture of hysteresis and elastic recovery, two other factors of value in perfecting spring performance.

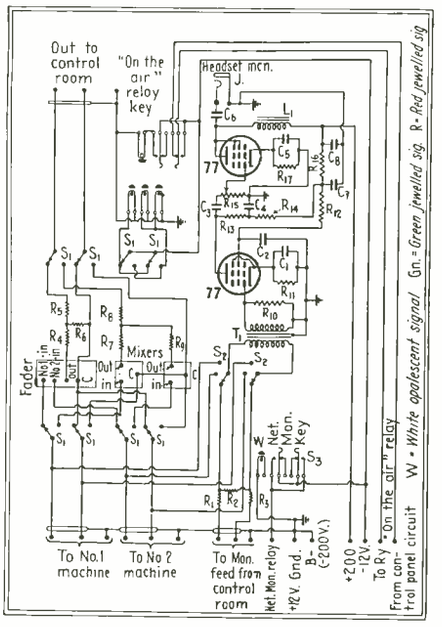
The "creep" test machine is one of the means which Hunter uses to take the guesswork out of spring making, to develop new uses for springs, to improve springs for present applications.



HUNTER
Science in Springs

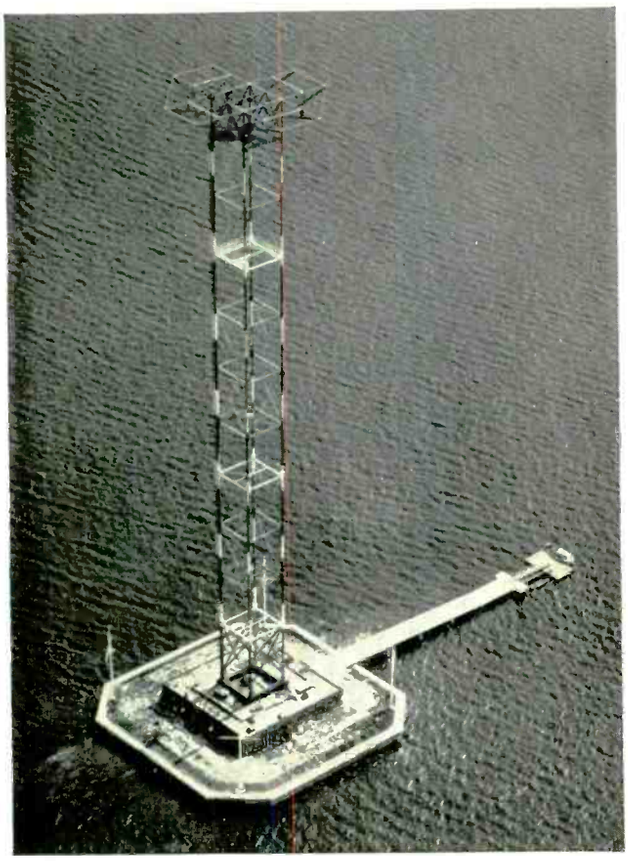
HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.

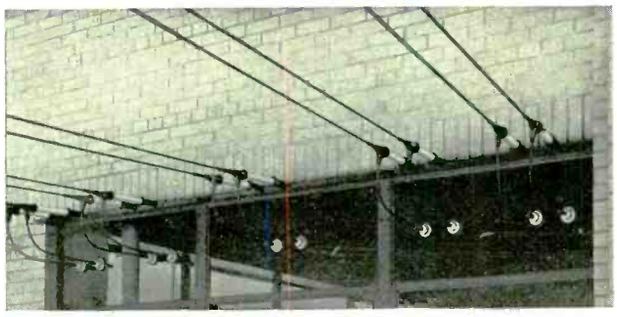
For normal program work involving transcriptions or recordings, a transfer-fader unit was selected as the simplest form of change-over device, while still retaining the fade-in feature. The Tech Laboratories in Jersey City, N. J., supplied us with one of their dual input fader units, mounted in their 214 Gove vertical mixer assemblies; this unit is known as type FA-214 fader. It was mounted horizontally and arranged for operation in much the same manner as that of a lever-type key switch, but still retaining the fade-in or fade-out features, which for operation required only the flick of a finger. The use of this fader did not solve other phases of operation, however, and conditions arose occasionally, for which it was necessary to superimpose the output of one transcription machine upon the output of the other. This necessitated the use of a dual fader or mixer setup, in addition to the transfer fader. For this purpose, two of the small sized Tech Laboratories mixers (type LE-240) were obtained, and a rotary switch employed, to transfer both the inputs and the outputs of the two systems into the common transcription circuit going to the control room for subsequent amplification, control and switching.



Circuit of transcription control unit

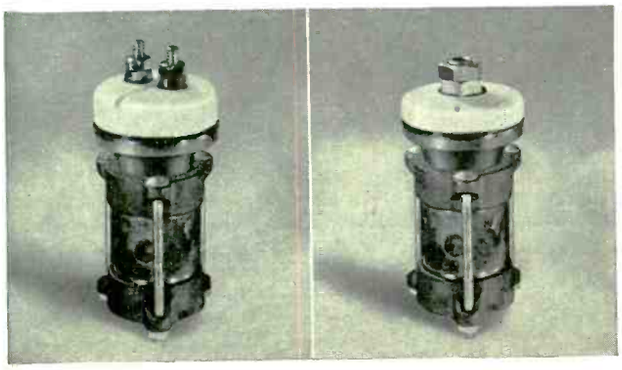
The next problem was that of monitoring and of pre-monitoring of discs, subsequent to their use. As close timing of transcribed program material is essential if smooth and accurate handling of the transcriptions is to be attained, it is necessary to employ some means of determining lead-ins on the discs. Previously employed was the old familiar method of placing a piece of paper against the stylus of the reproducer head and listening to the subsequent vibration of the sheet of paper. This procedure was quite unsatisfac-





(*Above*) 13 DIRECTIONAL ANTENNAS will serve another new Columbia installation—the short-wave station at Brentwood, Long Island, which will be used chiefly for broadcasting to South America and to Europe. Photo shows Isolantite lead-in and strain insulators on five of the thirteen antennas—one of the many ways in which Isolantite is used at this station.

(*Below*) FLARE-TYPE END SEALS for transmission lines are engineered by Isolantite's Radio Specialties Division specifically for the requirements of ultra-high frequency service, such as FM, television, airport beacons, and special applications. In these new designs, flared copper tubing is capped with an Isolantite disc of relatively thin cross-section—keeping unshielded portion of conductor to a minimum, and reducing lump capacity. End seals include solderless fitting for transmission line attachment.



tory and damage to both reproducer head and disc could easily occur. As headphones were frequently used in the transcription studio, despite the fact that loudspeaker facilities were available in this studio, a small two-stage amplifier was incorporated into this control unit in order to raise the output level of the reproducer heads to a value satisfactory for headphone monitoring. The input to this amplifier was approximately 20,000 ohms and the amplifier was connected through a three-position rotary selector switch.

The input to the headphone monitoring amplifier was arranged so as to bridge the 200-ohm output of each of the two transcription machines directly; in the first position (of this three-position selector switch) the monitoring amplifier is bridged across the left-hand or No. 1 machine, while in the second position the amplifier is bridged across the right-hand or No. 2 machine. In the third position, the normal or "on the air" monitoring circuit is fed to the monitor amplifier. As monitoring of our associated network facilities is frequently necessary in the studio, this on-the-air monitor circuit was fed through a double pole double throw relay in the control room and control facilities provided on the box in the form of a turn key, along with an associated signal lamp. It is realized that an additional position on the three-position rotary selector switch could have been utilized for this feature, but the relay facilities had been in operation at our station for some time and remained in operation as they were quite satisfactory.

• • •

HEADACHE CURE

This contraption, which is made of plaster, and contains an alarm clock, thermometer, a motor-driven egg beater, and several glass tubes painted gold is supposed to cure headaches. The police are having a headache trying to find the man who sold it to a woman for $5.00

"I got into Broadcasting back in '23..."

"*Looking back* on those days, I have to laugh at some of the things we did. But I've never laughed at the equipment we've used.

"*Our first transmitter* was a 100 watt Western Electric. Plenty of things gave us trouble in those days, but that transmitter caused us least worry of all. When we increased power, we sold the 100 watter and bought a 500 watt Western Electric.

"*Each time we stepped up*—to 1 KW, 5 KW and then to 50 KW—we stuck with Western Electric. And each time, we found a ready market for the old transmitter.

"*Perhaps there were times* when we could have bought a transmitter for less money—or maybe one with more shiney metal trim. But we looked at the works and workmanship. In 18 years, we've never bought a piece of equipment that didn't have the name Western Electric on it—and we've never regretted a single purchase.

"*I'm no engineer,* but I got a real kick out of some of that equipment. It was a thrill when we went to crystal control—and when we received a transmitter with stabilized feedback! Later, thanks to Western Electric and Bell Labs, we had the first single mast radiator in our territory. But about the biggest thrill of all comes each month when I look at our power bills and realize the savings made possible by the Doherty circuit in our present 50!

"*For 18 years* it has always been Western Electric for me—and it always will be!"

And we at Western too are proud of our long association with the industry. Although our energies are now engaged in the defense program, you may be sure that our interest and that of our distributors in broadcasting and in you who are a part of it is as keen today as in the past.

DISTRIBUTORS: In U. S. A.: Graybar Electric Co., New York, N. Y. In Canada and Newfoundland: Northern Electric Co., Ltd. In other countries: International Standard Electric Corporation.

Western Electric
EQUIPPED FOR BETTER BROADCASTING

Since individual transcriptions and recordings varied considerably in level, a volume control was also incorporated into the unit, controlling the gain in the second stage of this amplifier. As type 77 tubes were commonly employed in other studio equipment, it was decided to utilize this particular type for both stages. The first stage of the amplifier was pentode connected, while the second stage was triode connected, so as to provide a fairly low impedance (approximately 2000-3000 ohms) for direct operation of a headset. A push-pull interstage transformer was employed as an input transformer, while the remainder of the amplifier was resistance coupled, with an impedance coupled output circuit. A 12-volt supply was available in the control room, so series heater operation of the tubes in the monitoring amplifier was decided upon.

In order to quickly determine which of the two control means were in operation on the control box, switchboard lamp jacks were located over each of the three control devices; two red lamps located over each of the two mixers, while a green lamp was located over the transfer fader unit. The control circuits to these lamps were wired through the two position mixer-fader switch and the d-c supply for these indicator lamps was further wired

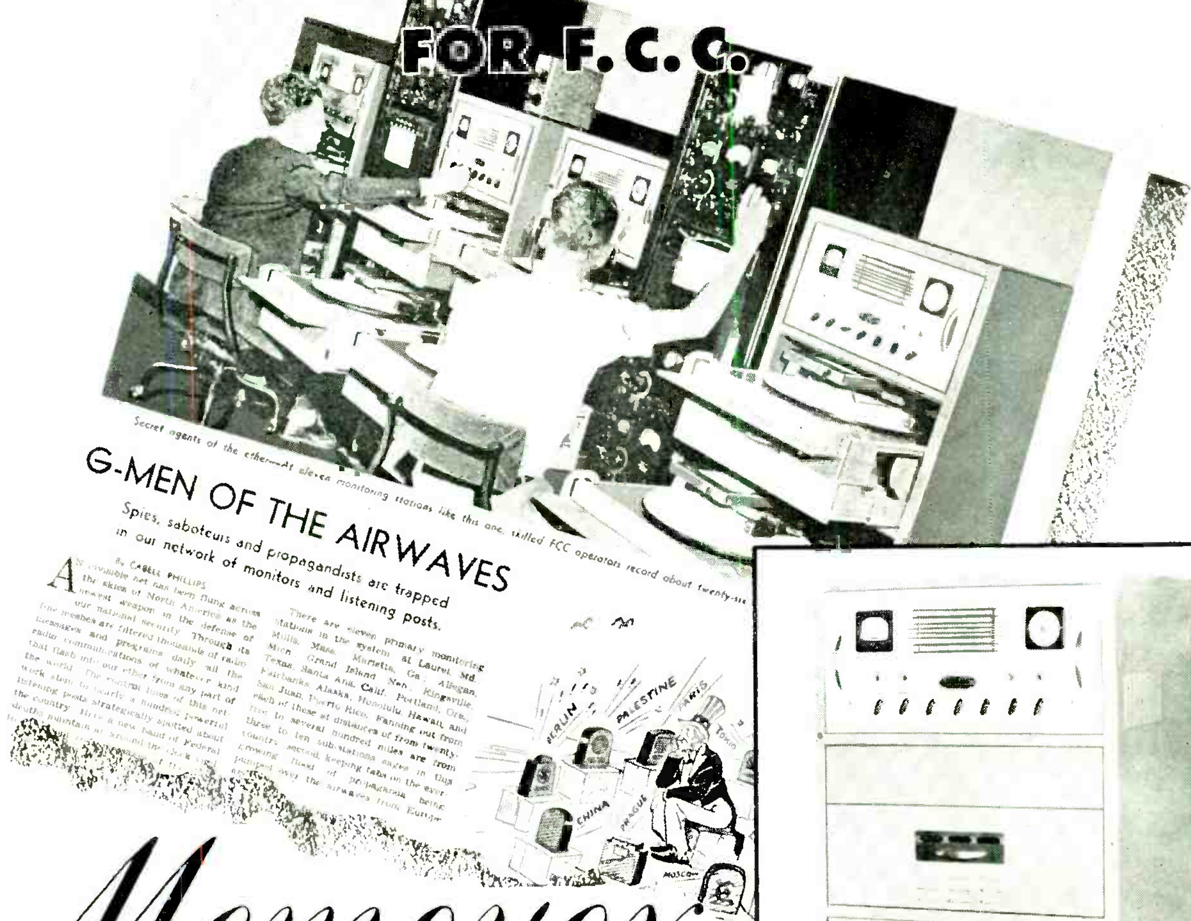
PARTS LIST:

R_1 = 2500 ohms ¼ watt or smaller
R_2 = 250 ohms ¼ watt
R_3 = 2500 ohms ¼ watt
R_4 = 62 ohms ¼ watt
R_5 = 62 ohms ¼ watt
R_6 = 900 ohms ¼ watt
R_7 = 73 ohms ¼ watt
R_8 = 73 ohms ¼ watt
R_9 = 73 ohms ¼ watt
R_{10} = 100.000 ohms ¼ watt
R_{11} = 3000 ohms ½ watt
R_{12} = 2.5 megohms ½ watt
R_{13} = 200,000 ohms ½ watt
R_{14} = 20,000 ohms ½ watt
R_{15} = 250,000 ohms log. taper vol. control.
R_{16} = 25,000 ohms ½ watt
R_{17} = 1000 watt ½ watt
(all of above are carbon resistors)
T_1 = RCA PP to PP Interstage Transformer
L_1 = Sampson Audio Plate Impedance
S_1 = Mallory-Yaxley Type 1222-L
S_2 = Mallory-Yaxley Type 1312-L
S_1 S_3 = American Automatic B-16
J_1 = Mallory-Yaxley Type A-1
C_1 = 25 mf 50 volt
C_2 = 0.25 mf 400 v
C_3 = 0.03 mf 400 v
C_4 = 0.25 mf 400 v
C_5 = 25 mf 50 volt
C_6 = 0.5 mf 400 v
C_7 C_8 = 8 mf 450 volt (dual unit)

Fader-Tech Lab FA 214
Mixers-Tech Lab LE 240

Cabinet — ParMetal SF 504 (18x9x8 inch
Chassis — to fit above cabinet.
Lamp Jacks — American Automatic & Western Electric
Terminal and Lug strips.
11-Conductor Jones plug & receptacle (receptacle to mount in wall plate)

KEEPING TABS ON PROPAGANDA FOR F.C.C.



Memovox

A FINE RECORDING AND REPRODUCING INSTRUMENT

DEPENDABLE and easy to operate, Memovox is today serving many uses . . . is fast becoming the Standard for quality recording, reproducing and transcribing. Memovox records one *full hour* on *each side* of its thin, inexpensive, flexible discs.

MODEL AA—For stationary installation (dual turntable)—is primarily used where reference recording must be continuous without interruption. The two recording units (each complete with reproducing and logging devices) are interlocked with a timing device. This operates the units alternately and provides an over-lapping to avoid loss of any recording.

MODEL B-1—For portable uses (single turntable)—is primarily intended for the recording of conferences, meetings and hearings.

MODEL AP-100—For transcribing and reproducing. It provides an ingenious, automatic repeat mechanism with foot pedal control for simple, easy operation.

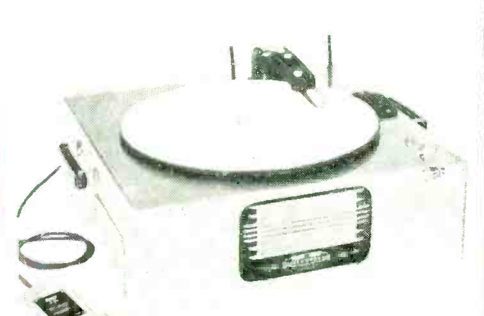
MEMOVOX, INC., 405 N. Maple Drive, Beverly Hills, California

Descriptive Bulletins furnished upon request

Model AA
Continuous Recorder and Reproducer

SOME PRESENT USERS OF MEMOVOX

Columbia Broadcasting System — Coordinator of Information — Federal Communication Commission — United Airlines — General Electric Company — National Broadcasting Company — Westinghouse Electric Company



Model AP-100
Transcriber and Reproducer

through the transcription position key in the control room, so that indication in the studio would take place when the circuit was energized.

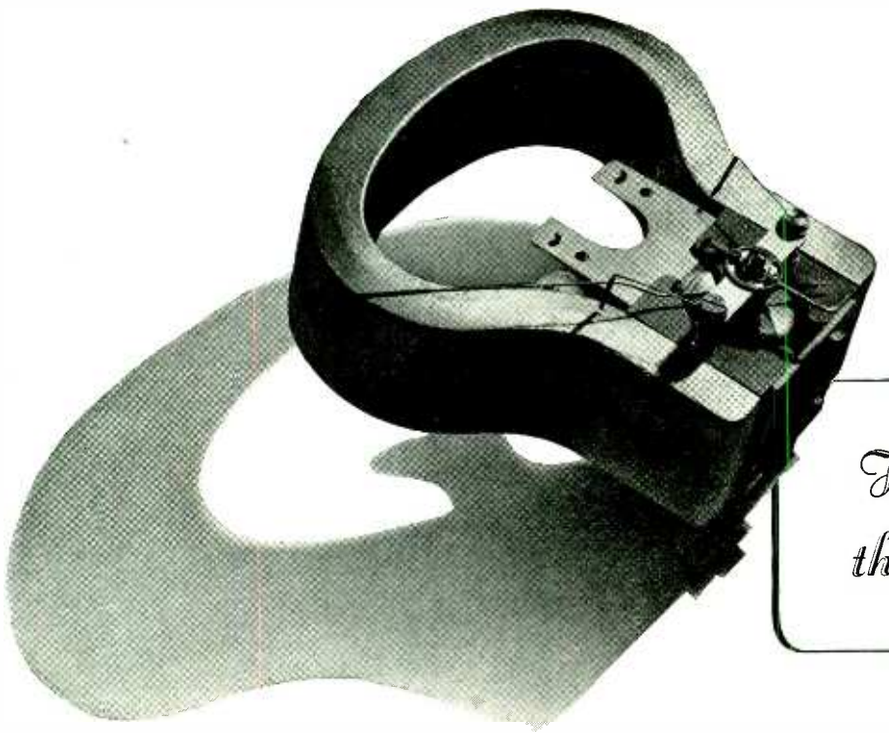
As shown in the illustration, two additional turn-keys and signal lamps were also located on the control unit. Facing the unit from the front, the left-hand key was used to energize the network monitoring relay and its associated signal. The right-hand key is used to control a relay operating a set of on-the-air signals which are located outside of the studio doors as a warning that air operations were either on or about to commence. This key was so wired that in its off position, operation of any of the microphone keys in the control room would energize the on-the-air relay. On programs where switch-overs were on an intermittant basis to and from this studio, the production personnel desired these lamps on continuously, even though the microphone at that particular instant might be off. Consequently, manual operation of this relay was provided by switching to the 12-volt feed when the switch was in the on position.

Terminating these connections on a plug-in basis has made the removal of the equipment from their associated circuits readily available for inspection or for cleaning purposes. A jack for the monitoring headset was also located adjacent to the terminal strips at the rear of the chassis.

In order that the chassis, which was attached to the sloping front panel, could be removed easily from the cabinet, spacer bushings, approximately $\frac{5}{8}$-inch in length and $\frac{3}{8}$-inch in diameter were installed between the front panel and the chassis. The front panel was then attached to the cabinet by means of the self-tapping screws, with which the cabinet came supplied. To facilitate cleaning operations of the transfer-fader unit, the front plate of the fader was made removable from the front of the unit by soldering two small machine screws to the brass mounting ears of the transfer-fader case. Consequently, in order to reach the studs and contact arms of this unit, the only operation required is to remove the control knob and the two machine screws holding in place the front plate.

Cleaning of the fader units, on the other hand, requires removal of the front panel and chassis unit from the cabinet. This is accomplished by removing the self-tapping screws holding the front panel assembly to the cabinet. As the transfer-fader unit is used more frequently than the faders, cleaning of these latter items is required only at intervals.

At WORC, this control unit is used with two RCA 70-C tables, so a suitable bench for supporting the unit was constructed of wood, covered with black masonite and trimmed with chrome molding. This bench was supported in the front by $\frac{1}{2}$-inch pipe fittings and fastened to the wall (in the rear) by angle brackets. The two RCA tables were then butted up against the bench to make a compact unit.



How accurate the instrument?

...HOW PERMANENT THE MAGNET!

So magnets may defy time...here they are being specially heat treated . . . just one of the many operations in magnet manufacture all under WESTON *control to insure lasting permanency and thus provide lasting dependability to all* WESTON *instruments.*

"How come," you say, "that so many WESTON Instruments manufactured ten, twenty or even fifty years ago are still giving dependable service throughout industry?"

For the answer . . . first consider the backbone of these WESTONS. Despite their advanced age . . . the magnets have *remained unchanged* . . . the strength of the magnetic field *remained constant.* Neither time, temperature variations, vibration, nor external demagnetizing influences have had any effect. Thus, with their full strength *"kept in,"* errors due to weakening have been *"kept out."*

The secret of the permanency of WESTON magnets dates back over a half century ago...when in the middle 80's Dr. Weston established the basic principles of design, and manufacturing control, which first gave the iron horseshoe perpetual magnetic life. And it is these same fundamental principles which still give magnets this essential quality of permanency . . . even when modern materials are employed.

So today, at WESTON, these same basic principles are faithfully carried out . . . to give magnets the *same lasting permanency* . . . to provide the *same life-expectancy* . . . to all instruments which bear the WESTON name. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

WESTON

Instruments

LABORATORY STANDARDS . . . PRECISION DC AND AC PORTABLES . . . DC, AC, AND THERMO SWITCHBOARD AND PANEL INSTRUMENTS . . . INSTRUMENT TRANSFORMERS . . . SENSITIVE RELAYS . . . SPECIALIZED TEST EQUIPMENT . . . LIGHT MEASUREMENT AND CONTROL DEVICES . . . EXPOSURE METERS . . . AIRCRAFT INSTRUMENTS . . . ELECTRIC TACHOMETERS . . . DIAL THERMOMETERS

THE ELECTRON ART

Measurement of high frequency attenuation, an azimuth indicator for air navigation, the analysis of tin-lead solders, an electronics spark generator, and fluorescent lighting for aircraft are reviewed

Measuring High Frequency Attenuation

ATTENUATION MEASUREMENTS are often made by passing currents of various frequencies over a section of the transmission line and measuring the input and output with thermocouples. The accuracy therefore depends on the stability and accuracy of the thermocouples. For most purposes this method is satisfactory, but greater accuracy is sometimes required. A new method of measurement has been developed by M. S. Burgess and H. H. Benning, and its features are covered in an article entitled "D-C Substitution Method of Measuring High Frequency Attenuation" by H. B. Noyes which appears in the October 1941 issue of the *Bell Laboratories Record*.

With the d-c substitution method, the accuracy of measurement is practically independent of the calibration and stability of the thermocouple. The thermocouple is used merely to relate the attenuation of the test line to a value of an adjustable calibrated resistance in a d-c circuit. The method requires, however, that either the d-c and a-c sensitivities of a thermocouple be identical, or the ratio between d-c and a-c sensitivities of the sending and receiving thermocouples be the same. A simplified circuit of the d-c substitution method is shown in Fig. 1.

With all three switches thrown up, the conditions are the same as those used in making ordinary measurement of insertion loss of the test pair between a fixed resistance R at the sending end and a series of three resistances at the receiving end which are adjusted to the value R. For such measurements, the thermocouple galvanometers at both ends are read simultaneously and the true input and output voltages are taken from the calibration charts for the thermocouples. From these, the insertion loss is computed. In the d-c substitution method, the pointer of the galvanometer at each end of the line is brought to a position on the scale where the sensitivity is greatest by adjusting the output of the oscillator and the resistances R_S, then an indicating pointer, operated by hand, is brought immediately over the galvanometer pointer to indicate its position. The three switches are then immediately thrown down, and a resistance is adjusted until the pointer of the input galvanometer returns to the position of the indicator pointer.

The resistance R_A, in the d-c reference circuit is then adjusted until the pointer of the galvanometer at the distant end is also brought in line with its indicator. When these two conditions are met, the loss in the reference circuit is the same as that in the test pair. The time that elapses between the two sets of readings is much too short for the accuracy of the measurement to be affected by the lack of stability of the thermocouples. Any convenient pair in the section is selected as the reference pair, and since various pairs differ slightly in resistance, and the resistance of any pair varies with the temperature, an adjustable building out resistance, R_{BO}, is added and so adjusted that its value plus the resistance R of the pair itself is always the same for a series of measurements. It is necessary that the reference pair have very little d-c leakage.

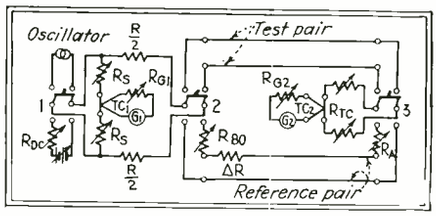


Fig. 1—Simplified circuit of the d-c substitution method of measuring high frequency attenuation

Since R_{BO} plus R is held constant, the insertion loss of the test pair may be determined directly from resistance R_A, and a previously prepared chart showing the insertion losses under the existing conditions for various values of R_A. The terminating resistance R at each end of the test pair should be equal and constant, and as nearly nonreactive as possible. The receiving resistance R is composed of the thermocouple resistance and two adjustable resistances. The latter may be set by means of a d-c resistance bridge which supplies current to the thermocouple equivalent to the test current. The thermocouple chosen should have a resistance which is less than R so that this total resistance may be controlled by series resistances rather than by shunts across the thermocouple. The latter method does not give satisfactory accuracy. Though the accuracy and stability of the thermocouple are not important, they have to be perfectly reversible. Equal currents must produce the same deflection regardless of the direction of the current. This condition is met by using special thermocouples of the separate heater type.

BRITISH WOMEN IN RADIO

Members of the Womens' Auxiliary Air Force Service undergoing instruction in the Morse Code in a training school

THAT *EXTRA* SOMETHING

The HK-454
250 Watt Plate Dissipation. A Modern UHF Tube

It's the extras that make a winner. Extra long life, Extra performance, and Extra stamina are built into every **GAMMATRON** tube. Fourteen years of pioneering tantalum tube design and manufacture have developed Heintz and Kaufman quality to the point where users today expect and get the **GAMMATRON** Extras. • Heintz and Kaufman engineers responsible for these developments will be glad to assist with your individual vacuum tube problem—your correspondence is invited.

GAMMATRONS of course

HEINTZ AND KAUFMAN
SOUTH SAN FRANCISCO LTD. CALIFORNIA U·S·A

Azimuth - Indicating Receiver

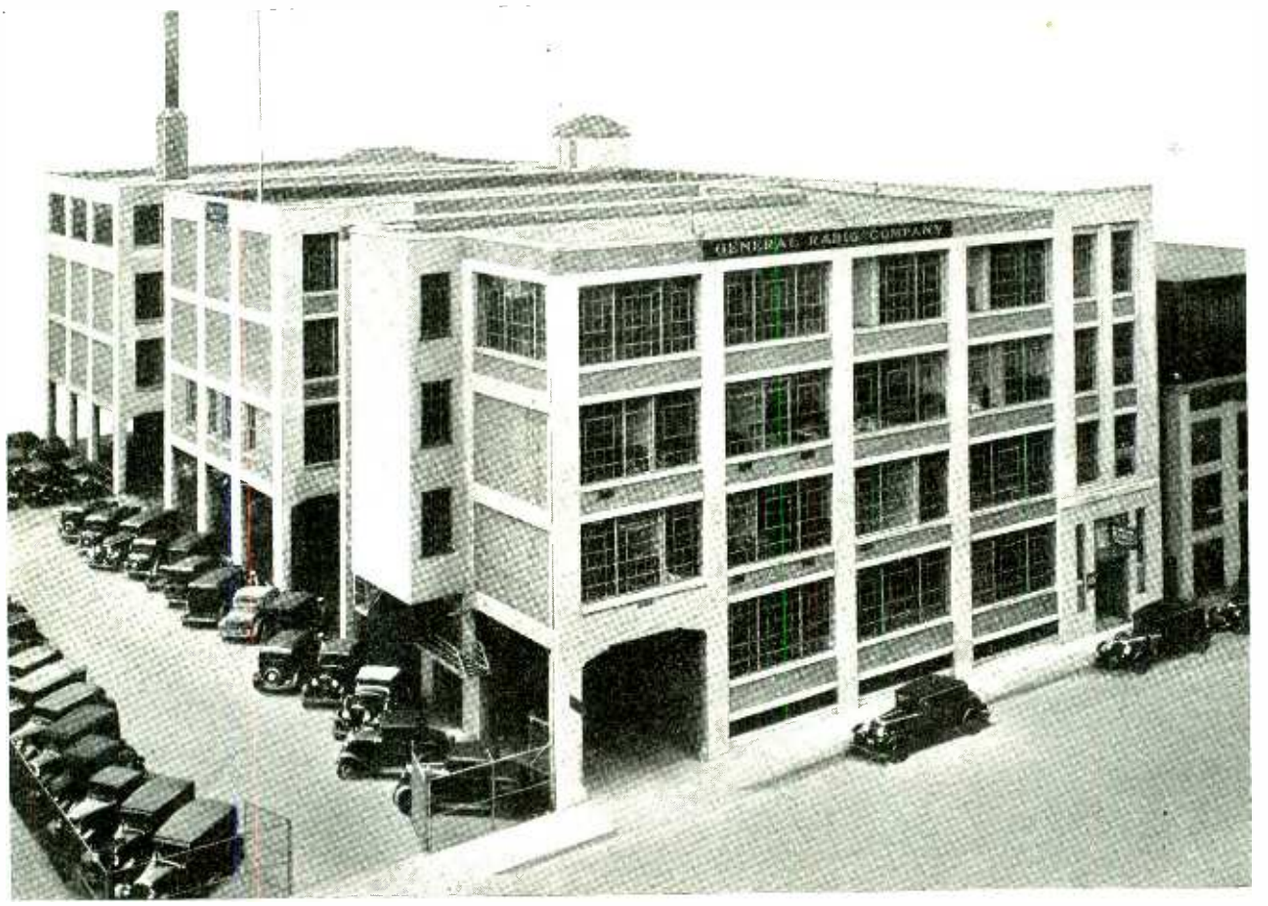
WHEN VISIBILITY CONDITIONS are bad an airplane pilot may easily determine his position by means of a newly developed azimuth-indicating receiver. He has merely to communicate with a ground station equipped with this new set and his position is immediately shown on an indicator panel which is a part of the ground station equipment.

The azimuth indicator in use at LaGuardia Airport. The indication appears on the cathode-ray tube screen

The details of this new device are given in an article called "Azimuth Indicator for Flying Fields" by H. T. Budenbom, which appears in the November 1941 issue of the *Bell Laboratories Record*.

The complete equipment consists of an antenna system, a ten-frequency radio receiver, and an indicator panel. The bright circle in the center of the panel is the end of a cathode-ray tube. A spot of light, normally at the center of the tube is deflected radially outward along the line of the bearing of the airplane as its radio signal is picked up. Any one of ten frequencies may be selected by the dial at the bottom of the panel, a light in the lamp bank at the left indicates the frequency selected. Behind the six vertical bands above the dial is a loudspeaker that reproduces the signal being picked up. The operator may also

The antenna system is located some distance from the airport and connected to the receiver by telephone lines



We Don't Want to Grow too LARGE

VISITORS to the laboratories and factory of General Radio are often surprised at our size. Some think we must occupy a hole-in-the-wall, others that we are spread out over acres.

Happily, we occupy a position between both of these undesirables. Our total floor space is 75,000 square feet, divided between three four-story buildings and occupying about a half a city block. Our total personnel is 287, of which number 30 are engineers.

G-R does not want to grow large; only by following the basic idea upon which the company was founded in 1915 can we continue to serve our customers in the instrumentation field. That idea was to have an organization large enough to get instruments turned out, in peace time, in sufficient quantity to satisfy our customers and give us a reasonable profit; and at the same time small enough to enjoy the flexibility essential to adapting research, engineering and manufacture to the ever rapidly changing developments in the electronic art.

The type of equipment manufactured by G-R does not lend itself to production-belt methods; G-R design will never be cheapened to make mass production possible.

As soon as we grow to be a large company, we lose most of the essential direct contact between engineers and customers, and between engineers and the shop; ideas when diluted by eighteen in-betweens in an organization lose some of their sparkle and much of their originality.

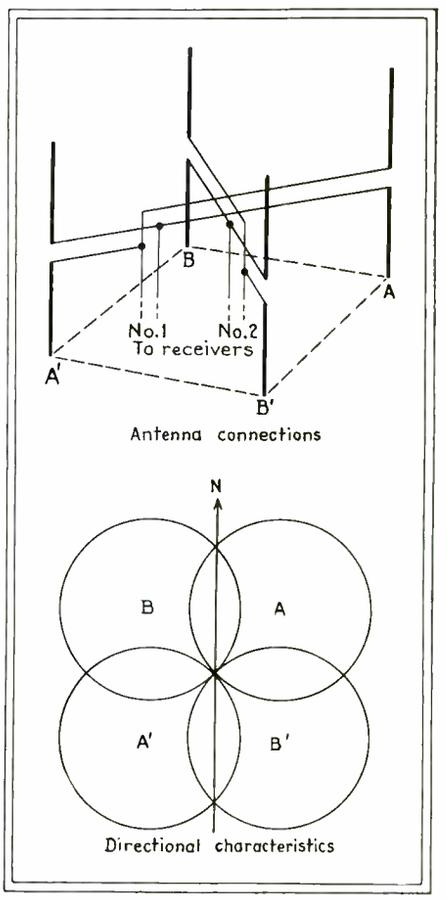
Fundamentally we have only one thing to sell: engineering ideas wrapped up in cabinets with control panels. Many concerns can manufacture more economically than we; few have such a large percentage of idea-developing engineers.

If G-R grows large . . . if it grows so large that to change a machine screw from a 6-32 to an 8-32 requires a design conference, a thousand dollars in drafting time and a month's delay for tooling . . . we will cease to perform the function for which the company was established: to design and manufacture precision electrical measuring apparatus at a price consistent with both the quality of the product produced and the type of persons employed.

GENERAL RADIO COMPANY
CAMBRIDGE, MASSACHUSETTS
Branches in New York and Los Angeles

dial one of seven sensitivity values to insure an adequate signal reception. The sensitivity value is indicated by the bank of lamps located at the right of the panel.

The antenna system consists of four dipoles located at the corners of a square, and a fifth dipole at the center. The four corner antennas are used for determining direction, and the central antenna serves as a reference of r-f phase to permit differentiation between directions 180 degrees apart. It also

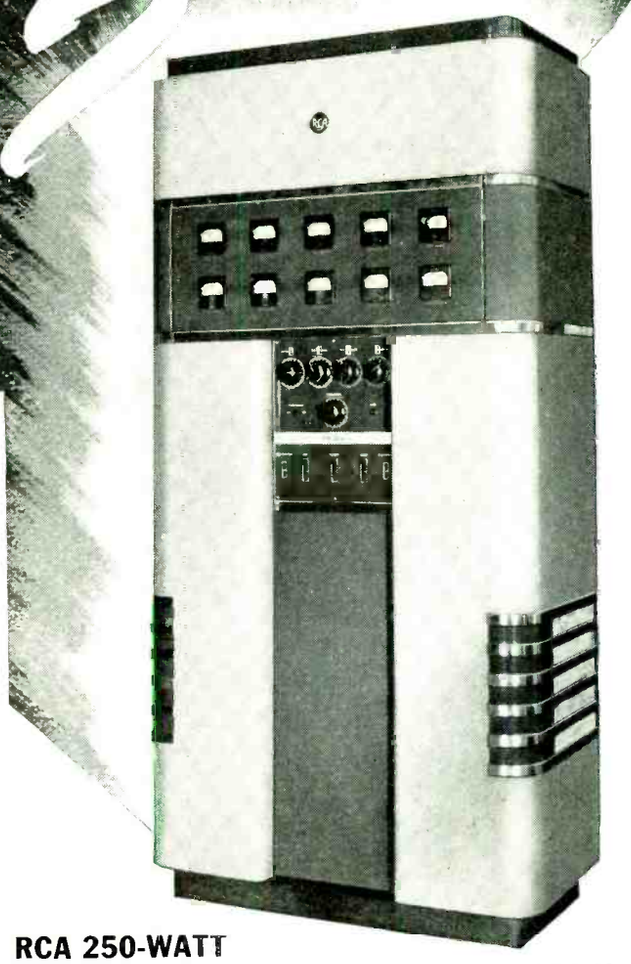


Connections of the four directional dipole antennas and their directional characteristics

is used to pick up normal communication signals. The connections of the four directional antennas and their directional characteristics are shown in the diagram. Each pair of directional dipoles is connected to the input of a pair of modulators which are also supplied with an audio modulating frequency, A_1 for one pair and A_2 for the other. The carrier and the audio modulating frequency are both suppressed, and only the sidebands of the audio modulation remain. The outputs of the directional modulators and the output of the center antenna are combined and passed to the radio receiver. Thus, the output of the receiver includes the received signal and the two directional components of frequencies A_1 and A_2. Filters separate these components; the signal is fed to the loudspeaker, and the two directional components are sent to the plates of the

CHOICE OF 84 AMERICAN RADIO STATIONS

Why?



RCA 250-WATT BROADCAST TRANSMITTER MODEL 250-K

ON THE MARKET for less than two years, the RCA Type 250-K Broadcast Transmitter has already been accorded an acceptance far beyond that of any other 25-watter produced by *any* manufacturer! The initial production-order, incidentally, was sold out *sight unseen* before the first 250-K ever came out of the factory.

It's only natural to ask, "*Why—?*"

Part of the answer lies in the extreme flexibility of the 250-K. It affords outstanding operation at 100 or 250 watts—and is easily adapted to 1,000-watt operation at any time by the simple and inexpensive addition of RCA amplifier unit and power supply Type MI-7187.

Another part of the answer lies in the *economy* of the 250-K. For example, it draws only 1625 watts from your power-line at average modulation on a 250-watt carrier . . . economy that helps keep power-bills *low*, thanks to its RCA-engineered high-level Class B modulation. Tube-costs are low. And installation is economical—economical because *simple*.

Program quality is part of the answer, too—audio is flat within 1½ db. from 30 to 10,000 cycles.

Dependable—? Ask any of the 84 stations who have bought the 250-K! For the RCA way is to work for dependability from the first line on the drawing-board to the last bolt in the final assembly!

Write for complete data and literature . . . *today*. As we go to press, the 250-K is still available for immediate delivery—but it may not remain so for long.

OUTSTANDING ACCEPTANCE!

These American Broadcasting Stations—including 1,000-watt stations using it as an exciter unit—have chosen the RCA Model 250-K . . . all within the past two years. And the list does not include still others to foreign stations, American police installations, and stations now under construction!

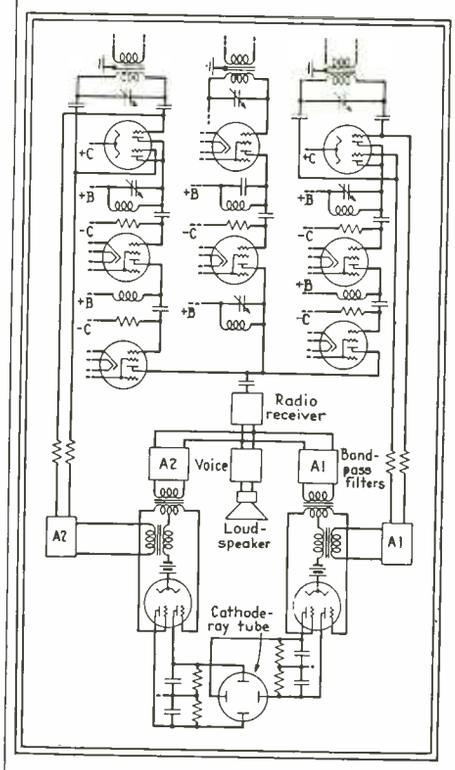
KANA	KBIX	KBUR	KBWD	KFBG	KFIO
KFIZ	KFMB	KFPW	KFXM	KGLO	KHAS
KHON	KLS	KLUF	KRJF	KROD	KSKY
KSRO	KUJ	KVFD	KVOE	KWIL	KWRC
KYCA	KYOS	WAJR	WARM	WATN	WBIR
WBML	WBOC	WBTA	WCBI	WCED	WCRS
WDAK	WDAS	WDEF	WFDF	WFIG	WFPG
WGAC	WGOV	WGTC	WHBQ	WHKY	WHUB
WHYN	WINX	WISR	WIZE	WKIP	WKMO
WKPA	WKWK	WLAV	WLBJ	WLKO	
WMJM	WMOB	WMOG	WMRN		
WORD	WOSH	WSAV	WSGN		
WSLB	WSOC	WSOO	WSRR		
WTHT	WTJS	WTMA	WWNY		

RCA Broadcast Equipment

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of Radio Corporation of America • In Canada, RCA Victor Co., Ltd., Montreal

New York: 411 Fifth Ave. Chicago: 589 E. Illinois St. Atlanta: 530 Citizens & Southern Bank Bldg. Dallas: Santa Fe Bldg. San Francisco: 170 Ninth St. Hollywood: 1016 N. Sycamore Ave.

cathode-ray tube through conjugate input demodulators. The rectified output of one pair of dipoles tends to deflect the spot along the line of one pair of plates, and that of the other dipoles along the line of the other plates. If there were only the two directional



Simplified circuit diagram of the azimuth indicator receiver

sidebands at the detector input of the receiver, there would be an uncertainty between directions 180 degrees apart. But the output of the central antenna, which is present with the two directional sidebands, provides the means of recovering the original tone frequencies and also serves as a reference of sign. The result is that the bearing is indicated correctly at all times.

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Spectographic Analysis of Tin-Lead Solders

THE TIN RESEARCH INSTITUTE'S publication No. 105 is a report of new developments in the spectrographic analysis of tin-lead solders. The Institute, controlled and supported by the International Tin Research and Development Council, consists of appointed delegates from various governments to represent tin producers in the Belgian Congo, Bolivia, British Malaya, the Netherlands East Indies, Nigeria, and Thailand. The American offices are located in the Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.

The report points out that because of the similarity of the spark spectra of tin and tin lead solder, the stand-

Engineers and Engineering Executives you are invited

I. R. E.

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SESSIONS

Morning, afternoon, and evening. The Show remains open until the start of the evening session on all three days.

SPECIAL NOTE—

to the Busy Engineer

This convention is being planned to help you keep in touch with the rest of the industry. Come in for at least one day—stay for all three if you possibly can. You'll go back with new ideas and a fresh perspective on your own job. Make up the time if you must, but come. You'll never regret it.

INSTITUTE OF RADIO ENGINEERS
330 WEST 42nd STREET
NEW YORK, NEW YORK

ardized conditions of excitation and photography previously used for the analysis of tin have been adopted for the determination of impurities in solder. Synthetic standards, including all the major impurities except copper, were prepared in the form of residues evaporated from solutions of the constituent metals. Alloys prepared with varying quantities of impurities were also dissolved in acid and the solutions evaporated. These residues were compared with the synthetic standards using a graphite-arc method. The residue method of analysis proved useful to check the composition of alloys to be used as standards.

Analytical tables are shown for the quantitative determination of small amounts of impurities of the order of 0.1 to 0.001 per cent of bismuth, cadmium, copper, and zinc. The appendix contains several suggestions for further work to improve the technique in the spectrographic analysis of residues.

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Electronic Spark Generator

ELECTRONIC EQUIPMENT FOR PRODUCING high frequency oscillating discharges is described in the October 1941 issue of the *General Electric Review*. The article is called "Electronic Spark Generator for Spectrographic Analysis" and is written by J. T. Mireles Malpica and T. M. Berry.

The circuit diagram of the generator is shown in Fig. 1. A 1000-volt transformer charges a power capacitor through a rectifying tube and suitable

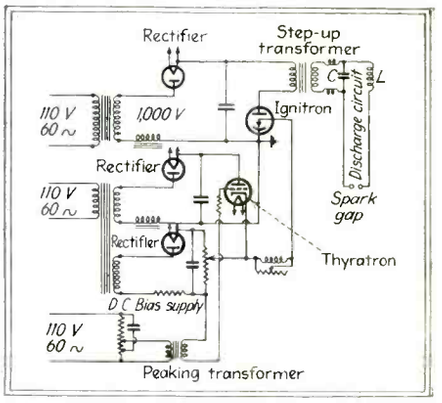

Fig. 1—Circuit diagram of the electronic spark generator

impedance. When this capacitor has obtained a maximum charge, it is discharged, by means of an auxiliary firing circuit and an ignitron tube, through the primary of a step-up transformer. The transient voltage on the secondary of this transformer reaches a peak of about 24,000 volts. This surge is delivered to the oscillating circuit made up of L, C, and the spark gap through the two r-f choke coils. Since the amount of energy delivered to the oscillating circuit is constant for each impulse, the energy dis-

sipated in the spark gap for successive discharges is also constant for a given gap separation. These discharges occur periodically, 60 times per second, and are synchronized with the voltage wave on the power capacitor.

The synchronization is accomplished by a firing circuit consisting of a peaking transformer, the thyratron, and the ignitron. The grid of the thyratron is controlled by the peaking transformer whose peak voltage is adjusted to correspond to the time of maximum charge of the power capacitor. This phase adjustment is accomplished by a capacitance-resistance combination in the peaking transformer circuit. The absence of rotating parts, synchronization troubles, and the dependence for constant operating conditions on the values of fixed electrical magnitudes are the outstanding features of this apparatus.

• • •

Fluorescent Lamps for Aircraft

A SHORT ITEM in the November 1941 issue of *Electrical Engineering* by R. F. Hays outlines the advantages of using fluorescent lamps in airplanes. The article, called "High Frequency Adapts Fluorescent Lamps to Aircraft", points out that fluorescent

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INSTRUMENT TO AID STUTTERERS

The electro-kymograph is being used at Wayne University's speech correction clinic to aid those who stammer and stutter. The afflicted individual's breathing is recorded on graphs, while the subject speaks into a microphone attached to the case recorder which reproduces the impeded speech for diagnosis. Prof. Eugene Hahn, director of the clinic, operates the machine

lamps, because of their high efficiency and good color characteristics, are ideal for lighting airplane cabins.

This is especially true since many planes are equipped with 400-cps, 120-volt generating plants. The efficiency of low voltage fluorescent lamps at 400 cps is about 20 percent higher than at 60 cps. This is about four times as great as the efficiency of the incandescent lamps normally used. The power factor is improved about 7½ percent at

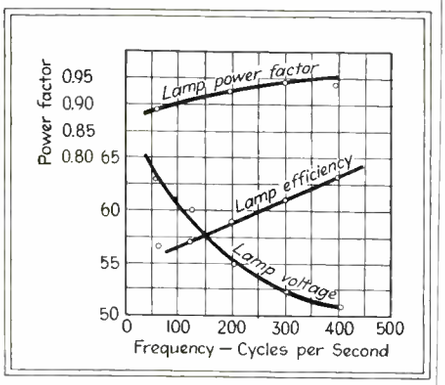

Fig. 1—Effect of frequency on lamp power factor, efficiency and voltage

400 cps also. The lamp control apparatus becomes simpler, smaller, and relatively lighter in weight at this higher frequency. These advantages are clearly shown in the curves in Fig. 1.

The electrode heating current and a starting voltage greater than line voltage at 400 cps are obtained by the simple means shown in Fig. 2. The inductance may be used as a ballast, so the capacitor is the only other necessary circuit component. With this con-

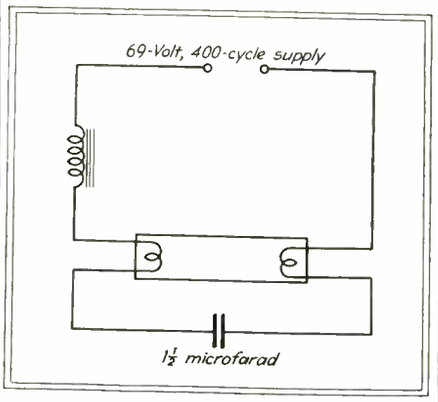

Fig. 2—Simple resonance circuit for operation of fluorescent lamps at 400 cps

trol system lamps start at supply voltages as low as 40 volts. Ordinarily, a line voltage of at least 1½ times lamp voltage is necessary for satisfactory operation. The advantage of high frequency operation is obvious. The line voltage need be no higher than lamp voltage, because resonance of the circuit keeps lamp voltage necessary for operation. The author also suggests other applications such as in buses and railroad trains.

Panoramic Radio

(*Continued from page 37*)

the modulation frequency increases, the sidebands move further away from the carrier frequency and become visible alongside the carrier deflection and it is these which vary in amplitude. When the modulation is higher than about 2000 cps it is possible to separate the sidebands from the carrier still further by reducing the sweepwidth of the adapter unit.

Single sideband modulation appears as two carriers of slightly different frequency. This is because one of the sidebands disappears leaving the carrier and the other sideband.

A frequency modulated carrier appears as a deflection which is "wobbling" sideways. Voice or music modulated f-m signals appear as numerous deflections spreading over a variable bandwidth depending upon the degree of modulation or frequency deviation.

A c-w signal appears and disappears simultaneously with the keying of the transmitter. When the signal is off, the frequency sweep closes at the base of the deflection. In rapidly keyed signals the deflection and the base line appear simultaneously.

Two signals whose frequencies are close enough together to cause an audible interference may appear on the cathode-ray screen as a single deflection. The two carriers will beat with each other and the deflection will vary in amplitude in step with the beat note. As the frequency separation is increased, or as the sweepwidth of the adapter is decreased, the extremities of the indications separate and the appearance is the same as a carrier with a single sideband.

Noise can be classed as a transient disturbance and is of two general types, periodic and aperiodic transients. Periodic transients, such as produced by automobile ignition, motors, buzzers, etc., will generally appear as indications moving across the screen in either direction. The motion across the screen is present because the source of noise is not in synchronism with the sweep frequency. If the noise is synchronized with the 60-cps power line, the indi-

cation will be at a fixed position on the screen. Aperiodic noises, such as static, result in irregular deflections and flashes along the entire length of the screen.

If the receiver used in conjunction with the panoramic adapter has a poor image rejection ratio, such images will be indicated normally except that as the receiver is tuned through the band the image deflections will move in the opposite direction to normal signals.

These few interpretations of the operation of a panoramic radio adapter attached to a receiver give a hint to its usefulness in the operation of receiving stations. However, its usefulness is not limited to radio reception, but is extended to many measurements wherever the quantity to be measured can be translated into a signal whose frequency can be continuously compared with a standard frequency. The accuracy of the measurements is not affected by frequency drift within the radio receiver or the adapter because a single frequency is not being measured, but rather a comparison of an undetermined frequency with a standard frequency.

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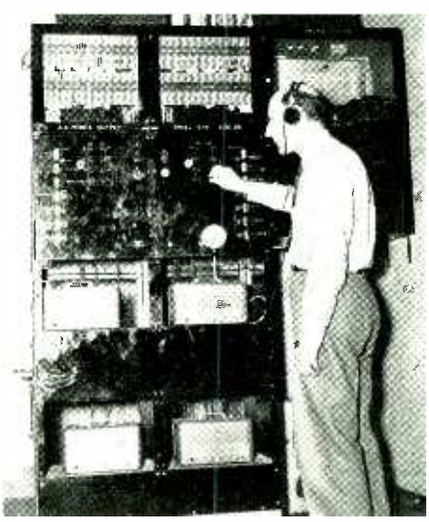
MUSIC



Mechanical engineer Lewis J. Koch checking the amplification of one of the amplifier units which feed music through the various private rooms and wards in the Los Angeles General Hospital. The patients plug in their headsets at a convenient outlet near their beds and thus receive the music from any one of 65 sound outlets. It is the belief of the directors of the hospital that music assists in the recovery of most patients

TUBES

An index of tubes described since June 1941, when a previous index was published, is presented as well as the RMA Tube registry and additional phototube information

INDEX

Types

Phototubes

Manufacturer's Abbreviations

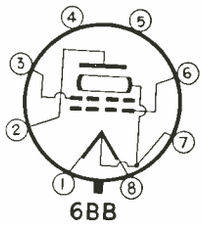
Cont.	Continental Electric Co., Geneva, Ill.
GE	General Electric Co., Schenectady, N. Y.
General	General Scientific Corp., Chicago, Ill.
G-M	G-M Laboratories, Chicago, Ill.
RCA	RCA Manufacturing Co., Camden, N. J.
West.	Westinghouse Electric and Manufacturing Co., Bloomfield, N. J.

Tube Registry

Tube Type registered by R.M.A. Data Bureau During October 1941

Type 3LF4

BEAM power amplifier, filament type, T-9 glass envelope-base, seated height 2¾ inches (max), 7-pin lock-in base.



6BB

RATINGS

	Series* Filament	Parallel** Filament
E_f (dry battery)	= 3.2	1.6 v (max)
E_f (ac-dc power line)	= 2.6	1.3 v (max)
E_b	= 110	110 v (max)
E_{c2}	= 110	110 v (max)
$I_{cathode}$ (zero signal)	= 6	12 ma (max)

TYPICAL OPERATION

E_f	= 2.8	1.4 v dc
I_f	= 0.05	0.10 amp
E_b	= 90	90 v
E_{c2}	= 90	90 v
E_c	= − 4.5	− 4.5 v
Peak A-F Signal Voltage	= 4.5	4.5 v
I_b	= 8.0	9.5 ma
I_{c2}	= 1.0	1.3 ma (nominal)
r_p	= 80,000	75,000 ohms (approx)
g_m	= 2,000	2,200 μmhos
R_l	= 8,000	8,000 ohms
Total Harmonic Distortion	= 8.5%	6.0%
P_o	= 230	270 milliwatts

Basing 6BB-1-0

*A resistor of 270 ohms must be used in parallel with the negative section of the filament (pins 7 and 8) to insure that the value of 6.0 ma total cathode current for each 1.4-volt section of the filament is not exceeded.

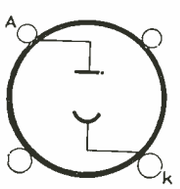
**For parallel filament operation connect pins 1 and 8 to positive voltage supply and pin 7 to negative voltage supply.

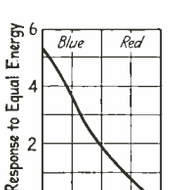
Phototubes

Type 59-D

G-M Laboratories

GAS-FILLED phototube, cathode area 0.86 sq in, seated height to center line of cathode 2 5/32 inches, overall seated height 3 9/32 inches, diameter of bulb 1 inch, 4-pin base.





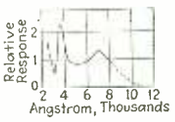
Sensitivity = 20 − 25 μa/lumen
Max Operating Voltage = 90 v
Max Anode Current = 25 μa
Max Ambient Temp = 100° C

Type 1038-A

G-M Laboratories

PHOTOTUBE, quartz envelope for ultraviolet measurements, cathode area 1⅛ sq. inch, overall length 6 inches, outside diameter 1 inch, supplied without base.

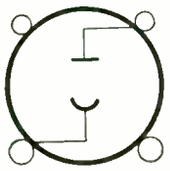
Operating Voltage = 90 v
Max Ambient Temp = 100°C
Max Anode Current = 25 μa



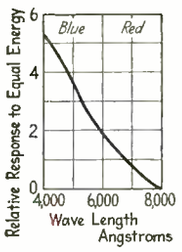
Type 71-D

G-M Laboratories

GAS-FILLED phototube, cathode area 1.25 sq in, seated height to center line of cathode 1⅞ inch, overall seated height 2 23/32 inches, diameter of bulb 1½ inch, 4-pin base.



Sensitivity = 20-25 μa/lumen
Max Operating Voltage = 90 v
Max Anode Current = 25 μa
Max Ambient Temp = 100° C



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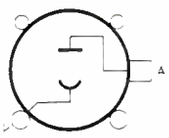
WASHINGTON AIRPORT STATION

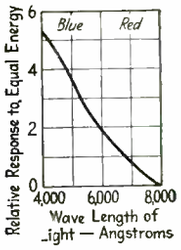
Archie Bloom, airway forecaster in rear, and A. C. Burg in the foreground at the teletype machine, are forecasting and sending the results to the general office in Washington. Weather stations make use of radio equipment but few of the radio sonde attachments which descend on parachutes when the balloons explode are recovered because much of the territory in the direction of prevailing winds is wooded or covered by water

Type 71-TD

G-M Laboratories

GAS-FILLED phototube, cathode area 1.25 sq in, seated height to center line of cathode 1⅝ inch, overall seated height 3¼ inches, diameter of bulb 1½ inch, 4-pin base.



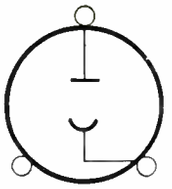


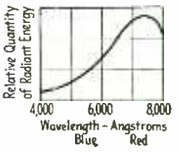
Sensitivity = 20-25 μa lumen
Max Operating Voltage = 90 v
Max Anode Current = 25 μa
Max Ambient Temp = 100° C

Type 51-A

G-M Laboratories

GAS-FILLED phototube, cathode area 0.3 sq in seated height to center line of cathode 1⅜ inch, overall seated height 1⅞ inch, diameter of bulb ⅝ inch, 3-pin base.





Sensitivity = 130 μap/lumen
Operating Voltage = 90 v
Max Anode Current = 25 μa
Max Ambient Temp = 100° C

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WIREPHOTO TRANSMITTER

A new wirephoto transmitter operated by the Associated Press was announced on Sept. 26 in New York City and is shown above. The instrument is said to utilize a new type of phototube which provides greater fidelity in reproduction. This compact transmitter, which folds up into the size of a suitcase, is shown ready for operation with a print, 7x9 in., on the transmitting cylinder

Rochester

(Continued from page 35)

lowed, and which was read by Mr. Frick of the General Electric Co., it was pointed out that several major improvements still remained to be made in noise meters. Drift with aging of the instrument was one of the more serious problems of individual instruments. Lack of complete agreement between calibration of units of different manufacture, or even the same manufacture was frequently found to be as much as 40 percent, and improvements in this direction were called for. It was also suggested that calibration of meters using sine waves might be subject to certain unnecessary restrictions or limitations, and to overcome this defect, it was suggested that standards be established, and the readings of various noise meters be given on several types of wave forms which could be easily generated. The calibration of noise meters using waves of sawtooth, sine, and square shape was suggested as a possible answer to this problem.

Plastics in the Radio Field

A paper on "The Use of Plastics in the Radio Industry" by H. M. Richardson read by Mr. Leverett of the General Electric Company, contained a general description of the various types of plastics in common use in the Radio Industry, pointed out the disadvantages and advantages of the various types, and discussed particularly the place of plastics in radio under the present national defense program. The plastics may be classed as: (1) phenolics, (2) ureas, (3) polystyrenes, (4) cellulose acetates, (5) vinylites, according to their composition, or (1) molded, (2) laminated, (3) extruded, and (4) cast according to the method of forming. The characteristics and main features of the various types of plastics were discussed, particularly with reference to their application for radio use. Main use of plastics in the radio field is for insulation, where low loss materials are required, especially at ultrahigh frequencies, and for decorative effects, where appearance is of greater consideration than the electrical properties.

Plastics are made of such common

materials as air, coal, petroleum, and water, and there is, consequently, no shortage of the basic raw materials under normal times. Because of the needs of national defense, shortages of certain materials does now exist, although the lack of adequate processing facilities is a matter of greater concern to radio manufacturers. As a result of shortage of molding facilities for civilian needs, engineers were urged to replace plastic materials with substitute materials, such as wood, which are plentiful for civilian needs. Certainly, those plastics used for decorative purposes only could be replaced by wood and similar materials. In the discussion which followed, Mr. Leverett mentioned that plastics could be made from an unusually wide variety of raw materials.

Civilian Radio Receivers

Dorman D. Israel, chief engineer of the Emerson Radio & Phonograph Corporation, spoke on "Civilian Receiver Design, 1942", and pointed out that an annual production of approximately 7½ million receivers would be necessary to maintain the necessary propaganda and information service which this nation requires to win the war and defeat the enemy. He also pointed out that there was a distinct difference between winning the war and defeating the enemy, and that the achievement of both aims required the fullest co-operation of all. Mr. Israel showed that engineers engaged in civilian production had four main opportunities to serve, as follows:

1. They can co-operate in programs of standardization so that the most effective use may be made of the materials, facilities, and manpower which is available for civilian production.

2. They can maintain the necessary flexibility to meet changing conditions, and, should anticipate, as much as possible, future changes which conditions may impose.

3. They can and should co-operate most fully with the various governmental agencies.

4. They should, at all times, keep clearly in mind their duty to make decisions with regard to their duty to society as a whole.

As a means of illustrating what engineers could accomplish, Mr. Israel showed a breakdown of a typical receiver for 1940 and 1942, and listing

the various materials and components used in its construction. This chart, reproduced on page 35, indicated many changes which could be made in the interest of economy for defense activities.

The application of frequency modulation to the transmission of television synchronization pulses was described by F. J. Bingley of the Philco Corporation. The system, known as "alternate carrier transmission" is based on the suggestion of A. V. Loughren in his paper published last year in ELECTRONICS The picture portions of the signal are transmitted by amplitude modulation in the conventional manner, but during the synchronizing signal, in addition to amplitude modulation, the carrier of the transmitter is shifted suddenly upward in frequency. This frequency shift causes the carrier at the receiver to ride up the slope of the picture i-f pass-band characteristic. As a result the developed sync voltage at the second detector is approximately five times as great as it would be with amplitude modulation alone. The rigidity of synchronization in the presence of a weak signal is thus greatly improved, as was illustrated in several slides taken with 100 and 250 microvolt input signals with tube noise and interference present.

One major problem presents itself when the signal arrives at the receiver simultaneously over two or more paths of different lengths. In

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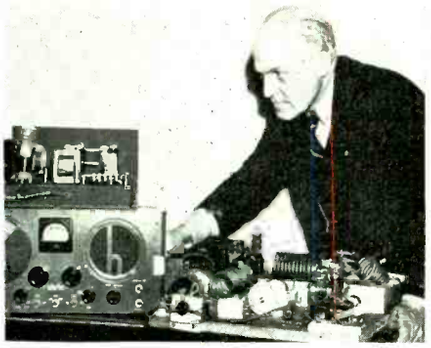
UNLICENSED TRANSMITTER CONFISCATED



U. S. Deputy Marshall Eugene Ahrends is shown above with radio equipment confiscated from an unlicensed operator who announced himself on the air as a German agent. Two years in prison and a $10,000 fine is the penalty for this violation of the Federal Communications Act

this case the stronger signal controls the synchronization of the picture while the weaker signals cause echo-pattern images. The echo pattern resulting from the carrier during the frequency shift (that is, the echo of the blanking signal) has a different frequency from that of the picture signal. A beat-note pattern generated by these two signals, introduces alternate white and black vertical bars in the picture, which run the full range from maximum white to black and hence are highly noticeable. The effect of these beat-echo bars is reduced by reversing the phase of the transmitted carrier at the beginning of every other line, so that the bars are cut up into alternate black and white segments which, after several fields, average out to a gray indistinguishable from the picture background.

The Alert Receiver

A means of calling the attention of defense workers to a radio receiver when announcements are to be made, was described by S. W. Seeley and H. B. Deal of the RCA License Laboratory. Use is made of the subaudible frequencies between 20 and 40 cps to actuate one or more tuned-read mechanisms tuned to particular frequencies. Standard broadcast stations have sufficient modulation capability at these low frequencies, and if the modulation level is kept low, and the source of the low frequency is free of harmonics, the result is practically inaudible even on a high-quality receiver. The tuned reed carries a contact which closes the coil circuit of a relay, which in turn turns on a light and rings a warning bell. It is necessary to leave the receiver running continuously for this service, but power consumption is about 25 watts and the cost of operation is but a few cents a day. The system was demonstrated on several receivers using the transmission of WHAM. A particularly suitable type of receiver for defense operation is a three-way receiver (a-c, d-c and battery operated) which remains in operation even if power lines are out of service. In the discussion it was pointed out that the "alert" service should have use for non-defense activity, particularly in connection with television receivers to warn televiewers of spot-news broadcasts and other unscheduled events.

THE INDUSTRY IN REVIEW

News

✦ Montoursville, Pennsylvania, just east of Williamsport on the Harrisburg highway, is the site of a new special-purpose radio tube plant planned by the Hygrade Sylvania Corporation, according to president B. G. Erskine and general manufacturing manager H. Ward Zimmer. Frank J. Prime of Emporium will be superintendent of the new plant which will occupy a 16-acre plot, provide 50,000 sq. ft. of floor space, and represent a total investment of one-half million dollars in building, grounds and manufacturing equipment . . . Westinghouse x-ray division administrative departments will move from Long Island City to the company's radio division plant in Baltimore about January 1. Manager Walter Evans advises that x-ray manufacturing departments are to remain in New York. Quarters vacated by Evans' administrative department will be used to expand manufacturing facilities for Army and Navy equipment. Westinghouse, incidentally, reports that it booked 250 percent more orders for x-ray and other special tubes in 1941 than in 1940 . . . Isolantite's production of ceramic parts at Belleville, N. J. will reach ten times the output level of a year ago after the completion of a million-dollar expansion program now in progress, according to president W. D. Waltman. Most important phase in the program is the construction, already under way, of a new three-story building which will add 80,000 sq. ft. to present productive area, installation of additional machinery of latest design with individual motor control. Extensive additions are also being made to production facilities in present buildings, direct supervision of the entire plant continuing under vice-president and general manager K. D. Hamilton . . . Production of several new types of resistors required in quantity for national defense has induced the International Resistance Company to add 30 percent more manufacturing space to it's Philadelphia plant to avoid crowding regular production facilities.

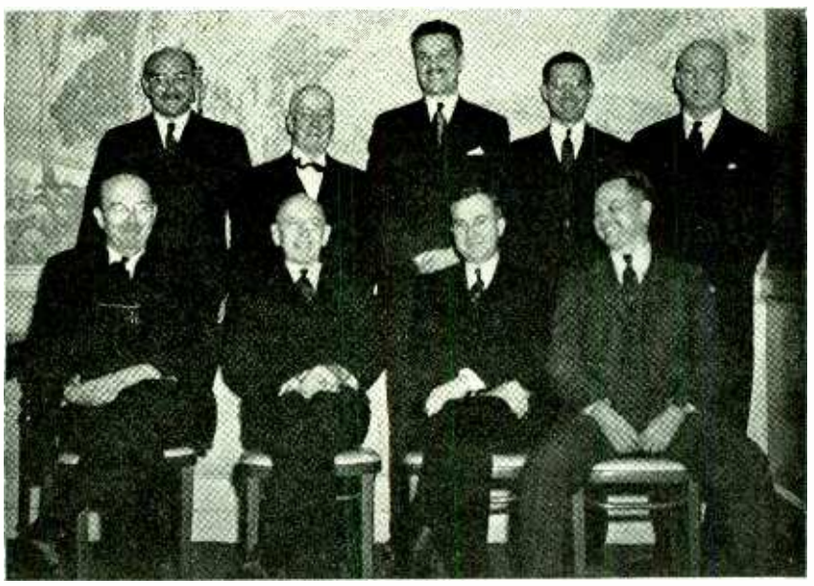
✦ I. J. Kaar, designing engineer in General Electric's Bridgeport radio and television department since November, 1934, has been appointed managing engineer of the receiver division. Mr. Kaar graduated from the University of Utah in 1924 with a B.S. degree in electrical engineering, joined G-E at Schenectady in that year. He will now be responsible for both engineering and manufacturing in the receiver division and will report to Dr. W. R. G. Baker, manager of the Bridgeport works . . . Robert M. Kalb, just appointed assistant chief engineer of the Kellogg Switchboard & Supply Co. of Chicago, was for 13 years research engineer at the Bell Telephone Labs. of New York, is a graduate of Ohio State's department of electrical engineering, and took post-graduate work at Columbia University . . . Charles C. Neighbors, in full charge of the Ferrocart Corporation's engineering and manufacturing, holds a B.S. in chemical engineering, spent several years with Western Electric and Bell Telephone working on metallurgical problems connected with powdered magnetic materials, and more recently was engaged in development and design of high-frequency iron-core materials with Aladdin Radio Industries . . . Gustave Heding, associated with the Teletype Corporation and its predecessor organizations since 1907, vice-president since 1938 and a director since 1939, has been appointed president. He succeeds Stanley Bracken, who has resigned to join Western Electric.

✦ More than a thousand invited guests, including many noted scientists and engineers, witnessed at Princeton, N. J. on November 15, the laying of the cornerstone of the new laboratory being built by the Radio Corporation of America and destined to be one of the world's foremost citadels of radio-electronic research. Major General James G. Harbord, chairman of the RCA board, who officiated at the ceremonies, predicted that when present dangers to freedom resulting from the warmongering of dictators is ultimately removed, the peacetime industrial application of scientific research will become a more vital factor in the world than ever before.

✦ Electrical Research Products, Inc., wholly owned subsidiary of the Western Electric Company, has been merged into the parent company and its domestic activities will hereafter be carried on as the Electrical Research Products Division according to W-E president C. G. Stoll. T. Kennedy Stevenson, former president of the subsidiary, becomes vice-president and a director of Western Electric.

✦ General Electric's board of directors has elected five new vice-presidents in connection with a major change in the company's organization. New officers are: Walter R. G. Baker, Chester H. Lang, David C. Prince, Elmer D. Spicer and Harry A. Winne. Under the new setup G-E will have four major operating departments: Radio and

HOUCK WINS 1941 ARMSTRONG RADIO CLUB AWARD



Harry William Houck (seated third from left), awarded Major Edwin H. Armstrong's (standing, extreme right) 1941 Radio Club of America medal for outstanding contributions to the radio art, assisted in the birth of the superheterodyne circuit in Armstrong's world war Paris laboratory, designed the second-harmonic super, is particularly noted for early work on capacitors which made practical the filter systems used in modern receivers. Pictured at the Club's banquet, at which the award was made are (left to right, seated): L. C. F. Horle, RMA engineering committee; Admiral Hooper; Harry Houck; Paul Ware, Du Mont Labs.; (standing) W. A. MacDonald, Hazeltine Labs.; George Clark, RCA; George Connor, Hygrade Sylvania; John Calahan, RCA Communications; and Major E. H. Armstrong

Walter R. G. Baker, one of five new General Electric vice-presidents, has been with the company since 1917, manager of its radio and television department since 1939

Television, under vice-president Baker, Apparatus, with Lang continuing to head up apparatus sales and directing defense activities, Prince in charge of application engineering, Spicer in charge of manufacturing, Winne in charge of design engineering and Earl O. Shreve in charge of commercial activities. Vice-presidents William R. Burrows and Roy C. Muir, formerly in charge of general manufacturing and general engineering operations respectively, become members of president Charles E. Wilson's staff, carrying out assigned duties in these fields.

✦ A Radio Industry Advisory Committee has been formed to work with OPM. Members, we are advised by Sidney J. Weinberg, chief of this government department's Bureau of Advisor Committees, include: Ben Abrams of Emerson Radio, W. R. G. Baker of General Electric, M. T. Balcom of Hygrade-Sylvania, W. J. Barkley of Collins Radio, A. Bloom of General Instrument, H. C. Bonfig of RCA, Roy Burlew of Ken-Rad, H. W. Clough of Belden, Allen DuMont of DuMont Labs, P. V. Galvin of Galvin Mfg., Larry Gubb of Philco, K. D. Hamilton of Isolantite, W. P. Hilliard of Bendix Radio, H. J. Hoffman of Westinghouse Electric, J. J. Kahn of Standard Transformer, L. L. Kelsey of Stewart-Warner, R. H. Manson of Stromberg-Carlson, Jack M. Marks of Fada Radio, Victor Mucher of Clarostat, L. F. Muter of the Muter Co., Harold L. Olesen of Weston, W. F. Satterwaite of General Dry Bat., Ernest Searing of International Resistance, S. M. Shure of Shure Bros., Ray Sparrow of P. R. Mallory, R. C. Sprague of Sprague Specialties, Arthur E. Thiessen of General Radio, S. T. Thompson of Zenith and A. S. Wells of Wells-Gardner.

Literature

Magnetic Flux Measurement. The determination of the distribution of magnetic flux and the leakage paths in complicated magnetic circuits is discussed by Leland D. Norton and John A. Cravatt in the August-September issue of the *DuMont Oscillographer*.

Communication Units. The Hallicrafters Co., 2611 Indiana Ave., Chicago, has just released a profusely illustrated catalog describing, picturing and pricing its complete line of communications equipment, including receivers for commercial or amateur a-m or f-m use, transmitters, an ultrahigh frequency transceiver, marine radiophones and a radio compass.

Radio Parts. A 1941–42 catalog available from the James Millen Mfg. Co., Inc., 150 Exchange St., Malden, Mass., lists this company's complete line of radio transmitting and receiving parts and accessories, giving complete specifications and in many instances photographs as well as mechanical drawings illustrating design. Included is a description of an amateur band 50-watt transmitter exciter, an electron-coupled oscillator, midget frequency meters of the absorption type and a precision crystal secondary frequency standard.

Rotary Machines. Bulletin 13–25, by Janette Mfg. Co., 556–558 W. Monroe St., Chicago, describes the complete Janette line of rotary converters and dynamotors, including a three page chart giving all technical details. Pictures show details of construction as well as complete machines.

Insulation. "Spauldo", an insulation material now furnished in continuous rolls by the Spaulding Fibre Company, Inc., Tonawanda, N. Y., is described in a 4-page bulletin prepared by this company. Noted is dielectric strength, tensile strength, Mullen strength, Elmendorf tearing strength, as well as other pertinent characteristics of interest to electronic engineers as well as motor designers to whom the bulletin is particularly addressed.

Cathode-Ray Report. "Pioneering the Cathode-Ray and Television Arts," a booklet prepared by Allen B. Du Mont Laboratories, Inc., Passaic, N. J., to outline work accomplished by the organization in its first decade of operation, historically covers the company's progress from the beginning to date. Included are stories concerning early commercialization of the oscillograph, electronic switch, cathautograph, resonoscope and television which will be of general interest. Listed are Du Mont patents, company key men.

Mallory Catalog. Complete specifications, including electrical characteristics, mechanical drawings and photographs of the firm's entire line of precision products, are included in a new catalog by P. R. Mallory & Co., Inc., Indianapolis, Ind. Detailed descriptions include specifications on Mallory replacement controls; control accessories; commercial, industrial and equipment type potentiometers and rheostats; circuit selector, all-wave and special switches; jacks and plugs; cable connectors and markers; knobs, nuts, washers, screws and grommets; dial and panel lights; fixed and adjustable resistors; capacitors of all types; noise-filters; "Vibrapacks" and vibrators; rectifiers, grid-bias cells and battery chargers.

Glass As Insulation. Available to electronic engineers from the Insulation Division, Corning Glass Works, Corning, N. Y., is a study by E. B. Shand, entitled: "The Dielectric Strength of Glass . . . An Engineering Viewpoint." The study is organized under three main headings: (1) dielectric failure of glass. (2) factors governing failure, and (3) curve data. It includes tables on disruptive strength, graphic presentation of breakdown characteristics, selected dielectric breakdown data on glass, oil puncture tests on power insulators, dielectric breakdown characteristics of "Pyrex" glass and porcelain.

Industrial Instruments. New literature available from Industrial Instruments, 156 Culver Ave., Jersey City, N. J. includes a price list of this company's entire line of Solu-Bridges, Solu-Bridge controllers, conductivity bridges, conductivity cells, Mega-Bridges, decade capacitors, distilled water checkers. Also available are data sheets giving complete specifications on each of these instruments, a new bulletin describing methods of using the Solu-Bridge for checking solutions used for bottle washing.

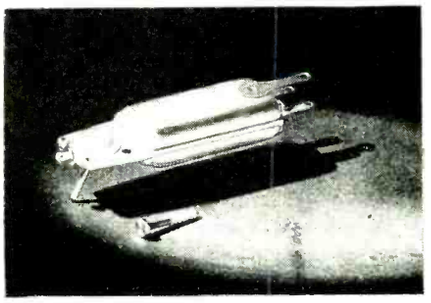
Test Instruments. The 1942 line of radio and electrical test instruments manufactured by Radio City Products Co., Inc., 88 Park Place, New York, is presented in a 20-page, illustrated catalog just announced. Included are specifications on more than 40 models of 22 basic test instruments, approximately half of which are general-purpose multi-testers. Also listed are vacuum tube testers, radio circuit analyzers, a radio signal generator, an electronic multi-tester, electrical appliance testers and combination units. Catalog is numbered 125.

Transformer Data. A bulletin just released by the New York Transformer Co. of 480 Lexington Ave., New York, describes typical high quality audio and power transformers, chokes and filters made to specification for individual manufacturers, contains a chart showing the size and dimensions of standard cases used by the firm.

New Products

Crystal Pickup Cartridges

WITH ONLY ONE OUNCE needle pressure an output of 1.4 volts at 1,000 cps may be obtained from the "Hi-Lo" crystal pickup cartridges manufactured by Shure Brothers, 225 West Huron Street, Chicago, Ill. A set screw per-



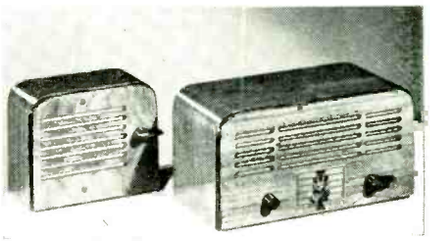
mits changing of needle without replacing the entire cartridge which employs a bimorph crystal. Six types of cartridges are available to fit the manufacturer's requirements. Without needle the list price of the unit is $4.

Speaker Volume Control

THE MODEL RC-1 SPEAKER POWER volume control manufactured by the Atlas Sound Corp., 1443-39th Street, Brooklyn, N. Y. has an essentially constant impedance for use across the voice coil of any speaker. It provides a uniform taper, with gradual control of volume from a full on to off position. Its power handling capacity is rated at 10 watts. A tapered wire wound voltage divider and a vitreous resistor are used and are mounted in a metal utility box. An etched indicator plate and red moulded bar knob are supplied. The volume control is 3 inches in diameter and lists at $3.50.

Intercommunication System

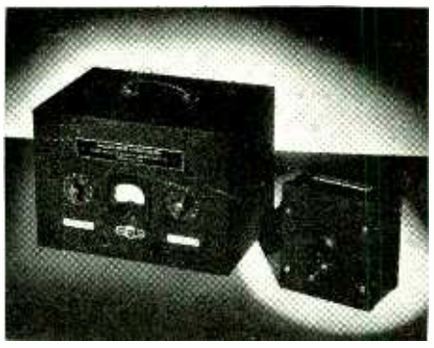
A LOW-COST INTERCOMMUNICATION SYSTEM, the Knight, is announced by the Allied Radio Corporation of Chicago. The unit offers complete privacy of conversation between executives or customers, and a balancing of substa-



tions when not in use. In most installations, the voice will carry more than 50 feet. Consequently, workmen may answer without leaving assembly line or their bench. The unit has a power output rating 2¼ watts so that ten substations can carry on five two-way conversations simultaneously.

Angular Sweep Potentiometer

THE ANGULAR SWEEP POTENTIOMETER recently announced by the Rowe Radio Research Laboratory, 4201 Irving Park Boulevard, Chicago, Ill. is a device which permits correlation of the angular position of any rotating or oscillating shaft, mechanically coupled to it, and the beam position of an oscillograph. Shaft speeds of between 0 to 20,000 rpm are permissible. Calibration of angular shaft position versus beam position can be made at 0 angular speed. Such static calibration can be accurately depended upon to hold surfaces even at the highest speed. The unit operates practically any oscillograph and should be connected directly to the deflection plate which is entirely independent of any amplifiers in the oscillograph.



The angular sweep potentiometer is applicable to any and all oscillographic studies where the angular motion is one of the functions. For example, it may be used in indicator work to obtain a curve of pressure versus engine angle in time motion studies to obtain the angular movement as a function of time, or in motor and generator studies to determine the voltage or current as a function of the angle of the shaft. Either gradual or transient changes of sweep cannot affect synchronization. Pictures cannot "slip" off the screen. Any particular portion of a picture can be placed in the center of the screen simply rotating the angular sweep potentiometer unit.

The apparatus consists of two units. The larger auxiliary case includes the power supply and is connected to the 110-volt power supply although for portable operation the power supply may be a 6-volt battery. The smaller unit is the angular sweep potentiometer proper. It has a 5-foot cable which plugs into the auxiliary unit. A ¼-inch shaft, approximately 1 inch long projects from the angular sweep potentiometer and provides a mechanical means of coupling.

Time Relays

THE NEW CRAMER TIME RELAYS, type RS1C and TD1C are synchronous motor-operated timers which either keep an electrical circuit closed for a pre-set time interval, or in the case of the TD1C can be used as a time delay

relay which, when energized, keeps the circuit open for a selected interval. The timers have an instantaneous reset feature and when restarted they repeat the timing without manual resetting. They are available with built-in manual backup or can be supplied for remote control. Auxiliary contacts can be furnished for audible or visual signal circuits or other applications as required. The timers have been developed particularly for industrial applications which require frequent operations with utmost reliability. Accurately machined and adjusted parts are used in all essential assemblies. The time relay consists of a synchronous motor unit which rotates a switch operating arm when the magnetic clutch mechanism is energized. When the clutch magnet is deenergized, it will release the switch operating arm, returning it instantly to the starting position by means of a reset spring. The starting position of the switch arm which determines the time setting is controlled by a micrometer setting knob located on the top of the housing, or with a frictionally held stop arm, if a field adjustment is desired. The main switch unit is rated at 1,150 volt-amperes and will satisfactorily operate a ½ hp motor. Various time scale ranges are available from 0 to 15 seconds as the minimum, with a minimum setting time of 1 second to 0 to 5 hours with a minimum setting time of 20 minutes.

Skyrider 32

THE MODEL SX-32 RECEIVER manufactured by the Hallicrafters Company, Chicago, Ill. offers additional important features such as two tuned r-f stages, six degrees of selectivity, wide-angle illuminated "S" meter, six tuning ranges for most satisfactory L/C ratios and uniformly high sensitivity, temperature-compensated oscillator, bandspread dial directly calibrated for the amateur bands. The tuning range is from 500 kc to 40 Mc in six overlapping bands, all of which are fully calibrated on the main dial, while an electrical bandspread system permits spread of any portion of the same tuning range. Complete with cabinet, the receiver is 20½ inches long, 14½ inches deep and 9½ inches high. It uses 13 tubes including a separate high-frequency oscillator and mixer tubes, two tuned r-f stages, an automatic noise limiting tube, a beat frequency oscillator, and an output stage using 6V6 tubes.

Sapphire Needle

A NEW DURALUMIN SHAFT sapphire playback needle, curved to meet the record straight on, without drag, is announced by the Duotone Company, 799 Broadway, New York City. The needle has a list price of $5, and is designed for professional or home use. The same organization has also brought out a sharpener for cactus needles, which lists at $1.

Two-Way Baffle

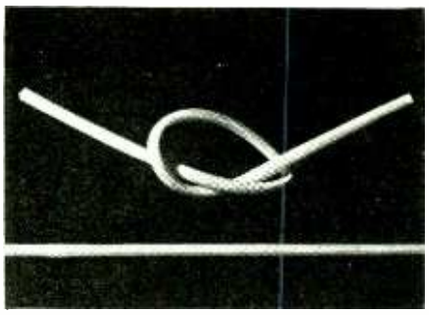
NEW TWO-WAY BAFFLES for 8i-nch speakers, and especially designed for paging and intercommunication systems, are available from the Atlas Sound Corporation, 1449 Thirty-ninth Street, Brooklyn, N. Y. With the baffles sound can be projected in two directions with a single 8-inch cone mounted between the two bell sections, which are of pressed steel with silver finish. The Model DF-8 two-way baffle lists at $10.

Microphone Mounting

IN MOTION PICTURE WORK the microphone must often be moved very rapidly. To accomplish this it is usually mounted on the end of a large boom which can be easily controlled and moved to any desired position quickly. Nevertheless, speed must also be accomplished without any mechanical noise or shock reaching the microphone, since such disturbances would spoil the recording and result in extensive retakes. Elimination of noise is accomplished by mounting the microphone in standard shear-type plate form mountings, manufactured by the Lord Manufacturing Company, Erie, Pa. The bonded rubber mountings effectively absorb all vibrations and shocks, and in addition supply an electrically insulated support for the microphone.

Sleeving

FIBROUS GLASS VARNISHED SLEEVING is announced by William Brand & Co., 276 Fourth Ave., New York. Glass braid is processed with a natural oil-base varnish which provides higher dielectric constants than such glass alone, increases degree of flexibility while at the same time reducing stretch



factor to a minimum. Special feature is precise rounding of the product during manufacture to eliminate circumferential wrinkles and gaps. Available in two grades, in all standard diameters established by this firm for the regular line of "Turbo" flexible varnished cotton tubing.

Ideal Products

THE IDEAL COMMUTATOR DRESSER COMPANY, 1631 Park Avenue, Sycamore, Ill., announces two new additions to their line. One of these is a new abrasive wheel type grinding wheel dresser which is used to resurface the motor driven abrasive grinding wheels found in every shop. Besides general cleaning and truing of a grinding wheel, the grinding wheel dresser may be used to cut out deep grooves and eliminate out-of-roundness thereby restoring out-of-balance wheels to true rotating ones. The other item is a step-down transformer which is plugged in between the power supply and the extension to reduce the second voltage to 6 volts. The low-volt transformer is particularly recommended for inspection of instrument work in damp hazardous locations.

Temperatures and Condensers

COMPENSATING CAPACITORS obtainable in any temperature coefficient from —0.005 percent to +0.005 percent per degree C over a temperature range between —40 degrees to +70 degrees C are announced by the Aerovox Corporation of New Bedford, Mass. The Aerovox Type K mica condensers are supplied only in low loss bakelite cases and are sealed for immersion. They are available in a limited range of capacitances and voltage ratings. Specifications for individual requirements will be supplied on application. The use of suitably designed condensers to be used with a given inductance makes it possible to design a circuit whose frequency is independent of temperature changes for any given adjustment of the second constant.

Giant-Screen Oscillograph

FOR LECTURE DEMONSTRATION purposes particularly and other applications where oscillograms of very large size are desirable, Allen B. Du Mont Laboratories, Inc. of Passaic, N. J. has developed oscillograph type 233. The instrument utilizes a 2532A20 intensifier teletron, which has a medium persistence green screen and is 20 inches in diameter. Final accelerating potential applied to the teletron is 6000 volts. Identical amplifiers provide for deflection along X and Y axes, with sensitivity of 0.020 r.m.s. volt per inch, frequency range for uniform transmission to within ±10 percent is from 5 to 100,000 cps at maximum gain settings, input circuits comprising 2 megohm constant impedance stepped attenuators with continuous adjustment between steps. An internal linear time base generator is provided for single or recurrent sweeps in the range from 8 to 30,000 cps. This generator can be synchronized with external signals, with signals of the power line with either positive or negative half cycle of the signal being amplified along the Y axis. Power supply, with electronic voltage regulation for low level amplifiers, is provided with the instrument, which weighs 250 lbs., and is mounted on a rolling table.

Black Heat

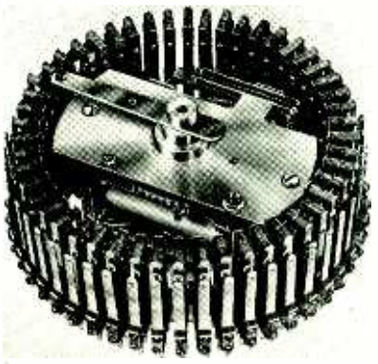
HEAT ELEMENTS, INCORPORATED, of Buffalo, N. Y. announce developments in the manufacture of black heat, an element constructed in a unique process by which electric filaments operating at temperatures below incandescent are interwoven with spun glass and other insulating materials. Woven on large looms with electric filaments, spun glass and other insulating materials comprising the warp and the woof, has resulted in a "blanket of heat" which has reduced fire hazards, is immune to short circuits by foreign objects and moisture and provides a plane area of uniform temperature. These units have already been used in airplane construction and should lend themselves admirably to use in temperature controlled ovens for quartz crystal oscillators.

Clip

A CONVENIENT METAL CLIP for the rapid assembly of cables, wires, rods, conduits or tubes is announced by Tinnerman Products, Inc., 2038 Fulton Road, Cleveland, Ohio. Nuts, bolts, washers, special brackets or hand clamps are eliminated and the entire assembly may be made from one side of a wall. The clips are normally of metal, but are also available with a rubber or Neoprene coating on the upper arm for protection.

Automatic Stepping Switch

EXCEPTIONAL FLEXIBILITY is inherent in the design of a new electromagnetically-actuated rotary switch designed by The Autocall Company of Shelby, Ohio for automatic, remote-controlled or manual operation. Around the circumference of the switch any number of contact "pile-ups" from 2 to 50 may be mounted and pile-ups are available in any combination of make, break or break-make, bridging or nonbridging or combinations of both, up to 12



springs. Operating mechanism actuates a "spider" with from 1 to 8 arms through Bakelite rollers and switch construction is such that the operating mechanism as well as contact springs may be readily removed for inspection without disturbing wiring. Available contacts will break 5 amp. 48 v.d.c., 1 amp. 125 v.d.c., 5 amp. 115 v.d.c. noninductive loads. Coils can be furnished for 48 to 230 v.d.c. Switches operate at a speed of 10 steps per second, are available in RORH (homing) and RORMR (magnetic release) types.

Welding Gun

WELDING GUNS WHICH LOCATE THEMSELVES automatically for spot weld assembly of units built of a number of parts are features of a welding fixture and gun assembly recently developed for the assembly welding of grills for a low-price 1942 automobile. Built by Progressive Welder Company, 3100 East Outer Drive, Detroit, the unit is provided with three guns mounted on arms projecting from a slide. The operation requires the performing of seventeen welds in the assembly of the unit. The fixture is so designed that the welds can be performed in groups of three, in five different positions of the welding gun, while in a sixth position only two of the guns are actuated. With two such welding fixtures it is possible for one to be loaded while the other is going through its assembly welding cycle. Guns are of standard progressive hydraulic design.

Phonoradio

A COMPACT, POWERFUL, NEW TABLE model automatic RCA victrola phonograph radio embodying a number of qualities in instruments of this type has been announced from Camden. The instrument, designated as model V-135, is an addition to the 1942 series of RCA instruments recently announced from Camden, N. J. Twelve 10-inch or ten 12-inch records may be played automatically.

SEARCHLIGHT SECTION

POSITIONS VACANT

ELECTRONIC ENGINEER young man under 35 as research and design engineer with Vacuum Tube hearing aid company, must be graduated EE with some electronic and acoustical experience desirable. Unusual opportunity to progress with company. Compensation secondary to proveable ability. Give age, complete education, experience and telephone number. Present staff know of this opening. Apply in complete confidence. P-296, Electronics 330 W. 42nd St., New York, N. Y.

ELECTRICAL ENGINEER capable of developing and designing new electronic circuits. Man capable of doing research and developing new circuits required. Experience in vacuum tube manufacture helpful. Permanent employment in Eastern city. P-303, Electronics, 330 W. 42nd St., New York, N. Y.

ENGINEER, Manufacturing experience on precision electrical apparatus, good mechanical and electrical background, probably previously employed on sound amplification and picture transmission, permanent position with well-established manufacturing company. Replies to P-305, Electronics, 520 N. Michigan Ave., Chicago, Ill.

ENGINEER ELECTRICAL—Nationally known manufacturer in the New York metropolitan area, needs an Electrical Engineer with mechanical aptitude and experience for manufacturing planning of high quality sound apparatus. Knowledge of instrument design and planning methods for assemblies as are found in modern microphones and reproducers. U. S. Citizens only. State age, education and experience. Box 559, Suite 1800, Times Building, New York.

POSITIONS WANTED

DO YOU NEED a dependable, sober broadcast operator? Radiotelephone first class license, graduate Coyne Electrical School also B.S. degree. Now employed and in good standing. Please give details. PW-304, Electronics, 330 W. 42nd St., New York, N. Y.

ELECTRICAL ENGINEER (E.E.) and Physicist excellent background, highly experienced (16 years) and efficient many patents, now employed, development, design, research wants adequate responsible position. PW-307, Electronics, 330 W. 42nd St., New York, N. Y.

ELECTRICAL ENGINEER, 36, now employed. 14 years experience in production and designing of electrical and mechanical equipments, transformers, etc. Seeks responsible position. PW-302, Electronics, 330 W. 42nd St., New York, N. Y.

POSITIONS WANTED

FIRST PHONE Second Telegraph experienced transmitter engineer R.C.A. Western Electric experience. Draft exempted. At present Chief Engineer at 250 Watt Station. Desire change. Eastern U.S.A. preferably New York. PW-301, Electronics, 330 W. 42nd St., New York, N. Y.

COMMUNICATIONS ENGINEER EXECUTIVE AVAILABLE

Married, age 40 years. 14 years practical experience design, installation operation and management all types high frequency radiotelephone radiotelegraph transmitters, receivers, antennas. Terminal equipments. Direct negotiations with Governments and management foreign local personnel. At present employed executive in charge South American radio operating subsidiary large U. S. communications organization.

Desires responsible position. Interesting assignment of greater importance than immediate salary considerations. Willing travel outside U. S. but no permanent foreign assignment. Has definite interest laison work between U. S. broadcasting organization and South American outlets.

Returning to U. S. after 7 year service personal reasons. Speak Spanish fair. Member IRE. Best possible references.

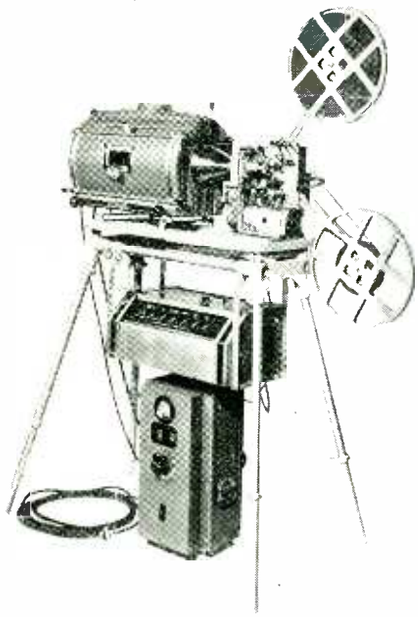
PW-306, Electronics,
330 West 42nd St., New York City

CONTACTS

FOR THE FIELD OF ELECTRONICS

Arc Lamp Projector

THE MODEL E HIGH INTENSITY arc lamp projector has just been announced by Victor Animatograph Corp. of Davenport, Iowa. This model is designed for heavy service to fulfill a demand for Victor which will produce ultrabrilliant extreme images in large



auditoriums and outdoor areas. The complete unit consists of a projector, a sound unit, amplifier, two speakers, an arc lamp, rectifier and projector for stand. Additional information including form No. 1052 is available from the Victor Animatograph Corp., Davenport, Iowa.

Battery Charger

A NEW TUNGAR TWO-RATE automatic battery charger for use with 6-volt and 12-volt batteries has been introduced by the General Electric Company, Bridgeport, Conn. Although originally marketed for charging automobile batteries, this unit will also be found of considerable interest in communication laboratories and installations where filament power is supplied from storage batteries. The new Tungar charger starts charging at 40 amperes and continues at this rate until the battery is from 80 to 85 percent charged. At this point the rate is automatically reduced to 16 amperes. Charging continues at this rate for three hours and the Tungar charger is automatically cut off. Operation of the charger is simple. A control button performs the dual function of turning the unit on and off and setting the charging time. A chart showing charging hours plotted against specific gravities charged for various capacity batteries is permanently fixed on the control panel. This chart enables operators to determine charging time required after measuring specific gravity of batteries. An ammeter which is provided indicates the charging rate.

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January to December issues, inclusive, 1941

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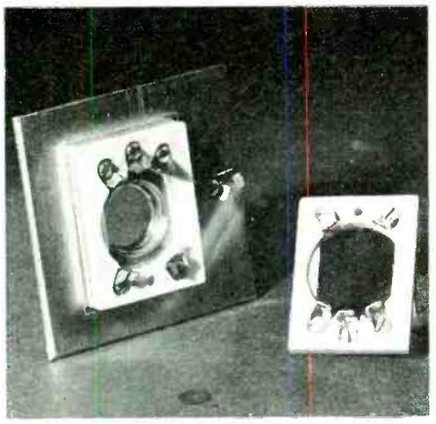
330 West 42nd St., New York City

AUTHORS INDEX

Acorn Tube Socket

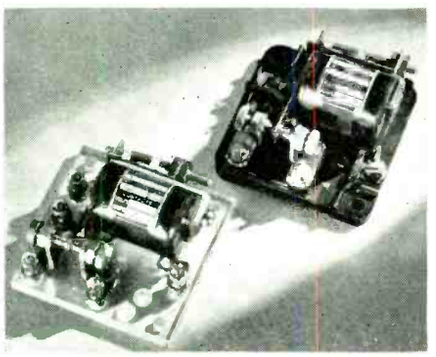
ROTARY MOTION of an "Acorn" tube locks it in the new type W901 socket developed of impregnated Alsimag 196, silver-plated phosphor bronze or beryllium copper, by Aladdin Radio Industries, Inc., 501 West 35th St., Chicago, Ill. Construction is such that strain on glass is along rim rather than at right angles to this rim, minimizing chances of fracture. Metal bites into leads close to glass, minimizing lead



length. Hole in base of socket may be used for mounting, or for insertion of an insulating plug to prevent reversing of tube. Socket measures 1 inch by 1⅛, may be obtained with bottom of ceramic base ground flat for mounting on a metal partition, and lists at $1.50. A method of by-passing, developed for use with it, eliminates objectionable resonant effects. Screen by-pass assembly, W902, consisting of flattened metal plate, mica insulating plate plus washers and screws lists for $0.60. Cathode by-pass assembly, W903, is similarly listed.

Air Photography Relay

PLEXIGLAS IS USED as the base for a new line of relays made by the Kurman Electric Company, 241 Lafayette St., New York for use particularly in connection with aerial photographic apparatus. At frequencies above 40 megacycles this acrylic plastic is said



to be especially valuable in resisting carbon tracking and dielectric breakdown. The thermo-plastic has great resilience and impact resistance and is of low specific gravity advantageous where equipment is installed in bombing and reconnaisance planes.

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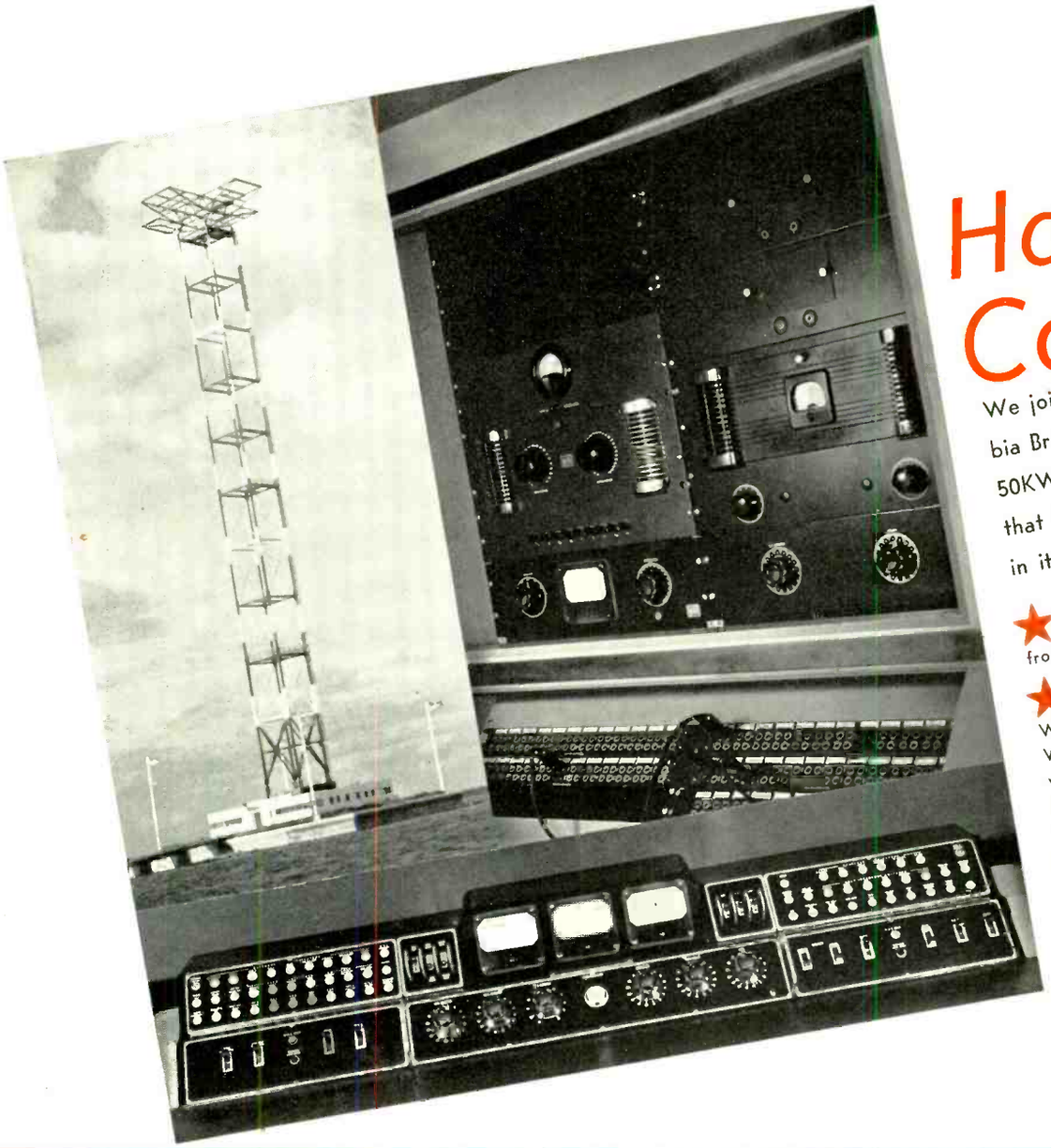


Hail Columbia

We join the nation in saluting Columbia Broadcasting System's new WABC 50KW transmitter, proud of the fact that DAVEN components are included in its construction.

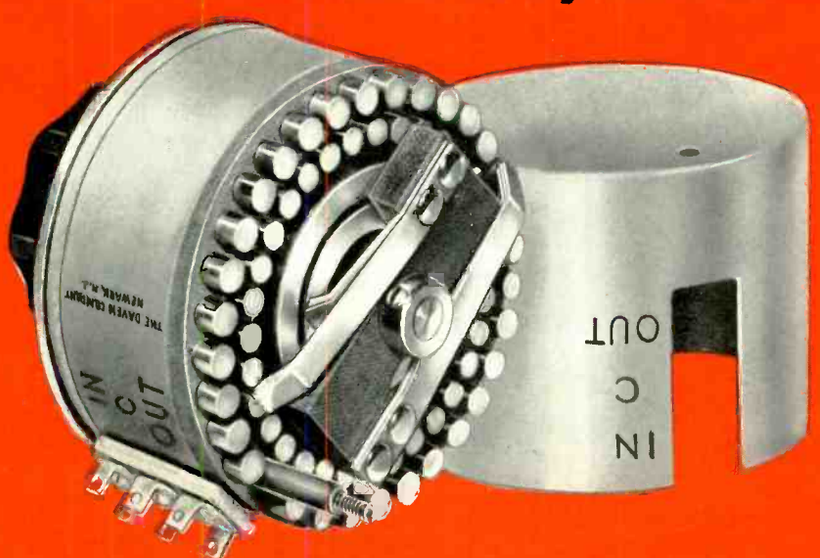
★ **UPPER LEFT** View of antenna rising from the transmitter on Columbia Island.

★ **UPPER RIGHT** A portion of the WABC audio facilities showing a DAVEN VI attenuator (to the right of the standard volume indicator in square instrument case) and DAVEN variable "T" type attenuators (in lower right panel, above jack fields).

★ **BOTTOM** Control console of the new WABC 50KW transmitter on Columbia Island, showing six DAVEN variable "T" type attenuators in the center, lower section of the panel.

Specify DAVEN ATTENUATORS

for high quality program distribution systems and as laboratory standards of attenuation.



The DAVEN catalog lists the most complete line of precision attenuators in the world; "Ladder", "T" type, "Balanced H" and Potentiometer networks—both variable and fixed types—as well as more than 80 models of Laboratory Test Equipment.

Where performance is the primary consideration, special heavy duty type switches for program switching and industrial applications, are available.

Many of your needs can be filled by DAVEN standard components. However, due to the specialized nature of high fidelity audio equipment, a large number of requirements are encountered where stock units may not be suitable. If you have such a problem, write to our engineering department.

THE DAVEN COMPANY

158 SUMMIT STREET • NEWARK, NEW JERSEY

80 Million Metal Radio Tubes

Placed 18 inches apart, the 80 million metal radio tubes sold since 1935 would reach around the world! More important, these 80 million tubes attest the tremendous acceptance accorded by the industry to the finer performance of metal-envelope tubes!

. . . and RCA is now producing metal tubes at fastest pace in history!

CURRENT PRODUCTION of metal tubes is the greatest in history — for the amazing *acceptance* accorded to metal tubes is still *increasing!* 80,000,000 metal-envelope tubes have been sold since 1935 . . and today *four* of the *six* largest-selling tube types are *metal* types!

Will They Be Available—?

If you have found difficulty or delay in obtaining RCA Metal Tubes, remember the reason: *it is not because production is low but because both defense and commercial demands are high.* And defense comes *first!*

Naturally, priority requirements in materials may limit the general availability of *all* types of tubes—for all types require valuable and limited metallic materials in their *internal* structure.

12 REASONS WHY
METAL Tubes are BETTER Tubes!

- Complete Self-Shielding
- Greater Flexibility in Design
- Greater Precision and Uniformity
- Lower Interelectrode Capacitances
- No Envelope Emission Troubles
- Freedom of Placement on Chassis
- Higher Getter Efficiency
- Simple, Efficient Grounding
- Single-ended Construction
- Large Pin-Contact Area
- Lower Socket Costs
- More Rugged Construction

RCA **METAL TUBES**

RCA Manufacturing Company, Inc., Camden, New Jersey

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