COMMUNICATIONS

- ★ RADIO ENGINEERING
- ★ F-M RECEIVER DESIGN FACTORS
- ★ A RECIPROCAL SLIDE RULE
- ★ LOW GROUND ANTENNAE
- ★ RADIO ALERT TONE SELECTOR
- ★ SURFACE LINE COMMUNICATIONS
- ★ U-H-F PRACTICE
- ★ AIRCRAFT COMMUNICATIONS

JULY

1943

For a full measure of service

Not only are men being tried on battlefronts, the equipment that they employ is being subjected to equally critical tests . . . with the lives of the men as the stakes. We at home, entrusted with war contracts, are overcoming serious raw material shortages through laboratory and production developments, making each individual tube that we produce do more than its planned job . . . and do it better.

Through a series of design refinements, Amperex engineers have developed transmitting and rectifying tubes that are being operated for longer periods of time than hitherto had been practical. These new Amperex radio and Radar tubes present a dual economy . . . many more hours of uninterrupted service . . . and priceless savings of scarce materials.

AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET • BROOKLYN, NEW YORK

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COMMUNICATIONS

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JULY, 1943

VOLUME 23 NUMBER 7

COVER ILLUSTRATION

A 75-watt, military type aircraft transmitter, on test.

(Courtesy General Electric)

We See...

REMOVAL AND CONSTRUCTION PERMITS for new transmitters, have been issued by the FCC to several stations during the past month. These grants are the first to have been made since the freeze order of April 27. The stations receiving authorization to move transmitter and studios were WGRC, New Albany, Indiana, and WDAK, West Point, Georgia. The construction permit was granted to Baylor University and C. P. Collins who plan to build a 50-kw daytime station in the southern portion of Texas. Some of the material for the station may come from Mexico, by way of XEAW.

The problem of manpower, prominent in the freeze order, seems to have been waived in the interests of public service and inter-American relationship. A good move, FCC!

THE UNPARALLELED INTEREST IN COMMUNICATIONS on Capitol Hill continues, with committee study and bills and amendments at a new peak. Just before Congress adjourned, Representative Holmes of Massachusetts introduced a Bill H.R. 3109 that would completely reorganize the FCC. Two divisions would be formed according to this bill, one to be known as a Division of Public Communications and the other a Division of Private Communications, each to have three members.

The bill, which has been referred to the Committee on Interstate and Foreign Commerce, permits appeals to be taken to the District Court in the District of Columbia, with a review by the Supreme Court, if necessary.

Action on this bill and others, in the fall, will be predicated on the results of the Cox FCC investigation. When Congress convenes again the business of *communications* will be spotlighted as never before!—L. W.

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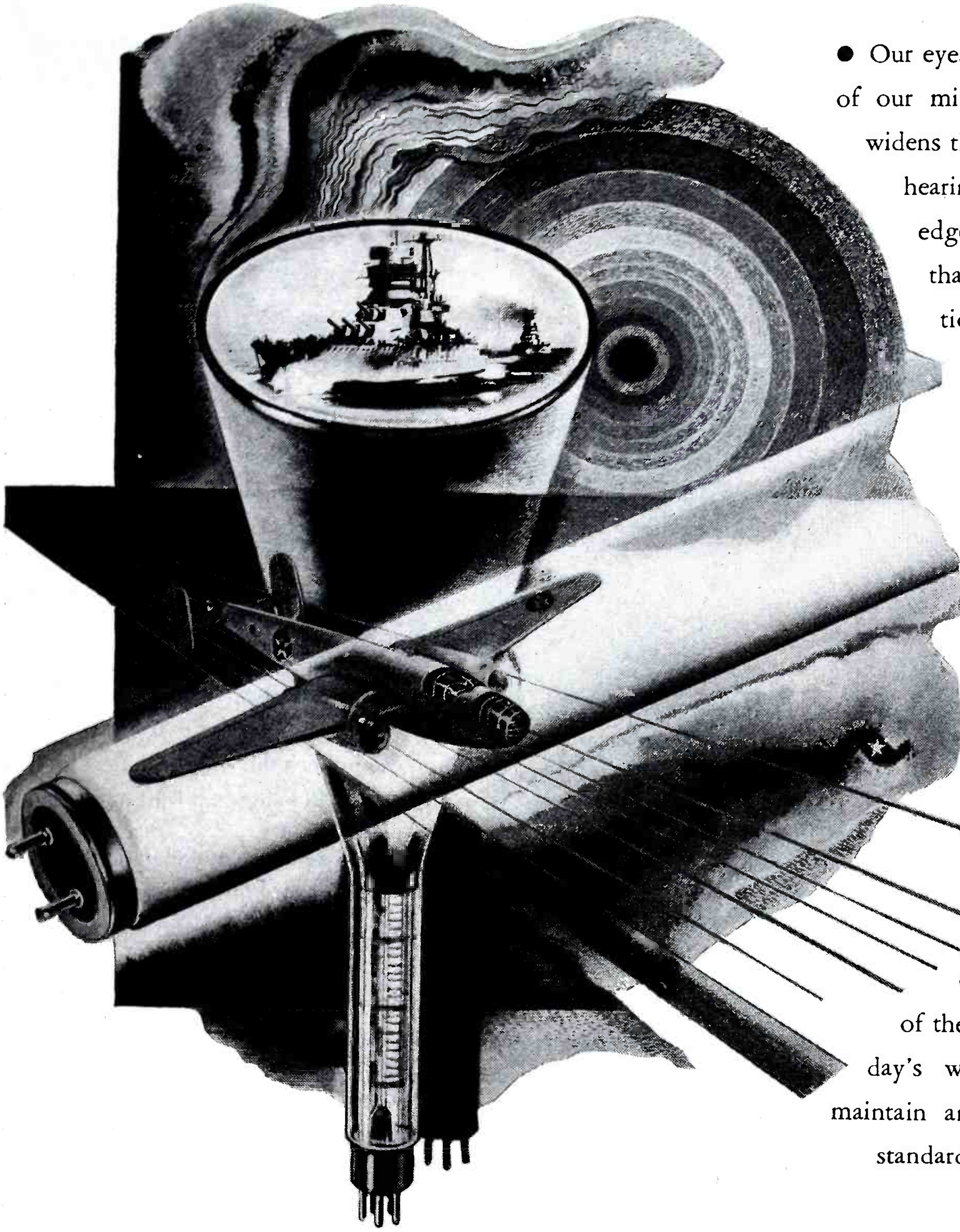
To see and hear beyond the beyond

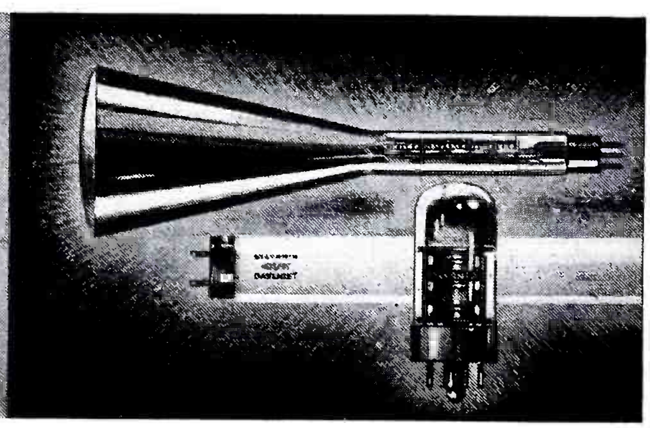


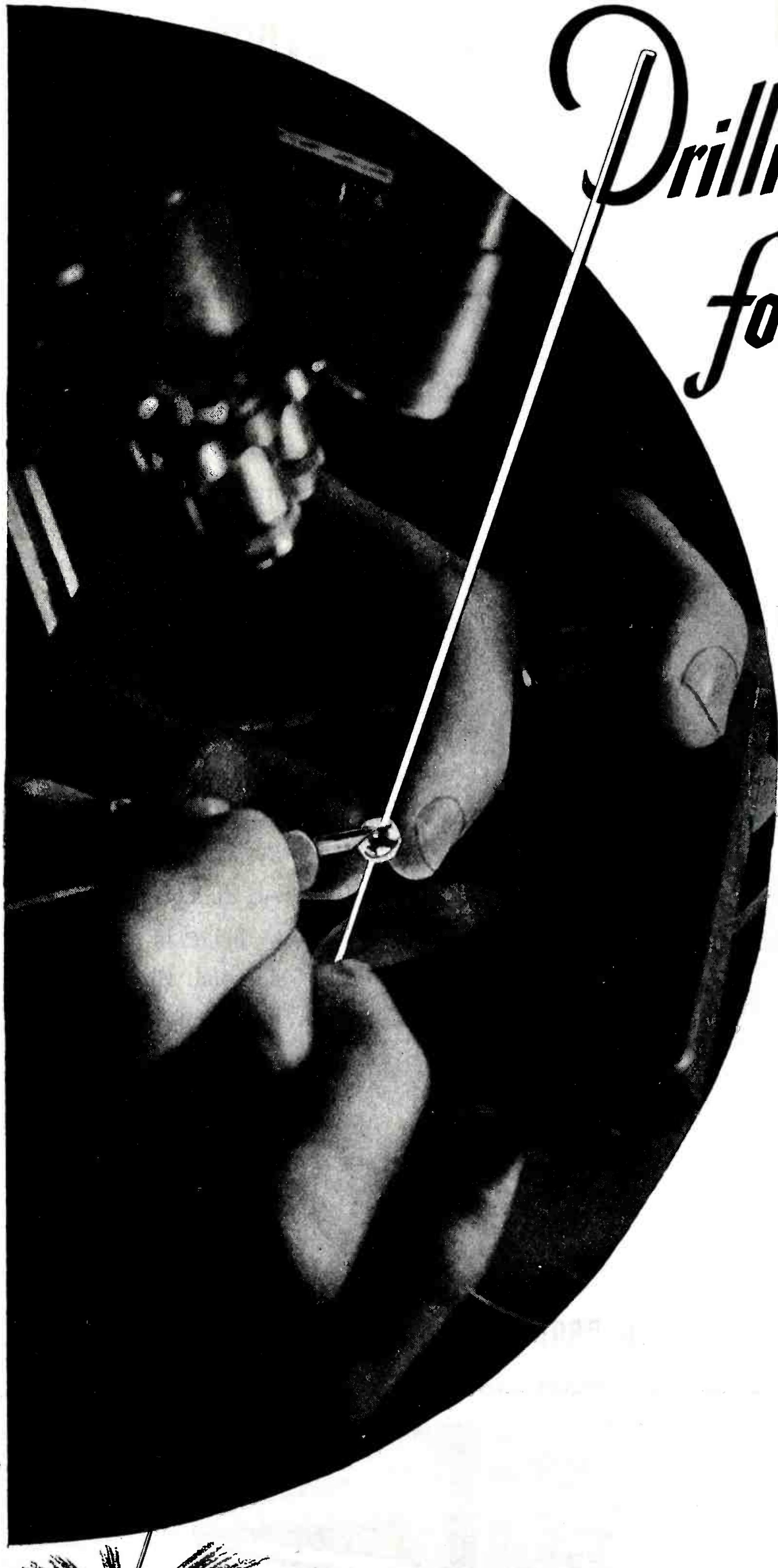
● Our eyes and ears are the advance guards of our mind's march forward. Whatever widens the horizons of human vision and hearing, reveals new vistas of knowledge. So our chosen work for more than forty years has been exploration of uncharted realms of sight and sound. Starting with the humble incandescent lamp, progressing to radio and electronic tubes, fluorescent lamps and equipment, we are today busy with ventures which are contributing vitally to the winning of the war. And important as these may be to Victory, their full flower will come as enduring boons to better living in the years beyond. How could anyone, glimpsing the rich promise of the future, be content to do each day's work with a firm resolve to maintain anything less than the highest standards known!

SYLVANIA ELECTRIC PRODUCTS INC., EMPORIUM, PA.

MAKERS OF INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES, RADIO TUBES, CATHODE RAY TUBES AND ELECTRONIC DEVICES

VITAL TO VICTORY is the ever-increasing number of electronic devices that miraculously bridge the gap between man and the machine tool in war industry. Electronic contributions to technology make inspection and processing more automatic and foolproof. From long experience, Sylvania has developed and applied electronic tubes to industrial as well as military uses.





THE EXECUTIVE WHO STOPS TO THINK . . .

Knows that "10% for War Bonds isn't enough these days"

Workers' Living Costs going up . . . and Income and Victory Tax now deducted at source for thousands of workers . . .

Check! You're perfectly right . . . but all these burdens are more than balanced by *much higher* FAMILY INCOMES *for most of your workers!*

Millions of new workers have entered the picture. Millions of women who never worked before. Millions of others who never began to earn what they are getting today!

A 10% Pay-Roll Allotment for War Bonds from the wages of the family bread-winner is one thing—*a 10% Pay-Roll Allotment from each of several workers in the same family is quite another matter!* Why, in many such cases, it could well be jacked up to 30%—50% or even more of the family's *new* money!

That's why the Treasury Department now urges you to revise your War Bond *thinking*—and your War Bond *selling*—on the basis of *family* incomes. The current War Bond campaign is built around the family unit—and labor-management sales programs should be revised accordingly.

For details get in touch with your local War Savings Staff which will supply you with all necessary material for the proper presentation of the new plan.

Last year's bonds got us started—*this year's bonds are to win!* So let's all raise our sights, and get going. If we all pull together, we'll put it over with a bang!

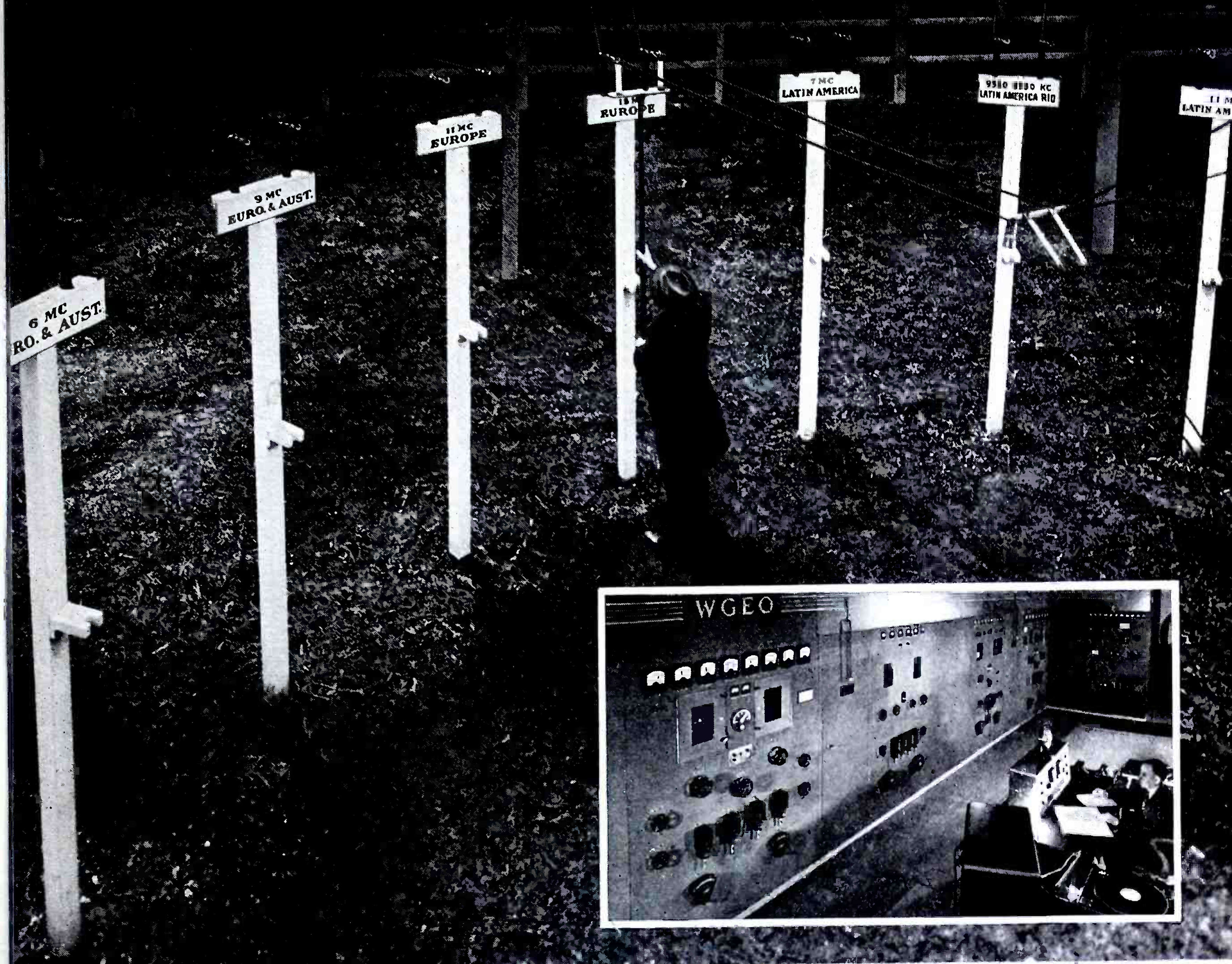
This space is a contribution to America's all-out war effort by

COMMUNICATIONS

you've done your bit
. . . now do your best!

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

All of America's 100-kw. transmitters have been built by G. E.



Switchyard at General Electric's 100-kw station, WGEO, in Schenectady, N. Y.

Forceful Allied propaganda is today beamed to all the Axis world by G-E international short-wave transmitters.

G-E pioneering in international short wave, begun in 1923, led to the development of nine American international stations of varying outputs up to 75 kw. Recently, G.E. added four more, two of them of 100 kw, the highest signal output of any American-built stations of that type. G.E. is now building three more giant 100-kw transmitters for the expanding American war needs.

General Electric is the only American manufacturer ever to have successfully designed and built international transmitters of such great power.

The G-E 100-kw and 50-kw transmitters for Station WGEO-WGEA, shown in the insert above, have their programs beamed by special panel-type antennae backed by ingenious dipole reflectors that step up the radiation efficiency.

In the main illustration is another G-E development, adding greatly to the flexibility and efficiency of international equipment. This antenna-feeder hookup gives quick manual switching from one directional beam to another—from one overseas work area to another. Day and night, this powerful station is working for a shorter war, a better peace.

What G-E Leadership Means to You

Informed thinking today points to changes in post-war broadcasting. It looks for a big increase in local FM stations. It foresees fewer but more powerful AM stations, and that television will grow, becoming an important factor in consumer markets.

General Electric offers any broadcaster a complete service in all three fields of FM, AM, television!

1. G.E.'s unmatched achievements in international transmitters are ample evidence of G-E ability to build new high-power AM transmitters and improved receivers after the war.

2. The fact that G.E. has built over a third of all FM broadcast transmitters and a large percentage of FM receivers is positive evidence of its continued leadership in the post-war FM field.

3. And four years of live-talent programming experiment in its own non-commercial television station, WRGB, plus its full line of television transmitters, relay transmitters, studio apparatus, and receivers provide a sum total of television equipment and experience that will be of immense value to the post-war broadcasting industry. . . . *Electronics Department, General Electric, Schenectady, N. Y.*

Tune in "THE WORLD TODAY" *and hear the news direct from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday listen to "The Hour of Charm" at 10:00 P.M. E.W.T. on NBC.*

• • •

42,000 hours of international service and still going strong! At WGEO, a G-E mercury-vapor rectifier tube — Type 857-B — has given faultless service since 1934.

GENERAL ELECTRIC FM · TELEVISION · AM

160-B6-6916

G-E employees are now purchasing over $1,000,000 in War Bonds weekly

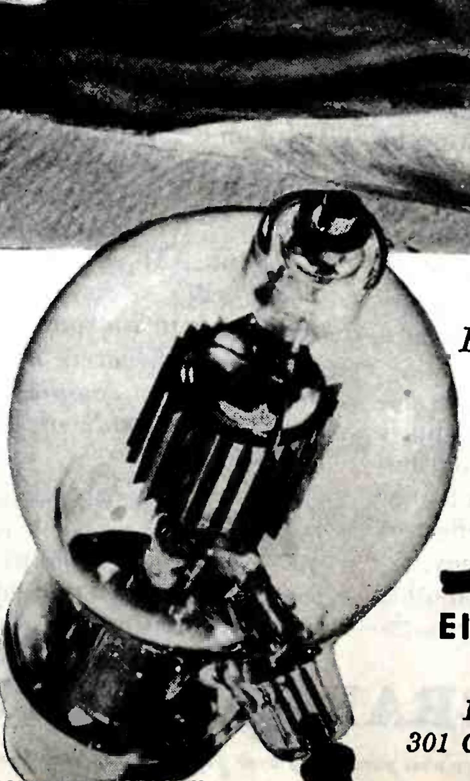
electronic briefs: FM

Radio is simply a method by which electrical energy is transmitted through space. By varying the intensity or frequency of this electrical energy, an intelligible signal can be created. The principle is the same whether dot dash code messages or voice and music are being transmitted. In the case of voice and music transmission the radio wave must be varied (modulated) at the same speed as the vibrations of the voice or music. The characteristics of electrical energy which can be varied or modulated are three: voltage, frequency and phase. Radio transmitters which vary the intensity (voltage) are called amplitude modulated and those which vary the frequency are called frequency modulated. The differences of these two systems can be understood easily by visualizing a beam of light. An audible signal can be transmitted by varying the light intensity (amplitude modulation) or by varying the color of the light beam (frequency modulation).

Static and other man-made electrical disturbances are identical in character to the amplitude modulated signal. Hence these disturbances are extremely bothersome to AM broadcasts. On the other hand these electrical disturbances do not essentially vary in frequency and consequently do not interfere with FM transmission. Another fortunate characteristic of FM is the fact that the stronger of two signals predominates, thus eliminating much inter-station interference and cross-talk. Further, and of great importance, the fidelity of tone can be made nearly perfect even when the heaviest of musical scores is being broadcast.

In frequency modulation as in all things in the field of electronics, vacuum tubes are the most important component. Eimac tubes have the distinction of being first choice of most of the leading electronic engineers throughout the world. They are consequently first in the most important new developments in electronics... FM for example.

Army-Navy "E" flag awarded for high achievement in the production of war material.



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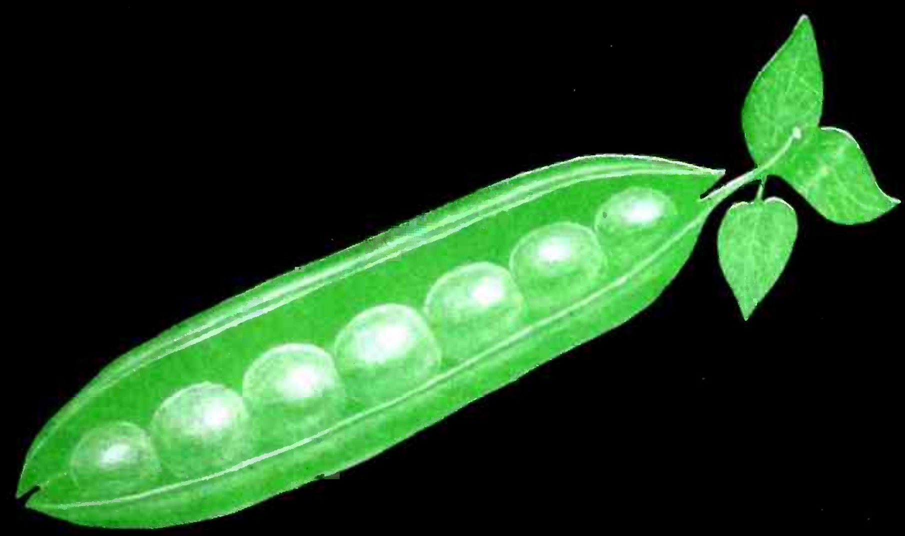
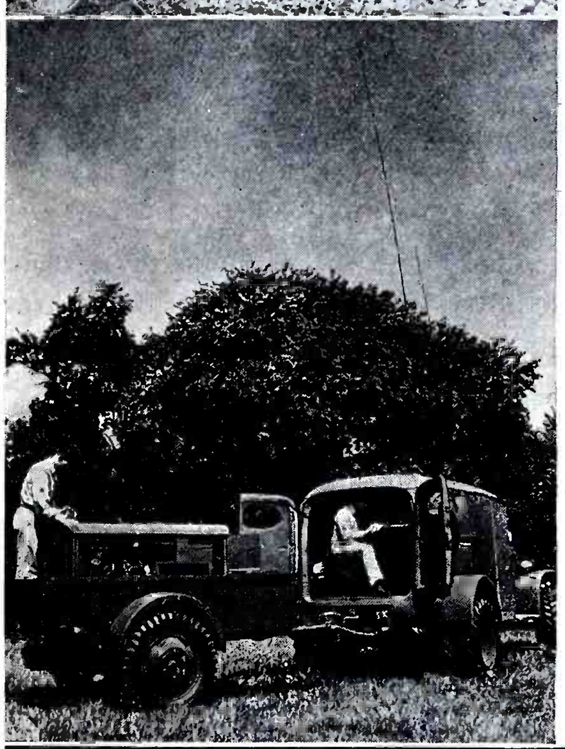


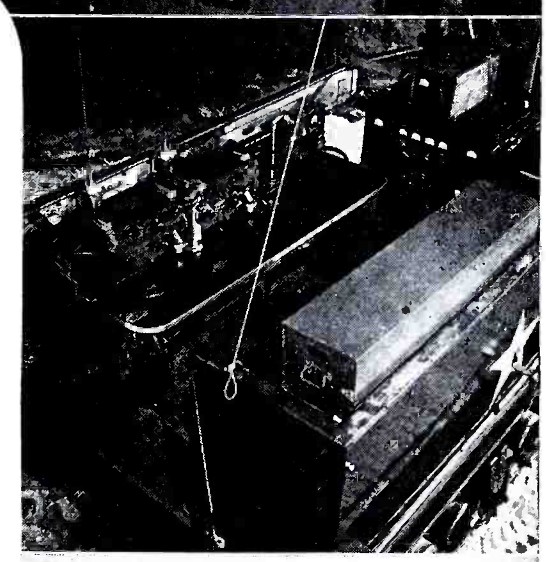
as peas in a pod

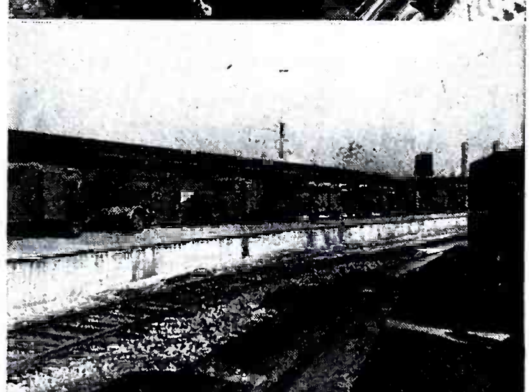
Winning "THE BATTLE OF COMMUNICATIONS!"

Mobile communications units assembled by Hallicrafters are helping to win the battle of communications on every fighting front. They are built to endure the rigors of modern warfare . . . The consistent performance of SCR-299 has been highly praised by leading members of our armed forces for its adaptability in meeting all the requirements of combat duty . . . A phrase best describing the SCR-299 was given when a leading military authority said, "It is to communications what the jeep is to transportation."

BUY MORE BONDS!







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THE WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT

Towers that talk . . .

Tall towers of slender steel. A spider web of steel flung across the sky. A small building. Nothing more.

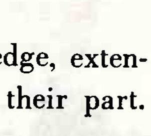
Nothing more?

Much, much more—for this is radio. And in radio as in man, the things unseen count most. Like the power of the human spirit, the energy of radio is invisible.

From the silence of these towers come the ringing words of patriot radio speakers—the lilt and lift of radio music—the saving grace of radio drama—the instruction and counsel of radio teachers and advisors—the linking of the people's needs and aspirations with the services of America's manufacturers and merchants.

This is the work of America's broadcasters, in which RCA is proud to assist. Through years to come radio broadcasting will render service now but dimly realized—not only in standard broadcast, but in FM, television, and facsimile—in these, too, RCA's special knowledge, extensive facilities and tireless research will play their part.

RCA's resources are today concentrated on war production. Yet RCA engineers are still available to help you solve your pressing technical problems. To the fullest extent possible under war conditions we shall continue to supply and service the vitally important broadcasting industry.



RCA

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COMMUNICATIONS

LEWIS WINNER, Editor

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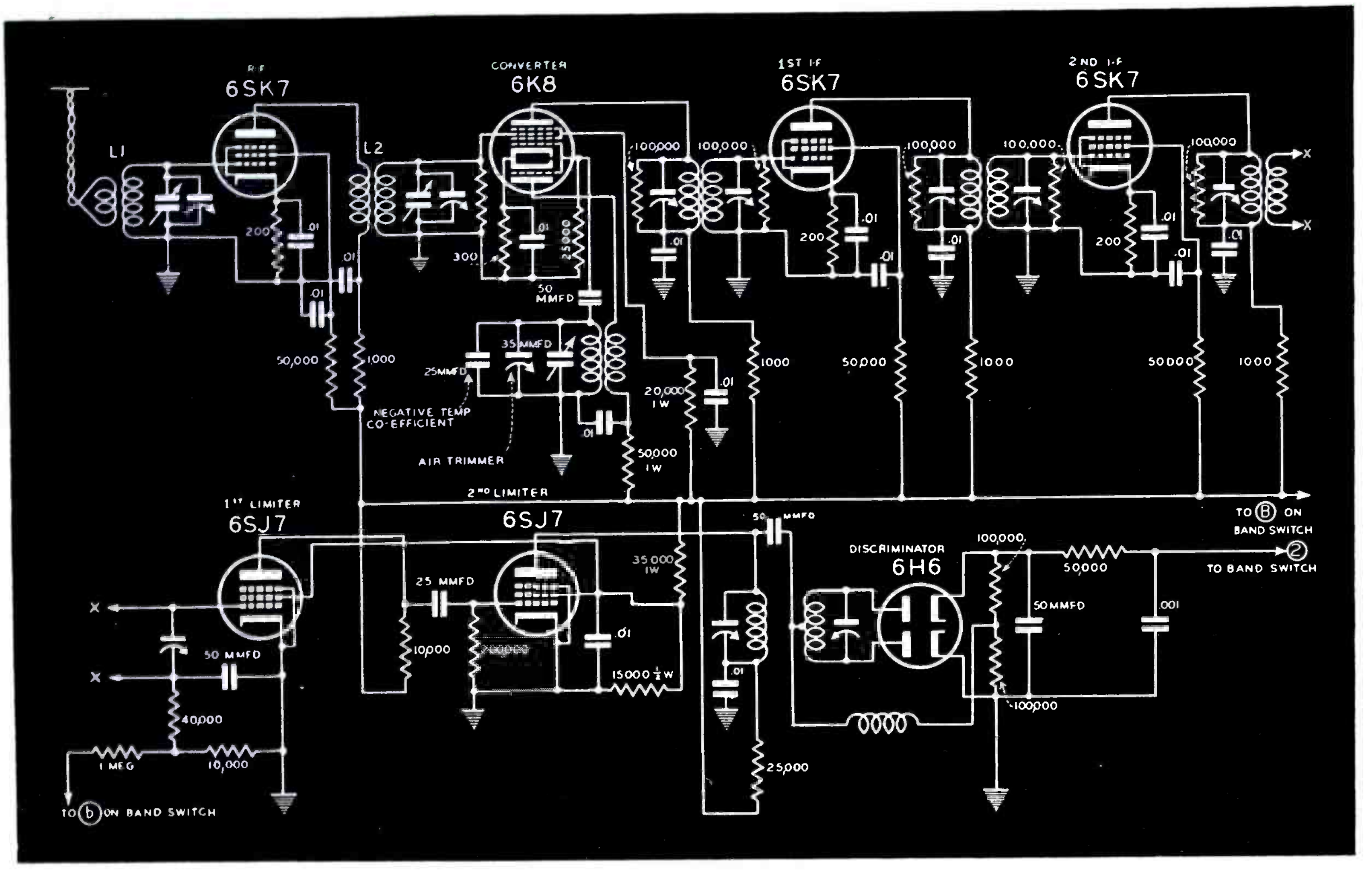

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Figure 1

The frequency modulation tuner developed by the author. On page 15 appear coil data for this tuner.

•

F-M RECEIVER DESIGN

by LOUIS PRESSMAN

Radio Supervisor, WNYF

New York Fire Department

IN development and design work involving improvements, it is usually prudent to construct a simple basic unit for study. When, therefore, f-m tuner design became our subject of study, a basic f-m unit was first constructed, using standard components.

In the unit selected for analysis, a superhetrodyne circuit was used. It consisted of a 6K8 oscillator-converter, two 6SK7 intermediate frequency amplifiers, one 6SJ7 limiter and a 6H6 Foster-Seeley discriminator. For audio, a good broadcast receiver was used. Prior to actual testing, we, of course, set up standards of performance that we should like to meet.

After a period of operation, the unit under test was found deficient in such features as overall gain; adequate limiting; oscillator stability; inter-

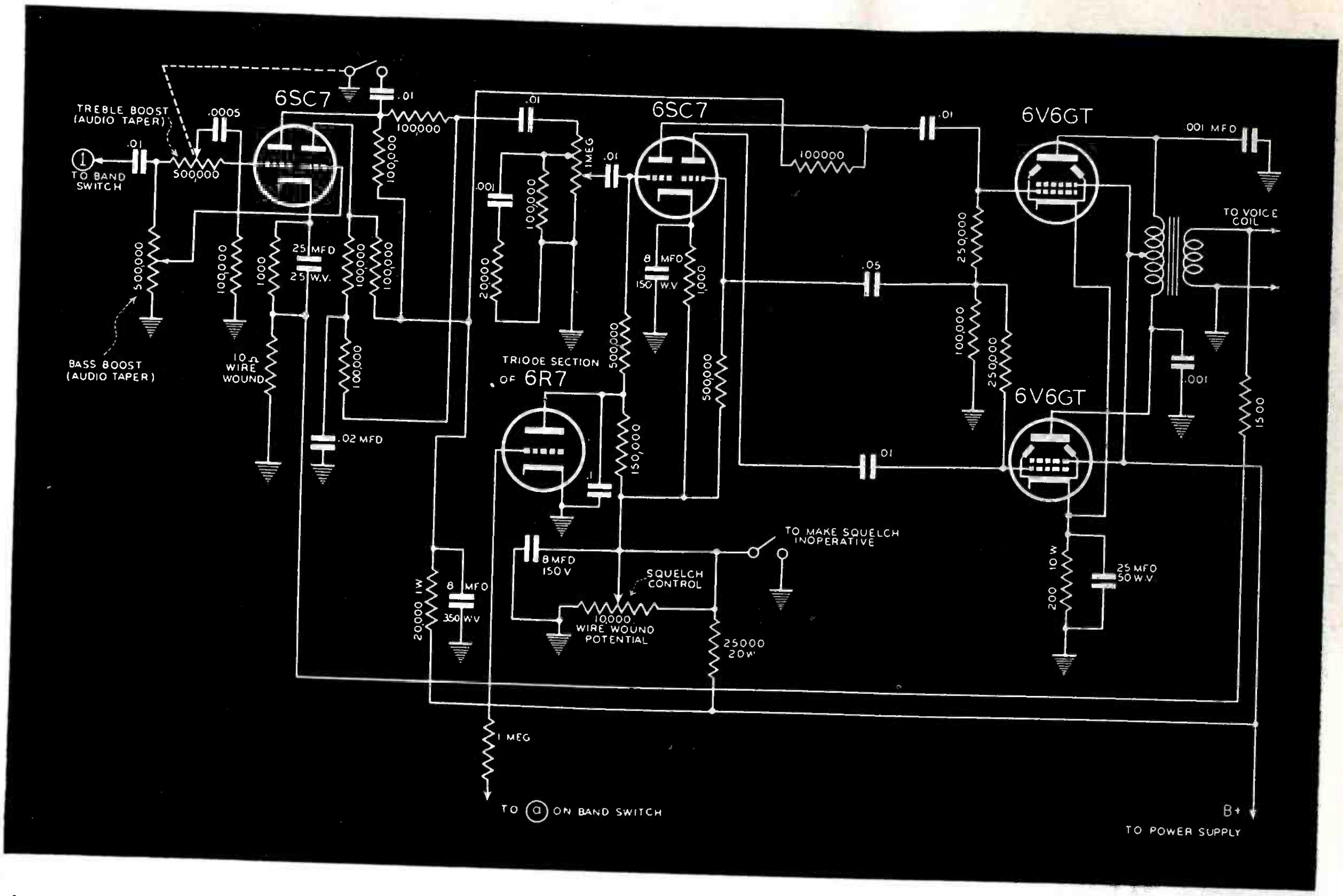


Figure 2
The audio frequency amplifier developed for use with the f-m tuner.

channel noise suppression, and audio fidelity.

The problem of overall gain was the first considered. Gain, of course, ties in with limiting for satisfactory noise reduction. However, no matter what type of limiter is used, unless sufficient signal amplification is available, inadequate limiting will result. Experience indicated that two stages of i-f amplification was the maximum that could be used with stability. The gain could have been increased by substituting higher gain tubes in the i-f stages and then adding a stage of radio frequency amplification or a combination of both.

Substitute Tubes Considered

The high-mu television tubes, 1851, 1852, and 1853 were considered for substitution of the 6SK7 tubes used in the i-f stages. The 1851 was discarded because of the longer leads involved, since the grid had to terminate in a top cap. The 1852 was superior to the 6SK7, but its erratic behavior and high cost ruled against it. The 1853 showed lower gain factor than the 6SK7. This is evident from the equation for maximum theoretical gain for the i-f stage which is

$$\sqrt{\frac{G_m}{2\pi f c}}$$

where G_m is the mutual conductance, c is the grid-to-plate capacity and f is the intermediate frequency. The gain factor then is G_m/c.

I-F Amplifier

One of the factors involving gain is frequency. Since first stage gain decreases as the square root of the frequency, a low value of i-f should be chosen. However, if too low a value is selected, image difficulties may be encountered. The RMA recommendation of 4.3 mc. for the i-f was followed even though higher frequency coils were then obtainable. No trouble was experienced with these coils with reference to gain and proper band pass characteristics.

Difficulties did arise with oscillation in the first i-f stage. The trouble was traced to the practice of returning all of the stage bypass condensers to one point on the chassis. It was found necessary to use two separate bypass grounding points; one for the input and cathode, the other for the output circuit and screen grounding point. This resulted in a clean, stable i-f amplifier. No shielded wire was used in this circuit at all.

The R-F Stage

In the r-f stage standard design was found effective. The tuned circuit, of course, was ganged to and tracked with the mixer input circuit. The addition of this stage plus the use of a doublet antenna, cut to resonate in the middle of the 42- 50 megacycle band, brought the overall gain up to an entirely satisfactory level for the reception of stations in the metropolitan area. Voltages up to 100 volts were developed across the limiter grid resistor.

Overlapping Prevented

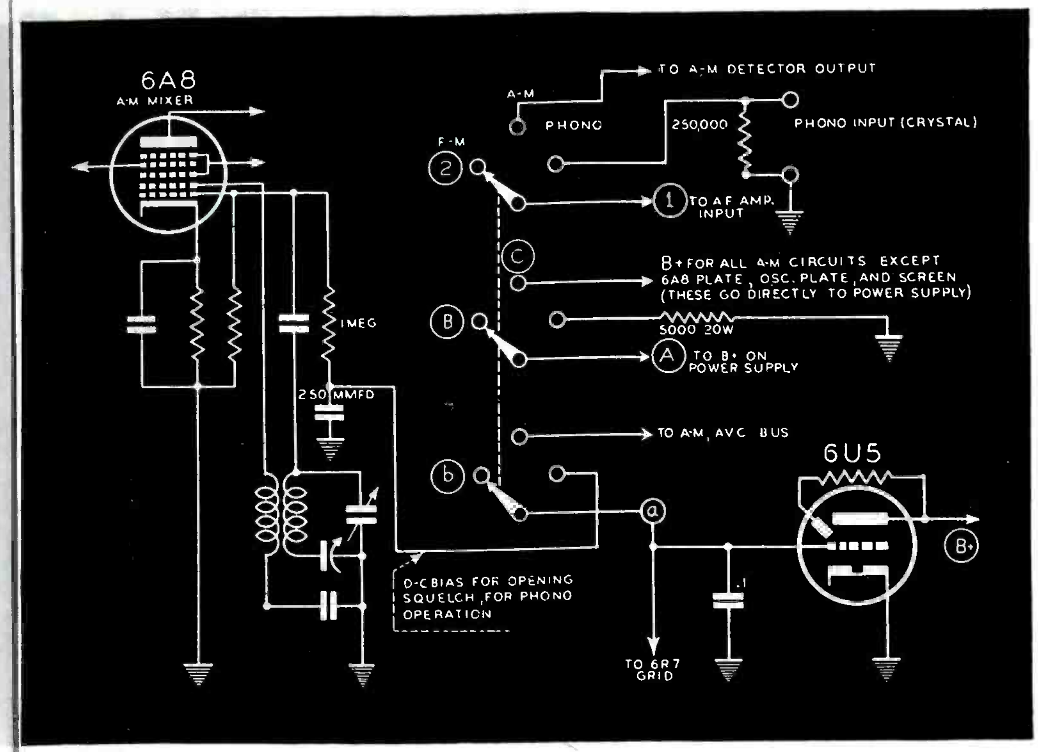
To prevent overlapping of the 6U5 tuning indicator, the tuning eye grid had to be tapped down on the limiter grid resistor, so that only twenty per cent of the voltage developed would actuate the indicator.

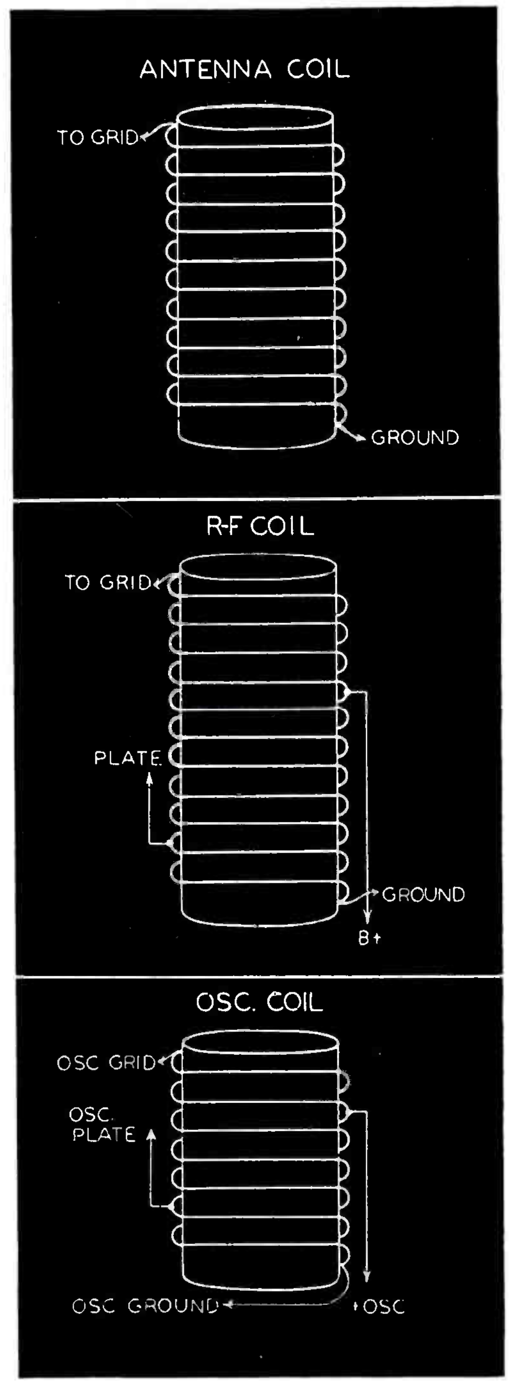
Leads in this stage were made as short as possible and no trouble of any kind developed.

The tuned circuit constants will be discussed later.

Limiting

It was found that even with high signal input carriers noise reduction was not quite satisfactory. Some types of noise rode through and appeared in the output regardless of the plate voltage applied to the limiter. Satisfactory noise reduction was achieved by adjusting the limiter grid resistor and condenser along with the plate voltage. However this combination did not hold for every type of noise encountered, and apparently a single





tube limiter could not do an entirely satisfactory job.

J. A. Worcester, of the General Electric, in an RMA technical bulletin (November 12, 1940), discussed the subject of limiting quite fully and recommended the use of two limiters in cascade. The immediate superiority of this circuit to that of the single tube in practice was evident. The second 6SJ7 limiter was therefor installed. Since resistance-capacity coupling is used between the two limiters, a neglible amount of space and component addition was involved.

Figures 3 (top) and 4 (right)

In Figure 3 appears the bandswitch system. Coil data appears in Figure 4. The antenna coil consists of 7 turns, spaced the diameter of wire, which is No. 16 dcc. The primary contains two turns interwound at the lower end. The r-f coil also has 7 turns with a 4-turn primary at lower end. The tickler consists of three turns of No. 20 dcc wire, while the grid winding consists of four turns of No. 16 wire, double spaced. Forms are 5/8" polystyrene.

Oscillator Stability

During the period of operating the tuner it was found that very bad drift occurred. Not only was there an initial period of warming up, but occasionally shifts in frequency developed during normal operating time.

Since the signal circuits tuned 42 to 50 megacycles, the oscillator being on the high frequency side of the signal, tuned 46.3 to 54.3 mc for an i-f of 4.3 mc. Such a range was easily covered with 3 to 15 mmfd midget condensers shunted with 3 to 30 mmfd trimmers for setting the band.

It was believed that the *LC* ratio was not favorable towards the minimization of varying shunt capacity effects due to heating, etc. Operating the oscillator on the low frequency side of the signal circuits appeared to result in more stable operation due to the lower frequency and thus allowed the use of more capacity. With more capacity actually in use for tuning, plus more for padding, a more favorable LC ratio would result. The oscillator therefore was re-designed to tune 37.7 to 45.7 mc. The usual methods of calculation indicated a tuning capacity variation of approximately 30 mmfd. In order to track with the signal circuits, about .2 microhenries of inductance was required for the oscillator. It was necessary to provide a total capacity variation of 60 to 90 mmfd. Such a total capacity readily lent itself to the adoption of an additional factor contributing to the frequency stability; negative temperature coefficient capacity compensation.

Specifically, tuning was accomplished with a 3 to 35 mmfd isolantite insulated midget condenser. This condenser was shunted with an adjustable air padder having a maximum capacity of 35 mmfd, plus a 25 mmfd negative temperature coefficient condenser, with compensation of .0007 mmfd per mmfd per degree Centigrade. To ensure proper operation of this capacitor, it was mounted directly over the oscillator plate dropping resistor. The plate resistor heats the capacitor for proper temperature-capacity cycling.

The stability of the 6K8 in itself is quite good. Factors aiding in maintaining this stability are avoidance of over-excitation of the oscillator and utilization of good power supply regulation. The tube manufacturer's recommendation of operating the oscillator at 150 microamperes of oscillator grid current was followed. This was accomplished by adjusting the feedback winding on the coil and varying the oscillator grid leak.

Since voltage variations applied to tube elements will cause frequency change, and avc bias swings applied to the signal grid of the 6K8 will sometimes cause a frequency change, avc was not used. As a matter of fact avc was found to be unnecessary, thereby removing another possible source of trouble. Adequate power supply regulation was obtained by using swinging choke filter input, plus conservative ratings of components. More than average line voltage variations caused no noticeable frequency change.

The basic tuner had an oscillator on the high frequency side of the signal. This required frequent manual adjust-

(*Continued on page 66*)

A RECIPROCAL SLIDE RULE

For Parallel Resistors

by ROBERT C. PAINE

A FREQUENT problem encountered in laboratory work is the selection of two resistors for parallel linking to produce a required value. A similar problem is the combination of two condensers in series to produce the required equivalent value. Mathematically these problems are of the form

$$R_{eg} = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)}$$

which can be written

$$\frac{1}{R_{eg}} = \frac{1}{R_1} + \frac{1}{R_2}$$

or for condensers

$$\frac{1}{C_{eg}} = \frac{1}{C_1} + \frac{1}{C_2}.$$

These equations can be solved readily by a special *reciprocal slide rule* divided according to the natural reciprocals of the numbers involved. These reciprocals are added mechanically for the sum of the reciprocals, $1/R_{eg}$, in the same manner as the logarithms of numbers are added on the *Mannheim slide rule* for multiplying. In Figure 3, this comparison is illustrated. Scales R_1 and R_2 correspond to the CI and D scales, respectively, of the ordinary slide rule.

The scales for the *reciprocal slide rule* are shown in Figure 1. Since the reciprocal of ∞ is zero, this is the starting point for the R_1 scale. The division corresponding to the number *2* has been chosen as the end point. The whole scale is 200 millimeters long. Since the reciprocal of 2 is 0.5, this fixes the scale as 0.5 equals 200 mm, or 1.0 (if carried that far) would equal 400 mm. On this basis the

(*Continued on page* 86)

Scales for Figure 1 A

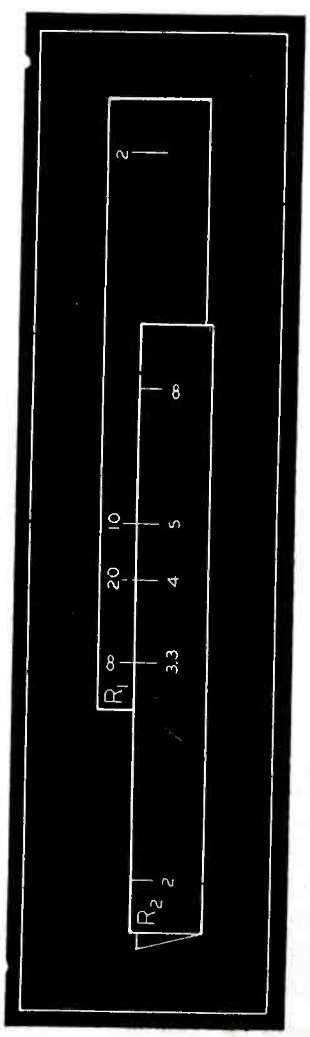
No.	mm	No.	mm
∞	0.0	5.0	80.0
50	8.0	4.8	83.5
30	13.0	4.6	87.0
20	20.0	4.4	91.0
18	22.0	4.2	95.0
16	25.0	4.0	100.0
14	28.5	3.8	105.0
12	33.0	3.6	111.0
11	36.5	3.4	117.5
10	40.0	3.2	125.0
9.5	42.0	3.0	133.5
9.0	44.5	2.9	138.0
8.5	47.0	2.8	143.0
8.0	50.0	2.7	148.0
7.5	53.5	2.6	154.0
7.0	57.0	2.5	160.0
6.5	61.5	2.4	166.5
6.0	67.0	2.3	174.0
5.8	69.0	2.2	181.5
5.6	71.5	2.1	190.0
5.4	74.0	2.0	200.0
5.2	77.0		

(*Values given to nearest* .5 *mm*)

Scales for Figure 1 B

No.	mm	No.	mm
∞	0.0	10.5	95.0
100	10.0	10.0	100.0
80	12.5	9.5	105.0
60	16.5	9.0	111.0
50	20.0	8.8	113.5
40	25.0	8.6	116.0
35	28.5	8.4	119.0
30	33.0	8.2	122.0
28	35.5	8.0	125.0
26	38.5	7.8	128.0
24	42.0	7.6	131.5
22	45.5	7.4	135.0
20	50.0	7.2	139.0
19	52.5	7.0	143.0
18	55.5	6.8	147.0
17	59.0	6.6	151.5
16	62.5	6.4	156.5
15	66.5	6.2	161.0
14	71.0	6.0	166.5
13.5	74.0	5.8	172.5
13.0	77.0	5.6	178.5
12.5	80.0	5.4	185.0
12.0	83.5	5.2	192.0
11.5	87.0	5.0	200.0
11.0	91.0		

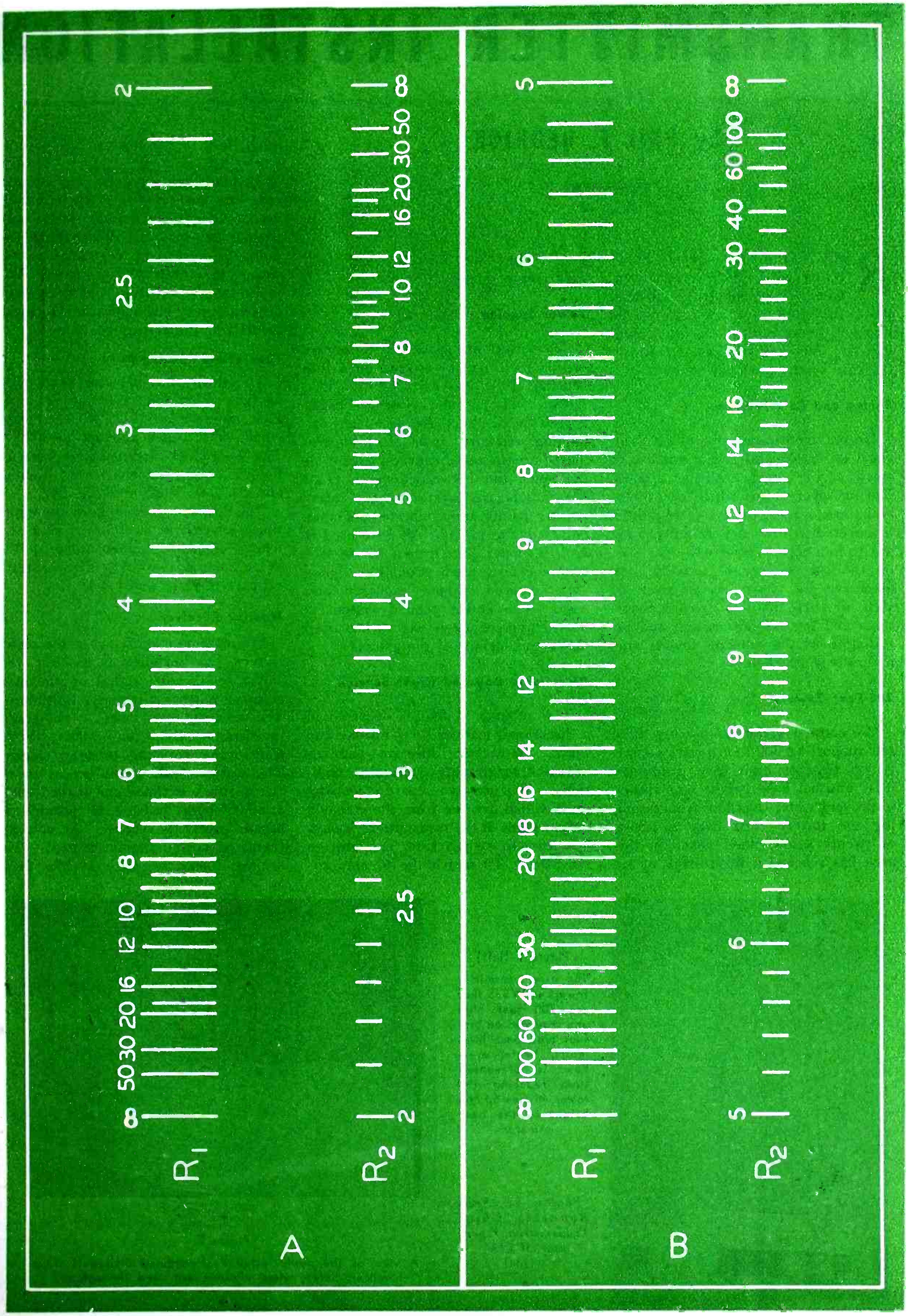
(*Values given to nearest* .5 *mm*)



Figures 1 (page 17), 2 (right), and 3 (left)
In Figure 1 appears the reciprocal slide rule scales for solving the equation

$$R_{eg} = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)}$$

In Figure 2 appears the table of values used in laying out the slide rule scales of Figure 1. At the left, Figure 3, appears the method of mounting and using the reciprocal slide rule scales.


R1
R2
A
R1
R2
B

TRANSMITTER INSTALLATION

by PHIL F. HEDRICK

Chief Engineer, WSJS

RECENTLY we completed installation of a 5-kw transmitter, which supplanted a 250-watt unit. In view of our low bottom land location, many unusual problems prevailed. This was particularly true in the case of the antennae system.

Spring and Rain Problem

On our transmitter site which is located on creek land, are a number of small springs and drainage ditches. During severe rains which occur several times a year, the complete bottom is covered with water ranging from one to four feet. Incidentally any spot on the site surface is actually only about two feet above a water level. In view of these natural ground conditions and the rainfall, design and installation of the antenna towers was naturally a problem.

300-Foot Towers

We chose a system employing three self-supporting 300-foot towers mounted on ten-foot high base insulators. This unusual base height was chosen to prevent water overflow from reaching the tower. For over a period of twenty years, flood water in this area has reached a flood stage of six feet. Thus we have an additional four feet of leeway.

Tower Spacing

The towers are spaced 67½ degrees or 308 feet and are erected on a line bearing 108 degrees East of true North. The ground system consists of 180 radials, each 400 feet long, extending outward from each tower. These are spaced 2 degrees, except on the center line between towers. Here the radials are carried to the intersecting points and connected together on a bonding radial. All wire used is No. 10 copper, hard drawn. A 48-foot square copper mesh ground screen is also centered around each antenna base. The entire ground system is buried approximately six inches deep below the surface of the ground.

Directional Day and Night Service

The antenna system is operated in a directional manner for both day and night. However, different patterns are used to simplify operating conditions. We use two separate phasing units which are fed from the common output point of the transmitter. Relays are used to switch from one unit to the other. To match the 67-ohm coaxial lines to the towers, L-type networks are used at all three towers. Each tower has a regular and a duplicate line with relays at each end to permit switching of lines should any trouble develop. In determining the night pattern, we, of course, first chose a theoretical phasing factor. We found that under actual operating conditions, a very close approach to these theoretical values was possible.

Theoretical Phasing Data

The theoretical phasing values for daytime operation were as follows: East antenna, $-197.5°$; Center antenna, 0°; West antenna $+175.7°$. The theoretical current ratios were as follows: East antenna, .508; Center antenna, 1.0; West antenna, .567.

The theoretical phasing for the night time pattern was as follows: East antenna, $-162.8°$; Center antenna, 0°; West antenna $+168.8°$. The theoretical current ratio was 1:1.47:1.

Monitor Receiver

For maximum efficiency on the night pattern, we installed a monitor receiver on the 40° radial on the null pointing northeast towards Baltimore. The receiver used was a two-stage tuned-radio frequency affair, with transformer coupling between stages. The primary and secondary of these transformers is tuned and loaded with a 50,000-ohm resistor to provide a broad selectivity curve. A voltage regulated power supply is used. To achieve linear response at low field

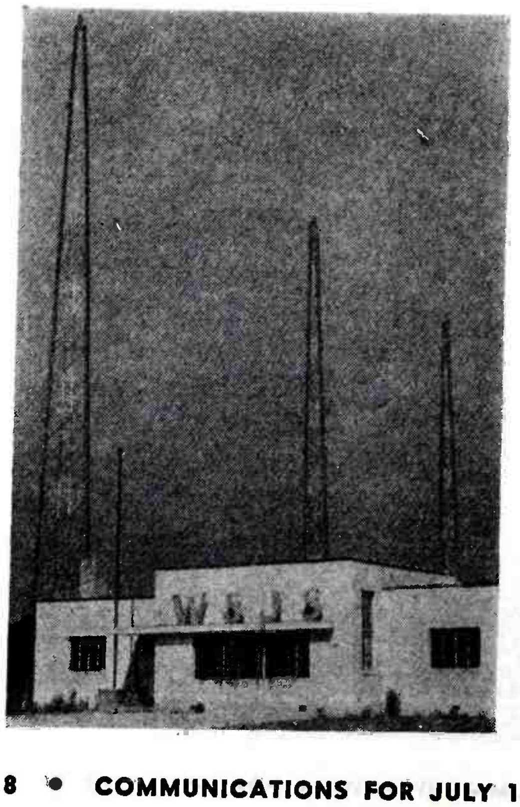


Figure 1 (left)
The new transmitter towers of WSJS that are 300 feet high and mounted on ten-foot high base insulators. Water overflow is prevented from reaching the tower, in view of the height of the base insulators.

[*Photos by Fred Bennett, Chief Transmitter Operator, WSJS*]

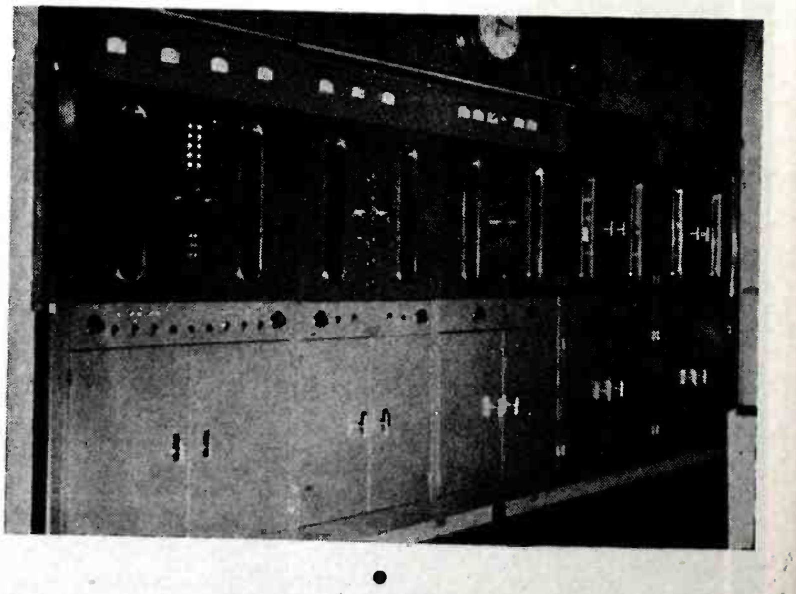


Figure 2
A view of the newly installed streamlined 5-kilowatt transmitter. Safety glass windows are used throughout.

IN A LOW LAND AREA

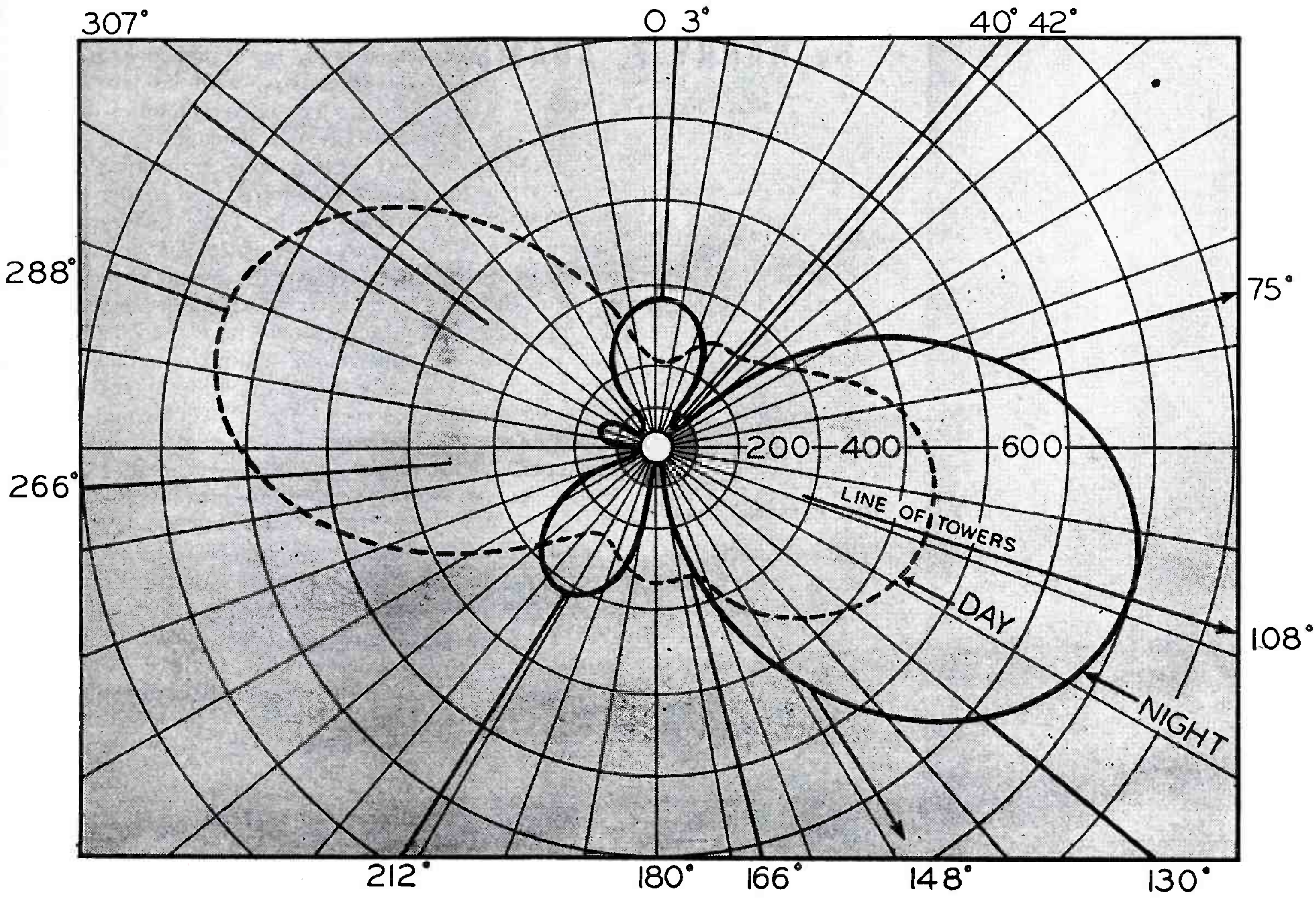


Figure 3

Pattern of day and night transmission from WSJS' new transmitter.

ıtensities, we use a diode detector. 'his particular receiver is located 1.2 ıiles from the transmitter. The out- ut of the monitor receiver is read ocally by a 15 ma milliammeter. The utput is also connected to a telephone ne running to the transmitter room here we also use a 15 ma milliam- ıeter.

he Phase Monitor

A type 2A Western Electric phase onitor is used in the transmitter ilding. Connections are made by eans of concentric lines developed cpressly for the phase monitor sam- ing lines. Incidentally all sampling nes and pick up loops are identical ıysically. This was an important oint and particular pains were taken see to it that identical characteristics prevailed throughout. We have found that phase reading on the phase monitor can be duplicated within one degree. Our new transmitter is of the latest Western Electric design consisting of a quartz crystal controlled oscillator operating into a two-stage radio frequency amplifier. This is followed by a two-stage audio frequency amplifier, a modulating amplifier stage, and a power amplifier stage consisting of two air-cooled tubes in a Doherty high frequency circuit.

Sequence Relays

The changing of the antenna pattern is accomplished with a set of sequence relays. To set these sequence relays in operation, it is only necessary to throw one switch. This action cuts the radio frequency drive to the final amplifier, throws the pattern changing relays, and restores the radio frequency drive to the final amplifier, all in about two seconds.

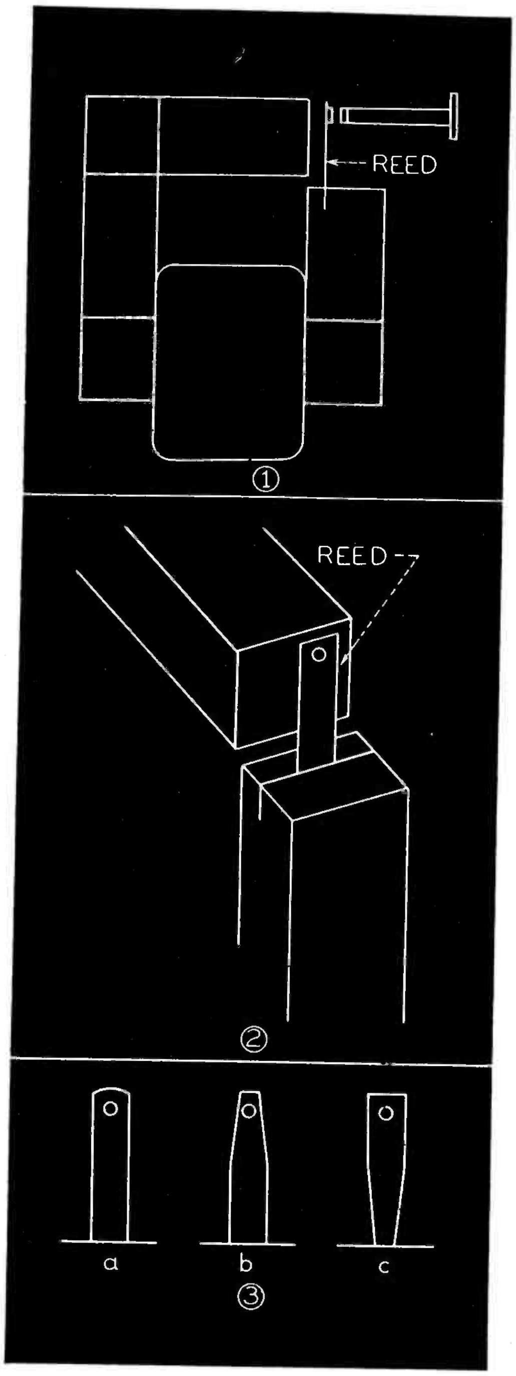
For field pickups, mobile equipment is used. It consists of a 100-watt short-wave transmitter and a 2-watt portable or pack transmitter. A special mobile truck houses this equipment, as well as portable recording units. The mobile transmitter unit is capable of covering a 25-mile radius.

In the old transmitter a single tower, 375 feet high was used. For this vertical radiator flood control methods were also used. However, the new antenna techniques are vastly superior to those used previously.

The present transmitter is about 4½ miles from the center of Winston-Salem, North Carolina. The site covers some 53 acres of land.

A TONE SELECTOR

For Radio Alert Systems



by HARRY E. ADAMS

Chief Engineer, WIBC

IN the design of an alarm system to be operated by the 1,000-cycle tone, the biggest problem is a filter circuit to discriminate against all other tones so that a sustained musical note will not operate the alarm. Sharply tuned circuits can be used if the necessary reactors and capacitors are available, but they become quite critical if selectivity sharp enough to be of much use is to be attained.

The Resonant Reed

In seeking a simple substitute the resonant reed used in frequency meters was suggested. Its construction seemed not too complicated and a little experimentation showed the idea to be workable.

Our alarm, shown in Figure 4, was constructed on a junked broadcast receiver chassis, with its power supply intact. The choice of tubes to be used was affected somewhat by the 2.5-volt heater winding available. Push pull 2A5's were used to drive the vibrating reed. Their grids were coupled to the voice coil terminals of the alert receiver by means of a push-pull output transformer, reversed. The output transformer used had several impedances available. Thus it was fairly simple to obtain a good match to the reed coil. The coil and core for constructing the reed unit were parts of a small receiver type filter choke.

The circuit controlled by the reed can be as elaborate as desired. We used a simple arrangement, using a minimum number of tubes to operate an alarm bell. No provision is made to indicate carrier breaks at the key station or power failures, but these refinements could be easily added. Of course, failure of the 57 tube or its plate supply will cause the alarm to sound.

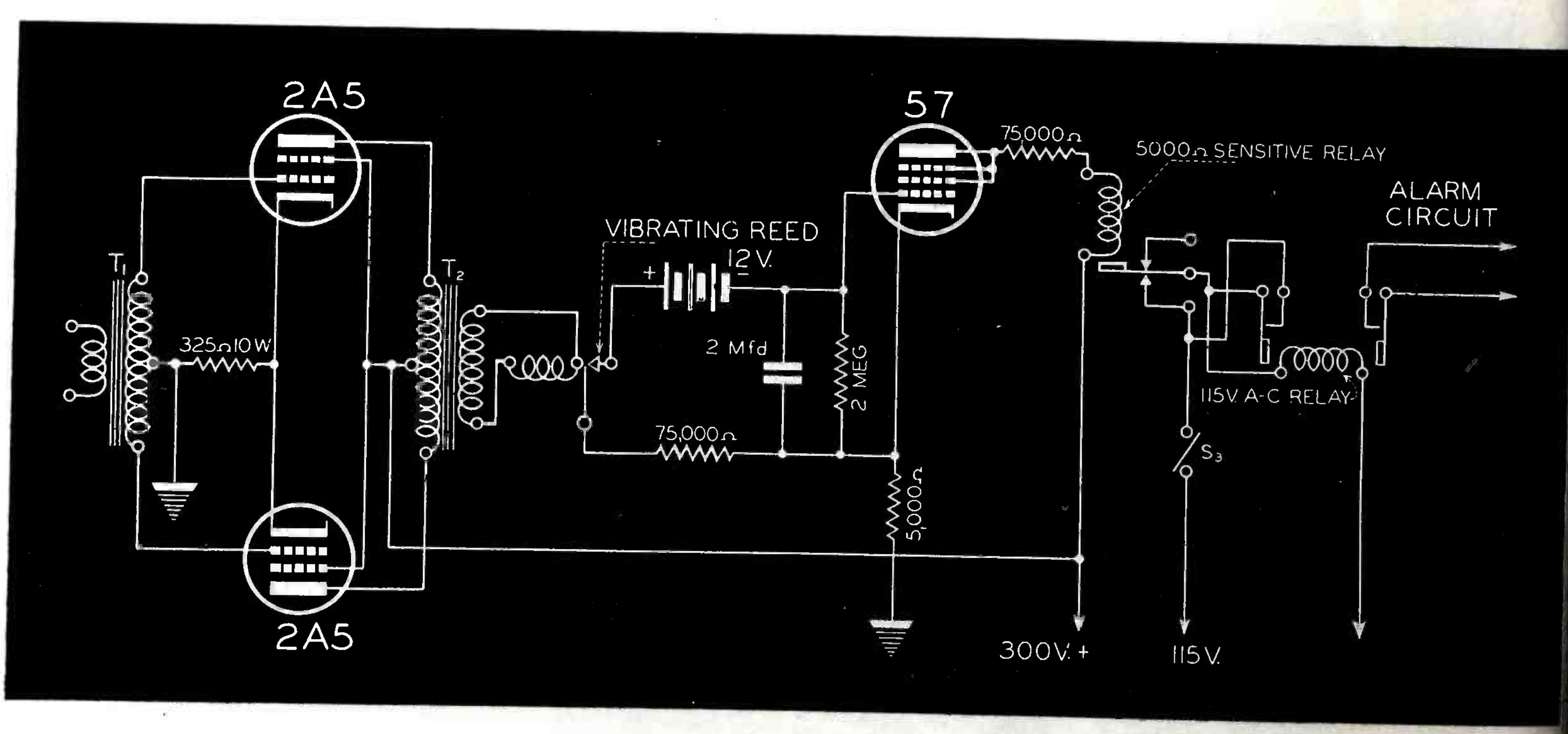
Use of the 57 Tube

The 57 s self-biased. The relay is a 5,000-ohm sensitive type, adjusted so that normal plate current holds the armature against the front contact. When the reed vibrates enough to strike its contact, a charge builds up in a 2 mfd unit. This charge is applied as additional negative bias to the 57

(*Continued on page* 87)

Figures 1, 2, 3 (left) and 4 (below)

In Figures 1, 2 and 3 are three possible variations in the shape of the reed for tuning it to 1000 cycles. *B* in Figure 3 illustrates the treatment to raise the frequency, while *C* shows the method used to lower the frequency. Figure 4, below, illustrates the tone selector circuit.



OSCILLOGRAMS OF COUPLING CIRCUIT TRANSIENTS

*(Part Two of a Two-Part Paper)**

by **GEORGE B. HOADLEY**

Assistant Professor

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Polytechnic Institute of Brooklyn

AND

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Instructor

Graduate Electrical Engineering Dep't

Polytechnic Institute of Brooklyn

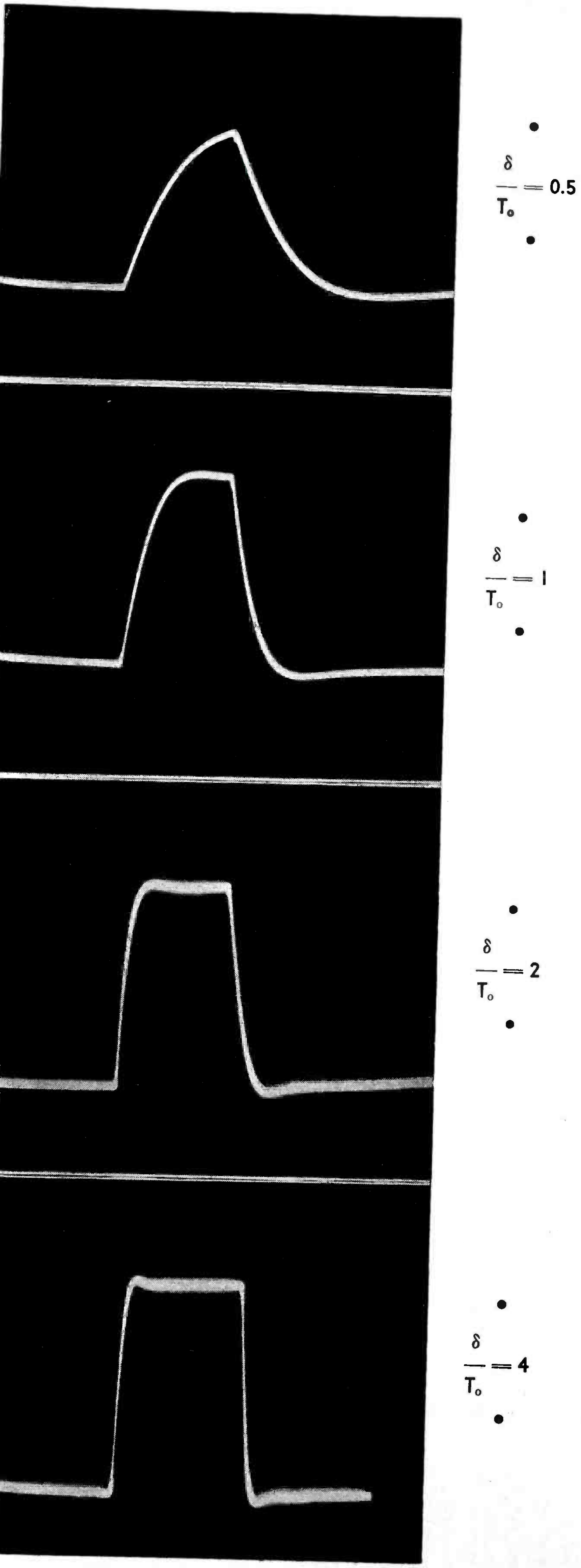

Figure 1 (left)

Oscillograms showing the transient response of an uncompensated amplifier when a rectangular pulse is impressed. In the top picture, the ratio of pulse duration, δ, to the period of the cutoff frequency, T_o, is one-half. In each succeeding picture, this ratio is doubled. The pictures show the improvement which results from an increased bandwidth.

IN the first part of this paper we discussed the theoretical aspect of the problem of transmission of a Morse dot or pulse through a coupling network. This discussion was based entirely on solutions of differential equations for the circuits considered. Oftentimes such solutions seem to be more readily accepted if experimental evidence to substantiate them is available. In what follows, we will present and discuss some oscillograms which were taken to substantiate the theory which we previously presented.

High Cutoff Frequencies

Wide-band amplifiers, in general, have such high cutoff frequencies that it is difficult to study the transient response of the circuits with ordinary oscilloscopes. This arises primarily from the fact that the amplifiers in the oscilloscopes usually are no better or not as good as the amplifier which is to be tested. One method of overcoming this difficulty is to introduce artificially large capacitances into the cir-

*Part 1 appeared in June COMMUNICATIONS.

Experimental Evidence in the Form of Oscillograms to Substantiate the Theoretical Curves Presented Last Month

cuit. The cutoff frequency is thus lowered sufficiently so that experiments can be performed without exceeding the limit of linearity of the oscilloscope amplifiers. The oscillograms which follow were taken using networks where the cutoff frequency (that is, the frequency at which the response had dropped to 0.707 of the value at zero frequency) was in the audio range. For most of the circuits tested this frequency was 1,000 cycles per second, but for the circuit whose oscillograms are shown in Figure 5, the cutoff frequency was in the neighborhood of 2,000 cycles.

Pulse Generator

The pulse generator which was used to supply the circuits under test produced a pulse width which could be varied between 300 microseconds and 5.2 milliseconds. The repetition rate of this pulse could be set at 30, 60 or 120 times per second and was synchronized with the 60-cycle line. The oscilloscope was also synchronized with the 60-cycle line so that steady pictures were easily obtainable.

In our theoretical discussion we emphasized the fact that the ratio of (δ), the duration of the pulse, to (T_o), the period of the cutoff frequency was the criterion which was a measure of the faithfulness of response. We indicated this by drawing on each response curve the number of half-cycles of the cutoff frequency which were included in the duration of the pulse. Theoretical results were given for values of this ratio equal to ½, 1 and 2. In presenting experimental results we have used these values plus an additional one where the ratio was 4.

Time Delay

One of the interesting theoretical deductions was that a time delay will

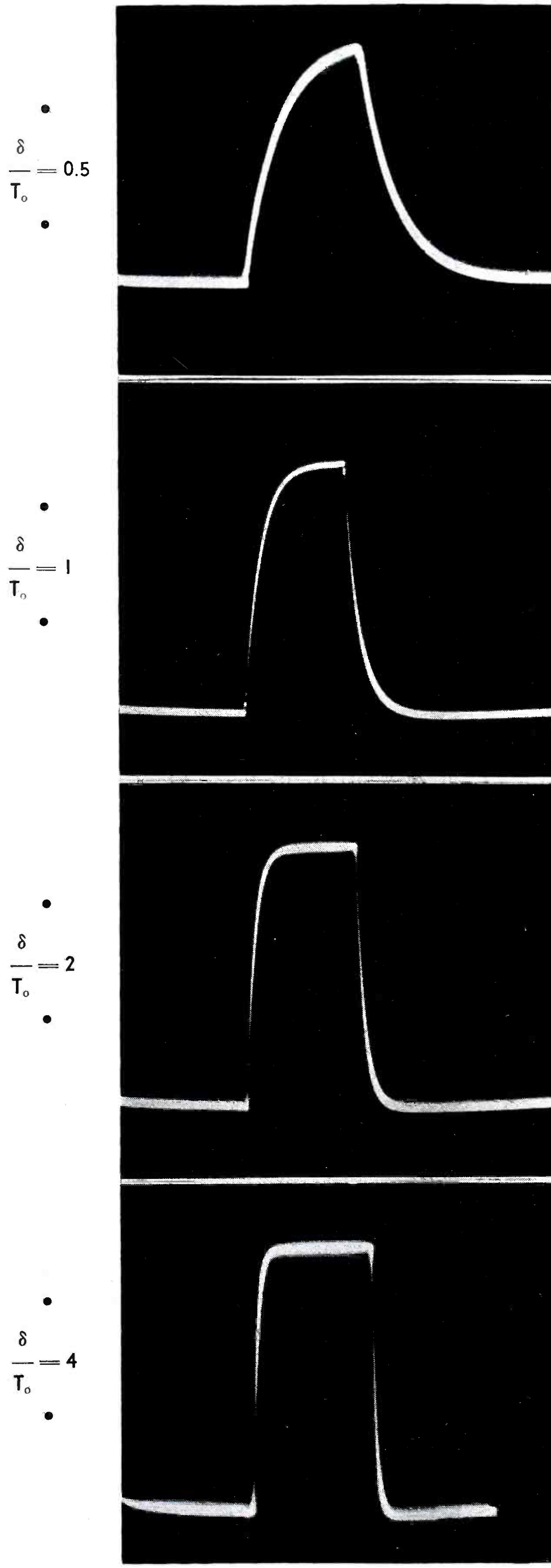

Figure 2 (right)

Oscillograms showing the transient response of an amplifier with a shunt-peaking circuit with $k = \omega_o L/R = 0.414$. The values of δ/T_o are the same as were used in Figure 1 and the advantages of an increased bandwidth are again evident. The value of the design constant *k*, which was used in this case, yields the flattest amplitude response in the vicinity of the origin. The amplitude response is illustrated in Figure 13 of our previous paper. Values of *k* greater than this critical value cause a peak to appear in the amplitude response, such as that shown in Figure 12 of the previous paper where *k* had a value of 0.5. Smaller values of *k* produce a response which begins to approach that of the uncompensated amplifier. The most linear phase response over the band of frequencies from zero to the cutoff of the uncompensated amplifier results when *k* is adjusted to 0.32.

in general be introduced by the coupling network. In order to illustrate this in the oscillograms a special differentiating circuit was arranged so that small impulses would appear on the oscilloscope at the beginning and at the end of the impressed pulse. These are clearly visible upon the negatives but probably most of them would have been lost in the process of reproduction, so vertical bars have been drawn on the oscillograms over the pulses. The groups of pictures are aligned so that the time of initiation of the pulse for each picture is on the same vertical line.

The Uncompensated Amplifier

The first circuit which we checked experimentally was that of the uncompensated amplifier whose theoretical curves were shown in Figure 7 of our previous paper. The experimental results are shown in Figure 1, and comparison with the theoretical ones will show substantial agreement. When the pulse is initiated, the voltage rises exponentially, and when the pulse ends the voltage decays along a similar curve.

Shunt-Peaked Compensated Circuit

Figure 2 shows the result with a shunt-peaked compensated circuit in which k = 0.414. Normally, compensation raises the cutoff frequency but the circuit used for these pictures was so arranged that the cutoff frequency with compensation was again 1,000 cycles. Thus, the curves of Figure 2 do not readily show the effect of compensation on the circuit used in obtaining Figure 1. The emphasis is on the relation between cutoff frequency and fidelity of reproduction.

No oscillograms were taken for the shunt-peaking circuit with k adjusted to the value 0.5 since the results do not differ materially from those obtained using k = 0.414. A theoretical comparison of these two values was shown in Figures 10 and 11 of our previous paper and actual oscillograms verified these predictions. The value 0.414 was chosen because it yields the flattest amplitude response in the vicinity of the origin and exhibits no

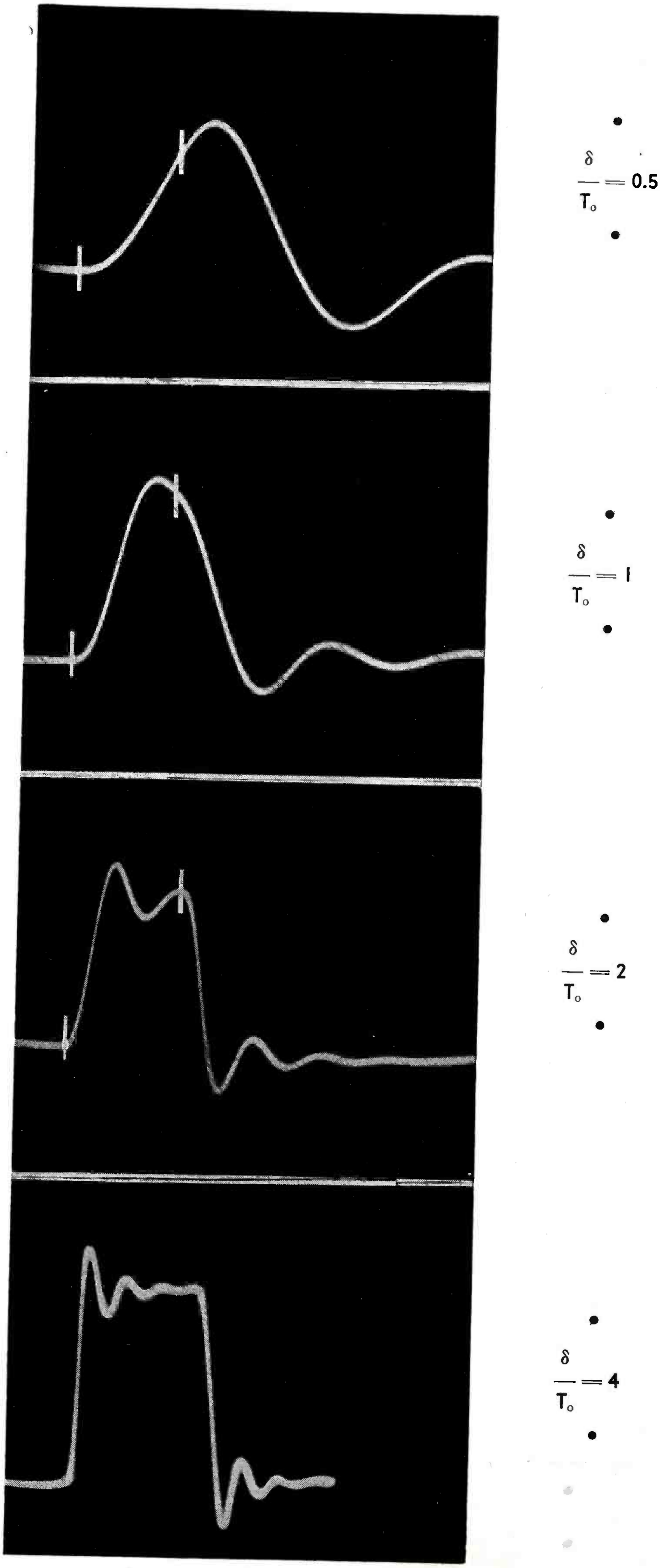

Figure 3 (left)

Oscillograms showing the transient response of an amplifier compensated with the series-peaking circuit with k = 1 and the input and output condensers equal. In these pictures the beginning and end of the applied pulse have been marked with short vertical bars. Time delay is quite noticeable in this circuit especially at the low values of δ/T_o.

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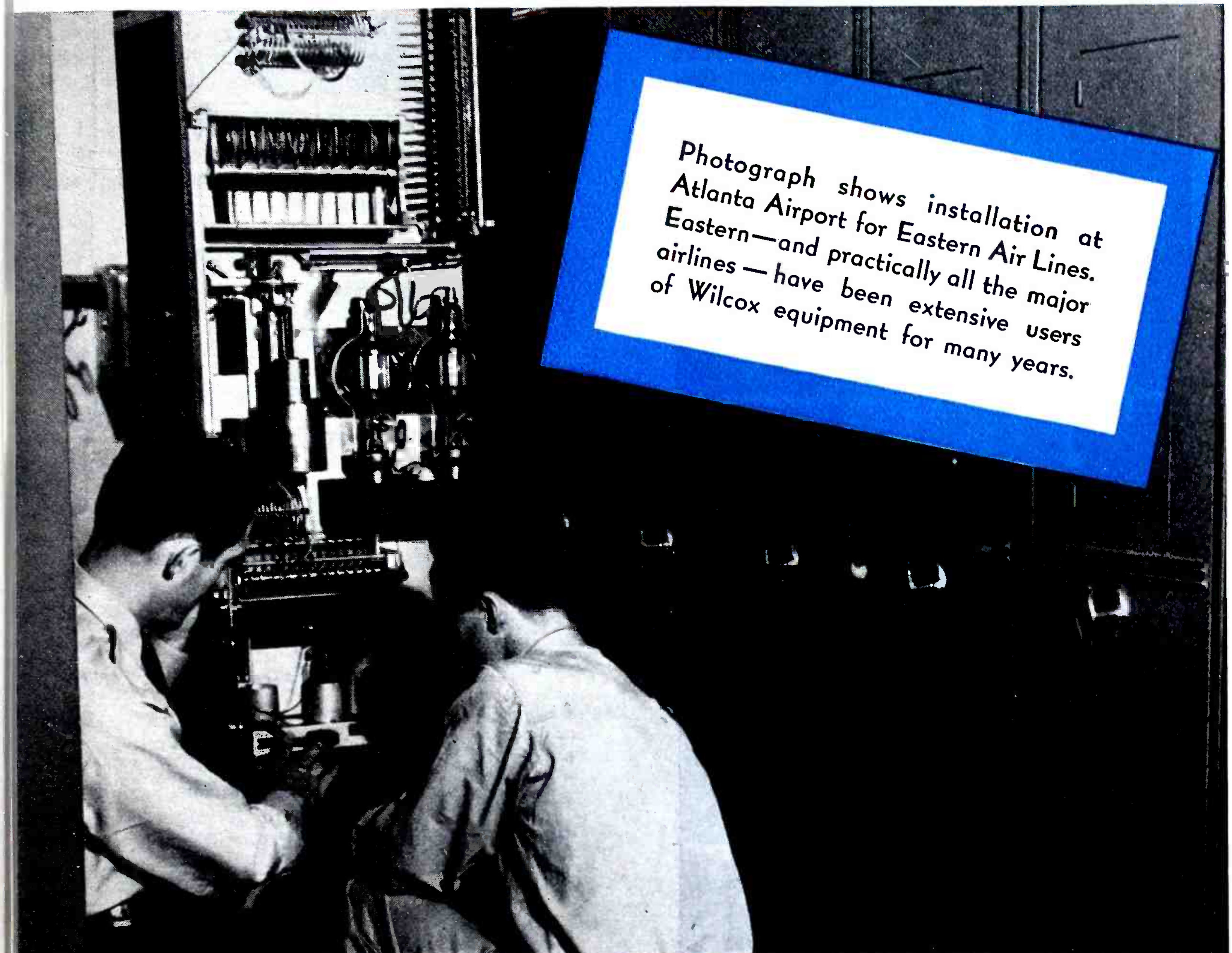

Photo, Courtesy Eastern Air Lines

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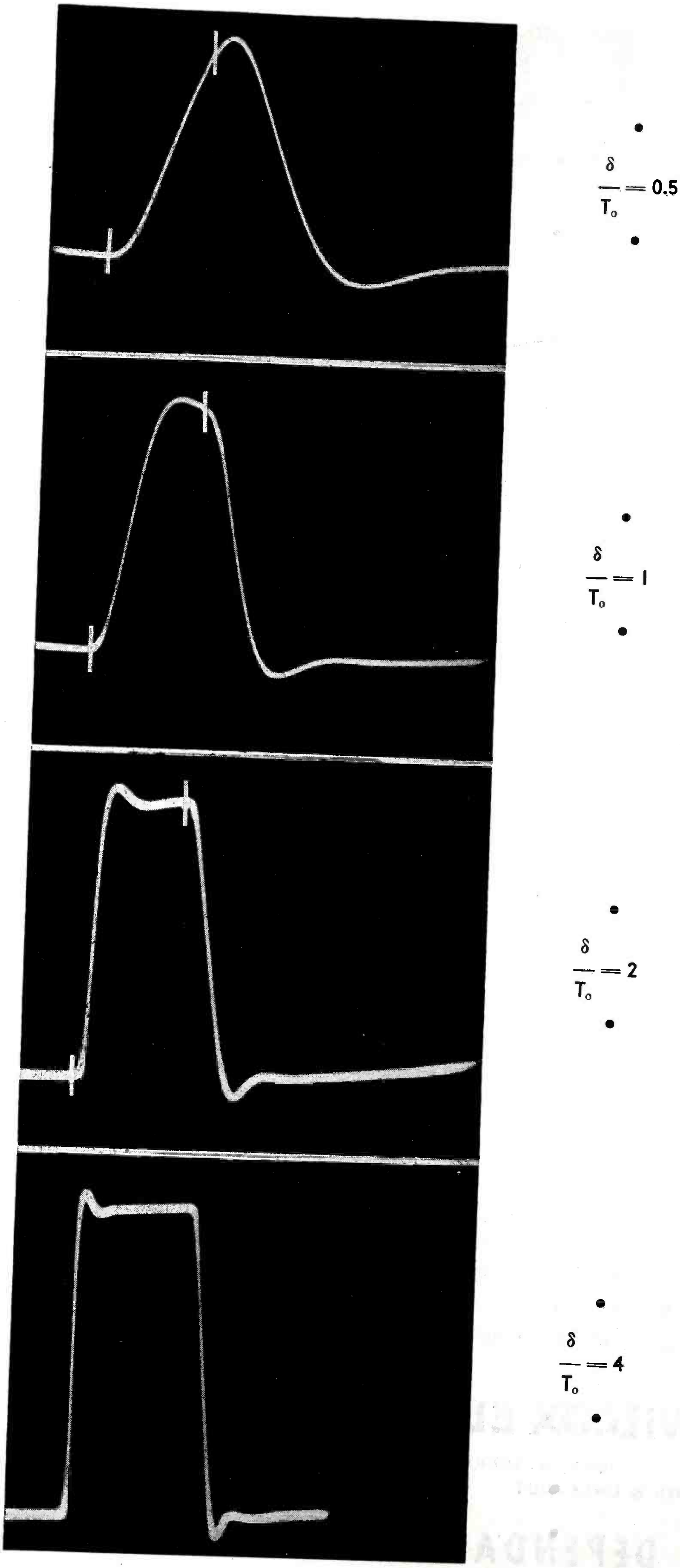


maximum beyond the origin. In this respect only it is a critical value of *k*. Values of *k* higher than that chosen for the oscillograms of Figure 2 exhibit a greater "overshoot" in the transient response and a steeper rise on the leading edge. As *k* is reduced in value, the overshoot gradually disappears and the leading edge approaches the exponential shape of the uncompensated amplifier.

Figure 3 shows the transient responses of the series-peaking circuit with k = 1 and with the input and output condensers equal. These photographs agree with the theoretically predicted curves shown in Figure 16 of our preceding paper. The response is seen to be oscillatory which indicates that the circuit is not too successful in reproducing the applied pulse.

Flat Amplitude Response

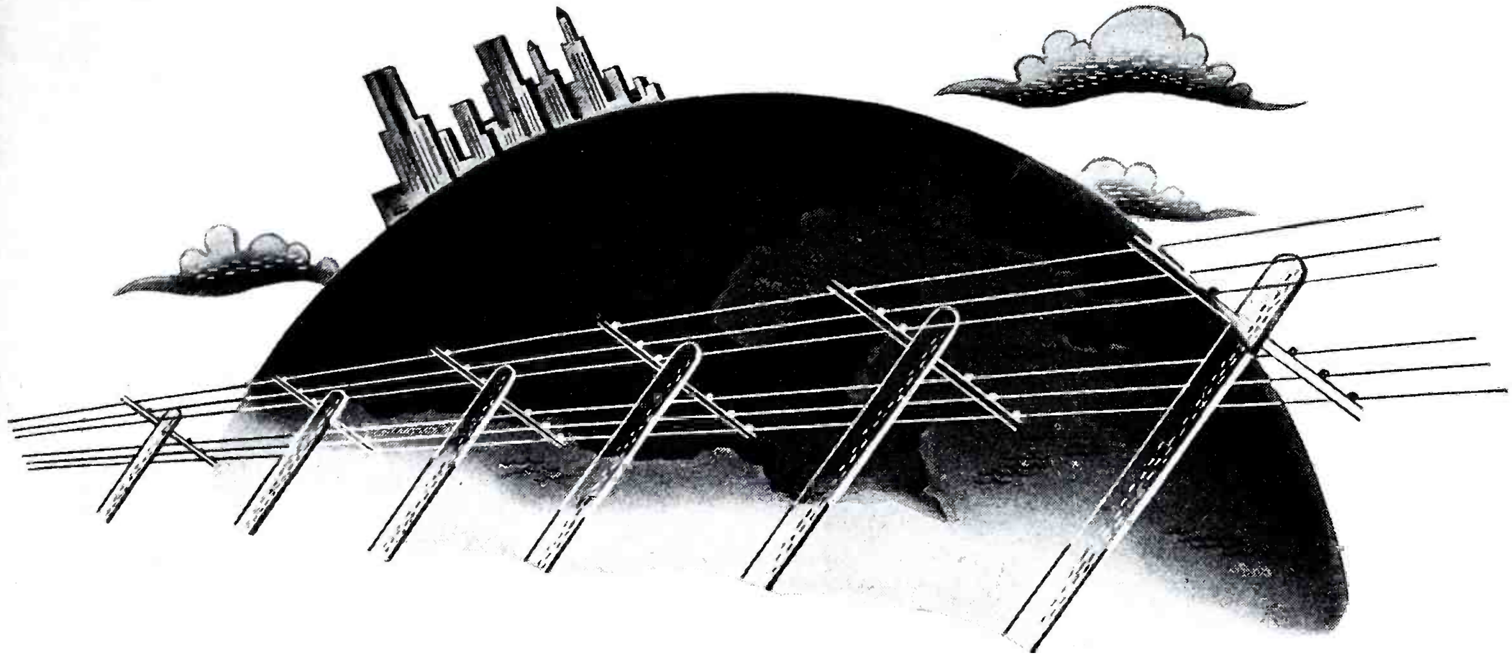
Several approaches have been made in the literature to effect a better adjustment of this circuit. One which endeavors to provide the flattest amplitude response at the origin yields a value of k of 2/3 and indicates that the output condenser should be three times as large as the input condenser. The transient response of a circuit with this type of adjustment is shown in Figure 4. Notice that the amplitude of the oscillations has been considerably diminished so that this circuit gives a better reproduction of the pulse than the previous one.

Transient Response of W. E. Filter

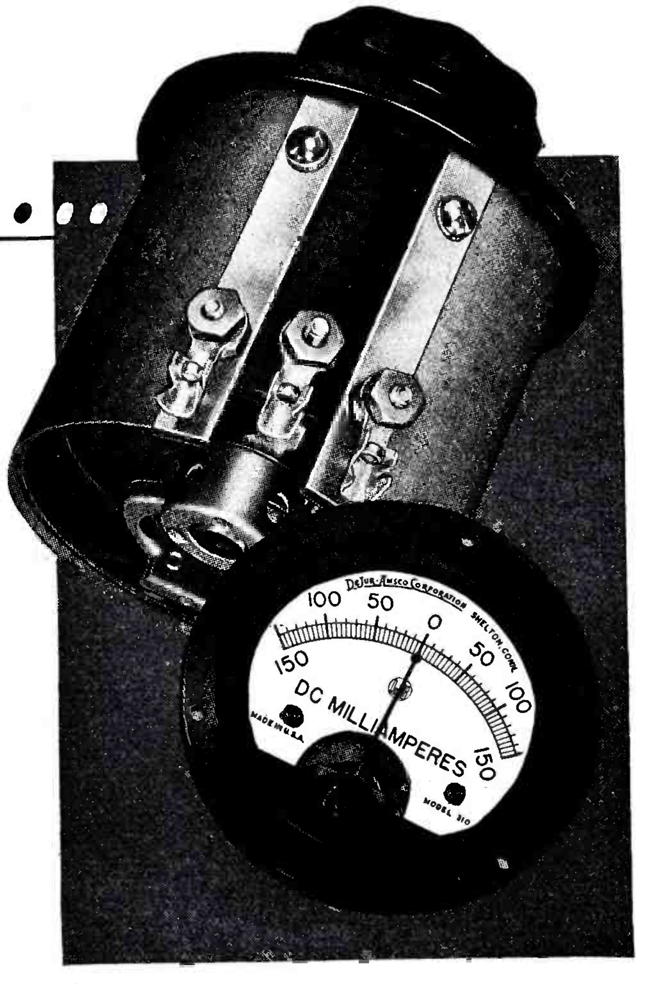
As a final presentation, Figure 5 shows the transient response of a Western Electric type 13-A filter. Notice that the response again contains oscillations of a rather large amplitude. Such oscillations are usually considered to arise from the presence of a sharp cutoff somewhere in the network and the filter under test did have such a cutoff. These photographs may be compared with the theoretical results for the ideal filter shown in Figure 17 of the previous paper. The photographs show that the actual filter has no response before the pulse be-

Figure 4 (left)

Oscillograms showing the transient response of the series-peaking circuit with k = 2/3 and the output condenser 3 times the size of the input condenser. These values of the parameters give a much better transient response than the values used for Figure 3, since the oscillations have been almost completely eliminated.



Keeping them open . . .



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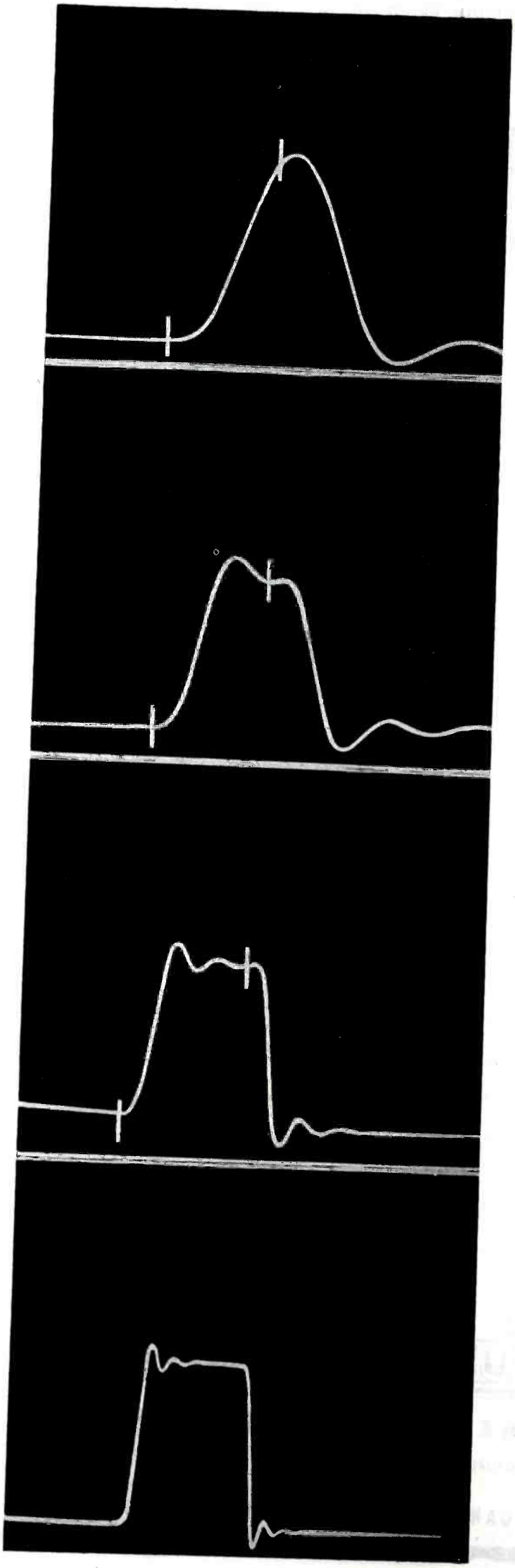

$\frac{\delta}{T_o} = 0.8$

$\frac{\delta}{T_o} = 1.5$

$\frac{\delta}{T_o} = 3$

$\frac{\delta}{T_o} = 5$

gins, and that the actual oscillatio decay so that the second maximum less than the first.

In viewing these oscillograms should be kept in mind that for of them the cutoff frequency was ta en as the actual cutoff frequency the network under consideration a not as the cutoff frequency of sor simpler circuit from which these m have been derived. Thus they are n especially well suited for the dire comparison of the different circui as compensating circuits. Rather the are intended to emphasize the bas fact that in order to reproduce an ap plied pulse faithfully, a certain min mum band-width in the coupling ci cuit is required. The magnitude c this band-width can be determined onl after a careful consideration of th use which is to be made of the outpu signal.

Some very general conclusions ma be drawn, however, from the result of the transient analysis of these cou pling circuits. In general, the adjust ment of the coupling circuit constant which provides the flattest amplitude response, does not, at the same time produce the most linear phase response, i.e., the most constant delay time for all frequencies lying within a given bandwidth. The converse is, of course, also true. Neither flat amplitude response nor constant delay time is then a reliable criterion for predicting the fidelity of transmission of a step voltage or a rectangular pulse.

It can also be said in general that when the circuit adjustment provides a very steep rise on the leading edge of the transmitted pulse, this is usually accompanied by an appreciable overshoot followed by a train of damped oscillations. When steps are taken to reduce the magnitude of the oscillatory phenomenon, the steepness of the leading edge is adversely affected.

If a coupling circuit is to be designed specifically to transmit a rectangular transient with optimum fidelity, sufficient bandwidth must first be provided. A criterion must then be established which makes a suitable compromise between overshoot and steepness of rise. Such a criterion should, of course, be applied to the overall response in the case where several identical stages are operated in cascade.

Figure 5 (left)

This series of pictures shows the transient response of a commercial low-pass filter. Time delay is again evident as is the presence of oscillation. Enlargements of the original oscillograms for this series have been retouched because the exposure time was insufficient for satisfactory reproduction. This was unnecessary in the four preceding figures.

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EXCELLENCE IN MUSIC AND VOICE RECREATING INSTRUMENTS

V-H-F TUBES AND WAVE GUIDES

Types and Uses Discussed

by RALPH G. PETERS

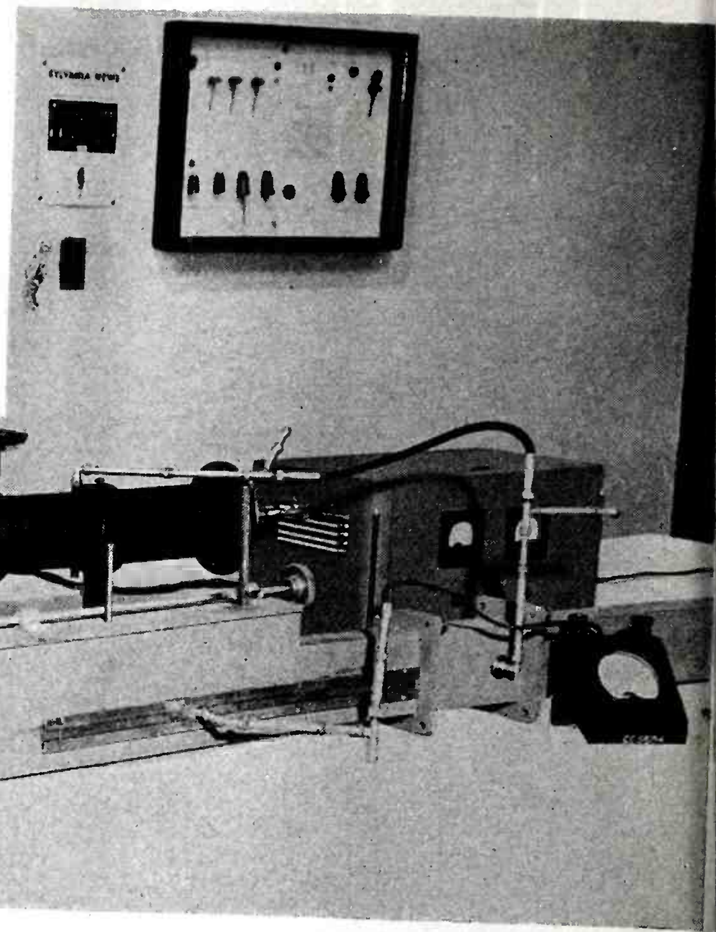
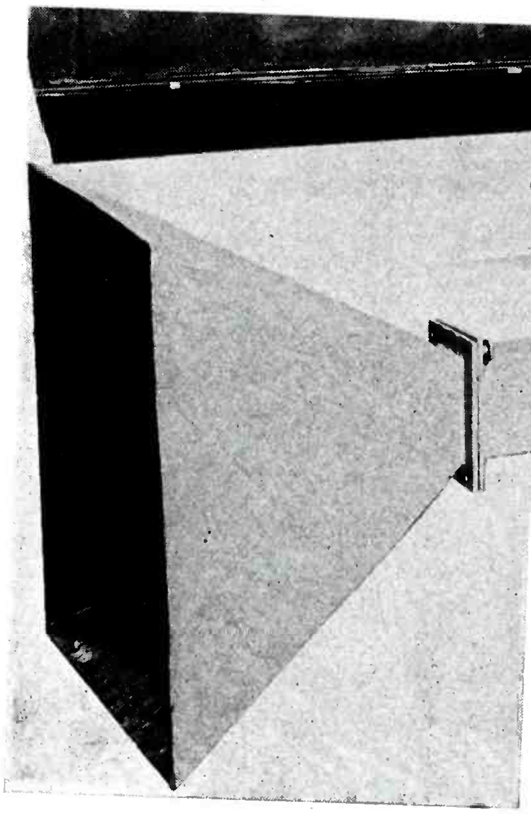



Figure 1
Shown here is equipment used in determining cut-off frequency of rectangular wave guide, and method of coupling guide to oscillator with coaxial cable and measuring units.

THE constantly expanding field of communications has embraced a new frequency spectrum . . . *microwaves.* While the existence of this band (approximately those frequencies between one meter and one centimenter) has long been recognized, and experimental work dates back a number of years, no real advance in its use has been made previous to the past few years.

To the communications engineer, the importance of microwaves lies in their future commercial possibilities. While fundamental electrical formulae apply, the greater use of electromagnetic theory in the explanation of v-h-f phenomena and the technique involved in its generation and detection, have created new concepts differing from accepted radio design practice. The illustrations shown here of v-h-f equipment used in the electrical laboratories of the University of Illinois, demonstrates this difference.

The broad electrical problems encountered at lower frequencies, name-

(*Continued on page* 93)

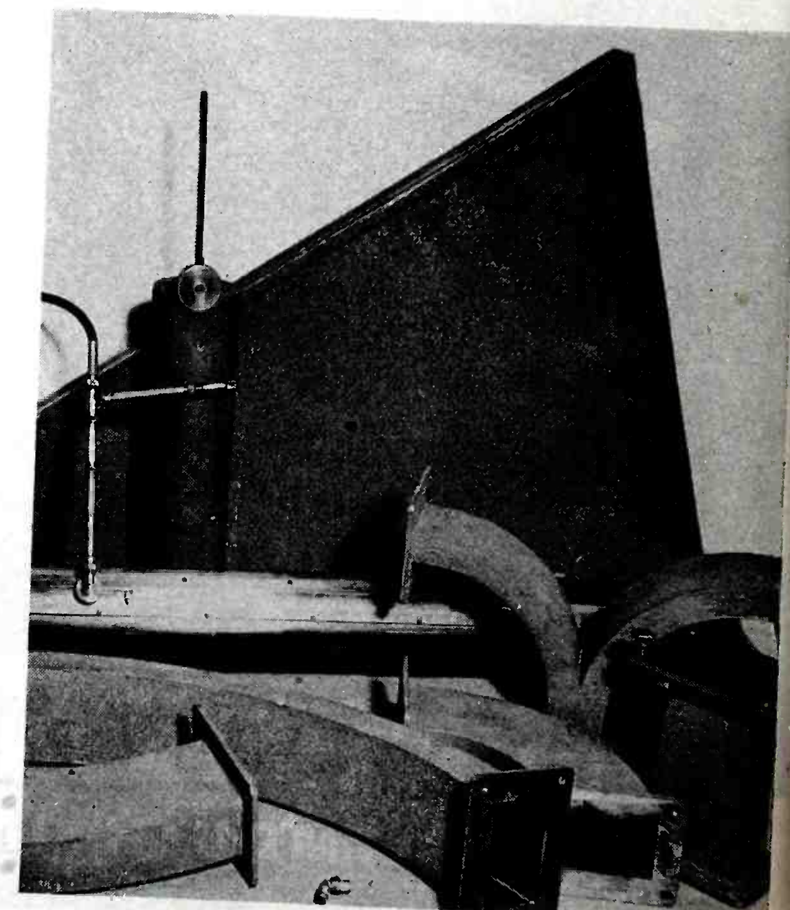
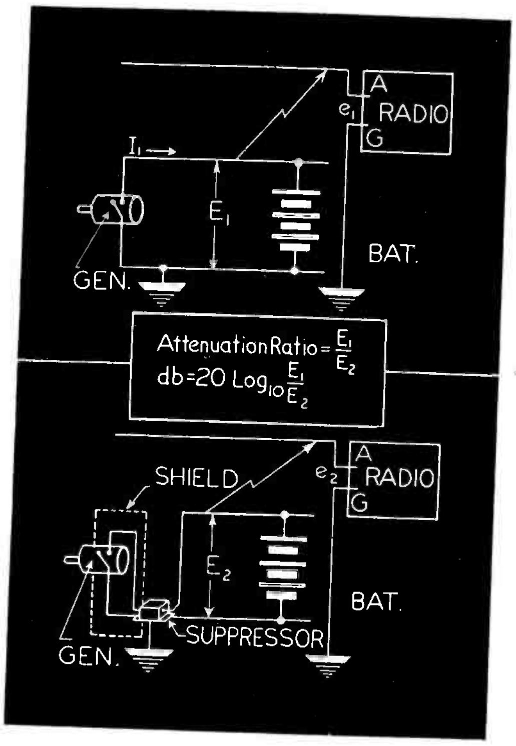


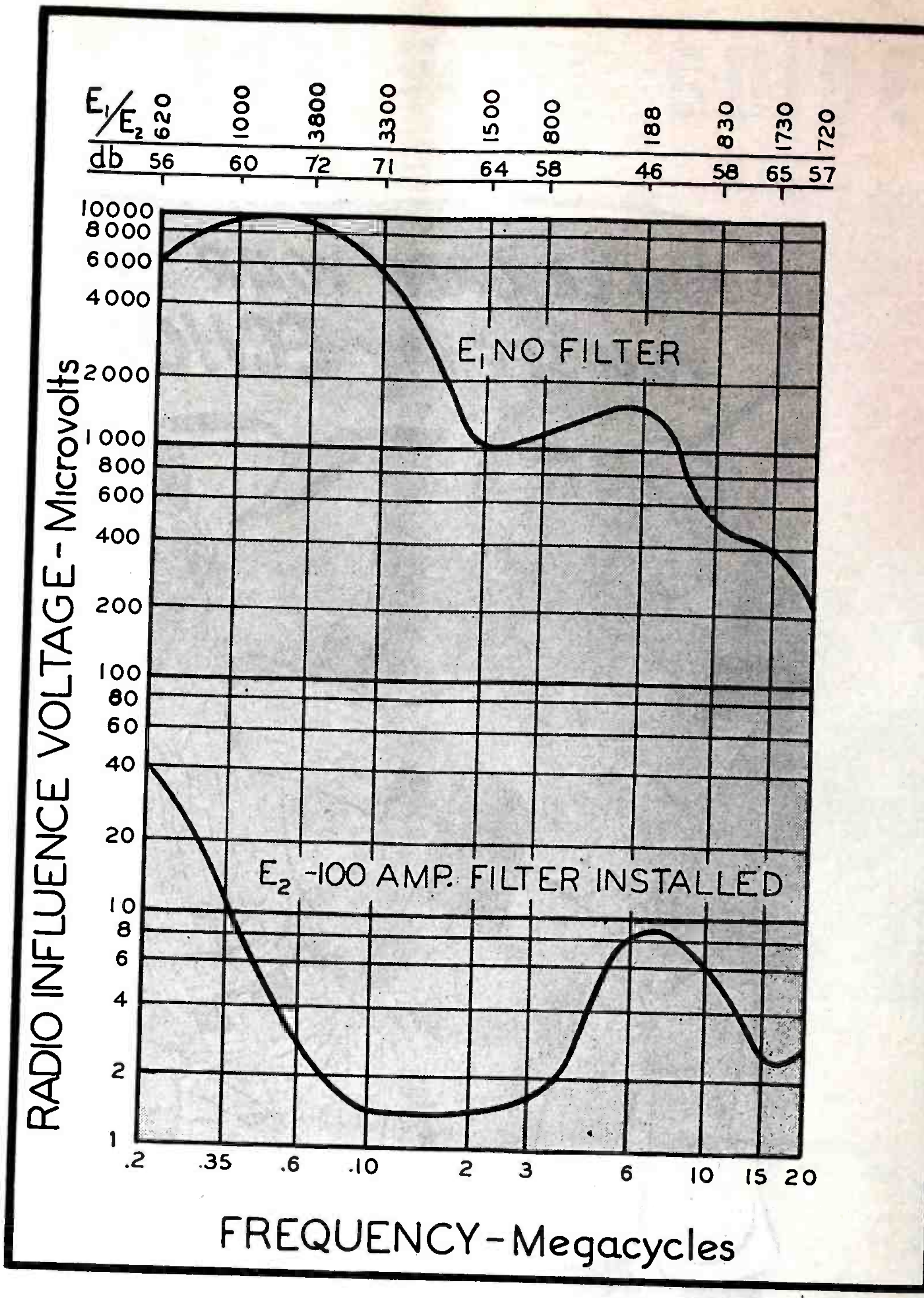
Figure 2
An assortment of wave guide apparatus, coaxial matching units and horn. The units shown here and in Figure 1 were built in the laboratory of the University of Illinois.

(*Photos by W. R. Wildhagen*)

Figures 1 (below) and 2 (right)

In Figure 1, appears an elementary case of a power circuit and a receiving system. The disturbance voltage and current result from a complex phenomena involving very rapid changes. It therefore can be treated as a radio frequency voltage and current, not of a single frequency but of a spectrum covering a wide range of frequencies. The induced disturbance voltage which appears at the antenna and ground terminals is indicated by e_1 and is known as *radio noise voltage*. The disturbance voltage on the power circuit which produces radio noise voltage on the antenna indicated at E_1 is the *radio influence voltage*. The ratio E_1/E_2, known as *attenuation ratio*, is a measure of the effectiveness of the suppressor. In Figure 2, we have the radio influence characteristic of an aircraft generator circuit. Characteristic results of filter and no filter action are shown.





AIRCRAFT RADIO NOISE FILTERS*

by C. W. FRICKE

General Engineering Laboratory

General Electric Company (Schenectady)

AND

S. W. ZIMMERMAN

Lightning Arrestor, Cutout & Cap.

General Electric Company (Pittsfield)

THE importance of the use of radio in aerial navigation is well known. Of comparable importance to the operation of the aircraft, however, is the use of electricity in other forms, as for instance for engine ignition, lighting, control, and a variety of purposes. Since commutators and other forms of arcing contacts used in this equipment may cause interference with radio under some conditions, careful planning is necessary to secure the fullest use from both power and radio equipment, and not overburden the aircraft with attachments solely to make the radio work.

To obtain installations which are reasonably free from radio interference of this kind, due consideration must be given to all of the component parts. For example, attention should be given to the shielding of radio equipment so that it will not be subject to direct pickup of radio noise phenomena. Furthermore, unnecessarily close proximity of power and radio circuits to each other, which gives close coupling for radio noise, should be avoided. In regard to the power equipment, disturbances which give rise to interference should be avoided as far as possible and the proper suppression and shielding employed where necessary.

With the understanding that proper attention is to be given the installation as a whole, this paper discusses the particular phase of the subject which deals with control of radio interference as a complex voltage on the

(*Continued on page 34*)

**A paper delivered before the sectional AIEE meeting at Pittsfield, Massachusetts and the annual Cleveland AIEE meeting.*

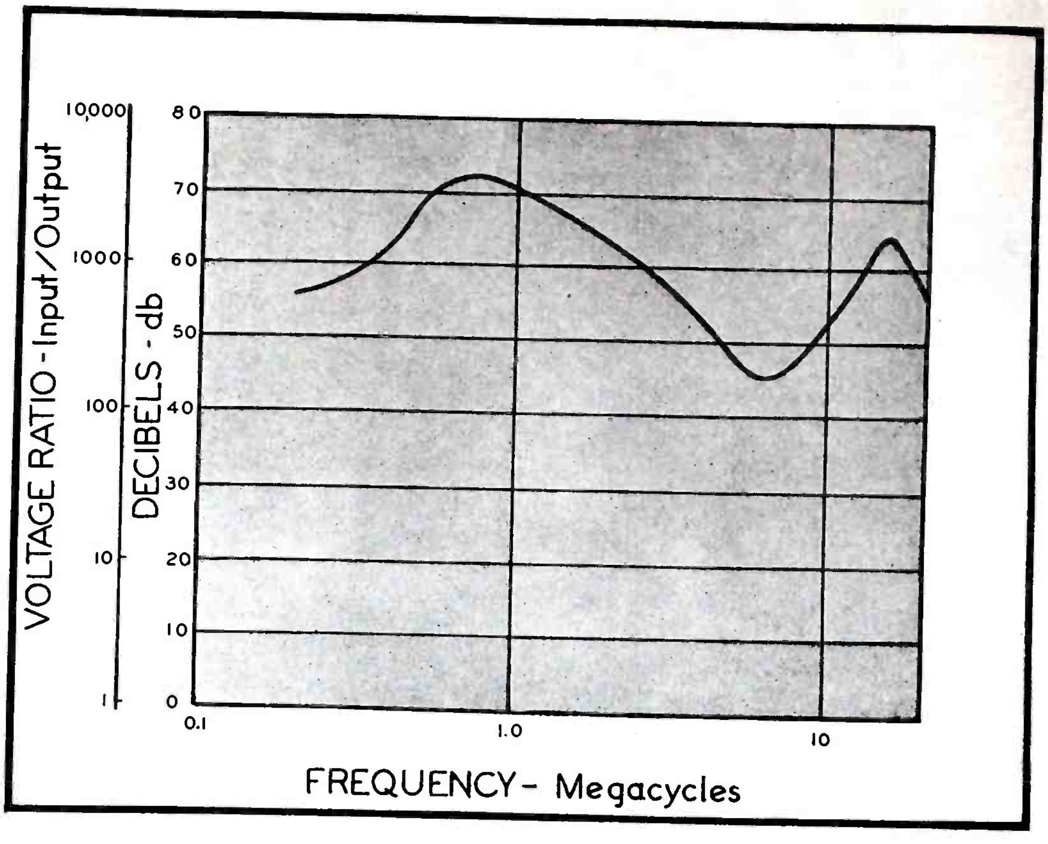


Figure 3

Attenuation characteristics of the 100 ampere filter. These data were compiled from a generator test. The vertical scales given show numerical ratio and insertion loss in decibles.

(*Continued from page* 32)

power circuit called *radio influence voltage*. Reducing or suppressing this voltage reduces the noise in the radio set resulting from this cause. The paper deals particularly with two suppression devices, capacitors and radio noise filters. Filters have been especially useful in many situations on aircraft equipment. They provide an effective and practical means of suppression for these applications.

Available Filters

Manufacturers of filters have made available certain sizes of filters intended to cover a large majority of the requirements for aircraft. Filters are available in 25, 50, 100 and 200 ampere ratings applicable to d-c circuits up to 50 volts. These filters are contained in a metal case which is provided with suitable mounting brackets.

They consist of a series-line inductance with a capacitance at each end. Two terminals are arranged for connection of the filters in series with one side of the power circuit in which the noise voltages are to be suppressed. The other side of the power circuit is grounded and the filter case is also grounded. When tested in a circuit with aircraft equipment, noise reduction ratios in the order of 200-to-1, to 5,000-to-1 (46 to 74 decibels) are obtained, over the frequency range of 0.20 to 20 megacycles. Also on a circuit standardized for rating performance, noise reductions of 1,000-to-1 to 10,000-to-1 (60 to 80 decibels) are obtained over the same frequency range. Weights of these filters range between 1.5 and 3.0 pounds depending on current rating. Overall outside dimensions including mounting flanges range in length, breadth and height, from 4″ x 3¾″ x 2½″ to 5½″ x 4¼″ x 3″, respectively. The filters will retain their suppression characteristics over a temperature range of 40°C below 0 to 90°C above. Vibration tests in all possible positions of filter operation and at frequencies and amplitudes met with in service insure against mechanical failures.

Interference Control Factors

An elementary case of a power circuit and a radio receiving system is shown in Figure 1 *a*. The supply generator has a commutator which produces small, but extremely rapid changes in the current and voltage. This causes a disturbance voltage and current, indicated at E_1 and I_1. In this diagram only the disturbance component is represented. The disturbance voltage and current result from a complex phenomenon involving very rapid changes and can, therefore, be treated as radio frequency voltage and current, not of a single frequency but a spectrum covering a wide range of frequencies. The presence of this voltage and current, E_1 and I_1, in the power circuit causes induction in the paralleling radio circuit, similar to the induction which takes place when a radio frequency voltage is applied to the power circuit. The induced disturbance voltage which appears at the antenna and ground terminals of the radio set is indicated by e_1 and is called *radio noise voltage*. The disturbance voltage on the power circuit which produces radio noise voltage on an antenna, already described and indicated at E_1, is the *radio influence voltage* (*RIV*). Both of these quantities can be measured in microvolts at various frequencies by means of a frequency-selective instrument called the *radio noise meter*[1].

Minimizing Power Equipment Noise

There are several ways in which the possibility of interference with radio due to power equipment can be minimized. Referring to the elementary case of Figure 1 *a*, it is evident that physical separation between the power circuit and the radio circuit would reduce the radio noise voltage. However, space limitations in an aircraft make it impractical to control interference by this means alone. It is also evident that complete shielding of the radio system would eliminate or reduce the radio noise voltage. An example of complete shielding would be a well shielded, independently powered radio set, with the antenna lead-in shielded up to the point where it emerges from the fuselage of a metal aircraft. A similar result would be obtained if it were practical to completely shield the power system by enclosing the generator, battery, and other apparatus in metallic containers and running connecting wires in continuous metal conduit. The shielding of power circuits carrying 100 amperes or more and extending to all parts of the aircraft has the disadvantage of weight and inconvenience in servicing the power system. However, complete shielding is commonly applied to some types of apparatus and circuits as, for instance, engine ignition.

Localizing Disturbances

Referring again to Figure 1 *a*, it is seen that reducing or suppressing the radio influence voltage E_1 reduces the radio noise voltage e_1. This can be accomplished either by reducing the disturbance itself or by localizing; that is, confining the disturbance in the apparatus which produces it. A radio *noise suppressor* is a device which does this. It is connected to a piece of apparatus such as a generator, as indicated in Figure 1 *b*. It does not obstruct the flow of normal power but does prevent the flow of the unwanted disturbance. In terms of radio influence voltage the purpose of the suppressor is to reduce the voltage E_1 of Figure 1 *a* to a smaller value

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(*Continued from page* 34)
E_2 shown in Figure 1 *b*. This results in reducing the radio noise voltage e_1 to a smaller value e_2. The ratio $\frac{E_1}{E_2}$ called *attenuation ratio* is a measure of the effectiveness of the suppressor. It is often expressed in decibels according to the relation

$$db = 20 \log_{10} \frac{E_1}{E_2}$$

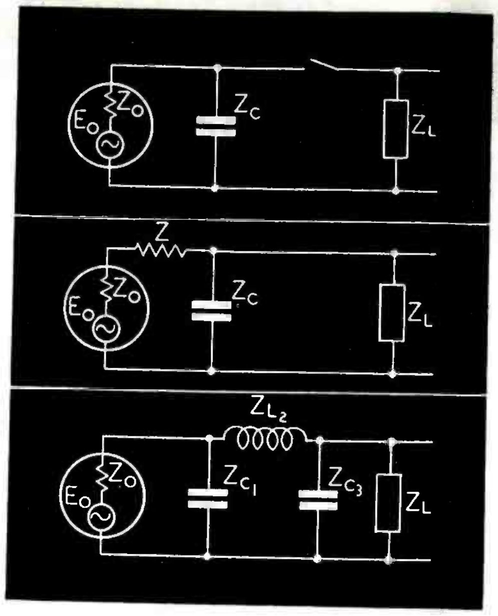
This is called the *attenuation* or *insertion loss*. The performance of a representative suppression device, in this case a filter in a circuit such as Figure 1 *a* and *b*, is shown by Figure 2 wherein the upper curve (E_1) shows the *RIV* without the filter and the lower curve (E_2) shows the *RIV* with the filter, plotted against frequency. The ratio of these two quantities, also plotted against frequency, is shown on Figure 3. Two vertical scales are given, one showing the numerical ratio, and the other insertion loss in decibels.

Suppressor Arrangements

Suppressors have been applied to power circuits in many cases for such purposes as smoothing out ripples present in a d-c voltage or reducing distortion of an a-c voltage as well as radio noise reduction. While many different suppressor arrangements might be used, experience indicates that certain simple structures can be used to best advantage. Figure 4 shows a simple arrangement for smoothing out the ripple present in the voltage of a certain d-c machine. It consists of a shunt capacitor across the terminals. The capacitor does not pass direct current and hence does not interfere with the normal operation of the machine. In the diagram, E_0 represents the ripple voltage, Z_0 represents the impedance of the machine for this ripple, and Z_c represents the corresponding impedance of the capacitor. It will be seen that Z_0 and Z_c act as a potential divider for the ripple voltage E_0. For example, if Z_c is one-tenth of Z_0, only one-tenth of E_0 appears on the outgoing circuit. In other words this arrangement gives 10-to-1 reduction (20 db).

Adding Impedance

Sometimes it is advantageous to add impedance to the machine, as at Z in Figure 5, especially if the machine itself has very little impedance. This arrangement is called an *L filter*. In many cases the shunt capacitor of Figures 4 or 5, is replaced by a series-tuned circuit, called a resonant shunt. It reduces the harmonic in the same manner as the capacitor, but is selec-



Figures 4 (top), 5 (center) and 6 (bottom)
In Figure 4, the capacitor is shown as a suppressor. In Figure 5, we have the L filter as a suppressor, and in Figure 6, we have the Pi filter as a suppressor.

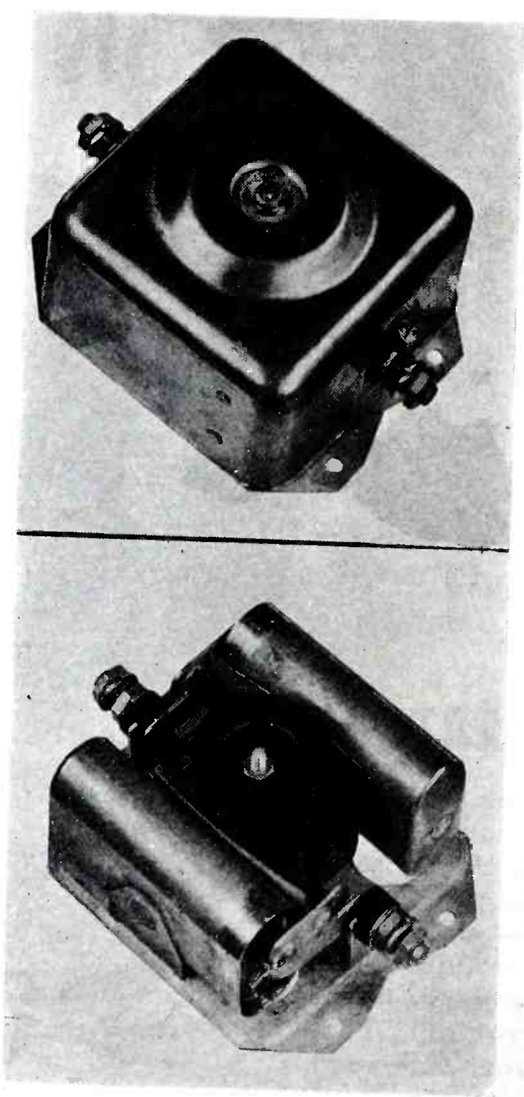


Figure 7
Typical radio noise filters.

tive for a particular frequency. When several harmonics are involved a separate resonant shunt is provided for each frequency. For a-c machines this scheme has the advantage of frequency discrimination between the fundamental and the harmonics.

A further arrangement which has been particularly helpful in the field of radio noise suppression is the *Pi filter* shown in Figure 6. It acts as a two-step potential suppressor. Z_0 and Z_{c1} constitute the first step which is similar to Figure 4. Z_{L2} and Z_{c3} constitute the second step. This affords further reduction. For example, if each step gives 10-to-1 reduction or 20 db, the overall reduction will be 100-to-1, or 40 db. A practical aircraft filter of this type is shown in Figure 7.

The *L filter* and the *Pi filter* are similar in structure to certain simple filters known as low-pass filters employed in communication practice.

Use of Suppressors in Aircraft

The selection of a radio noise suppressor to fit a given situation and the proper way to install it so that it will function properly involves a number of considerations which are discussed in the sections which follow. These considerations are brought out with reference to a type of aircraft power supply system that has been studied extensively but the conclusions are not necessarily restricted to this type of system. A common situation is that of a power supply consisting of one or more generators driven from aircraft engines and operated at about 28 volts d-c, a two-wire circuit (one side of which, usually the negative side, is solidly grounded to the body of the aircraft), standby storage batteries, motors and various other devices such as amplidynes, dynamotors, and inverters. Some of these pieces of apparatus have commutators, vibrating contacts, certain types of thermionic elements or other features required for their normal operation, which may give rise to radio influence voltage. Tests have been made on apparatus representative of these various types. It has been found that the selection of the proper suppression equipment depends upon the following: (1)—The required attenuation of the radio influence voltage; (2)—Frequency range to be covered; (3)—Impedance characteristics of the apparatus and circuit, and (4)—Power currents which the suppressor device must be able to carry.

Quantitative Data

Complete quantitative data on the first three items are not usually at hand, and most situations have to be treated on the basis of representative tests and experience with the use of suppression devices. With the aid of such knowledge, the kind of suppression equipment to employ can be de-
(*Continued on page* 38)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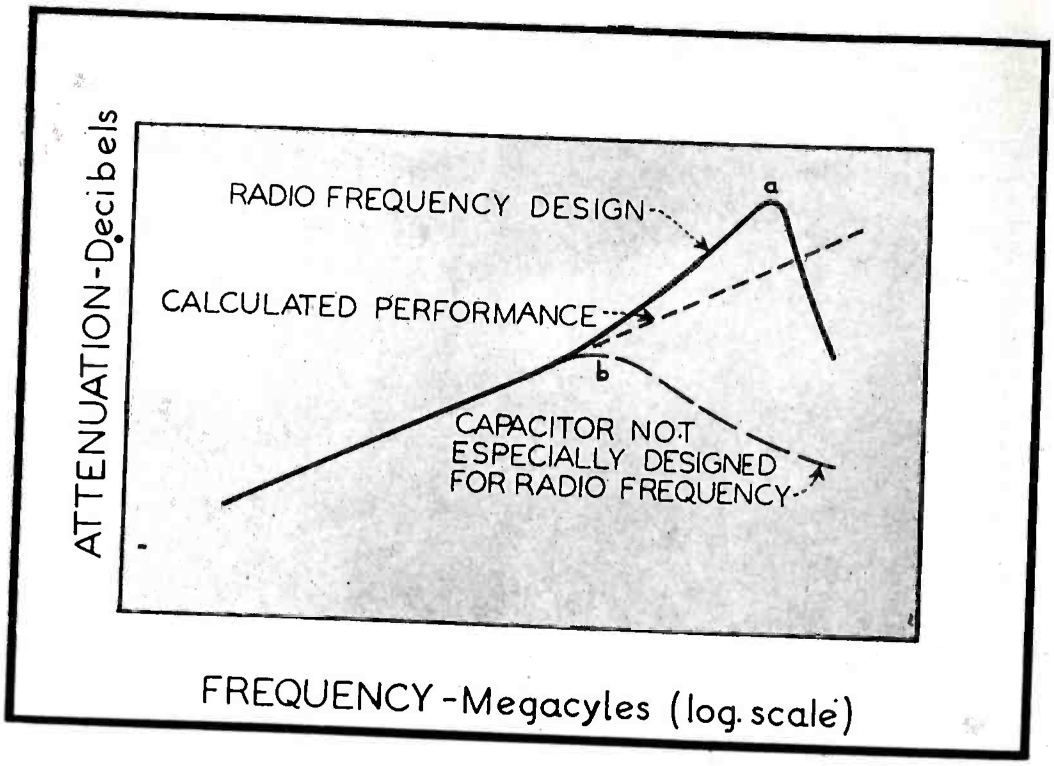

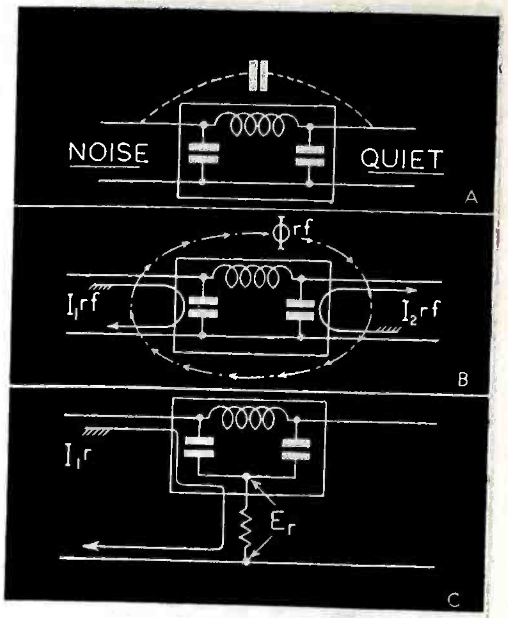

Figures 8 (left) and 9 (top)

Figure 8 shows the radio influence suppression characteristics of capacitors. In Figure 9, we see the three types of coupling or the capacitative (A), inductive (B) and conductive (C).

(*Continued from page* 36)

cided upon. In some cases a capacitor as in Figure 4 can be used to best advantage. In other cases a filter arrangement such as Figure 5 or Figure 6 gives the best results.

Capacitors as Suppressors

There are devices having small current ratings such as 5 amperes or less, where it is possible to use capacitors effectively. This is particularly true when the required attenuation is between 10-to-1 and 100-to-1 and the frequency range is not large, such as the range of standard broadcast frequencies. A capacitor has the property of very low impedance at high frequency. In the case of an ideal capacitor, the higher the frequency, the lower the impedance becomes. It must be remembered, however, that every resistor, inductor and capacitor possesses to some degree all three of the properties—resistance, inductance, and capacitance. In the case of the capacitor some means of connection to the apparatus circuit is necessary. These connections may have appreciable length and, therefore, appreciable inductance. To determine the effect of these properties a capacitor was tested in a circuit similar to Figure 4 with resistances used to represent the circuit impedances Z_o and Z_L. Voltage was measured with capacitor off and capacitor on. The ratio of voltage E_1 with suppressor off as in Figure 1 *a*, to E_2 with suppressors on as in Figure 1 *b*, which is the attenuation ratio, is shown in Figure 8 plotted against frequency.

The straight line, dotted at the upper end, represents the calculated attenuation for a pure capacitance. The solid curve shows the actual attenuation. It will be noted that the attenuation over the lower part of the frequency range coincides with the pure capacitor, but the attenuation at the upper end is quite different and is characterized by a peak at point (*a*). At this point actual performance exceeds the calculated performance based on pure capacitance due mainly to capacitor resonance, but there is a rapid falling off of attenuation ratio at frequencies above this peak, instead of an increasing attenuation ratio as there would be with an ideal capacitor. The frequency at which the peak occurs, in the case of the capacitor tested, which was of a special design for high frequency, was between 5 and 10 megacycles. The characteristic of another capacitor of the same value, but not specially designed for high frequency, is shown by the broken line for comparison. The shape of the latter curve indicates that the capacitor has somewhat more inductance and more resistance at high frequencies, which limit its effective range to about 2 megacycles.

Effectiveness of High Frequency Capacitor

Referring to the *high frequency* capacitor, the maximum effectiveness and the frequency at which it occurs, at (*a*), depend upon all three of the quantities—resistance, capacitance, and inductance. In this frequency region, increasing the capacitance does not necessarily increase the effectiveness and may result in reduced effectiveness depending on the other factors. Sometimes advantage is taken of the *peak* effectiveness by choosing suitable values of capacitance and length of leads to control the inductance so that the peak occurs at a desired frequency. The usefulness of this scheme is somewhat limited and it is generally preferable to make the capacitor leads as short as possible.

The curve of Figure 8 indicates in a general way the field of application for capacitors as suppressors. At the lower end of the curve, which in this example corresponds to about 0.2 megacycle, the capacitor has less effectiveness than at the higher frequencies. While the effectiveness at this frequency can be improved by making the capacitance value larger, this usually results in considerable size and weight. A further increase in attenuation can be obtained by means of a filter shown in Figures 6 and 7, with less bulk and weight. At the upper end of the frequency range, that is above 5 or 10 megacycles, the effectiveness of the capacitor is limited by the inductance of leads and other factors besides capacitance. In and above this frequency range it is usually necessary to use a filter giving an attenuation curve such as Figure 3. In the frequency range from about 1 to 5 megacycles there are many cases where the capacitor as a suppressor is the best solution. The most important considerations in the use of capacitors as suppressors are the characteristics of these capacitors in the desired radio frequency band and the proper arrangement of leads and connections.

Whether capacitors are used instead of filters depends on the economies, allowable weight and size and the required performance.

Filters as Suppressors

When apparatus rated 1 kw or more has to be suppressed over a wide range of frequencies such as 0.2 to 20 mega-

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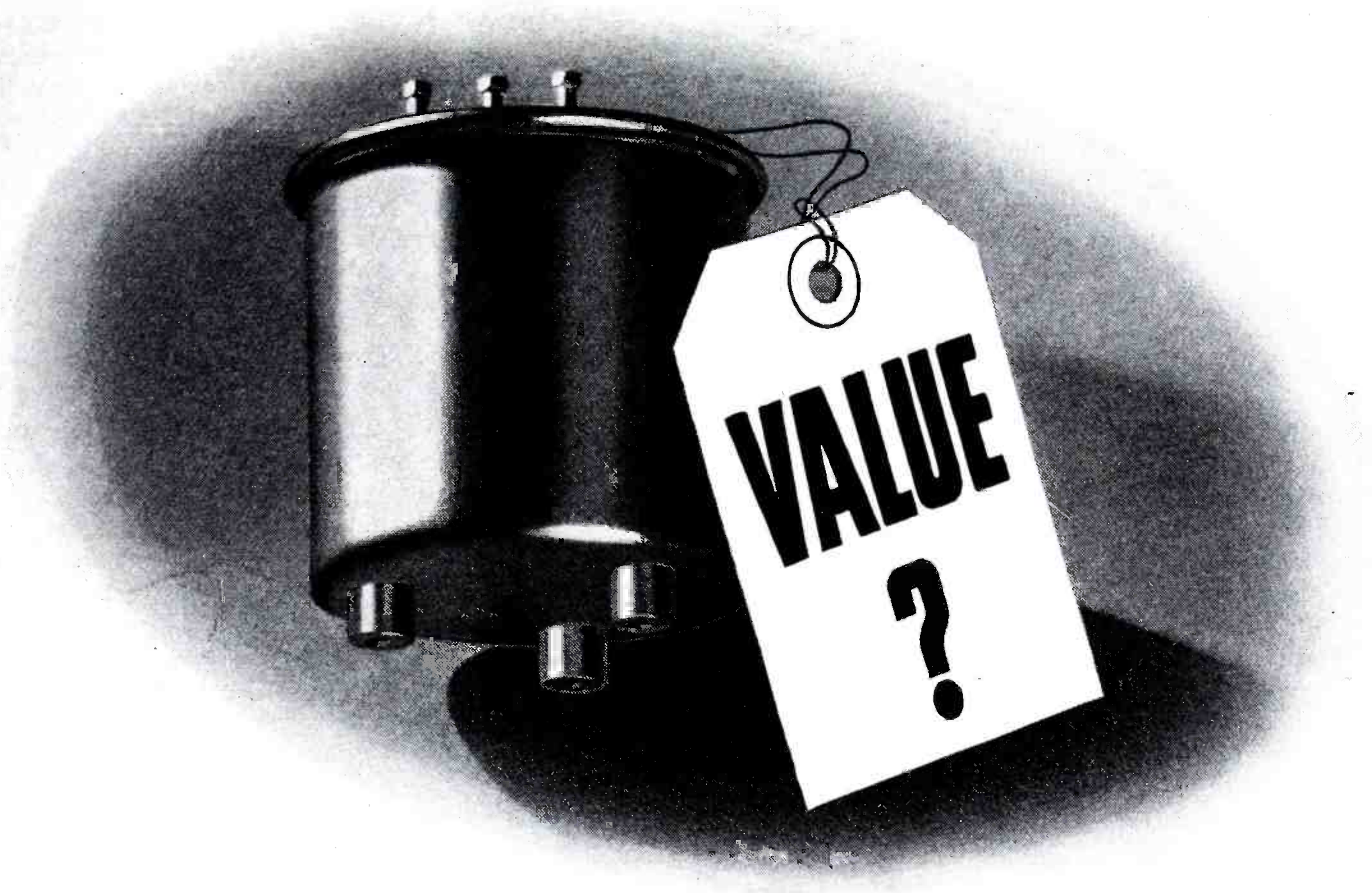
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cycles, and suppression of 40 db or more is required, a capacitor is not generally sufficient for reasons shown above. While in some instances filters have been specially designed and assembled as part of a piece of equipment, the general situation calls for the availability of filters as separate items to be selected and applied as the need arises. Manufacturers have made available certain sizes of filters intended to cover a large majority of these requirements. To meet as nearly as possible the general requirements outlined above, these filters are designed to give attenuation characteristics based on measurements on a variety of apparatus and experience of aircraft operators over the frequency range of radio equipment used in aircraft. Impedance characteristics of aircraft equipment and circuits have been taken into account in a general way by the use of a laboratory test setup to be described later.

Filters on Heavy Duty Generator

To illustrate the application of these filters the case of a 2.5 kw, 28-volt d-c generator will be considered. The full load current of this machine is 90 amperes approximately. The filter rated 100 amperes would, therefore, be selected and installed as illustrated in Figure 1 *b*. Filter performance is illustrated by Figure 2, already referred to in this paper, when the filter is properly installed.

To obtain the full degree of effectiveness which the filter is capable of giving, careful attention to certain installation details is necessary. While a generator is referred to as an example, the discussion is intended to apply to a variety of apparatus. The filter should preferably be close to the generator. The intervening circuit must be shielded, the enclosure generally consisting of a conduit which forms a continuous shield with the generator and filter cases. The filter base must be well grounded, for instance, mounted directly on the grounded metal structure. The grounded side of the circuit should be well grounded at a point immediately adjacent to the filter.

Isolating Radio Influence Voltage

The importance of this and other factors to the proper functioning of such a filter can be seen by reference to Figure 9. Here three important factors are emphasized, all of which are usually present to a greater or less degree simultaneously. Let us assume that we wish to isolate the radio influence voltage appearing at the left from the circuit at the right.

Figure 10
Front view of a radio noise-filter insertion-loss test device. The instrument is complete with amplifier, oscillator, power supply and voltage stabilizer.

Capacitive Coupling

Capacitive coupling is one of the things that may interfere with predicted good performance. It results from the presence of extraneous capacitance between input and output circuits as indicated by C in Figure 9 *a*. To high frequencies this provides a bypass and allows extraneous voltages to appear in all or certain parts of the quiet circuit in spite of the presence of the filter.

Inductive Coupling

Inductive coupling is another condition to be avoided. If the impedance to radio frequency currents flowing at the left is small, as it should be for a well designed filter intended for suppression, radio frequency currents flowing through this circuit may set up electromagnetic flux. If this flux is allowed to cut the conductors of a quiet circuit, it will introduce a radio frequency disturbance as illustrated. In many cases magnetic shielding can be used to reduce this coupling. Electromagnetic flux at commercial frequencies must be shielded with heavy sections of magnetic material. At radio frequencies flux penetration can be prevented to a great extent with thin conducting surfaces. Inductive coupling occurs only when there are loops existing in input and output circuits.

Conductive Coupling

Conductive coupling is shown in Figure 9 *c*. Radio frequency currents in the circuit at the left flow through a common ground lead having an impedance Z. As a result voltage E, appears across this impedance and is directly introduced in the circuit which is intended to be quiet. This type of induction may occur unless particular care is taken to secure a good ground connection. The case of the filter should be solidly connected to the electrical ground plane. The impedance of only a few inches of ground wire are extremely detrimental to filtering action.

To obtain a quiet circuit all sources of noise must be taken care of. One filter can sometimes be arranged to suppress more than one source. For instance, if the generator in the above example has a voltage regulator which causes radio noise and all connections to this regulator are made between the generator and the filter, the filter suppresses noise from both sources. All other connecting wires such as field leads must also be connected on the generator side of the filter.

In general the important things to give attention to in the installation of a filter are location, shielding of the unfiltered parts of the circuit, and ground connections.

Measurements

Tests are needed to check the performance of filters under actual operating conditions and to obtain data on which further designs and improvements can be based. The effectiveness of filters is determined by making two measurements of radio influence voltage, preferably on an actual installation in an aircraft. These measurements are made . . . (*a*)—without filter in the circuit and (*b*)—with filter in the circuit.

Measurements on the input and output sides of the filter do not indicate the effectiveness of the filter because the filter itself charges the circuit constants. The necessary equipment for these tests consists of a radio noise meter[1] and a reliable signal generator for calibration.

To get measurements within the accuracy[2] of the noise meter, certain precautions are necessary, particularly in tests made on an aircraft in flight. Among these are . . . (*a*)—mainten-

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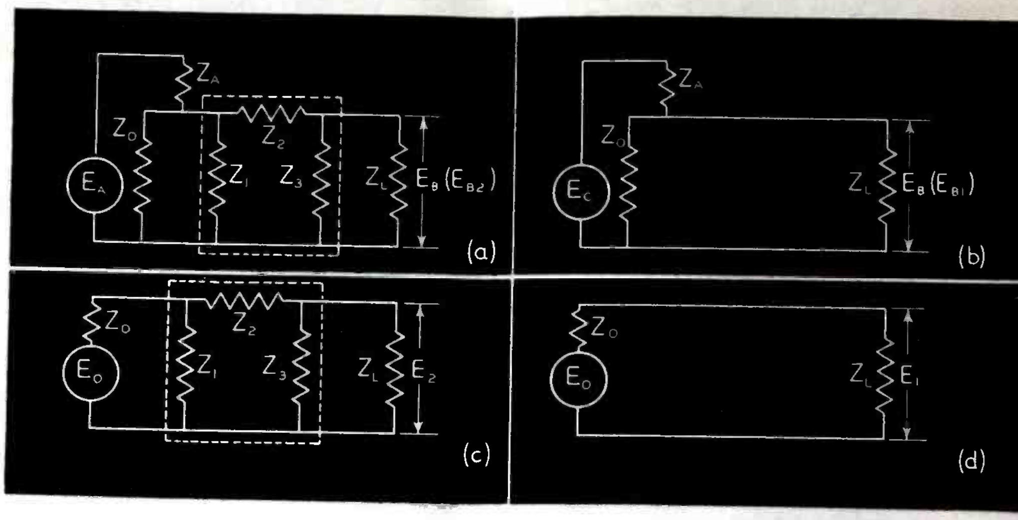

Figure 11

Here we see the laboratory and apparatus circuits for rating filter performance. In the laboratory circuit . . . *(1)* Where the signal generator voltage E_A is held constant, the effectiveness $= E_{B1}/E_{B2}$, where E_{B2} = value of E_B filter in, and E_{B1} = value of E_B filter out. The ratio is the same as E_1/E_2 in the apparatus circuit and is independent of Z_A. (2) Where the output voltage E_A is held constant, the effectiveness $= E_A/E_C$ where E_A = signal generator voltage, filter in, and E_C = signal generator voltage, filter out. The laboratory circuits are shown at *A* and *B*. At *C* and *D* are the apparatus circuits where the effectiveness $= E_1/E_2$.

ance of proper battery voltage, (*b*)—proper alignment and adjustment of the noise meter and frequent calibration checks against the signal generator; (*c*) placing the noise meter close to the test point which in measurements with the filter should be right at the filter terminal on the *quiet* side; (*d*)—avoiding test locations where the noise level is high; (*e*) providing the noise meter with cushions to eliminate mechanical vibration, and (*f*)—providing a temperature controlled chamber when low temperatures are encountered.

In addition to tests on the actual equipment it has been found useful to make tests on filters at radio frequencies in a laboratory circuit. This setup approximates in a general way the impedance characteristics of a piece of aircraft equipment and the associated circuit. The filter performance curves so obtained are not interpreted as those to be expected on apparatus, but rather as those obtained in a standardized test circuit. However, the general experience has been that the filters showing the best performance on this network also showed the best performance in actual apparatus. This test has proved useful in the development of filter designs and in checking the product of the factory. Figure 10 shows a filter tester based on this method used in a factory.

A diagram of the laboratory circuit in somewhat common use is shown in Figure 11. Filter performance in this circuit is obtained by measurements without the filter in the circuit and with the filter in the circuit. The analysis given in the *Appendix* shows that laboratory circuit indicates the same performance as an actual apparatus circuit with a certain set of impedance values.

The measurements just described on a laboratory circuit or on the actual power circuit do not take into account the radio equipment and circuits. A complete study of filter performance should include measurements on the radio equipment. Consideration of the measurement equipment and technique for this purpose is beyond the scope of this paper.

APPENDIX

Laboratory Circuit for Filter Performance Tests

The laboratory test is made with sine wave voltages at radio frequencies. The voltage source or signal generator is connected to a resistance network shown in Figures 11*a* and *b*. Z_0 and Z_L represent the apparatus and circuit impedances and consist of 20-ohm resistors. In addition, a 300-ohm resistor Z_A is connected in series with the signal generator to adapt the circuit to the internal impedance characteristics of available signal generators. This 300-ohm resistor does not affect the test result because it cancels out in the *Filter-Out* to *Filter-In* ratio as shown by the equations. Z_1, Z_2 and Z_3 represent a *pi-filter* (see Figure 6).

The test may be made in two ways. The signal generator voltage may be held constant and two values of output voltage E_B obtained; E_{B1} with filter out (Figure 11*b*) and E_{B2} with filter in (Figure 11*a*). The ratio E_{B1}/E_{B2} is equal to the filter attenuation ratio, as will be demonstrated.

The following approximations which hold for practically all test setups have been made for the purpose of simplifying the analysis:

The neglected effect of Z_L on Z_3 is neglected.

The paralleling effect of Z_0 (to the left) and of other impedances (Z_2, etc., to the right) on Z_1 is neglected.

The impedance looking into Z_2 from the left (Figure 11*a* and *c*) is assumed to be the same as Z_2 itself, which neglects the added effect of Z_3 and Z_L.

The impedance looking into the circuit from the signal generator *i*, Figure 11*a* and *b* is assumed to be equal to Z_A which neglects the added effect of Z_0, Z_1, Z_L, etc. The largest error occurs in Figure 11*b* where the actual value is 310 ohms and the approximate value is 300 ohms, the value of Z_A.

The impedance looking into the circuit from the source in Figure 11*d* is assumed to be equal to Z_0 which neglects the added effect of Z_1 etc.

In Figure 11*a*, the value of E_B is approximately

$$E_{B2} = E_A \frac{Z_1}{Z_A} \times \frac{Z_3}{Z_2} \qquad (1)$$

When the filter is removed, Figure 11*b*, and the signal generator voltage kept the same ($E_C = E_A$), E_B becomes approximately

$$E_{B1} = E_A \frac{Z'}{Z_A} \qquad (2)$$

where Z' represents Z_0 and Z_L in parallel.

Combining these equations we have

$$\frac{E_{B1}}{E_{B2}} = \frac{Z' Z_2}{Z_1 Z_3} \qquad (3)$$

It will be shown that this equation gives the same ratio as the voltage ratio E_1/E_2 in the apparatus circuit, Figure 11*c* and *d*. In the former (filter in), the voltage E_2 is given approximately by the relation

$$E_2 = E_0 \frac{Z_1 Z_3}{Z_0 Z_2} \qquad (4)$$

In Figure 11*d* (filter out) the voltage E_1 is given by the relation

$$E_1 = E_0 \frac{Z_L}{Z_0 + Z_L} \qquad (5)$$

Combining (4) and (5) we obtain

$$E_1 \doteq \frac{Z_0 Z_L}{Z_0 + Z_L} \times \frac{Z_2}{Z_1 Z_3} \qquad (6)$$

Since the term $\frac{Z_0 + Z_L}{Z_0 + Z_L}$ gives the value of Z_0 and Z_L taken in parallel which is designated by Z' in equation (*3*), the right-hand members of (*3*) and (6) are the same and therefore

$$\frac{E_{B1}}{E_{B2}} = \frac{E_1}{E_2} \qquad (7)$$

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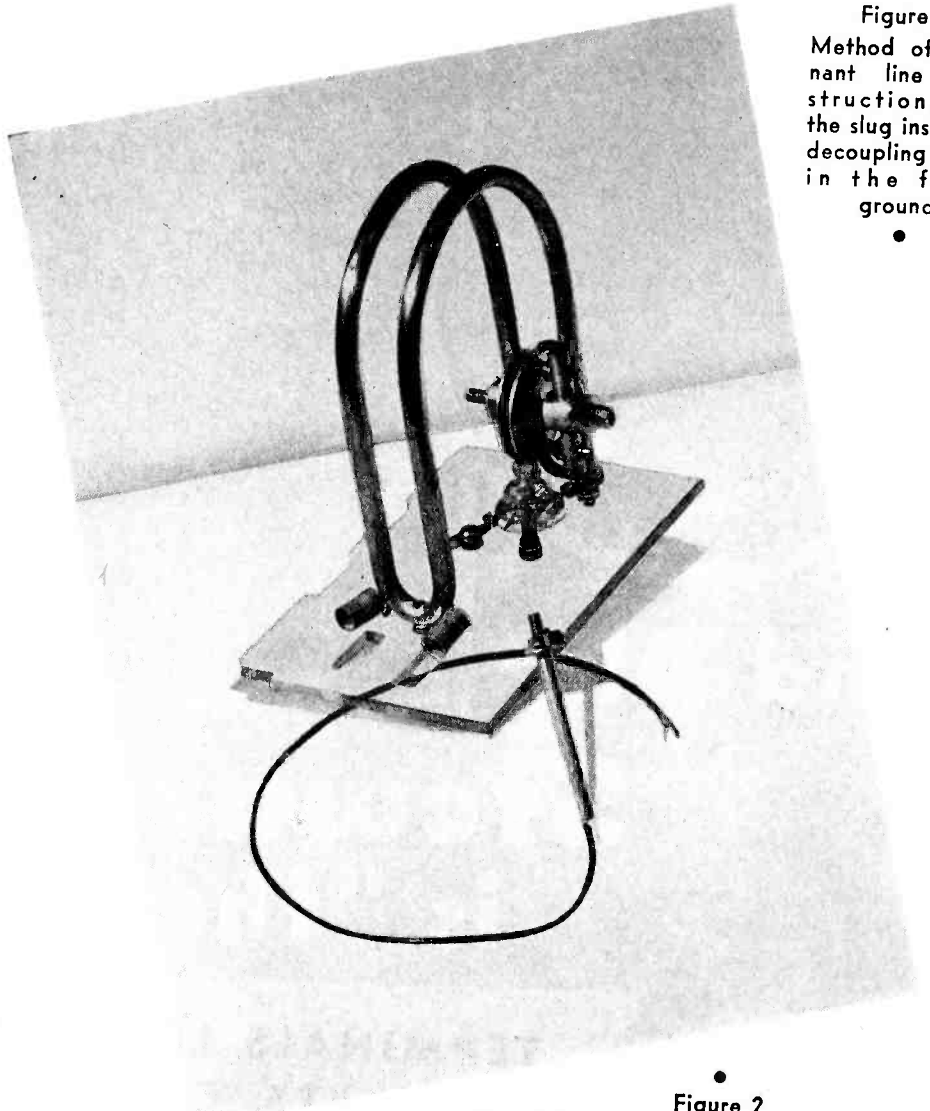


Figure 1
Method of resonant line construction, with the slug insert for decoupling shown in the foreground.

Figure 2
An u-h-f receiver combining super-regeneration and superheterodyne.

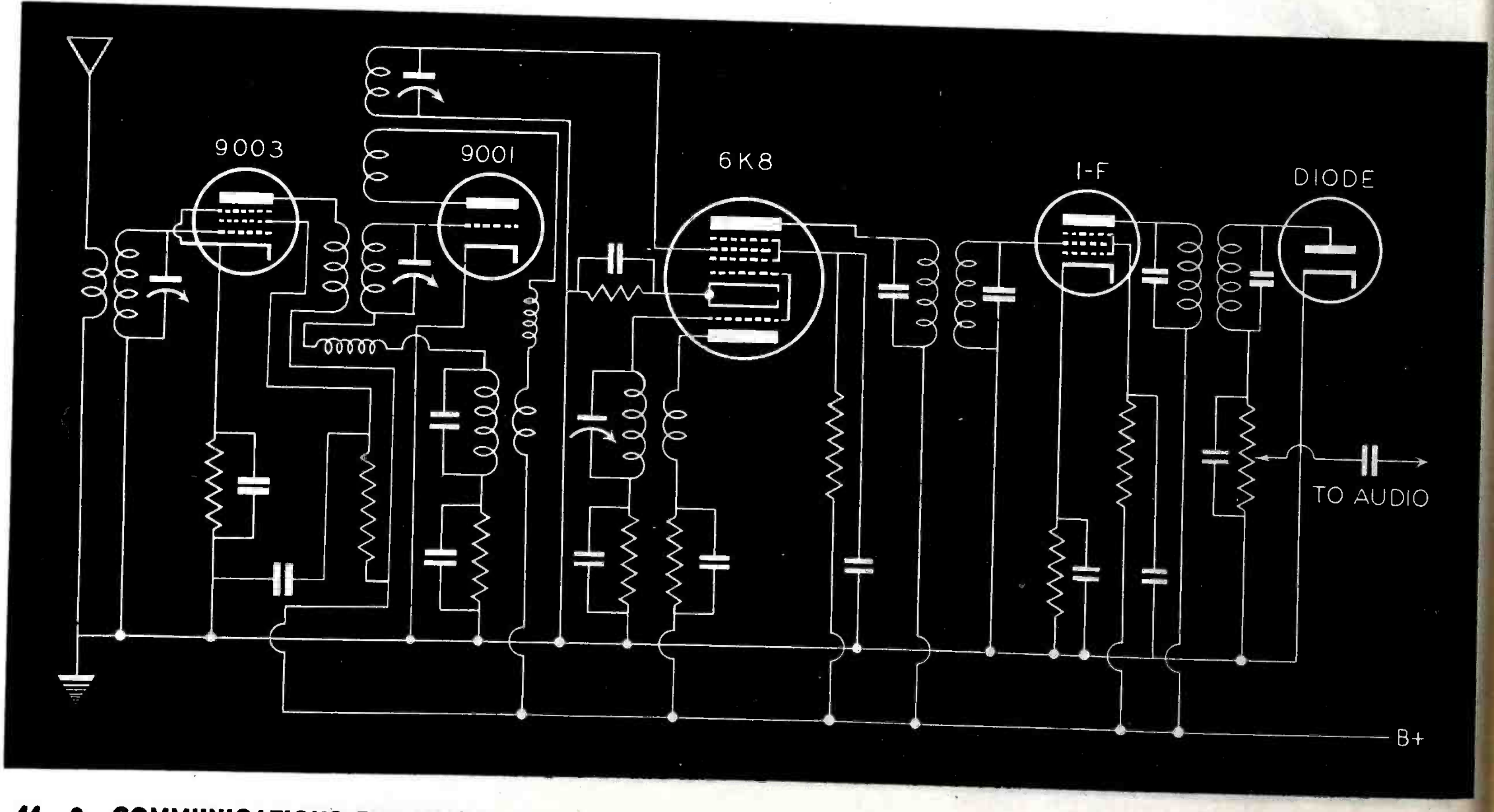
IN resonant line design, it is sometimes necessary to limit the space occupied by the lines. In Figure 1, we see one method of accomplishing this, with the added features of rigid construction and negative temperature compensation.

In this method, polystyrene is used as the mounting base, and the shorted end of the resonant line is attached by means of a screw to this same sheet of polystyrene. For increases in temperature, the polystyrene expands increasing the distance between centers of the resonant line, thereby decreasing both the inductance and capacitance of the line.

In the foreground of the illustration is shown a type of slug insert used to decouple the tube from the resonant line. The lead is then formed into a choke for shunt feed. A polystyrene sleeve is used to insulate the slug from the line, and the acorn tube prong is attached directly to it.

S-R and Superheterodyne

Below, Figure 2, is shown a method of combining super-regeneration and superheterodyne, for use at u-h-f. Its purpose is to allow investigation of low power transmitters at frequencies above 100 megacycles. For multiple band coverage the super-regenerative portion may be made a separate unit so that frequencies up to 500 megacycles may be investigated.



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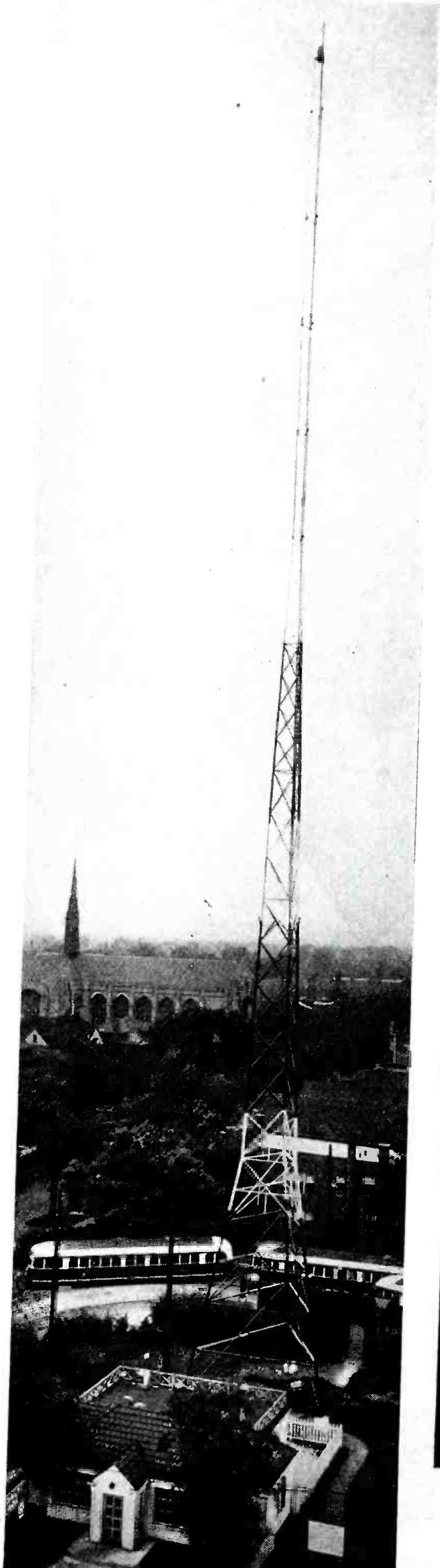


THE importance and usefulness of mobile communication systems have become dominant factors on many fronts during the past year. For years mobile systems have been accepted as a necessity in police and allied patrol work. It has now entered other phases of use, such as on transportation systems. In Chicago, for instance, the surface lines which travel over a very wide area, adopted a mobile communication system after long study.

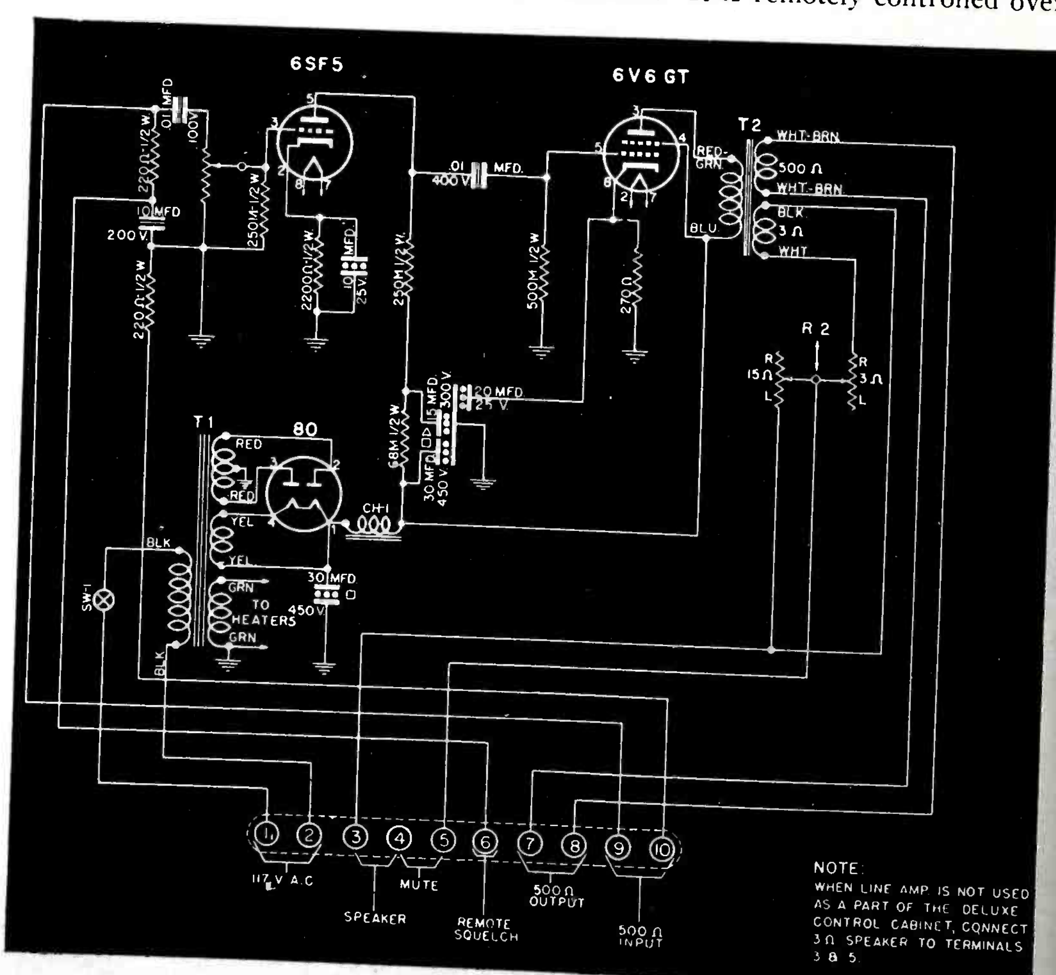
Although the officials were dubious at first, tests proved to them that a mobile system would not only eliminate transportation troubles, but expedite control.

The new system which is of the f-m type, provides transmission of messages covering fires, flooded underpasses, collisions on right of way, stalled vehicles, disabled transportation, altercations with passengers, ailing passengers, trolley feeder trouble, etc. These messages are sped to a central source, from where dispatches to nearby patrol and wreck cars are transmitted. Practically instant aid is given in this manner.

The system uses 41 two-way mobile units or 18 sedans and 23 trucks. There are also 7 sedans equipped with one-way systems. In the truck classification are wreck wagons, emergency tower trucks, cable trucks and electrical line repair and construction tower trucks.

The 18 cars contain cruising supervisors. There is a car for each of the 15 districts. In the remaining 3 cars are those who supervise work of the other 15. The men of these cars also assist in maintaining car schedule. They participate, too, in repair work when necessary.

On the western city limits, several miles north of the east-to-west center line, the basic 250-watt transmitter is located. It is remotely controlled over



Figures 1 (left) and 2 (above)
Figure 1, the 250-foot high antenna. Line amplifier is shown in Figure 2.

SURFACE LINE MAINTENANCE

Figures 3 (top) and 4 (right)

In Figure 3 appear typical patrol cars used in the Surface Line system. The interior of one of these cars is shown in Figure 4. In these cars are cruising supervisors who not only report incidents but who also participate in maintenance and repair.

a pair of wires from a main console that is 7½ miles away. The transmitter is of the unattended type housed in a tile building immediately adjacent to the base of a 250-foot high illuminated three-legged tower. A ⅞″ copper nitrogen-filled feed-line connects the transmitter output to a half-wave vertical, coaxial antenna.

Transmitters and receivers are designed for the 30 to 40 megacycle band. They are adjusted, of course, to an assigned frequency within this range, with a quartz crystal to within 0.01%. In the transmitter oscillator stage, a 7C7 is used. The i-f stages also use 7C7's and a 6V6. In the exciter are 807's, while in the modulator we find 7A8's and 100th's.

The triode section of the 7C7 is in a triode crystal controlled oscillator system. The first r-f amplifier stage is of course modulated. The maximum percentage of modulation is 100% for 15 kc deviation.

The normal grid current of the r-f amplifier operating at 250 watts output is 85 to 90 ma.

The 30-watt transmitters use a 7C7

(*Continued on page* 50)

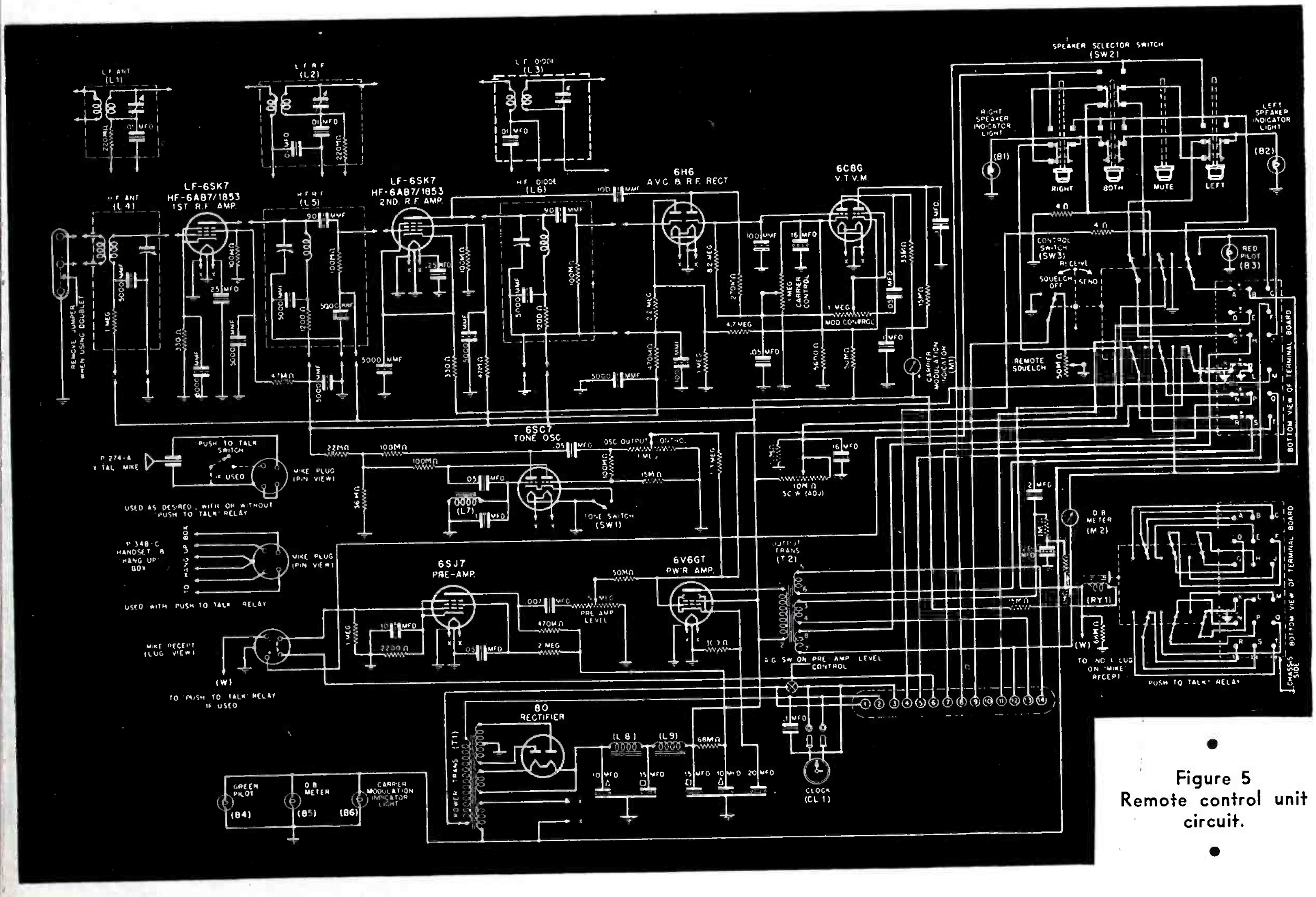
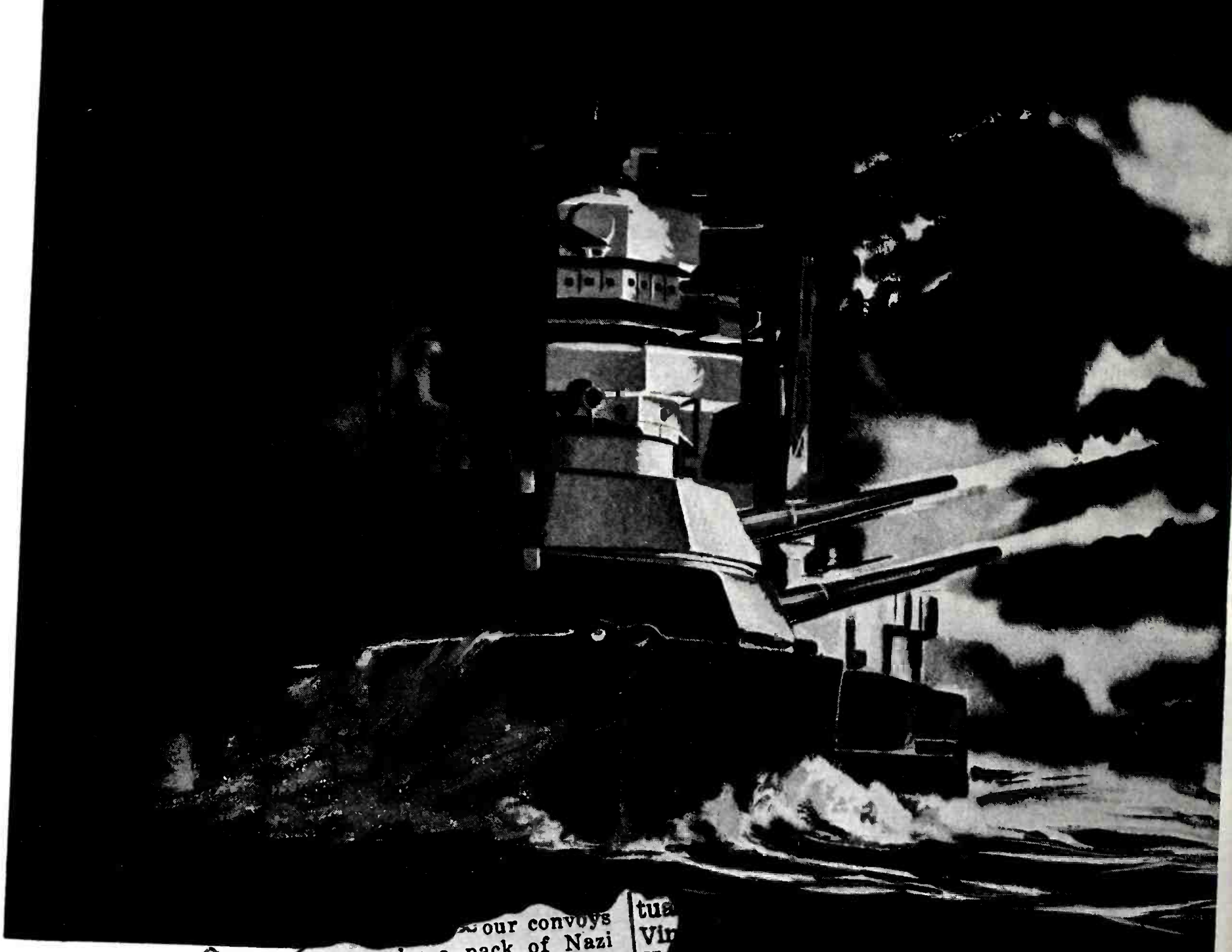


Figure 5
Remote control unit circuit.

"In the Blackness of a Jap Battleship



... our convoys was set upon by a pack of Nazi submarines. They got one of our merchant ships, but we got four of their submarines.

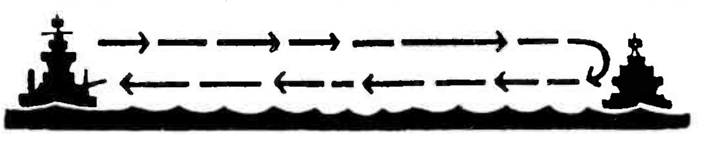
History will some day record the part radio and the radar have played in giving us fighting superiority over the Axis. But let me give you one instance. On the night of Nov. 14, off Guadalcanal there lay a Japanese battleship. It was a stormy night. Eight miles away was a ship of our fleet. With the use of the radar our ship with its second salvo, sank the Jap battleship in the blackness of night, eight miles away. Is there any wonder that the ...

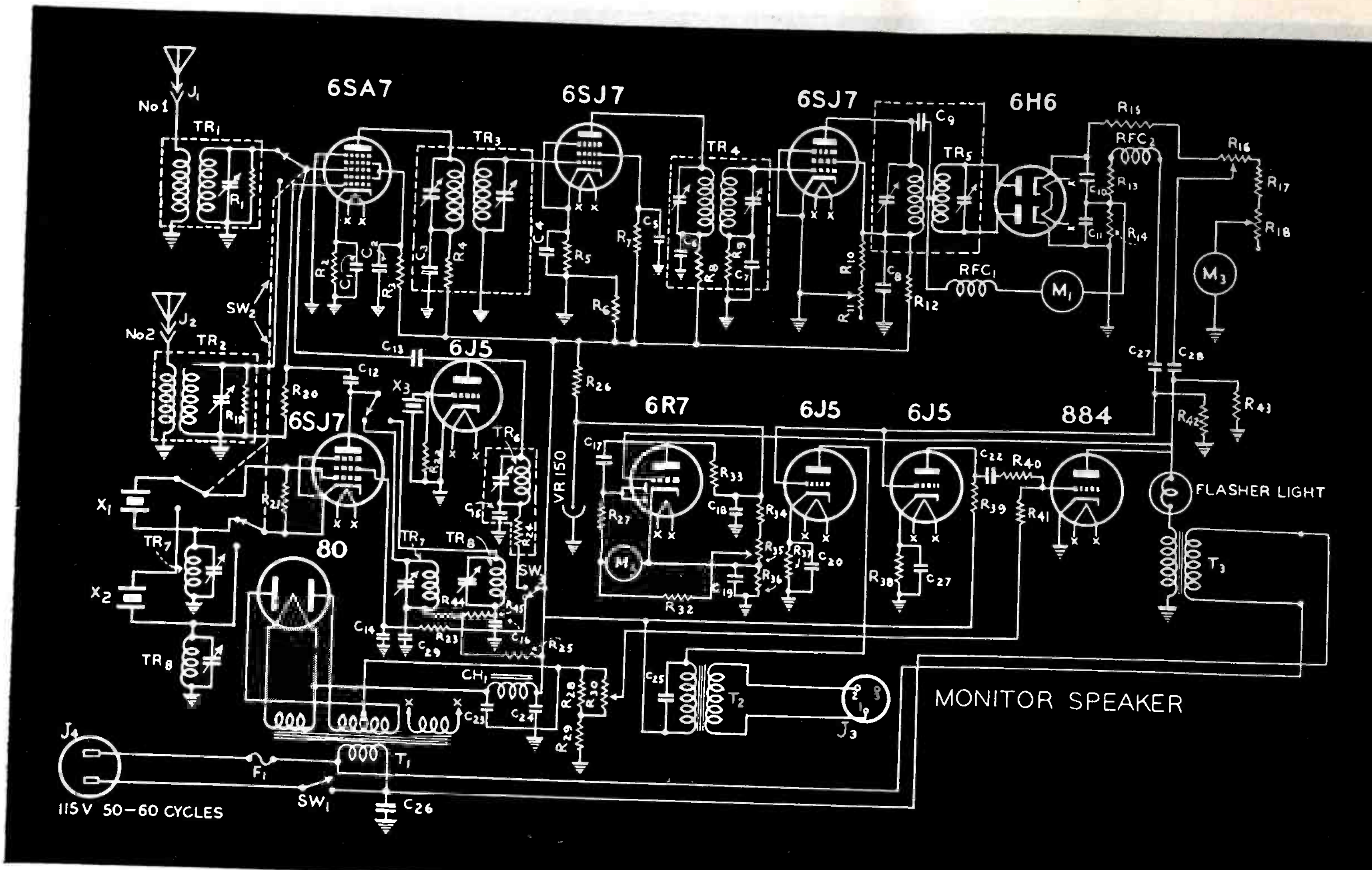
EXTRACT *from address by James F. Byrnes, Director of War Mobilization, at Spartanburg, S. C. May 31, 1943, broadcast over the Blue Network.*

Radar principles were first applied to aviation by RCA through equipment built and installed in its own plane in 1937, in connection with a study of collision prevention.

In 1938, RCA built an experimental Radar installation for the U. S. Navy. As the result of tests, in October, 1939 the Navy placed with RCA its first order for service Radar equipment. Since then, vast strides in the development of Radar in RCA Laboratories

RADIO





(*Continued from page* 47)

in the oscillator stage, in triode crystal form. The i-f stages use 7C7's as quadruplers, and a 6V6 in doubler fashion. In the final stage is an 807 while in the modulator stage will be found 7A8's. These units, like the main transmitter, cover the 30 to 40 mc band, with crystal control.

The line for remotely controlling the transmitter is leased from the local telephone company. This line is also used for talk back. A second pair of wires operated with the first pair is used for limiting control of the squelch on the receiver at the transmitter point. Incidentally each line has a direct current resistance of 1,200 ohms.

The voltage impressed on the telephone wire to control the transmitter is approximately 65. This keeps the current at approximately .008 ampere with a 6,500-ohm relay at the transmitter.

In the 30-watt transmitter installations, a 13-tube receiver has also been incorporated. In the sedans, the receiver and transmitter are mounted on the floor in the rear of the forward seat. A roof-top antenna is used.

These antenna are of the quarter-wave Marconi type mounted at an angle of approximately 45° to the vertical to accommodate pass under viaducts.

On the line tower trucks a horizontal dipole antenna of ¼" copper tubing is used. This tubing is held in place with stand-off insulators by two parallel railings on top of the truck. This type of system provides a decided directional effect with the signal from the mobile unit being strongest at the open end.

Three of the line trucks are equipped with the quarter-wave Marconi system included as previously described.

The ground for the Marconi system was formed by covering the underside of the front overhang of the cab (where the antenna is supported) and an adjacent vertical position of the outside of the cab with No. 26 galvanized iron.

With these antenna, complete coverage of the entire city has been possible. This includes areas under steel viaducts, except in a few instances, where an unusual amount of steel has been used in construction.

To indicate the actual frequency swing of the carrier in k-c of maximum excursion for sine wave audio modulation of the f-m transmitter, a special f-m monitor is used. Whether or not this modulation is symmetrical about the nominal carrier frequency is indicated on a center frequency deviation meter. This instrument also has a carrier level meter, allowing the operator to judge the input characteristics immediately.

In this f-m monitor is a converter, fed by a crystal oscillator. The output of the incoming signal passes through a broad-band intermediate frequency

(*Continued on page* 90)

Figure 6
The f-m monitor. Below appear resistor and capacitor values.

RESISTORS

Symbol	Value	Symbol	Value
R 1	10,000	R23	50,000
R 2	250	R24	25,000
R 3	20,000	R25	5,000
R 4	2,000	R26	7,500
R 5	400	R27	50,000
R 6	50,000	R28	300
R 7	50,000	R29	350
R 8	2,000	R30	10,000
R 9	250,000	R32	10,000
R10	40,000	R33	10,000
R11	20,000	R34	1 meg.
R12	50,000	R35	2,000
R13	100,000	R36	1,000
R14	100,000	R37	1,500
R15	30,000	R38	2,000
R16	20,000	R39	25,000
R17	30,000	R40	50,000
R18	20,000	R41	30,000
R19	10,000	R42	1 meg.
R20	25,000	R43	500,000
R21	50,000	R44	2,000
R22	50,000	R45	2,000

CAPACITORS

Symbol	Value	Symbol	Value
C 1	.006	C15	.006
C 2	.006	C16	.006
C 3	.006	C17	1 mfd
C 4	.006	C18	.1
C 5	.006	C19	10 mfd
C 6	.006	C20	10 mfd
C 7	25 mmf	C21	10 mfd
C 8	.006	C22	.05
C 9	25 mmf	C23	16 mfd
C10	100 mmf	C24	16 mfd
C11	100 mmf	C25	.002
C12	50 mmf	C26	.02
C13	25 mmf	C27	.02
C14	.006	C28	.02
		C29	.006

Perhaps you fail to recognize us under this new name — Electronic Corporation of America . . . but a name really means very little. It's the knowledge and skill of an organization that count. We've been manufacturing sound systems, test equipment and numerous electronic devices, and the roots of our experience are almost as old as radio itself. The principals and most of the personnel of ECA have functioned as a unit for many years. New employees, added to our force because of the important war work we are doing, have become imbued with our cooperative spirit. Consequently, internal harmony is at its highest pitch . . . and we're able to produce just a little bit better, a little bit faster. Such a combination of experience and teamwork can't be beat. If you're in need of a dependable supplier we may, as our schedules permit, be able to help you.

THIS WAR CAN BE SHORTENED. Although engaged 100% in war work, we find time to seriously consider the home front. Surely the news from the battle front is good . . . but the war hasn't been won yet. In fact, we can lose it if we fail to adjust our domestic problems. Labor-management difficulties, race riots, personalities, vicious rumors . . . hurt rather than help. Let's cut them out . . . let's work together . . . let's shorten this war.

ELECTRONIC CORP. OF AMERICA

45 WEST 18TH STREET • NEW YORK 11, N.Y. • WATKINS 9-1870

BOOK TALK . . .

DYNAMICAL ANALOGIES

By Harry F. Olson, Acoustical Research Director, RCA Laboratories and Lecturer in Sound Engineering, Columbia University, New York . . . 196 pp. . . . New York: D. Van Nostrand Company, Inc. . . . $2.75

A unique presentation, in which analogies between electrical, mechanical and acoustical systems are presented. Covered are such interesting subejcts as corrective networks, isolators, filters, transients, theorems and applications in electrical, mechanical and acoustical systems and electromechanical transducers.

There are eleven chapters. Among the topics covered are definitions of terms used in dynamical analogies, elements in electrical systems, wave filters, driving systems, generating system, etc.

Each of the subjects discussed are illustrated by electrical, acoustical, rectilineal and rotational (the latter two being mechanical) drawings to explain the analogy.

One of the most interesting chapters is that on applications. Here analogies of direct radiator loud speakers, rotational vibration dampers, machine vibration isolators, etc., are analyzed. An analogy employing the fundamental principles of vibrations produced in mechanical and acoustical systems is provided.

In the chapter on wave filters, low pass, high pass, band pass and band elimination wave filters in electrical, mechanical rectilineal, mechanical rotational and acoustical systems are analyzed. The chapter describes how the use of electrical data can be used in mechanical and acoustical systems to control, suppress or eliminate vibrations.

Dr. Olson has written this book in the same lucid manner as his previous book on *Elements of Acoustical Engineering*. In this previous presentation, Dr. Olson provided a profound discussion of acoustical principles and their application. In this volume, he shows how dynamic analogies can be used effectively in the design of microphones, speakers, pickups, turntable filter systems, facsimile receivers, supersonic transmitters and receivers, etc.—*O. R.*

• • •

ELECTROMAGNETIC WAVES

By Sergei A. Schelkunoff, Member of the Technical Staff, Bell Telephone Laboratories, Inc. . . . 500 pp. . . . New York: D. Van Nostrand Company, Inc. . . . $7.50

The study of electromagnetic waves is one of the most intriguing subjects in communications. In this new book, Dr. Schelkunoff presents a fluent discussion of the subject, based on his research and consulting experience at Bell Laboratories and the courses he gave on electromagnetic waves at Brown University.

Intended as a textbook as well as for reference work, engineers and students will find this volume one of the most practicable books ever published.

The practicing engineer will find basic theoretical information on radiation, wave propagation, wave guides and resonators, while the research engineer will find many pages of appropriate equations that will serve as a basis for investigations.

There are eleven chapters in this book covering the following subjects . . . vectors and coordinate systems; mathematics of oscillations and waves; Bessel and Legendre functions; fundamental electromagnetic equations; impedors, transducers, networks; waves in general; transmission theory; waves, wave guides, and resonators; radiation and diffraction; antenna theory, and the impedance concept. In the discussion of vectors and coordinate systems, the vector language is used in place of the vector analysis to simplify electromagnetic wave discussion. In the chapter on *waves in general*, Dr. Schelkunoff discusses calculation of fields when currents producing them are known; radiation from current elements and current loops; waves on conducting wires; guided waves treated semi-quantitatively, and the use of complex variables for solving electromagnetic problems.

The chapters on *waves, wave guides and resonators* are in two parts. The first covers a rather simple discussion and the second develops the more advanced subject of plane and spherical waves in unbounded and bounded regions. Here we find discussions of metal tubes, coaxial lines, etc. A review chapter is presented also in the form of problems, questions and exercises.

This work is one of the most extensive ever published. Dr. Schelkunoff is to be congratulated on presenting so complete a volume.—*O. R.*

• • •

BASIC ELECTRICITY FOR COMMUNICATIONS

By William H. Timbie, Professor of Electrical Engineering and Industrial Practice, Massachusetts Institute of Technology . . . 603 pp. . . . New York: John Wiley & Sons, Inc. . . . $3.50.

This is a book of fundamentals written for workers in communications and industrial electronics. Professor Timbie presents the basic electrical principles that every worker must be familiar with to solve a variety of problems that arise in practice. He discusses such fundamentals as molecules, atoms and electrons and protons, as well as vacuum tubes and gaseous conduction. However, both subjects are explained with extreme clarity so that their usefulness is fully appreciated and understood.

In the fifteen chapters, we find discussions of magnets and magnetic circuits, inductance and capacitance, electrical communication systems and Thevenin's theorem. This theorem is quite useful in solving many complicated circuits.

Classroom technique of questions and answers are employed at the conclusion of each subject. In addition typical practical examples are provided within the discussions.

An interesting assortment of explanatory photographs and schematic diagrams appear throughout the book. —*O. R.*

• • •

WHAT YOU SHOULD KNOW ABOUT THE SIGNAL CORPS

By Harry M. Davis, Office of the Chief Signal Officer, War Department, and F. G. Fassett, Jr., Editor of the Technology Review, Massachusetts Institute of Technology . . . 214 pp. . . . New York: W. W. Norton & Co., Inc. . . . $2.50

One of the most interesting branches of the Service, the Signal Corps, receives an effective analysis in this presentation.

Although the details presented are of a non-technical nature, engineers and technicians nevertheless will find the data interesting, revealing as it does the fascinating story of the Signal Corps from its inception to present day operation.

The book reveals just how a Signal Corps man is trained and his function in the Service. Since Army Photography is also a branch of the Sig-

BOOK REVIEWS

al Corps, a chapter is devoted to this phase, too.

Two very interesting chapters in the book are those covering the communications system of the Signal Corps and materiel problems.—*O. R.*

• • •

THE NEW CHEMICAL FORMULARY, VOL. VI

Edited by *H. Bennett* . . . 636 pp. . . . Brooklyn, New York: The Chemical Publishing Company, Inc . . . $6.00

In view of the activities of chemists in radio today, this reference book takes on added significance. Hundreds of formulae on paints, varnishes, lacquers, metals, alloys, etc., will be found among the pages. Complete details on the uses and applications also appear. Adhesives, emulsions, inks and marking materials, lubricants and oils, materials of construction, paper, rubber, resins, waxes and plastics, etc., are also included in the various formulae discussions.

Substitutes for metals, minerals, oils, dies, etc., appear in another interesting division of the book.

In the appendix appear many charts covering such topics as alcohol proof and percentage table, thermometer reading conversions, etc. A list of suppliers of chemicals is also provided.

This new volume, the sixth in the series, is most complete and will prove very helpful to designing, development and production engineers.—*O. R.*

• • •

THE AMERICAN STANDARDS FOR TRANSFORMERS, REGULATORS AND REACTORS

Prepared by *ASA Sectional Committee on Transformers*, which includes representatives of standardization bodies of the American Institute of Electrical Engineers, Electric Light and Power Group, National Electrical Manufacturers Association, Association of American Railroads, U. S. Department of Commerce and National Bureau of Standards. . . . 90 pp. . . . New York: American Standards Association. . . . $1.25.

This ASA issue contains an unusually complete compilation of standards data.

Included in this volume are definitions, standards and other related details on ratings, temperature rise, insulation classes and other performance specifications for induction units including distribution, power and regulating transformers, reactors, instrument transformers, constant-current transformers, step and induction voltage regulators, current-limiting reactors and general purpose specialty transformers. The new test code for transformers is also included in this edition. Guides for the operation of transformers and regulators are also discussed. According to the ASA, the test code and operation guides have been designated as American recommended practices.

The guides for operation are very interesting in that they provide a means of knowing loading characteristics under various surface characteristics. The guides for loading transformers, according to the ASA, recognize that the loads permissible for a transformer vary over a wide range depending on the operating conditions, such as ambient temperature, cooling facilities, etc.

Plans are under way to publish an addendum report once a year in which changes and additions will appear.

This book is certainly a worthwhile addition to any technical library.—*O. R.*

• • •

RADIO DATA HANDBOOK

By *Lieutenant Nelson M. Cooke*, United States Navy, U. S. Naval Research Laboratory, Washington, D. C. . . . 48 pp. . . . Chicago, Illinois: Allied Radio Corporation . . . $.25

A handy pocket volume with fundamental data useful in laboratory and shop. Many pages are devoted to formulas covering decibels, resistance, capacitance, inductance, reactance, resonance, frequency, *Q* factor, impedance, conductance, admittance, transients, etc. Color codes and coil winding data appear in another section. Here, too, we find charts on interchangeable tubes, pilot lamps, plug-in ballast resistors.—*O. R.*

• • •

RADIO TROUBLESHOOTER'S HANDBOOK

By *Alfred A. Ghirardi*, Author of the *Radio Physics Course, Modern Radio Servicing and Radio Field Service Data* . . .744 pp. . . . New York: Radio & Technical Publishing Co. . . . $5.00

In this, the third wartime service edition, an unusual variety of servicing data appear. Mr. Ghirardi presents, for instance, case histories of common trouble symptoms and remedies for over 4,300 models of over 200 makes of home and auto-radio receivers and record changers. These data are presented in step-by-step fashion.

The alignment of I-F peaks of over 20,000 superhetrodyne receivers is featured in another section of the book. A rapid trouble-shooting chart for common troubles in home receivers and auto radio models also appears in this newest edition.

To facilitate installation of auto-radios, all of the American passenger cars since 1933 are listed with ignition system data. Gear ratios and dial directions of auto-radios are also presented in chart form. A discussion of auto-radio ignition interference in all types of cars appears, too. In addition, wiring diagrams of 88 recent models of American cas are presented.

Presented in chart form, too, are vibrator buffer-condenser replacement data, recommended *replacement* and electrically *comparable batteries* for 1,250 models of portable radios, *physical dimensions* and *electrical specifications* of 12 different makes of *A*, *B* and *A-B* dry batteries and packs for portable and farm radio, grid bias resistor resistance values and wattage ratings for all self-biased tubes, receiving tube classification and operating characteristics and basing data, tube types for substitutions, etc. Base pin and socket connection diagrams for standard tube RMA bases are also presented.

Chapters are also devoted to . . . special - purpose tubes, transmitting tubes, cathode ray tubes, U. S. Navy standard tube types and their nearest commercial (RMA) equivalents, U. S. Army standard tube types and their nearest commercial (RMA) equivalents, U. S. Army-Navy preferred list of tube types to be used in new equipment, modernizing old receivers by substituting newer types of tubes, tube testers, interpretation of RMA receiving tube ratings, and pilot and dial lamps.

RMA standards also appear in the following charts . . . molded resistors, flexible resistors and resistor-cords; preferred values of molded resistors; molded mica condensers; power, I-F, interstage audio and output audio transformer leads, and proposed symbols for radio schematic diagrams.

Included, too, are a variety of calculation charts covering Ohm's Law,

(*Continued on page* 87)

SLID

by L. S. METCALFE

The basic electricity slide-film kit.
(*All photos, courtesy Jam Handy Picture Service*)

LIKE most industries, the communications industry has found it necessary to fill gaps left in the plant and field by experienced mechanics drawn into the armed forces through the draft or by changing to other lines of work. To this end, the present limited available reservoir of trainees for the industry have to be taught as quickly as possible. Specially executed slidefilms have provided an effective way of providing this training.

A series of such slide-films, sponsored by the United States Army and the U. S. Office of Education covering communications has been made available for industrial training programs. The series covers the first five official outline courses in the PIT (pre-induction training) program, as a part of the High School Victory Corps Organization. Subjects covered are: . . . fundamentals of radio, shop work, auto mechanics, machines, and electricity. These outlines are based upon material contained in Army technical and field manuals, and represent those studies which the armed forces consider most important at this stage o[f] the war.

Perhaps the most important of these five studies is that on the fundamentals of electricity, for which a series of twelve *reading* or discussional type slidefilms have been provided.

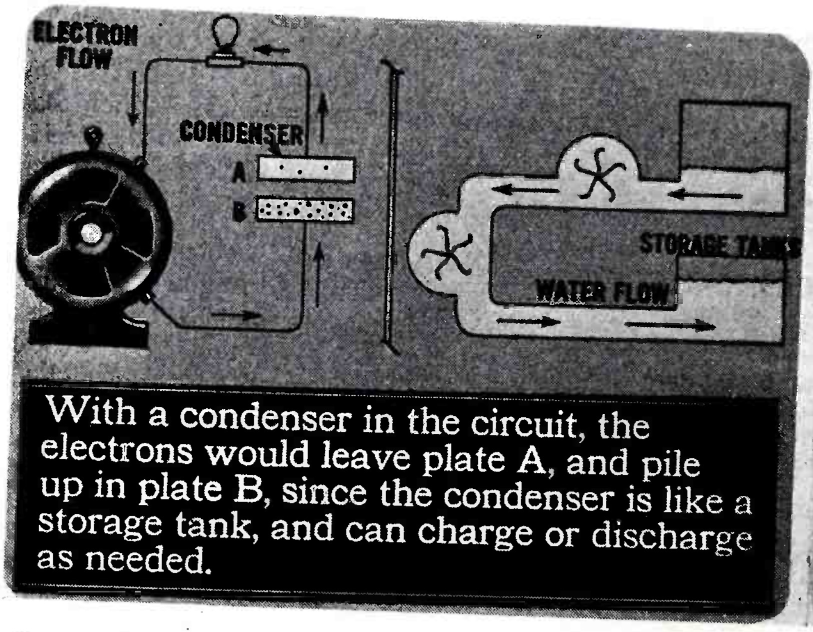
It is not the purpose of films of this type to alone provide a complete course in any study. They are *supplementary* to other methods of teaching, and are intended to save the time of the instructor, ease his or her present heavy burdens, and speed up the process of teaching at a time when trained man power needs are beyond available supply. Experiments and usage have proved that slide-films, properly integrated in vocational studies, save as much as 40 per cent of the time needed to finish a course. In electricity, for instance, by rapidly giving the beginner a general over-all understanding of principles, tools and techniques of the subject before he or she passes on to workshop or class room for more detailed study in specializations.

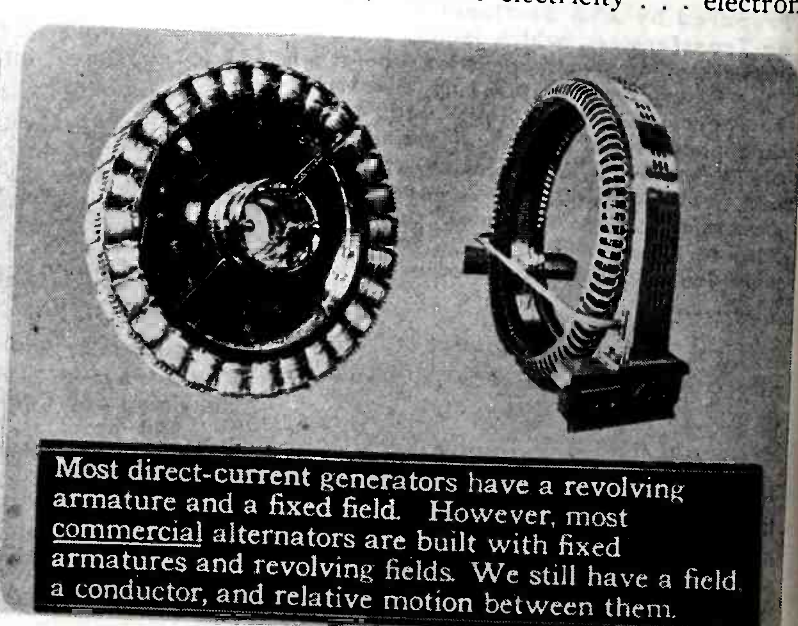
These twelve subjects or films, each the basis of a single lesson in basic electricity, total 888 individual pictures — drawings, photographs, charts and exhibits. Subjects are:

(*1*)—Magnetism . . . general properties and laws of magnets; magnetic effects (56 pictures).

(*2*)—Static electricity . . . electron

Closeups of typical slide-films.





FILMS FOR TRAINING

theory of positive and negative charges (91 pictures).

(*3*)—Current electricity . . . laws of current flow in the various types of circuits (73 pictures).

(*4*)—The electric cell . . . change of chemical energy into electrical energy; primary and secondary cells (46 pictures).

(*5*)—The Storage Battery . . . construction and use of the commercial storage battery (101 pictures).

(*6*)—Electromagnetism . . . construction and use of the electromagnet; effects of the electromagnet field (56 pictures).

(*7*)—The Generator . . . principles of the generator; types; generating direct and alternating current (80 pictures).

(*8*)—Alternating Current . . . inductance, capacitance, and impedance in a circuit; transformers and rectifiers (85 pictures).

(*9*)—Electric Motors . . . principles of the motor, direct and alternating current motors; universal motors (70 pictures).

(*10*)—Electric Meters . . . construction and operation of various types of meters for electrical use (81 pictures).

(*11*)—Applications . . . heating and light (63 pictures).

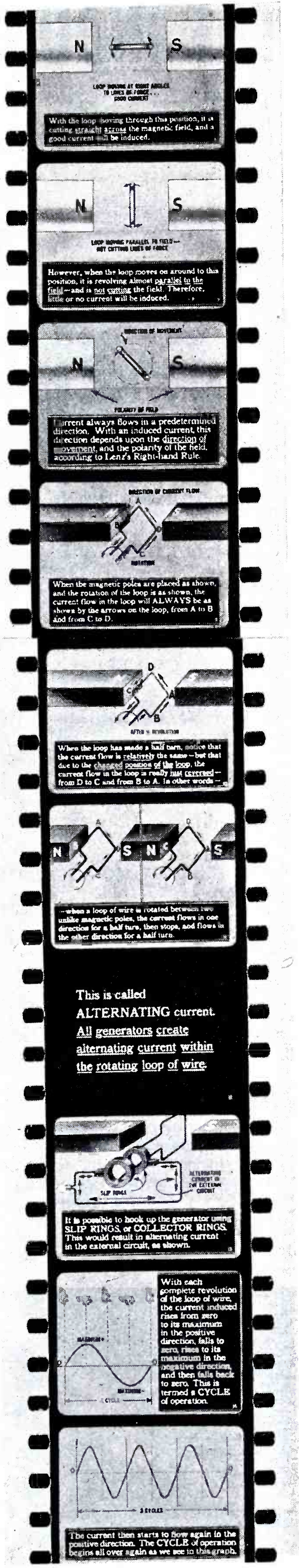
(*12*)—Applications . . . solenoids, motor uses, radio, and electroplating (74 pictures).

The films are of the *reading* or discussional type; a strip of 35 mm safety motion picture film with explanatory text, letterings, legends or notations superimposed on the film. The specific purpose of this form of film is to permit the instructor to read and speak without interference, and students to talk if desired. They supply illustrated material in illuminated form for class participation, and to encourage *discussion.*

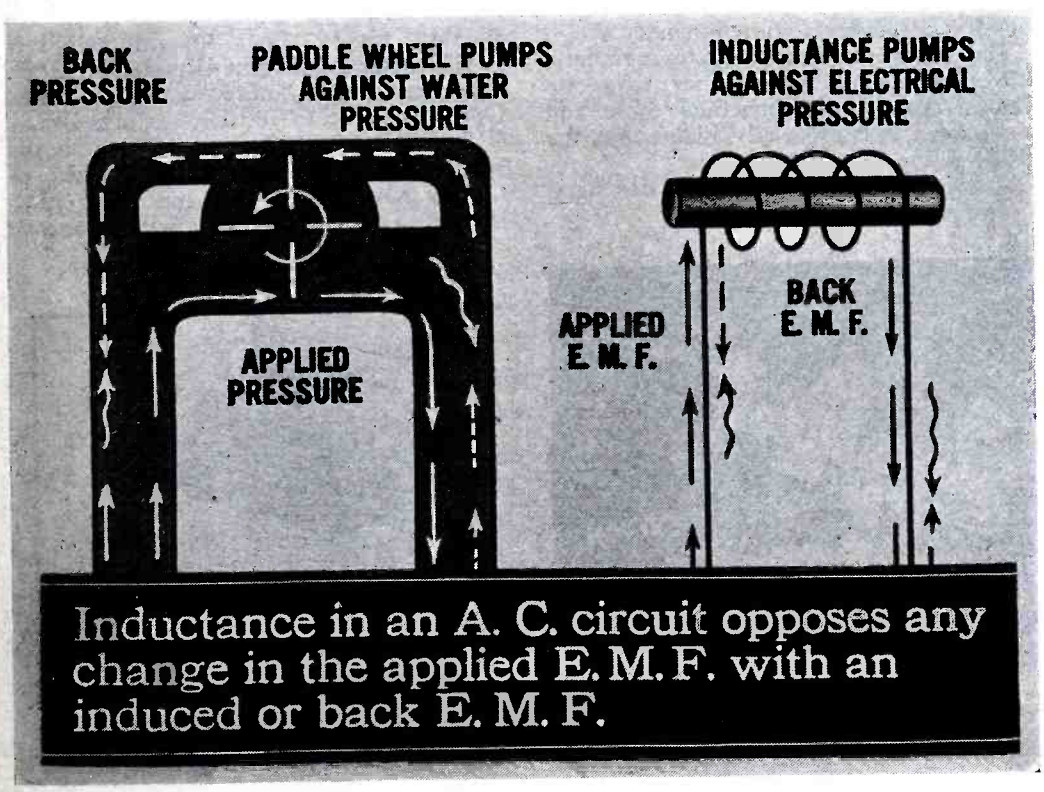
In addition to providing an approved *pattern* for conducting a class in basic electricity, these slide-films have other uses in the radio field. They can be projected on wall, ceiling or floor of workshop, giving the individual a visualized *pattern* of procedure in any job he is doing, in which he may find a *refresher* necessary. Or, the individual student can use the films as a refresher course even after completion of the course itself.

The usual procedure is as follows when films of this type are correlated with or integrated with the course . . . (*a*)—Introduction of the subject of the lesson by leader or instructor, including his own ideas. (*b*)—Projection of the film with pause as the instructor reads the captions slowly aloud—from the screen. (*c*)—General discussion of the subject, ques-

(*Continued on page* 83)



At right, a section of slide-film showing sequence of presentation in the study of alternating current. Below, an enlarged view of one of the slide-films used in the study of a-c.



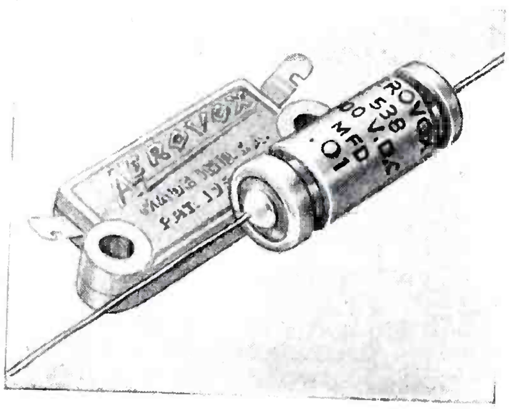
THE INDUSTRY OFFERS

TINY OIL-IMPREGNATED OIL-FILLED CAPACITORS

Ultra-small oil-impregnated oil-filled capacitors for use in assemblies where both space and weight are at absolute minimum, have been announced by Aerovox Corporation, New Bedford, Mass. Originally designed as metal-cased alternates for mica capacitors, these oil tubulars (Type 38) are now being used for newly-designed equipment.

Metal case on the unit is capped by an Aerovox double-rubber-bakelite terminal insulator assembly. Units are available with both terminals insulated or with one terminal grounded to the case. Terminals are pigtail type.

Normally supplied without outer sleeve, but can be had with insulating jacket adding 1/16" to diameter and length. Sizes are 1" and 1 3/16" long, 5/16 and 7/16" diameters. Castor (Hyvol) or mineral oil impregnant and fill; 300 to 800 volt, d-c, working. Capacities range are from .001 to .01 mfd.



* * *

WHITE PENCIL TRACING CLOTH

An improved white pencil tracing cloth, *Whitex*, has been developed by the Frederick Post Company, Box 803, Chicago, Illinois.

The material is said to be moisture resistant on both sides.

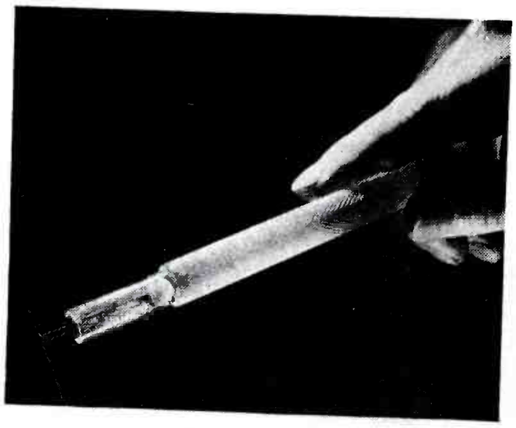
Glass-like transparency is said to be another feature.

Samples of this new white pencil tracing cloth can be secured by writing on letterhead stationery.

* * *

PLASTIC WRENCH

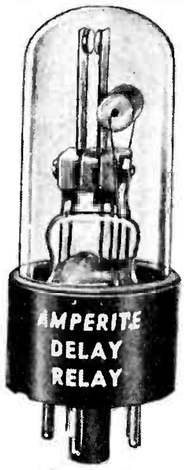
A wrench made of light-weight plexiglas and designed for assembly operations on radio equipment has been developed by Wells-Gardner Company, Chicago, and the Klise Manufacturing Company, Grand Rapids, Michigan. The wrenches are used for tightening hexagonal nuts in aligning intermediate frequency coils.



AMPERITE THERMOSTATIC DELAY RELAY

Delays from 1 to 100 seconds are said to be possible with a new thermostatic delay relay, developed by the Amperite Company, 561 Broadway, New York City. The relay is compensated for ambient changes of —40 to +100° F. It can be furnished in single pole, either normally open or normally closed. Contacts are capable of handling up to 12 amperes, 115 volts a-c or d-c.

The unit is hermetically sealed in an inert gas to assure clean contacts at all times. Replacements can be made easily. Fits standard octal radio base.



* * *

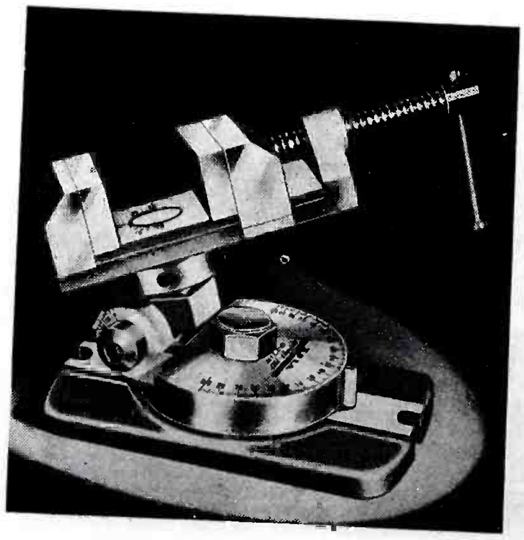
DRIV WHEEL MOVEMENT VISE

A Hilco all-angle driv-wheel movement vise has been announced by the Berco Manufacturing Company, 429 West Superior Street, Chicago. It was designed and engineered by the industrial engineering firm of Melvin Douglas & Associates, Chicago.

Features include a patented drive wheel motion which gives 2¾" lateral clearance; double swivel construction which permits any horizontal position; right angle clearance which allows perpendicular position without base obstruction; positive horizontal setting for highest 180 degree accuracy; elimination of excess chucks, many other machine tools and bench use. It is especially adapted for the Hilco universal cutter-grinder.

The vise is recommended for grinders, drill presses, milling machines, magnetic chucks, many other machine tools and bench use. It is especially adapted for the Hilco universal cutter-grinder.

There are three sizes: 3½", 4½" and 6" jaw widths.

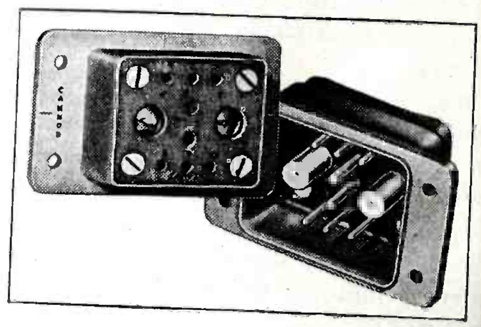


CANNON CONNECTOR

A rack type connector, DP-B, is now being made by Cannon Electric Development Co., 3209 Humboldt Street, Los Angeles, Calif.

Differing radically from the standard round or oval faced connectors, the DP-B is rectangular and is so designed to fit rack equipment. The shell is tapered to effect a close fit when engaged and the two units of the complete connector are self aligning, but are dependent upon the accuracy of the equipment it connects.

The insert insulation is made of molded phenolic, having eight standard contacts of brass, silver-plated, and two coaxial contacts of the same material and finish, with isolantite insulators. Two contacts are 30 amp. and six are 15 amp. Shell is die-cast aluminum alloy, with sand blast and clear lacquer finish. Four mounting holes have diameter of .144 countersunk for No. 8 flat head machine screws. Weight of receptacle .276 (lbs) and plug .266 (lbs).



* * *

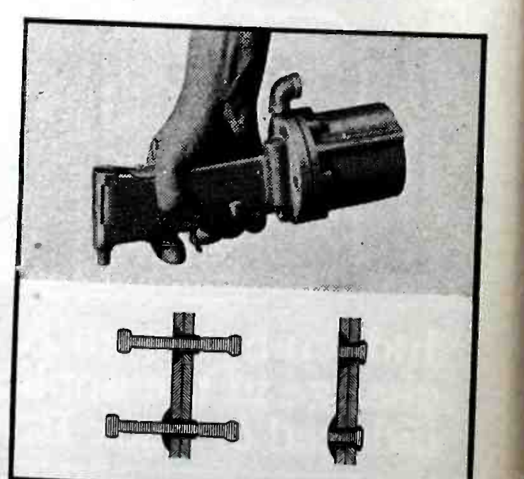
CHERRY RIVET POWER GUN

For the high speed application of Cherry Blind Rivets in double surfaced structures, where access to one side of the work is obstructed, Cherry Rivet Company, 231 Winston Street, Los Angeles, Calif., have developed a power gun, G-15. Tests are said to show that Cherry Rivets can be installed at a rate of 1600 per hour with this tool.

This new gun is all-pneumatic. Cast aluminum, steel, and bronze are used in its construction. Hose connections are standard for ¼" lines. Overall height is 10⅝", with maximum diameter of 3⅞". The gun weighs approximately 4½ lbs. Operates on 75 to 100 lbs, psi pressure.

Three interchangeable pulling heads handle the three standard diameters of Cherry Rivets, 1/8, 5/32 and 3/16, either hollow or self-plugging types. Clearance

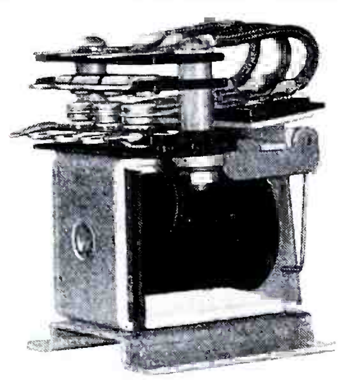
(*Continued on page* 58)



RELAYS BY GUARDIAN

★ **Today they are off the air . . . voices stilled . . . home-built rigs carefully covered. For most of yesterday's "hams" are lending their experience, knowledge, and ingenuity to the war effort . . . creating and perfecting new communication devices . . . the amazing new flight recorder, for instance . . . or Radar. But whether they work in a wartime lab or have their "office" in a Fortress, they are still close to one of their early friends—"Relays by Guardian".**

One of the newer developments is a multi-purpose aircraft radio relay pictured at the right. It is built in contact combinations up to three pole, double throw. Coils are available in resistances from .01 ohm to 15,000 ohms. At 24 volts DC it draws 0.12 amperes. This relay is also built for AC with a contact rating of 12½ amperes at 110 volts, 60 cycles. Standard AC voltage is 92-125 volts but coils are available for other voltages.



Aircraft Radio Relay
DC Model—Bulletin 345
AC Model—Bulletin 340

Write on your business letterhead for these new bulletins: B-8, Six pages of Aircraft Contactors—195, Midget and Signal Corps Relays — B2A, Aircraft Relay — SC65, Solenoid Contactor.

GUARDIAN G ELECTRIC

1623-G WEST WALNUT STREET CHICAGO, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

THE INDUSTRY OFFERS . . . —

(*Continued form page* 56)

around the rivet axis is 3/8". The tool operates equally well in any position.

* * *

WARD LEONARD AIRCRAFT POWER RELAY

For aircraft power circuits, Ward Leonard, Mount Vernon, New York, has designed the bulletin 103 relay. The armature and contact assembly are said to be designed to retain either position under high values of acceleration of gravity and shock and vibration conditions.

The normally-open, single pole contacts are rated 25 amperes at 24 watts d-c non-inductive load, with good characteristics on inductive loads. The contact gap and tail spring tension are adjustable.

Molded bakelite nearly 3/8" thick forms the base measuring 1 3/8" x 3 1/8". Two holes are provided in the base for mounting.

Complete data is contained in bulletin 103, available on request.

* * *

PRECISION TYPE RESISTORS

Slotted-terminal, wire-wound high-accuracy resistors for precision apparatus are now being made by Instrument Resistors Company, Little Falls, N. J.

Two types, P-2 and P-4, are available. Type P-2 has one-half watt rating with a maximum resistance of 500,000 ohms. It is 9/16" long, with a diameter of 3/16". Type P-4, with a one-watt rating, has a maximum resistance of one megohm. Measurements are 1" by 3/16" in diameter.

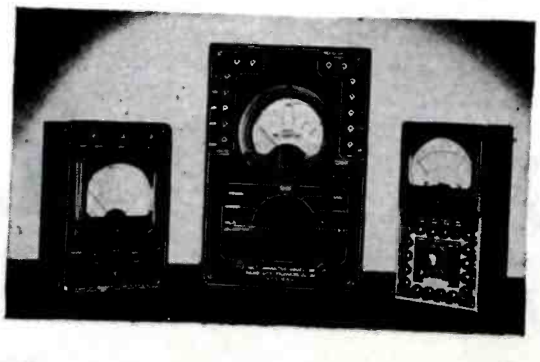
Terminals on both types are .025 hot tinned copper, slotted to take stranded or solid wire. Mounting is permitted by No. 6 holes through centers of bobbins.

* * *

NEW RCP TEST INSTRUMENTS

Three new test instruments, a pocket-size multimeter, output meter and volt-ohmmeter have been developed by Radio City Products, Inc., 127 West 26th Street, New York City.

The compact multitester, model 442, has a 200-microampere movement and a sensitivity of 5,000 ohms per volt. There are four d-c milliammeter ranges: 0-0.3-6/30/150 (with a first scale division of 5 microamperes); four d-c voltmeter ranges: 0-6/150/300/1500 (with a first scale division of 0.1 volt); four a-c voltmeter ranges: 0-6/30/150/600 (with a first scale division of 0.1 volt); four output voltmeter ranges: 0-6/30/60/150/600, and four decibel ranges from —6 to +50 db. The output meter, model 471, a rectifier type a-c voltmeter has an output meter, with a constant impedance of 4,000 ohms. All resistors are precision wire wound, and said to be accurate within 1%. Five voltage ranges are available by turning a selector switch: 0-1.5/6/15/60/150. A self-contained condenser for blocking and d-c components is connected to separate terminals.



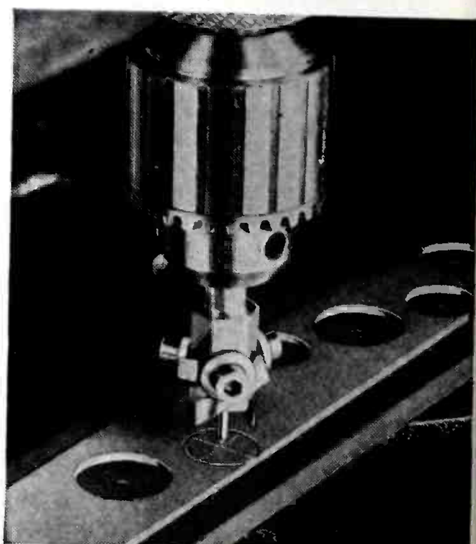
The volt-ohmmeter, model 481, has a meter sensitivity of 50 microamperes. The d-c voltmeter readings are from 0.1 to 1,000 volts, d-c milliameter readings from 0 to 100 milliamperes; resistance measurements range from 0.1 ohms to 10 megohms. Energy for resistance measurements is supplied from self-contained batteries.

* * *

ADJUSTABLE HOLE CUTTER

A three-blade adjustable hole cutter is now being produced by the Robert H. Clark Company, 3424 Sunset Boulevard, Los Angeles, California. The manufacturer states that the cutter will stand the wear and strain of heavy drill press operation and is well suited for use in portable air motor drills.

The cutter is said to cut precision holes from 1" to 5" in diameter and up to 1" in thickness of metals, plastics, hard fiber, pressboard and on uneven surfaces. Sizes are available for use in hand drills, pneumatic motors, milling machines, drill presses and lathes. It is said that the cutter eliminates the necessity for boring and reaming a hole because of the precise, clean cut it produces on the first attempt. Shank of the tool is heat treated. The three tool bits are made up of high-speed steel, precision ground. The hardened and ground pilot can be removed so that a lead drill may be used in drill presses.



* * *

MASTER STATION AND SUB-STATION UNITS

Master station and selector type sub-station units are now being made by Talk-A-Phone Manufacturing Company, 1219 West Van Buren Street, Chicago, Illinois. The units are said to provide private conversation between each other without interruption or eaves-dropping by the remote stations, and, in addition, communication with the different sub-stations at will. Any master station may also have a private sub-station with which no other master can communicate or listen in on.

With the new innovation of selector type sub-stations, outlying stations can now select the master to which they wish to speak and originate the call. Thus a completely flexible inter-office communication system may be had with instant

(*Continued on page* 62)


FIRST in Custom-machined PLASTICS
CANVAS BAKELITE
POLYSTYRENE
DUREZ
CATALIN
*BAKELITE
MATERIAL: LUCITE
O.D. ½" + .0005 − .0000
INTERSECTION OF CROSSLINES WITHIN .001 OF CENTER.
WIDTH OF LINES .004
LAMINATED BAKELITE
EBONY ASBESTOS
PLEXIGLAS
VULCANIZED FIBRE
FIBRE
LUCITE
SOLVED by BRILHART
TENITE
LINEN BAKELITE
BRASS AND POLYSTYRENE MOLDED TOGETHER
Daily the BRILHART Company through its wide experience and engineering skill breaks new bottlenecks on the war production front in PLASTICS.
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VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

Scholarships

J. R. POPPELE, chief engineer of WOR-Mutual and chairman of our Marconi memorial scholarship committee presided over the annual meeting of the committee in his office on July 7, 1943. Participating in the discussion were Dr. Zinn representing the American Institute of the City of New York; Joseph Kraus, to whom goes a great deal of credit for doing a large portion of the detail work in the contest conducted by his organization, Science Service, and William J. McGonigle, VWOA president.

Science Service together with the American Institute of the City of New York sponsor science clubs in high schools throughout the United States. It is through these facilities that an examination in mathematics and physics, the two most closely related subjects to radio in the high school curriculum, is conducted among the senior classes in the various schools.

The five top ranking contestants in the examination are then eligible for consideration for a Marconi memorial scholarship. The committee considers the mark the individual makes on the examination as well as his complete high school record. Each participant submits a short thesis on *Why I want to be a Radio Engineer* as well as an autobiographical sketch outlining his interests and hobbies. The committee carefully weighs each of the elements placing due emphasis upon the individual's previous interest and progress in radio experimentation and attempts to establish the degree of initiative and *drive* of each prospect.

This year the committee finds it possible, through the good offices of C. J. Pannill, president of R. C. A. Institutes, Inc., to present two Marconi memorial scholarships at RCA Institutes in a two-year general course. The need of an additional scholarship was found necessary because of the close ranking of the two leading contestants in all of the elements considered. In a tie for first place in the contest were Frederic Corbin Leiner, 17 years, graduate of the East St. Louis Senior High School, East St. Louis, Ill., and Francis Herbert Horne, 17 years, graduate of the Johnstown High School, Johnstown, Pa.

At a meeting of the Executive Committee of the Los Angeles-Hollywood Chapter VWOA. L. to R., Leroy Bremer, Dr. Lee de Forest, James Chapple, Richard Stoddard and Hal Styles, Chapter Chairman.

In second place was Lothar Schnitkin, 18 years, graduate of Brooklyn Technical High School, Brooklyn, N. Y. Our Association will present Mr. Shnitkin with a scholarship in the home study division of Midland Radio and Television School.

The presentation of the scholarships took place in a broadcast over WOR and the Mutual Broadcasting System on the anniversary of the death of Guglielmo Marconi, July 20, 1943. The presentations were made by our president with each of the winners acknowledging his acceptance. The program was opened and closed with the transmission of the historic letter "S" first intelligence ever to be transmitted across the Atlantic by wireless—by Ted McElroy, world's champion radio telegraphist.

Congratulations

OUR honorarv president Dr. Lee de Forest will be seventy years on August 26. Congratulations, Doc.

Doc is as busy as ever, as usual. He is developing diathermy equipment, as well as communication units for the government.

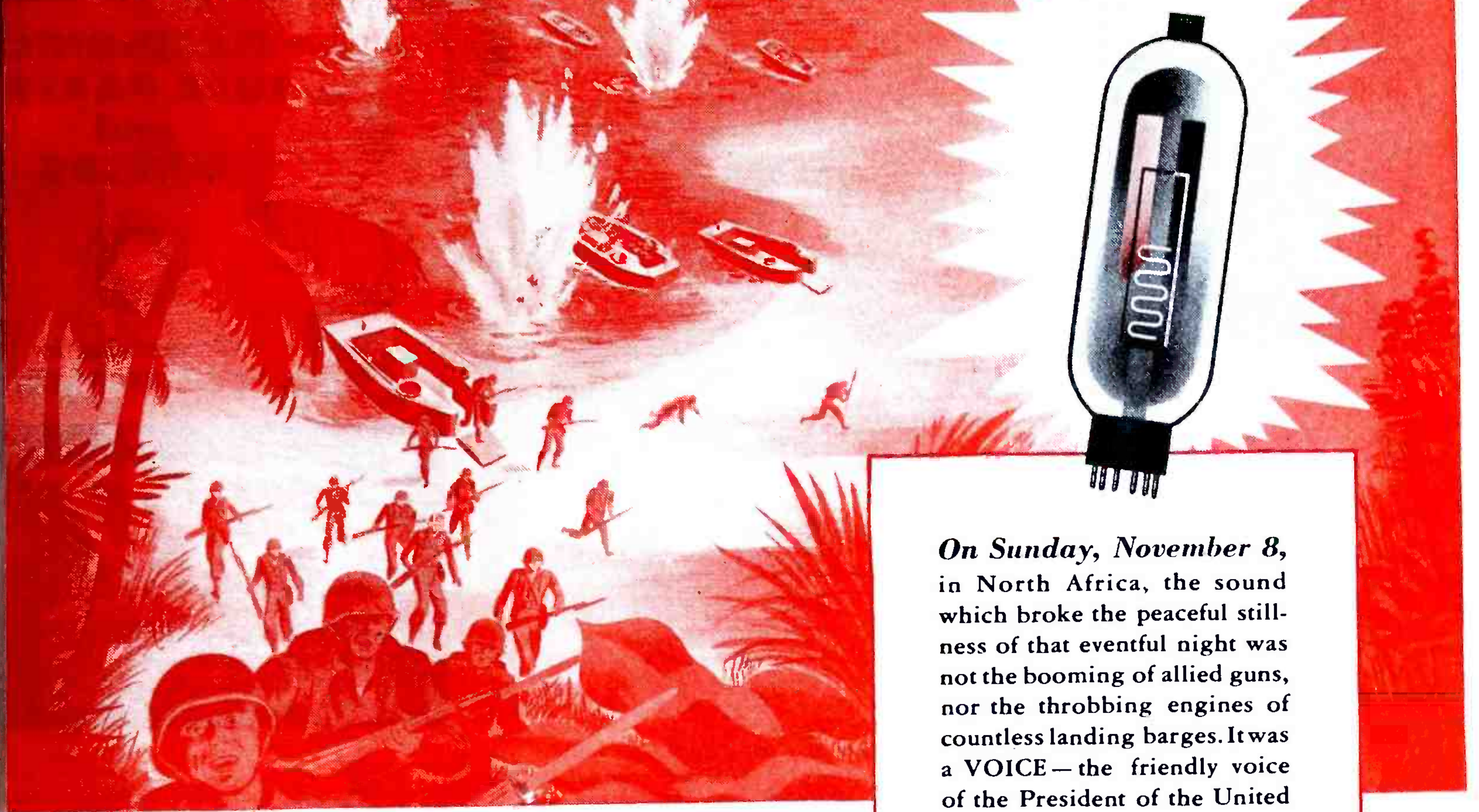
We, of course, are extremely proud to have Doc de Forest as our honorary president. We hope that next year it will be possible to have Doc present to personally accept our congratulations.

THE Veteran Wireless Operators Association extends sincere congratulations and every wish for success to Major General Harry G. Ingles who assumed the post of Chief Signal Officer of the Army on July 1, 1943. General Ingles' most recent post before becoming Chief Signal Officer was that of Deputy Commander in the European theatre of operations. He is 55 years old and a graduate of West Point, 1914. His Signal Corps experience dates back to the beginning of the last war during which period he did notable work. He has been a Signal Officer in the

(*Continued on page* 91)

Their guns were loaded and aimed ... yet

ELECTRONICS FIRED THE FIRST SHOT



On Sunday, November 8, in North Africa, the sound which broke the peaceful stillness of that eventful night was not the booming of allied guns, nor the throbbing engines of countless landing barges. It was a VOICE — the friendly voice of the President of the United States saying "We come among you to repulse the cruel invaders —Have faith in our words—Help us where you are able."

At many points where our boys landed along the North African coast there was little, if any, resistance because electronics had already won the day. By short wave radio America's motives had been made clear. Days of fighting were avoided. Thousands of lives were saved.

Distinguished service on many fronts has won the electronic tube a place among the great weapons of modern warfare. Yes, electronic tubes can *fight!* And to supply these fighting tubes for our fighting forces the men and women of National Union have doubled and *redoubled* production. We know the day is coming when these tubes and the knowledge which builds them will be reconverted to the needs of peace. In National Union's plans for this new age of electronics, there is to be a comprehensive industrial service . . . to aid engineers and production men in applying the miracle of electronics to their production, testing and packaging processes. Today, to the extent that present war work will permit, National Union invites consultation with producers of war goods regarding their electronic tube problems.

NATIONAL UNION RADIO CORPORATION • NEWARK, NEW JERSEY • LANSDALE, PA.

NATIONAL UNION RADIO AND ELECTRONIC TUBES

Transmitting Tubes • Cathode Ray Tubes • Receiving Tubes • Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Exciter Lamps • Panel Lamps • Flashlight Bulbs

THE INDUSTRY OFFERS . . . —

(*Continued from page* 58)

contact to all vital points without the use of a central switchboard operator.

Operation on the system is 110 volts, a-c/d-c. These systems are available in 10, 20, 30, 40, 50, etc., stations.

* * *

PLANT-BROADCASTING UNIT

A standardized and packaged unit for voice-paging and music broadcasting has been announced by the Operadio Manufacturing Company, St. Charles, Illinois.

The unit operates 20 to 40 loud speakers and covers an area of up to 100,000 square feet. The cabinet requires only 22" of floor space.

The control cabinet can be located near the telephone switchboard, or placed in any convenient location with connection to the microphone and key cabinet at the switchboard. Paging calls may be sent over the system while music is being played by means of an automatic control which decreases the music volume.

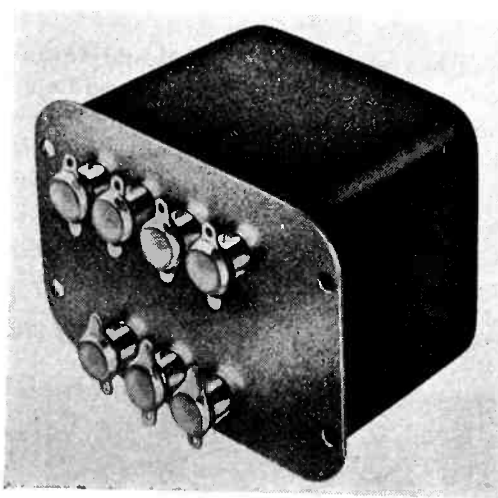
In the unit is an 8" p-m monitor speaker, automatic phonograph for 10" and 12" records, voltage amplifier and power amplifier. A dynamic microphone is also supplied.

* * *

HERMETICALLY SEALED TRANSFORMERS

A moisture and dust-proof transformer that is said to meet all Navy and other specifications for hermetic sealing has been announced by Peerless Electrical Products Co., 6920 McKinley Avenue, Los Angeles, 1, Calif.

Glass or porcelain insulators with metal bands are used. These insulators are soldered into the transformer case which is of cold drawn copper-plated steel. A Vac-sealing impregnation process that is said to insure impregnation without solvents or other deleterious material present inside the coil, is used. A special type of impregnant used, is said to cure completely under heat.



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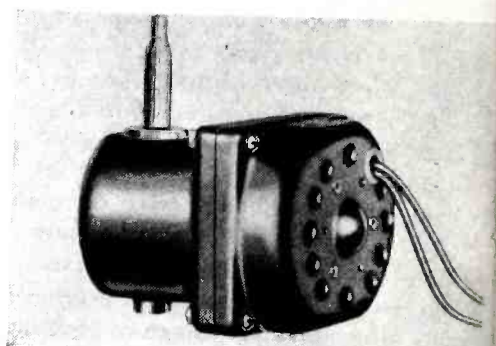
CONSTANT SPEED MOTOR

A small, self-starting, constant speed motor, that is said to maintain speed regulation under wide variations of voltage, load, and temperature, is now being made by the Rotom Manufacturing Company, Alhambra, California.

Measuring 4⅜" x 3⅛" x 3¼", this motor is available for operation on 110 or 220 volt, 50 or 60 cycle source at 14 watts input. Gears are of helical-cut laminated bakelite, and are completely enclosed and protected. Forced ventilation assures cool operation.

Shipping weight is but 5½ pounds.



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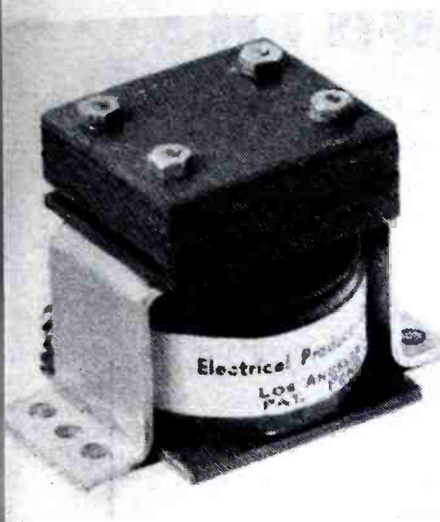
SEALED CHAMBER MIDGET RELAY

A sealed chamber is one of the safety features in the latest midget relay, produced by Electrical Products Corporation, Los Angeles, Calif. The sealed chamber is said to serve as an effective arc quench and effectively reduce fire and explosion hazards. While rated at 25 amperes, the new relay is said to operate satisfactorily at 50 amperes and is said to have been tested without failure at 120 amperes high inductive load. Overtravel spring is said to insure positive contact pressure and instant break release. It is tamper-proof, since it is factory adjusted and sealed. Reversible contacts is another feature of this new relay. If worn with excessive use contacts may be reversed in the field providing new surfaces without disturbing adjustment. Weight only 4.7 ounces.

Tests to which the relay has been subjected includes vibration of 55 cycles per second with .06" excursion;

eleration of 10 gravity units, and salt ay tests of 240 hours duration.



* * *

DRTABLE CABLE TAPE WINDER

tape cable in location, where standd factory cable taping equipment cant be used, the Leathem D. Smith Shipilding Co., Sturgeon Bay, Wisconsin, ve produced a portable cable tape nder.

The tool can be used without power with a standard portable electric drill r power. It is adaptable for different ze cables.

* * *

ELENIUM STACKS OW MADE BY G. E.

elenium rectifier stacks have been added the G. E. tungar and copper oxide ectifier line.

As is the case with other types of etallic rectifiers, the selenium stacks an be arranged to obtain higher current utput by connecting the stacks in parllel, and higher voltage ratings can be btained by connecting the stacks in eries.

An important advantage of the Selnium stacks is their light weight and mall size.

Mounting of Selenium rectifier stacks n equipment can be accomplished in varius ways. They can be bolt mounted or tud mounted directly to equipment asemblies. They are also available with nounting brackets of various types for onvenient assembly to panels, etc.

* * *

OHMITE CIRCULAR SLIDE-WIRE RHEOSTAT

A rheostat-potentiometer for low resistance low wattage applications, has been

(*Continued on page* 82)

NEWS BRIEFS OF THE MONTH . . .

WERS SCOPE BROADENED

The Federal Communications Commission has issued an order permitting the War Emergency Radio Service to go into action "during emergencies endangering life, public safety, or important property, for essential communications relating to civilian defense or national security."

Previously, WERS had been limited to operation "only during or immediately following actual air raids, impending air raids, or other enemy military operations or acts of sabotage . . . for essential communications relating to civilian defense." The previous order also only permitted WERS to operate during national emergencies, but only when normal telephone and telegraph services were disrupted. Under the new regulations, WERS will be able to operate in the event of floods, fires, hurricanes, riots, and other local emergencies, whether or not telephone and telegraph services were in working order.

* * *

POLICE TO HOLD WAR COMMUNICATION CONFERENCE

The annual conference of APCO will be held in Madison, Wisconsin, August 31, September 1 and 2. The conference was originally scheduled for Buffalo. However, due to the absence of Lawrence D. Geno, Buffalo supervisor and conference host, the plans were altered. Discussions of the serious manpower, equipment and radio interference problems that face police officials in this time of national emergency, will be featured.

* * *

RMA OFFICERS ELECTED

At the recent RMA meeting in Chicago, Paul V. Galvin was reelected president. Reelected as vice-president were Ray E. Sparrow and M. F. Balcom. Mr. Balcom heads the tube division and Mr. Sparrow, the parts division. R. C. Cosgrove was elected vice-president and chairman of the set division. Thomas A. White, newly elected vice-president, was also elected chairman of the amplifier and sound equipment division. W. P. Hilliard was also elected a vice-president. Leslie F. Muter was reelected treasurer and Bond Geddes was also reelected to his post of executive vice-president and general manager.

* * *

POLYTECHNIC INSTITUTE OFFERS NEW ESMWT U-H-F COURSE

A twelve-week course covering the advanced theory of ultra-short electromagnetic waves will be given at Polytechnic Institute of Brooklyn by William MacLean. The course will cover the following subjects: Giorgi or MKS system. Review of Maxwell's equations. Complex vectors and power and the complex Poynting vector. Plane waves (polarization by reflection, absorption in metals, depth of penetration). Introduction of Lorentz and Hertz potentials, retarded potential integrals. Radiation from antennas, directivity patterns. Transmission lines from wave viewpoint (propagation of higher modes, connection between circuit theoretical formulae and the principal mode of field theory). Wave guides, round and rectangular (modes and attenuation). Resonators (natural frequencies and Q).

FCC RELEASES LIST OF AVAILABLE OPERATORS

The available operators listing plan discussed by James Lawrence Fly at the NAB War Conference in Chicago (COMMUNICATIONS, May 1943) has been officially inaugurated. The FCC has already mailed to the War Manpower Commission and to interested groups in the industry, the names of first- and second-class radio telephone licensees who have reported themselves available for immediate emplqyment in essential communications jobs.

The list was prepared from responses to a postcard survey of a 1,000 of the nation's 20,000 licensed radio telephone operators.

* * *

STATIC ELIMINATOR DEVELOPED BY GOODYEAR

Gilbert J. C. Andersen, research physicist for Goodyear Tire and Rubber Company, has developed a new device known as *radio static neutralizer*. It was stated the device not only subdues static to the point where it no longer interferes with reception, but for the first time converts the electrical energy of the static into useful work.

"The device is not equal to f-m," Goodyear stated, "but can reduce or eliminate some kinds of static which baffle f-m."

The entire device, about 4"x2"x2¼", weighs less than six ounces.

No detailed data have been released.

* * *

GEN. INGLES NOW SIGNAL CORPS CHIEF

Major General Harry C. Ingles has succeeded Major General Dawson Olmstead as Chief Signal Officer. Gen. Olmstead resigned on June 30, at his own request. Gen. Ingles will automatically replace Gen. Olmstead on the five-man, policy-making Board of War Communications.

Gen. Olmstead will be military representative on the Telecommunications Board which functions under the Secretary of State.

Gen. Ingles has been a Signal Corps officer and a member of the general staff of the War Department in the Caribbean Defense Command, and later chief of staff of that command. He also served with Gen. Andrews as deputy commander of the European theatre.

WJZ TRANSMITTER TO BE MOVED

Permission to move the 50 kw transmitter of WJZ, New York, and its 25 kw auxiliary transmitter, from the NBC transmitter house at Bound Brook, N. J., to a separate WJZ transmitter house at Lodi, about 15 miles closer to New York, has been granted by FCC.

New short-wave transmitters will be installed in the vacated building, at the request of OWI.

According to James O. Weldon, acting chief of the Bureau of Communications Facilities of the OWI Overseas Branch, OWI would provide three of the new short-wave transmitters. The fourth unit will be built by NBC from components on hand.

* * *

GOULD ASKS FOR LIFTING OF BAN ON HOME DISCS

In an appeal to Ray Ellis, director of the Radio and Radar Division of the War Production Board, Sidney S. Gould, president of the Recording Corporation, has asked for a review of the home recording disc restrictions in Limitation Order L-265. In his request for this review, Mr. Gould stated that home discs should be exempted because "not a single item required for the manufacture of home recording discs needs a priority" and that "neither priority steel nor priority machinery is required to process" these discs.

* * *

NEW HEADSET FOR SIGNAL CORPS

In view of the peculiar construction of new helmets worn by American soldiers, Signal Corps engineers in association with engineers of private industry have developed a compact flat-type headset, which fits under the helmet. An interesting feature of the new headset is a soft plug which fits into the orifice of the outer ear, thus eliminating outside noises. These inserts afford increased sanitation too, for each user receives a new insert with the headset issued to him.

The headset is said to have a very flat frequency response and can be used very effectively for both telephone and radio work.

* * *

AIEE ELECT OFFICERS

Nevin E. Funk, vice-president in charge of engineering, Philadelphia Electric Company, Philadelphia, Pa., was elected president of the American Institute of Electrical Engineers at the annual national technical meeting of the Institute that was held in Cleveland, Ohio. Vice-presidents elected were: W. E. Wickenden, Cleveland, Ohio; C. W. Ricker, New Orleans, La.; L. A. Bingham, Lincoln, Nebr.; J. M. Gaylord, Los Angeles, Calif., and W. J. Gilson, Toronto, Canada.

* * *

LAMINATED PLASTICS DISCUSSED AT INSTITUTE MEETING

A new era of peacetime consumer applications of laminated plastics appears to be on the horizon, according to Formica engineers and chemists who ap-

(*Continued on page* 68)

For more than 46 years the products of the hicago Telephone Supply Company have been the andard for high quality workmanship. From their ception in the engineering laboratories to the crafts-anship of the finished article, Chicago Telephone Supply products are planned for maximum performance and trouble-free long life. If you are a manufacturer of electronic equipment—all of the engineering skill and great production facilities of Chicago Telephone Supply Company are at your service.

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ELKHART ★ INDIANA

Manufacturers of Quality Electro-Mechanical Components Since 1896

F-M RECEIVER DESIGN

(*Continued from page* 15)

ment of the main tuning control over a considerable period of time. A vacuum tube voltmeter, reading limiter-developed bias, was observed for a maximum indication, when a carrier was tuned in. Frequency drift was indicated by a dropping of the meter reading. Re-tuning brought the reading back to its original maximum indication.

After the oscillator was changed to the low frequency side of the signal, the vacuum tube voltmeter was connected as before and the readings observed. Variation of readings were practically negligible from the moment of switching on the unit to over extended periods of observation. The only noticeable change noted could be attributed to fading in the band. Contrary to popular opinion we have found that fading does take place on f-m signals. However, as long as the signals do not drop below the point of adequate limiting, no ill effects will be noticed. When the reading on the tuner being analyzed did drop, no amount of retuning would bring it back to a previous maximum indication. Only the signal fading-in restored the indication to the original value.

Interchannel Noise Suppression

Noise found in the 42-50 f-m band was surprisingly great. Listening to the unit over a period of time indicated the need of some sort of interchannel noise suppression system.

A brief resume of the most common method of *squelching* may be of interest. A direct current amplifier control or "squelch" tube is used with its plate circuit common to the grid circuit of one of the audio frequency voltage amplifiers. The squelch tube normally operating at 10 to 50 volts, draws only a few microamperes. This plate current will provide an *IR* drop across the common plate audio grid resistor so as to bias the audio amplifier beyond or at plate current cut-off. This, of course, renders the audio system inoperative. A small negative voltage applied to the squelch tube with respect to its cathode (usually grounded), will usually cut off its plate current because of the low plate voltage used. This immediately removes the *IR* drop from across the common plate-grid re-

(*Continued on page* 76)

Figure 5

The middle section of the chassis showing condenser gang assembly. The polystyrene feed-through bushing can be seen beside the rubber grommets carrying the condenser leads to their respective coils beneath the chassis. The oscillator padder set screw can be seen below the smaller dial drum.

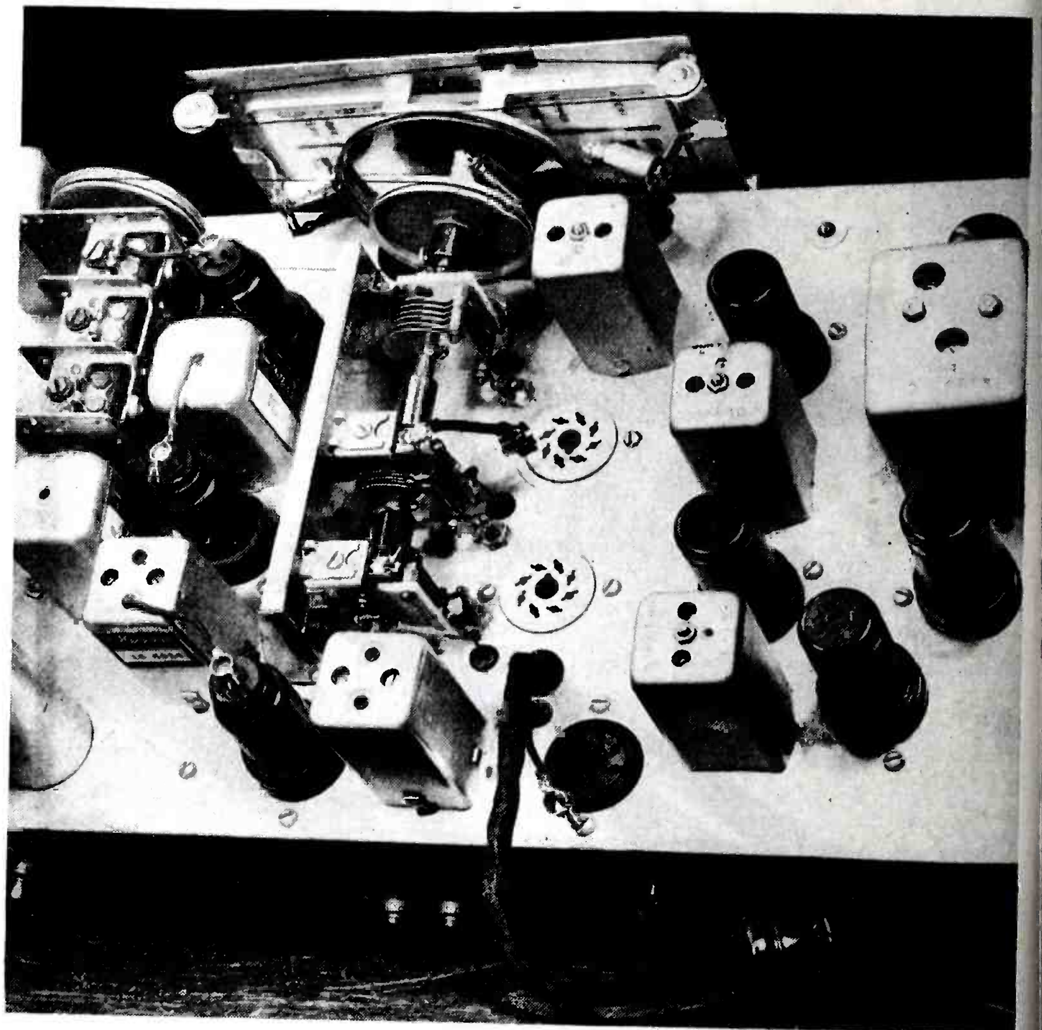
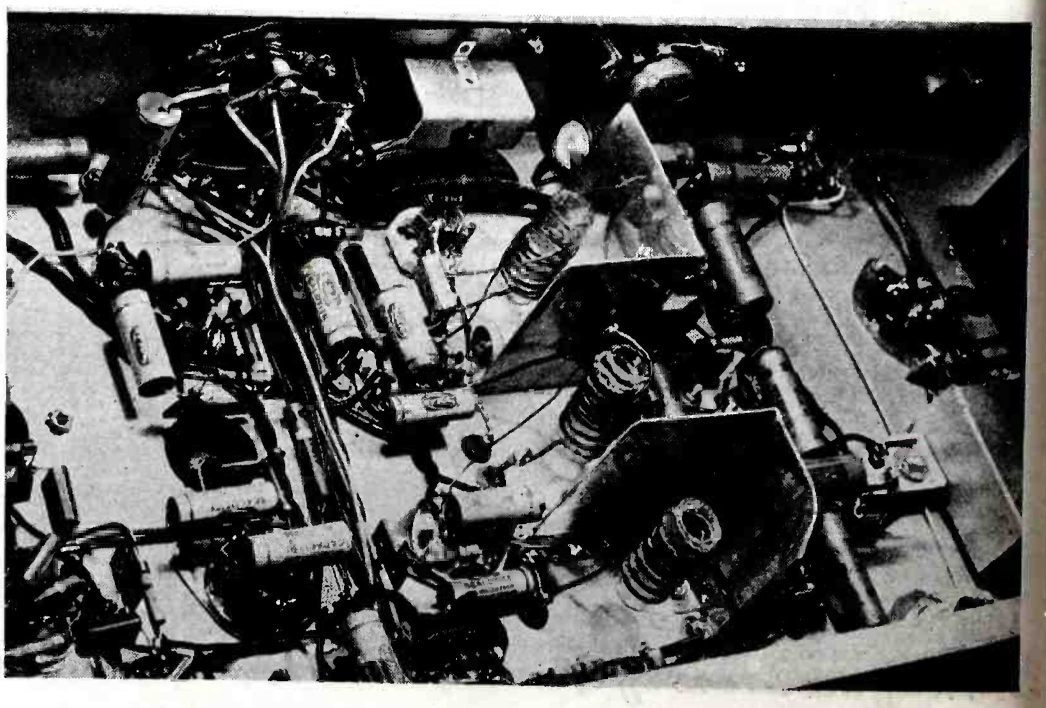


Figure 6 (below)

Bottom view of chassis showing r-f coil assembly. The oscillator coil and its air padder to the left is closest to the top. The inter-stage coil is in the middle, and the input coil is at the bottom. The negative temperature coefficient capacitor is seen directly over the air padder just underneath the oscillator plate dropping resistor.



NEWS BRIEFS OF THE MONTH . . .

(*Continued from page 64*)

peared at the recent annual meeting of the Ohio Mechanics Institute, Cincinnati, Ohio.

The program arranged by D. J. O'Conor, Formica president and board member of OMI, revealed that laminated plastics will be utilized in a variety of postwar applications with many new innovations. The two limitations namely color and heat resistance have been overcome to a great extent, thus eliminating a laminated plastic production problem.

* * *

J. A. BENNAN AND J. C. DALEY IN NEW JEFFERSON ELECTRIC POSTS

John A. Bennan, former president of Jefferson Electric Company, Bellwood, Illinois, has been elected chairman of the board. J. C. Daley was elected president and treasurer, and A. E. Tregenza, executive vice-president. James M. Bennan has been elected vice-president and general sales manager; A. A. Flick, Jr., vice-president, charge of manufacturing, and R. A. Hoagland, vice-president in charge of war contracts.

Four executive engineers have also been appointed: E. G. Goddard, in charge of commercial products; R. J. Horstmann, in charge of radio and electronic products; L. Mauerer in charge of design and development, and E. W. Rickmeyer, in charge of mechanical products.

The Jefferson Electric Company was founded in 1915 by John A. Bennan and J. C. Daley.

John A. Bennan

J. C. Daley

* * *

NEW CANADIAN REP FOR UNIVERSAL MICROPHONE

Atlas Radio Corp., Ltd., 560 King St. W., Toronto, 2, Canada, has been appointed exclusive representative for the Universal Microphone Co., Inglewood, Calif., for the Dominion of Canada and Newfoundland. D. Lou Harris is executive officer of the Atlas Corporation.

* * *

S. J. KESSLER LEAVES ROYAL EASTERN

S. J. Kessler, veteran radio sales executive, has resigned from the Royal Eastern Electrical Supply Co., New York.

* * *

HAYDU BROTHERS TO BUILD NEW PLANT

An additional plant will be built shortly by Haydu Brothers, Plainfield, New Jersey.

Established in 1930 by George K. and Zoltan Haydu, this company has specialized in the production of precision wire forms and metal stampings for the vacuum tube industry. Also produced in their factory are machined metal products such as burners for melting glass, nickel and steel ribbon wire, etc.

* * *

GIRL PLANS AND PRODUCES TELEVISION PROGRAMS

Helen Rhodes, a 1942 University of Michigan graduate, is now at WRGB, General Electric's television station in Schenectady, N. Y., as announcer, program planner and producer.

She creates, rehearses and directs wartime picture and sound programs transmitted to the Albany-Troy-Schenectady upstate area. Her work involves all the problems of radio, stage and movie production.

* * *

CBS ENGINEERING PERSONNEL CHANGES

H. A. Porter has joined the CBS maintenance department and Barney Zweig has been added to the short-wave studio as technician.

Dramin Jones, former staff technician for WABC's Columbia Island transmitter, is now assistant supervisor of the maintenance department, and Hugo Busch, formerly on the maintenance staff, is doing mechanical engineering in the construction and building operations department.

Additions to the apprentice training staff of the engineering department are Ralph Novick and Harry L. Side.

* * *

NEW ISSUE OF "GENERAL BOX"

A new 16-page issue of the *General Box* is now being distributed by the General Box Company of Chicago. This issue tells the story of heavy duty boxes, a new type of wirebound container, designed to combat the hazards of overseas transit.

* * *

WASHINGTON TELEVISION LICENSE REQUESTED BY DU MONT

Allen B. Du Mont Laboratories, Inc., have just filed with the Federal Communications Commission a request for the reinstatement of a commercial television station application for Washington, D. C. The station will operate on channel 1 or 50,000 to 56,000 kilocycles.

Du Mont now operates the New York television station, W2XWV, on a scheduled program basis, each Sunday evening, from 8:30 until almost 10:00.

* * *

NEW INTERNATIONAL DIVISION AT SYLVANA

An International Division with Walter A. Coogan as director, has been announced by Sylvania Electric Products, Inc. As part of its expanded activities, the International Division will include the operations formerly carried on by the foreign sales department.

* * *

ENGINEERING CO. EXPANDS

The Engineering Co., 27 Wright St., Newark, N. J., manufacturer of tube parts, has enlarged its facilities, with increased factory space. Daniel Kondakjian is president of the company.

* * *

HEROES TALK TO JENSEN RADIO EMPLOYEES

Two men, both of whom have been decorated with the Order of the Purple Heart for outstanding bravery beyond the call of duty, Fireman 1st Class Arthur W. Ambler of the U. S. Navy, and Sergeant John E. Barry of the U. S. Marines, spoke to employees of Jensen Radio, Chicago, Ill., recently.

Tom White of Jensen and the heroes who spoke to Jensen employees.

* * *

DR. J. J. PYLE IN NEW G. E. PLASTICS POST

Dr. J. J. Pyle, former group leader in charge of research and chemical development at G. E., has been appointed chemist in charge of the plastics laboratory succeeding Dr. G. F. D'Alelio, who has resigned from the company. J. W. Underwood was named administrative assistant to Dr. Pyle.

* * *

INSTRUCTION BOOK PRODUCTION DEPT. AT SUPREME PUBLICATIONS

A new department devoted to the preparation of instruction manuals, for manufacturers with government contracts, has been opened by Supreme Publications, 328 South Jefferson Street, Chicago, Illinois. The department will be under the supervision of M. N. Beitman.

* * *

SOUTH BEND 9" LATHE CATALOG

A twelve-page, file size catalog illustrating and describing 9" bench and metal column base lathes has been published by the South Bend Lathe Works, South Bend, Indiana.

These lathes are designed for machining small parts on production, toolroom, and general work. To facilitate their selection, tabulated specifications give information on capacities, feeds, speeds, and dimensions.

* * *

UNIVERSAL MICROPHONE INSPECTOR WINS BOND FOR BROADCAST WORK

Florence Hillstead, an inspector at Universal Microphone Co., Inglewood, Calif., was recently awarded with a war bond by Billie Burke for participating on Miss Burke's CBS program.

Mrs. Hillstead is active in Communication work in the Civil Defense Corps in Los Angeles.

* * *

REVERCOMB AND PLACE OF NAB ENTER SERVICES

Everett E. Revercomb, NAB auditor, has received a commission as ensign in the Naval Communications Division.

Russell P. Place, NAB counsel, has entered the Office of Strategic Services.

* * *

PEERLESS VICTORY CATALOG

A supplement to bulletin 430 covering a victory line of transformers has been released by Peerless Electrical Products Company, 6920 McKinley Avenue, Los Angeles, Calif.

* * *

NEW PLANT FOR NATIONAL UNION

To provide additional tube manufacturing facilities National Union Radio Corporation has purchased a modern plant in Robesonia, Pennsylvania.

* * *

RESISTOR-CONDENSER COLOR CODE CHART

A color-code wall chart with RMA resistor and condenser color codes and color code marking arrangements used by all resistor and molded mica condenser manufacturers has just been issued by the Radio & Technical Publishing Co., 45 Astor Place, New York City. The chart published in conjunction with the release of the 3rd Edition of *Radio Troubleshooter's Handbook* by Alfred A. Ghirardi, may be obtained by enclosing a 3 cent stamp to cover postage.

* * *

PIONEER GEN-E-MOTOR WORKERS IN ABSENTEEISM CAMPAIGN

In a public rally in Chicago, Pioneer Gen-E-Motor employees pledged their allegiance to a *Stay In The Safety Zone* campaign, to stop absenteeism and also reduce accidents.

The *Safety Zone* campaign was presented by David Bright, president of Pioneer Gen-E-Motor. Invited guests included

(*Continued on page* 70)

NEWS BRIEFS

(*Continued from page 69*)

Governor Dwight H. Green of Illinois; Colonel Paul G. Armstrong, Illinois Selective Service Director; Major General Henry S. Aurand, Commanding Officer of the 6th Service Command; Admiral John Downes, Commandant of the 9th Naval District, and Wilfred Hansford Gallienne, British Consul in Chicago.

* * *

NOISE DATA IN G. R. EXPERIMENTER

The latest issue (*June*) of the *General Radio Experimenter* carries an interesting analysis of vibration and sound. Sections 9, 10 and 11 of the discussion on sound are contained in this issue. They cover vibration and sound, the vibration meter and its use.

* * *

NEW SOLAR PLANT PAPER

The first edition of a plant paper known as *The Solar System*, has been issued by the Solar Manufacturing Corporation, Bayonne, N. J. The entire proceedings of the "E" presentation are illustrated and described in this first edition.

Shown too in this issue is the new Solar plant in the Mid-West that will be in operation shortly.

* * *

HALLICRAFTERS SENDS ANNIVERSARY GREETINGS TO SIGNAL CORPS

Congratulations to the United States Army Signal Corps on their 83d birthday, were sent recently by the Hallicrafters Company, Chicago, Illinois.

* * *

INTERNATIONAL NICKEL REISSUES DATA ON NICKEL IN RADIO

Two papers on nickel in radio, have been reissued by the International Nickel Company. One paper is by E. M. Wise covering an analysis of *Nickel in the Radio Industry* and published originally in the June, 1937, proceedings of the Institute of Radio Engineers. The other reissue entitled *The Properties of Pure Nickel* written by E. M. Wise and R. H. Schaefer, originally appeared in Metals and Alloys, September, November and December, 1942.

* * *

HARRY G. SPARKS, NOW PRESIDENT OF SPARKS-WITHINGTON

Harry G. Sparks, son of the late Captain William Sparks, has been elected president and general manager of Sparks-Withington Company, Jackson, Michigan. Mr. Sparks has been vice-president and general manager since 1936.

* * *

SYLVANIA BULLETIN ON 28D7 TUBES

An engineering news letter describing the performance characteristics of 28D7 tubes, in resistance and transformer coupled circuits, has been released by Sylvania Electric Products, Inc., Emporium, Pennsylvania.

Circuits using the 14R7 as a driver, triodes of the 14E6, 14A4 or 14N7, and transformer coupled drivers, are shown in this bulletin.

* * *

JOHN HABER DEAD

John S. Haber, vice-president of Philco International Corporation, died recently in Havana, Cuba.

* * *

FRY NOW NORTH AMERICAN PHILLIPS AD MANAGER

Harry E. Fry has become Advertising Manager of North American Philips Company, Inc., Dobbs Ferry, N. Y.

* * *

UNITED ELECTRONICS WINS "T" FLAG

United Electronics Company, Newark, N. J., has received a "T" flag for outstanding sales of war bonds. Harry Murphy, Deputy State War Savings Administrator, presented the flag to R. H. Amberg, president.

Max Rogel was in charge of arrangements and acted as master of ceremonies.

* * *

WALTER A. HOUGHTALING, DEAD

Walter A. Houghtaling, assistant engineer of Automatics of Western Union Telegraph Company until his retirement in 1938, died recently.

Mr. Houghtaling was one of the pioneers in the development of the Western Union multiplex system, which is used xtensively for long-distance trunk line elegraphy.

* * *

AMA ACCEPTS AUDIPHONE

The Western Electric hearing aid orthoronic audiphone has recently been accepted by the American Medical Association's Council on Physical Therapy for nclusion in its list of approved devices.

* * *

RCA TELEVISION BULLETIN

The evolution of television, as developed by RCA Laboratories, is told in an ineresting eight-page bulletin released by he Radio Corporation of America.

* * *

S. I. COLE ON RMA EXECUTIVE COMMITTEE

S. I. Cole, president of Aerovox Corporation, was elected a member of the Executive Committee of the Radio Manufacturer's Association, at its annual convention, recently held in Chicago.

* * *

V. K. ULRICH MARRIED

Vinton K. Ulrich, Engineer in Charge of War Activities for Hytron Corp., Salem, Mass., was married recently to Evelyn Haley.

* * *

DISCUSSING POST WAR

S. Gordon Taylor, Technical Editor, Office of Chief Signal Officer, Washington, D. C., and Burton Browne, of the Burton Browne Advertising Agency, Chicago, discussing post war planning.

* * *

FEININGER HEADS RESIN AND INSULATION MATERIAL DIVISION AT G. E.

A new division of the Appliance and Merchandise Department of G. E. to be known as the Resin and Insulation Materials Division, has been formed with E. L. Feininger as manager. The new division will be responsible for the manufacture, engineering and sales of insulating varnish, glyptal, varnished cloth and mica products.

* * *

PHOTOCOPY BULLETIN

A folder describing the latest photocopy machine of the American Photocopy Equipment Company, 2849 N. Clark St., Chicago, Ill., has just been released. Copies are available gratis.

* * *

PRESS WIRELESS NEWS

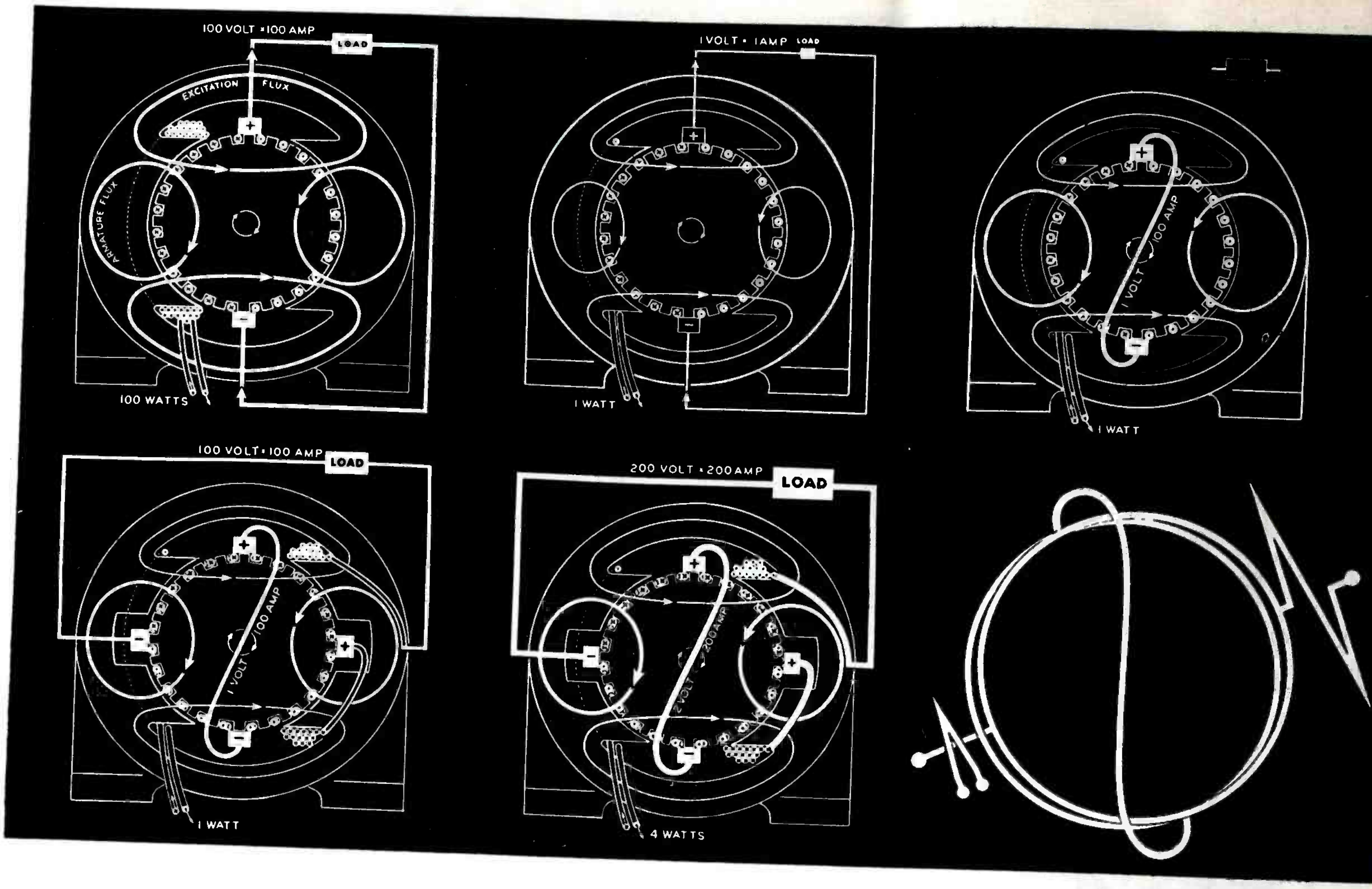
An interesting house organ known as the *Press Wireless Signal* is now being published by the staff of Press Wireless, Inc,. Hicksville, Long Island, N. Y.

* * *

AIRCRAFT ACCESSORIES OPENS NINTH PLANT IN KANSAS CITY AREA

Aircraft Accessories Corporation opened

(*Continued on page* 80)



Figures 1, 2, 3 (top row, left to right) and 4, 5, 6 (bottom row, left to right).

THE AMPLIDYNE

by FREMONT FELIX
Industrial Engineering Division
General Electric Company

ONE of the most important electrical developments of recent years is the amplidyne. Since its first application in the late 1930's it has improved many existing electric applications and made others practical which were not practical before.

The amplidyne is an externally-driven d-c generator, outwardly similar to a conventional motor or generator. But its ingenious and unique use of a short-circuit and compensating winding creates such precise electrical balance that an electrical signal as small as ½ watt will instantly release kilowatts of power capable of controlling the most powerful electrical machine. Figures 1 through 5 explain this unique principle of the amplidyne.

The D-C Generator

In Figure 1 we see a conventional two-pole 10-kw d-c generator driven at constant speed. For the sake of simplicity, the armature is shown serving also as commutator and a single exciting field coil is shown on the north pole. The small circles with dots show conductors where the current is directed towards the reader and the small circles with arrow tails show conductors where the current is directed away from the reader.

About 100 watts of excitation power supplied to the field coil creates the excitation flux. This flux is producing a full-load voltage of 100 volts, which circulates 100 amperes full-load current through the load, taken as a resistance of 1 ohm.

The load current, in flowing through the rotating armature conductors, creates a stationary armature flux because the armature conductors on the left of the brush axis always carry current in the same direction and the armature conductors on the right of the brush axis always carry current in the opposite direction. The combined effect is the same as that of a stationary solenoid, producing flux as shown in the left and right flux loops. This armature flux is of about the same magnitude as the excitation flux but it is not doing any useful work.

Utilizing the Armature Flux

Two questions arise: Can this idle armature flux be utilized? Can the excitation power, now too large for accurate control devices, be reduced to a point where small, fast response devices can be used, and yet release the same full output?

With a smaller field coil, and with excitation power reduced from 100 watts to 1 watt, the same conventional generator appears as in Figure 2. The new reduced excitation power creates only 1 per cent of the original excitation flux. Voltage at the brushes is reduced from 100 volts to 1 volt, and the load current, also reduced from 100 amperes to 1 ampere, produces only 1 per cent of the former armature flux.

Thus, one objective has been attained . . . excitation power has been reduced to a value where it can be

(*Continued on page* 74)

ONE *Expert* TO SEND THE MESSAGE

Miss Gertrude Theberge records results of 955 ultra-high-frequency performance tests.

ONE *Expert* TO PROVIDE THE EQUIPMENT

VR105-30 and VR150-30
gaseous voltage-regulator tubes

Specialists on the Factory Front must back up those on the Fighting Front. As an American, you would be proud to see at Hytron carefully trained girls holding down important supervisory and technical jobs, and displaying manual dexterity on fine work which a watchmaker would admire.

Here at Hytron we realize fully our responsibility for fashioning well the radar, radio, and electronic tubes upon whose performance the lives of our fighting men depend. To fulfill this trust, we have gone all out to train hundreds of new specialists capable of building to exacting standards countless dependable War tubes. That their skills may help bring closer the day when our boys come marching home, is the sole purpose of all Hytron employees.

Oldest Exclusive Manufacturer of Radio Receiving Tubes

Hytron ELECTRONIC AND RADIO TUBES **Corporation**

HYTRON RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

THE AMPLIDYNE

(*Continued from page 72*)

readily supplied and handled by precise control devices.

Restoring Working Flux

How can we restore full-load working flux and yet retain this low excitation power? A *short circuit* across the brushes, as in Figure 3, restores the armature current and consequently the armature flux to their full original values. This is because the internal resistance of the armature winding is assumed to be 1/100 of the load circuit resistance. The load has been disconnected. The excitation power and flux continue to be extremely small, but they now control the full-sized armature flux.

But the armature flux is still idle. Can we *harness* it, and put the armature back to work delivering full kilowatt output?

The Addition of Brushes

To put the short circuit to work, two new brushes are added, as in Figure 4, one in the center of each armature flux loop, just as the conventional brushes are located in the center of the excitation flux. Let us assume for a moment that these new brushes are not connected to any load and that we are only measuring the voltage between them. We had assumed in Figure 1 that the armature flux was of about the same magnitude as the full excitation flux in the same figure. The armature flux being full value produces full voltage, 100 volts, between the new brushes. We now connect these new brushes to the same load . . . one brush directly, the other through a compensating field shown on the south pole. Full current, 100 amperes, circulates through the load. In the same armature conductors, the new load current adds to and subtracts from the short-circuit current. This is shown by the four different combinations of *dots* and *tails* now seen on the armature conductors.

Note, however, that the new load current in the armature conductors cannot set up its own armature flux which would be directed from right to left because any tendency in this direction is neutralized by a compensating field of equal and, as shown by the *dots* and *tails,* of opposite strength. The output of 10,000 watts is released by an excitation power of 1 watt.

Assume that the excitation current is suddenly doubled (an increase from 1 watt to 4), Figure 5. This instantly doubles the short-circuit current, producing double output voltage (200 volts) and forcing double current (200 amperes) through the load. Thus, by merely raising the control input by three watts, output is raised from 10 kilowatts to 40. To obtain comparable changes in output in response to minute changes of excitation with conventional generators would require two generators—a small control signal would excite the first one; the output of the first generator would excite the second. The output of this second generator would considerably amplify the small control signal to the first one but with a cumulated delay in response.

Excitation

In the amplidyne, the equivalent of a full-size exciter (utilizing the same armature structure and conductors) is available to forcibly excite the output generator for fastest response. The speed of response of the amplidyne is further accelerated because the output flux is produced by the armature conductors from within the armature structure so that even the flux which leaks through the air produces useful voltage.

The symbol shown in Figure 6 graphically represents the amplidyne as two full-sized generators *compressed* into one. The minute control field and the short-circuited circle are identified with the first stage. The compensating field and the other circle connected to the load are identified with the second stage.

Amplification and Speed

The amplidyne provides an entirely new combination of amplification and speed. . . . two stages of amplification faster than any single stage could be.

Easy to work with, the amplidyne is in every outward aspect similar to a conventional exciter. All the user need concern himself with are the excitation input and working output. Because the amplidyne uses only the simplest laws of rotating electrical machines, and because there is practically nothing to wear out, it stays put. The bearings will last a lifetime, and the brushes which handle small currents will run a close second.

In Figure 6, we have shown the amplidyne as a two-stage amplifier responding to a single control field.

If several control fields, independently excited from signal devices, are placed on the same pole structure, the amplidyne will respond to their resultant action and amplify it in the same manner as for a single field.

The small space required by the individual coil makes is possible to have a normal complement of four fields permitting many independent functions to control the amplidyne output.

Each of these fields is easily adjusted by a small resistor or other means, and since their current requirements are so small, their action may be automatically blocked by small rectifiers as long as a certain operating condition or limit is not reached.

AIRCRAFT RADIO NOISE FILTERS

(*Continued from page* 42)

Equation (*7*) shows that within the approximations stated the laboratory test shows the effectiveness which the filter being tested would have in an apparatus circuit having the same value of Z_0 and Z_L.

It is generally more convenient to reduce the signal generator voltage in Figure 11*b*, filter removed, to give the same value of output voltage E_B as in Figure 11*a*, filter in. The effectiveness is then given by E_A/E_C which is the same ratio as E_{B1}/E_{B2}. This is demonstrated as follows:

Equation (*1*) becomes

$$E_B = E_A \frac{Z_1 Z_3}{Z_A Z_2} \qquad (1')$$

Equation (*2*) becomes

$$E_B = E_C \frac{Z_1}{Z_A} \qquad (2')$$

Combining these equations we obtain

$$\frac{E_A}{E_C} = \frac{Z' Z_2}{Z_1 Z_3} \qquad (3')$$

Referring to equations (*3*) and (*7*) it is evident that

$$\frac{E_A}{E_C} = \frac{E_1}{E_2} \qquad (8)$$

This relation enables the filter effectiveness to be determined from the signal generator voltage calibration, in which case the voltmeter on the output (E_B) is used merely as an indicator.

Bibliography

[1]*Methods of Measuring Radio Noise. 1940;* Report of Joint Coordination Committee on Radio Reception of EEI, NEMA and RMA. EEI Publication G9, NEMA Publication 107, RMA Eng. Bulletin 32.

[2]CC. M. Froust and C. W. Frick, *Measurements Pertaining to the Co-ordination of Radio Reception with Power Apparatus and Systems,* AIEE Conference; January 1943.

F-M RECEIVER DESIGN

(*Continued from page 66*)

sistor and removes the blocking bias from the audio tube, allowing it to function normally. Of course, some type of manual adjustment is necessary to provide for particular noise conditions. This control may be a bucking bias applied to the grid of the squelch tube or a simple plate voltage control to determine the exact value of negative control voltage necessary to reduce the squelch plate current to zero. The squelch may be tied to the avc line. In the basic unit, it was connected to the limiter grid circuit through a filter network.

Time Delay Necessity

Proper time delay is necessary so as to discriminate between random noise pulses and a constant carrier. Capacity from squelch plate to ground is usually satisfactory and its value is not critical. Values of .1 mfd to .25 mfd are typical. A large sustained noise voltage will open the squelch and appear in the output. On the f-m band only diathermy signals were found to operate the squelch; normal noise between carriers did not appear in the receiver output when tuning from carrier to carrier. The squelch circuit selected for our purpose was chosen after a number of others were tried. This circuit is very simple and utilizes a minimum number of components. The squelch level is adjusted by varying the plate voltage to the squelch tube. A 10,000-ohm wire wound potentiometer is part of the power supply bleeder connected at the ground end. To prevent the potentiometer itself from acting as part of the squelch plate resistor and to provide smoother action and a minimum of voltage changes in the receiver, the moveable arm was strapped over to the B+ end of the potentiometer. Since variation of the arm supplies positive voltage to the squelch plate and also to the audio grid, the audio tube cathode return is not brought to ground as is customary. By bringing the cathode resistor to the arm of the potentiometer, both the grid and cathode have the same positive potential applied. Thus there are no bias changes as a result of altering the squelch level. Bypassing brings the tube returns to proper ground potentials for signal frequencies.

For the improved model, we decided to have a completely separate receiver. Accordingly the f-m tuner was combined with a typical broadcast band superheterodyne and an audio system capable of taking advantage of the audio range available with f-m. Diode detection was used in the a-m section using a 6R7 duo-diode-triode. The triode section served admirably as the d-c squelch tube. Since squelching was desirable on a-m also, the 6R7 was tied into the avc line through the band change switch.

The 6R7 appeared more satisfactory than a 6Q7 for squelching purposes. Apparently, the lower mu 6R7 has a lower plate impedance than the 6Q7 at very low plate voltages and currents. The former tube provided adequate squelch bias across 150,000 ohms, while the latter tube required 500,000 ohms. It was felt that 150,000 ohms in series with the normal grid resistor of the audio 6SC7 would provide a more stable amplifier than with the 500,000-ohm addition method.

The squelch circuit added complications when the audio system was tried as a record playing amplifier. When reproducing records the B+ voltages were removed from the f-m and a-m tuners to prevent on-the-air signals from interfering with the recordings. This was done through a three-position a-m/f-m-phono-bandswitch. With no signal to provide control voltage to the squelch tube, the audio amplifier remained blocked and, of course, would not supply any output from the recordings. While a manual switch could have been added to the receiver, an automatic method was desired. A unique method solved this difficulty.

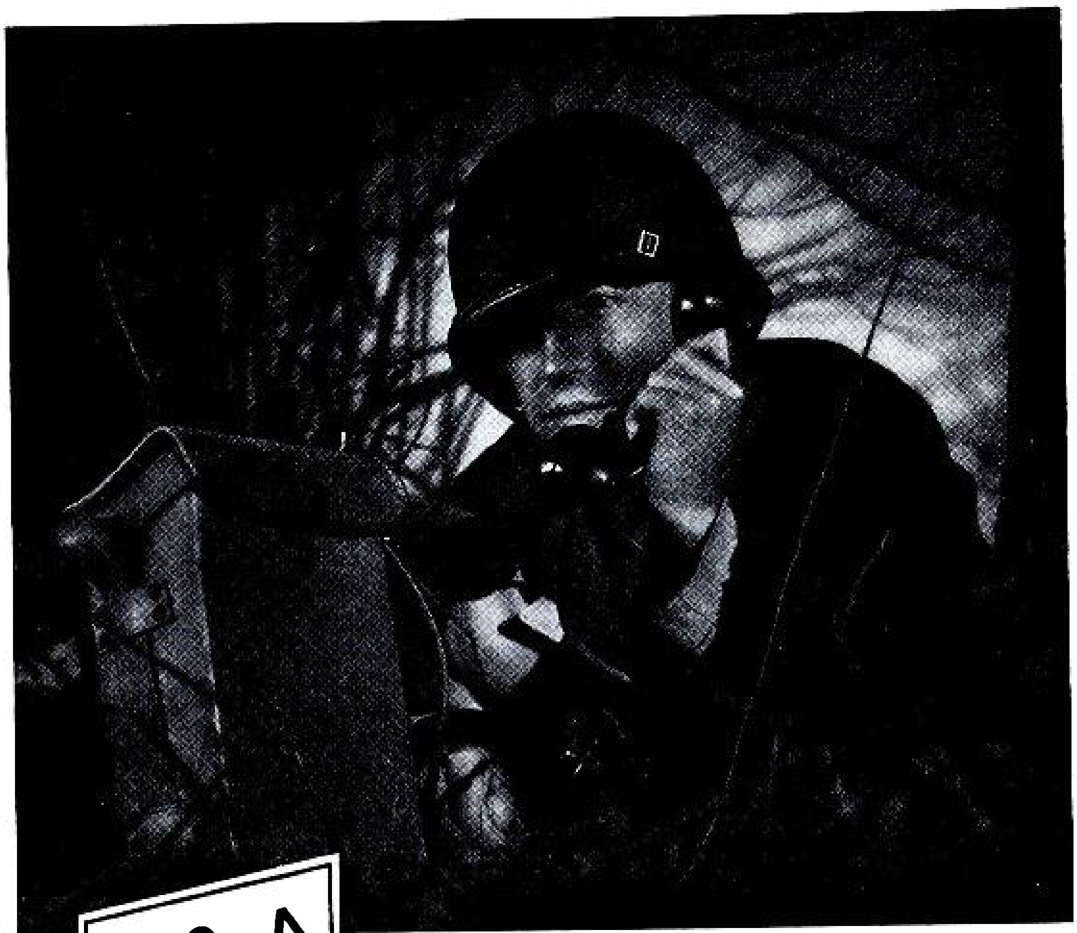
A negative bias voltage was available from the oscillator grid circuit that could control the squelch tube. The a-m oscillator was used for this purpose, feeding the bias through a simple *RC* filter of 1 megohm and 250 mmfd to the 6R7 grid, from the phone contact of the bandswitch. The a-m oscillator 6A8 operates at all times then, with the r-f and i-f stages being disconnected to disable the a-m tuner with the switch in f-m and phono position.

Audio System

While the audio system of the receiver used in conjunction with the tuner was a good one, full advantage of f-m transmission could not be obtained.

As stated previously, the power supply was of standard single phase, 60-cycle design, utilizing conservatively rated parts. Since chassis space had by now become rather limited, it became necessary to dispense with any ideas of high quality transformers. At least one interstage transformer would have eliminated some of the difficulties in obtaining the combination of those

(*Continued on page* 78)



(*Continued from page 77*)

qualities we felt were necessary in the audio amplifier.

These qualities were . . . a minimum of distortion, continuously variable bass and treble boosting, low hum and noise output, adequate audio output and a squelch circuit. A minimum of distortion pre-supposes push-pull output, push-pull input to the output tubes using a transformer or phase inverter and some form of inverse feedback. It was necessary to employ a phase inverter in this unit.

Difficult Problems to Solve

The problems of combining the phase inverter, inverse feedback and the squelch circuit functions, so as to involve no ill effects of one with the other, was the severest one to solve.

One of the troubles frequently encountered with audio frequency amplifiers, is thermal agitation and other noise components developed in carbon resistors. If these resistors are located in the circuits ahead of the volume control, then low volume settings of the gain control develop a poor audio signal-to-thermal noise ratio. Actually, a complete attenuation of the input signal still allows these noises to appear in the output.

It was decided, therefore, that the volume control be placed as close to the output end of the system as possible. Care was taken, however, to prevent the possibility of excessive signals from over-driving the audio stages before the control. Still, high enough gain was necessary in the stages after the control to provide sufficient output from the phono input.

In the f-m tuner, the limiters leveled out the signals suitably, so that this input did not fluctuate between wide unknown limits. In the a-m tuner, the avc could be depended on to keep the detector output fairly constant. Therefore for exceptionally strong a-m signals, an adjustable i-f cathode sensitivity control was mounted on the rear of the chassis.

In the improved model, the first audio frequency stage consisted of a tone boosting circuit. This circuit is a factor in preventing overdrive, since the detector output is considerably attenuated before being applied to the grid of the tube. The gain of this stage is approximately *one*, with all controls in minimum boost position. The only exception is the grid of the bass boost section. This tube is excited directly from the detector output and it would seem that overdrive were possible. However, this amplifier passes only the lower audio components, and the only chance for overdrive to this tube grid is at maximum bass boost. Under normal conditions of operation even with maximum boost, no signs of overdrive were perceived.

Booster Circuit

An explanation of the boost circuit may be in order. At minimum treble boost, the arm of the potentiometer is moved towards the grid, shorting out the .0005-mfd condenser. All audio frequencies are attenuated by the ratio of signal voltage across the 100,000-ohm grid resistor to the 500,000-ohm resistor. The grid is then excited from the voltage divider, and only one-sixth of the signal voltage from the input is available to the grid for amplification. At maximum treble boost, the arm is adjusted so that the .0005-mfd condenser shunts the half-megohm potentiometer. This combination will impress more of the higher audio frequency components on the grid, since the reactance of the condenser to these frequencies is small compared to the effect of the reactance for lower frequencies. This circuit affords a continuously rising response starting at about 3,000 cycles. At minimum bass and treble boost, the amplifier response is constant within 2 db from 100 to 12,000 cycles. Maximum treble boost affords approximately a 10 db rise at the higher end.

The bass boost circuit is a straightforward amplifier containing a low pass filter network in its plate circuit. The plate circuits combine the various audio components in accordance with the degree of adjustment set up by each potentiometer. To prevent distortion, the plates are not connected together directly for the combined output. This would allow each tube plate impedance to work into the other, causing each tube to operate into a load equal to half its plate impedance. The plate isolation resistors prevent this and allow greater output without distortion than would be possible without the resistors. Approximately 10 db boost is available around fifty cycles per second. It is entirely feasible to peak at a lower frequency by making the .02-mfd capacitor larger in value. However, it was felt that the .02-mfd unit afforded results more pleasing to the ear.

The ability to boost high frequencies is limited to the original quality of the signal. For any circuit that discriminates between the high and low frequency components of a complex signal such as voice or music, will favor the harmonics against the fundamental components. If harmonic distortion is present in the signal, boosting the highs will, of necessity, provide greater output for the distortion frequencies than for the fundamentals. Care must therefore be taken in adjusting the treble boost circuit. This defect is fundamental with all types of treble boost circuits and nothing can be done about it.

In the circuit used, sine wave input to the audio system showed no distortion in the output for maximum treble boost, the waveform being checked with the oscilloscope. F-m input through the tuner also indicated no waveform irregularity.

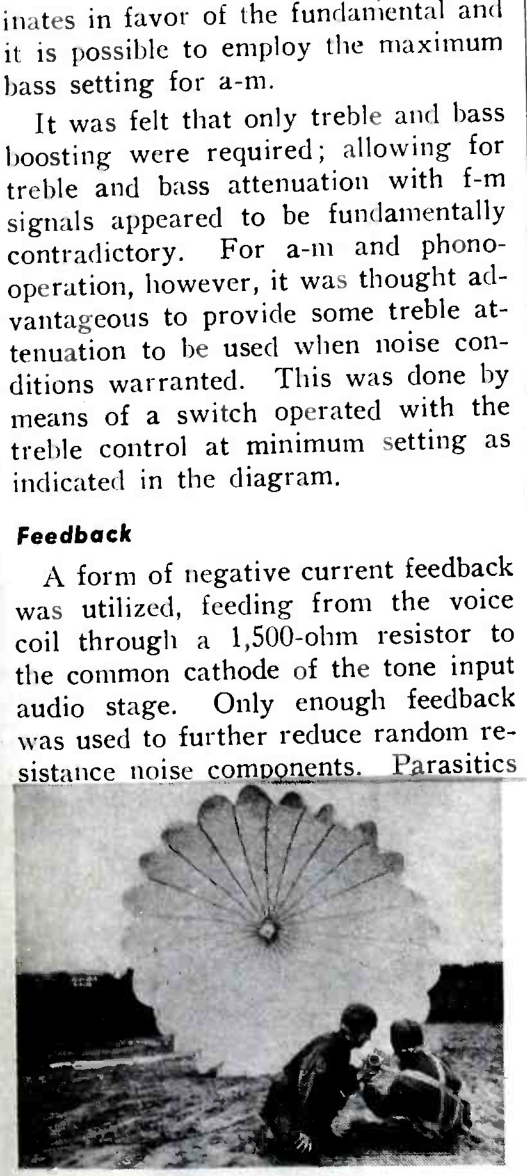
The a-m portion of the receiver was designed with no particular regard to wide band response. In fact, average or better selectivity was thought desirable. Due to the suppression of upper side band frequencies, the treble boost control is normally adjusted to a setting higher than used when listening to f-m. Because of possible phase shift in the a-m i-f stage plus some diode detector non-linearity, high order harmonic components are set up. It is therefore not feasible to utilize the maximum treble setting for a-m stations.

Conversely, bass boosting discriminates in favor of the fundamental and it is possible to employ the maximum bass setting for a-m.

It was felt that only treble and bass boosting were required; allowing for treble and bass attenuation with f-m signals appeared to be fundamentally contradictory. For a-m and phono-operation, however, it was thought advantageous to provide some treble attenuation to be used when noise conditions warranted. This was done by means of a switch operated with the treble control at minimum setting as indicated in the diagram.

Feedback

A form of negative current feedback was utilized, feeding from the voice coil through a 1,500-ohm resistor to the common cathode of the tone input audio stage. Only enough feedback was used to further reduce random resistance noise components. Parasitics



John Daly, reporter on the G.E. spot news program, during a recent broadcast.

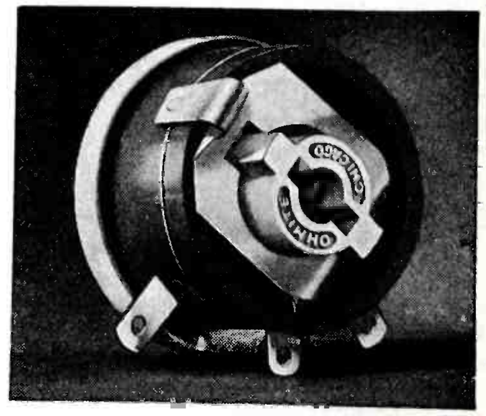
THE INDUSTRY OFFERS . . . —

(*Continued from page* 63)

designed by Ohmite Manufacturing Company, 4835 West Flournoy Street, Chicago, 44, Illinois.

A length of resistance wire is stretched tightly around the outside of a cylindrical core on the unit which is bonded to a ceramic base. The wire is firmly anchored to two terminals. Contact to the wire is made by a phosphor-bronze spring arm which is connected to a third terminal. The provision of three terminals allows the unit to be used as a potentiometer or voltage divider.

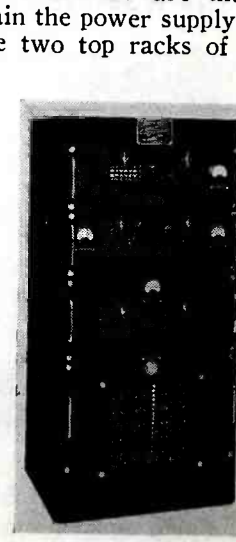
The maximum resistance which can be supplied on this unit is approximately 1 ohm while the minimum total resistance can be made approximately 0.1 ohm. Since the contact arm travels along the wire from end to end, the resistance variation is stepless. Shafts for knob control or for screw driver control can be supplied. These units are made to order to suit the particular application and inquiries on this basis are welcomed.



AIR ASSOCIATES TRAFFIC TRANSMITTERS

A new type of fifty-watt ultra-high frequency transmitter for airport traffic control is now being produced by Air Associates, Inc., 5827 West Century Boulevard, Los Angeles, 43, Calif., in addition to a similar unit for operation on low frequencies but convertible to ultra high operation. The ultra high frequency unit designated as model TUI, features file cabinet construction, with four racks mounted on ball bearing tracks. Frequency range is 126-132 mc, whereas the low frequency unit, designated as Model TMO, has a range of 200-400 kc.

External appearance of the two transmitters is identical. The two lower racks of each transmitter are interchangeable and contain the power supply and modulator. The two top racks of the low and



ultra-high frequency transmitters are the same size, and by removing the two racks from the model TMO low frequency transmitter and replacing them with the two racks designed for the TUI high frequency unit, the TMO is thus converted for ultra high operation.

Simplicity of servicing has been given the utmost of consideration in their design since they are required to operate 24 hours per day. Two crystals are provided with each transmitter, one active and the other ready for instant service should the active one fail.

SLIDE-FILM TRAINING

(*Continued from page* 55)

tions and answers; (*d*)—Second projection of the film, with pauses at prearranged points for detailed commentary, explanation and discussion. (*e*)—Summation of the subject by the instructor. (*f*)—Book study. (*g*)—Shop demonstration. (*h*)—Work projects. (*i*)—Examinations.

Slide-films have been found to be of the greatest efficacy in teaching any skill or vocation of the how-it-is-made, how-it-works, how-to-do-it variety.

In general, the slide-film medium is utilized for supplementing actual how-it-works and how-to-do-it instructions while motion pictures of the sound and silent variety have another purpose. They are superior in rousing interests and in revealing the importance and significance of the science and its role in industry, and everyday life. With a slide-film, the show may be interrupted at any point at will and the subject and pictured material discussed by the instructor and by the class itself. This is not such a simple matter with a motion picture which does not easily lend itself to stoppage.

For instance, there are pictures of this type available, supplementary to slide-film programs, such as *Have You See It,* which delineates, in sound and pictures, how and why you see a motion picture move on the screen. This film is one reel in length on 16 mm, and tells the story very simply of persistency of vision, and how it makes motion pictures possible. Animated drawings show how the image of an object is transmitted by the optic nerve to the brain, and how the image fades, instead of stopping abruptly when the object is removed from the field of vision. The construction and operation of the modern motion picture projector is also revealed while the commentator whose voice is recorded on the film itself, amplifies and explains.

Another motion picture of this type is called *Spot News,* and by the use

(*Continued on page* 95)

TRANSMISSION LINES

[*In the April, 1943, issue of* Communications, *Dr. Victor J. Andrew discussed transmission lines as reactors.*

We have received many requests for diagrams illustrating (1)—the method of installing the quarter-wave line up inside the tower where the insulated portion of the cable is just a quarter-wave long, and (2) the method of running the quarter-wave isolating line horizontally, parallel with the ground, with the ground as one of the conductors. These illustrations appear herewith.]

IN Figure 1, we have the method of installing the quarter-wave line up inside the tower, while in Figure 2 appears the quarter-wave isolating line diagram.

The latter method is used in feed-

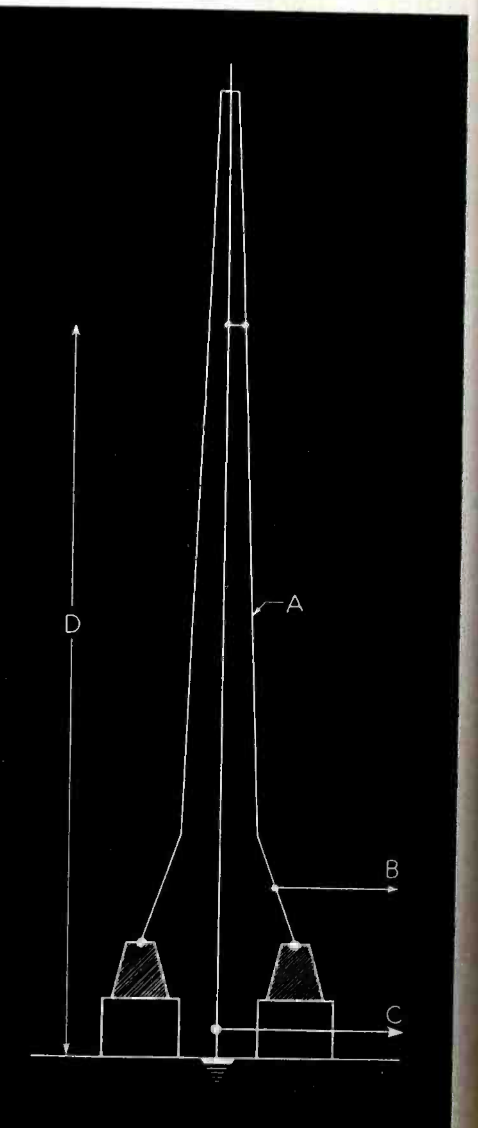


Figure 1
Here we have the method of feeding an u-h-f antenna atop a low frequency antenna without interfering with the performance of the l-f antenna. *A* is the l-f antenna, with *B* its feedline. *C* is the coaxial feeder for the u-h-f antenna. *D* represents a resonant ¼λ of *C* for the l-f antenna. Grounding the u-h-f coaxial feeder will have the effect of connecting a reactance across the base insulator of the l-f antenna, changing the antenna's resistance and tuning adjustments.

ng power to an f-m antenna on top of the standard broadcasting antenna at WSBT. In this installation, the f-m coaxial cable is 1⅜" in diameter. To reduce radiation and heat losses in the quarter-wave section of the transmission line, a ground return is not relied upon. Instead four wires are carried parallel to the coaxial cable and equally spaced in the usual five-wire transmission line construction. These wires are grounded at both ends and at each supporting pole.

Quarter-Wave Lines as Insulators

The use of these quarter-wave lines as insulators for tower lighting circuits or for u-h-f receiver or transmitter circuits for less than 1000 watts power is not recommended. From the performance they provide, simpler and smaller filters operate equally well. In addition they are much more economical.

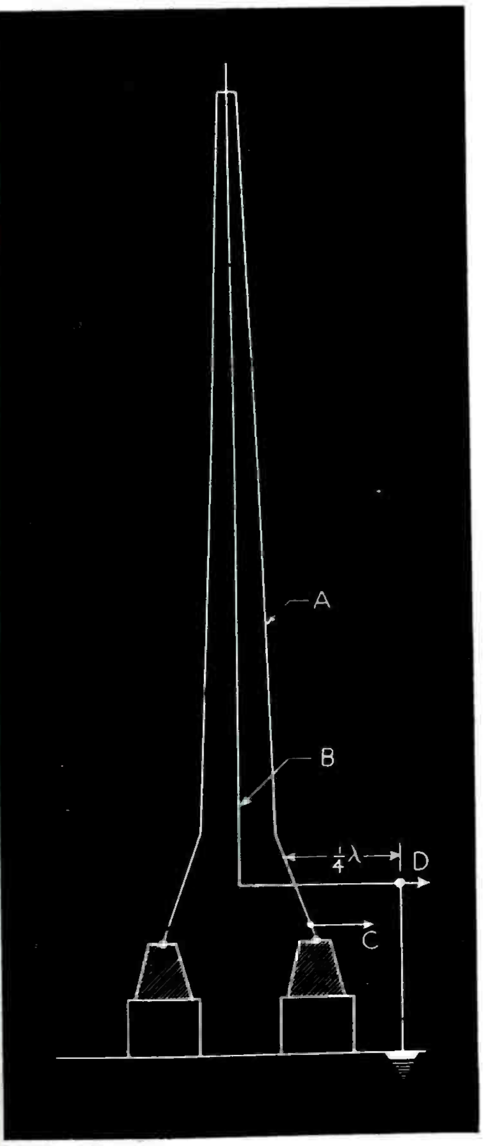


Figure 2

The method used to feed an f-m antenna atop a l-f antenna is shown here. The method used here is similar to that in Figure 1, except that the ground plane is used as one of the conductors. *A* is the l-f antenna, *B* is the coaxial cable feeder for the f-m antenna, *C* is the feed line for the l-f antenna, and *D* represents a ground point on the coaxial feeder ¼λ of the l-f for the horizontal portion.

RECIPROCAL SLIDE RULE

(*Continued from page* 16)

scale can be divided for other points between ∞ and *2*. For example, the division corresponding to *5*, the reciprocal of which is 0.2, would be placed at a distance of 0.2×400 mm or 80 mm from ∞. All points shown in Figure 1*A* have been computed in this way. The scale R_2 is simply the reverse of R_1, laid out from right to left instead of from left to right.

It will be noted that between ∞ and *5* in Figure 1*A* the points become rather close. It is convenient for greater accuracy in this region to use a second set of scales in which R_1 extends only from ∞ to *5*. Such a set of scales is shown in Figure 1*B*. This has been constructed similar to Figure 1*A*, but it uses a scale of 0.2 (reciprocal of *5*) equalling 200 mm. The scales of Figure 1*A* would be used for problems in which the combined resistance values are in the region of *2* to *5* and those of Figure 1*B* in the region of *5* to *20*. Of course, the decimal point can be placed where desired, as in a Mannheim rule, providing it is consistent on both scales R_1 and R_2. Thus, the scales of Figure 1*A* mentioned above can mean 20 to 50, or 200 to 500, etc.

One convenient way to use the scales shown in Figure 1 is to cut them out and mount them on strips of cardboard as shown in Figure 3. One strip is formed in a *V* shape, in which the other can slide. The *V* strip can be mounted on a piece of wood or metal to stiffen it.

Figure 3 also shows how the scales of Figure 1*A* are used to obtain the combined resistance of two resistors in parallel, 4 ohms and 20 ohms, or two condensers in series, 4 mfd and 20 mfd, $1/4 + 1/20 = 1/3.3$. We may have this problem to consider when we wish to learn the resistor that can be used in parallel with 4 ohms to obtain 3.3 ohms.

The rule also shows what other combination of resistors will give the required value. In this case it is seen that a combination of 5 ohms and 10 ohms will also provide a value of 3.3 ohms. This is probably the most useful application of the rule. Of course, more than two resistors can be combined by taking them two at a time. Continuing with this problem, we note that 40 ohms in parallel with 200 ohms equals 33.3 ohms or the decimal point could be placed as desired. It must be placed consistently in both elements of the problem.

The *reciprocal slide rule* can be used

(*Continued on page* 91)

TONE SELECTOR

(*Continued from page 20*)

control grid. Condenser-resistor values were chosen to give the proper delay action. The charge will leak off without reducing the plate current enough to release the relay, if the signal causing the reed to vibrate does not continue at least 5 seconds. This prevents operation by a chance musical note unless it is sustained for more than the 5-second period. This, along with the sharp selectivity of the reed, makes false alarms rare.

To adjust the reed to 1,000 cycles, it must be made large enough to resonate at some lower frequency, then carefully trimmed to bring the resonant point to 1,000 cycles. An accurate audio oscillator is almost a necessity for this work due to the sharp response of the reed. As a final check, the 1,000-cycle tone available from most broadcast station frequency monitors can be amplified and used to check the reed. Since this tone is accurate usually to within one or two cycles per second, it makes an excellent standard.

Reed Size

The size of the reed will depend somewhat on the material used. We cut one of the laminations of the choke used for the vibrator unit for this purpose. When completed and pruned to the operating frequency, the reed was ½" long and ⅛" wide. Before attempting the tuning, the approximate size was determined. Then a small silver contact was soldered to the tip to provide good electrical connection when the amplitude of the vibrations brings it in contact with the adjustable contact, which is also tipped with silver. The audio oscillator was then used to drive the 2A5 stage and the frequency varied to find the point of resonance. From that point careful trimming and filing brought the resonant point up to 1,000 cycles. The sharpness of the response can be partly overcome by increasing the input to the reed coil. However, even with a fairly heavy driving power, the reed will be completely insensitive to tones over 15 or 20 cycles from the resonant frequency.

Adjusting the Reed

In tuning the reel, if the frequency is found somewhat low, trimming as shown at *b*, in Figure 3 will raise the frequency. If the proper point is accidentally passed, the frequency can be lowered somewhat by filing and trimming as shown at *c*. The care with which this work is done will determine the number of attempts necessary to get a good reed.

A-C Relays Used

In Figure 4, the 115-v a-c operated relay has two sets of normally open contacts. One set is used to operate the alarm bell, and the other set used to keep the relay closed when it is once tripped. This keeps the alarm going until switch S_3 is manually opened to stop it. The 5,000-ohm relay will reset itself automatically as soon as the tone signal stops and the 57 tube begins to draw normal current.

Figure 2 Details

As the detail in Figure 2 shows, the reed is sweated into a thin saw slot in the laminations of the iron core. This provides a firm mechanical unit, though some other means of clamping it in place would doubtless serve.

BOOK TALK

(*Continued from page 53*)

reactance, resistance, power transformer design, etc.

This volume, with its wealth of data, is a handy book for student, technician and engineer to have around.—*O. R.*

PRODUCTION HELPS

Men and women on the communications production front are winning new laurels daily for their *speed up* contributions.

The saving of 350 pounds of copper and 450 manhours per year was effected recently by an interesting production suggestion of Charles Chudoba, a machinist at RCA. His suggestion covered a method of preventing burnt out coils on production heating equipment. He proposed enclosing the coils in fibre glass sleeves. This prevents sweat, oxide and scales from short circuiting the turns of the coils. The sleeves have been in use for three months without a single burnout.

Another interesting speed up contribution has been made by John M. Gillespie, electrician at Western Electric. He designed and constructed a small electric oven thermostatically con-

(Courtesy Westinghouse)

The Dynetric balancing machine shown above has proven to be an effective production aid. It provides for the balancing of rotors for motors while running at normal speed. With the aid of a stroboscope the operator sees the operation on the revolving rotor that is out of balance and reads the amount directly on a meter. By this method the exact location and amount of corrective mass necessary to eliminate vibration can readily be determined.

(Courtesy, Westinghouse)

The cathode-ray oscillograph is also an effective production aid. Here we see the device being used by W. E. Burkey of Westinghouse to study the path of an artificial lightning stroke through lightning arrestors under investigation. The lightning generator develops 60 kilovolt surges which are measured by the oscillograph.

trolled to provide an even heat in heating certain type crystals.

A new process of lapping electrodes mechanically instead of by hand, suggested by Gerald Thinnes of RCA, has saved many manhours. Electrodes were formerly lapped by hand with a production cycle of two minutes per electrode. The suggestion by Mr. Thinnes provides the lapping of 12 electrodes in ten minutes or approximately .8 of a minute per electrode. The electrodes are lapped in a method similar to that used in crystal production.

A new cable board to make cable harness assemblies, which has saved approximately 1,400,000 feet of critical wire, has been designed and developed by Ernest H. Kirkpatrick and Henry Scher of Philco. In the old method, wires were wrapped around nails and later cut to size and skinning. In the new method, wires are cut to exact length in an automatic wire cutting machine.

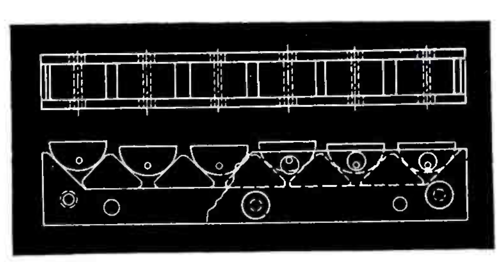
An interesting new use of the hectograph machine suggested by Mrs. Ann Keefe Drewes of RCA has eliminated a three-day wait for duplicate forms.

A universal pressure equalizer for clamping multiple pieces of different thicknesses which cannot be held in a standard clamping device has been developed by Daniel Wollpert of General Electric's radio transmitter planning department.

It is constructed with movable parts that allow pressure to be shifted and equalized across the face of the clamp. Multiple pieces then can be held tightly even though there is a variance in their thickness due to machining tolerances. An ordinary vise could not hold a multiple of pieces tightly enough for machining purposes.

The shifting of pressure is accomplished by allowance for movement of the equalizer parts, which consist of half-round and triangular pieces. When there is a difference in thick-

(Continued on page 91)



Universal pressure equalizer which holds different size pieces for milling, developed by Daniel Wollpert of General Electric.

SURFACE LINE SYSTEM

(*Continued from page* 50)

amplifier and limiter stage to a discriminator transformer and associated diodes. The a-c and d-c voltages across the load resistors are used to operate the kc modulation meter, a peak flasher circuit and the center frequency deviation meter.

The input is fed through the antenna to the control grid of a 6SA7. The injector grid receives a voltage from the crystal oscillator which is 6SJ7 operated in a frequency quadrupling circuit.

The modulation product of the crystal oscillator and signal frequencies is fed into an intermediate frequency amplifier and limiter stage whose resonance response is flat 40 kilocycles either side of the center frequency of 5 megacycles.

The discriminator transformer receives its voltage from the limiter stage and has practically a linear slope to plus or minus 35 kilocycles either side of 5 megacycles.

D-C Center Zero Meter

A direct current center zero meter is used as a voltmeter measuring the upset voltage across the diode load resistors. Since this voltage is a function of the displacement of the signal frequency, it may be calibrated in kilocycles off of resonance, indicating the carrier shift from assigned frequency.

A portion of the audio voltage developed across the diode resistors, when a frequency modulated wave is appearing in the discriminator network is applied to a linear vacuum tube voltmeter. The output is calibrated to read in kilocycles of excursion from the average or center frequency. When this excursion is sinusoidal with respect to time, the meter then reads the maximum excursion of any sustained modulation of approximately .4 of a second.

The flasher circuit operates on any peak voltage to indicate maximum excursion of very much shorter duration. This need not be of sinusoidal origin.

To keep resonance of the discriminator secondary on exact frequency, a 5-megacycle oscillator is operated, with some of the voltage fed into the i-f channel. This permits readjustment from time to time due to weather conditions or mechanical replacement.

Transmitter Features

In the main transmitter will be found provision for 80% filament voltage on the finals during standby, a switch for reducing plant voltage on finals during tuning, a switch for disconnecting the a-c supply to all units except receiver and modulate exciter, and provisions for readily placing the 50-watt modulated exciter having two 807's in parallel on the air, in the event of trouble in the high voltage system. A constant voltage regulating transformer is used on the 60-cycle supply to the transmitter.

Ground System

Each of the tower legs in the antenna at the fixed point is grounded with four 10-foot long ½" copper clad ground rods. Each is located 10 feet apart and connected by a copper cable to the steel base resting on individual reinforced concrete pads. A copper cable connected to one of the grounding cables extends up one leg of the tower to the point where the ⅞" coaxial feed line makes a bend to enter the transmitter room. At this point, this copper cable is sweated to the coaxial cable.

(The writer wishes to thank Paul Murray, chief radio engineer, Chicago Surface lines; Galvin Manufacturing Co.; Doolittle Radio, Inc., and Sola Manufacturing Co. for their assistance in the preparation of this paper.)

RECIPROCAL SLIDE RULE

(*Continued from page* 86)

for other non-electrical problems. For instance, it is possible to determine the conjufiate foci of an optical lens,

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}.$$

PRODUCTION HELPS

(*Continued from page* 89)

ness of the parts to be held, the half-round pieces shift their position and the triangular pieces shift into position behind them, holding the part securely.

The equalizer is primarily for milling and can be used with any standard or cam vise. It is adaptable for clamping either round or rectangular pieces as well as pieces with irregular surfaces such as castings. It can also be used as part of an assembly fixture. When used in a vise it is fastened securely to the movable jaw. The stationary jaw is then made to suit the shape of the parts to be machined and is spaced to match the equalizer.

DESIGN PRECAUTIONS FOR OSCILLATORS USING FILAMENT-TYPE ACORNS

EXPERIENCE with filament-type acorn tubes as oscillators in transmitting equipment has shown that, under some conditions of operation, oscillation may continue after the filament voltage has been removed unless the plate voltage is also removed. When the filament voltage is removed from an oscillator tube having particularly low filament power consumption, continued oscillation frequently takes place because of continued heating of the filament by the plate current.

Continued Oscillation Factors

Continued oscillation has been found most likely to occur . . . (1)—with a tube having high emission capability, (2)—with an exceptionally well-designed circuit, and (3)—with a high value of oscillator plate current; it has been observed with oscillator tubes operated at moderate values of plate voltage and current.

Filament Voltage Recommendations

Because of these results in the laboratory and in the field, it is recommended that both the filament voltage and the plate voltage of filament-type miniature, GT, and acorn oscillator tubes used for transmitter purposes be removed when equipment employing these types is "shut down." Usually, a convenient method is to break the minus filament and the minus plate supplies with a single, double-pole switch.

Saving B Power

The recommended procedure insures that the oscillator will always stop functioning in the *off* position, saves *B* power, and avoids interference with reception in combined transmit-receive equipment.

VWOA NEWS

Continued from page 60)

Phillipines and for two years directed the Fort Monmouth Signal School.

Major General Dawson Olmstead, an honorary member of our Association, retired as Chief Signal Officer of the Army at his own request on June 30, 1943, after completing a world encircling inspection of Army Signal Corps facilities throughout the world theatre of operations. Our good wishes go with General Ohmstead in his new assignments.

F-M RECEIVER DESIGN

(*Continued from page* 79)

chosen after a number of others were considered, including low plate impedance triodes.

The f-m tuning condenser required three sections, a 3-15 mmfd for the antenna input, a 3-15 mmfd for the mixer input and a 3-35 mmfd unit for oscillator tuning. No such commercial gang was then available. Thus a special unit was made. Three midget isolantite-insulated condensers were borrowed from an old 5-meter *ham* transmitter and ganged together on an aluminum bracket. This was mounted above the chassis and connected to the coils below by means of small polystyrene feed-through bushings.

Degeneration and loss in gain was anticipated in the tuning unit due to common coupling in the common shaft of the condenser gang. Therefore the sections were connected together with insulated couplings and separate grounds were brought out for each circuit. Two of the condensers apparently had been manufactured with slightly off-center shafts and quite a strain was put on the insulated coupling. Electrically jumping the couplings produced no effect on gain as indicated by a vacuum tube voltmeter in the first limiter grid. Therefore, loss in gain if any was attributed to other sources. A brass coupling was substituted between the oscillator and mixer input sections.

The only difficulty experienced with the converter stage were oscillations in the mixer input section. This was cured by shunting the tuned circuit with 10,000-ohm, ½-watt unit, as close to the grid as possible. The shunt trimmers were adjusted for tracking of the i-f circuits near the high frequency

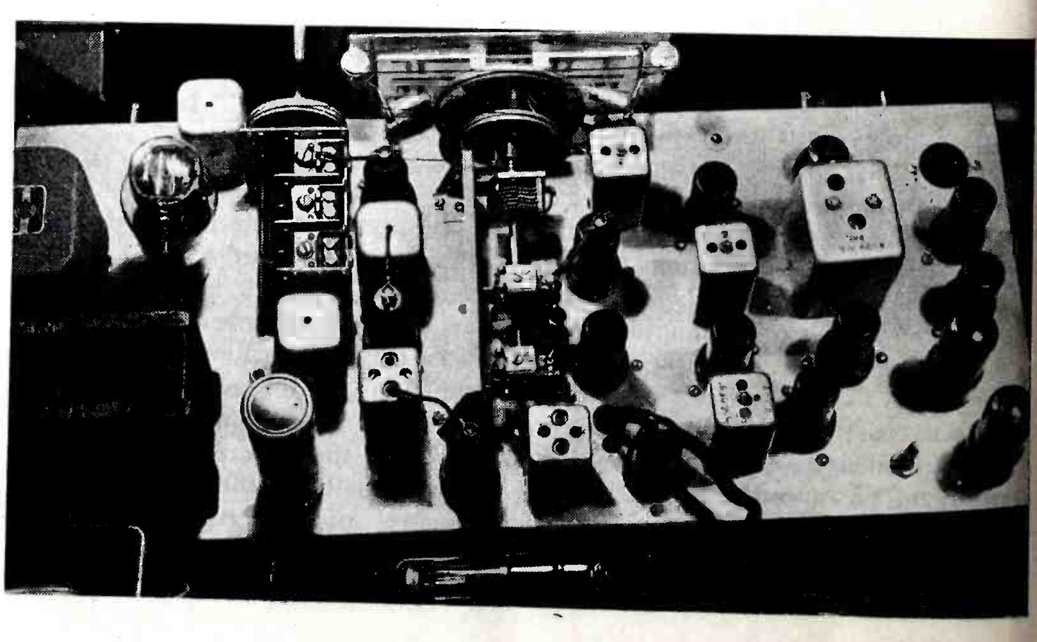


Figure 7

An overall view of the f-m chassis. Note that the tube lineup follows a zigzag pattern. This procedure was followed to minimize interstage coupling. The vacant socket at the upper right is for a tuning meter plug for lining up the discriminator.

nd, the end turn of the coil being djusted for tracking near the low frequency end of the band.

The oscillator shunt air padder was djusted to set the band at the high requency end, and the end turn of the oil was adjusted for tracking near the ow frequency end.

Coil Data

The r-f and oscillator coils were vound on ⅝" *o-d* polystyrene forms. All the grid windings were of No. 16 louble cotton covered wire, others of No. 22 dcc. The coils were mounted nderneath the chassis and connected o their respective tuning capacitors on op of the chassis by small polystyrene eed-through bushings. The chassis vas not used for tuned circuit returns. nstead bus wire connected each rotor o its coil end via a rubber grommet nsulated hole through the chassis. The coil forms were supported by the leads connecting to the various circuit components.

I-F Alignment

The coils used were designed to have a slightly rounded top in the band pass characteristic curve. This made it easy to adjust each for maximum without the use of a wide swing f-m signal generator. After adjusting the i-f trimmers this way the response curve was checked with a wide swing f-m signal generator and no difference was noticed in the shape of the curve. The discriminator was adjusted according to normal procedure.

It was found that a tuning indicator was definitely necessary for proper operation of the improved model of the f-m unit. A d-c voltmeter in the discriminator circuit did not provide greater tuning accuracy than the 6U5 tuning eye connected to the first limiter grid circuit; provided that all circuits track properly.

V-H-F STUDY

(*Continued from page* 30)

ly frequency generation, amplification, transmission and detection, apply equally to microwaves. Electron transit time, radiation and dielectric losses, circuit parameter limitations, phase shifts and skin effects tend to limit the maximum frequency obtainable with standard radio equipment at u-h-f. The frequency range has been extended somewhat by the construction of tubes adopted to u-h-f operation and the use of the resonant and concentric lines, but efficiency has been poor and control has been critical.

For these reasons, tubes and circuits adapted to v-h-f have been developed which overcome these difficulties. The tubes developed for this work include the magnetron, klystron, Haeff U-H-F, and Hahn-Metcalf velocity modulated types.

The magnetron in its most common form consists of a cylindrical plate split lengthwise, and a coaxial filament, with a magnetic field surrounding this structure and approximately parallel to the cathode. The electromagnetic field serves to control the direction of the electron stream. Several types of circuits have been used employing this tube, the most popular of which is called transit-time magnetron, in which the kinetic energy of the electron is converted to potential energy collected by the oscillating circuit.

The klystron is a velocity modulated tube. Electrons emitted by a cathode pass through a grid which serves a control and focusing electrode. These electrons then pass through a narrow opening leading to a dual cavity reso-

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V-H-F

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nator, which consists of a *buncher*. Variations in electron velocity cause them to arrive at points within the cavity resonator in *bunches;* hence the term. The *catcher* portion of the resonator is so adjusted as to cause the slower electrons to come to rest on its farthest wall. This prevents a reverse electron velocity, which would tend to take energy from the resonator. The resonant circuit is attached to the cavity resonator. At the far end of the tube is a collector plate, which is used to return those electrons passing the *catcher* back to the cathode, to an exterior circuit.

The Haeff U-H-F tube substitutes grids for the cavity resonators of the klystron.

The Hahn-Metcalf velocity modulated tube accomplishes a similar result by shielding the velocity modulated grid from the cathode with an additional grid, whose potential is fixed with relation to the cathode.

For very high radio frequencies, coaxial lines reduce to hollow wave guides. The latter may be either cylindrical, square, or rectangular tubes. They are usually of copper, but for ease of construction, brass, that has been silver plated, is used. Some typical examples of hollow wave guides are shown on page 30, of this issue. It will be noted that an appreciation of mechanics is of considerable help. Wave guides are far superior to coaxial feeders at v-h-f because of their lower attenuation factor. For example, the attenuation factor at 10 cm, for a typical hollow wave guide, is less than .02 db per meter, as compared with .4 to 5 db per meter for the coaxial line. Short lengths of the latter may be used for convenience of construction, without serious signal attenuation. The action of a signal transferred to a hollow wave guide is comparable to that of a signal trans-

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SLIDE FILM TRAINING

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of various motion picture techniques, explains in simple fashion how wire photos are transmitted. In this, a simple model is used of a length of rope wound around a wooden drum on which is painted an image which, as the rope unrolls to another drum, transfers the image to that drum. This is also a one reel subject in 16 mm.

While the presently available films are limited, the number is increasing steadily largely because of the importance of the science in the various phases of the war production effort and in the fighting forces. These pictures will be made available to engineers and the electrical industry as they are ready for release and especially for post war purposes in training men and women. These films will be distributed by the various training film agencies whether of official origin or not.

V-H-F

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mitted in space between the Heaviside layer and the earth. It may also be used as a resonant element by closing one end and tuning by means of a close fitting piston. And it may be used as a directive element by flaring the sending end, as shown in the illustration at the top of page 30, the flare being in effect a coupling element between the wave guide and the ether.

Matching between hollow wave guides and coaxial feeders is usually accomplished by feeding the central conductor of the coaxial line in a vertical plane through the guide.

It should be noted that v-h-f tubes, previously mentioned, may also be used as amplifiers and detectors. However, for laboratory work, probe detectors are used to trace the wave path. These usually consist of a hollow wave guide, with the piston arrangement previously mentioned, a small opening or iris at the receiving end, and a small probe partially inserted into the guide and connected to a crystal rectifier. The probe is sometimes so constructed as to move along the longitudinal surface of the guide. The latter is known as a traveling detector and is used to measure standing waves present in the wave guide. It is important that the probe be tuned to resonance, usually accomplished by the piston method previously explained.

In this presentation an effort has been made to acquaint the communications engineer with the terms and methods used at v-h-f.

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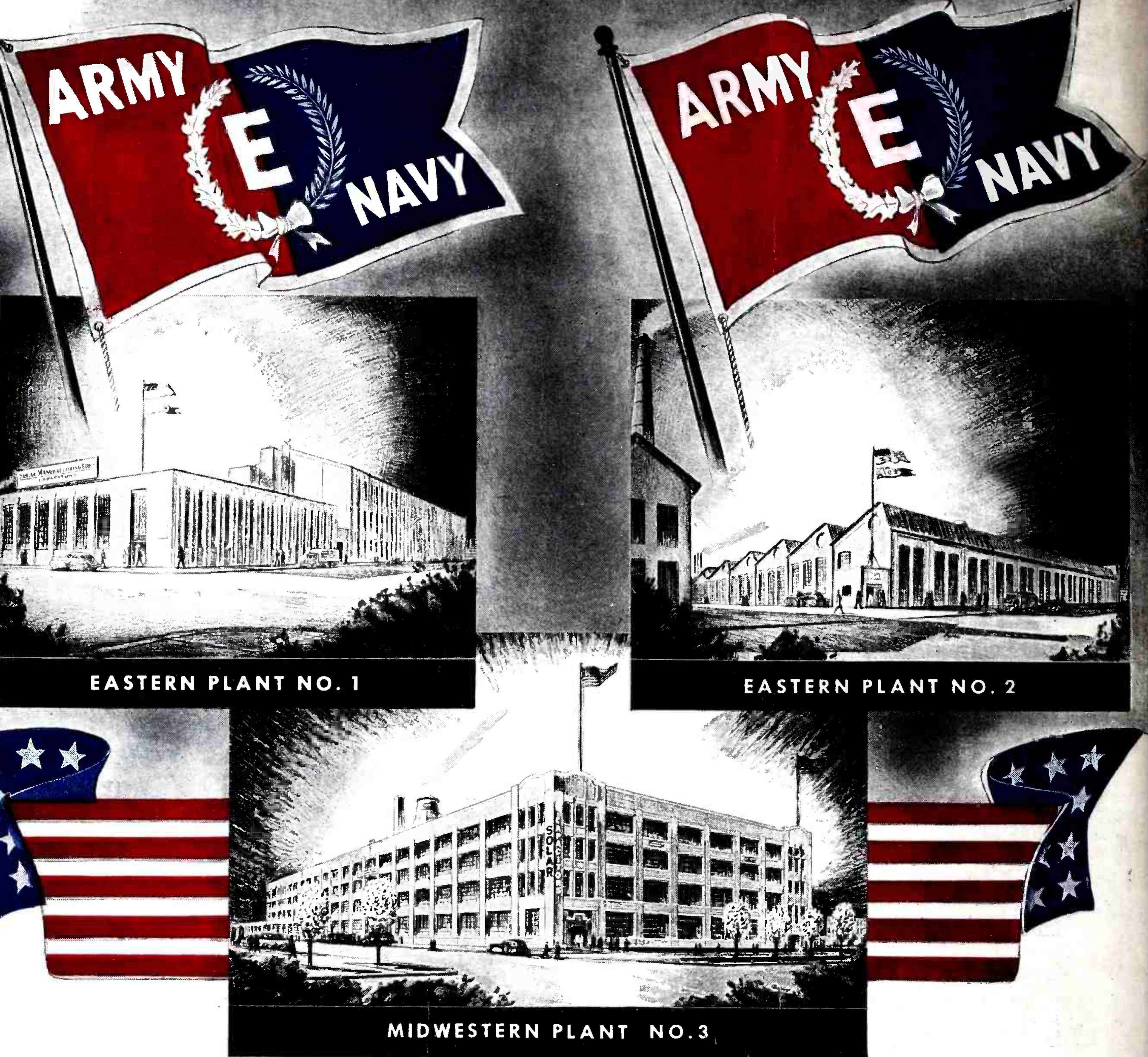

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