CROSS TALK

AR . . . On May 18 FCC required possessors of diathermy apparatus, ding equipment in stock, to register h apparatus with the commission. an estimated 100,000 units capable angerous communication, although orming meritorous service in other cities, were brought under the regu- y powers of the government com- ications agency. War had accom- hed something that peace had not. ral industry-wide meetings of com- ications and medical people had held in past years seeking to find y by which the troublesome emis- of the medical apparatus could be ented from creating havoc on com- ication channels. There is every be- now that some definite policy can ffected regarding these important ronic devices. Actual registry was red to be completed by June 8, extended to June 22.

Louisiana a doctor was ordered to operating an x-ray machine that fered with aircraft communication. may be a precedent which will to start a cleanup of many ether rs which have bothered communi- people no end. For years your r has suffered a distinct blank of many megacycles in his re- r where the interference from eliminators on nearby printing es created an uproar. These devices te at high voltage and produce sparks which could easily be keyed s the old spark transmitters could eyed.

lities and industrial concerns have advised to exercise caution about asing or installing blackout mask- r warning devices until the several ning bodies have settled the basic ements. The warning has been on the basis that it is futile to equipment which may not satisfy and regulations soon to be issued. will apply, presumably, to the elec- types of devices offered on the market, either speculatively (we'll build it if you order it) or from actual stock.

On June 9, the FCC ordered that everyone owning a radio transmitter who does not hold a station license for it to register the machine with the FCC. Our own rig (W2GY, W2EJ et al) of past days long ago fell apart in the garage under the joint action of the weather and ants which, somehow, got into the wooden base and pried the components apart. Rust took care of the metal parts. We hope no license is required.

On May 19, OPA excluded from the General Maximum Price Regulation sales of Brazilian rock quartz crystals. This meant that the Government or its agencies can buy quartz crystal at prices higher than established maximum levels. On the previous day WPB had placed the sale of quartz crystals under such control that they could be used only for products for use as implements of war for the Army, Navy, Government agencies or Lend-lease, as oscillators and filters for use in radio systems operated by Federal agencies or commercial airlines and as telephone resonators.

▶ **JINX** . . . There is, around every editorial office, a jinx. Sometimes he parks in someone's memory; sometimes he goes to see the printer; there are always plenty of places between writing copy, editing it, setting it in type, proof reading it once or twice, printing it in cold type where the jinx can get in his licks.

As a useful addition to Mr. Sasso's article in July on "Plastics as Dielectrics" the editors prepared a list of manufacturers and suppliers of plastics. On the copy to the printer was the name of Plax Corporation of Hartford, makers of polystyrene high frequency communication components. Either the typesetter did not set this material, or the jinx threw the type away or something; anyhow it did not appear on page 67 under G where it belonged.

Usually jinx picks on our best friends; this time he worked on a new friend who, we hope, will not think we treat all new friends in this apparently cavalier manner.

▶ **PERSONNEL** . . . A wartime manpower board, WMC, soon will step into the situation regarding scarcity of skilled manpower. It is not certain, yet, how far this commission will go toward controlling movements of men from place to place, toward killing the raiding that goes on, toward getting good employers and good employees together, but something is urgently needed. Much time is spent by ELECTRONICS staff, willingly but not always efficiently, in trying to find skilled men for various government and government-sponsored privately-controlled jobs. A further expenditure of time and effort goes trying to find places for men who wish to serve their country as civilians or in uniform but who do not know where to turn. Most of these men are highly trained and in great demand, and it is only natural that each man wants to know where his talents will best serve. If he gets into the wrong place he is more or less stuck and someone else, needing him badly, cannot get him. Some agency to coordinate all this sort of thing would help tremendously.

▶ **A-1-A** . . . ELECTRONICS is the proud possessor of an order of this high rating for reprints of its UHF Technique articles as published in the April issue. With the same solemnity and the same number of signatures of civilians and army officers that would purchase an antitank gun, a batch of reprints was ordered.

Tobruk fell yesterday.

Broadcasting Under War Conditions

Technical operation of broadcast stations adversely affected by wartime shortages o equipment and engineering personnel. Pooling arrangement and strict maintenanc urged to conserve existing reserves. Replacement of equipment is critical problem

By J. B. EPPERSON,

Chief Engineer
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and BEVERLY DUDLEY

Acting Managing Editor,
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THE effects of war conditions on the broadcast industry are demanding the most careful consideration of both operating and regulatory bodies at the present time. From the standpoint of technical operations these problems are primarily twofold, although additional factors sometimes enter to affect the operation of broadcast stations adversely. The main problems are: (1) difficulty in obtaining replacement tubes and repair parts due to the high priorities required, and (2) shortage of technical operators and engineers. Unless some way is devised to care for their future needs, broadcast stations may face eventual shutdown in cases of equipment failures.

The equipment and tube shortage is brought on because all manufacturers of transmitting equipment and tubes are extraordinarily affected by the war. All are carrying a heavy defense load, with the result that the A-10 priority rating formerly assigned to broadcasting for maintenance and repair became practically worthless for obtaining tubes and other equipment. Recognizing this condition, WPB issued its order P-129 on April 23, 1942, assigning an A-3 rating for critical materials needed for maintenance and repair. However, because of the increasing scarcity of critical materials, it appears that the A-3 rating is little better than the former A-10 rating when it comes to the purchase of transmitting tubes. This is borne out by the following extract from a form letter received from one tube manufacturer immediately after the P-129 order became effective:

"The critical nature of many essential materials required in the manufacture of transmitting tubes is such as to make it impossible for us to replenish our stock under the A-3 rating. Under these circumstances we shall continue to supply tubes wherever possible against your orders when covered by the A-3 rating. We feel that you should be advised, however, that for reasons aforementioned, we can fill such orders only provided we have the materials available and we do not have any other unfilled orders bearing higher ratings. It will also be impossible for us to commit ourselves to definite delivery unless the preference rating be sufficiently high to enable us to use it in the purchase of additional materials."

With few exceptions, broadcast stations have managed to keep their equipment in a satisfactory operaing condition, but this has been accomplished largely at the expense of reserve stocks of materials. There can be no doubt that the demands on equipment manufacturers have not yet reached their maximum and that it will be necessary to devise some way by which it will be possible to care for future demands of the industry.

Pooling Arrangement as Conservation Aid

To alleviate the shortage of equipment (especially tubes) and to assure that broadcast service will be maintained to the fullest, a "share the spare parts" program has been recommended by the Defense Communication Board (now the Board of War Communications). In brief, this proposal, released on May 24, calls for: (1) inventory of equipment of all stations, together with establishment of requirements of minimum equipment necessary to maintain operations, (2) establishment of conservation districts, each district to contain enough stations so that a representative stock of parts is avai able in each and to be presided ove by a civilian administrator and tw assistants, (3) the district administrator and his assistants will b charged with the checking and control of the inventory stock in hi district and the redistribution, on sales basis, of surplus equipmen from one station to another.

Such a plan could operate onl with the full co-operation of th broadcasters and this co-operation i assured by the fact that it originate with the broadcasters themselve and was prepared and submitted t the BWC by the Domestic Broadcasting Committee of the Board. It i believed that the operation shoul go a long way to relieve the priorities problem now confronting th 900-odd broadcasting stations in repair and maintenance materials.

It would appear that such a provision for conservation is not only ticklish in its administration, but is at best, only a temporary stop-gap There is evidence that not all station operators are fully behind this plan since, it is pointed out, the "share the spare parts" program penalizes the well managed, conservatively operated stations for the benefit of the less efficient stations. Another difficulty with this program as initially outlined is that it makes no provision for the replacement of parts which may be used up in normal operation. Under a system of this sort it is conceivable that all the broadcasting services of the country could disintegrate simultaneously, like the "One Horse Shay."

The lack of parts is of little concern for many recently modernized stations, or those near metropolitan centers of supply, but it is an increasingly difficult problem for the stations in areas remote from production facilities. A number of stations are unable to obtain such spare parts as condensers, resistors, socke transformers or repair parts for their transmitters. Extension of audio line facilities is hampered, and portable and remote amplifying equipment once damaged will probably not be replaced. This situation is being faced as a matter-of-fact problem whose solution must, somehow, be obtained.

Many stations have instituted a complete house cleaning program in which broken and obsolete parts from used equipment have been repaired and reclaimed for future use, even if under restricted conditions. More rigid schedules of repair and maintenance are being enforced, and systematic maintenance is aided by assigning regular duties on a well planned time schedule. Most stations have reduced the filament voltage of tubes to obtain longer life, the amount of reduction being determined by limitations of audio distortion or power output. One station engineer reports that the life of tubes in his station has been increased from 4½ to 7 months through such a procedure.

With regard to tubes, many broadcast operators are caught between the sharp points of a two-horned dilemma. On the one hand they are required by the standards of good engineering practice to maintain an adequate supply of replacement tubes. On the other hand, the heavy demand on tube production for military services makes it difficult or impossible to conform to these regulations. To alleviate the situation somewhat, some stations are reclaiming old tubes previously regarded as unsuitable for operation, but which may be pressed into service under a program of restricted materials. Other stations have experimented with the repair of old tubes. Some engineers feel that too little attention is being given to the rebuilding of transmitting vacuum tubes as a war conservation measure. According to the statement of one company which has rebuilt several tubes, approximately 90 per cent of the defective transmitting tubes above 250 watts in size can be satisfactorily rebuilt. The cost of rebuilding a transmitting tube is ordinarily one-half that of a new tube of the same type. A rebuilt tube might even be better than a new one, providing the tube was originally built before substitute materials were employed.

Even more important than the shortages of tubes and other physical equipment is the shortage of technically qualified personnel for station operation. Through the exercise of additional maintenance and repair work, a station in normally good operating condition can be kept in satisfactory operation for a considerable length of time, with capable technical administration. But the technically trained operating and engineering personnel are vital to its operation and cannot be so easily replaced. Many stations are having difficulty in obtaining experienced technicians since so many have been absorbed by the various government services. The main difficulty arises from the necessity of placing inexperienced men in important positions, and the inability to find individuals with a background sufficiently adequate to become thoroughly trained in a short time.

Personnel Shortages, too!

There is no blanket deferment from military service of men engaged in station operation. Indeed, the broadcast industry has contributed many of its best technical personnel to the Army, or Navy, to various government administrative agencies, or to technical teaching and research jobs, all of which further the country's war effort. Certainly no one makes such a change without the fullest desire to be of maximum assistance, while those left to carry on are performing equally valuable (if less publicized) work in the additional duties imposed upon them. But several stations have lost heavily of their technical personnel, and are unable to replace licensed operators. The loss of technical personnel does create a serious question as to how the normal services are to be maintained or even extended with an ever-decreasing technical staff.

There are several partial solutions to the problem of personnel; none are completely satisfactory. Control room operators having operator's licenses but no transmitter experience, have been transferred to the operation of the transmitter, and have, in turn, been replaced by persons less experienced. Qualified individuals who, for one reason or another, are not likely to be called into military service, have been used wherever possible. The shortage of personnel has, in some instances, led to outbidding by various stations for the services of those still available. However, a more frequent and self-reliant approach seems to be that of training personnel for broadcast jobs by the NYA or other agencies. In several cases women have been trained as control room operators. It is too early to draw definite conclusions from the few cases in which women have actually been engaged in control room work, although there are indications that qualified women operators are entirely capable of discharging control room duties properly.

Concern has been expressed by some station managers that the necessity for employing less experienced personnel may force a relaxation of standards of operation which could become permanent. Under such conditions, those technically trained men now leaving the broadcast industry might be expected to find other careers for themselves after "the duration." Nevertheless, the opinion is frequently expressed that relaxation of certain standards of good engineering practice, especially with regard to requirements as to distortion tolerances and time off the air, will help materially in easing the present problems.

Several stations, especially the smaller ones, complain of loss of revenue at a time when prices are rising and additional services are required of their operating personnel. The monitoring of key stations for blackout warnings is a problem for some stations who have already lost heavily of their operators and find themselves operating with shoestring personnel. Protection of the station against possible invasion or bombing attacks, fire, lightning, or acts of sabotage requires additional vigilence, especially of stations near the territorial limits of the United States. The need for emergency service equipment, in the event of failure of regular equipment, is recognized by foresighted operators, but again difficulty is encountered in obtaining the necessity priority ratings for engine-driven generators and similar equipment.

Broadcasting forms an integral and important part in the lives of all in the United States. It is a powerful and important factor in knitting

(*Continued on page* 56)

Electronic WELDIN

An introductory discussion of the design problems involved. Basic power circuits. Selecti of tubes to fit the work. Phase shift current control. Timing methods. A commerc synchronous spot welding machine control

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RESISTANCE WELDING is a broad term which can be subdivided into spot, seam, pulsation spot, projection, butt, and flash welding. As a procedure, it is well known but it did not come into general prominence until after the development of electronic control. Soon after electronic control was made available it became evident that existing jobs could be run faster and that many combinations and materials that previously could only be welded in the laboratory could be welded in production.

Why is electronic welding control so important? To answer this question, a few facts regarding welding machines must be given. To make a resistance weld, the two pieces to be welded must be held in close contact and under pressure. The weld is made by passing a definite amount of current through this joint for a definite period of time, causing the metal at the joint to soften and the grains to interlock. The result is like a rivet in mechanical properties.

SCHEDULED

Part 2

Electronic Controls for Seam. Pulsation and Special Welding Machines

Part 3

Magnetic and Electrostatic Energy-Storage Welding Machine Controls

Part 4

Checking Resistance Welding Controls With a Cathode-Ray Oscilloscope

General Considerations

Current through the work will seldom be less than 1000 amperes and may be as high as several hundred thousand amperes. The metal sections in the current path are usually large, therefore the resistance is quite low. The mechanics of getting the pressure where it is needed usually call for a fairly long and large loop of conductor connected to the secondary of the welding transformer. This, together with the low resistance factor, means a highly inductive, low power-factor load. The power-factor range is from as low as 0.1 to as high as 0.9, with the average about 0.5. This brings out one very significant fact—the control must work satisfactorily over a wide range of power factor.

To generate the required heat at the joint, the time of application of the current must be precisely controlled. The increment of time when working with alternating-current is the cycle, therefore the timing is in terms of cycles of the supply frequency. This doesn't mean that the elapsed time is the equivalent of so many cycles. It means that time starts at a predetermined point on the supply voltage wave and ends at the corresponding current zero point so many cycles later.

Weld timers must operate differently for the different types of resistance welding. Spot and projection welding require a single impulse of power, adjustable from 1 cycle to 30 cycles, or ½ second on a 60-cps power supply. Seam welding requires a series of power impulses spaced by a definite "off" time. Both the "on" and the "off" time ma be adjustable over a range of 1 30 cycles. Pulsation spot weldin timers are similar to seam weldin timers except that only a definit number of "on" times are permitte to pass and then the control is locke out and cannot start a new series o impulses until the spot initiatin switch is operated. Such "countin control" is usually designed for op eration over a range of from 1 to 1 power impulses.

The fact that the power factor i low, that the time is short and tha the energy must be the same for each power application, dictates that fo best performance welding power must be applied without transient This feature is called synchronou starting and is a valuable contribution made by electronic control.

Tube Data

Welding controls must be designed to handle from a few hundred volt-amperes, for welding small parts, to 1000 or more kva, for welding heavy parts and structures. Ignitron tubes are commonly used to control large powers. These are mercury pool tubes with immersed starting electrodes. They are artificially cooled, usually by water. For the smaller welding jobs, hot cathode thyratrons are available. Both thyratrons and ignitrons are half-wave rectifiers, therefore two tubes must be used in an inverse parallel fashion to conduct both halves of the a-c wave. Figs. 1A and 1B each show two ignitrons connected in series with the primary of a welding transformer. Two such tubes make the equivalent of a single-pole, single-throw switch.

Ignitrons are rated for two conditions; first, the maximum current

CONTROL . . . Part 1

By H. L. PALMER

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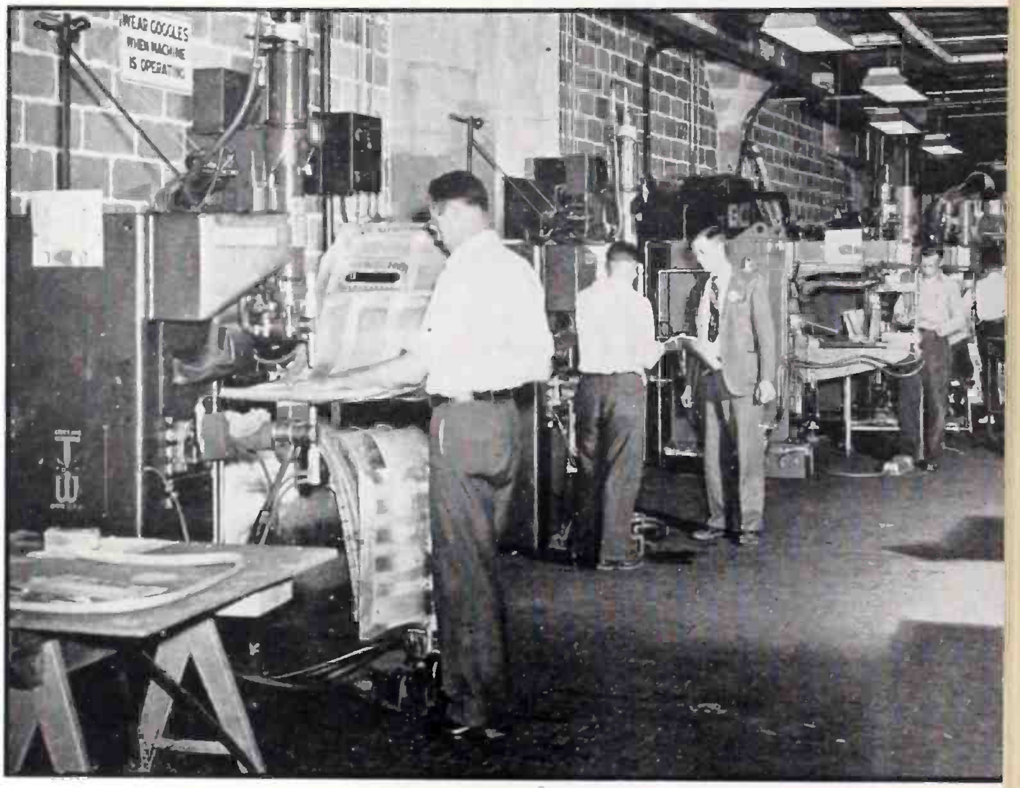

A-c type spot welding machines with synchronous welding control fabricate aluminum alloy parts in an eastern aircraft plant

tit can be controlled regardless of tl conditions of operation; second, t average current, or the equiva- lt continuous current, that can be ctrolled. These two limiting rat- is are related to one another and ci best be expressed by curves. A thd condition, the voltage of the siply, also affects the other two, refore a series of curves are re- hed for different voltages.

atings are usually expressed in ens of rms demand current against dy cycle. By duty cycle is meant th percentage of the total time cur- rt is passed by the tubes. The 200– 2 volt and the 400–500 volt rating curves for typical ignitrons available for welding control are given in Fig. 2. It should be noticed that on the curve for each size tube is given an averaging time, which is a measure of the thermal capacity of the tube as applied to its rating. This is the maximum time over which the duty cycle can be calculated. The maximum length of spot that can be allowed under the rating for any given value of welding current is the duty cycle for that particular value of current times the averaging time. This is the maximum allowable length of spot, regardless of how long the tube is off between spots. For example, consider the size C tube on 500 volts with a during-weld current of 1500 amps. The tube can operate with a spot length or "on" time of 0.15x7.1 sec. = 1.06 sec., providing the tubes are allowed to remain idle 6.04 sec. It must also be remembered that any one spot must not be over 1.06 sec. even though the tube is off for an hour between spots. The 1.06-sec. "on" period does not have to occur

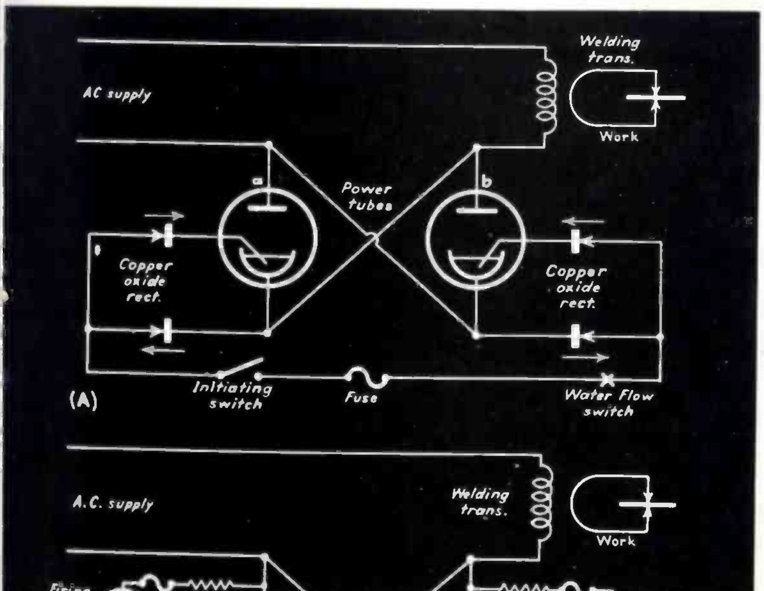

FIG. 1—(A) An electronic welding contactor without phase control or timing. (B) A power circuit used in many synchronously controlled systems, particularly where high voltage supplies are employed

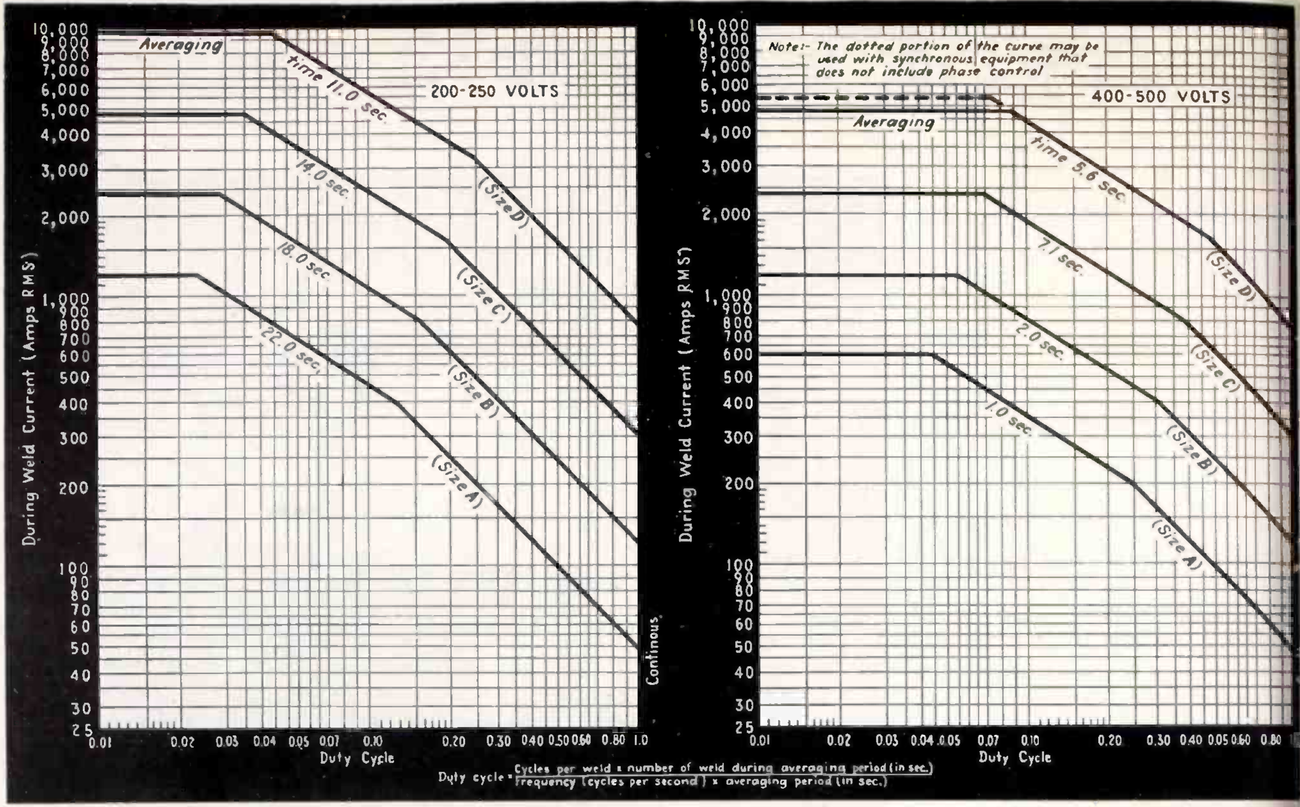

FIG. 2—Rating curves for four typical ignitron tubes used in welding control equipment. Data at the left is for 220 while that at the right is for 440-volt supplies

in one continuous spot. It can be the total conducting time during any 7.1-sec. interval.

Ignitrons tend to have a constant kva rating and therefore the allowable currents for 220 volt operation are somewhat higher for the same duty cycle than for 440 volts. (Hot-cathode thyratron ratings for welding are somewhat simpler in that the ratio of peak to average is lower and the current rating is more nearly independent of line voltage.)

Power Circuits

Certain types of welding do not require full electronic control but speed of operation and maintenance problems make an electronic contactor desirable. The simple circuit shown in Fig. 1A, involving two ignitrons and four copper oxide rectifiers, has been developed to meet this need. With this circuit the power tubes will conduct when the initiating switch is closed and cease to conduct when the switch is opened. No synchronizing feature or timing is included in such a control.

The copper oxide rectifiers are required to prevent damaging reverse current flow from pool to ignitors. When anode *a* is positive and the initiating switch is closed, current will flow from point *a* through the lower right rectifier, through the flow switch contacts, fuse, initiating switch and the upper left rectifier into the ignitor of the first tube and back to the other side of the line through the welding transformer. When this current flows from the ignitor to the pool a cathode spot is formed and the ignitron carries current for the half cycle.

In tracing this current two alternate paths were available at two places in the circuit. First, at the cathode of the second tube an alternate path is shown, through the ignitor and its copper oxide rectifier. Notice that this copper oxide rectifier is connected to oppose current flow from the pool, while the lower right rectifier allows an easy flow of current. Thus the ignitor rectifier prevents any appreciable amount of reverse current flowing through the ignitor of the second tube. The other choice occurs at the second group of rectifiers, affiliated with the first tube. Here it should be noticed that the ignitor series rectifier is connected to allow current to flow to the ignitor into the pool while the other rectifier blocks the flow directly to the pool. When anode *b* is positive the current path is reversed and the second ignitron will be fired, causi both half cycles to flow to the weldi transformer. This action will co tinue as long as the initiating swit is closed and will cease when it opened.

A conventional power circuit wh synchronous starting is required shown in Fig. 1B. In this arrang ment, thyratrons are used to fire t ignitrons by connecting the ignitr ignitors to the ignitron anod through the thyratrons so that lo current will flow to the ignitors un the ignitrons are fired. When a ignitron starts to conduct, the v tage across the associated thyratro is reduced to arc drop or about 1 volts, which stops its conduction an therefore, the current through th ignitor. The grid in the thyratro provides a flexible means of contr

These two basic power circuits wi meet the requirements of a complet line of welding controls. The choi of one or the other is determined b the control functions required an the operating conditions encountere The application of the tube ratin curves is the same in either case. Th circuit of Fig. 1B has certain tech nical and economic advantage where the supply exceeds 600 volts

Two functions of control can b

performed—the amount of welding current or "heat" can be varied by means of phase control, and the application of power can be timed to meet the requirements of the welding operation. Both phase control and timing can be applied independently or together.

Control Circuits

Phase shift control may be added to the Fig. 1A circuit by putting in series with the contacts of the initiating switch a pair of inversely connected thyratrons as shown in Fig. 3. Control is applied to the grids to these two thyratrons so as to delay their firing during each half cycle. Thus each ignitron is delayed in firing until the associated thyratron starts to conduct. Two methods of controlling the thyratron grids suggest themselves. The simplest is to apply an alternating voltage to the grids of the thyratrons and vary its phase by means of a conventional phase-shift network. When grid voltage is negative it holds the thyratrons nonconducting, allowing the tubes to conduct as the grid goes positive on the next half cycle. By shifting the crossover point the angle of firing can be shifted. Figure 3B shows the phase relation of the anode or line voltage, grid voltage, and line current.

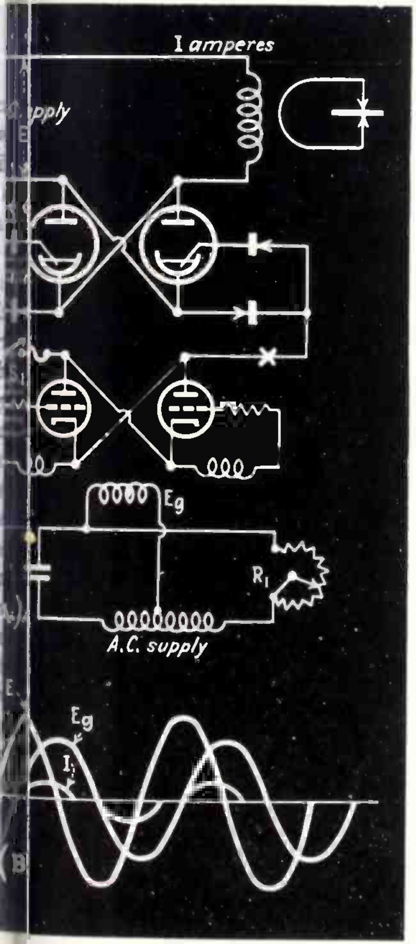

FIG. 3—(A) Contactor with simple phase control added. The amount of current passed to the welding machine depends upon the position of R_1. (B) Phase relations of line voltage E, grid voltage E_g and line current I for one position of R_1.

A second method of phase controlling is shown in Fig. 4A. In this case a separate thyratron bias voltage is used and control of the thyratrons is effected by a peak voltage superimposed on the bias voltage. The peak voltage is shifted by the phase shift network to vary the firing point. On and off control of this combination can be obtained by means of a series contact, as in Fig. 3, or it can be controlled by changing the a-c bias with a bucking transformer as shown in Fig. 4A. The phase relations of the on and off conditions are shown in Fig. 4B. The phase shift system using a peaking transformer has the advantage of avoiding completely the transients that can exist on the first half cycle when the Fig. 3 circuit is used because the tubes can only fire when a peak is present. Thus, if the initiating switch is closed just after a peak the tube will not fire but will wait until the peak on the next half cycle. Timing may be off by a half cycle but no transients will be generated.

Phase shift heat control is added to power circuit 1B by putting a phase shift control on the grids of the two thyratron firing tubes. This is done by adding an a-c bias 180 deg. out of phase with the anodes, then superimposing a peak voltage that is not high enough to break through and drive the grids positive. When the power tubes are supposed to conduct, the thyratron bias voltage is reduced by a bucking voltage just great enough to let the peak voltage drive the grids positive. In this way the firing point can be changed by shifting the phase of the peak voltage. Such a circuit is shown in Fig. 5A. Figure 5B gives the phase relations with the power tubes non-conducting and Fig. 5C shows the voltage conditions when the power tubes are conducting.

It will be noticed that whenever an alternating voltage is used to hold a thyratron non-conducting, as in Figs. 4A and 5A, a capacitor is connected around the current-limiting grid resistor. This gives a d-c component of negative grid voltage due to grid rectification, which avoids difficulty due to false firing by transient voltages that might occur as the alternating bias voltage is building up negative.

Timing Circuits

The timing function can be added to either of the power circuits shown in Figs. 1A and 1B, or it can be added to the power tube phase control combinations shown in Figs. 4A and 5A. To turn any of these circuits on, it is necessary to switch an alternating voltage, which means the two control tubes must be connected in inverse parallel to control both halves of the a-c wave. In such a circuit the cathodes of the two control tubes are not at the same potential, which prevents their connection to the same timing control voltage. This is overcome by the use of a trailing control circuit as shown in Fig. 6. The two control tubes *A* and *B* are connected in such a way as to energize the control or grid transformer when they conduct. The grid circuit of tube *B* is made up of three elements with the polarities as shown. The bias voltage is 180 deg. out of phase with the anode and therefore keeps tube *B* non-conducting, with the aid of the grid resistor and capacitor combination, as long as the feedback transformer is de-energized.

As long as tube *A* is held off by the timing circuit, the feedback transformer will not be energized and the control or grid transformer will have zero secondary voltage. Now assume that the timing voltage puts the grid of tube *A* positive when its anode is positive, causing tube *A* to conduct for a half cycle. This energizes the feedback transformer and, due to the inductance in the circuit, the current in the primary of the control or grid transformer will continue past the zero of the voltage wave as in any lagging circuit. This means that as the current in tube *A* goes to zero there will be a positive voltage on the plate of tube *B* and the feedback transformer will put a positive voltage on the grid that makes tube *B* conduct for a half cycle.

As long as the grid of tube *A* conducts, tube *B* will follow the next half cycle. This is only true when the load has a lagging power factor. If the current through tube *A* went to zero at the voltage zero there wouldn't be any voltage to fire tube

B. However, practically speaking, there is usually enough leakage reactance in the feedback transformer to cause the current to lag enough to make tube *B* trail. When the grid of tube *A* goes negative, the feedback transformer will be de-energized when tube *B* stops, and when tube *A* does not fire there is nothing to fire tube *B* and the control or grid transformer is de-energized.

A trailing tube circuit has a number of important features as applied to resistance welding control. This circuit provides a means of controlling two tubes whose cathodes are at different potentials from one timing source. The suggested solution also uses only one tube in the timing circuit, so that there is no problem of matching tube characteristics. With a trailing tube circuit there is no possibility of getting an odd number of half cycles. This insures against a d-c component and possible saturation of the welding transformer, which is of extreme importance when designing seam welding controls where the "on" and "off" times are comparatively short and occur with the secondary shorted continuously by the electrodes.

The basic scheme of Fig. 6 is added to Fig. 1A by connecting the two thyratrons *A* and *B* in place of the initiating switch and connecting the primary of the feedback transformer across the welding transformer. The application to Fig. 1B is to add the bias and feedback voltage to the grid of one of the thyratrons, with the primary of the feedback transformer across the welder. When adding to Figs. 4A and 5A, Fig. 6 is added complete. The control or grid transformer is used in place of the transformer controlled by switch S_1.

The timing circuit itself is that part of a welding control which gives the control its name, as the power and control circuits in one or the other of the forms just described are used in all types of welding. It is the timing circuit that makes a control a spot welder control, a seam welder control, a pulsation spot welding control, or all three.

A commercial spot welding c
trol, without phase control and usi
the power circuit of Fig. 1B,
shown in elementary form in Fig.

The control is made up of a rec
fier furnishing d. c. for timing a
control circuits, a keying tube to i
sure starting at the desired point
the voltage wave after closing t
switch, the timing and leading tub
and trailing and power tubes.

Complete Circuit

The rectifier is of the convention
type with a filter reactor, *X*, and
filter capacitor C_1. A voltage divid
made up of two components, R_1 a
R_2, is connected across the filter
rectifier output. The major part
the voltage appears across R_1 a
charges the timing capacitor. Th
small voltage across R_2 is used
d-c bias on the keying tube, T_1. Co
nected across a part of R_1 is th
filter combination R_3, and C_3, whi
makes the timing practically ind

(*Continued on page* 117)

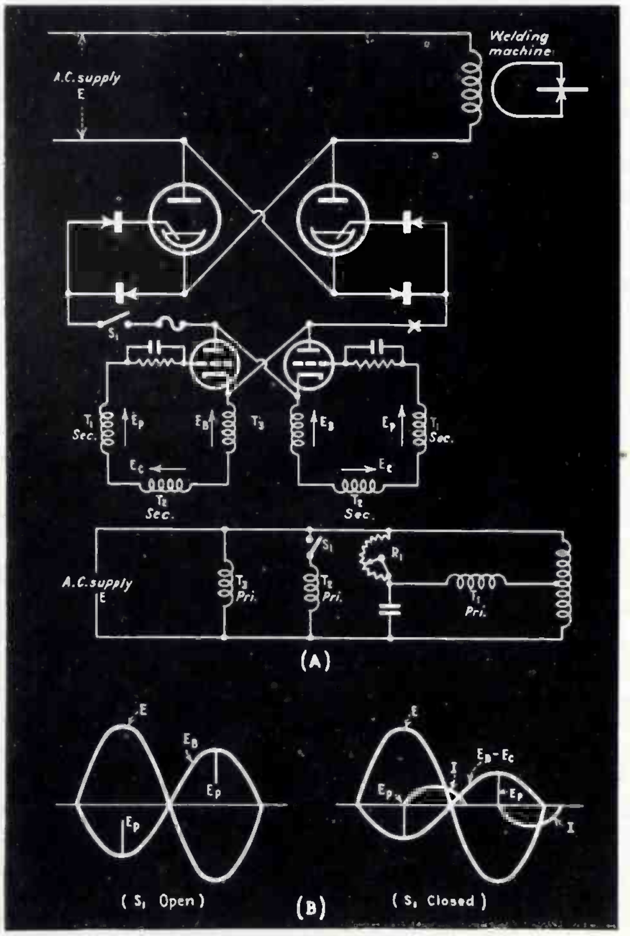

FIG. 4—(A) Another form of phase control, added to an electronic contactor. The amount of current that will flow to the welder is determined by the position of R_1 (B) Voltage and phase relationships, as explained in the text

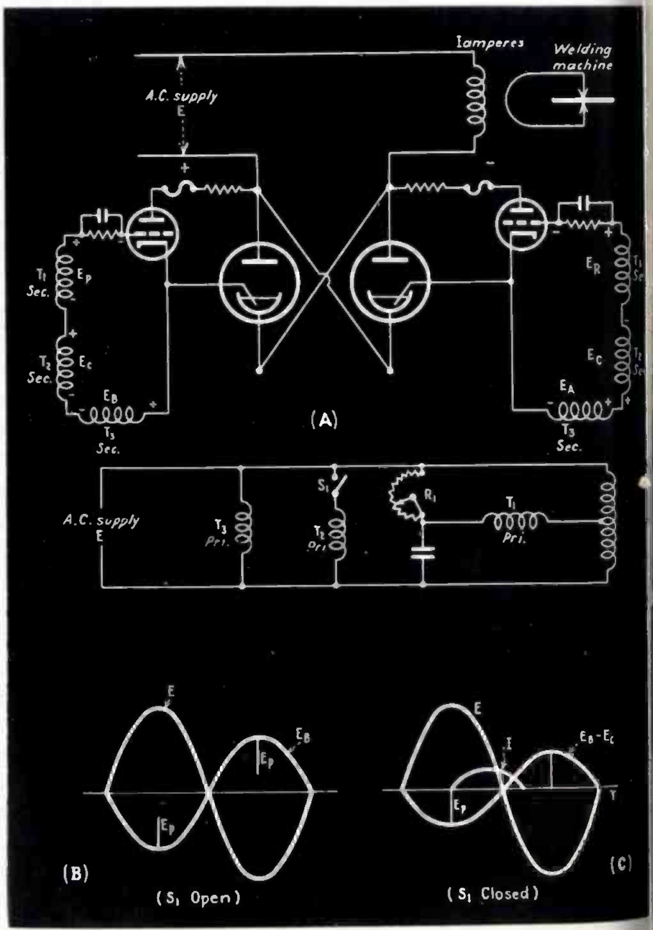

FIG. 5—(A) Phase control added to Fig. 1B. The amount of curren that will flow to the welder depends upon the adjustment of R_1. (B Voltage and phase relations with S_1 open. (C) Voltage and phas relations with S_1 closed and the tubes passing current

Unsymmetrical Attenuators

his article presents a graphical method of designing T or π resistance attenuators and simplified means of converting to a dissymmetrical network where impedances of different agnitudes must be matched

By P. M. HONNELL

Southern Methodist University

WHEN the need arises for an attenuator with a given loss ich will match terminal apparatus lines of unequal impedances, it ll be found necessary to compute e values of the branch resistances the required pad since such data nnot ordinarily be found in curves tables. For a T or π network of nstant impedance level, however, h information is usually available. Now by utilizing a symmetri- pad which matches one of the two pedances and a transformer of per ratio to match the other impdance, the required network can ays be realized. But it is not ally convenient, and certainly not nomic, to utilize this combination, ecially as it is possible in most tances to replace both the con- nt impedance pad and the trans- mer by a dissymmetrical pad.

The purpose of this note is to sum- rize the results of the matrix nsformation* which may be used to obtain the branch resistances of the dissymmetrical pad which will fit the required terminal impedances, from design data for the resistance of the branches of a symmetrical T or π pad of the desired attenuation. This follows in Sections I and II. If exact branch resistance values for symmetrical T or π pads (of any impedance level) are not available, they may be obtained from the curves in Section III with fair accuracy.

Section I—T Pad

It should be understood at the outset that the values of branch resistances of a symmetrical T or π pad of given impedance level (say 600 ohms) may be changed to any other impedance level (say 500 ohms) by multiplying all the branch resistances by the ratio of the required to given impedance levels (namely 500/600 or 5/6 in this example). Thus it is always possible to adjust available data for a pad of the desired loss to fit one of the two impedance levels.

In Fig. 1A, for example, the symmetrical pad giving the desired attenuation, and having branch resistances r_a, $r_b = r_a$, and r_c has been chosen to match the input impedance Z_1. Since the pad is of constant impedance level, the output impedance Z_2 can be matched only by means of the (ideal) transformer of impedance ratio 1:a².

The branch resistances r_a', r_b', and r_c' of the dissymmetrical pad (Fig. 1B) which will replace both the symmetrical pad and the transformer (Fig. 1A), are obtainable from the following equations:

$$\left.\begin{aligned} r_a' &= r_a + (1-a)\,r_c \\ r_b' &= a^2\,(r_a + r_a) - a\,r_a \\ r_c' &= a\,r_c \end{aligned}\right\}, \qquad (1)$$

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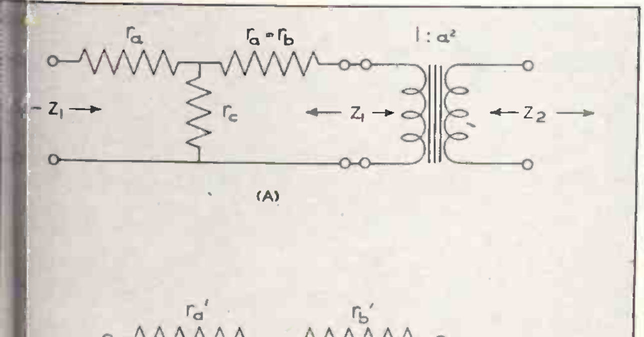
* E. A. Guillemin, "Communication Networks," John Wiley (1935), Vol. II, Chapter VI, Section 5.



1—Symmetrical T pad and ideal transformer (A) and the ctrically equivalent dissymmetrical T pad (B), both having the same loss

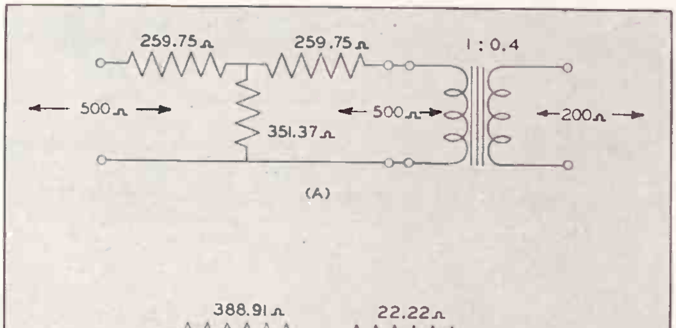


Fig. 2—Examples of dissymmetrical T network (B) equivalent to symmetrical T network and ideal transformer (A), both with 10 db loss

where impedance ratio is given by

$$a^2 = Z_2/Z_1, \quad (2)$$

the ratio of output to input impedance levels. The equations maintain the loss from input to output terminals of the network invariant.

Without going into an exhaustive analysis, it may be evident that for a given ratio of impedance levels, or a^2, negative elements for r_a' or r_b' may occur. In such an event, the only alternative is to choose a network with more attenuation, which will then result in realizable resistances. Of course, either r_a' or r_b' may actualy be zero in the limiting case. This result may answer a question that has undoubtedly arisen in the reader's mind: "Wherein does a symmetrical network and (ideal) transformer differ physically from a dissymmetrical network?" The answer lies in the fact that for a given terminal impedance ratio the former can be approximated physically for any attenuation, whereas the latter network has a definite minimum attenuation below which some of its elements become physically unrealizable.

Numerical Example

As a concrete numerical example of the application of these equations, consider a 10 db pad, required to match impedances $Z_1 = 500$ ohms and $Z_2 = 200$ ohms. From tables (or Section III), the following resistances for the branches of a symmetrical, 10 db, 500-ohm level pad are obtained:

$$\begin{aligned} r_a &= 259.75 && \text{ohms} \\ r_b = r_a &= 259.75 && \text{ohms} \\ r_c &= 351.37 && \text{ohms.} \end{aligned}$$

From Eq. (2) we obtain for the ratio of output to input impedances,

$$\begin{aligned} a^2 &= 200/500 = 0.4, \\ a &= 0.63246. \end{aligned}$$

Substituting these values into Eq. (1), we obtain for the branch resistances of the dissymmetrical pad:

$$\begin{aligned} r_a' &= 259.75 + (1 - 0.63246)\ 351.37 \\ &= 388.91 \qquad \text{ohms} \\ r_b' &= 0.4\ (259.75 + 351.37) \\ &\quad - 0.63246\ (351.37) = 22.22 \quad \text{ohms} \\ r_c' &= 0.63246\ (351.37) = 222.22 \ \text{ohms.} \end{aligned}$$

The resulting dissymmetrical network equivalent to the symmetrical pad and (ideal) transformer is shown in Fig. 2B.

Section II—Dissymmetrical π

In order to simplify the mathematical expressions, it is desirable when dealing with π networks to express all quantities as admittances. Since resistors of commercial manufacture, and measuring equipment in general, are calibrated in terms of impedances, computed circuit admittances must be converted into impedances before the final circuit elements are obtained physically. But this is a mere matter of reciprocation of the branch admittance of the network, and should cause no confusion, if the inverted omega is recognized as the conductance symbol in mhos.

Thus, the equations which relate the symmetrical π pad and (ideal) transformer to the equivalent dissymmetrical π, working between unequal terminal admittances, are as follows:

$$\left.\begin{aligned} g_a' &= g_a + (1 - 1/a)\ g_c \\ g_b' &= (1/a^2)\ (g_b + g_c) - (1/a)\ g_c \\ g_c' &= (1/a)\ g_c \end{aligned}\right\}, \quad (3)$$

where

$$1/a^2 = Y_2/Y_1 \quad (4)$$

is the ratio of output admittance Y to input admittance Y_1, of the terminal equipment.

As shown in Fig. 3A, g_a, $g_b = g_a$ and g_c are the branch conductances of the symmetrical π, with the dissymmetrical π branch conductances g_a', g_b', and g_c' given by Eq. (3) shown in Fig. 3B.

Numerical Example

As a numerical example, we consider again a pad with 10 db loss, this time a π, working from 200 ohms into 500 ohms (Fig. 4A). For the ratio of admittances $(1/a^2)$ we have converting the terminal impedances to admittances,

$$1/a^2 = Y_2/Y_1 = \frac{1/500}{1/200} = 0.400,$$

which gives

$$1/a = 0.63246.$$

Reference to tables or the curves of Section III gives the following values for the branch conductances of a symmetrical π pad of 10 db loss, and 1/200 mho admittance level:

$$\begin{aligned} g_a &= 2.5975 \times 10^{-3} && \text{mho} \\ g_b = g_a &= 2.5975 \times 10^{-3} && \text{mho} \\ g_c &= 3.5136 \times 10^{-3} && \text{mho.} \end{aligned}$$

The symmetrical 10 db π, therefore, and the required 0.4 admittance ratio (ideal) transformer are shown in Fig. 4A.

To obtain the equivalent dissymmetrical π, substitute these values into the Eq. (3), giving:

$$\begin{aligned} g_a' &= 2.5975 \times 10^{-3} + (1 - 0.63246) \\ &\quad 3.5136 \times 10^{-3} = 3.8902 \times 10^{-3} \ \text{mho} \\ g_b' &= 0.4\ (2.5975 + 3.5136) \times 10^{-3} - \\ &\quad 0.63246\ (3.5136 \times 10^{-3}) = 0.22243 \times 10^{-3} \\ &\quad \text{mho} \\ g_c' &= 0.63246\ (3.5136 \times 10^{-3}) = 2.2220 \\ &\quad \times 10^{-3} \ \text{mho} \end{aligned}$$

The desired dissymmetrical π is shown in Fig. 4B, together with the

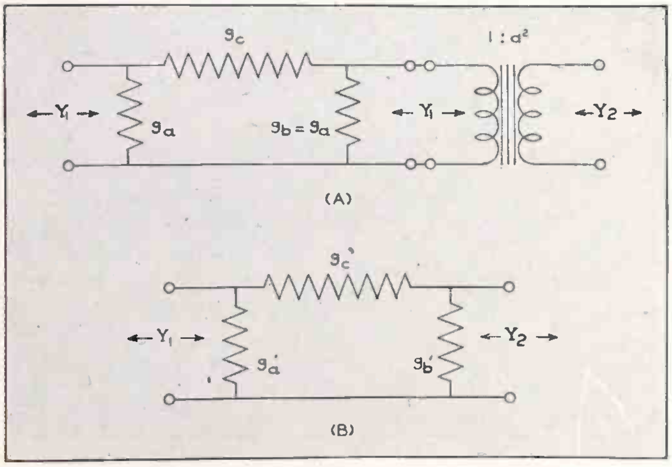


Fig. 3—Symmetrical attenuator and ideal transformer (A) and equivalent dissymmetrical attenuator, (B), with the same loss

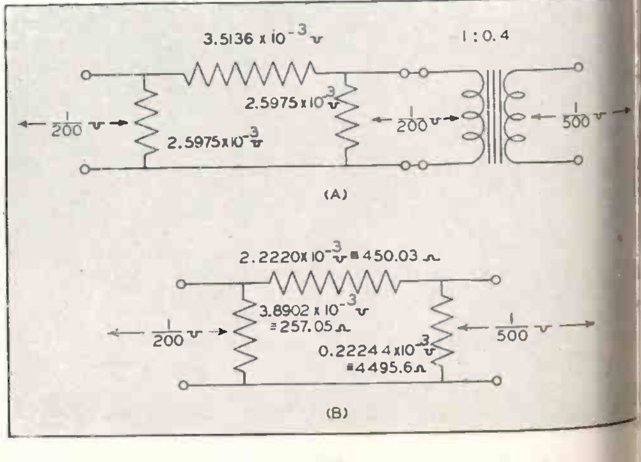


Fig. 4—Dissymmetrical pad of 10 db loss (B) equivalent to symmetrical and ideal transformer (A) both having the same loss

tanch element resistances as well as cıductances, obtained, of course, by tking the reciprocals of g_a', g_b' and g.

S:tion III—Design of Symmetrical T or π Attenuators

Ϝhere would be no point in repeatiı; here the design equations for s,nmetrical attenuators, since such ıiormation is readily available. Fwever, for those who do not wish tıcalculate the numerical values of b.nch resistance or conductance for s;ametrical attenuators, the graphs iı Fig. 5 are presented for conviience.

'he two curves in the figure provıe the basic design constants of T oıt pads of any constant impedance le:l, and of 0.1 to 100 db loss. The oıinate of the graph gives the bınch impedance of T pads, and the b nch admittance of π pads on a n malized basis, that is, on a 1 olı or 1 mho level. For any desired iredance or admittance level, multiy all the values from the curves fı the particular attenuator by the dired impedance or admittance le:l. The abscissa of the graph is tł desired attenuator loss, for which th branch values are to be determıed. Although the graph is selfe:lanatory, it may best be demonstıted by a numerical example.

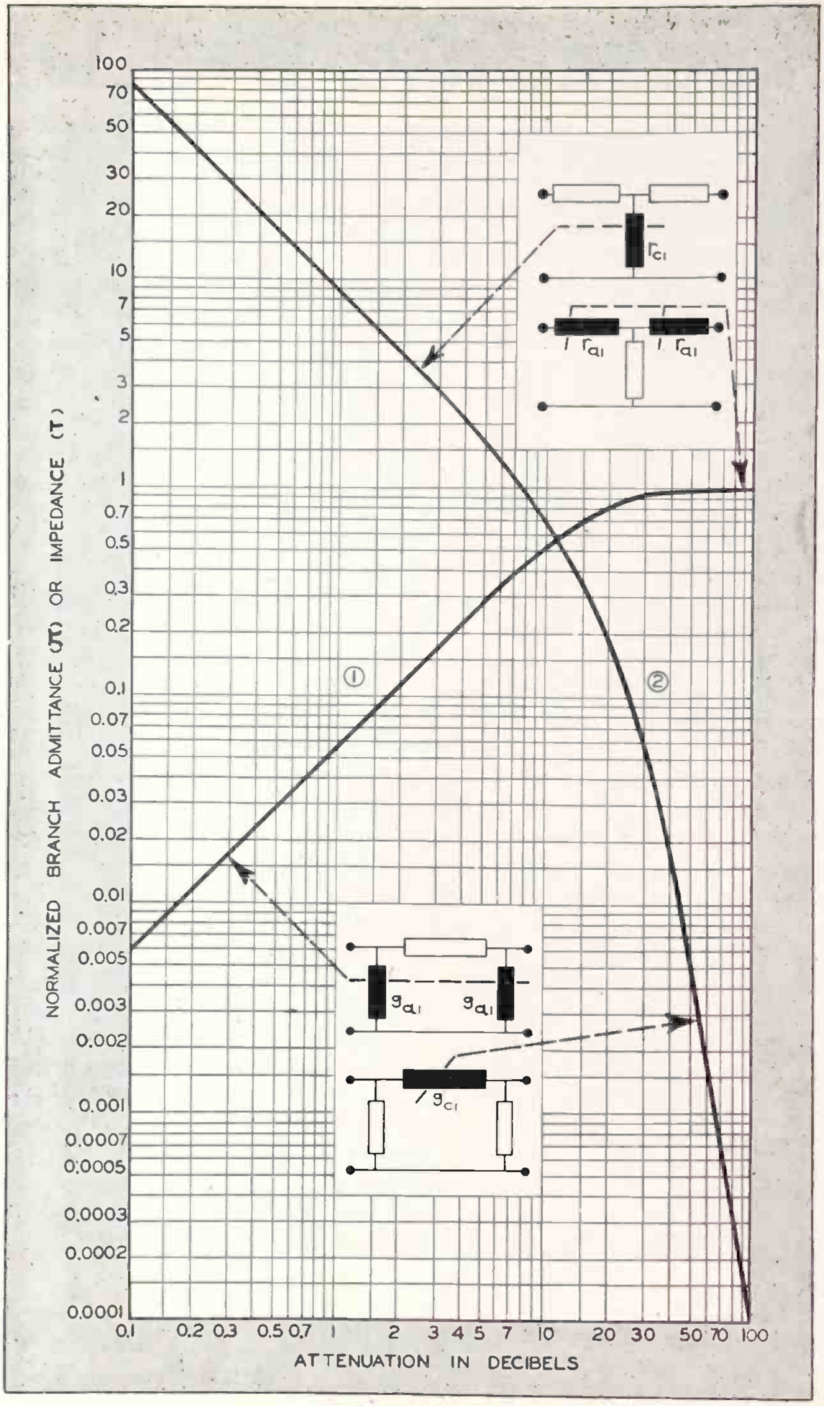


Fig. 5—Graph showing the normalized impedance or admittance for the series and shunt arms of T and π networks. Curve 1 applies to shunt elements of π network or series elements of T network, while curve 2 refers to shunt elements of T network or series elements of π network. The values obtained from this graph must be multiplied by the impedance level for which the symmetrical attenuator is designed

Numerical Example—T Pad

Rıuired: A 10 db T pad, 500 ohm inedance level. From curve 1, Fig. 5, /e find, at 10 db on the abscissa, th

$$r_{a1} = r_{b1} = 0.52,$$

aı from curve 2, still at 10 db on the ab:issa, we find that

$$r_{c1} = 0.70.$$

Tlse values are on a 1 ohm basis (ıat is the reason for the subscpt 1).

o obtain the branch resistances fo the 500-ohm level pad, multiply caı factor by 500, giving:

$$r_a = r_b = 0.52 \times 500 = 260 \text{ ohms}$$
$$r_c = 0.70 \times 500 = 350 \text{ ohms.}$$

Tlse values compare with r_a = 2575 and $r_c = 351.37$, obtained from ex:t equations, as given in the exanıle in Section I.

π Pad

Reıired: A π pad of 10 db loss, 200 ohı impedance level. We first recall thı on an admittance basis, this wıld be a 10 db pad of 1/200 mho adıittance level. From curve 1 of Fig. 5, we obtain at 10 db on the abscissa:

$$g_{a1} = g_{b1} = 0.52,$$

and similarly from curve 2,

$$g_{c1} = 0.70.$$

These values are on a 1 mho basis. To obtain the branch admittances on the required 1/200 mho admittance level, multiply each factor by 1/200, giving the branch conductances as:

$$g_a = g_b = 0.52 \times (1/200) = 2.6 \times 10^{-3} \text{ mho}$$
$$g_c = 0.70 \times (1/200) = 3.5 \times 10^{-3} \text{ mho}$$

These values compare with $g_a = g_b = 2.5975 \times 10^{-3}$ mho, and $g_c = 3.5136 \times 10^{-3}$ mho, obtained from exact computations, given in the numerical example in Section II.

ELECTRONIC Switching Simplifies

In carrier current communication systems, electron tubes are used to effect voice stimulat sequence operations to provide rapid and automatic conversations without feedback. Th article gives the outlines of one highly successful design

By J. D. BOOTH

Westinghouse Electric and Manufacturing Co., Baltimore, Md.

TODAY, many high voltage power transmission lines are being used for telephonic communication by radio. In power-line-carrier-communication, the high frequency currents travel along the power line and are not radiated into space. At each power station a complete high frequency transmitter and receiver are used. Because of electronic switching, the system is ready to transmit or receive signals almost instantly when a person speaks into any one of several microphones.

Since it is desirable to utilize only one carrier frequency for each communication channel, all of the transmitters and receivers are tuned to the same frequency. At each station, the transmitter output is connected in parallel with the receiver input and coupled through suitable insulating capacitors to the high voltage transmission line. Because of this parallel connection, when the system is transmitting, the local receiver must be shut off; and when receiving, the local transmitter must be inactive. In many space radio communication systems, the user is required to push a button to accomplish the transfer from receive to transmit. A newly developed voice controlled transfer scheme, working on electronic principles, has now eliminated the necessity of pushing a transfer button.

The transfer is accomplished by means of electron tubes, without any moving parts. The basic operation is indicated in Fig. 1. Two transmitter-receivers (the minimum quantity necessary for a channel) are shown with each divided into four parts: (A) transmitter input (audio system), (B) transmitter output (carrier system), (C) receiver input (carrier system) and (D) receiver output (audio system).

In the standby condition, i.e. no user talking, the input circuits A and C must be active and the output circuits B and D must be inactive. The reason for this is obvious when it is noted that the output terminals of B are directly connected to the input terminals of C and the output terminals of D are directly connected to the input terminals of A. For the "transmit" condition, A_1 and B_1 must operate, and C_1 and D_1 must be blocked. For the receive condition C_2 and D_2 must operate and A_2 and B_2 must be blocked. This requires four transfer functions which must be performed in the following order: (1) block local receiver carrier system (C_1), (2) actuate local transmitter carrier system (B_1), (3) block remote transmitter audio system (A_2), and (4) actuate remote receiver audio system (D_2).

These functions are initiated b speaking into the microphone of a ordinary telephone handset. The are accomplished in a very short tim to permit the person at the remo end of the channel to hear and unde stand the first syllable spoken. Whe the speaker stops talking, the syste must return to the standby cond tion as quickly as possible. The s quence for releasing the four tran fer functions is 2-1-4-3, 2-4-1-3, o 2-4-3-1.

Unfortunately, the difference b tween speech and noise is sometime only a matter of opinion. The ele tronic transfer circuits are unabl to select and respond exclusively t the proper sounds. In fact, the onl feasible method of accomplishin this choice is for the speaker to tal louder than the noise level at hi microphone. In some cases this i very simple. However, the energ content of some syllables is e tremely small. Also, the peak soun energy from some common source of noise, such as typewriters, is quit

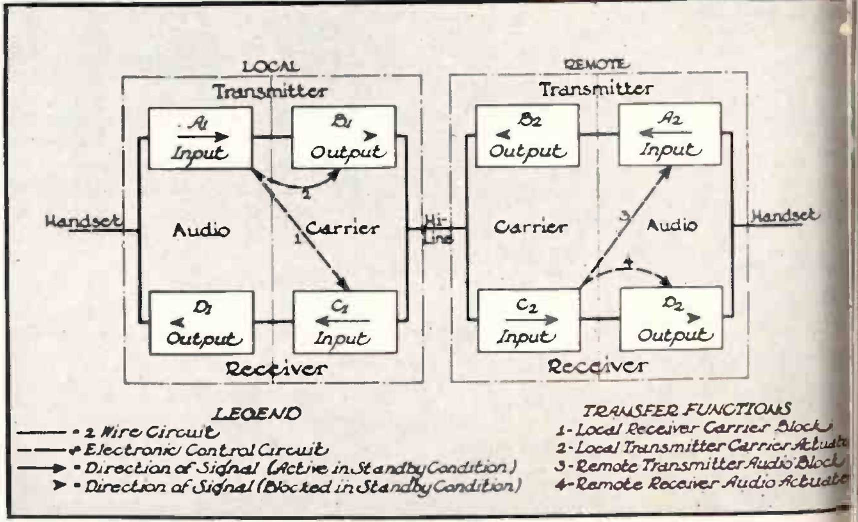


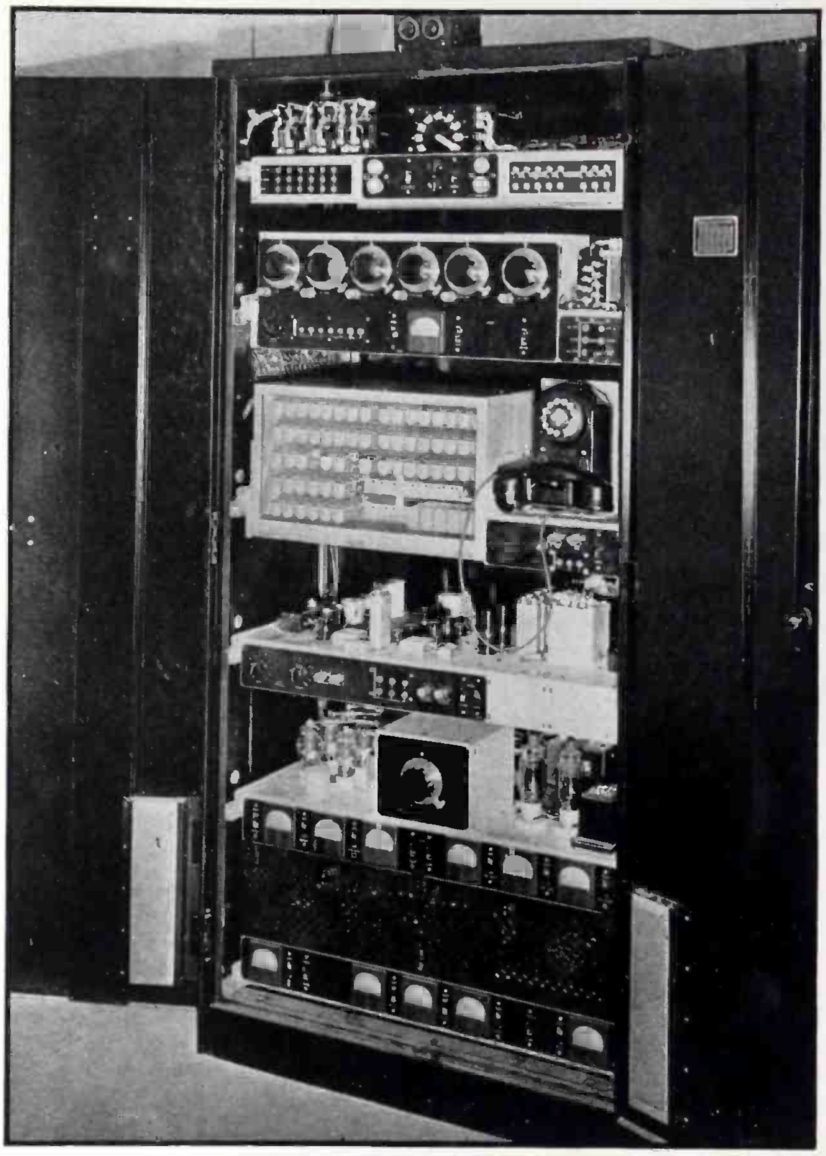
Fig. 1—Functional diagram, in block form, of power line carrier frequency channel with electronic switching control

POWER-LINE COMMUNICATIONS

gh. To guard against the undesir-
le transmission of such noises, the
cuits may be so arranged that
unds of short duration even if
ther high in amplitude will not
use transmissions.

It is not so easy to take care of the
de variations between syllables and
tween different speakers. The most
actical solution seems to be to pro-
le a slight time delay in releasing
nction 2. This insures the trans-
ssion of weak syllables following
atively louder ones and greatly
proves the intelligibility. To take
re of weak syllables preceding
ich louder ones, a quick-acting au-
tnatic gain control in the speech
plifier of the transmitter is used.
assure the proper sequence of
nsfer functions under all condi-
ns, the circuits are so arranged
t a gradual increase in the in-
sity of sound at the microphone
kes them operate in the same or-
as if the initial sound were very
d.

o understand how these various
ctions are performed, it is neces-
y to delve more deeply into the
uit details. (See Fig. 2.) For
ction 1, speech is amplified by the
iable gain and isolation amplifiers.
is then rectified and is applied as
ositive voltage to the grid of the
eiver blocker tube to overcome
high negative bias which holds
tube well beyond cutoff for the standby condition. The plate current of the receiver blocker tube passes through a resistor in the receiver carrier amplifier grid circuit. A very high bias is thus applied to cut off the receiver. For function 2, a portion of the output of the isolation amplifier is rectified. Negative voltage is applied to the grid of the transmitter actuator tube. The blocking of this actuator tube starts the transmission of carrier because the plate current of this tube passes through a resistor in the master oscillator screen circuit and holds the screen negative for the standby



General view of power line carrier frequency communication system in steel protective cabinet

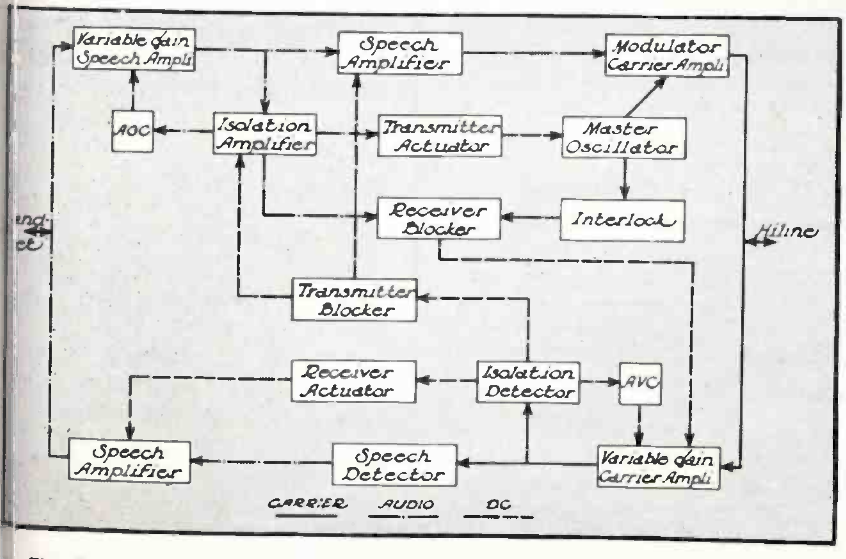


Fig. 2—Functional diagram of transmitter and receiver for the power line carrier frequency system

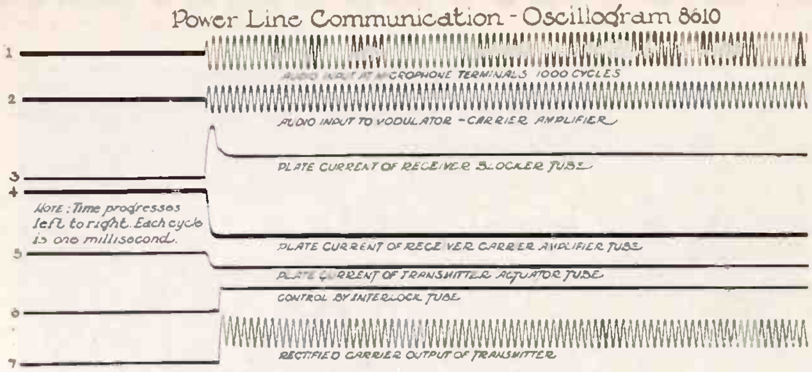


Fig. 3A—Oscillograms illustrating application of input tone

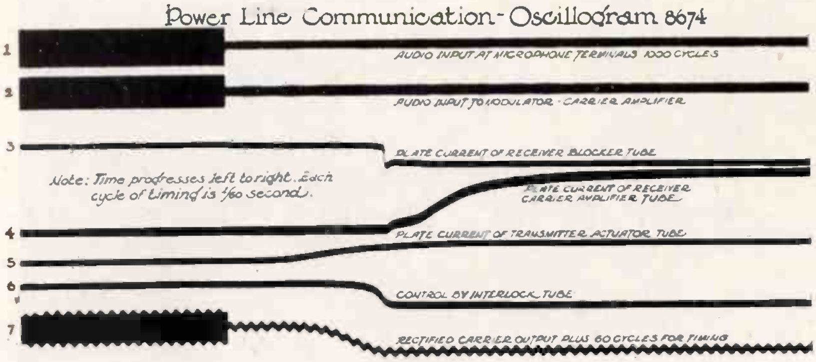


Fig. 3B—Oscillogram showing stopping of input tone

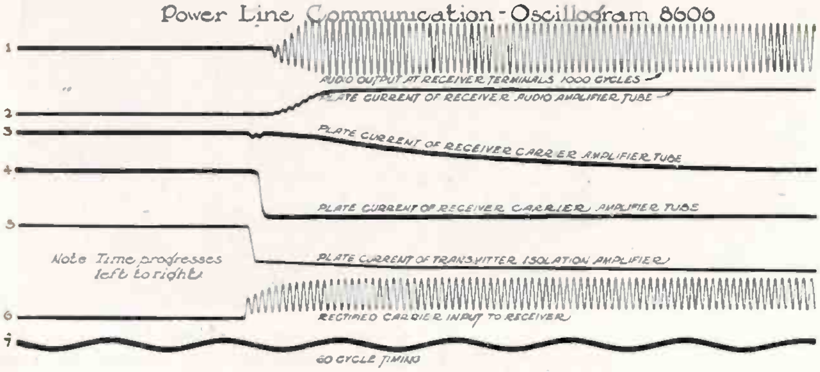


Fig. 3C—Oscillograms illustrating operation of carrier system showing that transmitter speech and isolation amplifier are cut off immediately when audio input is applied

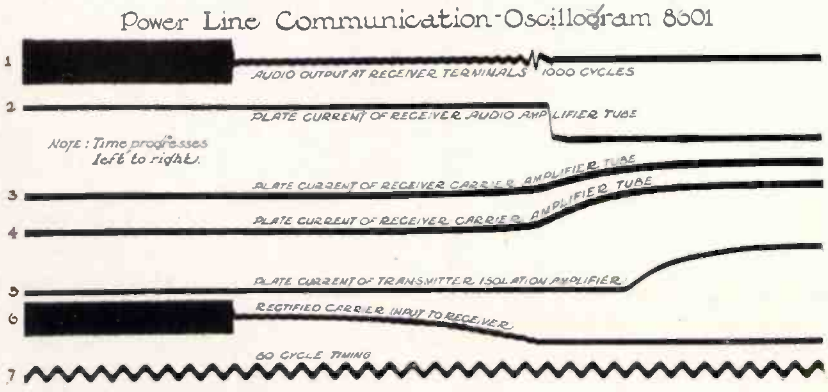


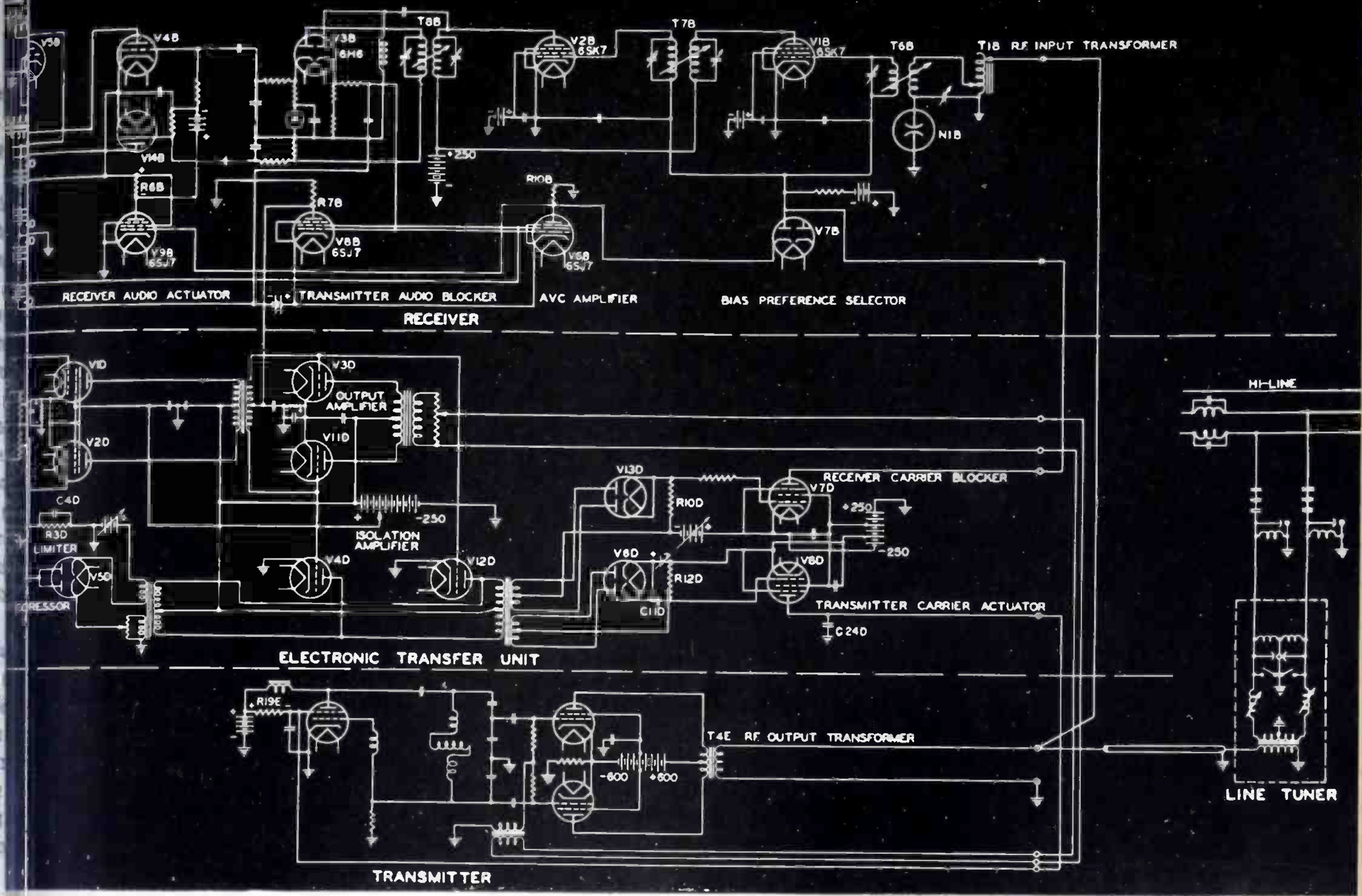
Fig. 3D—Oscillogram illustrating return of carrier system to normal or stand-by operation

condition required at this ti
For function 3, the received c
rier is amplified and rectified. Po
tive voltage is applied to the grid
the transmitter blocker tube wh
is held considerably negative for
standby condition. The plate c
rent of this tube passes through
resistor in the grid circuits of
speech and isolation amplifiers in
transmitter circuit. This provi
blocking bias for the transmit
audio system. For function 4, a n
ative voltage is applied to the g
of the receiver actuator tube. T
plate current of the receiver actua
tube controls the bias of the spe
amplifier tubes in the receiver wh
are cut off for the standby conditi
Thus, the receiver audio system
made active.

To produce the proper release
quence, an interlock circuit as sho
in Fig. 2 is provided which holds t
receiver blocked after speech st
as long as the transmitter mas
oscillator is operating. The A
and AVC circuits shown in Fig. 2
conventional except that they oper
almost instantaneously.

The control tubes (type 6SJ7)
standard high vacuum, high-μ, sha
cut-off pentodes. The trigger acti
is due to the circuits used and p
ticularly to the use of high cont
voltages and high biases. The use
high vacuum tubes practically eli
inates the effects of ambient temp
ature which are rather serious
the case of certain types of gas fil
tubes. Furthermore, the necesity f
interrupting the plate voltage
stop ionization is, of course, elimi
ated. The use of standard recei
tubes in the preferred series not o
minimizes the upkeep cost but
cilitates obtaining replaceme
when necessary. All tubes in the
sign may be had in the open mark

The tests shown in Fig. 3 we
made at the factory using a dumm
transmission line in place of t
high voltage power line. The top li
of oscillogram 8610 shows the app
cation of a 1000 cps tone as a su
stitute for speech. With this su
stitute, the functioning of the sy
tem is the same as when an operat
speaks into the microphone. T
second line shows that modulation
instantly applied to the modulato
carrier amplifier. The third li
shows the pulse delivered by the r
ceiver blocker to the receiver ca
rier amplifier grids. The fourth li



pansion of Fig. 2 into a simple practical diagram. Micro- ione output goes to V1D, V2D, V4D and V12D. For transfer nction 1 (local receiver carrier block) output of V12D is recti- d by V13D and amplified by V7D to appear across a resistor the receiver carrier amplifier grid circuit to block the plate rrent of V1B and V2B. For transfer function 2 (local trans- tor carrier actuate) amplified a-f from V4D and V12D is ctified by V6D to block plate current of V8D. At the receiv- station, modulated carrier passes from hiline through upling capacitors, line coupling tuner, coaxial cable to V1B d is amplified by V1B, T7B, and V2B. V3B acts as a de- tor for transfer function 3 (remote transmitter audio block) and its filtered d-c output is amplified by V8D to block V3D, V11D, V4D and V12D preventing transmission from the local station until the distant station speaker ceases talking and releases the channel. Transfer function 4 (remote receiver audio actuate) is accomplished by operating the grids of V6B and V8B in parallel. V6B controls gain of the receiver carrier amplifiers, and blocks V9B when a carrier of usable magnitude is received. Plate current of V9B flows through R6B and normally blocks a-f amplifiers V4B and V14B, by the drop across R6B. Thus there is no audio output from the receiver until a sufficient carrier has been received to block the transmitter audio amplifier

shows that the plate current of the receiver carrier amplifier is cut off completely in less than 2 milliseconds. The fifth line shows that the transmitter actuator plate current also is cut off in less than 2 milliseconds. The seventh line shows modulated carrier slightly delayed by a capacitor discharge circuit to provide the proper starting sequence. The sixth line shows the interlock taking control instantly when carrier becomes available.

Oscillogram 8674 shows the results of stopping the input tone. Note that the transmitter actuator, line 5, does not block the oscillator abruptly since this might cause objectionable transients (clicks). A 60-cycle timing current was added to line 7. This shows that the carrier persisted almost 250 milliseconds after the input tone stopped.

Oscillogram 8606 illustrates functions C and D. The sixth line shows the application of a modulated carrier to the input terminals of the receiver. The fifth line shows that the transmitter speech and isolation amplifiers were cut off almost immediately. Lines 3 and 4 show that the plate currents of the first and second stages of the receiver carrier frequency amplifier are reduced by the automatic volume control. One of these stages is controlled very quickly and overshoots somewhat. The other stage is controlled much more gradually to maintain a more nearly uniform output. Line 2 shows that the receiver speech amplifier becomes gradually active in the proper sequence. Line 1 shows the receiver speech output to the listener. The gradual build-up is coordinated with the automatic sensitivity control characteristics of the human ear so as to provide better intelligibility than would result from an instantaneous start at or above the final level.

Oscillogram 8601 shows the return of the receiver to standby conditions after the cessation of speech.

These oscillograms clearly indicate that both the transmitter and the receiver are made active from the standby condition very quickly. In fact, the transfer takes place so rapidly that the delay is not noticeable. The users of this communication system seldom realize that they are unable to talk in both directions at the same time until the listener tries to interrupt the speaker. Then, the listener is reminded that he must be polite and wait until the speaker stops to take a breath. Fortunately, most speakers breathe quite frequently and, in so doing, allow the circuits to return to the standby condition.

Wave Form Circuits for CATHODE

Mr. Lewis concludes his summary of circuit arrangements for providing timing axes an waveform control in cathode-ray tube oscillography by dealing with amplitude and im pedance methods of changing wave shape

By H. M. LEWIS
Consulting Engineer

The first part of this article, published in the July 1942 issue of ELECTRONICS, dealt with the fundamentals of cathode-ray oscilloscopes and some fundamental forms of *RC* and *R/L* generators used as timing axes. The second and concluding part continues with a discussion of additional means of providing waveform circuits.

The circuit arrangement of Fig. 13 is one which is frequently employed to produce saw-tooth current in an inductance for magnetic scanning in television. This circuit illustrates, in the broadest way, the impedance control of waveform.

As an initial source we have the low voltage impulse wave, e_o, of the group of waves labelled *A*. The output circuit of V_1, termed a shaping circuit, is comprised of $R_1C_1L_1$ in series and the voltage across this load impedance is of the complex form, e_1. The output circuit of V_2 is the impedance comprised of the scanning inductance, L_2, with inherent shunt capacitance C_2 and resistance, R_2. With a proper choice of circuit constants in the shaping circuit, the output voltage, e_2 is a large amplitude impulse of the same form as e_o. The relations required fo reproducing the original waveform are:

$$L_1 C_1 = L_2 C_2 \qquad (2$$
$$L_1/R_1 = C_2 R_2 \qquad (3$$
$$C_1 R_1 = L_2/R_2 \qquad (4$$

In other words the series circuit i tuned to the same resonant frequency as the parallel circuit an the *RC* time constants of one circuit equal the *L/R* time constants of th other.

To understand the circuit operation clearly we must refer to the saw-tooth derivative series shown in Fig. 14. This series of related waveforms is such that each waveform is the mathematical derivative of the form immediately below it. Thus the double impulse *A* is the derivative with respect to time of the impulse wave *B*, which is the derivative of the saw-tooth wave *C*, which is the derivative of the parobolic impulse wave *D*. The series may be extended in either direction. Conversely we may say that *B* is the integral of *A*; *C* is the integral of *B* and so forth.

These four forms are commonly encountered in reactive circuits since the current through a condenser is the time derivative of the voltage across the condenser; the voltage across an inductance is the time derivative of the current through the inductance. i.e.,

$$e = L \frac{di}{dt} \qquad (5)$$

$$i = C \frac{de}{dt} \qquad (6)$$

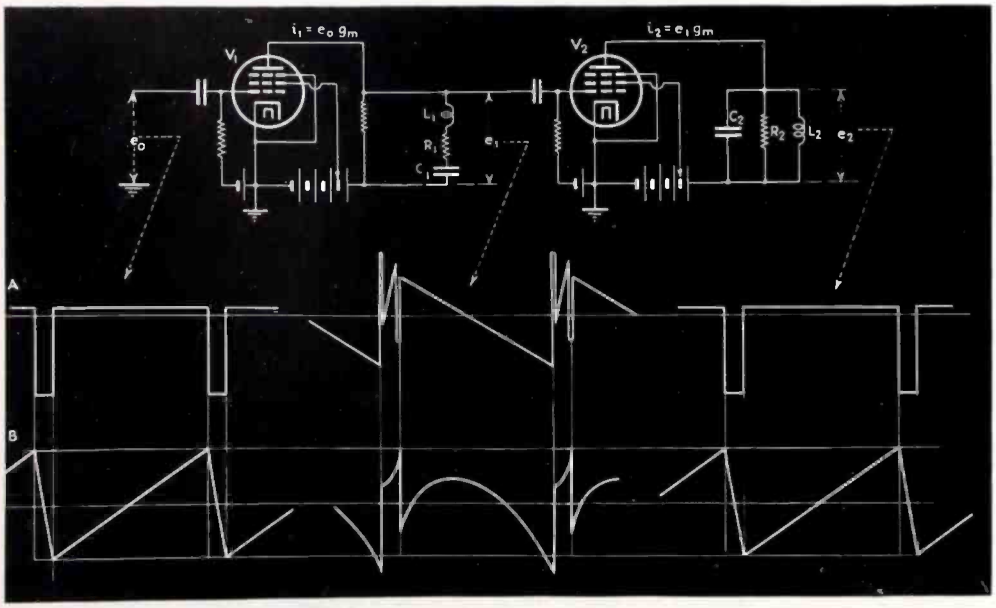


Fig. 13—A two-stage amplifier with series circuit in output of first stage and parallel circuit in output of second stage. If the values of these output circuit constants are properly selected, the output waveform is a replica of the input

RAY TUBES—Part II

Another way of saying it, is that ch waveform represents the rate of ange of the waveform immediately llow it. For example each trace and trace of the saw-tooth *C* is shown a straight line of constant slope. nce the retrace interval of the lse wave *B* is at a constant height oportional to the steepness of the w-tooth retrace and in the posi- e direction since the saw-tooth race has a positive slope. The ce interval of *B* is negative and stant at a value corresponding to lesser negative slope of the saw- th trace.

The double impulse *A* would be nprised of points at plus and nus infinity if the sides of the se *B* were infinitely steep as dwn. In practice this cannot be e and finite double impulse forms readily obtained usually with onential sides due to distributed acities. The waveform *D* is a abola during the trace interval ied to an opposite small parabola ng the retrace interval.

he waves are all shown with an axis since in coupling through sformers and capacities a d-c ponent will not be translated. l it is to be observed that, since average value of an a-c wave over omplete cycle is zero, the areas he wave above and below the are equal.

ecurrent waveforms may be re- ed into harmonic series of sine n cosine components by means of ourier series analysis. This has done*, for the saw-tooth wave- n *C* and the corresponding series waves *B* and *D* then obtained by rention and integration respec- y. In summation-form these s are:—

$$\text{olic wave}\left\{ i = \sum_{m=1}^{m=\infty}\left(\frac{2I}{\pi^2\omega}\cdot\frac{\sin m\,b\,\pi}{b\,(1-b)}\cdot\frac{1}{m^3}\right)\cos m\,\omega\,t \right. \qquad (7)$$

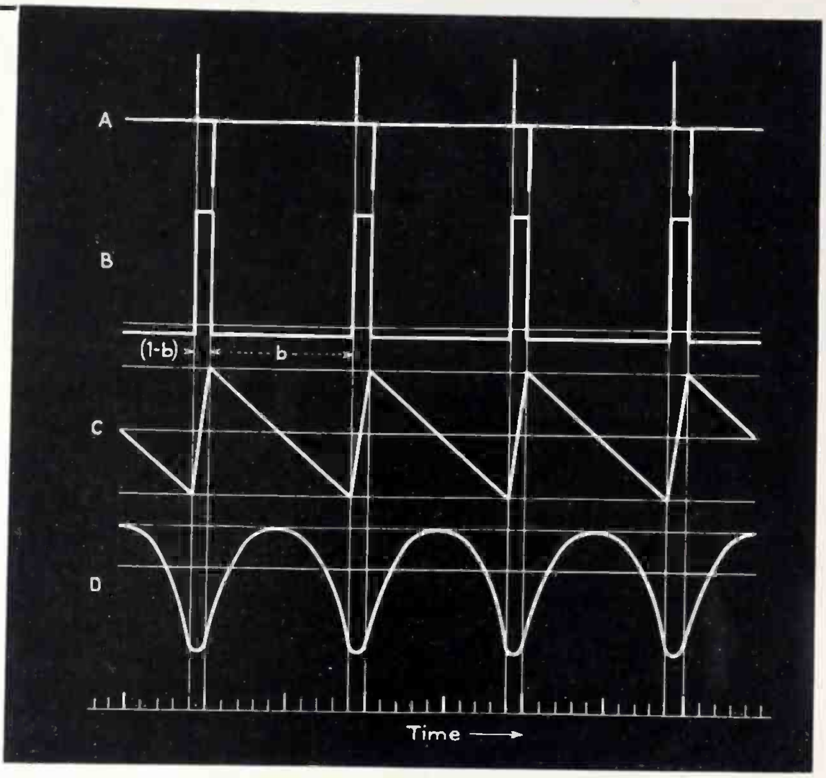


Fig. 14—Derivative and integral waveforms frequently encountered. Any one waveform is the derivative of the waveform immediately below it; conversely it is the integral of the waveform immediately above it

$$\text{Saw-tooth wave}\left\{ i' = -\sum_{m=1}^{m=\infty}\left(\frac{2I}{\pi^2}\cdot\frac{\sin m\,b\,\pi}{b\,(1-b}\cdot\frac{1}{m^2}\right)\sin m\,\omega\,t \right. \qquad (8)$$

$$\text{Impulse wave}\left\{ i'' = -\sum_{m=1}^{m=\infty}\left(\frac{2I}{\pi^2}\omega\,\frac{\sin m\,b\,\pi}{b\,(1-b)}\cdot\frac{1}{m}\right)\cos m\,\omega\,t \right. \qquad (9)$$

where $\omega = 2\,\pi\,f$

m is the order of harmonic

b is the fraction of cycle during which trace occurs.

Returning now to Fig. 13 it will be evident that, since pentodes are employed, the current i_1 through the series circuit is of the same waveform as the grid voltage e_o. For the applied pulse *A* we have then a pulse voltage across R_1, a saw-tooth voltage across C_1 and a double impulse voltage across L_1. The addition of these three waveforms is the complex voltage e_1 as inspection will reveal.

The output current i_2 from tube V_2 will therefore be of this waveform. In order that e_2 shall be of impulse waveform the double impulse current component must flow through C_2, the impulse component through R_2 and the saw-tooth component through L_2 since this condition is required by the derivative series. The choice of the impedence elements with the relations previously given will produce this division of the complex current components through the several parallel elements.

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*By Madison Cawein, Unpublished Report—April 1938.

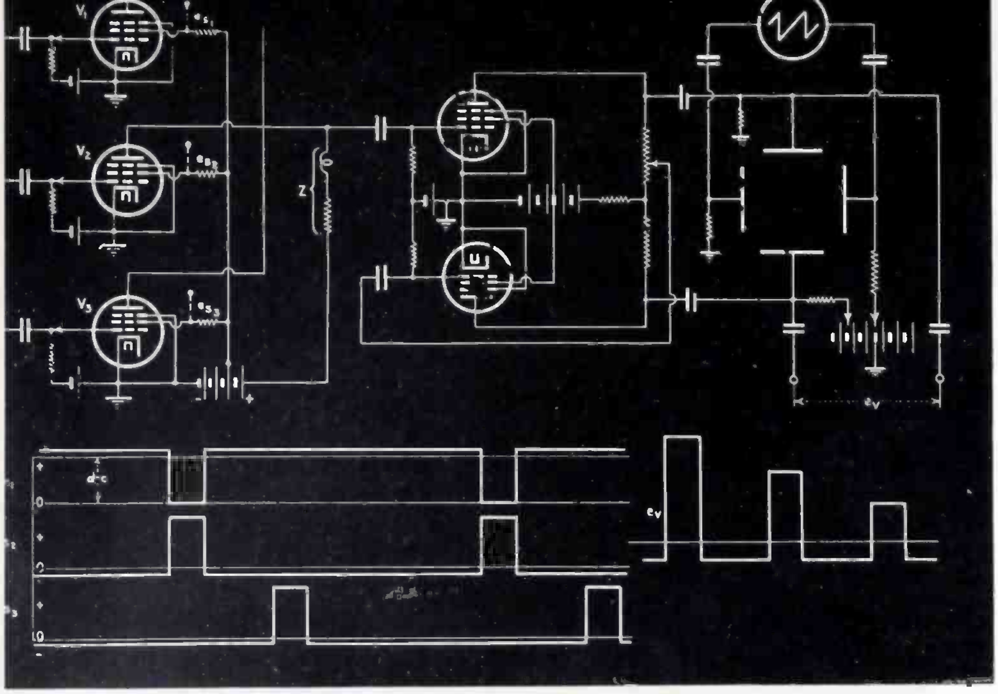


Fig. 15—By applying various input voltages to the grids of the amplifier tubes V_1, V_2, and V_3, these voltages may be combined and the resultant effect viewed on the screen of the cathode-ray tube

For electrostatic deflection, the circuit of Fig. 13 is also employed to develop saw-tooth voltage across the inductance, L_2, or across a secondary winding coupled to L_2. This is illustrated in the series of waveforms labelled *B*, where the initial source of voltage, e_o, is of saw-tooth form. The voltage across the shaping circuit is the complex form, e_1, and is comprised of a saw-tooth component across R_1, a parabolic component across C_1, and an impulse component across L_1. The output voltage is of the required saw-tooth form. The current through L_2 is of parabolic form while currents through the shunt elements, R_2 and C_2 are of saw-tooth and impulse form, respectively.

Since all periodic waveforms are comprised of a fundamental plus a large number of harmonic frequencies the waveforms are readily modified by frequency discrimination. Hence care must be taken in translating waveforms to provide circuits of suitable bandwidth and linear phase characteristics. The characteristics of filter and other networks are now commonly studied by observing the waveform at the filter output as compared with that applie at the input. The square wave, pulse having equal trace and retrac intervals, is frequently employed fo this purpose since the changes du to frequency and phase distortion ar easily recognized. A number of articles on this form of testing hav recently appeared in the literatur

Amplitude Control of Wave Form

The complex waveform e_1 of curv *A* Fig. 13 could of course be mad up by combining components of puls saw-tooth, and double pulse derive from separate sources in chose amplitude. Many complex forms i television practice are made up b such addition and subtraction.

A general circuit arrangement fo combining waveforms and viewin them on an oscillograph is shown i Fig. 15. The several waveforms wil be applied to the grids of the thre pentode amplifiers having a commo impedance load *Z*. The combine voltage is thereby developed at th input of the balanced amplifier and so applied to the vertical deflection plates of the oscilloscope. Some complex waveforms, for example those of the standard television synchronizing signal, are made up of sections of one type of pulse which is abruptly changed during intervals to another type. This is accomplished by "keying." Thus a group of keying signals are developed by relaxation oscillators such as the pulse

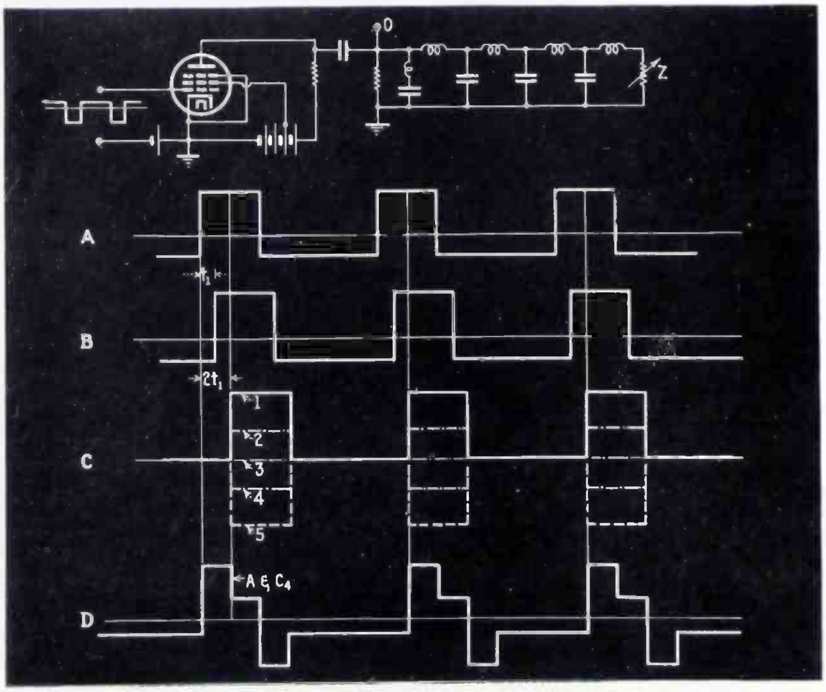


Fig. 16—An artificial line provides time delay of input pulses, which may then be combined with other voltages to form new wave shapes

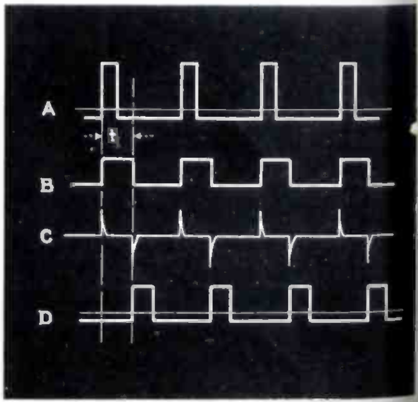
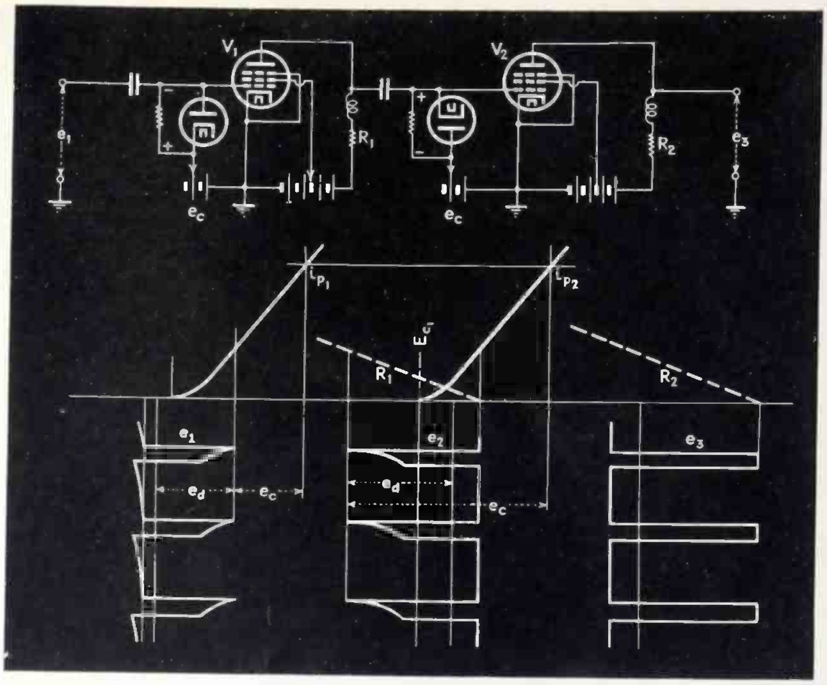


Fig. 17—A square-wave generator rather than the transmission line may be used to provide suitable time delays



g. 19—Circuit for providing successively, amplification and clipping of signal, to produce wave pulses with steep sides

waves e_{s1}, e_{s2} and e_{s3}. Each screen grid d-c voltage connection is suitably chosen and the pulse voltages are applied at the respective screen grid connections as indicated. It is evident that e_{s1} is the same as e_{s2} but oppositely poled and augmented by a d-c potential. Hence the major part of the time the component from V is alone transmitted. When the pulse occurs V_1 is keyed out and V_2 is keyed in to change the waveform during the pulse interval. When the pulse of V_3 occurs the signal from V is added to that of V_1 for the duration of the pulse interval.

It is often desirable to view certain sections of a long cycle of complex waveforms. This may be accomplished by keying the position of the time axis on the oscillograph screen. For example a composite wave of pulses of different height such as e_v may be made up from three pulse sources by means of a combining amplifier. This will be applied as indicated to the vertical plates to change the position of the vertical axis. The frequency of horizontal saw tooth deflection will also be increased so that a single horizontal time axis trace occurs during each pulse interval. Thus we may view three sections of the complex cycle simultaneously and compare the waveforms of these sections. An example of this type of waveform viewing is shown on the cover of ELECTRONICS for April 1939 where sections of the "odd" and "even" portions of a complete cycle of television synchronizing signal are shown as separate and directly comparable intervals. Keying pulses are often applied to the grid of the oscillograph tube to blank (blackout) the screen except during predetermined intervals which are to be observed.

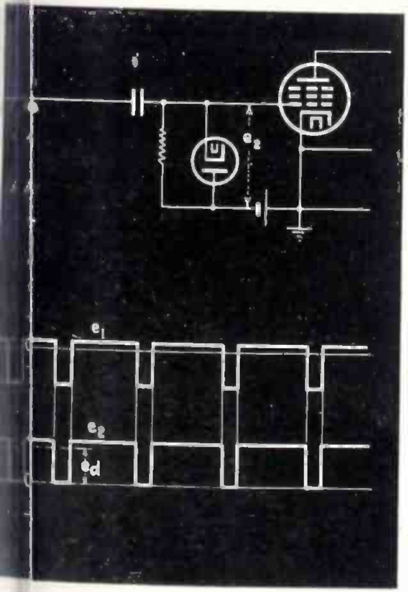


Fig 18—Circuit for operating pulse waveforms from a fixed level

Frequently a desired waveform may be built by the addition or subtraction of available forms and by delaying and then combining these forms. A long artificial line is frequently employed to provide short delays. Thus in Fig. 16 if the artificial line is designed to pass the essential frequency band of a pulse voltage such as A applied to the input, then the voltage wave at the far end is of the same form delayed by the time interval t_1 as shown at B. If the far end is terminated by a resistance Z equal to the surge impedance of the line no reflection occurs. If however we vary Z and if the generator end is also terminated to avoid a second reflection then the wave reflected back to the generator end will be delayed by the interval $2t_1$ as shown at curve C. However the amplitude and polarity of the reflected wave will depend on the far end termination, Z.

If Z is infinite (open circuit) the reflected wave is shown by the solid line waveform (1). If Z is somewhat greater than the surge impedence the reflected wave is decreased in amplitude as at (2). No reflection is indicated at (3) when Z equals the surge impedance. Reflection with reverse polarity indicated at (4) occurs with Z less than the surge impedence and full amplitude with reverse polarity as shown at (5) occurs when the far end is short circuited.

The output waveform viewed at O may therefore be varied in form by varying Z. The waveform shown at (D) is an example of the form due to the original wave (A) and the reflected wave (C_4). The waveform viewed at various points along the line will differ due to the difference in delays between the transmitted and reflected waves. If only the delayed wave is wanted it may be obtained with the total delay $2t_1$ by applying the voltage O, and the grid voltage of the tube, to inputs of a combining amplifier whereby the component form A is neutralized and reflected wave C is developed.

Because of the long lines required and the care required in building them, electronic methods are generally more serviceable in obtaining long delays of impulse waveforms. In Fig. 17 we have a pulse waveform A and our problem is to obtain a related form D which is delayed by the interval t_1 and has the pulse intervals as shown. Our procedure

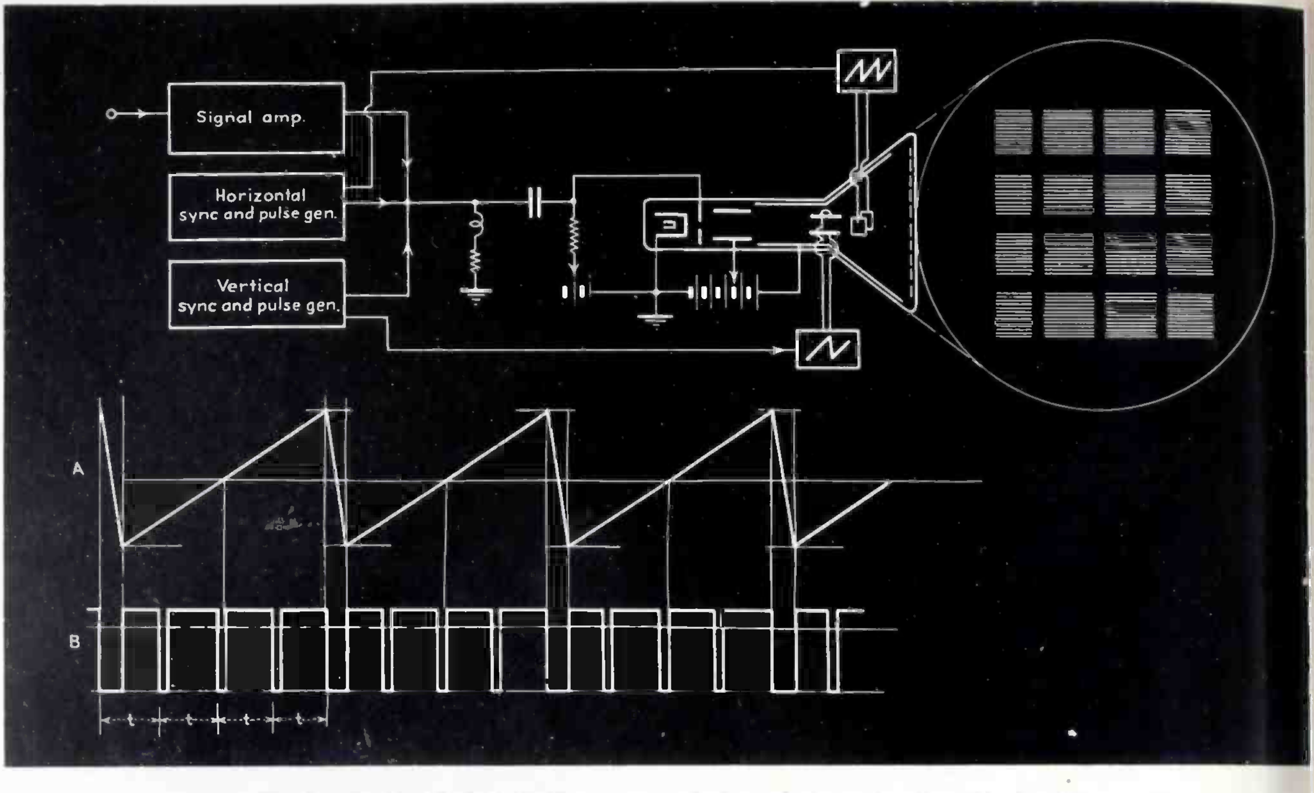


Fig. 20—Functional diagram illustrating method of obtaining two-dimensional saw-tooth deflection on screen of cathode-ray tube with vertical and horizontal scanning

is to use wave *A* to synchronize a relaxation oscillator at the same periodicity and to adjust the circuit constants of the oscillator so that the pulse intervals correspond to the delay interval t_1. In any circuit path of the oscillator which carries current of the form *B* we insert a small inductance or transformer so that double pulse voltage of the differentiated waveform *C* is developed across a winding. This voltage is applied to a second relaxation oscillator in polarity such that synchronization is effected by the second pulse of the pair. This gives us a source of pulses suitably delayed and by adjusting the circuit constants of this second oscillator to give the desired pulse intervals we achieve the required waveform *D*.

It will be noted that the waveforms have been shown relative to an a-c axis which divides the area equally above and below the axis. The amplitude of a pulse relative to the axis will thus depend automatically upon the ratio of trace to retrace time. Referring back to the waves of the derivative series (Fig. 14) it will be seen that the saw-tooth *C* has a value of $b = 0.9$. The corresponding pulse wave *B* therefore has the positive amplitude 9 times that of the negative amplitude.

It is frequently necessary to operate pulse waveforms from a fixed level irrespective of its interval ratios. This is termed stabilization and is generally effected by employing a diode to develop a d-c component equal to the peak value of the wave. Thus in Fig. 18 the a-c impulse wave coupled to the vacuum tube grid is that shown as e_1. The diode converts this wave to the form shown as e_2. This is because the diode, poled as shown, draws a small amount of current at each pulse peak to develop and maintain the positive d-c component e_d. If e_1 is of opposite polarity it is preferable to reverse the diode to develop a negative peak value of d-c stabilizing potential. Frequently the control grid of the vacuum tube may then be used in place of a diode to stabilize the wave by drawing a small amount of grid current as each positive peak occurs.

In the best of the circuits we have been discussing the precise pulse waveforms are not generally available. They generally occur in the exponential form first mentioned and are thereafter shaped by limiting or clipping. This is generally done by applying the pulse wave in large amplitude to a vacuum tube stage or stages as shown in Fig. 19. Stabilization as also illustrated in this circuit will generally be employed. The diagrams show that the waveform e_1 is set partially beyond cutoff of the characteristic i_{p1} of tube V_1 due to the battery bias e_c and stabilizing diode bias e_d. The output voltage developed across R_1 is the amplified form e_2 having flat trace intervals. The wave e_2 is set with the peaks beyond cut-off of the characteristic i_{p2} of V_2 by battery bias e_c and diode bias e_d so that the output voltage developed across R_2 is the desired pulse e_3. By this successive process of amplification and limiting we may produce pulses with sides as steep as our circuits permit.

Expanded Time Bases

Two dimensional saw-tooth deflection is common in television wherein the horizontal traces are spread vertically by a second lower frequency vertical saw-tooth deflection voltage to form a grid of lines or picture area. This process is shown in Fig. 20. The pulse generators indicated in block diagram each include sub-multiple pulse generators so that a waveform such as *B* related to the scanning waveform *A* is developed in each unit. The waves of form *B* from each unit are applied to the control grid as shown to blank the retrace and establish dark lines corresponding to the pulse peaks which divide the screen area into time intervals. A standard source of frequency may be employed to synchronize the horizontal and vertical pulse generators so that precise time intervals of known value are established. Signals whose time durations are to be determined are then added to the grid voltage by the amplifier shown. Their effect of brightening or darkening of the screen marks their position on this two dimensional time scale. Systems for depicting various network characteristics have been developed using this type of expended time scale.

Another two-dimensional time scale is the circular trace of Fig. 21. A phase splitting network serves to provide time quadrature sinusoidal deflection voltages to the deflection plates which are in space quadrature. An elliptical trace results which becomes circular when the two deflection fields are of equal amplitude. This is a case of rotating electrostatic field.

Thus

$$x = K_1 e_h = K_1 E_1 \cos \omega t \qquad (10)$$

where e_h is horizontal deflection voltage

$$y = K_2 e_v = K_2 E_2 \sin \omega t \qquad (11)$$

where e_v is vertical deflection voltage

$$x^2 + y^2 = \rho^2 \qquad (12)$$

From Eq. (10) and (11) above we may write

$$\frac{x^2}{(K_1 E_1)^2} + \frac{y^2}{(K_2 E_2)^2} = \sin^2 \omega t + \cos^2 \omega t = 1 \qquad (13)$$

which is the equation of an ellipse, If $K_1 E_1 = K_2 E_2$ then, with (12) above

$$x^2 + y^2 = (K_1 E_1)^2 = \rho^2 \qquad (14)$$

which is the equation of a circle. Also we note that

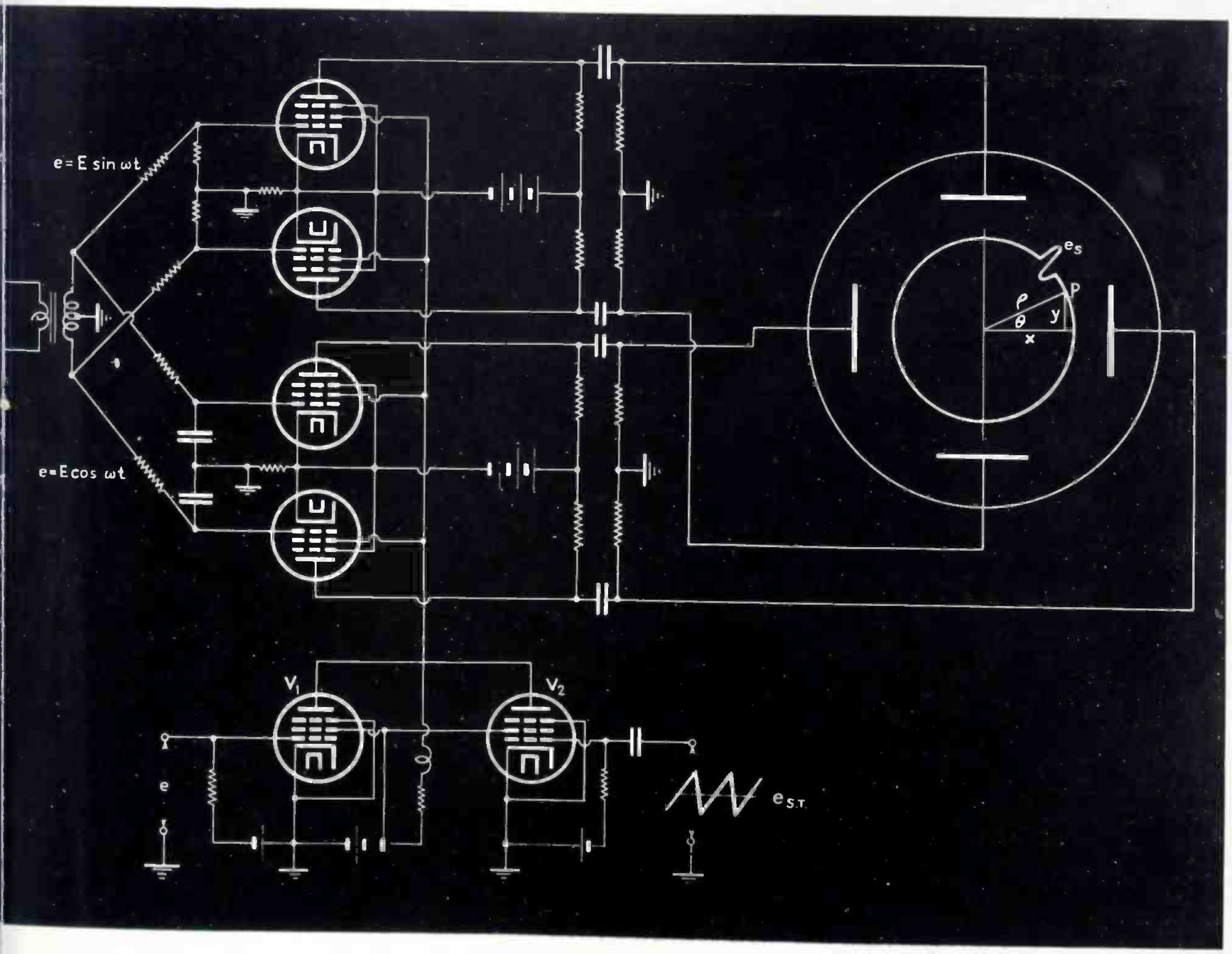
$$\theta = \tan^{-1} \frac{y}{x} = \omega t$$

when the trace is a circle.

Ordinarily the deflection sensitivities K_1 and K_2 of the two pairs of plates are sufficiently equal so that we need simply make the deflection voltages equal to obtain a circular trace. The radius of the circle, which the spot traces at angular velocity ωt is then directly proportional to the voltage E as Eq. (14) shows. A signal e_s applied to V_1 is effective therefore to change the radius of the circle, as indicated on the diagram. If the signal e_s is periodic at the frequency $f = \omega/2\pi$ then the ripple it produces on the circular trace is stationary. If e_s differs in frequency from f it will move around the circle.

If a saw-tooth voltage is applied to the tube V_2 as shown, then it will be evident that the radius of the circular trace will change linearly with time. If the periodicity of this saw-tooth voltage is f_{st} and lower than f, then the trace becomes a spiral which is stationary if f_{st} is a submultiple of f. Otherwise the spiral will rotate. If f_{st} is much higher than f then the diagram becomes radial; like a series of spokes radiating from a central hub. Signals applied to the oscillograph grid or to the tube V_1 will register on these expanded time scales and a variety of useful arrangements are possible.

Fig. 21—Phase splitting circuits are employed to produce two-dimensional deflections in polar coordinates



Notes on Band Pass

By H. HOLUBOW

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THE following notes represent simplifications in methods of calculating the performance of band pass and band elimination filters, especially when it is necessary to allow for the dissipation in the coils. The usual notation holds, i.e., F_1 and F_2 are the critical frequencies (cut-off), F_m is the median frequency in the critical band, R is the terminating resistance.

Band Pass Filters

Although there are a number of networks which may be used as band pass filters, the constant K type, shown in Fig. 1, is most commonly employed. In this structure, the product of the series and shunt element impedances, Z_1 and Z_2 respectively, is a constant equal to K^2. The expected performance of the band pass filter is usually obtained graphically from the values of $Z_1/4Z_2$. These values are usually given in texts and handbooks in terms of the cut-off frequencies. The calculation of $Z_1/4Z_2$ becomes quite cumbersome when dissipation must be taken into account, but the simplifications that follow are useful in that they do not entail much sacrifice in accuracy.

The impedance of the series arm Z_1 at any frequency F_{11} may be expressed as follows:

$$Z_1 = j\, 2\pi\, F_{11}\, L_1 - j \frac{1}{2\pi\, F_{11}\, C} =$$

$$j \left[\frac{2\pi\, RF_{11}}{\pi\, (F_2 - F_1} - \frac{4\pi\, F_2\, F_1\, R}{2\pi\, F_{11}\, (F_2 - F_1)} \right]$$

Simplifying,

$$Z_1 = j\, 2R \frac{F_{11}^2 - F_2\, F_1}{F_{11}\, (F_2 - F_1)}$$

The impedance of the shunt arm

$$Z_2 = \frac{1}{\dfrac{1}{j\, 2\pi\, F_{11}\, L_2} + j\, 2\pi\, F_{11}\, C_2} =$$

$$j \frac{2\pi\, F_{11}\, L_2}{1 - 4\pi^2\, F_{11}^2\, L_2\, C_2}$$

Substituting for L_2 and C_2 their values from Fig. 1,

$$Z_2 = j \frac{RF_{11}\, (F_2 - F_1)}{2\, (F_2\, F_1 - F_{11}^2)}$$

whence

$$\frac{Z_1}{2\, Z_2} = \frac{2\, (F_{11}^2 - F_2\, F_1)\, (F_2\, F_1 - F_{11}^2)}{F_{11}^2\, (F_2 - F_1)^2} \qquad (1)$$

The attenuation of the band pass filter at any point may now be calculated from the relation

$$\cosh a = 1 + \frac{Z_1}{2\, Z_2}$$

or graphically from

$$\frac{Z_1}{4\, Z_2}$$

This equation, however, is cumbersome to use, but the following simplification can be made:

For any point on the filter curve corresponding to F_{11} there is another point F_{22} such that $F_{11}\, F_{22} = F_1\, F_2 = F_m^2$. Substituting $F_{11}\, F_{22}$ for $F_1\, F_2$ in Eq. (1), the following is obtained:

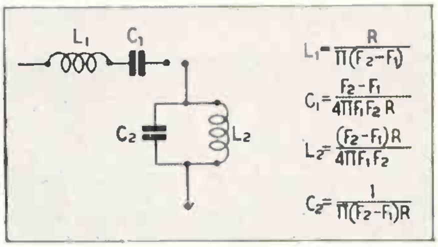


Fig. 1—Constant K band pass filter circuit

$$\frac{Z_1}{2\, Z_2} = \frac{2\, (F_{11}^2 - F_{11}\, F_{22})\, (F_{22}\, F_{11} - F_{11}^2)}{F_{11}^2\, (F_2 - F_1)^2} =$$

$$\frac{2\, (F_{11} - F_{22})\, (F_{22} - F_{11})}{(F_2 - F_1)^2} = -2 \frac{(F_{22} - F_{11})^2}{(F_2 - F_1)^2} \qquad (2)$$

This may now be written as

$$\frac{Z_1}{2\, Z_2} = -2 \left(\frac{F_{\Delta 1}}{F_\Delta} \right)^2 \qquad 2(a)$$

where $F\Delta_1$ is the band spread at the points of determination (F_{22}, F_{11}), while F_Δ is the band spread of the filter between points $F_2 - F_1$. A curve (Fig. 2) may now be made that will give the theoretical determination of the attenuation at any point of any constant K band pass filter.

Attenuation in Filters with Dissipation

The attenuation of a band pass filter obtained by means of curve in Fig. 2 assumes no dissipation either in the reactors or condensers. The dissipation in condensers is usually small and can be neglected; the dissipation present in the coils, however, is considerable, especially at the audio frequencies. In the ideal filter there is no attenuation within the pass band, while in an actual filter the attenuation within the pass band may be considerable, especially i the narrow band pass filters. However, if the attenuations at the mid-frequency $F_m = F_1F_2$, and at F_1F are known, the response of the filter may easily be determined.

In the contstant K band pass filter at the frequency F_m, $X_{L1} = X_{C1}$ and $Z_1 = 2\pi\, F_m L_1\, d$, or $Z_1 = \frac{2\pi\, F_m\, L_1}{Q}$, where d is $\frac{r}{2\pi\, FL}$ or $Q = \frac{2\pi\, FL}{r}$ (r is the equivalent series resistance of the reactor) and L_1 is the series arm inductance. In terms of the cut-off frequencies (Fig. 1).

$$Z_1 = \frac{2\pi\, F_m\, R}{Q\pi\, (F_2 - F_1)} = \frac{2\, F_m\, R}{Q\, (F_2 - F_1)}$$

In the shunt arm, $X_{L2} = X_{C2}$, and assuming dissipation present in the inductances only,

$$Z_2 = \frac{X_{L2}\, X_{C2} - jr\, X_{C2}}{r + j\, (X_{L2} - X_{C2})} = \frac{X_{L2}\, X_{C2}}{r} - jX_{C2}$$

or

$$Z_2 = QX_{L2} - jX_{L2}.$$

Inasmuch as the Q of a filter choke is seldom smaller than 20, the reactive component jX_2 may be neglected and, from Fig. 1,

$$Z_2 = QX_{L2} = 2\pi Q \frac{F_m\, (F_2 - F_1)\, R}{4\pi\, F_1\, F_2}$$

$$= \frac{Q\, (F_2 - F_1)\, R}{2F_m}$$

and

$$\frac{Z_1}{Z_2} = \frac{4\, F_m^2}{Q^2\, (F_2 - F_1)^2}$$

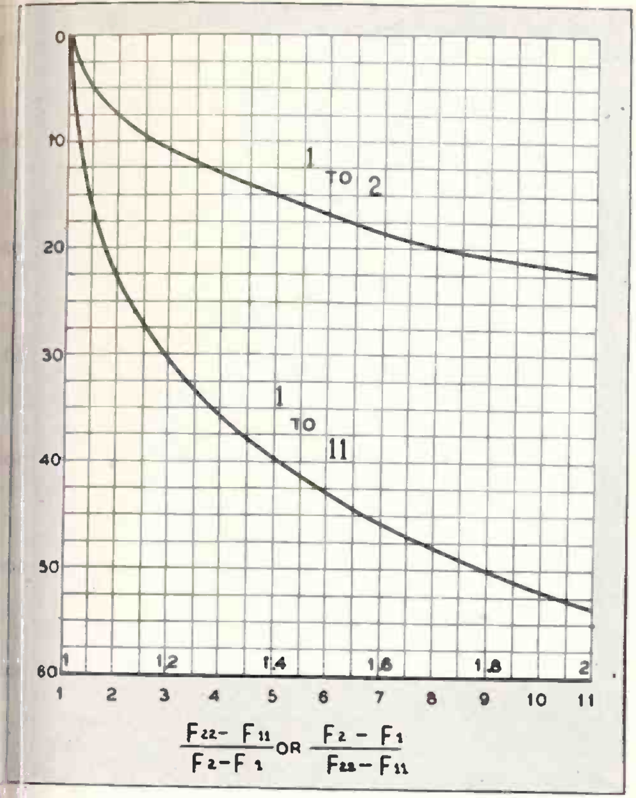
and

$$\frac{Z_1}{2Z_2} = \frac{2}{Q^2} \left(\frac{F_m}{F_2 - F_1} \right)^2$$

at

$$F_{11} = F_m$$

ınd Band Rejection Filters



F. 2—Curve showing attenuation of band pass filter, without taking into account resistance in coils or condensers

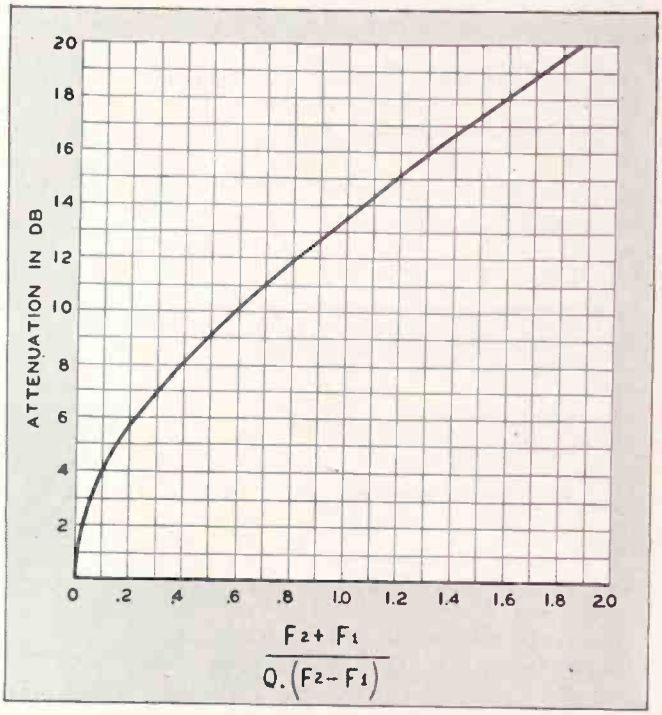


Fig. 3—Attenuation of band pass filter at the critical frequencies F_1 and F_2 when the coils have dissipation

Attenuation at f_m

he attenuation at the midband frequency may be found from tables of hyperbolic functions where

$$\cosh \alpha = 1 + \frac{Z_1}{2Z_2}$$

when α is attenuation in nepers. However, inasmuch as α at the midband frequency is less than one neper, the following approximation may be used:

$$\cosh \alpha = 1 + \frac{\alpha^2}{2\,!} + \frac{\alpha^4}{4\,!}$$

Using the first two terms

$$1 + \frac{\alpha^2}{2\,!} = 1 + \frac{Z_1}{2Z_2}$$

or

$$= \sqrt{\frac{Z_1}{Z_2}} = \frac{2}{Q} \times \frac{F_m}{F_2 - F_1} \text{ nepers,} \qquad (3)$$

$$\alpha = \frac{17.3}{Q} \times \frac{F_m}{F_2 - F_1} \text{ decibels} \qquad (3a)$$

he error from using this expression is less than 4 percent for α less than 8 db.

Attenuation at a Cut-off Frequency, F_1

In the same manner it may be shown that at F_1

$$\frac{Z_1}{2Z_2} = 2\,\frac{\left[d\,\frac{F_1}{F_m} + j\,\frac{F_2 - F_1}{F_m}\right]^2}{(1 - jd)\left[\frac{F_2 - F_1}{F_m}\right]^2}$$

where d is the dissipation factor of the filter components. Performing the indicated operations

$$\frac{Z_1}{2Z_2} = 2 \times$$

$$\frac{d^2\left(\frac{F_1}{F_m}\right)^2 + j2d\frac{F_1}{F_m}\left(\frac{F_2 - F_1}{F_m}\right) - \left(\frac{F_2 - F_1}{F_m}\right)^2}{\left(\frac{F_2 - F_1}{F_m}\right)^2 - jd\left(\frac{F_2 - F_1}{F_m}\right)^2}$$

Inasmuch as d is usually small, all terms containing d^2 or d^3 can be neglected.

$$\frac{Z_1}{2Z_2} = 2\left[-1 + j2d\,\frac{F_1}{F_2 - F_1} + jd\right]$$

$$= -2 + j2d\left[\frac{F_2 + F_1}{F_2 - F_1}\right]$$

$$= -2 + j\,\frac{2}{Q}\left[\frac{F_2 + F_1}{F_2 - F_1}\right]$$

The attenuation at F_1 or F_2 may be obtained from the curve in Fig. 3 where the abscissas are in terms of

$$\frac{F_2 + F_1}{Q\,(F_2 - F_1)}$$

or

$$d\,\frac{F_2 + F_1}{F_2 - F_1}$$

To illustrate the procedure in the design, let us assume that it is required to obtain the expected performance curve for a band pass filter when $F_1 = 3000$ cps, $F_2 = 4000$ cps, and the dissipation factor of the coils is 0.04 ($Q = 25$), and in which $F_m = \sqrt{4000 \times 3000} = 3450$. The theoretical performance of the filter may be calculated as shown.

F_{11}	F_{22}	$\frac{F_{\Delta 1}}{F_\Delta}$	Attenuation in db
2800	4300	1.5	17
2600	4620	2.02	22.5
2400	5000	2.6	28.0
2000	6000	4.0	36.0
1500	8000	6.5	44.5
1200	10000	8.8	50

In this table either F_{11} or F_{22} is

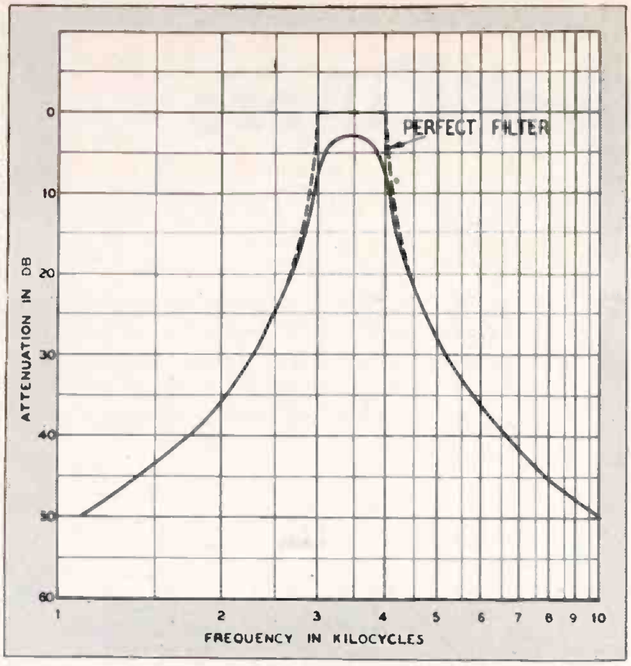


Fig. 4—(Left) Performance curve of band pass filter as calculated by the methods outlined in this article

Fig. 5—(Below) Band elimination filter of the constant K type in which the series and shunt reactances are as shown, in terms of the terminal resistance *R*

assumed and the other frequency is calculated from

$$\frac{F_1 F_2}{F_{11}} \text{ or from } \frac{F_1 F_2}{F_{22}}$$

and

$$\frac{F_{\Delta 1}}{F_{\Delta}} = \frac{F_{22} - F_{11}}{F_2 - F_1}$$

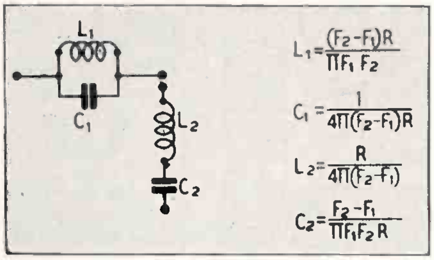
The attenuation in decibels is obtained from Fig. 2. The insertion loss at F_m is obtained from Eq. (3a) and is

$$\frac{17.3}{25} \times \frac{3450}{1000} = 2.4 \text{ db}$$

The insertion loss at F_2 and F_1 is 7.6 db, (obtained from Fig. 3). The expected performance curve of the filter is as shown in the heavy line on Fig. 4.

Band Rejection Filters

The band rejection filter does not find as wide an application as the band pass filter. Nevertheless, it is desirable to be able to predetermine the performance of this type of filter. There is only one type constant K structure that is commonly used, as shown in Fig. 5.



Using the same method of analysis as in the case of the band pass filter, it is found that

$$\frac{Z_1}{2Z_2} = -2\frac{F_2 - F_1}{F_{22} - F_{11}} = -2\frac{F_\Delta}{F_{\Delta 1}}$$

This relation is similar to that obtained for the band pass filter except $F_2 - F_1$ and $F_{22} - F_{11}$ are interchanged. The theoretical performance of a band rejection filter may be then obtained from curve in Fig. 2 using $\frac{F_\Delta}{F_{\Delta 1}}$ for the abscissas.

At midband frequency $2\pi FL = \frac{1}{2\pi FC}$ for both the series and the shunt arm. At F_m,

$$Z_1 = 2\pi F_m L_1 Q = \frac{2F_m (F_2 - F_1) RQ}{F_1 F_2}$$

$$Z_2 = \frac{2\pi F_m L_2}{Q} = \frac{F_m R}{2(F_2 - F_1) Q}$$

$$\frac{Z_1}{2Z_2} = 2\frac{(F_2 - F_1)^2 Q^2}{F_1 F_2} = 2\left(\frac{F_2 - F_1}{F_m}\right)^2 Q^2$$

Attenuation a at midband may be obtained from the relationship

$$\cosh a = 1 + \frac{Z_1}{2Z_2}$$

where

$$\cosh a = \frac{e^a}{2} + \frac{e^{-a}}{2}$$

Inasmuch as the attenuation is usually large,

$$\frac{e^a}{2} = \frac{Z_1}{2Z_1} = 2\frac{(F_2 - F_1)^2 Q^2}{F_m^2}$$

or

$$e^a = \left[2\frac{F_2 - F_1}{F_m} Q\right]^2$$

The attenuation

$$a = 2 \log_e 2\frac{F_2 - F_1}{F_m} Q \text{ nepers,}$$

or

$$a = 40 \log_{10} 2\frac{F_2 - F_1}{F_m} Q \text{ decibels}$$

At the cut-off frequencies F_2 and F_1

$$\frac{Z_1}{2Z_2} = -2\frac{\frac{F_2 - F_1}{F_m} - jd\left(\frac{F_2 - F_1}{F_m}\right)^2}{\left(\frac{F_2 - F_1}{F_m}\right)^2 - j2d\frac{F_1}{F_m}\left(\frac{F_2 - F_1}{F_m}\right)}$$

Simplifying and discarding terms containing d^2 and d^3, we obtain

$$\frac{Z_1}{2Z_1} = -2 - j2d\frac{F_2 + F_1}{F_2 - F_1} =$$

$$-2 - j2\frac{F_2 + F_1}{Q(F_2 - F_1)}$$

The attenuation at points F_2 and F_1 for band rejection filter is obtained in the same manner as for band pass filter from Fig. 3.

Broadcasting Under War Conditions

(Continued from page 35)

together the nation as a unified whole. It is perhaps the most effective single method of disseminating propaganda, in the dictionary sense of "tending to persuade by just discussion and argument." One has only to listen to an hour's radio program to be convinced of the importance broadcasting is playing in the building up of national solidarity, for each and every program makes its appeal for some cause or another which is intended to further our war effort. Only one important speech from Washington or London need be marred, through failure of strategically critical equipment or of inexperienced personnel to bring us forcefully to the realization that broadcasting must be maintained because it is so vital a ccg in our vast war effort.

There is no use taking an alarmist's point of view with regard to the present situation, for those factors which are being recognized as potentialy dangerous can be rectified in time to alleviate any serious disruption of service. Nevertheless, the problems confronting the broadcasting industry must be squarely faced immediately, so that steps may be taken to assure the industry that it will receive the personnel and equipment it requires to maintain its services.

PROPAGATION CONSTANT AND CHARACTERISTIC IMPEDANCE

of High Loss Transmission Lines

Graphical and analytical methods for determining the characteristic impedance and propagation constant of transmission lines having high losses resulting from series resistance are presented in this Reference Sheet

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By **KARL SPANGENBERG**

Stanford University

MANY transmission lines have a negligible leakage conductance but have a relatively high series resistance. This is particularly true of lines operated at radio frequencies. For such lines the usual formulas for low loss lines are in serious error.

There are many applications of lines especially designed to have a high loss besides those high loss problems normally encountered. Such applications include power dissipating lines in which a short section of a transmission line which has a high resistance is used.[1] Other applications include attenuating sections in which a section of a high resistance lines used to reduce a voltage.

In the accompanying charts are shown universal characteristics of such lines. These curves show simultaneously the components of the line characteristic impedance and of the propagation constant.

Characteristic Impedance

A line with a negligible leakage has series impedance of

$$Z = R_s + j\omega L \qquad (1)$$

and shunting admittance per unit length of

$$Y = j\omega C \qquad (2)$$

where R_s represents the series resistance of the line per unit length,
L represents the series inductance of the line per unit length, and
C represents the shunting capacitance of the line per unit length.

Such a line has its characteristic impedance given by

$$Z_o = R_o\sqrt{1 - \frac{jR_s\lambda}{2\pi R_o}} \qquad (3)$$

where $R_o = \sqrt{L/C}$, is characteristic impedance for R_s equal to zero, i.e. no loss, and
λ represents the free space wavelength.

It is convenient to express components of the characteristic impedance in units of R_o, thus

$$\frac{Z_o}{R_o} = \frac{R}{R_o} - \frac{jX}{R_o} = r - jx \qquad (4)$$

where r represents the real part of Eq. (3), or the resistive component of the characteristic impedance, in units of R_o and x represents the imaginary part of Eq. (3), or the reactive component of the characteristic impedance, in units of R_o. It will be seen in the above that the factor $R_s\lambda/R_o$ is the series resistance per free space wavelength in R_o units.

Some approximations for limiting cases are useful. For small R_s, (less than R_o/λ,)

$$x = R_s\lambda/4\pi R_o \qquad (5)$$

$$r = 1 + (x^2/2) \qquad (6)$$

For R_s, greater than $30R_o/\lambda$,

$$r = \sqrt{R_s\lambda/4\pi R_o}\left(1 + \frac{\pi R_o}{R_s\lambda}\right) \qquad (7)$$

$$x = \sqrt{\lambda R_s/4\pi R_o}\left(1 - \frac{\pi R_o}{R_s\lambda}\right) \qquad (8)$$

Propagation Constant

The propagation constant of the line per unit length is given by

$$\gamma = \frac{2\pi}{\lambda}\sqrt{-1 + \frac{jR_s\lambda}{2\pi R_o}} \qquad (9)$$

It is convenient to express the components of the propagation constant in terms of the values per free space wavelength, thus

$$\gamma = \alpha + j\beta \qquad (10)$$

where α represents the attenuation constant per free space wavelength
β represents the phase shift constant per free space wavelength

It is seen that the attenuation constant is zero for zero series resistance and increases without limit as the series resistance increases. The phase shift per free space wavelength is 2π radians for zero series resistance and increases without limit as the series resistance increases. For R_s, less than R_o/λ

$$\alpha = R_s\lambda/2R_o \text{ nepers per free space wavelength} \qquad (11)$$

$$\alpha = 4.34\, R_s\lambda/R_o \text{ db per free space wavelength} \qquad (12)$$

$$\beta = 2\pi\left[1 + \left(\frac{R_s\lambda}{R_o}\right)^2\frac{1}{8}\right] \text{ radians per free space wavelength} \qquad (13)$$

$$\beta = 360\left[1 + \left(\frac{R_s\lambda}{R_o}\right)^2\frac{1}{8}\right] \text{ degrees per free space wavelength} \qquad (14)$$

For large R_s, (greater than $30\,R_o/\lambda$)

$$\alpha = \sqrt{\pi R_s\lambda/R_o}\left(1 - \frac{\pi R_o}{R_s\lambda}\right) \text{ nepers per free space wavelength} \qquad (15)$$

$$\alpha = 27.35\,\sqrt{R_s\lambda/R_o}\left(1 - \frac{\pi R_o}{R_s\lambda}\right) \text{ db per free space wavelength} \qquad (16)$$

$$\beta = \sqrt{\pi R_s\lambda/R_o}\left(1 + \frac{\pi R_o}{R_s\lambda}\right) \text{ radians per free space wavelength} \qquad (17)$$

$$\beta = 180\,\sqrt{R_s\lambda/R_o}\left(1 + \frac{\pi R_o}{R_s\lambda}\right) \text{ degrees per free space wavelength} \qquad (18)$$

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[1] G. I. Brown and J. W. Conklin, Water-cooled Resistors for Ultrahigh Frequencies, ELECTRONICS, Vol. 14, No. 4, April 1941, pp. 28.

The graph is plotted to show the reactive component of the characteristic impedance plotted against the real component, both components of which are measured in terms of units of R_o. The curves also show the attenuation in 2π nepers, plotted against the phase shift in 2π radians. For convenience in using small values, the graph is divided into two portions, the portion in the insert showing the region near the origin on an enlarged scale.

The use of the graphs is illustrated in the following examples.

Example 1: A rhombic antenna is fed with 1 kw of power at 10 meters or 30 Mc. The antenna radiates 60 percent of the input power and puts 40 percent or 400 watts into the terminal impedance. It is desired to dissipate most of this power in a transmission line made of No. 10 iron wire so that only 40 watts reaches a resistor at the end of this line. The terminal impedance should be nearly 600 ohms.

The No. 10 iron wire has a diameter of 0.1019 in. At 30 Mc the skin depth is of the order of 0.0001 in. so that the ordinary skin depth formulas for resistance can be applied. The resistance of the wire is about 1156 ohms per wavelength.

Let R_o = 600 ohms. Then $R\lambda/R_o$ = 1156/600 = 1.927. From the charts, R/R_o = 1.0116. Therefore R = 606.96 ohms. Also, $-X/R_o$ = 0.0553, so that $-X$ = 33.18 ohms. Hence, $Z_o = 607 - j\,33.2$ ohms.

The attenuation is 0.0553x54. 3.03 db per wavelength. For power to be reduced to 1/10 of initial value or 10 db, the lengt the line must be 10/3.03 = 3.3 wi lengths = 33 meters. This lengt wire will dissipate 360 of the watts fed into it. The other 40 w must be taken up by a terminal sistor. A 1.5 inch spacing of wires is needed to give the impeda characteristics indicated above.

Example 2: It is desired to m an attenuator, for use at 51.5 cm, Mc, in the form of a section o concentric line. The line is to hav section of its center conductor m of a metallized resistor. Use a 1 ohm resistor, 1 inch in length, ¼ inch in diameter. At this freque the resistance will be assumed no be affected by the frequency.

At 51.5 cm, one wavelength is inches long. The high resistance tion of the line has a resistance R 1000 ohms per inch. Let the cha teristic resistance of the line about 75 ohms which is given by ing an outer cylinder with an in diameter of ⅞ inch. Therefore R R_o = 1000x20/75 = 267. Using high resistance approximation

$$\text{attenuation} = 27.35\sqrt{267}\left(1 - \frac{\pi}{267}\right) =$$

439 db per wavelength = 21.95 db per in

The resistive component of the ch acteristic impedance is

$$r = R/R_o = \sqrt{\frac{267}{4\pi}}\left(1 + \frac{\pi}{267}\right) = 4.69$$

Therefore R = 4.69x75 = 352 oh and the reactive component of ch acteristic impedance is

$$-x = -X/R_o = \sqrt{\frac{267}{4\pi}}\left(1 - \frac{\pi}{267}\right) =$$

Therefore $-X$ = 4.52x75 = ohms, so that $Z_o = 352 - j\,339$ oh

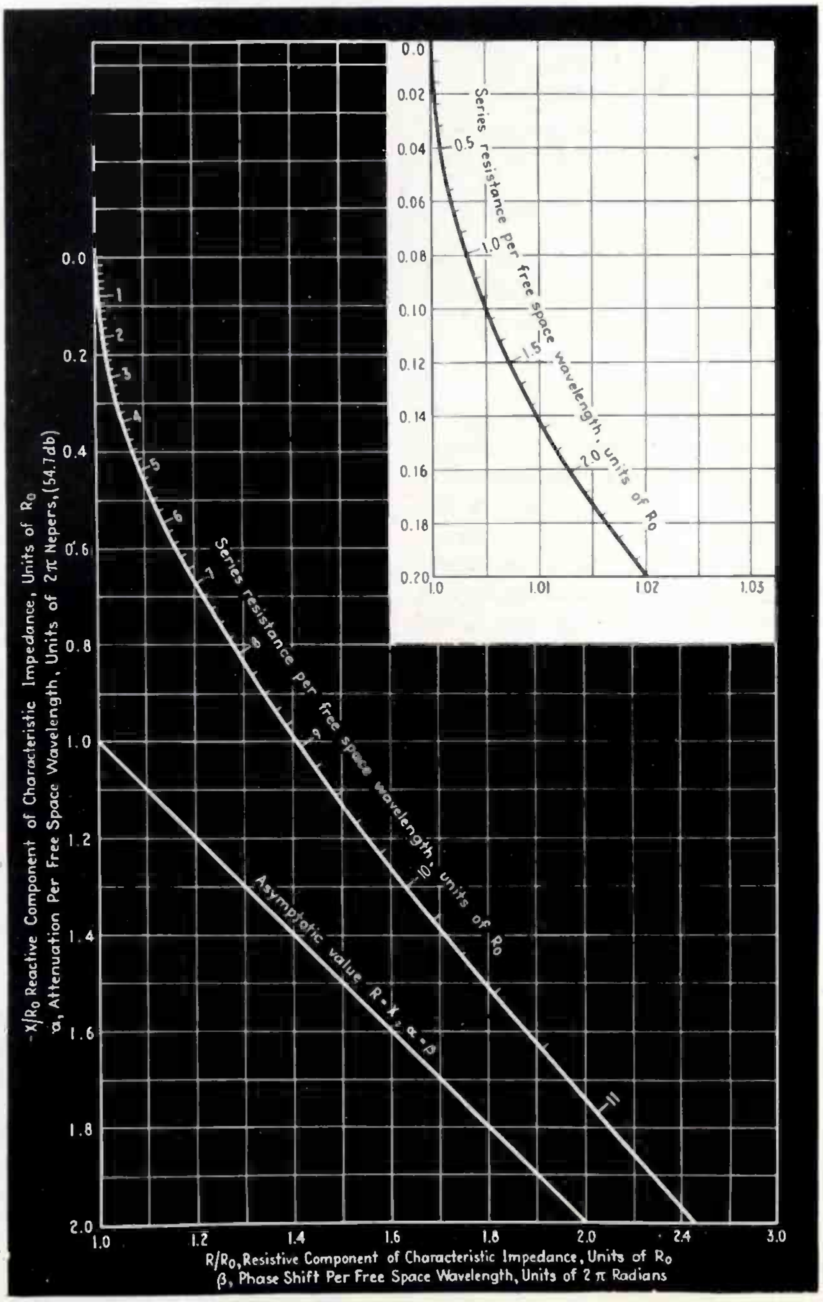
From the phase shift formula the 1 inch or 1/20 wavelength secti the phase shift is calculated to b

$$\text{phase shift} = \frac{180}{20}\sqrt{267}\left(1 + \frac{\pi}{267}\right) = 149.$$

It will be observed that the pha shift and the characteristic impe ance differ tremendously from t corresponding low loss values.

The high resistance 1 inch secti of line must be matched to t $75 + j0$ ohm non-resistive portion the line in both directions. Wh this is done the attenuation of t section is approximately 22 db an the phase shift 149.5°.

Reactive and resistive components of characteristic impedance, and attenuation and phase shift of transmission lines with high losses. The insert, upper right corner, is an enlarged scale drawing for small values of the graph



OCD Carrier Current Tests

INVESTIGATING the practicability of using existing electric power distribution lines for disseminating preliminary air-raid warning signals and general information to civilian defense personnel, the Office of Civilian Defense has conducted a series of tests in an eastern city and suburban environs, using existing broadcast receivers without alteration for picking up carrier-current or "wired radio" signals fed to the lines on 720 kc.

Four requirements were laid down in advance. These were:

1. *Radiation from the lines shall be of no directive value to enemy raiders.*
2. *The signal at all desired terminal locations must be dependable, adequate and must not be affected unduly by standing nodes, power loads, or other line characteristics.*
3. *The substation equipment for generating and superimposing the carrier must be of reasonable power rating, and must entail a minimum of critical materials.*
4. *The signal must be capable of central point control and must not be unduly subject to sabotage or jamming or false signals.*

Line Data

Three types of power distribution lines were available in the area selected for the tests:

TYPE "A"—In the heavily loaded downtown area all low voltage secondaries are connected in multiple or parallel ("grid type" network). Service is fed to the system at various points, depending upon load requirements. Feeder lines are interconnected to several power sources. All distribution is essentially underground, with various transformer vaults strategically located throughout the area.

TYPE "B"—In outlying areas underground 4,000-v feeder line distribution is employed. Underground pole and subway type transformers are fed from strategically located substations which are in turn fed from three-phase 13,000-v lines. Low voltage secondaries of underground pole or subway type transformers distribute power to service entrances over an area of approximately square blocks in residential sections and approximately one square block in neighborhood commercial areas. Feeder distribution from the substation is by three-phase, 4,000-v "Y"-type distribution with the center-tap or neutral grounded at the substation as well as at various points throughout the system.

TYPE "C"—In suburban areas the usual overhead power line distribution system is used. Various substations are interconnected by both 13,000-v and 4,000-v three-phase feeders. The three-phase 4,000-v feeders emanating from these various substations distribute power to subscribers in the various residential and commercial areas. The primaries are shunted at convenient points by the usual pole type transformer. Low voltage secondaries which distribute power to subscribers generally run parallel to the primary feeders for a distance of one-quarter wavelength or more.

Equipment Used

Equipment used for the tests consisted of two relatively low power radio transmitters, one consisting of a composite electron-coupled oscillator-buffer stage and a 6L6G power amplifier, high level modulated by means of a three-stage audio amplifier and the other consisting of a 25-watt amateur transmitter modified for broadcast band operation. The latter unit used a type 807 tube in the final r-f amplifier. Both units were equipped with the usual microphones and audio oscillators capable of turning out a 1,000 cps tone. They were capacitively coupled to distribution lines.

Broadcast receivers used for the tests included battery portables, auto-radio and standard line-operated types. Reports were also solicited from listeners located in the areas selected for the tests.

Test Results

Testing results on *Type "A"* lines, a transmitter was coupled into power service lines at a fuse box located on the seventh floor of a downtown office building. Various nearby locations were checked to determine the area covered. The signal was received satisfactorily in other offices on the same floor and, in some instances, on other floors but in no instance was there any indication that the signal followed electric power distribution lines outside the building. By using a portable battery operated receiver a strong signal was detected three-quarters of a block from the building. Tests even at this distance, however, indicated that noise level caused by elevators, motors, diathermy and other electrical equipment precluded satisfactory results in accordance with requirements 2 and 3. The result was not unexpected inasmuch as heavily loaded neutral-grounded grid networks carry several times the power load experienced under average urban conditions. (The problem of civilian defense communications and signalling is not considered serious in central business areas due to the usually ample telephone and alternate wire facilities available.)

Testing on *Type "B"* lines, a transmitter was connected at a substation. Dummy load against earth ground was used for preliminary tuning of the resonant *L/C* coupler. When connected to the 4,000-v primary very little retuning was required, indicating that the distribution line was being fed under almost short-circuit conditions. The neutral of the three-phase 4,000-v system was well grounded at almost the same point. An estimated five watts of power went into the distribution system. A tour of the area supplied by the particular line bus "disconnects" which were energized indicated good coverage and proved that the signal was following the 4,000-v feeder lines. Although but one phase of the three-phase 4,000 v-primaries were energized directly it was apparent that the other two phases were receiving equal energy as transformers connected to these phases appeared to radiate the same signal strength. Strong signals were detected at manhole locations by means of a portable battery operated receiver for approximately two miles distance from the substation. Where transformers were of the subway type, fully shielded, no signal was received. Tests conducted with various receiver coupling methods to determine to what extent the signal was being induced into low voltage house secondaries were generally unsuccessful. No attempt was made to bridge primaries to secondaries of subway transformers, inasmuch as the equipment needed to do so on the scale which would be required was considered unjustifiable. It was concluded that although requirements 1, 3 and 4 were accomplished satisfactorily terminal locations desired in requirement 2 were limited to the comparatively few points where access to the 4,000-v primary

(*Continued on page* 130)

How The Wind Blows

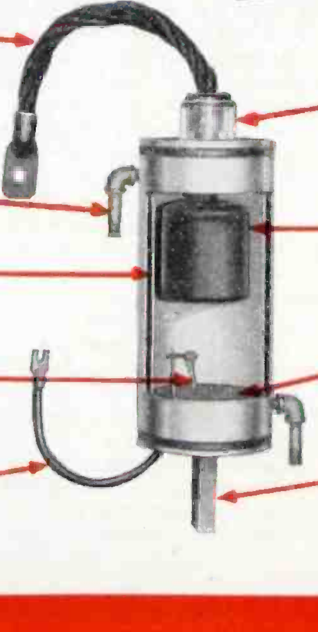
THE OFFICE OF CIVILIAN DEFENSE, investigating every possible means of keeping civilian air-raid wardens and other officials in constant touch with headquarters, has already set up a War Emergency Radio Service plan in cooperation with the FCC

NOW THE OCD is hard at work investigating alternate signaling facilities. Here are some pertinent notes concerning one phase of the busy organization's carrier-current investigations.

G-E IGNITRON

The ignitron is a mercury-arc rectifier having a special control electrode or ignitor for starting the arc. Of the three G-E ignitrons shown, the two farthest left are welding-control types; the one above, a power-rectifier type.

Cutaway view of a typical welding-control type ignitron. For power-rectifier service, G-E ignitrons, in addition to the features shown below, include a deionization baffle, a splash-hood baffle, and an auxiliary anode.



Anode lead—connects tube in series with line.

Hose connection for cooling water.

Stainless-steel tube wall surrounded by water jacket.

Ignitor—with tip immersed in mercury pool. Connected in series with timer to control tube operation.

Ignitor lead.

Strong glass seal to insulate anod

Anode — made of treated carbo

Mercury pool (cathode).

Cathode terminal for support of tub and for connection in series wit line.

oday's Electronic Answer

Myriad New Applications Lie Ahead for the Electronic Engineer

THE use of ignitrons in industry has grown steadily in the elding-control and power-conversion fields. The advantages ed by their use over ordinary mechanical devices are many: 1) here are no moving parts, hence little or no attention is red—one reason for the low maintenance expense of elec- c equipment. (2) G-E ignitrons are sturdy and do not re- extreme care in handling. (3) Because they are replace- units, tube failure results in only the few minutes' shutdown sary for making a replacement.

FAST, ACCURATE, RESISTANCE-WELDING CONTROL

this field, G-E engineers have developed electronic-control ment using ignitrons which now makes it possible to weld s and alloys once difficult or impossible to weld. Ignitrons immediately accepted for this job because of (1) their abil- pass the very high currents needed to develop the necessary and (2) their quick response. The flexible and accurate onic control of current with ignitrons is evidenced by er, neater, and faster welds and a reduction of rejects.

he sale of these tubes conveys no license, either expressed or implied nder patents of the General Electric Company other than those coo- ing the tubes themselves.

The long life of G-E ignitrons and the ease of replacement are also important. Another consideration is their comparatively small size. Since they require only a small amount of auxiliary apparatus, valuable space can be saved in high-production shops.

SIMPLIFIED, QUIET, HIGH-POWER CONVERSION

Power rectifier service is a new field of application for ignitrons in which G-E engineers are also contributing. Electronic rectifiers show how these tubes can replace hard-to-get rotating equipment, and often do a better job, with fewer auxiliaries, lower installation cost, less maintenance, higher efficiency, simpler control, and with no noise or vibration.

One application suggests another. Think of G-E ignitrons when accurately controlled high-current surges are necessary for a job.

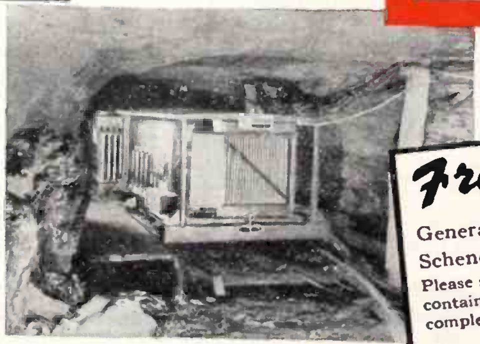
Electronic control is fast making yesterday's impossible jobs a regular part of today's production. General Electric has a complete line of electronic tubes—for work that must be done better and faster. General Electric Co., Radio, Television, and Electronics Department, Schenectady, N. Y.

RESISTANCE WELDING IS A HIGH-SPEED, PRECISION PROCESS when ignitrons are used to control the high-current surges necessary for this work. There are practically no resistance-welding machines in use today that require currents higher than G-E ignitrons are able to control.

Welding control Types*	Price	Kva Demand	MAXIMUM RATINGS Corresponding Average Anode Current Amperes	Maximum Average Anode Current Amperes	Corresponding Kva Demand	Cooling	Shipping Weight in Lb	Ask for This Bulletin
GL-415	$33.00	300	12.1	22.4	100	Water	6	GET-968
FG-271	55.00	600	30.2	56.0	200	Water	12	GET-967
FG-235-A	110.00	1200	75.6	140	400	Water	16	GET-967
FG-258-A	250.00	2400	192.0	355	800	Water	45	GET-967
Power-rectifier Types†	**Price**	**D-c Volts**	**MAXIMUM CURRENT Peak Amp**	**Average Amp**	**Average Amp 1 Minute**	**Cooling**	**Shipping Weight in Lb**	**Ask for This Bulletin**
GL-427	$55.00	125	30	5	...	......	3	....
FG-238-B	355.00	300 600	1800 1200	300 225	400 300	Water	35	GEA-3565
FG-259-B	200.00	300 600	900 600	150 100	200 133	Water	22	GEA-3565

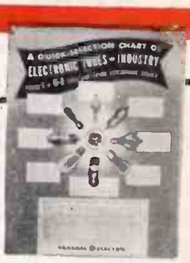
* Ratings are for voltages of 600 volts rms and below. Ignitor requirements for all welding-control types are 200 volts and 40 amperes.

†Typical ignitor requirements for power-rectifier ignitrons are 75–125 volts, 15–20 amperes. Maximum requirements are 150 volts, 40 amperes.



PWER-RECTIFIER SERV- E MADE EASY in E. D. ulle mine at Blanche, Ky. A orle d-c substation, 200 kw, 75 olts, including a sealed- f itron-type rectifier. View on General Electric FG-238-B nitns and the FG-172 thy- tro used for firing.

There's a G-E Electronic Tube for Every Electronic Device



Free —Quick-selection Chart of G-E Electronic Tubes for Industrial Use

General Electric, Section 162-3
Schenectady, N. Y.

Please send me........copies of your quick-selection chart containing condensed technical data and prices on your complete line of industrial electronic tubes.

Name....................

Company....................

Address....................

....................State....................

162-3

NERAL ELECTRIC

THE ELECTRON ART

Engineers at I.R.E. convention discuss engineering activities under war conditions, application of f-m to home recording, and award Morris Liebmann prize to Dr. S. A. Schelkunoff for contributions to the theory of electromagnetic wave radiation

Summer Convention of the Institute of Radio Engineers

Smaller than any convention within recent years was the Cleveland Summer Convention of the Institute of Radio Engineers, held at the Statler Hotel, June 29, 30, and July 1. A total registration of approximately 250 persons was indicated with an attendance at each of the meetings of about 180. This low attendance and the lack of papers on new developments reflected war-time activities of the radio engineers.

Highlights of the convention were the luncheon on Tuesday afternoon, at which Frazier Hunt, General Electric News Commentator analyzed world affairs and evaluated them in terms of recent developments in the Mediterranean, the banquet on Tuesday night which included a talk by George C. A. Hantelman on his collection of 14,000 recording discs, and the trip on Wednesday evening to Nela Park, and the Warner-Swasey Observatory to view the large Schmidt telescope.

At the banquet on Tuesday Evening, the Morris Liebmann Memorial Prize for 1942 was awarded to Dr. S. A. Schelkunoff of the Bell Telephone Laboratories "for his contribution to the theory of electromagnetic field in wave transmission and radiation."

In opening the convention on Monday morning, addresses of welcome were given by A. F. Van Dyck, president of the IRE, P. L. Hoover, chairman of the Cleveland Section, and Carl E. Smith, chairman of the Convention Committee. In his address, Mr. Van Dyck emphasized the position of the radio engineer in the country's present war effort, and pointed out that while a certain amount of secrecy may be necessary to prevent the enemy from knowing what is being developed in this country, this policy may become harmful if it prevents our own research workers or engineers from becoming familiar with the developments taking place at the present time. A free interchange of technical ideas is necessary if we are not to limit the present activities of research workers. Ways and means must be found to determine the results of research activities now under way. It was also pointed out that the Institute is engaged in an active program of standardization of radio components which, it is believed, will prove beneficial after the war. As a result of the recent urging by the War Production Board to minimize travel, it was indicated that the Cleveland Convention may be the last for the duration of the war.

The first technical paper of the Convention was "Recording Standards" by I. P. Rodman, Columbia Recording Corporation, New York, whose paper was largely a recital of the preparation and establishment of standards for recording and associated equipment used for broadcasting, under the sponsorship o committees organized in June, 1940, b the National Association of Broadcasters. The reports which have already been prepared, have been forwarded t all broadcasting stations. The standards covered such items as the mechanical dimension of records, direction and speed of rotation, the electrical chararcteristics, recording level, signal-to noise ratio and wow factor measurements. The most desirable frequency characteristics for transcription recordi was the point of most concern in the committee meeting establishing the standards. The standard finally adopted for lateral transcriptions was a rising characteristic, almost linear from −14 db at 100 cps, to + 16 db at 10,000 cps. For vertical transcriptions the standard rises almost linearly from −14 db at 50 cps to 0 db at 400 cps, is flat at 0 db between 400 and 1500 cps and then rises to +5, +10, and +18 db at 4200, 6900 and 10,000 cps, when the frequency scale is logarithmic, in both standards.

The second paper of the morning, and forming one of four papers on a symposium on sound recording and distortion was delivered by G. L. Beers and C. M. Sinnett, of the RCA Manufacturing Company, under the title "Recent Developments in Record Reproducing

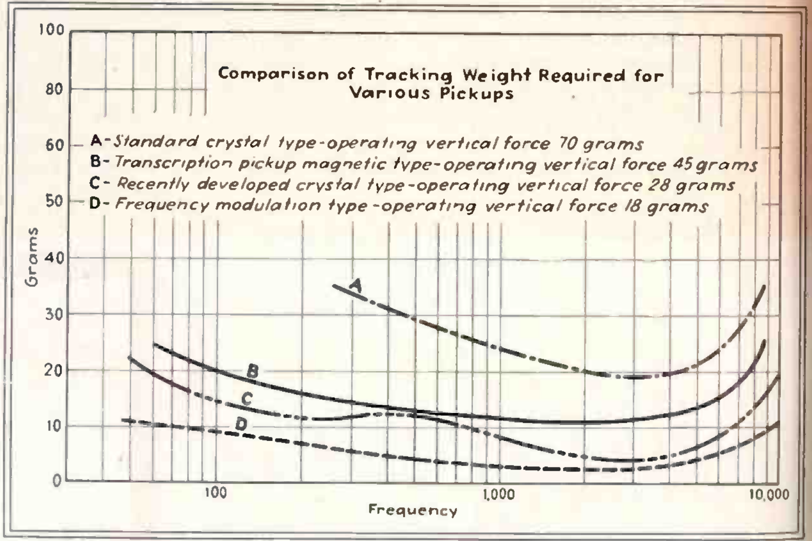


Fig. 1—Graph illustrating the tracking weights required for pick-ups of various construction and illustrating the advantage of the f-m type of pick-up (curve *D*)

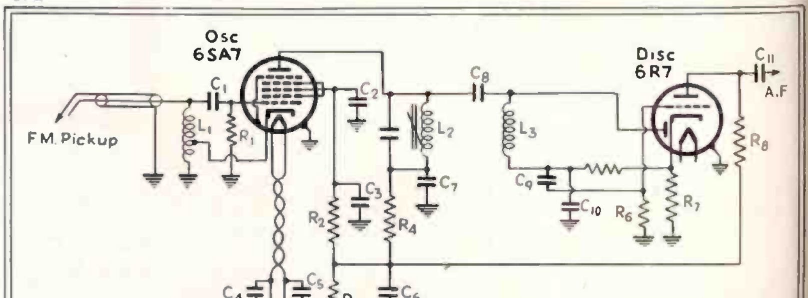


Fig. 2—Schematic wiring diagram of oscillator and discriminator of f-m phonograph pick-up recording system

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Systems." The research underlying this paper (as well as that for other papers, for that matter) was concluded before the United States entered the War. Investigations were conducted during the past two years to determine the prospect of materially improving the overall performance of record-reproducing systems. Considerable attention was directed toward the possibility of reproducing frequencies up to 10,000 or 12,000 cps from standard shellacked records without the introduction of objectionable surface noise. The possibility of producing a frequency-modulated signal by means of a special pick-up and associated circuits was studied and such a method was found to lend itself to a realization of many requirements considered essential to a satisfactory reproducing system. A new pick-up, consisting of a metal frame or mounting block serving as a support for an insulated plate which holds a thin ribbon and stylus, was developed as the first essential unit in the frequency-modulated system. The lateral displacement of the stylus in this pick-up results in a change in the position of the ribbon with respect to the fixed mounting block, and thus produces a change in capacitance. In the frequency modulation pick-up it is essential that the change in capacitance with displacement of the stylus be such as to produce a linear relationship between frequency change and motion of the stylus. This condition is fulfilled, to a practical extent, in the type of pick-up already mentioned.

The pick-up producing capacity variations may be connected directly across the tuned circuit of the oscillator. This arrangement is not particularly desirable because the tone arm is made unduly large and the heat from the oscillator tube causes the end of the tone arm, which is handled by the user, to become uncomfortably hot. The same result can be accomplished by mounting the oscillator tube in the main instrument chassis and connecting it to the pick-up through a resonant transmission line which is used as the oscillator tuned circuit.

A simple resonant circuit is utilized as the means for converting the oscillator frequency variations into changes in the amplitude of the signal applied to the diode portion of the 6R7 tube.

The schematic diagram of the circuit used in the f-m recording system is shown in Fig. 2. Considerable attention must be paid to an arrangement of circuit and components which are free from temperature changes, and at the same time enable the pick-up capacity variation to produce the desired frequency changes, as a result of modulation.

A considerable portion of the Beers-Sinnett paper was devoted to a discussion of the experimental and mathematical analyses carried out to determine the characteristics of:

(a) Lateral mechanical impedance,
(b) Lateral force acting upon stylus,
(c) Response characteristic of pick-up and tone.
(d) Tracking weight required to overcome vertical force due to lateral velocity,
(c) Tracking weight and relative output to be obtained with different radius of stylus.

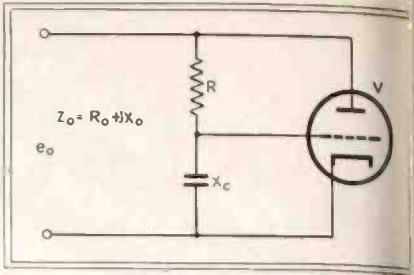


Fig. 3—Simplified wiring diagram of reactance tube circuit which acts as an adjustable inductance in the distortion meter described by J. E. Hayes. This type of circuit replaced the inductances in a bridged-T frequency discriminating circuit

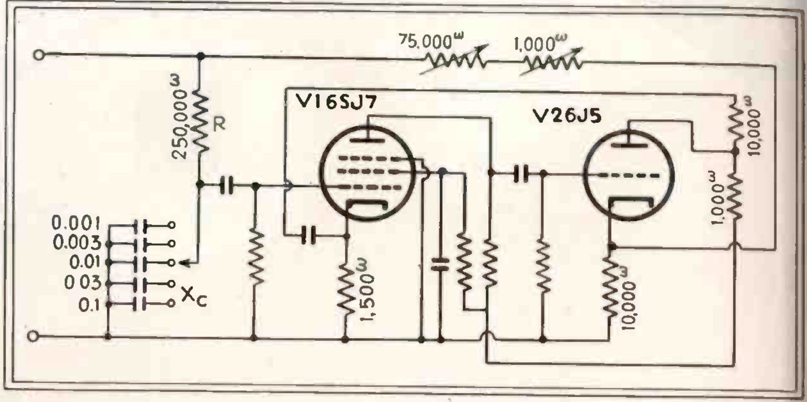


Fig. 4—Simplified schematic wiring diagram of the distortion meter. Gain is provided by the pentode, while proper phase relations are maintained by the triode cathode follower

An experimental frequency modulation record reproducing system, of the type described has been in use for some time. All of the evidence to date indicates that the system is a practical one and not adversely affected by changes in temperature, humidity and line-voltage.

The experimental frequency modulation pick-up meets the requirements of a satisfactory pick-up to a degree which has not previously been obtained in a relatively inexpensive device. The general performance characteristics in a pick-up of this device can be calculated within reasonable limits.

From the listener's standpoint, the experimental frequency modulation phonograph system which has been described, makes it possible when using conventional shellacked records, to extend the frequency range of a record reproducing system to 10,000 or 12,000 cps with a surprising freedom from surface noise, mechanical noise, and distortion. A further reduction in surface noise can be obtained with shellacked records if they are recorded with a high frequency accentuation characteristic which is comparable to that used in transcription. Experimental records of this type have been made. The surface noise obtained from these records with the frequency modulation reproducing system was reduced to a point where it was not objectionable to the most critical listeners.

Although the calculations and measurements which have been given are confined primarily to 78 rpm, records of the same performance advantages are retained in a frequency modulation reproducing system designed for transcription.

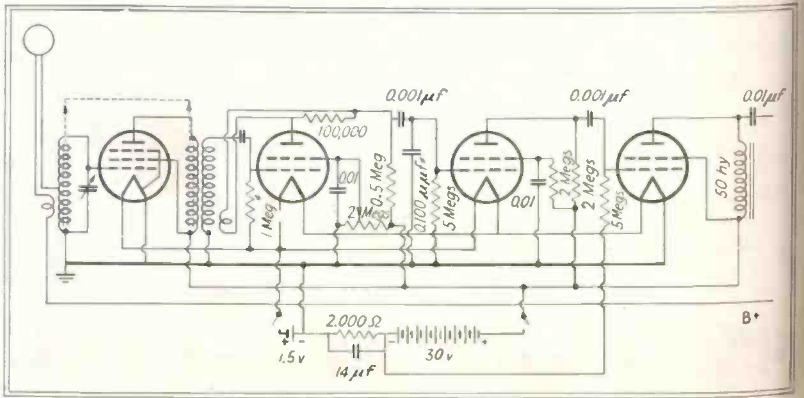
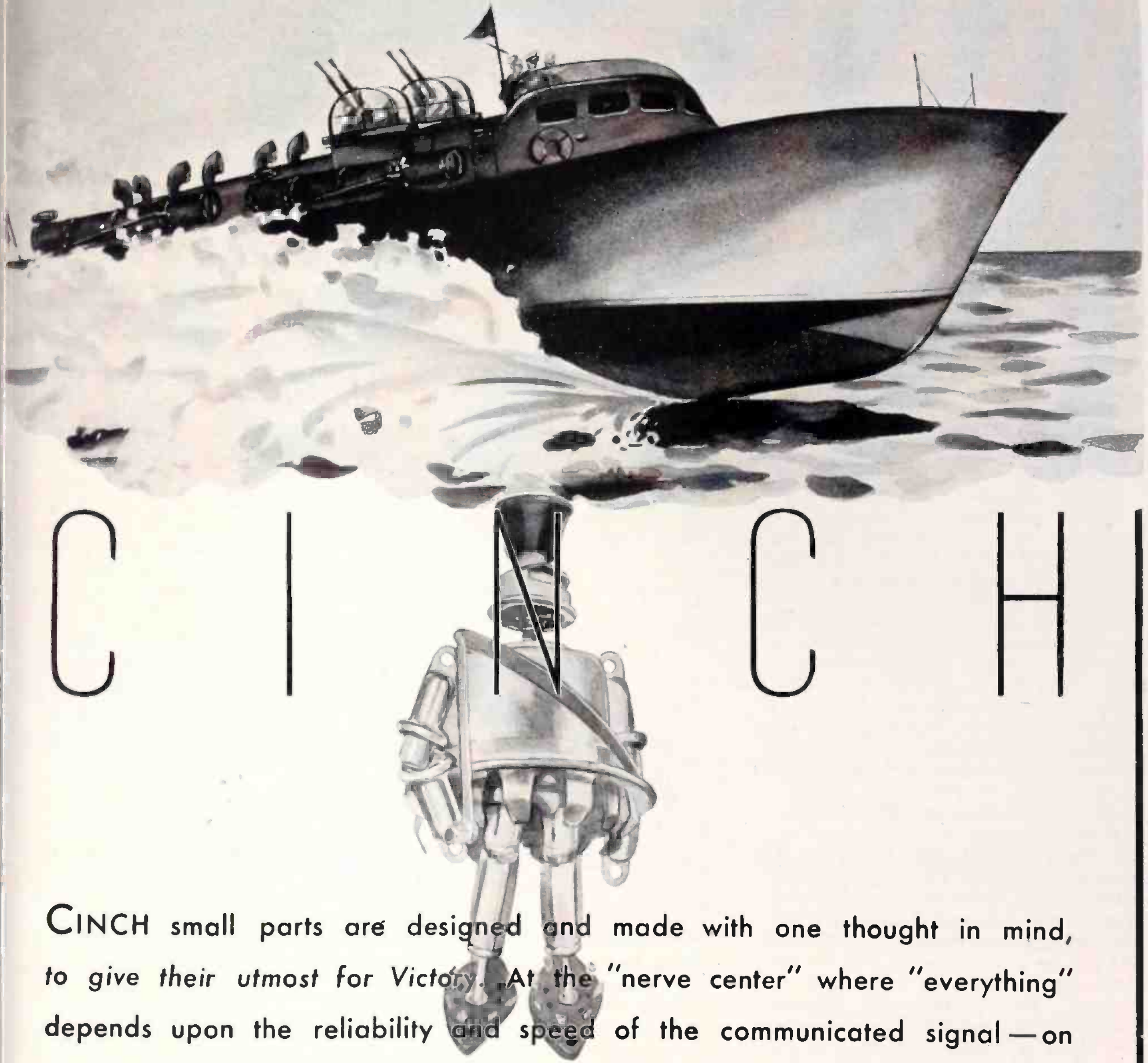


Fig. 5—Circuit of four-tube portable radio receiver which fits into breast pocket of man's suit, as described by W. J. Brown



A paper by H. E. Roys, RCA Manufacturing Co., Indianapolis, on "Measuring Transcription Turntable Speed Variations" was the third paper on the recording symposium of Monday morning. Because of the extensive use of discs of the transcription and home phonograph type in the radio broadcasting field, it is becoming more important to maintain high standards of record reproduction. One of the essential requirements is that of speed constancy or freedom from wows of the reproducing turntable. The term wow is now generally used to denote such speed variation.

The effect of speed variations as perceived by the ear occur as direct pitch variations at low rates, increasing to flutter at higher rates, and finally indiscernible as pitch changes but recognized as distortion due to the production of side bands because of frequency modulation.

Early wow equipment developed for measuring turntable speeds with the aid of a constant note record and a frequency modulation detector consisted of a tuned circuit where operation was on one side of the resonance curve. The present laboratory equipment which operates on the same principle has been improved and uses two tuned circuits in push-pull to balance out changes of input voltage. A magnetic tone wheel is used instead of records and two balanced pick-ups help to minimize errors due to misalignment and vibration.

Simplified equipment such as used by the RCA Service Department in which a bridge circuit with three resistance branches and one tuned circuit branch was described. With this type of circuit a band-pass filter is used in the input circuit and the tuned circuit of the bridge is tuned to the carrier signal. Any change in speed-frequency unbalances the bridge and is registered on the detector meter. The reading of the meter is then the wow of the turntable.

Due to operating directly at the resonance point of the tuned circuit a speed deviation in either direction gives the same voltage increase across the detector and doubles the frequency applied to the meter. The frequencies applied to the meter are low, however, when wow rates of frequencies corresponding to one revolution at 33⅓ and 78 rpm are encountered so that the ballistic constants of the meter are important. Tests made with different meters showed the difficulty of reading the meter accurately and to overcome this a special meter with a lower frequency resonance and increased damping was obtained. An improvement in accuracy of reading resulted.

The method of expressing the wow content as a single figure was discussed and preference given to the r-m-s method over the present peak to peak (maximum to minimum speed deviation expressed as a percentage of the average value) method.

A 16 mm film showing the swinging of the meters at low wow rates was shown at the convention.

"A New Type of Practical Distortion Meter" was described by J. E. Hayes, Canadian Broadcasting Corporation, Montreal. The distortion measuring instrument was developed since commercially available instruments were usually either rather critical in adjustment, or else could be used only on certain predetermined frequencies, and furthermore could be obtained only on orders having high priority rating.

A simple method of making distortion measurements may be based on the frequency selective characteristics of the bridged-T network. The difficulty with such a network made of the usual circuit elements is the lack of flexibility because of the large variable inductances required. This has been overcome in the design developed by Mr. Hayes by replacing actual inductances by their electrical equivalent inductances provided by a reactance tube circuit. The inductance is altered by varying the voltage.

A simplified reactance tube circuit is shown in Fig. 3 in which the voltage applied to the grid of the vacuum tube is retarded almost 90 deg. with respect to e_0 by making R large with respect to X_c. The plate current also lags e_0 by almost 90 deg., producing an effective inductance at the input terminal.

A practical embodiment of this circuit is shown in Fig. 4 where two tubes are required to obtain the desired results. A pentode tube provides the necessary gain, while a triode used as a cathode follower maintains the proper phase relationship and gives the low output impedence necessary for low values of reactance. Smooth control the reactance is obtained by a 76,0 ohm resistor, which changes the effect output impedance R_p of the tube This circuit is used as the electron inductance in the frequency discrimi ating circuit. The distortion meter con sists essentially of a bridge T aud frequency bridge circuit in which th inductance element is replaced b a reactance tube circuit. Because of th flexibility obtainable in vacuum tub circuits, it is a relatively simple matte to vary the effective inductance con tinuously over a fairly wide range, an thus allow the distortion meter to b used at any frequency in the audi range.

Certain precautions must be taken i a circuit of this type in order to avoi difficulties due to non-linear action o the reactance tube circuit. Applicatio of negative feedback effectively reduce the non-linearity, increases stability and at the same time keeps tube nois and hum at a minimum level. Certai limitations inherent in a reactance tube circuit of this type are:

1. It can be used only in relatively low-voltage circuits.

2. The Q of the circuits drops off o either side of some optimum frequency and

3. Care must be taken in the design of the amplifier portion so that phase shifts introduced by it do not cause the circuit to break into oscillation.

The final paper on the Monday morning session was "Frequency Modulation Distortion in Loud Speakers" by

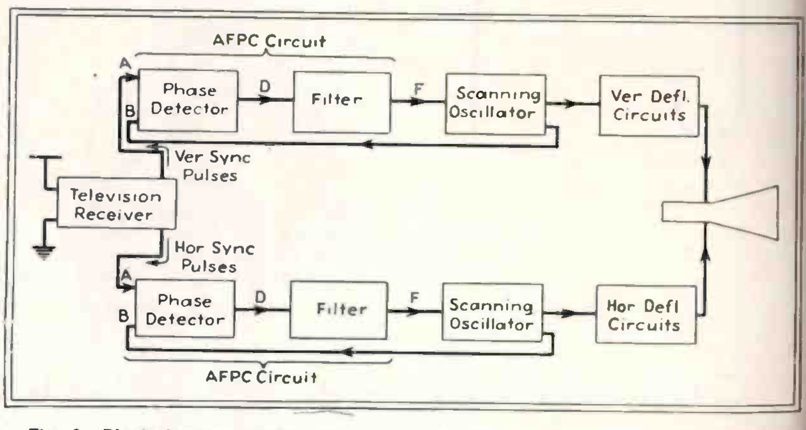


Fig. 6—Block diagram of the elements required in the automatic frequency and phase control synchronizing circuit described by Wendt and Fredenhall

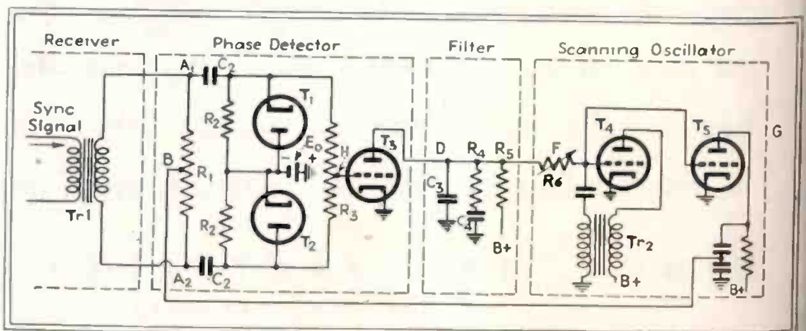
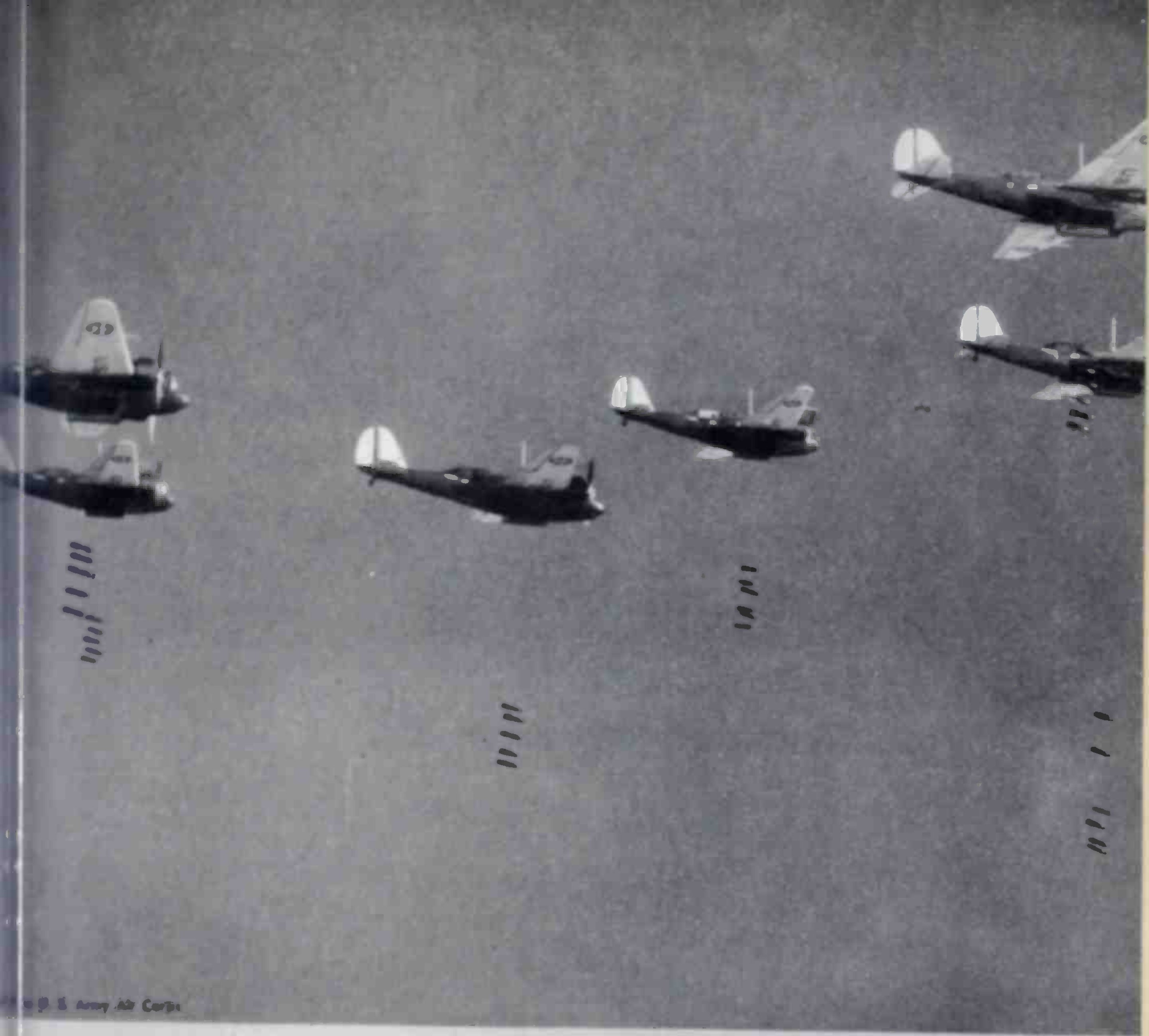


Fig. 7—Schematic diagram of connections of the phase detector and scanning oscillator of the AFPC television circuit



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G. L. Beers, and H. Belar, RCA Ma
facturing Company. It was shown t
as the frequency response range of
sound reproducing system is extend
the necessity for minimizing all forms
distortion is correspondingly increas
Although distortions contributed by t
loud speaker have been frequently a
alyzed, a type of loud speaker distorti
which has not received general consi
eration was described. This distorti
is the result of the Doppler effect, a
produces a frequency modulation
loud speakers reproducing complex to
It was shown by mathematical deriv
tion, supported by laboratory measur
ments, that this type of distortion m
be minimized by reducing the diamet
of the cone of the speaker and usi
separate speakers for both the low a
the high-frequency components.

The first paper of the Monday afte
noon technical session was "Radio F
quency Oscillator Apparatus and I
Application to Industrial Process Co
trol Equipment" by T. A. Cohe
Wheelco Instruments Co., Chicago. Th
paper described an electronic rela
mechanism which avoids many detr
mental features incidental to phot
electric equipment when applied to i
dustrial control. The apparatus de
scribed is Fig. 8, a type of tune
grid-tuned plate oscillator which take
advantage of the large steady curren
changes which may be made to tak
place in some varieties of self-excite
radio frequency oscillators, with small
changes in coupling or excitation.

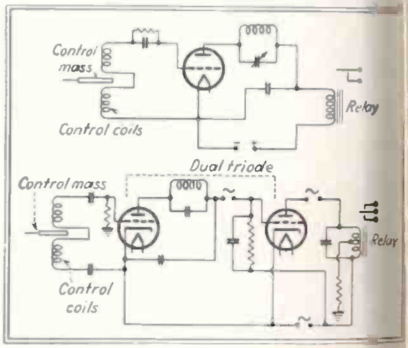


Fig. 8—Fundamentals of tuned-grid tuned-plate oscillator used as a relay. The control mass alters the plate current which in turn actuates a relay

In most instances the direct current component present in the plate circuit of such oscillators is allowed to flow through an electromagnetic relay of suitable characteristic which is maintained in a pre-chosen contacting position by suitable adjustment of the oscillator. Upon being tuned or de-tuned by the approach of a mass of metallic, in other cases, non-metallic material, to a suitable portion of the oscillator circuit, the oscillator causes a change in contacting position of the relay through the change in steady plate current value.

One form of the oscillator type relay mechanism has been applied widely to the problem of producing an electrical contact function by the motion of the pointer of a sensitive and delicate measuring mechanism without disturbing

4 Things Resistor Users Can Do

TO SPEED DELIVERIES...,CONSERVE CRITICAL MATERIALS

USE WIDER TOLERANCES WHEREVER POSSIBLE

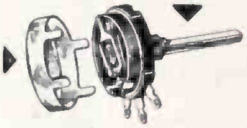
Wherever possible specify ± 20% or ± 10% tolerance resistors instead of ± 5% tolerance. Stocks of 10% in some ranges, and 20% in almost all ranges, are available whereas 5% resistors must be manufactured. In many types of resistors yield is based on tolerance, therefore the wider the tolerance the greater the yield. Specify wider tolerances to save material, time in delivery, delays in production.

USE STANDARD RESISTORS

Special resistors require special engineering, tooling, materials, and specially trained operators plus special Army and Navy stocks of spares which greatly complicate the problems of fast production and replacement in the field.

Resistor users are urged to use standard types and sizes wherever possible—standards of the industry, and the standards included in existing specifications for large percentage of Army and Navy equipment.

SPECIFY NON-FERROUS METALS FOR NON-CONDUCTING PARTS



In many instances, specifications can safely be revised to eliminate hard-to-get ferrous metals in favor of non-ferrous metals. This is especially true of non-conducting, non-functioning parts such as covers, shafts, etc. for controls and rheostats. Not only does this mean conservation of critical materials, but it serves as an aid in obtaining materials promptly.

SPECIFY DELIVERIES TO MEET ACTUAL PRODUCTION SCHEDULES

The problem of specified delivery dates versus actual production-use dates is a difficult one for both buyer and supplier. With IRC Resistors so generally specified for war work, however, and with IRC production devoted 100% to meeting these demands, our manufacturing problem is simplified when *production-use* dates are specified. On this basis, deliveries can often be staggered over an entire production period, rather than being demanded far in advance of actual use dates, thus taking a long step toward "on time" deliveries for all.

Whatever your war equipment resistor need, whatever your tolerance specifications or delivery dates, IRC will cooperate to the full limit of its greatly expanded facilities in meeting them. We realize there are many cases where none of the foregoing suggestions may prove applicable. Wherever they can be applied, however, they will play a part—small, but none the less important—in speeding up the war effort and increasing its efficiency.

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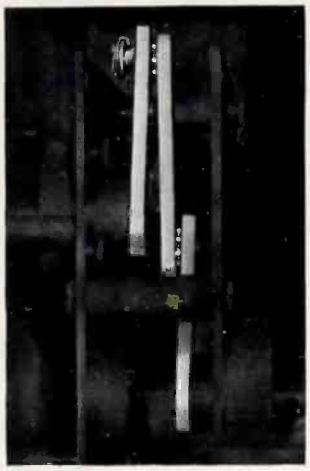


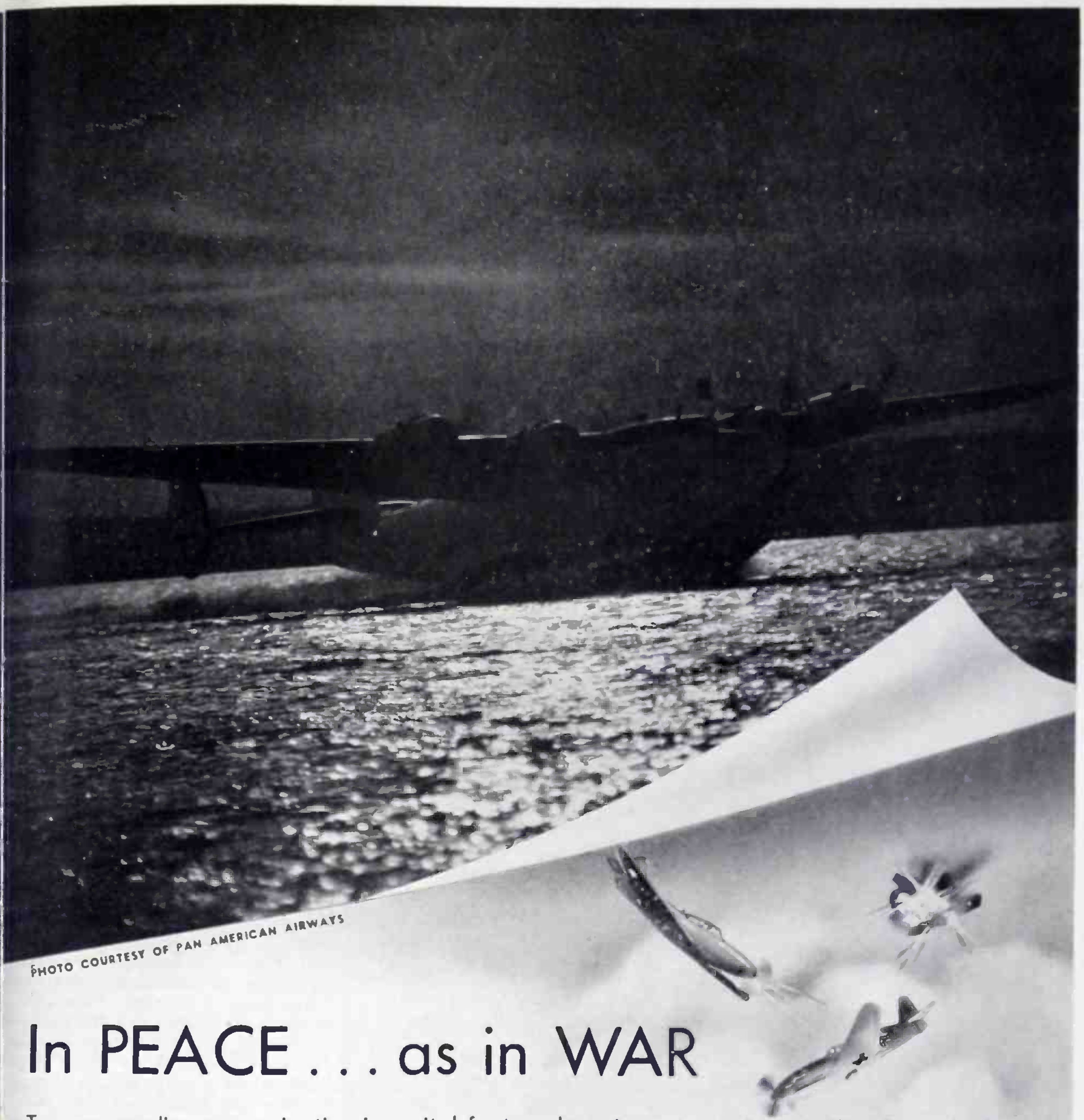
the measuring accuracy of the mechar ism. Other forms of the apparatu where described as applied to forms c industrial control in which no mechar ical measuring mechanism is involve but in which the motion of fluids suc as in manometer columns and flow meters, or moving masses of metalli non-metallic, solid or liquid materia were considered. The control function described are primarily concerned wit contacting action in which the contac determines the presence or absence o the controlled medium such as the elec tric power flow to a furnace.

The paper dealt finally with mor specialized forms of control function, i which the controlled medium must b throttled so that only sufficient controlled medium is made available to supply the demands of the process, consistent with maintaining a steady state of balance in the process.

A comparatively new type of electronic development, "The Scanning Microscope", was described by V. K. Zworykin in a paper of which J. Hillier and R. Snyder were co-authors. The new electron miscroscope of the scanning type has been developed to examine the surfaces of all material with the high resolving power afforded by the use of the electron beam. The new scanning microscope is suitable for the examination of opaque objects, whereas the usual type of electron microscope thus far in use has been limited to an examination of "transparent" subjects by passing the electron beam through the material under examination. In the scanning microscope the specimen is moved mechanically in such a way that each point of its surface is scanned in a systematic fashion by the electron probe in much the same manner as television scanning. The secondary electrons which are emitted from the point of the specimen bombarded by the electrons of the probe, are accelerated and projected on a fluorescent screen. The intensity of the light emitted by the fluorescent screen varies in accordance with the secondary emission properties of successive points of the specimen. This modulated light signal is converted into an electrical signal by means of a multiplier phototube and is then synthesized in a printed picture by an amplifier and facsimile printer system. The use of the electronic-light-electronic transformation of the image signal improves the signal-to-noise ratio by at least an order of magnitude over that found in conventional method of collection and voltage amplification.

In outlining this paper, Dr. Zworykin traced the difficulties in the development of this scanning microscope and showed how various methods of approach proved most promising at one time or another, depending upon the status of the television development of the time.

An experimental model of the scanning microscope has been constructed and has been successful in producing images of etched metal surfaces at magnifications as high as 10,000 diameters with a resolving power considerably better than 50 millimicrons.



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BUY WAR BONDS AND STAMPS

Dr. S. A. Schelkunoff, of the Bell Telepho Laboratories who received the Morris Li mann memorial award for his theoretic studies of the transmission and radiatio of electromagnetic waves

"Spectroscopic Analysis in the Man facture of Radio Tubes" was the tit of a paper delivered by S. L. Parson Hygrade Sylvania Corporation. Th paper was devoted to a description the use of spectrographic methods attacking some of the problems e countered in the manufacture of tube

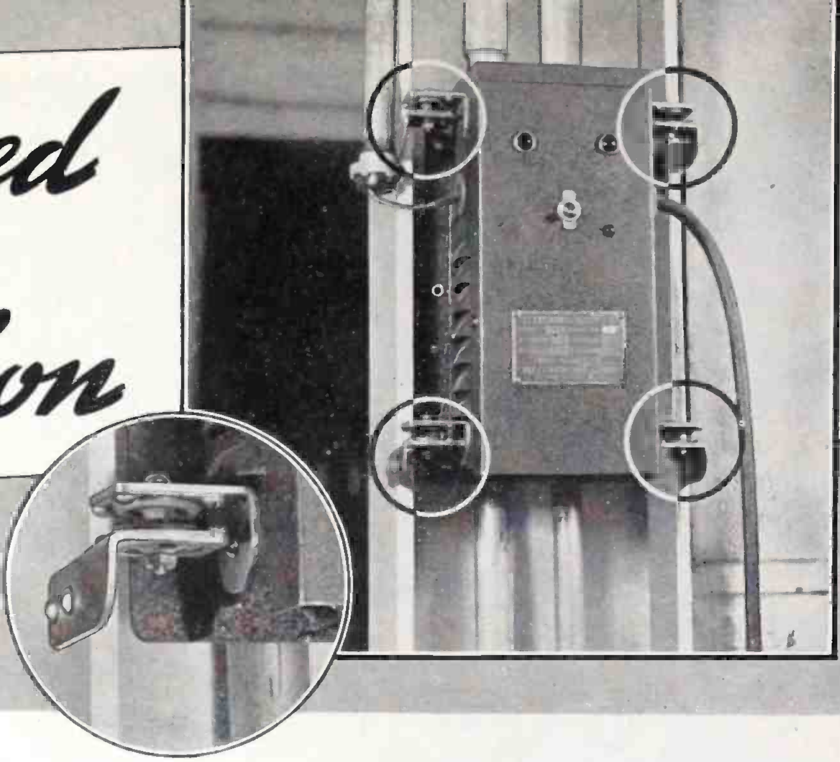
The spectrographic equipment installed at the Hygrade Sylvania pla was intended as a tool in attackin chemical, metallurgical, fluorescent an ceramic problems of tube manufactur The spectroscope and densitomete used in making and anlyzing the measurements, as well as the arc ligh sources were described in detail. Th various applications of this equipmen to the quantitative and qualitativ analyses of materials going into the manufacture of radio tubes were discussed, and it was shown how the spectroscopic laboratory was able to improve the quality of tubes, minimiz difficulties of manufacture through accurate and appropriate analyses.

A rather mathematical paper o "Minimizing Aberrations of Electro Lenses" was given by H. Poritsky of the General Electric Company in Schenectady. The primary object of the paper was the determination of minimum spherical aberration through the investigation of several possible ways of obtaining sharp focusing.

C. H. Gleason presented the paper "Half-Wave Voltage-Doubling Rectifier Circuit" of which W. D. Waidelich is co-author. Both men are with the University of Missouri. It was shown that the half-wave voltage-doubler is useful as a power supply and has several advantages over other circuits employing input transformers. It offers economy in cost, size, and weight and hence is used in transformerless receivers. For use in radio-receiver power supplies, it has the important advantages of having a common input and output terminal.

Although no analysis of this half-

Isolated from Vibration



When flexibly suspended on LORD BONDED RUBBER Mountings, ectronic equipment requires fewer tube replacements and retains its designed accuracy in any installation

VIBRATION from overhead cranes and production quipment can easily affect the accuracy and n operating life of electronic control equipment. facturers who want to be certain that their elec- n equipment will function as well in a steel mill, ample, as in a quiet laboratory, are using Lord tings to isolate destructive vibration. Standard Plate Form Mountings are manufactured for sup- g loads from ½ lb. up to 300 lbs. each. For er loads, Lord Tube Form Mountings are made ads from 20 lbs. up to 1500 lbs. each.

ypical installation is shown in the above photo- s of an electronic rectifier. This instrument is ily attached to a steel column at four points by Plate Form Mountings in series. Lord Mountings, properly installed operate freely in shear, and the vibrations are dissipated by a slight movement of the equipment on the mountings, rather than being absorbed in the instrument. The use of two Lord Mountings in series, doubles the axial softness, and increases the sensitivity and isolation efficiency of the mounting assembly. Double mountings are also recommended for applications when the vibrations are of a lateral nature in addition to vertical disturbances.

The services of Lord Engineers, who have had considerable experience in solving vibration problems in the electronic field, is yours for the asking. They will be glad to show you how proper vibration control can lengthen tube life, and eliminate other operating failures in existing and contemplated electronic equipment.

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TUBE FORM MOUNTINGS

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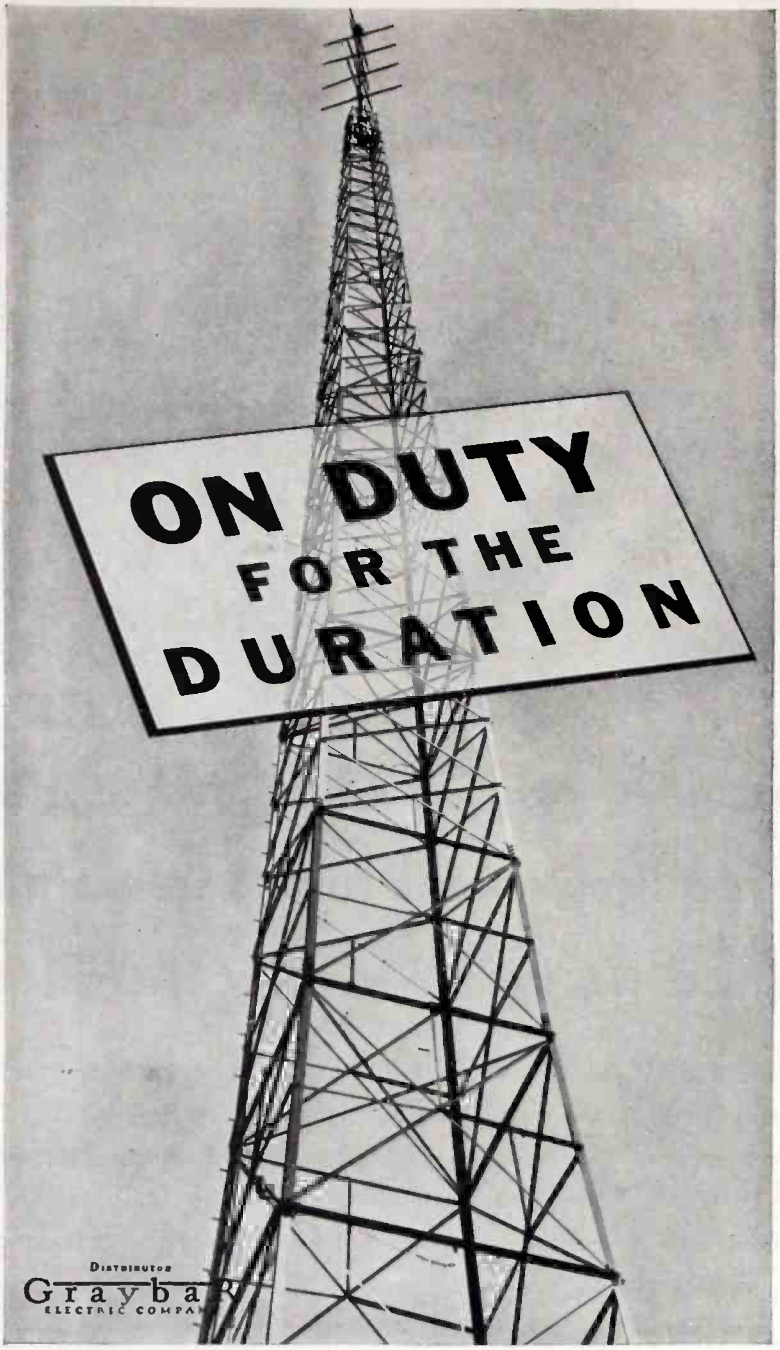


wave doubler seems to have been made, several references to its operation and applications may be found. The purposes of this paper were to present the results of the analysis by means of curves suitable for use in design, to compare some of the theoretical results with experimental results.

A comparison of the operating characteristics of the half-wave and full-wave voltage doublers shows that throughout the normal operating range (ωCR greater than 10) the full-wave doubler offers a higher input power factor, lower maximum tube currents, slightly less ripple (and of higher frequency) in the input voltage, and slightly better voltage regulation; while the half-wave doubler offers lower peak inverse tube voltages, lower effective input currents, and a common input and output terminal allowing both the load and input source to be grounded if necessary.

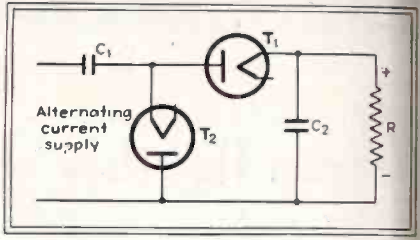
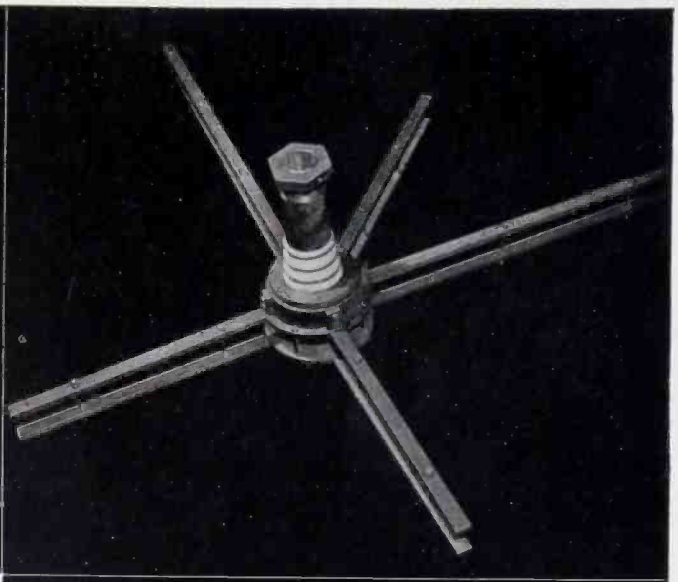


Fig. 9—Diagram of circuit of single wave voltage doubling rectifier

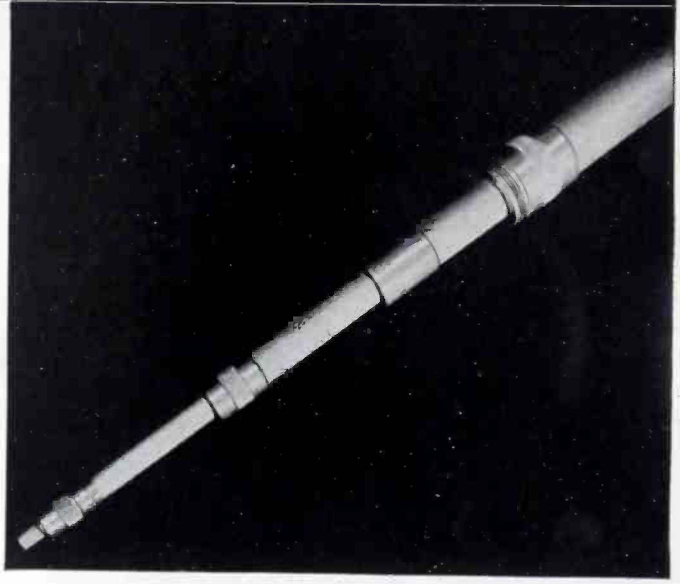
The performance of a half-wave doubler, Fig. 9, may be predicted if the capacitance of the two equal condensers, C_1 and C_2 and the load resistance R are known. Upon evaluation of the parameter (ωCR), the curves of Fig. 10 may be used to determine the operating characteristics of the circuit.

These curves may also be used to design a half-wave doubler to meet certain prescribed operating conditions. Often the input voltage and frequency, the output d-c voltage, and the output d-c current are specified. In addition, the application may restrict the percent ripple allowable in the output voltage. Hence E_m, E_{dc}, and I_{dc} are specified together with a restriction on the percent ripple r. From the curve of Fig. 10 the value of (ωCR) is fixed by the ratio (E_{dc}/E_m). The capacitance of the condensers may be found from ωCR, the load resistance, $(R = E_{dc}/I_{dc})$, and the supply frequency $\omega/2n$. The curves of Fig. 10 may be used to determine the peak inverse tube voltage and the maximum tube current, thus enabling the selection of rectifier tubes of proper inverse voltage and maximum current ratings, and percent ripple in the output voltage. If this value is greater than the percent ripple allowable, the output voltage may be filtered, or some compromise in the specified current and voltages may be made so as to increase the value of (ωCR). The percent ripple in the output can be materially reduced by placing a filter circuit between the output condenser and the load resistance. Insertion of a



SUBASSEMBLIES FURNISHED BY ISOLANTITE

release production facilities and personnel for major assembly jobs



IT IS the countless minor assembly operations that add to the cost and delay the production of war uipment. By turning over to Isolantite Inc., for bassembly, the parts in which steatite is combined h metal in various forms, you release needed pro- ction facilities and skilled hands for major assem- tasks. Isolantite's ability to furnish subassemblies it meet the most exacting demands is a matter of ord.

In addition to speeding war production, this "subas- nblying" gives you all the advantages of Isolantite.* nong these are the extremely close dimensional erances Isolantite's manufacturing processes per- t . . . its adaptability to the production of intricate pes . . . and a uniformity of product, high mechani- strength, electrical efficiency and non-absorption of moisture which contribute greatly to dependable insulation performance.

If you have a problem in production that is vital to Victory, Isolantite-furnished subassemblies might help solve it. War equipment manufacturers taking advantage of this unique service enjoy the benefits of Isolantite high-grade insulation at the same time that they ease the burden of war production.

ISOLANTITE

CERAMIC INSULATORS

ISOLANTITE INC., BELLEVILLE, NEW JERSEY

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filter will cause some alteration in operation of the doubler circuit as dicted from this analysis; however, analysis will still afford a rather approximation of the other operat characteristics of the doubler.

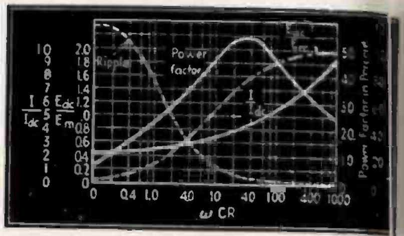


Fig. 10—Performance characteristics of the circuit of Fig. 9

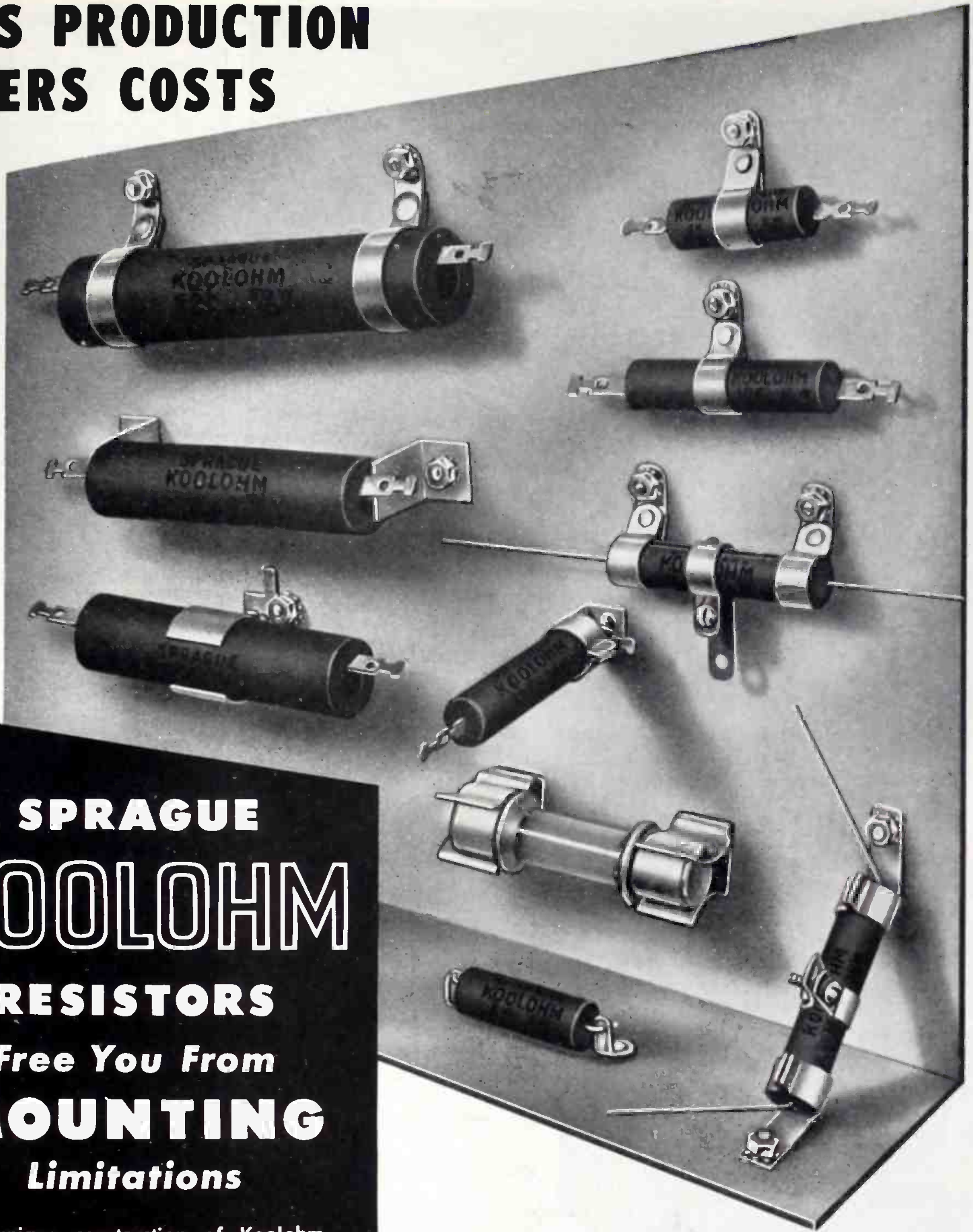
On the basis of the experimen vertifications obtained, the mathem cal analysis is representative of actual operation of the doubler circ and therefore, prediction of the p formance of the doubler by the analy seems justifiable. The assumption of tube drop while conducting seems have introduced little error, but large tube drops an extension of t analysis would have to be used.

It has been shown that the design this circuit and the predeterminati of its performance is facilitated by t use of the results of this analysis.

In opening the Tuesday morni technical session, J. A. Ouimet of t Canadian Broadcasting Corp., gave very timely paper on "Maintenance Broadcasting Operations During W time." A rather complete analysis the current wartime problems faci operators and engineers in broadcasti stations was made. The importa factors which must be taken into count include: (1) protection agai sabotage, by the erection of fences a barricades, by the provision of floo lighting, and armed guards; (2) pr tection of plants by fire instruction a precautions; (3) conservation of equi ment by efficient utilization, by go maintenance and operation practices, the rehabilitation of obsolete units, the elimination of unnecessary oper tions, and by the reduction of the pow of transmitters; (4) protection of tran mitter operation by emergency antenn for operation out of the driver stage by standby generators, and by stand transmitters of low power; (5) pr tection of studio operation by dispe sion of facilities, by the setting up emergency control points and by th use of portable equipment and mobil units.

It was pointed out that in all of the measures and others which may b taken, the engineering difficulties a minor ones and yet progress in over coming them is frequently most difficul The real problem of the broadcast en gineer is first to bring about a full an general realization of the seriousnes of the situation and secondly, to tak immediate and effective measures t meet that situation irrespective of th effort, inconvenience and constant self

SPEEDS PRODUCTION LOWERS COSTS



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RESISTORS
Free You From MOUNTING *Limitations*

The unique construction of Koolohm resistors allows them to be mounted directly to (and flat against) metal or grounded parts with complete resistor circuit insulation. This offers a flexibility in designing and manufacturing that is invaluable under today's changed — and changing — conditions.

Koolohms are doubly protected. The wire itself is insulated before being wound AND — all types are sealed in sturdy, chip-proof, ceramic or tempered shock-proof glass casings.

Therefore, they operate safely and dependably even when mounted directly to grounded parts with the simple attachments illustrated above. All of these methods of mounting are today being used by prime- and sub-contractors who are meeting exacting specifications with Koolohms.

Meter multipliers — high resistance, high-power units, truly non-inductive resistors — ferrule type resistors that withstand the most severe salt water immersion test and other features are found in Koolohms — the answer to practically all your resistor problems.

Write for further particulars, samples and catalog

SPRAGUE SPECIALTIES COMPANY
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THE ONLY RESISTORS WOUND WITH CERAMIC-INSULATED WIRE

discipline which these may entail.
the face of an emergency which n
strike at any time in any location, p
paredness is the first and most imp
tant duty.

H. B. Fancher, General Electric Co
pany, described a "High Power Te
vision Transmitter", station WR(
whose erection was started in 1938. T
transmitter is at Helderberg Mount
12 miles from Albany, and serves
Albany-Schenectady area. The stat
includes a 40 kw visual transmitter a
a 20 kw aural transmitter. That p
of the visual transmitter located at
main station consists of a high freque
receiver, a converter and a chain
linear Class B push pull amplifiers.
standard modulated vestigial side b
signal is received from the Schenect
studio or from the New York relay s
tions, over a high frequency radio li
These signals are then retransmit
from WRGB for television enthusia
in the Albany-Schenectady area. T
principal task at the transmitter w
the design of the high-gain, multi-sta
wide-band amplifier stages. The fi
stages each consists of a pair of wa
cooled triodes especially designed
television service.

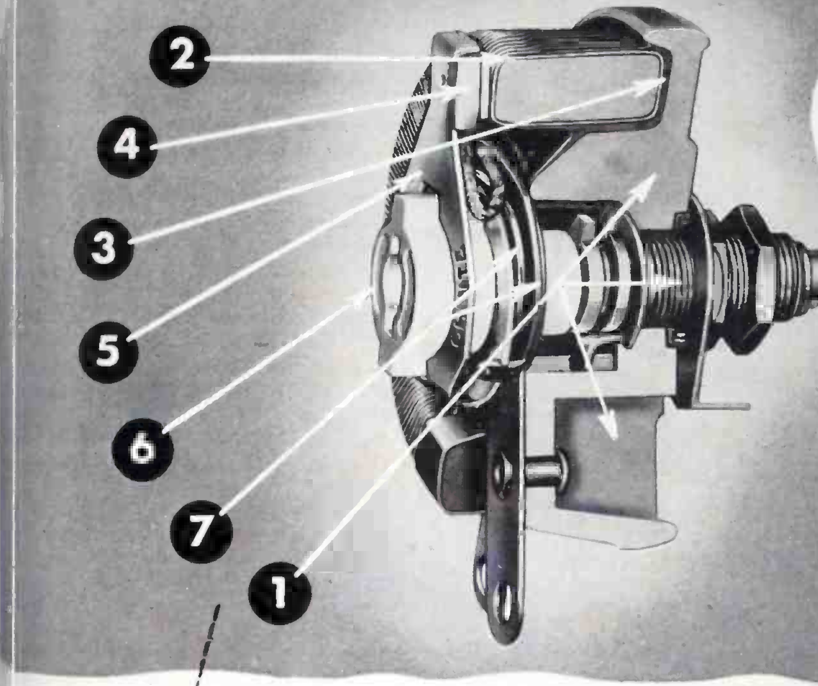
The aural transmitter consists of
50 watt exciter unit containing
oscillator, modulator, and freque
control unit, a 2 kw amplifier consist
of air cooled triodes, and a 20 kw amp
fier using a pair of tubes similar
those in the visual power amplifier.

H. W. Wells, Carnegie Institution
Washington, spoke on "Effect of So
Activity on Radio Communication."
was shown that the radio disturban
which are most severe are coincid
with intense magnetic storms which a
usually associated with active sun s
areas. Severe magnetic storms can d
rupt normal radio communication
several days and various occasions
interruption to land wire circuits ha
also been reported. It is felt, howev
that the progress which is being ma
in the observation of ionosphere pheno
ena will make it possible to pred
quite accurately the time and frequen
at which radio interference will be
maximum as well as a minimum.

W. J. Brown, of the Brush Devel
ment Company, described "The Devel
ment of a Pocket Radio Receiver"
such dimensions as to fit convenient
into the breast pocket of an ordina
suit of clothes, and containing a s
cially developed hearing aid unit wh
fits into the recess of the normal ear.

Unusual features of this circu
which is shown in the diagram of Fig
are the use of a four tube receiver e
ploying permeability tuning, the use
the cord connecting the hearing u
with the radio receiver as an antenn
and the very small physical dimensio
of the complete receiver. To all extern
appearances the portable receiv
greatly resembles the present-day hea
ing aid except that the batteries we
incorporated as a part of the radio r
ceiver rather than being a separate un
as is usually the case with hearing a
devices.

OHMITE Rheostats!



How Permanently Smooth, Close-Control Is Built-in

The cut-away view shows a number of the important features which make Ohmite Rheostats especially suitable for today's exacting requirements in industry, and in planes, tanks, ships.

1. Compact all ceramic and metal construction. Nothing to shrink, shift or deteriorate.

2. Wire is wound on a solid porcelain core. Each turn is a separate resistance step, locked in place and insulated by Ohmite vitreous enamel.

3. Core and base are bonded together into one integral unit by vitreous enamel.

4. Self-lubricating metal-graphite contact brush with universal mounting, rides on a large, flat surface. Insures perfect contact, prevents wear on the wire.

5. Tempered steel contact arm assures uniform contact pressure at all times. Pressure at the contact and at the center lead are independent.

6. High strength ceramic hub insulates shaft and bushing.

7. Compression spring maintains uniform pressure and electrical contact between slip-ring and center lead. Large slip-ring minimizes mechanical wear.

There are many other features which add to the dependability of Ohmite Rheostats—all proved on the Ohmite Life Tester illustrated below, and in actual service as well. They are built to withstand shock, vibration, heat and humidity.

Ten wattage sizes, from 25 to 1000 watts, from 1 9/16" to 12" diameter, in stock or special units to meet each control need. Approved types for all Army and Navy specifications.

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Write on company letterhead for complete, helpful 96-page guide in the selection and application of Rheostats, Resistors, Tap Switches, Chokes and Attenuators.

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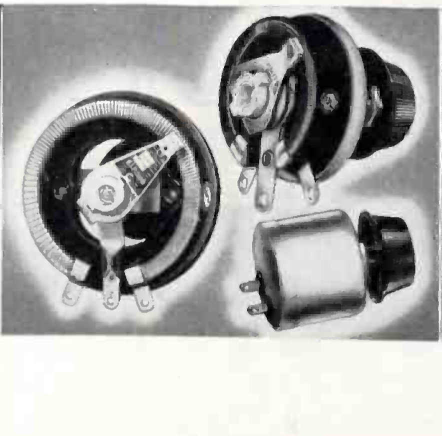

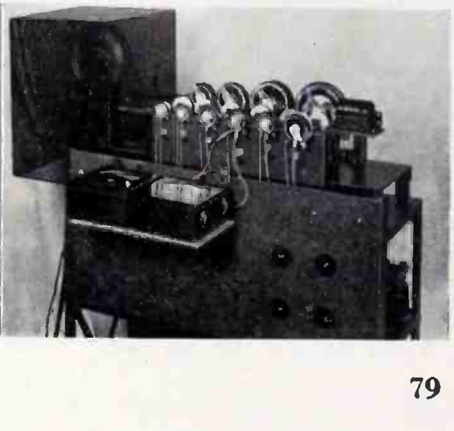

On Tuesday afternoon a symposi was held on the subject "What Ra Means in the War Effort." Discuss leaders in this symposium were A. Van Dyck, Paul Galvin, president of Radio Manufacturers Association; K. Jett, chief engineer, Federal C munications Commission; Neville Mil president of the National Associatio Broadcasters, and Capt. E. M. Webs of the U. S. Coast Guard.

Mr. Van Dyck pointed out that ra has had to go 100 percent to war that whereas the vacuum tube and te phony were beginning to be made use effectively in the last war, the te niques of ultrahigh frequency and t vision are important contributions the present war. It was also shown th as a result of present organized search, the rate of change of things the present time is exceedingly f The social and cultural aspects of th developments were also considered wh Mr. Van Dyck pointed out that te nical developments are proceeding such a pace and technical achieveme are so powerful that administrat must be made aware of their social a economic implications if they are perform their administrative and exe tive duties properly. This imposes additional responsibility on the en neers and technicians who must lea how to "sell" these technical devices people who will use them and adm ister their use. As a corollary of th argument it was shown that techni men must find out how to have more fluence in places of decision.

E. K. Jett outlined some of the mo recent developments of the Defen Communications Board (now known the Board of War Communication His talk was largely a survey of rece governmental activities which are a quately recorded in FCC orders a elsewhere.

The manufacturer's point of view w stressed by Paul V. Galvin who tra the conversion of the broadcast indu try from a peacetime to a wartime i dustry in a remarkable short period time. In the summer of 1940 some ha dozen companies were making a fe million dollars worth of radio apparat for the Army and Navy. During t latter part of 1940, throughout 19 and up to the present time, these firm have converted their entire productio to a war basis without disruption service. The magnitude of the job emphasized by the projection of a rad apparatus program in excess of on billion dollars.

The part which the broadcast statio are playing in the present war effo was ably outlined by Neville Mille president of the National Association o Broadcasters, who again pointed ou the need for social development keepin pace with technical developments.

A. O. Austin, president of A. O. Au tin, Inc., Barberton, Ohio, opened th Wednesday morning technical sessio with two papers entitled, respectively "Radio Strain Insulators for High Vo tage and Low Capacitance," and "Im proved Insulators for Self-Supportin

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Gentlemen:
Please send me your new free bulletin,
"THIRTEEN WAYS TO PROLONG TUBE LIFE."

The four colossal heads carved in granite on the rugged heights of Mount Rushmore will weather the storm and fury of ages to come.

Like this mightiest sculpture of man, GAMMATRON tubes are built to endure terrific punishment. Tantalum plate and grid construction, elimination of all internal insulators, and a special exhaust process positively prohibit the release of gas even at tremendous overloads.

GAMMATRON low voltage type filaments have a large reserve emission supply. They are conservatively rated, have an ample safety factor, and are operated at a point which provides the largest number of watt hours per dollar.

In these days the *extra* stamina of long-lasting GAMMATRONS is of greater-than-ever importance.

HEINTZ AND **KAUFMAN**
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GAMMATRONS OF COURSE!

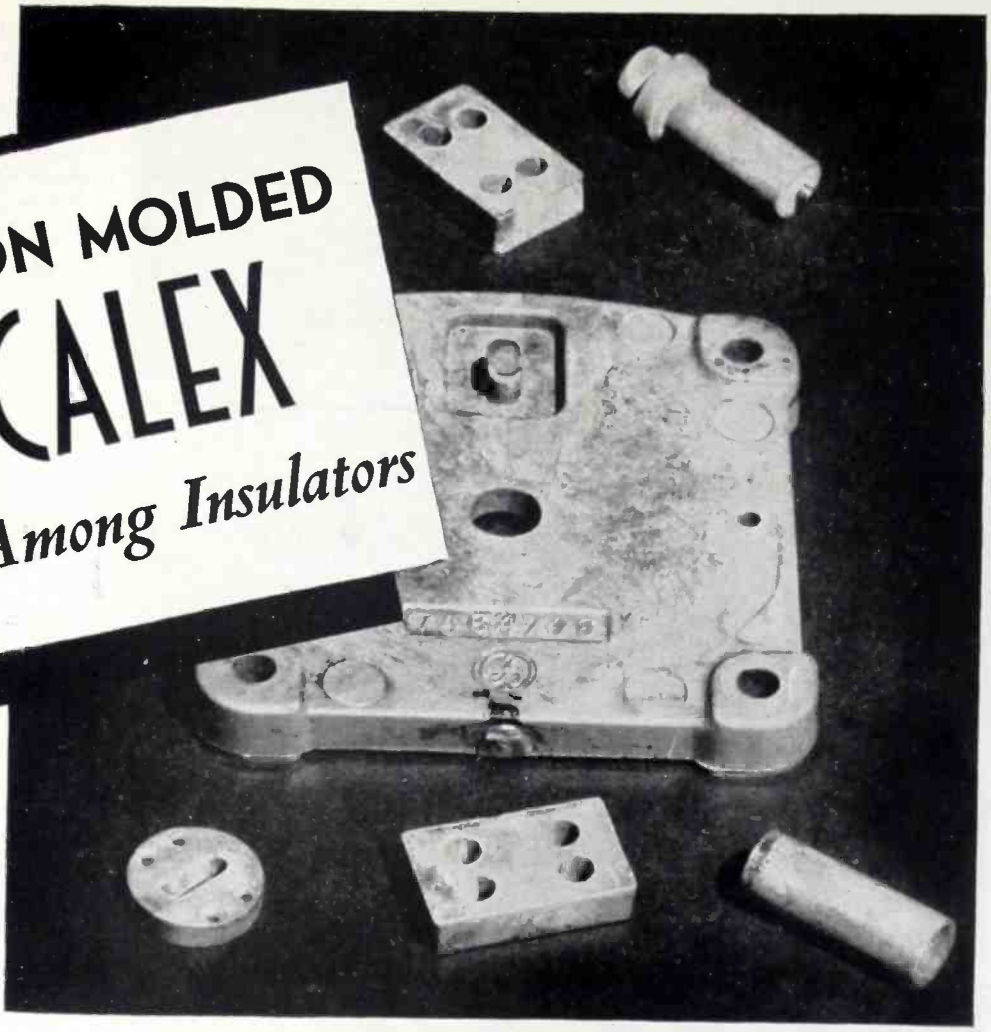
or Sectionalized Towers."[8] Both pap were on the same general topic and m be reviewed, therefore, together. In first paper the high voltage requi ments of radio insulators for withsta ing radio frequency loads were giv The effect of surface conditions in ma taining the quality of the insula tended to support the motto "Save surface and you save all," of the pa manufacturers. Some of the defects past insulator designs were pointed o In many cases the insulator suffe from high capacitance between terminals. In other cases, the path surface leakage was small whereas still other cases an insulator would quite serviceable for loads in tensi but would be subject to failure fr small transverse shocks or impact. type of insulator designed to overco these defects was described. Essentia it consisted of an insulating belt pregnated with resin or bakelite ma rials, contained in an outer protecti tube of porcelain or similar mater Appropriate corona sheaths were p vided as required. Insulators of t design are affected to a very slight tent by transverse impact loads, and m be used either in tension or compr sion. Thus, this design is suitable use as a strain or a compression type insulator.

A "Brief Discussion of the Design a 900-ft. Uniform Cross Section Gu Radio Tower" was given by A. E. W len of the Truscon Steel Co., Young town, Ohio. In contrast to the majori of papers usually presented before meetings of the I.R.E., this one was p marily a discussion of mechanical sign factors with consideration given such matters as wind resistance, effe of anticipated wind velocity in terms actual pressures on a complex tru form used in tower construction, corr balance of anticipated external load, complete analysis of the stress diagra under anticipated operating condition effect of ice and other loads, and so In the working out of this problem considerable amount of work was do with various types of sections whi were tested after sample models h been constructed.

The circular antenna, described by M. Scheldorf, has unusual applications for on vehicles, because of its ruggedness small size

INJECTION MOLDED MYCALEX

Unique Among Insulators



-IMYCALEX is a material possessing a combination sirable properties and characteristics not found to a degree in any other insulator. G-E Mycalex has over-all electrical properties and mechanical th than porcelain; it has refractory qualities superior enolic resins, gums, pitches, shellacs and other ic materials; and it may incorporate metal parts and s in molded parts, a feature not readily practicable ceramic products.

: G-E Plastics Department recently announced the opment of a method of injection molding for mycalex greatly extends the scope of application for this kable material.

TION MOLDED G-E MYCALEX PARTS HAVE DISTINCTIVE FEATURES:

Aore intricate shapes may be obtained.
inishing and machining operations are reduced or liminated.
Holes may be molded in part.
olerances may be held closer than in other types of olded insulation.

IN ADDITION, G-E MYCALEX HAS THE FOLLOWING PROPERTIES:

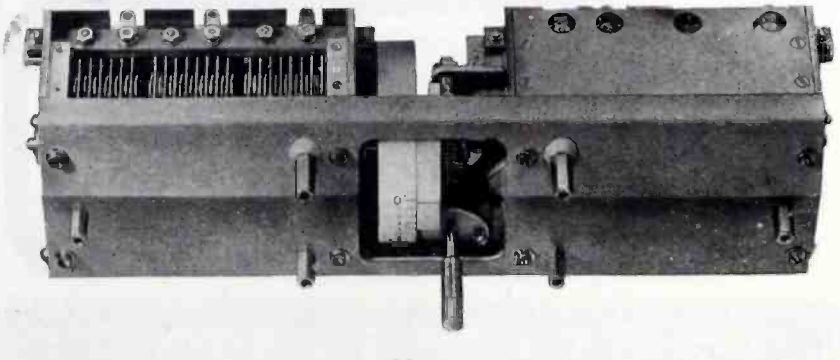
1. High dielectric strength.
2. Low power factor.
3. Prolonged resistance to electric arcs.
4. Chemical stability; no deterioration with age.
5. Dimensional stability; freedom from warpage, shrinkage, etc.
6. Imperviousness to water, oil, and gas.
7. Resistance to sudden temperature changes.
8. Low coefficient of thermal expansion.

Two types of G-E mycalex for injection molding are available,— general purpose, and radio grade,—both suited for many uses as insulators in the electrical industry. A booklet describing properties and applications may be obtained by writing Section H-7,

ONE PLASTICS AVENUE,
PITTSFIELD, MASS.

PLASTICS DEPARTMENT
GENERAL ELECTRIC

PD-51



A "Circular Antenna" was descri
by M. W. Scheldorf of the General E
tric Company. This is a new hori
tally polarized antenna whose outsta
ing feature is the radiation of subst
tially uniform energy in all directi
about the antenna without resorting
a complex structure or network to
cure this pattern. Essentially it is
rived from a half-wave antenna w
capacitive loading by bending the
ments around a circular shape as sh
in Fig. 11. Its low vertical ra
tion gives a twofold improvement
a single doubler and several units
be used to improve this gain. In mu
ple unit antennas the coupling betw
bays in such an arrangement has b
reduced to such an extent that adj
ments are simplified. The antenna
a pleasing physical appearance and
relatively small in size while it has
further advantage of being mecha
cally very rugged.

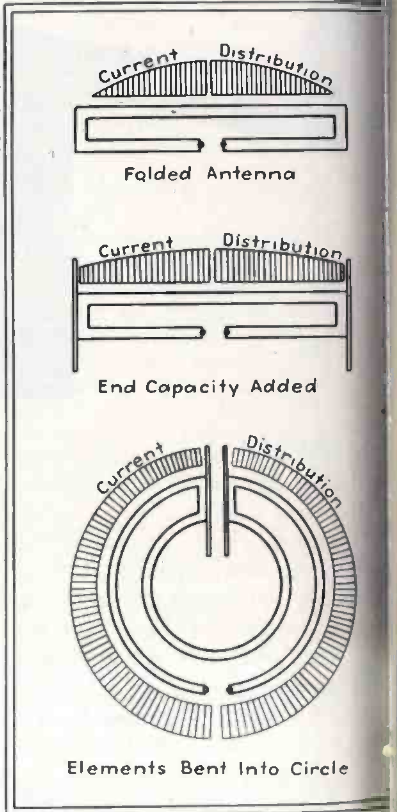


Fig. 11—Diagrams illustrating the deve
ment of the circular antenna from
folded doublet, at top

The features of the new antenna a
as follows: (1) A simple horizontal
polarized antenna with only two te
minals, yet essentially uniform in i
horizontal radiating properties; (
low mutual inductance between vert
bays with greatly improved adjustm
of multi-bay installations; (3) abil
to cover a wide frequency range w
one physical structure, through the
of simple means; (4) a system that
easily mounted to a pole of any dia
eter and grounded to that pole so th
there is lightning protection; (5)
system that may be applied to met
lically covered vehicles to an adv


"We were on their tails before they knew we were off the ground"

tage; (6) improvements in gains pe bay over existing units in the field; (7 a design which readily permits slee melting if desired; (8) a design whic is pleasing in appearance.

A paper by H. A. Brown and W. J Trijitinsky on "Stub Feeder Calculation" was not delivered.

An interesting analysis of the redesign of the antenna system for KDY was given by G. H. Brown of the RC Mfg. Company. The paper delivere was entitled "A Solution of the Problem of Adjusting Broadcast Directiona Rays with Towers of Unequal Heigh by J. M. Baldwin of KDYL and G. H Brown. The original antenna at KDY was a half-wave vertical tower radiator whose radiation pattern was to b modified to minimize interference i certain directions and reach the radi audience in other directions more effectively. The method of modifying thi radiation pattern consisted in erectin a quarter wave vertical tower as a reflector. Three means of determinin the radiation pattern were employe and all were found to work quite well One of these was based on measurements in the field using the original tower and its reflector. The results obtained by this method were checked b an experimental model built in th laboratory and both of these preliminary checks agreed quite well with the final pattern ultimately obtained.

A complete studio-transmitter (S-T) system for high fidelity program relaying studio and main transmitte was described by J. D. Keister of the General Electric Company who presented a paper "Television Video Relay System."

The entire equipment was designed for simplicity and reliability and of course uses the frequency modulation method of varying the carrier.

The 25 watt transmitter incorporates several novel features which account for the excellent performance obtained. Among these new tube designs especially suited for ultrahigh frequency operation are of most importance. A crystal control, double conversion superheterodyne receiver, employs such features as cascade limiting, carrier-of noise-suppression, and vertical chassis construction. Hermonics from the same crystal oscillator are used in performing both frequency conversions, resulting in an extremely stable unit. Both transmitter and receiver may be remotely controlled when proper compliance is made with the regulations of the Federal Communications Commission.

A high gain studio-transmitter antenna which meets all F.C.C. requirements is totally inclosed against the weather to avoid ice melting problems. An f-m station monitor, for FCC application, indicates center frequency continuously, as well as percent modulation interior level. All monitoring is also obtained from the same unit.

H. A. Breeding of the General Electric Co. presented a paper on "Mercury Lighting for Television Studios." Experiments with water-cooled mercury vapor

lamps for television studio lighting we carried out by the General Electric C at the New York World's Fair in 19 and finally culminated in a complete i stallation in the new modern studios WRGB at Schenectady in the fall 1941. Studio lighting in the televisic studio WRGB is provided by a series ceiling lights which may be controlle from an appropriate wall panel so th the horizontal and vertical directions maximum intensity may be varied b operators in the studio. Each of thes units contains three water-cooled H- lamps in their appropriate containe with metallic reflectors. The front su face of each of the ceiling lamps i provided with an irregularly surface sheet of glass to prevent excess unequa distribution of light. Each ceiling i stallation is on rows 9½ ft. apart acros the building and 6¼ ft. apart alon the building. The average space p unit is therefore approximately 120 s ft. and these units are mounted a proximately 14 ft. above the floo Ultimately there will be 19 luminaire of which 12 are installed and in operation at the present time. The averag footcandles with all of the floodligh pointed downward and oriented wit the long axis of the reflector across th room was found by measurement to b 315 footcandles. It is possible to buil up the intensity over a 10x15x10-f high scene to 650 or more footcandles o general lighting, with the upper portion of the scene reaching 1000 foot candles. By supplementing this lighting with floor lamps, good pictures ar produced with little or no discomfort t the performers. This "no discomfort" feature has been found to give excellen results.

Again performing for RCA, G. L Beers presented a paper "The Focusin View Finder Problem in Televisio Cameras". It was shown that the technical excellence of the television program frequently depends upon the characteristics of the view finder used in the television camera. Conditions peculiar to television make it desirable that the television camera view finder be of the focusing type in order that the image as seen by the television enthusiast may be properly focused. The requirements of an ideal view finder of this type are discussed not only from the angle of technical performance required but also from the angle of convenience of operation and speed of manipulation. The characteristics of various types of or-

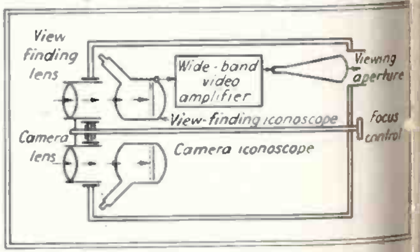


Fig. 12—Electronic view finder using two image forming tubes meets most requirements for view finder for television cameras

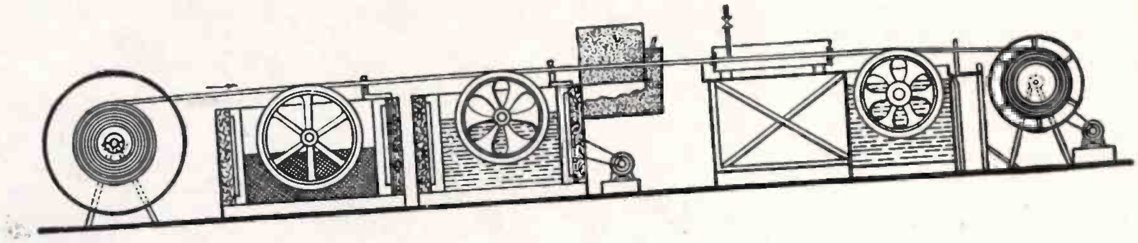
ciary camera view finders were discised but it was found that none of tse is ideally suited to television camers. The most suitable type of view fder which has been developed at the psent time is illustrated diagramrtically in the illustration of Fig. 1 Essentially it consists of a view fder lens and a camera lens of the sne general optical design, a viewing inoscope and a view finding iconospe, the latter of which features a vle band video amplifier and ultirtely makes the picture avaliable in a iconoscope. The view finding equipnnt is a miniature reproduction of the cnplete television monitoring system.

K. R. Wendt and G. L. Fredenall of t RCA Manufacturing Co. presented a paper "Automatic Frequency and Iase Control of Synchronization in Tlevision Receivers" as their solution o one of the problems in the reception o television images in providing satisf tory synchronization in the presence o noise. The system of synchronization wich has given satisfactory results up t the present time has depended for its o ration on the reception and separatn of individual pulses. Satisfactory s chronization can be obtained from t se signals which will in all other rpects provide an entirely acceptable pture with this method of synchroniztion. Nevertheless, for limiting conditns of service, particularly where the fid strength may be low, an improvemnt in synchronization will be effective al desirable provided that it does not iolve other complications or disadvantes. The new method of synchronizatn which was described by Mr. Fredell makes use of automatic frequency al phase control of the sawtooth scanng voltages. In this system, the sync onization depends not on the indivual pulses but rather on the average o many regular recurring synchroniing pulses so that the overall effect is a increased synchronization. Noise is natively ineffective since it occurs at a random distribution rather than at r ularly recurring intervals. Noise c not affect the horizontal resolution o interlacing.

Experimental receivers in which the a omatic frequency control of the snning oscillator has been incorported have operated well with a high immnity to noise.

Consideration of this new developmnt indicates that its use would resit in several improvements in tele-vion service. The system is particulay useful when severe noise conditions ocur since superior performance is realizl within the service area by the new mthod. Under excess noise conditions tl useful service area is extended with tl new frequency and phase control sitem. The maximum resolution permted by a television channel is attsed with the new system whereas it my not be attained in the old system eecially where noise is important. It isxpected that the cost of television receers will not be increased by the use o the automatic frequency and phase cetrol circuit, Fig. 6 and Fig. 7.

WAR
is engineered scrap



This war machine was built from an old pulley, the rear wheels of a truck and odds and ends of sheet steel.

It will never fire a projectile nor drop a bomb. But if our enemies really understood America it would frighten them.

The function of this scrappy gadget is to renew the weather-proofing on electric power wire . . . wire that would otherwise have to be junked.

▶ But war teaches us to look beyond machines to the hearts and minds of the men who make them.

In such perspective the device shown above takes on deep significance. It becomes a mechanical parable on the ingenuity of men whose job it is to keep electric power flowing to the vital war industries, regardless of shortages of copper, steel, rubber, aluminum.

▶ There are hundreds of such parables in every war-converted industry. Here are just a few from our great electric power plants:

. . . tons of bolts are being saved by a new method of rigging crossarms on electric poles.

. . . a southern generating station found its dam weakening. To keep the power flowing, holes were bored through the concrete and the dam bolted to bedrock!

. . . to avoid a shutdown, a middle-Atlantic utility worked out a method of stopping leaks around the giant valves controlling its water supply by mixing *sawdust* with the water. It worked.

. . . a western company bought old suspension cables from the wrecked Tacoma Bridge, untwisted them and used the metal as concrete reinforcement.

So goes the saga of electric power, as the industry does its share in the common task . . . With much of its trained man-power in the services, with priorities available only in the most urgent cases, the American utilities are showing the stuff American management and labor are made of.

But where are the stories of plants rushed into being almost overnight to supply electric energy?

As an American, you can thank your lucky star such stories are few. Generating plants and powe lines take years to build. For instance, our country' power equipment at the start of the war represente an investment of more than the present combined cos of the two-ocean navy and lend-lease expenditures

War conversion for this vigorous industry was al most as simple as pushing the light switch on you reading lamp. The power was there because energeti managements had created it in the normal course American life.

Some rush construction was necessary, but t electric power industry was first in war *because* it h been first in peace.

▶ The story goes back to the depression years. T utilities were the first to shake off the doldrums. 1935, they had already passed 1929 levels.

. . . By the time the war broke out in Europe, Ame ca's giant electrical capacity surpassed that of combination of potential enemies.

. . . It has grown since then, with 3½ million k capacity scheduled to be added in 1942. This y the industry also will spend 150 million dollars maintenance alone.

▶ Because of these private expenditures, beca the electrical companies started years ago to women on the convenience of electrical home ap ances . . . and because the industry has always b in advance of demand, it was ready for either pe or war, with the world's greatest system of po production and distribution.

★ ★ ★

In recognition of the miracle of war production—ac plished through the cooperation of American manage and labor with the W. P. B. . . . this advertisem published by the McGraw-Hill Network of Indus Communication.

McGRAW-HILL PUBLISHING COMPANY, Inc.

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PERHAPS you saw the advertisement on the opposite page, in the newspapers.

Did you notice those five examples of the way in which maintenance men are meeting the problem of war operation?

That's what this page is about.

If one public utility maintenance man works out a new way of reconditioning wire, his idea becomes really valuable to the country when all maintenance men with a similar problem find out how he did it.

If one man experiments with silver and bismuth as a substitute for tin solder, that becomes great news for a man who needs tin solder and can't get it.

That's why industry after industry has been able to meet the war production challenge . . . by swapping ideas.

▶ In industry, this idea swapping is done mostly through the editorial and advertising pages of the industrial press.

McGraw-Hill, for instance, keeps 153 editors and 725 engineer-correspondents busy digging up new methods of doing things.

Industrial advertisers, too, often send men into the field to discover new ways of making their products do more work, or last longer.

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▶ If you would like suggestions as to how to conduct such a survey, just write to Reading Counselor Department, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York.

* * *

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Textile World
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Wholesaler's Salesman

TUBES AT WORK

Continuous Balance Potentiometer Pyrometer

By ROBERT D. TOWNE and
D. M. CONSIDINE

A COMPACT ELECTRONIC balancing unit has replaced a galvanometer and complex system of cams and levers in the new continuous balance potentiometer pyrometer designed by The Brown Instrument Company.

Galvanometer balancing mechanisms previously used were cyclic in operation, with continuous mechanical motion providing intermittent periods during which the galvanometer was freed to assume its proper deflection unhampered by an engaging mechanism. In the new electronic system, unbalanced d.c. in the pyrometer measuring circuit is converted to a.c., amplified, and used to drive a motor in the proper direction to balance the measuring circuit and maintain correct instrument reading.

Use of the electronic unit eliminates galvanometer inertia, pivot friction, effects of vibration and changes in position. When a balanced condition has been established, there is no unbalanced voltage to be amplified and no driving power to be fed into the motor. No further motion takes place until a change in the measured condition requires further rebalancing.

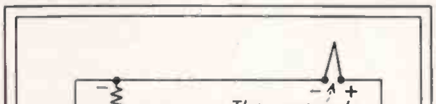


Fig. 1—Diagram of the complete continuous balance potentiometer pyrometer system

Measuring Circuit

The measuring circuit of the balancing system shown schematically in Fig. 1 consists of a thermocouple and a slide wire through which a known current is passed. Position of the slide wire contactor is adjusted mechanically to balance the voltage from the thermocouple. When the temperature changes, unbalanced d.c. appears across *AA*. This unbalanced voltage is changed into a.c. by the converter, which is a single-pole, double-throw switch actuated by an a.c. energizing coil so that it vibrates in synchronism with the 60-cycle line voltage. Contacts mounted on the vibrating reed feed the unbalanced voltage into alternate ends of the primary of a specially designed transformer, creating a 60-cycle control voltage which is either in phase or 180 deg. out of phase with the line a.c., depending upon the polarity of the unbalanced voltage of the measuring circuit.

Voltage and Power Amplifier

The a-c control voltage passes into a conventional voltage amplifier employing a three-stage resistance-capacitance coupled circuit. Each stage has an amplification factor of 50, providing total voltage amplification of 125,000. Tubes are high-mu twin triodes. A section of the second twin triode tube is used as a half-wave rectifier to supply plate voltage. The grid of this section is connected to the cathode so that this section functions as a diode.

The power amplifier consists of two identical twin triode tubes having their input circuits connected in parallel and their output circuits in push-pull. Since the twin-triode tubes perform duplicate functions, one of them will be disregarded in the following explanation, and the two sections of the twin triode tube under discussion will be designated tube 1 and tube 2. Referring to the schematic diagram in Fig. 2, in which polarity signs are arbitrarily assumed, tube 1 can conduct plate current only during the odd half-cycles of the control voltage from the voltage amplifiers, and tube 2 can conduct plate current only during the even half-cycles. Thus, a definite phase relationship exists between the control volt
from the thermocouple circuit and
power amplifier output.

Half-wave pulses of current will p
through motor winding *A* and c
denser C_1 during the odd half-cycles
the control voltage. During the ev
half-cycles, the tubes will pass no c
rent, but condenser C_1 will discharge
the motor winding *A*. Thus, with an

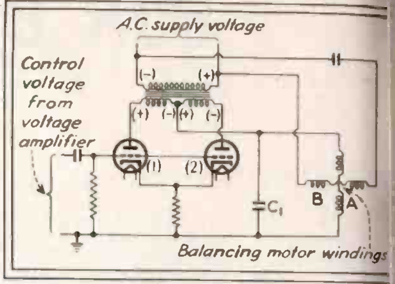


Fig. 2—Simplified schematic of the pow
amplifier

phase signal on the grid of the pow
tubes, a sine wave alternating volta
in phase with the supply voltage w
be developed across the motor windi
A. Conversely, when the control vo
age is 180 deg. out of phase with t
line voltage, a sine wave a-c voltage 1
deg. out of phase with the supply vo
age will be developed across winding

Balancing Motor

The balancing motor is a reversibl
two-phase induction type. The pow
winding is energized continuously b
the line voltage; the control windin
is energized, as explained above, by th
power amplifier. Thus, when the the
mocouple circuit is unbalanced, th
phase relationship between the tw
windings is determined by the dire
tion of unbalance. Hence the moto
which is connected through gears an
levers to the slide wire contactor an
to the instrument pointer, always r
tates in the proper direction to balanc
the thermocouple circuit, at the sam
time correcting the position of the in
strument pointer.

When the measuring circuit is ba
anced and the control voltage to th
grids of the power amplifier is zero, th
power tubes act as full wave rectifier
applying pulsating d.c. to motor contr
winding *A*. This brakes the motor a
the position of true balance and pre
vents overtravel.

Sensitivity of the electronic continu
ous balance unit is such that maximu
driving power of the balancing motor i

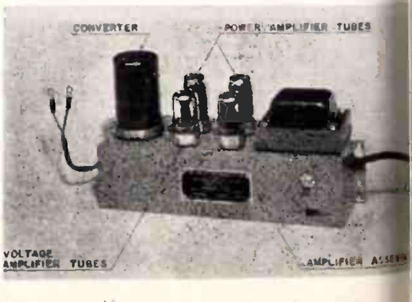
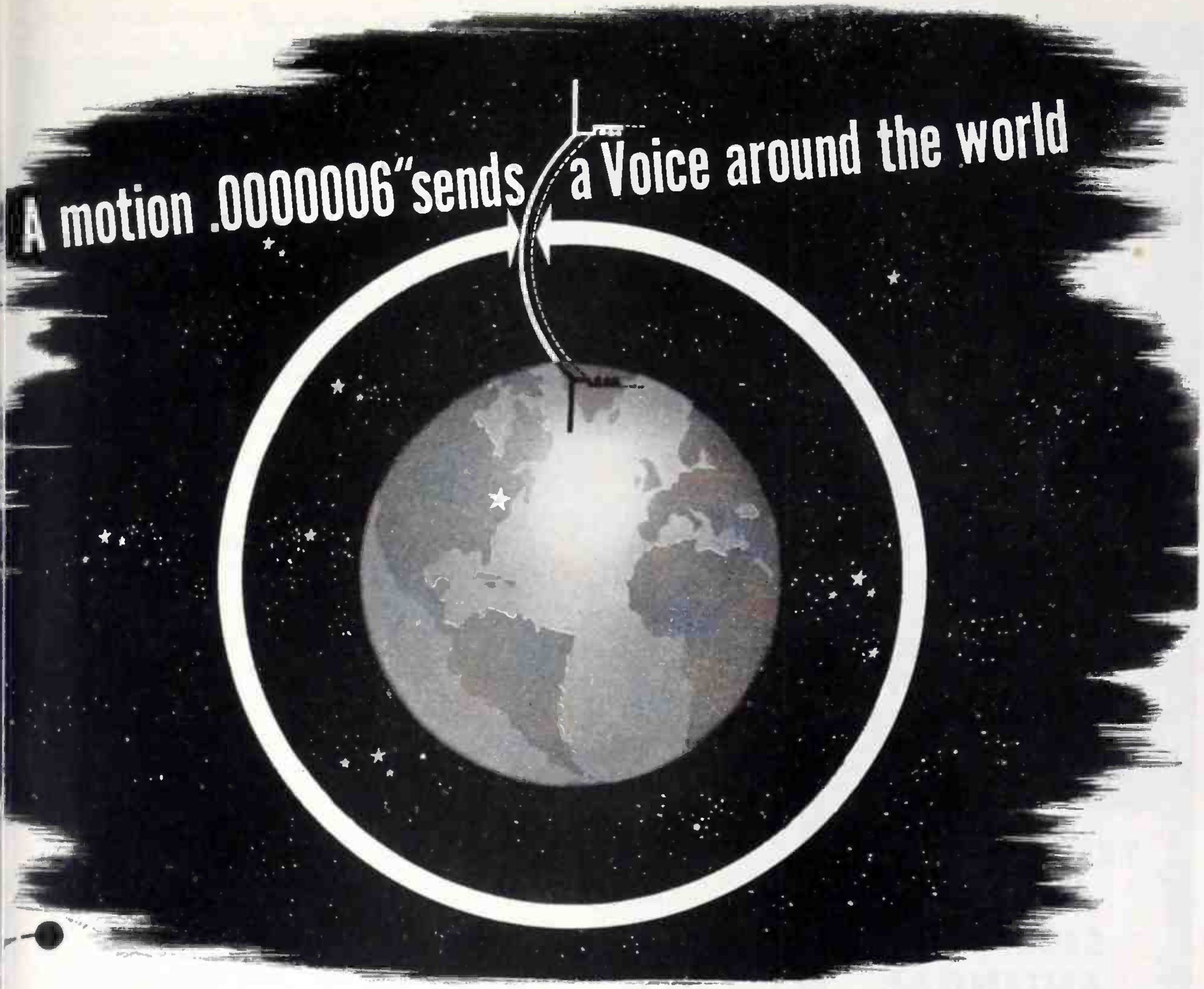


Fig. 3—Photograph of the electronic por
tion of the equipment



Microphone Diaphragm Design is a Difficult and Fascinating Art

THE Diaphragm is the heart of the Microphone. It responds to sound wave vibrations and actuates the translating element carbon, piezoelectric crystal, moving armature or moving coil. A Diaphragm must be extremely light—present a correct driving impedance to the sound wave and to the translating system—vibrate with uniform displacement or velocity at all frequencies. It must withstand atmospheric changes, extreme temperatures and hard service conditions of vibration, shock, gunblast. Whether designed for the studio or the battlefield, *it must function.*

The Diaphragm in the "556" Shure SuperCardioid Microphone is .0010" thick and weighs only 1/470th of an ounce. It drives a coil of wire in a magnetic field through .0000006 (six ten-millionths) inch, for average speech at 1 foot from the Microphone. This Diaphragm is designed so that it vibrates equally well at all frequencies from 40 to 10,000 cycles per second, yet is rugged enough to withstand the abuse encountered in daily service.

The Shure Engineering Staff are specialists in Microphone Diaphragm design. **At Radio Station WRUL, America's Powerful Short-Wave Station, Diaphragms in Shure SuperCardioid Microphones are moving this .0000006 (six ten-millionths) inch to send the Voice of Freedom around the world!**

Send for Booklet 172M

This booklet describes the theory of the SuperCardioid and the Shure SuperCardioid Microphone.

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SHURE

obtained with an unbalance of less than 0.06 percent of the scale span, which represents one convolution of the slide wire. This is equivalent to a 0.00005 volt unbalance in the thermocouple circuit.

Fig. 3 is a photograph of the electronic portion of the system.

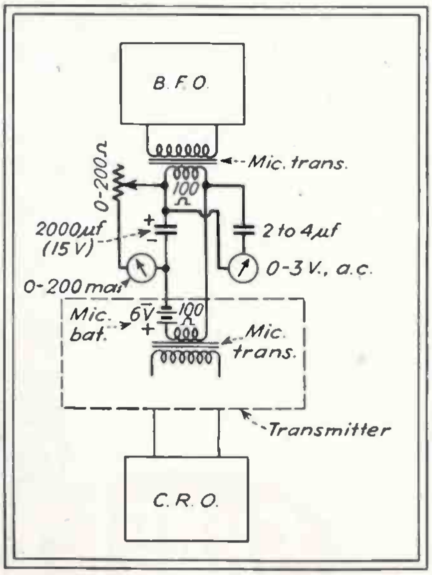
• • •

Transmitter Production Test

SPEECH AMPLIFIER and modulator performance of transmitters coming off the assembly line is rapidly compared with pre-determined standards by means of a simple yet commercially effective test setup devised by the engineering department of the Jefferson-Travis Radio Mfg. Corp.

A 1000 cps signal generated by a beat frequency oscillator delivering between 5 and 10 mw of power is fed to the microphone input terminals of the transmitter under test through a "dummy microphone" circuit consisting of an inverted microphone transformer having a variable resistor and a milliameter in series with one leg and a 2000-ohms-per-volt a-c voltmeter of the copper-oxide rectifier type across the line. An electrolytic capacitor bridging the resistor and the milliameter provides a low impedance a-f path while a paper dielectric capacitor connected as shown keeps d.c. out of the voltmeter.

When testing one particular transmitter series the variable resistor is adjusted so that 20 ma flows through the milliameter, establishing an input impedance condition comparable with that which obtains when a single-button carbon microphone furnished with the transmitter is connected in the circuit. The output of the bfo is then adjusted until the voltmeter reads 1.8 volts. Tests with transmitters known to be up to standard indicate that this input voltage should be sufficient to modulate t transmitter 100 percent, indicated by cathode-ray oscilloscope connected the transmitter output circuit in a co ventional manner.



Simple "dummy microphone" setup for testing transmitter speech amplifier and modulator performance in production

Where transmitters must be test over a definite audio frequency rang as in the case of a series in curre production on which specifications r quire that modulator output be fl within plus or minus 3 db between 2 and 3000 cps and at least 10 db dov at 60 and 5000 cps, production chec are accomplished with the same test d vice by holding a-f input voltage co stant while tuning the bfo over t necessary range and noting the mod lation percentage indicated on the ca brated cro screen.

• • •

An Electronic Profilometer

ROUGHNESS ON THE SURFACE of m terials finished by abrasives, by mi ing, turning, plating, grinding a other similar operations, may be mea ured by means of an electronic profi ometer designed by the Physicists R search Company of Ann Arbor, Mich gan. Surface irregularities from 0 to 1000 microinch above or below an average centerline or reference point are easily read on the scale of a calibrated rms meter. An instrument with a special scale permits readings between 0.1 and 1 microinch.

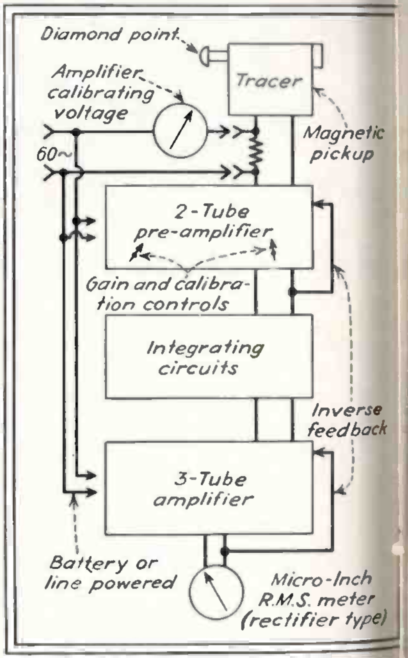


Fig. 1—Block diagram of the electronic profilometer, showing diamond-point p.m pickup tracer head, amplifier with inverse feedback, velocity compensating integrating circuit, rms microinch meter and provision for calibration check

Fig. 1 shows the circuit of the instrument in elemental form. Basically, the principle of operation involves generation of voltage in the coil of a p.m

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ELECTRONICS

pickup as a diamond-point stylus is moved over the surface to be examined, an amplifier and a rectifier-type output meter calibrated in rms microinches. Provision is made for calibrating the amplifier by means of voltage obtained from the power lines.

The Tracer

One tracer head available for use with the instrument, shown in Fig. 2, is about the size of a pack of cigarettes and so shaped that it may be conveniently held in the hand and moved over the surface to be examined. (It may also be bolted to any mechanical device, such as a motor supplied by the designers, suitable for effecting its motion.)

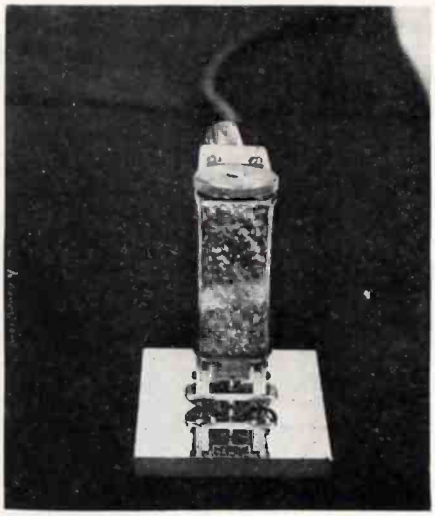


Fig. 2—Typical tracer unit. Note yoke supporting weight and establishing a reference level for the diamond point at the bottom, surface pressure adjustment knob at the top

A diamond is mounted on the end of a duralumin rod which is, in turn, screwed into a tube mounted on parallel springs. The parallel springs serve to restrict the motion so that it is essentially perpendicular to the surface. The upper end of the tube terminates in a coil form upon which is wound about 40 turns of wire two-thousandths of an inch in diameter. The coil is located in the field of a permanent magnet. When the tracer unit is drawn over the surface of the finish to be investigated the diamond transmits vertical motion to the coil. The output of the coil is proportional to the motion and is about 2 μv per microinch at a 60 cps reference frequency.

The diamond point is positioned midway between two cemented carbide "skids," mounted upon an inverted U-shaped "yoke." Skids may be moved up and down by adjusting a knurled control knob on the top of the tracer unit, so that the tension of the diamond point against the surface to be examined may be delicately controlled to suit the material whose surface is being measured.

The instrument's amplifier consists of a five-tube resistance-coupled circuit using transformer input and transformer output. Two inverse feedb circuits contribute to stability and prove frequency response, permitt circuit constants to be altered by factor of two-to-one without appr ably affecting the gain of the amplifi The input transformer is provided w a "six-ply" shield to avoid sensitiv to extraneous a-c fields.

The Amplifier

Because the profilometer tracer u produces voltage through the moti of a coil in a magnetic field, volta is proportional to the velocity at wh the turns of the coil cut the magne lines of force. Consequently, the v age produced by the tracer is prop tional to the speed at which the tra is moved over the surface. This veloc effect is compensated for by spec integrating circuits, designed to oper over a frequency range of from 20 10,000 cps, within plus or minus one

Calibration

The tracer head calibration is fected during manufacture by placi the point of the tracer in contact wi a brass block vibrating vertically the end of a brass reed. The up a down excursions of the reed are th transmitted to the diamond point, whi produces a reading on the profilomete rectifier-type meter. A microscope wi a calibrated eyepiece measures the and down excursions of the point. T meter of the profilometer is then a justed to read the value determin by the microscope measurement. Al during manufacture, amplifier gain measured by introducing a known i put voltage. The gain of the amplifi is thus expressed in terms of micr inches and becomes the calibration nu ber of the tracer. This calibratio number is stamped on the back of th tracer and enables any tracer head be used with any profilometer by pe forming an amplifier adjustment in th field.

To adjust the instrument so that reads true microinch units in the fiel the thermocouple meter shown in th upper left corner of Fig. 3 is em ployed. Alternating current from an 60 cps power line is fed through thi meter and through standardized re sistances to produce a known standard voltage drop. This drop, produced at power line frequency, is 100 μv. It i

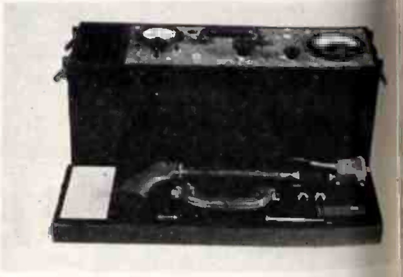


Fig. 3—The complete instrument, with cover removed. Tracer head, extra "yokes" and accessories may be seen in the foreground

ierted in series with the tracer unit al thus effects an open circuit calibrat1. With such a test voltage exciting t instrument amplifier, the output nter is adjusted to read the number o microinches stamped on the back of t tracer unit by means of a T-pad c trolled by a knob on the panel.

• • •

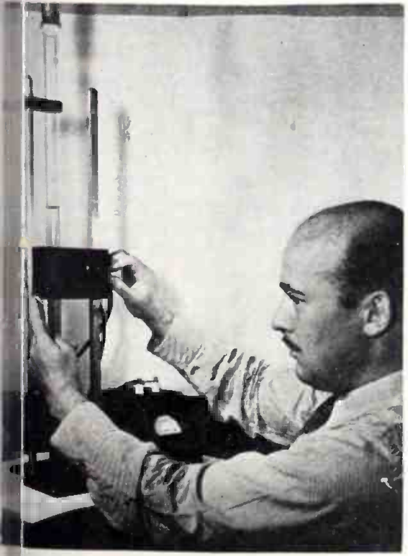
Ion-To-Glass Seals

THT SEALS BETWEEN iron and glass, eninating the need for the critical n:als nickel and cobalt, are now being e cted in the construction of vacuum tes by means suggested by General Fctric's Dr. Albert W. Hull and Dr. Lis Navias. Such seals involve the u of special glass compositions. One cisists of 45 percent silicon dioxide, 14 pcent potassium oxide, six percent siium oxide, 30 percent lead oxide and fi percent calcium fluoride. The rate o expansion is very close to that of in.

Then a glass containing lead is sealed incontact with iron some of the lead ams migrate from the glass into the in. Weakening of the resulting joint isvoided by placing a thin layer of lel-free glass directly over the iron, th sealing the lead-containing glass tche lead-free glass. The thin leadfr glass layer prevents lead from rching the iron yet is not thick eugh to crack and let air into the te.

• • •

POWDER PARTICLES



D A. A. Bates of Westinghouse demonsites P. R. Kalischer's device that quickly dermines grain size of metallic powders hing particles as small as 1/25,000 inch. Med with a liquid in a long glass tube, th particles intercept a light beam directed t a phototube as they settle. The rate awhich the solution clears up, indicated b anode current change through a milliameter, gives comparative data

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Moisture Determination in Non-Polar Compounds

By H. Loughnane

In NON-POLAR COMPOUNDS such as nap tha, recovered by a system using stea moisture remains in the solvent in bot the condensed an vaporous state. Th following method isolates the moistur and permits measurement of very sma quantities:

A chamber of known volume is purge with dry air and then a measure quantity of solvent or solution is adde The dry air above the solution is cir culated through the solution until it n longer takes up moisture. The de point of the air is taken to determin the number of grains of water presen in the air and this is compared wit the number of grains of solution re sponsible for the rise in humidity. (I practice, absolutely dry air is not r quired. Humidity may be read befor and after the air has been in contac with the solvent. The air is never al lowed to go to 100 percent saturation If samples are so laden with moistur they are diluted with dry solvent an the necessary correction made for vol ume change. In a converse manner small amounts of moisture may be mor readily measured by using a compara tively large amount of solvent with re spect to the volume of air in the chamber.)

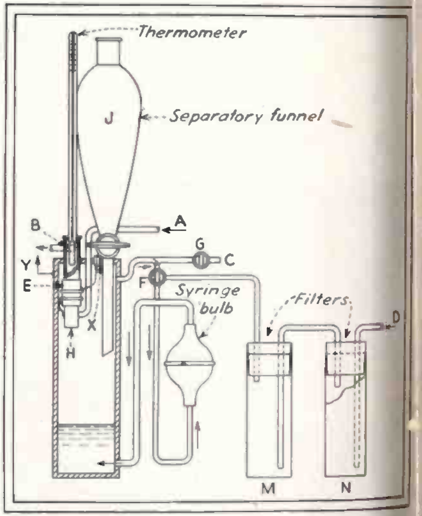


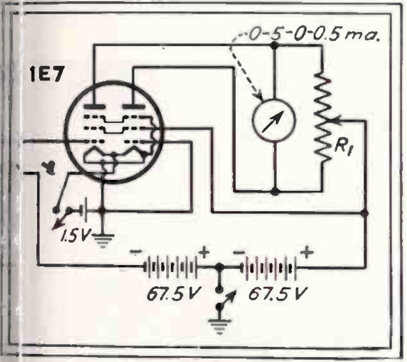
Fig. 1—Setup for moisture determination in non-polar compounds such as naptha

Fig. 1 shows the chamber, the valve arrangements, a small copper tank *H* and the drying filters *M* and *N*. The volume of this chamber and of the syringe bulb and the tubing is determined by filling up every air space with a dry solvent and measuring the volume of the solvent. With the aid of the bulb, dry air may be drawn through the drying filters to purge the chamber and, by changing the valves, this dry air may be re-circulated in the chamber to bubble through the solution. The tank *H* is fitted with small copper tubes in such a manner as to allow a brine solution to enter the tank a A, flow about the thermometer bulb al leave through B. The flow of the bne is controlled in order to permit a sw drop of temperature at the glass j ket E.

Electronic Measurement

The Pyrex jacket E contains two numb 18 tinned copper wires 1/64-inch a rt. One wire is grounded to tank H a the other is brought out through tl polystyrene bushing terminating a X.

ig. 2 shows the amplifier. This a plifier has an input resistance of 1 10^8 ohms and is capable of reading tl resistance of the microscopic film o moisture that forms on the glass j ket E without causing decomposi- ti of the film through electrolysis. A 1 tube has one control grid tied to g und and in its plate circuit, bridge f ion, is a 0.5-0-0.5 milliammeter. R_1 is sed to balance the meter to zero w n the remaining control grid is o a-circuited. In series with the open g and the conductors on the jacket E th e is a potential of 67.5 volts, positi side to ground. The connection f n the polystyrene bushing X is well s lded.



F 2—Circuit for measuring resistance of sture film condensed on inside of glass jacket

peration of the instrument is as fol ws: A measured quantity of solvent or olution is placed in the separatory fu el J. Valves are set to bring dry ai nto the chamber from D through M nd N and to exhaust through C. W the brine at a temperature of ab t 26 deg. F., the jacket is cooled un a meter indication shows that th e is condensation on the glass jacket. T temperature of the jacket is taken at he start of the meter movement. T is the dew point of the air from th dryers. The brine flow is then st ped and the chamber allowed to wa n up above the wet bulb temperatu . Further purging with dry air will ev orate moisture from the jacket and th meter will return to zero.

e solution is now introduced into th chamber. Air is allowed to escape at . This release of air should be us to control the flow of solution t the chamber. A low mark on the fu el used to keep a liquid seal over th chamber is suggested. With the sol ion in the chamber, valve G is c o d and F is turned to permit the circulation of air above the solution in such a manner that it bubbles through the solution. The temperature of the jacket is then slowly lowered while operating the syringe bulb. As we now have a closed system, the circulation will depend upon unequal pressures on either side of the syringe bulb, hence high pressures will be built up in the chamber on the compression cycles. This pressure will cause a premature reading of dew point but, on release of the pressure, the meter will start to fall, indicating that the temperature is in the wet bulb range.

When this point is reached the brine flow is adjusted to give a constant reading and the syringe bulb operated until the meter swings, occurring on compression, have reached the maximum. This will indicate that the volume of moisture on the jacket has also reached a maximum and that there is no more moisture available from the solvent. The chamber is then allowed to warm up past the wet bulb reading, or until the meter reads zero. Without any further operation of the syringe, the temperature is again allowed to fall in the jacket *E* until condensation takes place at normal pressures. This will be the actual dew point of the known volume of air.

The water content is then calculated from a psychrometric chart. Subtracting the water content that was first found, before the introduction of the solvent, the grains of moisture that actually came from the solvent may be readily compared with the weight of the solvent.

• • •

Hydrogen Moisture Check By Direct Electronic Method

THE QUALITY OF CERTAIN steels treated in atmosphere furnaces is largely dependent upon the purity of hydrogen gas flowing over the metal during manufacture. In bright annealing, for example, the hydrogen must be virtually free of moisture containing oxygen. Ordinarily, to measure the moisture content of hydrogen where dew points are less than 0 deg. C. a cooled and polished metal plate is inserted in the gas stream and the temperature at which condensation first occurs on this plate is noted. Below –40 deg. C. this method depends largely upon niceties of judgment on the part of the operator and is, therefore, subject to human error.

A direct electronic method of continuously monitoring the moisture content of hydrogen is illustrated in Fig. 1. Hydrogen of known moisture content is pumped through a special Westinghouse half-wave rectifier tube with intake and exhaust ports at a constant rate until the interior of the glass envelope is thoroughly purged. Regulated filament and anode potentials are then applied to the tube and adjusted to give a full-scale reading on the anode circuit milliameter. Hydrogen to be used in the steel-making process is then substituted for the calibrating hydrogen

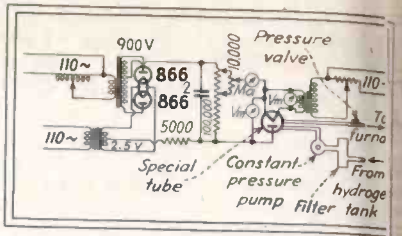


Fig. 1—Circuit of electronic device continuous monitoring of hydrogen g moisture content

and, with gas pressure and tube v tages maintained at the pre-determin values, any milliammeter readi change indicates a change in the mo ture content of the gas. Presence of mo ture, or oxygen, in the hydrogen flowi through the tube in amounts great than that in the gas used for calibrati collects more negative ions in the tub electron stream, increasing intern impedance and reducing anode curre

The special tube pictured in Fig. employs a tungsten filament and tungsten anode, this metal being sati factorily impervious to hydrogen. Moi ture determination by this process connection with certain other gas would, undoubtedly, require the use other tube metals impervious to su gases.

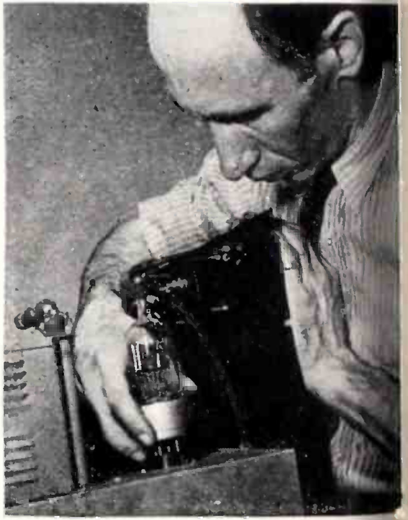


Fig. 2—The heart of the system, a specia half-wave rectifier tube with gas intake and exhaust ports

Variations in tube anode current with changes in gas moisture content could, obviously, be used to control the operation of dehydrating equipment, thus rendering the entire process fully automatic.

• • •

Vacuum Tube Voltmeters The Meter at Work

THESE TWO VOLUMES were reviewed in June ELECTRONICS and it has just come to our attention that the prices given are not correct. The book "Vacuum Tube Voltmeters" actually sells for $2.00, and "The Meter at Work" volume can be had for $1.50. Both are published by John F. Rider, New York.

NEWS OF THE INDUSTRY

First-quarter receiver production figures. Defense communication equipment and personnel survey. Wartime tube packaging. Notes about men and materials

Pople

D C. B. JOLLIFFE, chief engineer RCA La ratories and communications chairm of NDRC, was awarded honorary LL. degree by the University of Virgi, his alma mater at the school's 75 annual commencement.

lph S. Merkle, commercial engine Hygrade Sylvania, has been commi ioned First Lieutenant in the Coor ation Branch, U. S. Signal Corps.

vid Grimes has been made vice pr dent in charge of engineering, Jo ph H. Gillies, vice president in cha ge of radio production, and Robert F. err, vice president in charge of ser ce, all of Philco Corporation.

N s

vox CORPORATION celebrated its anniversary recently with presen of tokens of esteem to S. I. Cole, re ident and other officials and old in the company.

lin Corporation of America, facturers of cast and liquid resins lastics, has completely reorganized nufacturing facilities at its plant rds, N. J., has embarked on the n of a new building for the pro n of polystyrene molding com s, and the purchase of land, build nd equipment of the former U. S. Products Co., Inc., at Matawan,

stone Carbon Co., St. Mary's, , manufacturers of precision products is completing a large m of expansion of plant and acturing facilities.

President Roosevelt requested Congress on June 8 for an appropriation of $2,505,730,000 for the Signal Corps.

Seven official television listening posts have been established in Schenectady County, N. Y. where air raid wardens have been getting instructions originating in New York City relayed to them by the G-E television station.

More About Civilian Defense Communications

RULES GOVERNING THE operation of civilian defense radio stations (ELECTRONICS, July 1942, p. 103) released in June by the Federal Communications Commission specified that licenses would be issued to amateurs and others having the necessary technical training and equipment only through groups affiliated with the Office of Civilian Defense. The OCD simultaneously announced that it was preparing a manual explaining the procedure to be followed by properly accredited defense groups wishing to set up War Emergency Radio Service networks.

The manual referred to by the OCD is still in process of preparation as this issue goes to press but, in the interim, regional directors of the OCD have received a memoranda from director James M. Landis outlining suggested preliminary organizational steps which should be taken. Among the suggestions are the following: It is recommended that surveys be undertaken to determine to what extent equipment, licensed operator personnel and technical skill are available in each control

Radio Receiver Production-January to March 31*

	1942 Units	1941 Units	1942 Dollars	1941 Dollars
ast Receivers				
e sets	1,120,296	1,261,997	$14,379,700	$10,713,000
Co ole sets	141,883	124,976	5,710,900	3,857,600
ables	374,307	196,824	5,810,000	2,228,500
Te ision (no sound)	139	4	7,500	200
Au sets	216,910	650,035	3,671,200	10,405,800
a battery sets	195,854	157,077	2,761,900	1,845,800
adapters	4,798	884	120,500	20,100
phonographs	64,563	43,754	932,800	494,600
ation Apparatus				
combinations	227,120	112,684	5,761,100	2,034,600
les	223,791	106,119	16,345,500	6,498,700
, phono., and recorder	24,488	15,047	2,232,000	742,700
ision	92	23	17,300	3,100
ratus sans cabinets	127,608	93,641	2,323,600	1,237,900
Cor ol apparatus	780	834	10,600	7,200
al	2,722,629	2,763,899	$60,084,600	$40,089,800

pilled by the Radio Corporation of America from reports from its licensees.

Plastic Shut-Off Branded by Rogan

Heat Control Unit Branded by Rogan

Calculating Device Part Branded by Rogan

area. (The OCD does not encourage t
manufacture of new equipment, b
lieving that there is a sufficient supp
of parts and materials for purposes
construction already in the hands
amateurs or on the shelves of deale
and distributors, and will not endor
requests to the War Production Boa
for preferential treatment). Region
directors are urged to study the FC
regulations governing the War Eme
gency Radio Service and are also urg
to inform prospective station operato
of the contents of OCD publicatio
"Staff Manual" and "The Control Sy
tem of the Citizen's Defense Corps"
that such operators will be famili
with the organizational rules w
which they will be expected to comp
in the event that their equipment a
service is enlisted.

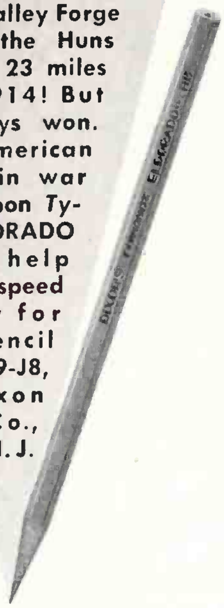
Within the OCD memoranda, it is i
teresting to note, is a statement to
effect that War Emergency Radio Se
ice nets will be required to show pro
that all transmitters within such ne
can be instantly silenced upon recei
of a single order at the District War
ing Center.

Music While You Work

THE ROLL CALL OF FACTORIES usi
sound system to furnish music to e
ployes while they work is most impr
sive. Music of the proper kind, le
and frequency relieves nervous fatig
and increases morale. Of course the
sound systems can be used for
nouncements, etc.

A new sound system division, crea
to handle the sound problems of g
ernment requirements and of war
dustries, has been established by
Stromberg-Carlson Tel. Mfg. Compa
and has taken over a large share
space in one of the company's n
plants. A. C. Schifino will head up t
new divisions, with A. R. Royle as sa
manager.

A. C. Schiffino, head (left) and
A. G. Royle, sales manager



Included in the new sound division's quarters will be a new development laboratory to handle specific sound system problems, and to conduct a continuous study of sound system equipment and correlate its studies with sound system research.

Within recent months, Stromberg-Carlson sound system engineers have installed sound systems in the ship repair station of Maryland Drydock Company, Camp Lee, Virginia, Bartlett-Hayward Co. of Baltimore, a division of the Koppers Coke Company, and many others.

A testing ground for the new sound division has been established within the Stromberg-Carlson plant in the form of a model sound system.

The new sound system will not only include a straight paging and voice system suitable for general and emergency announcements, but it will be able to carry musical programs to workers to speed production, pick up radio broadcasts, and through central control permit two way communications from guardhouse to guardhouse, or from guardhouse to all of the plant, or any section of the plant. A disaster provision has been built in, enabling each section of the plant to be segregated, in case of demolition, fire, etc., or enabling that section to summon help from either control station, or special department. The system is geared to serve sections with such varying noise levels as machine shops, or offices, serving each with a suitable but not disproportionate level of sound.

War work has been set to music recently in the Westinghouse Lamp Division, Bloomfield, N. J.

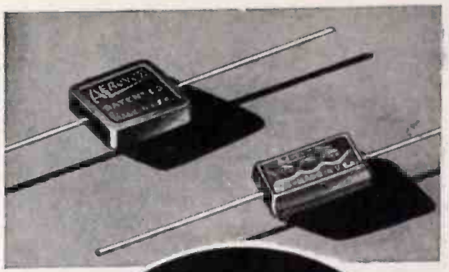
Loudspeakers stationed in main manufacturing areas now play marches, tangos and swing for five and a half hours a day while men and women turn out communications equipment for the nation's armed forces. Recorded music is also played in the Company's recreation rooms and cafeteria.

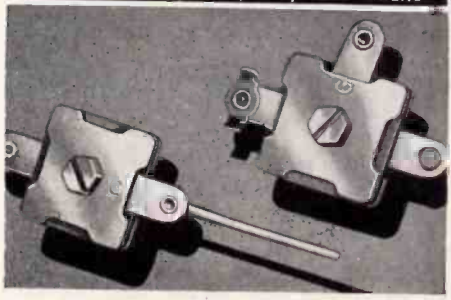
Band music, greets the first shift workers at 7 a.m. and continues for 15 minutes. Five other half-hour periods of music are scheduled during the eight-hour shift, one at lunch time and the rest timed to coincide with periods of "let-down" or fatigue among the workers. Music during the fatigue periods acts as a stimulant to the employes, reports show. Band selections are played at the end of the first shift and as new workers arrive for the second shift.

Service

TWO WELL KNOWN RADIO engineers have recently been given leaves of absence from their civilian posts to add their abilities to the war effort.

Robert M. Morris has been named a Chief Radio Engineer, U. S. Army Signal Corps, and assumed his duties in the office of the Chief Signal Officer, Washington, June 22. A pioneer in radio, Morris has been given a leave of absence from the National Broadcast-





ing Company for the duration of the war. Morris started his radio career as engineer for the A.T. & T. when WEAF was established. When NBC was formed in 1927 Morris was named Chief Development Engineer. In 1935 Morris developed the Orthacoustic method of making lateral electrical transcriptions. He continued as Chief Development Engineer until March, 1941, when he was named Business Manager of the NBC Radio-Recording Division, from which post he has been given leave to assume his new duties.

Robert M. Morris

P. C. Sandretto

P. C. Sandretto, superintendent of United Air Lines' communications laboratory in Chicago and a leading aeronautical radio engineer, has been given leave of absence by United to become a major in the Communications Directorate of the Army Air Forces at Washington.

As head of United's laboratory, Sandretto participated in many aircraft radio developments which have become standard on the nation's airlines. A graduate of Purdue Univers in electrical engineering, he was on t technical staff of the Bell Telepho Laboratories in New York before joined United Air Lines 10 years a

While still in college, Sandretto signed and built one of the first crys control broadcasting stations in t United States and, after his graduati worked on television research at P due's engineering experiment stati His work with United Air Lines perfecting plane-ground radio co munication and in ground radio rection finding of planes in flight h attracted particular attention.

Sandretto is the author of "Principl of Aeronautical Radio Engineering" be published early this Fall by t McGraw-Hill Book Co.

New Cartons for Tubes

A NEW PRINCIPLE of packing rad tubes which will result in major co tributions to the war effort in shippi space, material, handling and war housing savings, has been developed b RCA.

By the new method, RCA is savi some 120 tons of packing material year, and is able to ship approximatel twice as many tubes in a boxcar o truck, thus halving the need for critical shipping space. The new metho supplants packing, handling, storin and shipping practices which have bee common for many years.

To extend the value of the new packing principle more quickly, RCA ha granted patent rights to the new typ cartons to other tube manufacturers In addition, other tube manufacturer have been shown factory routines tha have been developed to make the mos efficient use of the new process.

The new packing ideas were developed by Charles I. Elliott, a 27-year-old packing engineer who was employed by the RCA tube division to study the company's methods of handling tubes during the manufacturing process, and preparing them for warehousing and shipping.

Old Systems Scrapped From Start

Mr. Elliott attacked the problem by consigning all existing packing containers to the scrapheap. Then he set about designing new type containers which would use the least possible amount of cardboard and that would make possible more efficient factory handling. He found that existing packing methods required the use of 210 separate pieces of packing material per 1,000 tubes. Improvised handling methods were used in the factory where tubes travel from one assembly operation to another. A packing box of 22 parts, some of them no longer obtainable, was used to store and ship glass tubes.

When he had finished re-designing

king cases, Mr. Elliott found that he d reduced the 210 pieces of packing 1,000 tubes to 24 pieces. He discered that a single one-piece, trayli container, planned to hold the tubes se within shipping cases, could also bused to save time in the manufacturi processes.

Sndardization Important in Wartime

tandardization of tube packages is vlly important in wartime for many rsons. Spare radio tubes can be made tit into spaces designed for them by th builders of planes, tanks, mobile uis, ships and other fighting equipmt. And the tube packages will fit th spaces, no matter from which facto they originated.

handling receiving tubes alone, sangs of 30 percent in material were aceved. Factory handling efficiency ha been stepped up 20 percent, loss by bkage has been materially reduced, as as the need for storage space. It is ow possible to pack 647,500 tubes of a ven type into a single boxcar, an inease of nearly 100 percent in capaty.

further improvement in the handin of the smaller types of receiving uls has been made in the form of a "cl" of cardboard which holds 10 ul. During testing, warehousing and hading operations, the "clip" of 10 uts is handled as a unit. However, wh the time comes for the tubes to be aced into individual cartons for shipme, the "clip" is torn into 10 pieces lo perforated lines, to become the iner support for each tube in its inival carton. Further, the old 31-pie glass tube carton had resolved tse into a smaller, eleven-piece box.

the case of a certain type power ub a wooden box used to transfer ma quantities about the factory and o e warehouse has given way to a mo compact cardboard box in which ne bes are transported with greater poction from breakage.

O universal box has been designed or acking all types of power tubes of e ame size, supplanting a large uner of various sized special boxes. ig ously designed inner supports do wa with the layers of wadding once ed while the application of simple wsf physics provides greater safety r e tubes when the box is subjected usual stress.

In he case of cathode-ray tubes, the p glass bulbs are now received at e ctory from the glass works in the m packing cases in which they are anorted throughout the manufacri, testing, warehousing and shipng rocesses. So much has been saved th cost of the packing cases that the ass company has agreed to furnish em o RCA without cost.

M Elliott's work has been carried uer the direction of L. E. Mitchell, anger of the Industrial Engineering pament devoted to the development ber methods through work simpliati.

'T overall savings under the new tb are tremendous, when consid-

ered in the light of the national emergency," Mr. Mitchell said. "In 194 we used 400 tons of packing materia In 1942, for the same quantity of tube we will need only 280 tons, a saving o 120 tons.

Not only does the new method packaging and handling tubes save on materials but it speeds up the tube testin by 30 percent enabling 30,000 hours o labor at the RCA plant to be devote to making more tubes. The fire hazar has been reduced since there is no shredded paper in packing cases and no loos partitions, the containers can be lai out flat and so require less storag space.

Radar

CHARLES F. KETTERING, President o the General Motors Research Corporation and Vice President of the Gener Motors Corporation has been appointed as consultant to the Radio an Radar Branch of WPB.

In announcing the appointment, Donald M. Nelson, WPB chairman, mad public a portion of a letter to Mr. Kettering, as follows:

"Our Radio and Radar program ha assumed such tremendous proportion that I feel it is now vitally important have someone of your outstanding capacity and accomplishments in th scientific world, to whom we can tur from time to time in the difficult tas of meeting the requirements to tha program. Your acceptance of the po tion of consultant to us in these matter makes me increasingly confident tha the job will be well done and I wish t take this opportunity of telling you ho pleased I am about the arrangement."

The Radio and Radar Branch is concerned with providing facilities for th production of radio communications, aircraft detector, signalling and fire control equipment. Ray Ellis is chief o the Branch, which reports to Harol Talbott, Deputy Director of the Production Division.

Late News

WPB PROHIBITION on use of coppe and brass in radio manufacture ha been lifted to permit manufacture o replacement vacuum tubes and variou types special types of radio apparat under certain circumstances.

Because of critical shortage o scientific equipment, university an other private laboratories engaged i research work unrelated to the production of materials or in other research no directly connected with the war effor will be unable to secure new laborator equipment unless the particular use i approved by the Director of Industr Operations. Repair parts may be obtained, however.

FCC has ordered all amateur tran mitters to be registered with the Commission by August 25. Thus the FCC will have a record of what equipment available, where it is, etc.

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ALLIED RADIO
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Colin B. Kennedy

In announcing the death of Colin B. Kennedy, one of the radio industry's pioneering spirits, we can do no better than to quote from a letter from E. F. McDonald, Jr. President of Zenith Radio Corporation.

"When, back in 1921, I became associated with Chicago Radio Laboratory, which two years later became Zenith Radio Corporation, to me the two great names in radio were Grebe and Kennedy, both of whom now have passed on.

"Colin Kennedy, back in those days, headed the radio company bearing his name with St. Louis as its headquarters. He was an engineer radio pioneer, a quiet, modest man, who sought no glory but contributed much to the early days of radio. He was one of the first holders of a license to manufacture home radio under Armstrong patents.

"Colin Kennedy, when he died, was doing his stint for his country as an OPM engineer assigned as civilian advisor to the Army Signal Corps."

Alien Patents

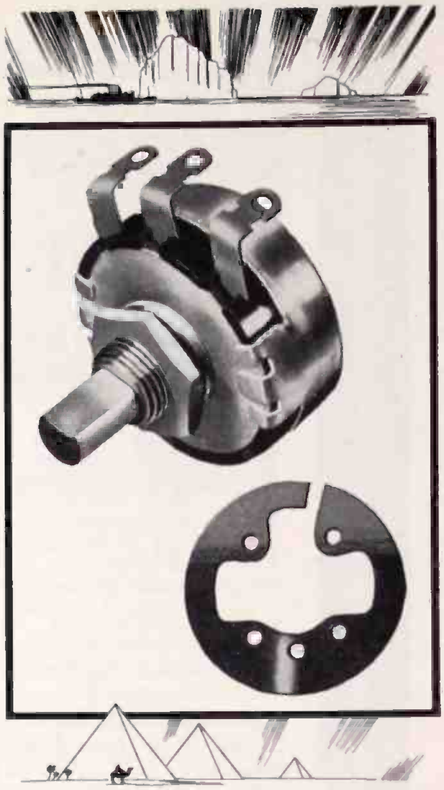
Alien Property Custodian has taken over approximately 3,000 patents and by end of September 40,000 may be in the same category. In one of the first groups of 600 taken over, 50 were Italian, 10 Hungarian, 100 Japanese and the remainder were German.

Furthermore, the Custodian requires everyone claiming any interest in patents or patent applications now or formerly owned by nationals of certain designated countries to report their interest on Form APC-2 by August 15, 1942.

• • •

REGISTER CONTROL

A G-E photoelectric color register control installed on a press in the plant of New York's Neo Gravure Printing Company is checked for synchronization by means of a cathode-ray oscilloscope



with the new
STABILIZED
Element

★ Quietly, modestly, quite unannounced, Clarostat Series 37 controls have, for many months past, been coming through with the *new Stabilized Element*. We wanted this outstanding development to prove its worth out in the field, by users, corroborating our own critical tests.

Results have spoken for themselves. Users have promptly spotted something *radically different* in non-wire potentiometers and rheostats. Remarkably accurate resistance values first and last; extreme immunity to humidity, temperature and other climatic conditions; minimized wear; noiseless operation; smooth rotation—these features have marked the introduction of the new Clarostat Stabilized Element—*stabilized* by heat-treatment, chemical-treatment, lubrication-treatment, for truly outstanding performance.

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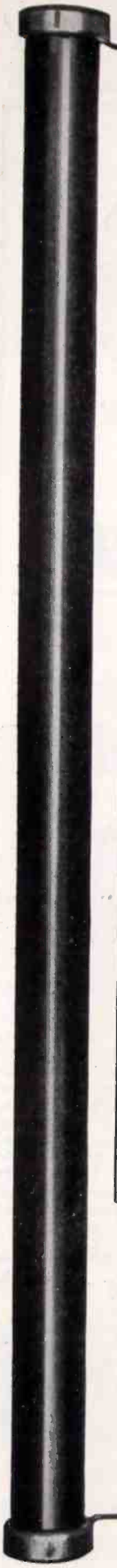
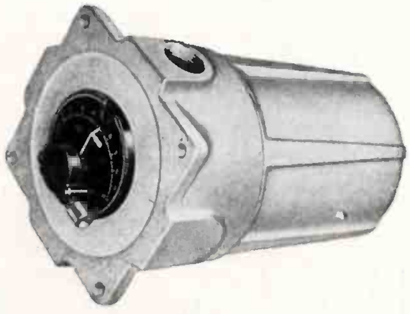


NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here

Explosion-Proof Timers

EXPLOSION-PROOF TIMERS suitable for operations in atmosphere containing gasoline, naphtha, petroleum, benzol, acetone, lacquer solvent, natural gas, etc., can now be had.



The illustration shows a Type TD1C explosion-proof time delay relay which is laid out for panel board mounting with the setting knob and dial projecting. Within this housing it is possible to mount either Type TD1C or TD1 with a small relay. The latter construction would be used where it is desired to control the timer from remote located momentary start button.

The R. W. Cramer Co., Inc., Centerbrook, Conn.

Printing and Coloring Acetate

WIRING DIAGRAMS, CHARTS, indicators and dials can be printed on plastic by a new process called "Print-Cote." Coloring plastics such as cellulose acetate is done by a process called "Printcolor." The "Print-Cote" method used for protecting cellulosic sheet plastic is to apply to the printed sheet a liquid film of cellulose acetate, coupled with a suitable solvent and plasticizer. The process is not a lengthy one and the coating will not peel off. The finished product is unaffected by oils, dirt or atmospheric conditions. These printed acetate plates can also be bent to conform to the shape of curved surfaces where necessary.

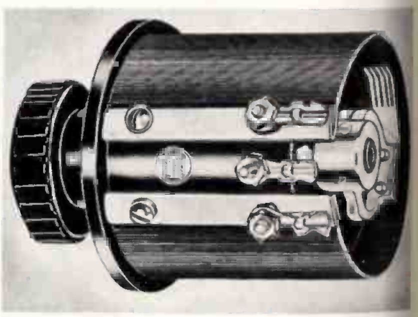
"Printcolor" plastics may be used for sheet stock, molded items and extruded shapes. In some cases, extruded shapes can be dyed in complete coils. Crystal clear transparent materials become transparent colors by this dyeing process, and translucent or opaque materials in white or light shades may be given a wide variety of colors. The dye penetrates the surface of the plastic, and the color is almost indestructible. The piece can be buffed without removing the color. Since the object to be dyed is not subjected to the action of solvent chemicals, its original finish is not altered, and it needs no subsequent polishing or processing.

Printloid, Inc., 93 Mercer Street, New York, N. Y.

Rheostat, Potentiometer

THESE RHEOSTATS, POTENTIOMETERS, designated as Types 260 and 275 are rugged and durable and were designed to withstand vibration, tropical heat, and moisture. They may also be used in high impedance vacuum-tube circuits where high values of resistance and low noise level are required.

Specially developed machines space wind the fine resistance wire on a strip of fabric base bakelite. These strips are then coated with a binding agent which cements the wire to the strip. A protective bakelite band is then placed externally over the fine wire strip protecting the wire from mechanical damage or derangement. This strip is then bent around and securely fastened to the bakelite supporting form. Constant contact resistance and low noise level is maintained for any position of the knob through the use of five separate wiping fingers which are self-aligning. The type 260 and 275 have the same mechanical characteristics with the exception of physical depth dimensions and wattage rating. These units are usually furnished for panel mounting and can be converted for top of table mounting by simply reversing the shaft. Either unit can be mounted



rectly on metal panels without short rcuiting the variable arm.

Specifications of Type 260 are maxi-um rating, 2 to 100,000 ohms; power ting, 6 watts; net weight, 6 ounces. ype 275 specifications are maximum sistance, 50 to 200,000 ohms; power ting, 11 watts; net weight, 8 ounces. th of these models have a rotation gle of approximately 327°, a stand-d 3-hole mounting, and a ⅜ inch di-ieter Bakelite shaft.

DeJur-Amsco Corp., Shelton, Conn.

acuum Tube Voltmeter

CURATE MEASUREMENTS throughout t entire audio frequency range are plified by Model No. 666, a vacuum te voltmeter specifically designed for t t purpose. Essentially a peak type o voltmeter, this instrument has a c stant input impedance resistance of 1 megohms. Although designed for 1–130 volt, 60 cps operation, provi-sn has been made for external battery

opation through appropriate term-in connections and a throw-over sup-pl switch. Readings are made quickly an easily. The instrument is equipped wi a 4½-inch rectangular meter hav-inga movement of 0-200 microamps. Ra es are 0-3-6-30-150 volts. Tubes use are type 6K6GT, 6X5GT, 6H6 and VR05–30. The latter is a voltage eg ator, eliminating errors due to line ol ge fluctuations.

dio City Products Co., 127 West 26 Street, New York, N. Y.

S -Locking Nuts

A W ACORN TYPE, self-locking nut is va able in three popular bolt sizes, No. -32, 10–24, and ¼ inch-20. They are ma of spring steel, heat treated and la d, and have spring-steel jaws that l s in and grip the bolt thread when he ut is tightened. They are light in e ht, low in cost, and are relatively o g, and can be used to replace regu-ar corn nuts or nuts with lock as rs.

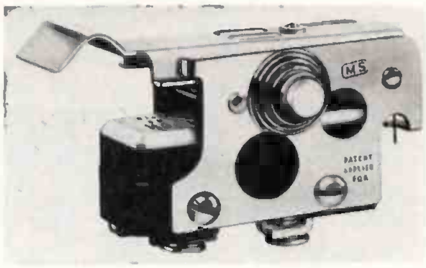
T Palnut Co., 61 Cordier Street, ton, N. J.

Densitometer

The basis of the Ansco Sweet densitometer (a photographic density measuring device) is its use of a photo-sensitive tube which, when placed in the path of a beam of light, varies the flow of an electric current in proportion to the intensity of the light. This current, after amplification, actuates a meter which is calibrated directly in terms of density. The electronic circuit remains stable over long periods of time and permits uniform calibration of the meter scale in terms of density. The densitometer is easily operated with a minimum of visual fatigue. Agfa Ansco, Binghamton, N. Y.

Switch Actuator

Designed for use in the throttle mechanism of aircraft and other applications, Type "T" Switch Actuator provides a light-weight, compact mechanism for performing a widely useful three-step operation. Steps in the cycle of operation are: closing a circuit by depression of an actuating arm; opening the circuit by mechanical release of the normally open switch while the actuating arm is held in the depressed position; and, return of the actuating arm to normal position. As used in aircraft, the unit employs the Micro Type R31 switch, Army Air Corps approved, and replaceable in the field. The Actuator is considered part of the aircraft, and no deviation permit is required. The "T" Actuator is supplied as a single unit, or in gang assemblies of 2, 3, or 4 units, left or right hand, spaced to meet customers' requirements. Other variations, such as pull instead of push button release, can be supplied, and the Actuator may be used with basic units other than the Type R31.



Micro Switch Corp., Freeport, Ill.

Electronic Photometer

The photometer is designed to measure very weak light, as well as thin light beams. It comprises a phototube, an electronic d-c amplifier and an indicating instrument. The unit operates from a power line without the use of batteries, and the amplifier circuit is stabilized so as not to be affected by line voltage variations. The instrument is self-contained and built into a port-

le case. The phototube is mounted in
"search unit" connected to the in-
ument by a flexible cable. The cur-
nt output of the amplifier is about
0,000 times higher than the input.
ree types of phototube will be sup-
ed, depending upon the spectral
aracteristics of the light to be meas-
ed. The photometer when exposed
incandescent light of approximately
55°K shows full scale deflection at
025 foot candle. The instrument has

ny applications in photography, and
n be used to measure the density of
ectrographs, brightness of paints,
asurement of low turbidities and
e, etc.

Model 505 is especially adapted for
densitometry of spectrographs, and
del 510 (battery operated), has a
rror galvanometer which provides
reased sensitivity.

Photovolt Corp., 95 Madison Ave.,
w York, N. Y.

idget Switch

EXTREMELY LIGHT and small switch
ng a rolling spring which snaps the
de from one position to another has
following specifications:—size,
x $\frac{31}{32}$ x $\frac{7}{16}$ inches; weight, 7¼ grams;
p, 0.040 inch; actuating pressure,
ounces or less; and ratings, 250 volt,
mp a.c., and 115 volt, 10 amp, a.c.

The Acro Electric Co., 3159 Fulton
ad, Cleveland, Ohio.

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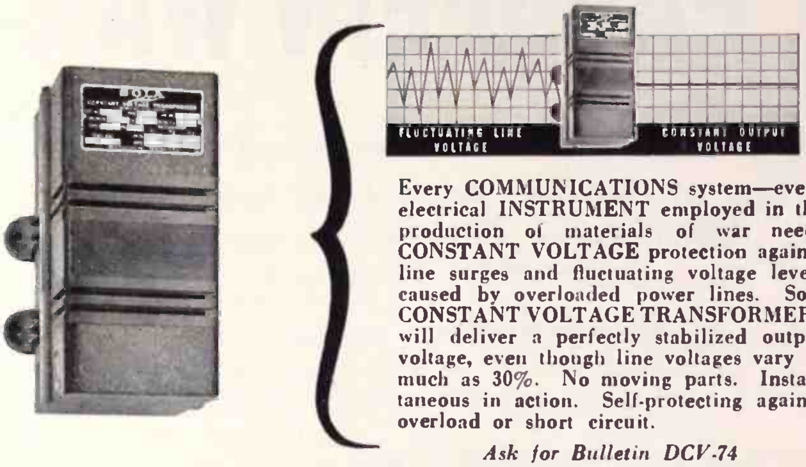
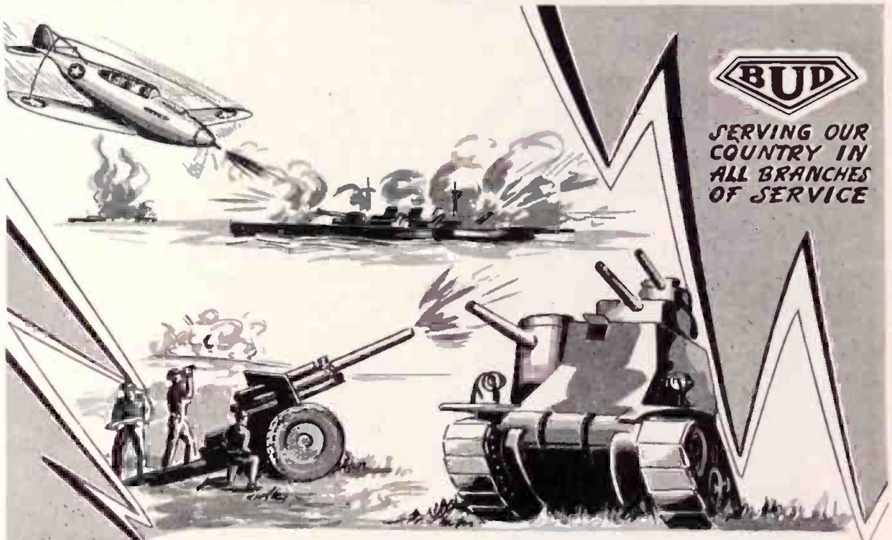
ct strength of 2.0 and a specific grav-
of 1.44. The plastic is available in
ck or brown color.

Durez Plastics & Chemicals, Inc.,
rth Tonawanda, N. Y.





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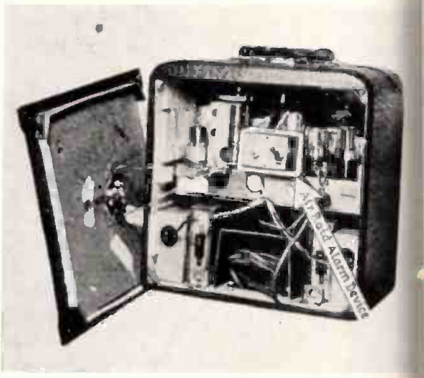
conforms to double curvature surface and because of its lacy openness, partially reveals the article packed. is light, uniform, easy to handle, an is economical. Potential users may ol tain a sample roll for one dollar fro the manufacturer, Research Product Corp., Madison, Wis.

Air-Raid Alarm

MODEL AR-101 AIR-RAID alarm is de signed to work on any automatic vol ume control type of radio set, tabl model or console, a.c. or d.c. or batter operated. The alarm is set off by th user's local "alert" broadcast station



When the radio station goes off the air, the alarm automatically goes on, creating a loud, penetrating signal in the radio, warning one that an air-raid alarm is in order. The unit is supplied complete, in a compact case.

National Union Radio Corp., Newark, N. J.

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positions who write for it on their company letterhead, mentioning their title and the make of socket screw they use. At a glance, this finder gives all of the important dimensions of the standard sizes of socket head cap screws, stripper bolts and set screws. The finder is 10 inches in diameter and is printed in two colors on heavy card stock.

Parker-Kalon Corp., 200 Varick Street, New York, N. Y.

Literature

Insulating Varnishes and Compounds. The different characteristics of baking, air drying, finishing, and miscellaneous varnishes are described. Also a description of red oilproof enamels, machinery enamel, special lacquers, shellac, cable lacquers, synthite varnishes and insulating compounds. The booklet includes conversion tables and tank capacity charts. This may be secured from the John C. Dolph Co., 168 Emmett St., Newark, N. J.

Circuit Control Switches. A pamphlet describing circuit control switches for use in signalling equipment, communication apparatus, instrument panel boards, utility lighting systems, specialized lighting equipment, aircraft circuit control systems and many other industrial applications may be had from General Electric Co., Accessory Equipment Sales, Bridgeport, Conn.

Soldering Iron. A circular which describes and illustrates the uses of "Hexacon" screw tip and plug tip soldering irons. The new "Hatchet" iron described has the handle offset to give better balance and reduce fatigue so that better soldered joints may be perfected. Hexacon Electric Co., 161 W. Clay Ave., Roselle Park, N. J.

Metal Shielded Wire. This recent booklet tells about the method of shielding insulated wire with seamless aluminum or copper tubing against electrical interference, noise, moisture and mechanical damage. Bulletin 201 contains mechanical and electrical specifications of approved aircraft wire manufactured to specifications No. AN-J-C48 and No. 95-27074 by General Motors Corp. Both booklets obtainable from Precision Tube Co., 3824-26-28 Terrace St., Philadelphia, Pa.

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Condensers. This catalog lists the essential condensers, resistors and test instruments in demand and which are still produced. Also included are motor starting replacement capacitor listings. Aerovox Corp., New Bedford, Mass.

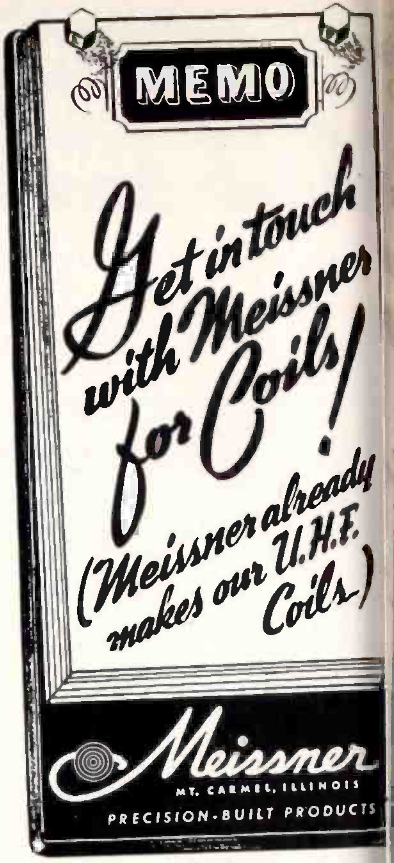
Interchangeability Chart. A transmitting tube interchangeability chart has just been released by the General Electric Co., Radio & Television Dept., Schenectady, N. Y.

TIN Research Report. This report (publication No. 109) summarizes recent researches and developments in the uses of tin in industry. It discusses quite thoroughly tinplate and hot-tinning, electro-deposition of tin and tin alloys, bearing metals, foil, bronzes and chemical compounds of tin. Publication No. 109 available from Battelle Memorial Inst., 505 King Ave., Columbus, Ohio.

Flexible Shafting. An illustrated book showing the many uses for flexible shafting in power drive and remote control. Reproductions show the applications of flexible shafting in airplanes, automobiles and radio. Circle Ess shaftings are graphically illustrated along with illustrations of shaft end and casing end fittings. Manual D from F. W. Stewart Mfg. Corp., 4311 Ravenswood Ave., Chicago, Ill.

Antenna Measurements. In the June 1942 issue of *Experimenter* "Antenna Measurements with the Radio-Frequency Bridge" is discussed. This article outlines the means for measuring antenna systems, gives a convenient procedure and points out the precautions if satisfactory results are to be obtained by present owners of the popular Type 516-C radio-frequency bridge (recently discontinued). Also just released is an up-to-date price list for Catalog K and a list of the new instruments announced since the publication of Catalog K. Both available from General Radio Co., 30 State St., Cambridge A, Mass.

Electronic Devices. This is the third and final discussion on "Industrial Applications of Electronic Devices". This covers inverters and features the following; "direct current" transformer, thyratron temperature control circuits, thyratron ignitron arc light timer, electronic welder control and radio interference. Prepared by the Engineering Dept., Aerovox Corp., New Bedford, Mass.



Mrophones. This booklet "Long Live Yr Microphone" gives many helpful hts on the use and care of crystal, diamic and carbon microphones. Also pctical pointers on feedback, cable, pgs, output, response and other infmation. Bulletin 173G from Shure Bs., 215 W. Huron St., Chicago, Ill.

n Powders. The characteristics, and alications of carbonyl iron powders a given in this twenty-three page klet. The three different grades of .W. carbonyl iron powders, designed as "E", "TH" and "C", are disised and their special applications a pointed out. Also included are gphs of relative Q-values vs freqncy of G.A.W. carbonyl iron powders "" and "C". Available from Advance Svents & Chemical Corp., 245 Fifth A., New York City.

Cloidal Graphite. A revised technical bletin No. 230.8 includes applications f the use of Colloidal graphite dispsions such as "Aquadag" (in water), "ldag" (in petroleum oil), "Castord" (in castor oil), "Glydag" (in gcerine) and "dag" dispersions used ithe more volatile liquids. Also coved are "Prodag" a concentrated graphi for parting compounds, coarse wire dwing and forging lubricants and a nv type 1175 designed for heavy duty sh as shell forging work. Available m Acheson Colloids Corp., Port Iron, Michigan or from Denham & , 812 Book Bldg., Detroit, Michigan.

pper Springs. Bulletin No. 4 gives in ail the functions and uses of beryll-n copper coil or flat springs. It dissses the Carson Electronic Microter which measures wire diameter, l etc. Available from Instrument ecialties Co., Inc., Little Falls, N. J.

crophones and Acoustic Devices. A calog for help in the selection of crophones for various war and civil applications. Technical data is ven on dynamic, crystal, and carbon crophones for use in ordnance plants, my camps, air terminals, broadcast ations, police mobile and station ansmitting equipment, industrial war ctories, OCD control centers, etc. so included is a story telling how crophones are measured. Catalog . 154, Shure Bros., 225 W. Huron St., hicago, Ill.

lf-Locking Nuts. The design, adntages, assemblies, types, and apication of various types of Palnuts are scussed in this booklet. Suggestions r use on war products are included. vailable from The Palnut Co., Inc., Cordier St., Irvington, N. J.

Sectional Resistors. An 8 page cata on sectional resistors for a-c and circuits, non-inductive, wire wound hermetically sealed. The booklet o lines their construction, flexibility interchangeability. Contains illust tions of various parts and the lat part of the book contains tables gi size, voltage, resistance and pri Catalog 43-820 is available from De 7-N-20, Westinghouse Elec. & Mfg. East Pittsburgh, Pa.

Measuring and Control Instrumen This 16-page bulletin describes a illustrates unit construction of temp ature controllers. Remote controlle combustion safeguard equipment a other instruments are covered. Pri and list numbers of catalog sections a also included. Bulletin Z6000 fro Wheelco Instruments Co., Harrison Peoria Sts., Chicago, Ill.

Filters and Coils. This forty-six pag catalog gives a complete listing of radi interference filters and coils for mobi equipment. It is very complete in deta and specifications. Catalog No. 4 maybe obtained from the J. W. Mille Co., 5917 S. Main St., Los Angele Calif.

Indicating Instruments. D-c and a-c in dicating instruments for mounting o switchboards are described in this 12 page catalog. The instruments include are ammeters, voltmeters, wattmeters frequency and power factor meters synchroscopes, rectangular triplex ammeters and horizontal edgewise triple ammeters. The dimensions, weights and list prices on all instruments are included. Catalog 4220, Roller-Smith Co., Bethlehem, Pa.

RCA Questions and Answers. A brochure designed to answer many questions that are asked about the multitudinous activities of RCA. The history of the company, its board of directors and officers, its record of earnings and other financial data, photographs of its laboratories and plants—all this and more is in this book. R.C.A. Bldg., 30 Rockefeller Plaza, New York City.

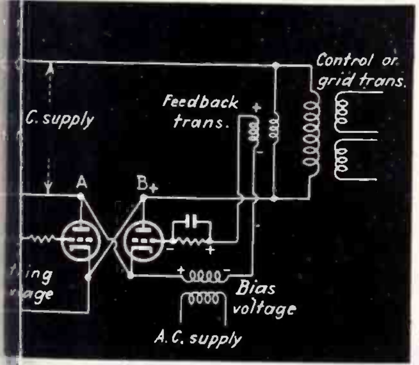
Guide Book. Two booklets from Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York City, a Guide Book to tape, cloth, sleeving, tubing, papers; and Compounds on waxes, asphalt and similar hydrocarbons, Rubberseal cloth, and copper; both giving considerable useful information on the characteristics of insulating materials of the company. Also a convenient wall map giving dimensions of materials, etc.

lectronic Weld-ng Control

(*Continued from page* 40)

ndent of line voltage regulation be-
use point A will be held reasonably
nstant by the energy stored in ca-
citor C_3. The slider on R_1 deter-
nes the actual potential of point A
en C_3 becomes charged through

The keying tube T_1 has the voltage
ross R_2 applied to its grid as nega-
e d-c bias that would normally hold
e tube non-conducting. Connected
series with this d-c bias is the
condary of a peaked wave or im-
lse transformer that makes the
id positive so that the tube can
duct once every cycle, at a time
pendent upon the position of the
ak. The position of this peak is
ermined by adjusting the value of
in series with the primary. It



. 6—A "trailing" tube control circuit

l be noticed that the normal posi-
, 1, of the initiating switch S_1
ps the plate circuit of T_1 open so
t it cannot pass current even
ugh the grid goes positive once
ry cycle.

Vith initiating switch S_1 in the
nber 2 position, the plate cir-
t to T_1 is closed and the next
itive peak will cause it to pass
rent through R_5. This current
continue to flow as long as
s closed, regardless of voltage ap-
d to the grid of T_1 because of
characteristics of a thyratron on

direct current. The voltage across R_5 will be the same as that across R_1 minus the arc drop of T_1. This same voltage is applied to the resistor R_6 and capacitor C_2 network. The time required to charge capacitor C_2 up to a given voltage will depend on the value of R_6.

Assume that the initiating switch S_1 is in the number 1 position. Point B, which is the cathode of the leading control tube, is at the same potential as point C because no current is flowing in resistor R_5 and the C_2R_6 combination is completely de-energized. The grid of T_2 is connected to point A through current limiting resistor R_7, which is definitely negative with respect to point C, therefore T_2 is held non-conducting. When switch S_1 is thrown to the number 2 position, R_5 is energized and for the first instant before C_2 starts to charge, R_6 will have the full voltage of R_5 across it and point B will be at the same potential as point D minus the drop in T_1. Under this condition the grid of T_2 is positive with respect to the cathode point B and the tube conducts. Immediately, C_2 starts to charge and at a certain time later, point B will be at the same potential as point A. At approximately this time T_2 will cease to conduct, as its grid goes negative with respect to its cathode.

The time required for point B to reach the potential of point A depends on the value of R_6. Therefore, by adjusting R_6 the time can be changed from a short time (½ cycle) to a long time (½ second). By making R_6 a series of fixed resistors co trolled by a tap switch, the time ca be adjusted in one-cycle steps. Th slider on R_1 allows the designer t compensate manufacturing tolerances of resistors and capacitors.

Tube T_2 serves the dual purpos of being the timing tube and th leading firing tube for one ignitro power tube. Tube T_3 is the firin tube for the other power tube and i controlled by a feedback transforme connected across the welding transformer. The details of operation ar the same as for Fig. 6. The use o this type of circuit insures full cycle of power applied to the welder, whic avoids saturation of the weldin transformer even though the calibration should shift. For this sam reason, the calibration is much less likely to shift because the timin would have to shift a whole cycle t make any change in the time.

To add phase control to this synchronously timed spot welding control it is necessary to connect the grid of tube A in Fig. 6 in place of the grid of tube T_2 in Fig. 7. This combination produces synchronousl timed voltage on the primary of the control or grid transformer of Fig. 6. Now, if this control and grid transformer are put in place of T_3 in Fig. 5A the combination will be a synchronously timed spot welding control with phase control, using the power and firing tubes of Fig. 5A, the control tubes of Fig. 6, and the timing circuit of Fig. 7.

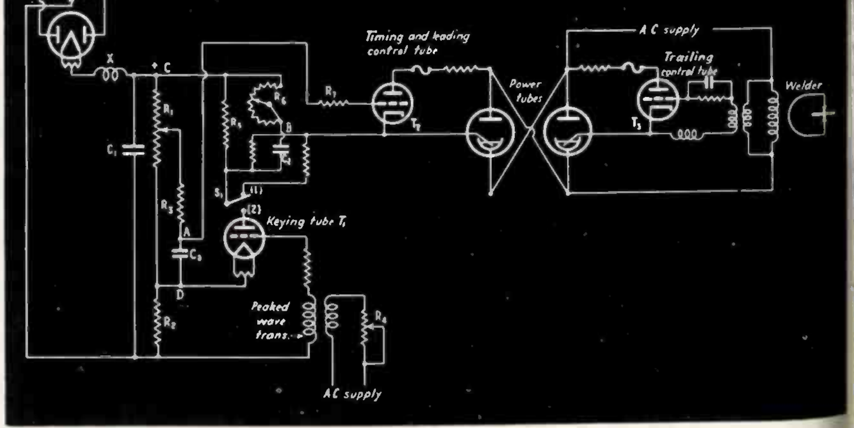


Fig. 7—Elementary circuit of a spot welder control without phase control

RECENT U.S. PATENTS

Each week the United States Patent Office issues grants to many hundreds of inventions that pass the acid test of that office. A few of those relating to electronics are reviewed here

Antennas

Phase Measurement. Voltmeter connected ¼ wavelength from each of two antennas by means of a 2-wire transmission line. A. G. Kandoian, IT&T. Dec. 1, 1939. No. 2,283,676. See also No. 2,283,677 to Kandoian on a localizer beacon composed of a central and several side radiators which are fed energy in proper phase and amplitude with respect to central radiator.

Direction and Position Finder. At regular intervals a receiver is tuned to several known marker frequencies, light sources illuminated alternately under control of the receiver, light shutter rotated with a tunable loop in synchronism at a rate within the persistency of vision. Philip Bernstein, Press Wireless, Inc. Dec. 11, 1940. No. 2,282,541.

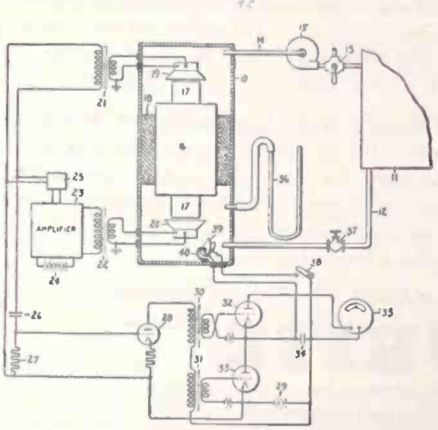
uiding System. Finding the direction of an electromagnetic wave transmission comprising two sets of three antennas, one made up of loops in mutually perpendicular planes, another of doublets perpendicularly arranged, cathode-ray oscillograph etc. H. G. Buignies, IT&T. Sept. 1, 1938. No. 2,[illegible]2,030.

Non-communication Applications

Contour Device. Means for outlining contours at various elevations from stereoscopic photographs comprising resonant circuits, phototube apparatus, rectifiers etc. Harry B. Porter, March 19, 941, No. 2,283,226.

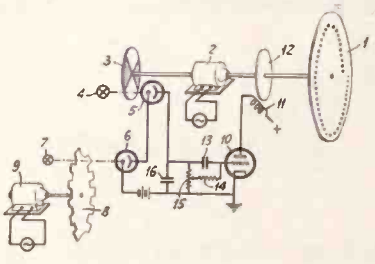
Wave Analysis. In using an oscillograph for wave analysis, a ray is deflected in one direction by a generator of predetermined wave form and deflected in another direction in accordance with an oscillatory wave of a second frequency and of an unknown wave form to be analyzed. Means are provided for varying the intensity of the ray intermittently and periodically at a third frequency differing from the second frequency by a fourth frequency which is normally related to the first frequency in an integral ratio. D. E. orgaard, G.E. Co., Nov. 1, 1940. No. ,280,531.

Density Measurement. Resonator with electromagnetic transmitting and receiving apparatus at the free ends of the resonator, amplifier free to oscillate at a frequency determined by the density of the gas admitted to the resonator and means to compensate frequency for temperature variations in gas. W. Mikelson, GE. Jan. 16, 1940. No. 2,283,750.



Spark Coil Tester. Charging a condenser from a rectifier circuit and alternatively connecting a spark gap to the condenser and to the spark coil. S. S. Verney, Auto Electric Supply Co., San Francisco. Oct. 19, 1940. No. 2,283,399.

Synchronizing Apparatus. Method of synchronising a rotating body with that of a rotating standard comprising phototube apparatus and a braking system. Herre Rinia, RCA. Sept. 26, 1939. No. 2,281,954.



Generator. Circuit to produce triangular waveforms with sides of equal slope using gas and vacuum tubes. B. M. Hadfield, Associated Electrical Labs. May 13, 1940. No. 2,282,130.

Burner Control. Application of phot tube to burner in a furnace. D. W. Fehenbach, M Kansas City Journal-Post C July 31, 1939. No. 2,283,496. See al No. 2,282,551 to R. E. Yates, Dryi Systems, Inc., Chicago and No. 2,28 619 to C. R. Roberts, Brighton, Mich.

Hysteresoscope. Application of cat ode-ray tube to measuring core mat rials. S. C. Leonard, GE. March 2 1940. No. 2,283,742.

Frequency Measurement. Measu ing an unknown frequency by arithm tically combining the unknown to an interpolating frequency and adjusting t latter until it differs from the standa frequency by an integral multiple the same amount as the unknown diffe from another integral multiple of t unknown whereby the unknown is calc lated from the difference and the know integral multiple frequencies. T. Slo czewski and F. R. Stansel, BTL, In Aug. 3, 1940. No. 2,283,616.

Follow-up System. Light responsi device, source of light, follow-up syste for repositioning the light responsi device, and means for anticipating t effect of the follow-up system co prising means for varying the eman tion of light prior to the operation the follow-up device. Mathias Mich Allis-Chalmers. July 31, 1940. No. 2 283,121.

Telemetering. No. 2,281,710 to Ca Oman, WE&MCo. on a system for tran mitting pulses at a rate proportional a measured quantity; and No. 2,283,0 to Ward Leathers, IBM, on a method measuring resistances over a wire li

Waveform Selection. Use of a line and a square law detector and a pola ized relay for distinguishing betwe currents having a waveform with high peak factor from currents havi a waveform of low peak factor. D. Gannett, BTL, Inc. Oct. 25, 1940. N 2,282,719.

Measurement Apparatus. Determi ing a magnitude having a related pho electric effect measurable potent metrically. A. E. Parker, ETL. June 1938. No. 2,282,741.

Measurement. Two patents, No 21,282,480 and 2,282,726, E. A. Keel and H. S. Jones, Brown Instrument C on measurement and control apparat

Time Delay. Circuit using a col cathode gas tube of the OA4G typ Otto Weitmann, IBM. Nov. 20, 194 No. 2,282,108.

Differential Analyzer. Phototube amplifier circuits for comparing optica properties. S. J. Murcek, WE&MC July 13, 1939. No. 2,282,198.

iezoelectric Apparatus. Patent Nos. 2,81,778 and 2,282,369 to W. P. Mason, BL Inc. The following description is f m Claim 1 of No. 2,281,778. A piezoeltric quartz crystal vibratory body h ing its opposite rectangular major f es parallel to an X axis and inclined a n angle of +49°30′ with respect to t Z axis as measured in a plane perp dicular to said major faces, the m or axis over-all length dimension a the width dimension of said major f es being inclined 45 degrees with r ect to said X axis, said over-all l th dimension being in effect divided in a plurality of equal length elementa lengths corresponding to the nume al order of a desired harmonic freq ncy, said width having a dimensi al ratio of less than 0.8 with respect t said over-all length dimension, the th kness dimension between said major f es being one of the values midway b ween the nearest values given by the e tions:

$$\frac{L}{T} = \frac{m^2}{10.88n}$$

a

$$\frac{W^2}{LT} = \frac{m^2}{10.88n}$$

re L, T and W are respectively said o r-all length, thickness, and width d ensions expressed in the same units, n s the numerical order of said harm ic frequency, and m is equal to π(i +) where i is an even order integer th is one of the integers, 2, 4, 6, 8, 10, 1 14, 16 and 18.

ccelerometer. Apparatus for determ ing maximum and minimum of att ed acceleration comprising inertiaa uated elements, with means so that a leration may be classified according t he pitch of an audible signal. James A Buchanan, U. S. Navy. Jan. 2, 1941. N 2,283,180.

hase Comparison. Method of comp ng phase displacement between t voltages, comprising two amplifiers c nected to the voltages, rectifiers conn ted to the amplifiers and actuated by t vector sum and difference of the s plied voltages, a work circuit res sive to the differential effect of the r ified currents, and means controlling t gain of the amplifiers in accordance w the total amount of the rectified c ent whereby the operation becomes i pendent of the amplitude of the s plied voltages. E. S. Purington, R . April 27, 1939. No. 2,281,995. S No. 2,282,951 to G. B. Englehardt, E , Inc. on a method of measuring p se shift.

Oscillators

elaxation Oscillators. Gas tube and v um tube in series across d-c line; p tive line to anode of gas tube; cond er from positive terminal to anode o acuum tube; cathode of vacuum tube

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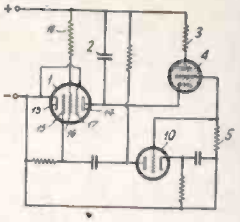
to negative terminal; grid of gas tube to negative terminal through an impedance; and means for controlling potential of grid of vacuum tube in accordance with potential across the above



mentioned impedance. H. Pieplow, GE. June 10, 1939. No. 2,282,340. See also No. 2,282,895 to F. H. Shepard, Jr., RCA, on a relaxation oscillator producing saw-tooth waves. Two tubes and an electron storage device between anode of each tube and grid of the other tube and rectifiers for maintaining grids positive with respect to cathodes.

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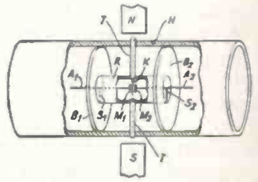
Waveguides. Nos. 2,281,551 and 2,281,552 to W. L. Barrow, Research Corp., New York. Sept. 10, 1937 and Oct. 31, 1938.

Oscillator. Nos. 2,283,894 and 2,283,895 to I. E. Mouremtseff and G. L. Dinnick, WE&M Co. Resonator type devices.

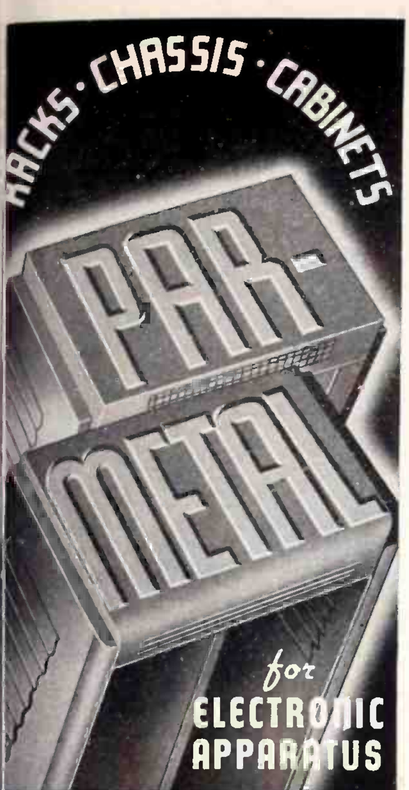
Bias system. Sources of uhf and dc connected serially in cathode-anode circuit of a tube, the dc being poled and proportioned so that this tube is biased beyond the upper knee of the saturation curve so that current occurs in pulses only during a half cycle of the uhf. R. S. Ohl, BTL, Inc. June 18, 1940. No. 2,283,568.

Magnetron. Tube contained within a coaxial cable with cathode perpendicular to axis of cable, inner conductor of cable being short relative to cable and



having extension which constitutes antenna for exciting the cable. W. Engbert, Telefunken. April 7, 1941, No. 2,282,856.

Modulation. Method of modulating a long-line controlled oscillator by placing modulating input in series with a d-c biasing potential. C. W. Hansell, RCA. Nov. 16,1938. No. 2,282,295.



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High-frequency Amplifier. At frequencies sufficiently high that the input conductance of a conventional amplifier tube is so positive that it is difficult to develop voltage between cathode and grid, a tube having a cathode, a positive grid-like structure, a control electrode, and an output electrode; potential on electrodes so arranged that a variation in output electrode current is produced which, in relation to input potential, in the vicinity of the applied grid potential is definable by the equation $i = ke^n$ where n is less than 3/2 and the operating potential of the control grid is negative, i is plate current, e is grid voltage and k is a constant. Horst Rothe, Telefunken. Dec. 21, 1937. No. 2,282,886.

Television Circuits

Discharge Device. An electronic device suitable for use in television comprising an evacuated envelope containing an electron permeable light responsive structure upon which a light image is projected and constructed to develop and retain an electrostatic charge image; a source of electrons for producing a focused electron beam of constant current intensity for scanning one side of the electron permeable structure to project electrons through the structure, the electrons being modulated in intensity in passing through the structure during the scanning by reason of the electrostatic charge image developed on the structure. H. G. Lubszynski, E&MI, Ltd., Jan. 15, 1937. No. 2,280,922.

Synchronizing System. Means for transmitting synchronizing signals to a remote scanning system and means for returning the synchronizing signals from the scanner to the original apparatus. By means of a phase comparator a regulating voltage in accordance with the phase difference between the returning synchronizing signal and the master signal is secured for controlling the synchronizing signals. Ulrich Knick, Fernsch Akt. June 14, 1939. No. 2,278,788.

Receiving System. Method for receiving television signals where a common modulated carrier is used for both synchronizing and picture signals comprising band pass circuit to separate the signals. D. L. Plaistowe, RCA. July 16, 1938. No. 2,268,671.

Amplification

Feedback amplifiers. No. 2,282,870 to E. S. Lundie, RCA; No. 2,282, 605 to D. G. Lindsay, Amalgamated Wireless; No. 2,281,618 to J. M. Riddle, Jr. RCA; No. 2,281,644 to Paul Weathers, RCA.

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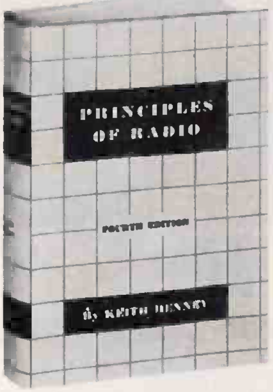

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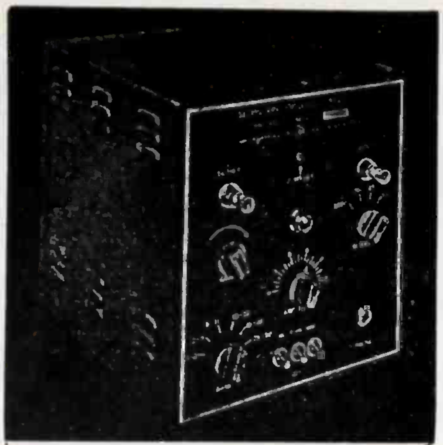


Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronic industry or comment on articles which ELECTRONICS has published

Patents

In the Crosstalk column of Electronics, July 1942, the editor complains about the lack of a description of inventions patented in the U.S. in "full, clear, concise, and exact terms." In particular the editor complains that the single claim of each granted patent published in the *U.S. Patent Office Gazette* is inadequate as a full description of the invention claimed and that, therefore, reading of the *Gazette* is of no value to the engineer. Finally, the editor finds the claims of U.S. patents ambiguous, excessively broad, and lacking a full disclosure of the invention.

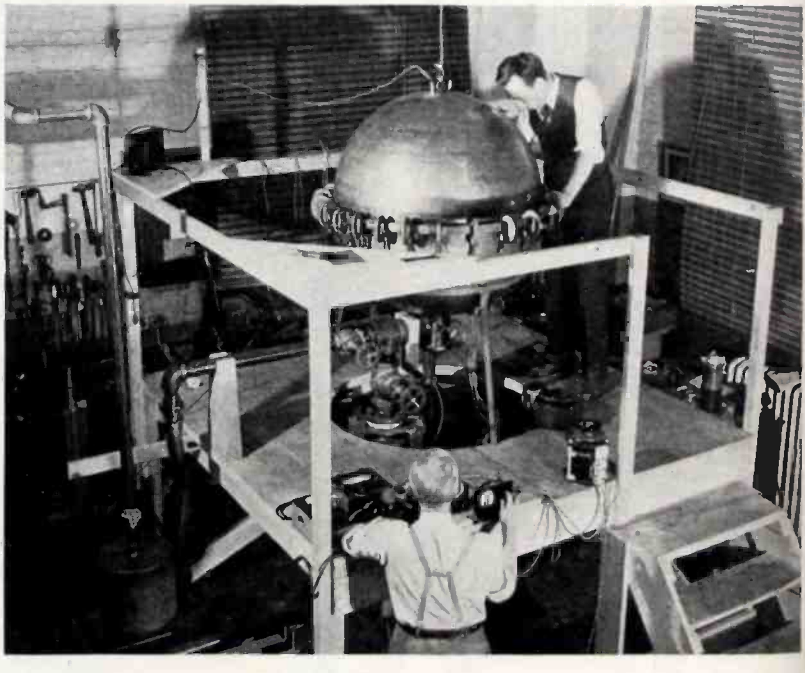
As a communications engineer and registered patent agent I would like to attempt to clarify some of the questions raised in Crosstalk and often raised by engineers.

Crosstalk quotes from a court decision as follows: ". . . it is a precedent to the obtaining of a patent that the applicant shall, in his written application, describe his claimed invention or discovery in 'such full, clear, concise, and exact terms as to enable a person skilled in the art . . . to make, construct, compound, and use the same.'"

This quotation refers to a requirement contained in the U.S. Patent Laws, which applies to the so called patent specification or the detailed description of the invention and the drawings, which are part of the application and which constitute the disclosure of the invention. It is, however, not to be applied in this general manner to the claims as attempted in Crosstalk, since it is not the purpose of claims to give a detailed description of the invention.

It should be kept in mind that a patent is primarily a legal instrument granting to the patentee a monopoly, the extent and boundaries of which are defined in the claims. The basis for the monopoly granted and defined in the claims is the disclosure of the invention which is found in the patent specification and drawings, which are required fully to describe the invention. Therefore, the engineer who wishes to find a disclosure of the nature and aims of the invention should consult the specifica-

GLARE OUT OF GLASS



Glass surfaces to be treated are placed in a large metal globe, as much air as possible is removed by a vacuum pump, then a tiny bit of magnesium fluoride is electrically evaporated, coating each surface with a film about 1/300,000th of an inch thick. Surfaces treated in the metal globe can be handled without damaging the non-glare surface. Glass to be treated is placed in metallic frames and then stuck to the inside of the globe by alnico magnets. Dr. Hewlett is peering into the sphere and C. W. Moore, his assistant, is at the controls ti and drawings for this purpose and not the claims. If it were the function of the claims to set forth a detailed description of the invention, the specification would be superfluous.

y own experience has been that the Gazette, which usually publishes only a single claim and figure of the drawing of each granted patent, is valuable in selecting patents of interest. However, a full disclosure can be obtained from the specification, which is part of the patent, copies of which are available at some libraries or from the Patent Office at the price of 10 cents per patent.

osstalk complains that "most of the claims of most of the patents published are completely non-understandable without a great deal of study." To spend much time trying to deduct the details of an invention from the single claim published in the *Gazette* seems an inefficient way of operating, since the full disclosure can be had for 10 cents. The determination of the scope of a claim with reasonable accuracy requires study of the complete patent, because claims are always to be interpreted in connection with the disclosure, and this often does require a great deal of study.

o patent claims are cited in Crosstalk, the first of which relates to a method of manufacturing electrical devices "of the general character indicated." These last words quoted directly from the claim are further evidence of the fact that the specification must be used to interpret claims. The latter enumerates a series of method steps. The editor questions whether the invention resides in the individual steps or in the summation thereof. A claim must always be considered in its entirety and, therefore, the invention obviously resides in the summation or combination of the steps. The recitation in the claim of each additional step represents an added limitation of the monopoly granted and it is not feasible to ignore any one of the steps enumerated in the claim. Therefore, this claim intended to protect the invention resides in the particular combination of method steps and does not cover any individual step per se, each of which may be common knowledge in the art.

second claim cited in Crosstalk relates to a welding system comprising a combination of elements. Again it is the particular combination of the enumerated elements which is patented and not any one element per se. The patented invention does not reside in the "control device" listed as an element of the combination, since it is not permissible to use such a broad term without any description of the structure of the element, if the invention resided in that particular element. Several decisions of the Patent Office and the courts deal particularly with this matter, and I am quite certain that the specification of the patent from which the claim is taken, contains a description of the "control device," which in itself probably does not constitute a patentable invention.

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quoted. He would not infringe the claim unless he carried on every step in the particular combination and for the particular purpose.

It would not be necessary for him to dope out a control device, as no doubt one is fully disclosed in the specification of the patent.

Your statement that the claims are written by lawyers and not by engineers is in error. A large majority of patent lawyers handling technical patent prosecution are engineers first and lawyers second. Most of them received engineering degrees before they studied patents or law.

I may say that I have no knowledge of the inventors or owners of these patents, nor as to their numbers.

At a time when there is so much wholly unjust criticism of the patent system, your magazine, which is the spokesman of an art so greatly dependent on patents for its development, should be extremely careful of any statements made.

You are careful as to the technical content of your magazine and would not publish an article on an electronic subject unless it were carefully checked or its author were a recognized expert. You should deal similarly with a subject such as patents and patent law.

There are many able patent counsels in New York who would no doubt be very glad to give you any information or advice necessary to discuss the matter properly and correctly.

HOWARD W. HODGKINS

Harmonic Filter

I HAVE READ with interest Mr. R. Snoddy's article in the May 1942 iss of ELECTRONICS. In this article he h shown that the characteristic impedan of the line differed from the manufa turer's value of inductance given as 4. x 10^{-6} henries per 60 ft. which was to d termine the capacity for the same 60 section. This is shown to be 954 x 10 farads per 60 ft. Then, through a pro ess of working out the equations co taining (R, L) and (G, C) in their pol form, the phase shift factor is comput by the equation of the propagation co stant, namely:

$$\gamma = \sqrt{Z\ Y}$$

Granting the characteristic impe ance of the manufacturer to be wron let us use the computed values of Z the characteristic impedance, 68.2 ohn and C, the capacity per 60 ft., 954 x 10 farads and see if there is not a simpl way to arrive at the same resul namely, that the velocity of propagatio on the line is 93.6 percent, the velocit of light in free space.

My approach is as follows: $\frac{V}{c} =$

Where V = velocity of the wave in the line
c = velocity of the wave in free spa
= 3×10^{10} cm/sec
θ = angular velocity in free space
β = angular velocity in the line.

$$V = \frac{1}{\sqrt{L.\,C.}}$$

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where L_o and C_o are the unit inductance and capacity per cm length.

We now have upon substitution:

$$\frac{1}{\sqrt{L_o C_o}} \sim \frac{\beta}{\theta} ; \frac{\beta}{\theta} \sim \frac{1}{\sqrt{L_o C_o c}}$$

$$\frac{\beta}{\theta} \sim \frac{1}{1.07} = 0.936 \times 100\% = 93.6\% = \frac{V}{C}$$

This would mean λ_o in free space = 664 ft. at 1480 kc and λ_1 (wave-length in the line) = 664′ × 93.6 = 622′ or

$$\frac{\lambda_1}{2} = 311'$$

Thus we see we can arrive at the same result by what seems to me a much shorter method.

Robert F. Lewis
New York City

Tropical Radio Receiver Trouble

I was naturally very interested in Mr. H. C. Schwalm's comment in the March, 1942 "Backtalk" column on my article of a year earlier concerning tropical radio receiver troubles.

His comment is similar to that of many men who have struggled with this problem, and I quite agree with him when he states that the corrosion of the high potential windings in receivers is due to electrolysis.

He suggests in the case of an audio transformer that a choke in inductance-capacity coupling be used to take the high potential from the transformer winding; and in the case of a speaker field the speaker frame be placed at a higher positive potential than the field winding to prevent electrolysis. The same procedure, he says, might be applied to other parts of the set. He mentions some applications that have been tried. and I have also seen such schemes used with some success.

I can imagine the alarm caused in some engineers minds by the idea of placing the chassis or speaker frame at high potentials. I can also imagine Mr. Schwalm's retort that you don't dare touch the frame or chassis of most North American receivers after they have been in the tropics a few weeks anyhow. The leakage currents automatically raise their potential to high values while operating, unless they are definitely tied to ground.

However, I do not feel that the solutions offered by Mr. Schwalm are the best answers. In the case of the inductance-capacity coupling the high potential has simply been transferred to the winding of the choke. If it is made of the same materials as the transformer the problem still exists, but in the choke instead of the transformer.

The presence of leakage currents in the various parts of a receiver detunes the r.f. and i.f. transformers, changes the grid bias on tubes, upsets AVC action, and in various ways greatly reduces performance. The electrolysis is only the most annoying feature because it eventually stops operation completely, and requires costly repairs.

It would seem to be much more desirable to use better insulations and better designed insulators so that the leakage currents do not exist, even under extremely humid conditions.

At the same time that I was observing these faults in commercial equipment in the tropics I was working with U. S. Army Signal Corps equipment that was operating under the same weather conditions. However, the Signal Corps equipment had been built to meet rigid specifications with regard to humidity and temperature. From my observations I am sure that receivers can be built with conventional circuits that perform as well in humid climates as in the more temperate ones.

Nearly every radio design engineer in North America is now working on equipment for our armed forces which must meet those rigid humidity tests. If the lessons they learn there will only be carried over to commercial products they can certainly make friends in tropical America.

W. E. Stewart
Formerly Ass't Radio Eng., Panama Air Depot

UHF Nomenclature

Several letters have been published in this column and in Crosstalk dealing with the terms to be decided upon for the very high frequencies, or very short wavelengths, which are now coming into use. Readers interested in the background for the following letters should see Electronics.

Mr. William A. Stirrat of Schenectady suggests that since engineers like to reduce matters to logarithmic terms, the higher frequencies could be designated as log cycles. Thus a frequency of 1 megacycle would be represented by 6 lcs. A 10 megacycle frequency would be in the 7 lcs range. He also suggests the ranges from 0 to 1, 1 to 10, 10 to 100 etc., be given spectra letters A, B, C, etc. In his system a frequency of 7500 Mc would be designated as 9.875 lcs or $K_{.875}$.

Two other proposals are cited in full since they are simpler and have a better chance of being worked upon by other engineers.

"Since reading that portion of Crosstalk for May, 1942, dealing with proposed names for 10^9 and 10^{12} cycles per second, I have been looking around for established precedence, both of the prefixes which others have recommended and the one which we have been using in connection with 10^9 cycles per second. To date, however, my quest has been fruitless.

"For a period of over a year now, this laboratory has employed the name begacycles for frequencies expressible in units of 10^9 cycles per second. We believe that our choice has a basis in logic because of its resemblance to megacycles. The Greek prefixes deci, centi, and milli, resemble closely the prefixes billi and trilli, which others mentioned, yet unlike the Greek prefixes, they do not designate units which are submultiples of unity.

"We should like to propose, therefore, that the prefixes bega and trega adopted for factors of 10^9 and 10^{12} r spectively."

R. M. Bow
Director of Researc
Hygrade Sylvania Corporatio

"I have been interested in the Cros talk items in Electronics relative UHFI. I think Mr. Pickard's sugge tion of billicycles and trillicycles is most excellent one. I have only one a ditional comment and that is that th gives only four divisions for the whol range and also, for many workers in th higher frequencies, the use of wav lengths has certain advantages.

"These two points could be taken ca of by speaking of the millimeter ban or millimeter waves and dekamete waves. In other words, the followin ordinary metric table could be used:

Millimeter	0.001 mete
Centimeter	0.01 mete
Decimeter	0.1 mete
Meter	1 mete
Dekameter (or decameter)	10 meter
Hectometer	100 meter
Kilometer	1000 meter
Myriameter	10,000 meter

We would, therefore, speak of broadcasting using the hectometer band o range.

"So far as I can find out, there is n common expression for a unit of length that corresponds to 1/10 millimeter. However, the term "micrometer" is well known and, of course, is equivalent to 0.001 millimeter. Even at the way progress has been made the past few years in expanding the spectrum on the high-frequency side, it may be a little time before we are using micrometer waves and, even then, the mechanical engineer may claim them as a part of his sphere of thermodynamics."

W. C. White,
Engineer
Electronics Laboratory
General Electric Company

• • •

OCD Tests

(*Continued from page* 59)

might be available and convenient for civilian defense use.

Testing on *Type "C"* lines, a transmitter was coupled to the overhead lines at a substation whose 4,000-v primary feeders are extended to and interconnected with other substations serving a dozen or more small towns throughout the county. A 75-mile tour was made and it was found that in a majority of these small towns there was a well-distributed pattern or radiation which fulfilled requirements 1, 2, 3 and 4 satisfactorily. It was the general concensus that local distribution in these various areas could usually be accomplished by extremely low powered "phonograph oscillators" operated as remote-controlled carrier-current transmitters and turned on or excited by a carrier radiated along the 4,000-v primary feeders.—W. MacD.