The RADIO ENGINEERS' DIGEST

JULY 1945 VOL. 1, NO. 12

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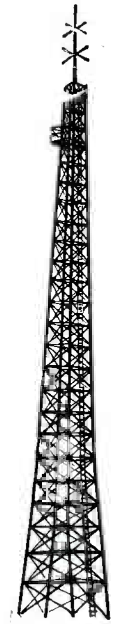

THE RADIO ENGINEERS' DIGEST

JOHN F. C. MOORE, *Editor*

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ORBITAL-BEAM U-H-F TUBES

Reprinted from Electronics

By R. M. Smith

Camden Forge Co., Camden, N. J.

Output frequencies as high as 500 Mc can be varied continuously or shifted back and forth between two or more values by applying appropriate keying signals to electrostatic deflecting plates, so as to vary the transit time between control grid and plate

FEW conventionally designed electron tubes will operate with any efficiency above 100 megacycles and fewer still at frequencies of 500 Mc and higher. However, this is not to say that successful operation is not obtainable in the ultra-high-frequency band (300 to 3,000 Mc) with conventional tube construction, because there do exist some new types of tubes which have been designed especially for such frequencies. These tubes are not generally spoken of as being conventional, however, at this stage of the game.

The writer had occasion to assist in the development of a secondary emission type tube especially designed for use at 500 megacycles or lower. The tubes had the appearance of an overgrown acorn tube. From the laboratory work a number of unique characteristics were found which suggested some new uses and advantages offered by this kind of tube.

ULTRAHIGH-FREQUENCY PROBLEMS

Aside from the problem of efficiently driving the input control grid at ultra-high frequencies to put the useful signal onto the grid element where it has control on the amount of electrons passed on to the anode, there are a number of other problems arising from within the tube itself. Among these are the limitations imposed by the electron transit time. Electron travel time from the cathode to the control grid constitutes one source of trouble and the result of this is a loading effect causing poor power factor for the input driving circuits. With extremely close spacing between the cathode and control grid and with high electron velocities this loading effect can be reduced to workable values where tubes of the acorn variety are used.

The characteristics which we are to discuss herein, however, are those imparted by the flight time of the electrons after they leave the control grid and until they strike the anode or, in this particular case, the secondary emitter. This flight time, if appreciable compared to the interval of time represented by one cycle of the operating frequency, very definitely has control over the operation of the device.

GRID-ANODE TRANSIT TIME

In view of this consideration the electron transit time was made approximately equal to the time of one cycle of the operating frequency, so as to have a synchronous or in-phase relation. It was found that this in-phase relation does exist and that if the transit time was made to vary, a corresponding shift in frequency response or a reactive effect on the external circuits was observed. Thus we can say that a change in the electron transit time has a corresponding reactive effect, the sign of which being determined by the direction of the change in time relative to the carrier frequency. These reactive influences were utilized as a means of control over the tube and its associated circuits.

Although a secondary emission type was used for the experimental work, the principles of control by transit time variation would apply in triodes and similar

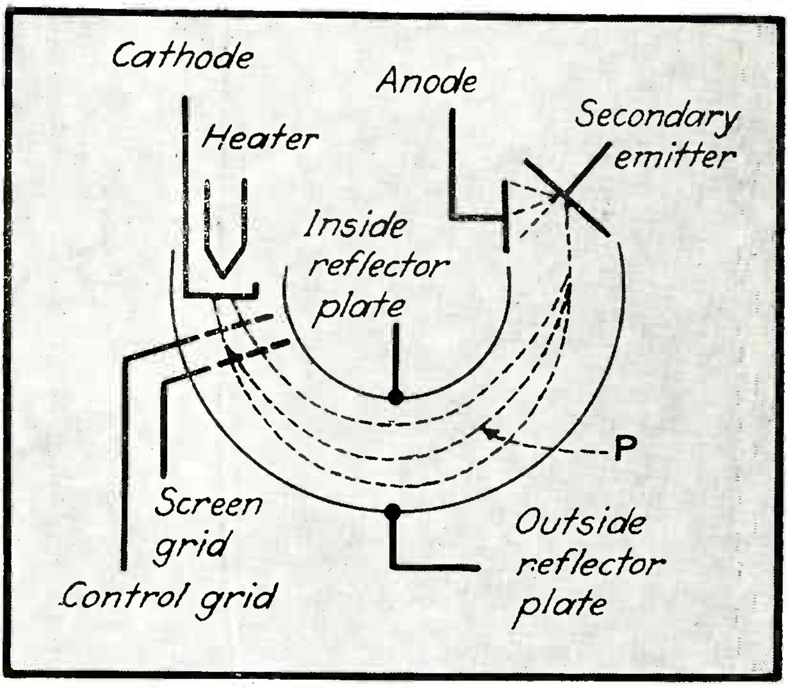


Fig. 1 — Basic electrode arrangement in an orbital-beam tube

tubes where the electrons are collected by the anode, bearing in mind that the physical design must allow for the control of the electron transit time in the manner described. A triode oscillator circuit is generally preferred for simplicity. Since we were interested mostly in receiver circuits with high gains per stage, the secondary emitter tube was used because of its inherent high mutual conductance. As a power amplifier this tube was found advantageous, as will be pointed out later.

PRINCIPLE OF ORBITAL-BEAM TUBE

The essential elements of the first orbital-beam tube are shown in Fig. 1, and include a heater. cathode, control grid. screen grid, inside reflector plate, outside reflector plate, secondary emitter. and anode. If we were to visualize the flight of a single electron. for example, we find that after its emission from the cathode, attraction by the positively connected screen grid provides it with an initial velocity sufficient to carry it through the screen grid, beyond which the higher potentials applied to the various other elements speed it along some curved path, say *P*, to the secondary emitter where its collision with the activated plate causes the radiation of secondary electrons, some of which strike the anode.

The velocity of the electron during this flight remains substantially constant as determined by the static potentials applied to the various elements, and its path has been made purposely circular. The circular path permits lengthening or shortening of the flight path, thereby causing more or less time to be required by the electron in traveling from the control grid to the secondary emitter. The normal direct voltages applied to the various elements are approximately as follows: screen grid—150 v, inside reflector plate—150 v, and outside reflector plate—200 v. To lengthen the path a greater d-c potential is applied to the outside reflector or less to the inside reflector. The electron having an initial velocity and potential as determined by the screen grid is either attracted toward a higher-potential field or repelled by a lower one, so that it is effectively guided along the curved course by the curved electrostatic field existing between the two reflecting plates. In other words, by adjusting the d-c potentials applied to the reflecting plates the mean diameter of the circular flight path taken by the electron is caused to vary more or less. This control effect is the nucleus of the characteristics utilized in this conception. The principle of electron stream deflection is similar to that employed in other applications such as the cathode-ray oscilloscope, beam tubes and others.

PULLING EFFECT

If the tube and its connected circuits were made to oscillate at a frequency corresponding to the order of time taken by the electron in its traveled path, it was found that by varying the length of the electron flight path and consequently the time taken, considerable reaction or pulling effect was reflected upon the circuit, resulting in a change of operating frequency. The degree of control made possible

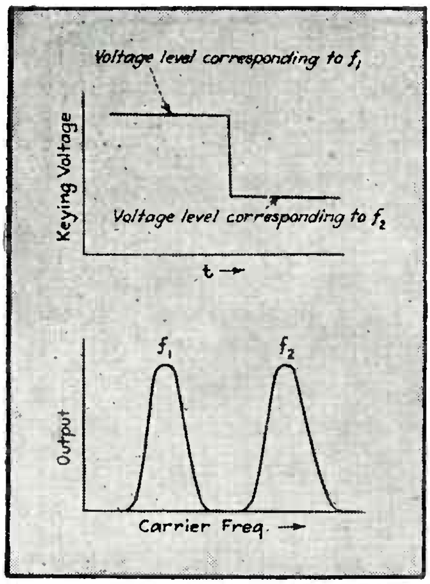


Fig. 2 — A square-wave keying signal fer to an orbital-beam oscillator gives two-aband transmission with a single tranh-mitter

is appreciable. By way of example, the particular tubes which were used gave a response variation amounting to ±0.5 percent at 500 megacycles before any reduction in oscillation strength took place. This frequency change was obtained by a 2-percent variation of the d-c potential applied to either reflecting plate.

It can be shown that the above phenomenon can be reduced to capacitive or inductive reaction effects and thus utilized for a number of circuit functions such as circuit compensation, oscillator stability and frequency response change, regeneration control, multiple-band and wide-band reception.

POSSIBLE APPLICATIONS

These considerations immediately suggest the possibility of applying modulation signals to the reflecting plates for obtaining the following modes of operation: sine-wave modulation for communication and other uses: square-wave keying signals to obtain two or more distinct operating conditions, such as multiple-band reception or transmission (see Fig. 2), and saw-tooth keying signals to obtain a sweeping effect covering a continuous band of frequencies (see Fig. 3).

An orbital-beam tube is normally used in single-ended fashion as shown in Fig. 4, where the output circuit is connected to the anode. It was found that it also

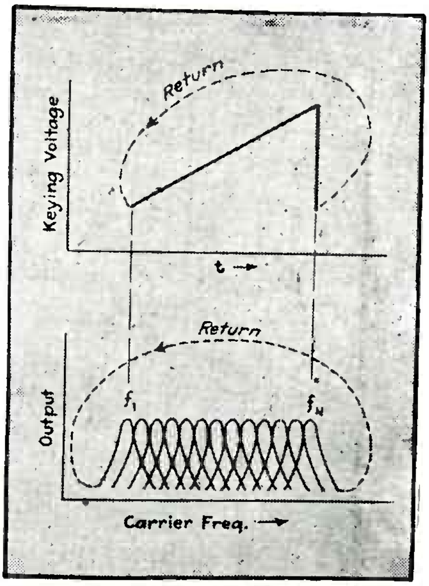


Fig. 3 — A saw-tooth keying signal fed into an orbital-beam oscillator gives a sweeping effect covering an entire band of frequencies

worked quite well as a push-pull driver, with the secondary emitter and the anode connected to the opposite ends of a push-pull resonant circuit as shown in Fig. 5. In the latter case, when used as a power amplifier, a power gain equivalent to 1.414 times that of the single-ended circuit was obtained.

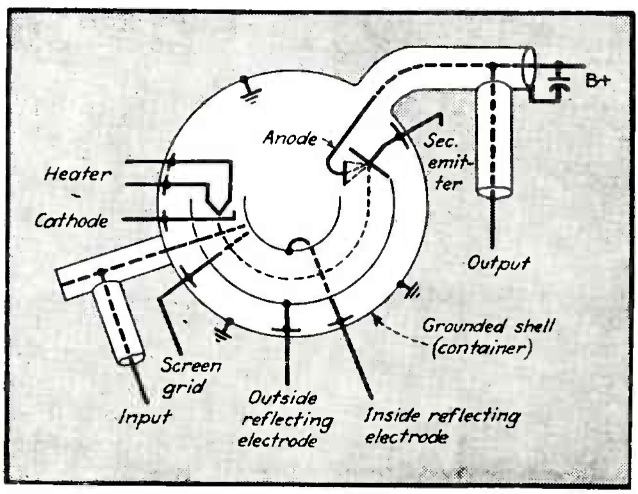


Fig. 4 — Single-ended operation of an orbital-beam tube acting as an amplifier

EXTERNAL CIRCUITS

A few words about the external circuits are in order at this point. At 500 megacycles the advantages of concentric resonant line circuits, either $\lambda/4$ or $\lambda/2$ in effective length, are numerous and these lines were used in the work of development. Proper matching of the input and output terminals of the tube to their connected circuits is most essential, as well as the effective grounding of the other elements at the operating frequency. If modulating signals are applied to one or both

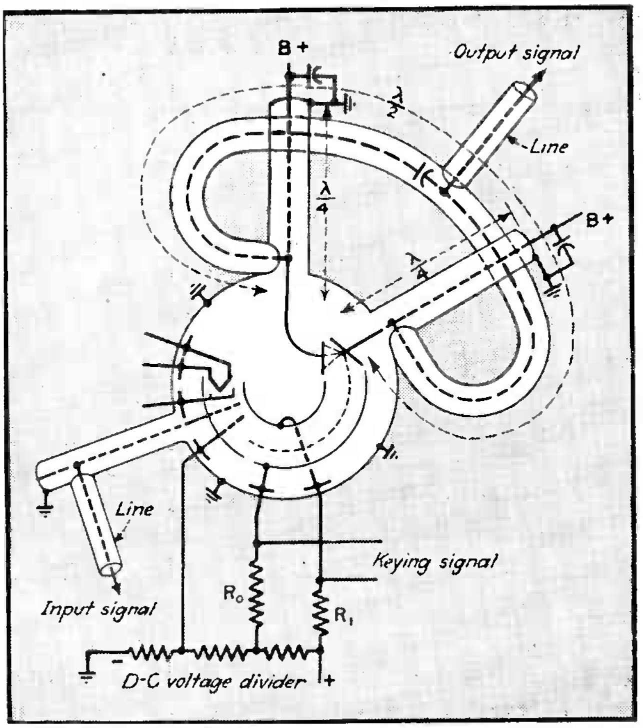


Figure 5. — Use of a coaxial resonant line with an orbital-beam tube to secure push-pull amplification

of the reflecting plates, then band-pass type filtering is required in the leads to these elements in order to properly ground the r-f carrier currents while passing the modulating signals.

In Fig. 5 it will be noted that provision is made for impressing a modulating signal onto the reflecting plates. Resistors R_0 and R_1 are in series with the battery leads to these plates. Generally only one plate is used for a single application; however, there are conceivable applications where both plates might be used for a dual modulation scheme.

In conclusion, it should be remembered that in order to control the electron flight time within a given tube, assuming constant velocity, a circular or orbital path with suitable deflecting plates must be provided, and to obtain the reactive or phase effects discussed herein the physical dimensions must be such to cause the flight time to be approximately equal to the time of one cycle of the operating frequency. Whether the tube is a secondary emitter or a straight anode collector does not matter in the sense and manner of control. It does, however, make a difference in the relative gain derived, being somewhat in favor of the secondary emitter type. A greater flexibility in circuit arrangements, with some added complications, is possible with the latter type.

NON-LINEAR RESISTORS

Reprinted from Radio

By A. P. Howard

Describing the characteristics and applications of these resistors

CERTAIN materials — apart from those commonly employed in the resistor industry — exhibit peculiar characteristics when exposed to temperature and/or voltage stresses. These materials have been commonly termed temperature-sensitive or voltage-sensitive materials.

The separate effect of temperature is sometimes difficult to ascertain for, with increased current flow and resultant heat dissipation, either the voltage coefficient or the tempeature coefficient could be the determining factor.

Consider the case of a typical carbon resistor, which shows properties of both temperature and voltage coefficients. Here we slowly increase the voltage across the resistor with the accompanying voltage coefficient causing a decrease in resistance. At this point increased current is flowing and the unit is heating more rapidly, causing a further decrease in the resistance due to temperature coefficient. This process can be carried on until final destruction of the resistor, without determining cause or effect.

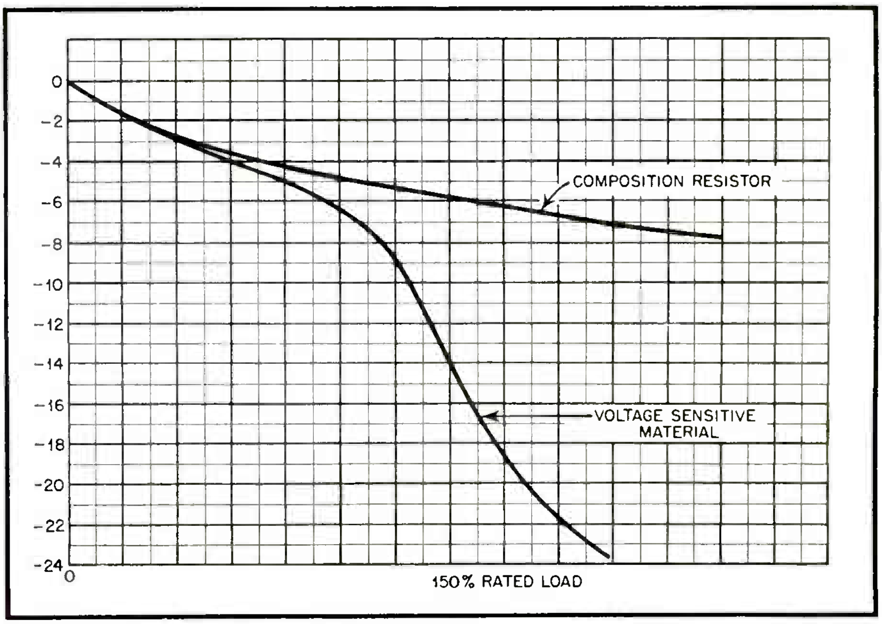


Fig. 1 — Resistance vs. voltage curves for voltage-sensitive and composition resistors

Certain arbitrary assumptions have been made, in order to differentiate temperature from voltage coefficient. Conventional measurements state that temperature coefficient is the property of a material over a wide range of temperatures and with a fixed low potential applied. This causes certain errors in measurements at the upper temperature ranges, but these are not important for our purposes since the ultimate use of these resistor products would have the same errors present.

At the same time, voltage coefficient is based on a fixed temperature with several potentials applied. Here, again, non-linearity is also due to certain temperature influences over a period of time.

Only certain materials can be employed to obtain a temperature or voltage sensitive material. These are limited, at the present time, to the carbon products, ceramic forms, and certain metal oxides or sulphides. The carbon products, such

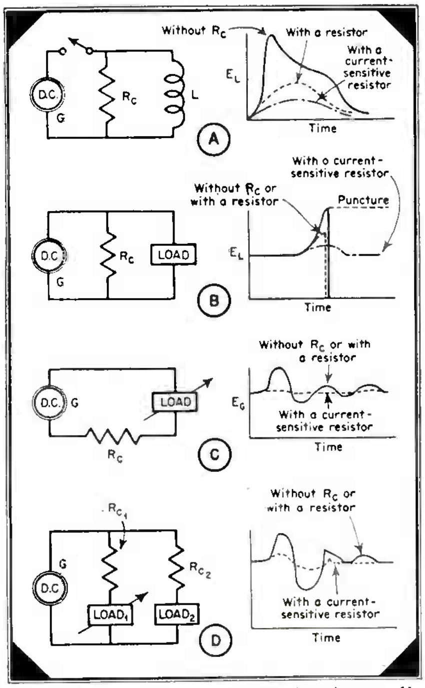


Fig. 2 — Current-limiting circuit applications for non-linear resistors

as silicon carbide, exhibit voltage sensitivity to a greater degree than the ceramic or metal oxide. A typical curve of resistance versus voltage is shown in *Fig.* 1. In this case the typical behavior of a carbon resistor is given for reference.

It will be noted upon examination that the resistance changes non-linearly and as an exponent of the voltage or current applied. Certain commercial manufacturers have been able to produce resistors which vary as the eighth power of the current in series, but common commercial substances are more nearly a variant of the third or fourth power of the voltage impressed.

MANUFACTURING PROCESS

The silicon carbide materials are prepared in several forms: as resistors *per se* or as discs. The raw silicon carbide is mixed with a ceramic binder and pressed to drive off excessive water. This disc or resistor is then uniformly heated. As with the composition resistor. the properties of resistance, temperature coefficient, and voltage coefficient are directly dependent upon the firing temperature and time, molding pressure, and basic constituents.

Because of the non-linear characteristic of the resistor, harmonics can be expected in the output in direct proportion to the current sensitivity of the resistor. As the change with current increases, the harmonic distortion will also increase.

APPLICATIONS

These materials appear to lend themselves to certain applications. These applications immediately suggested are current-limiting devices, such as shown in *Fig.* 2. All these circuits are basically protection devices: *Fig.* 2*a* shows a silicon carbide material employed to limit the induced voltage after the opening of the switch. As part of the damping circuit, it dissipates a portion of the energy to which the coil insulation would otherwise be subject. *Fig.* 2*b* shows a shunt limiting device where excessive voltage surges are to be encountered. Because of its relatively instantaneous response, the resistor would not act until the voltage reached the predetermined level, and then drain off the excess current ordinarily damaging to the load. *Fig.* 2*c* shows a variation of *Fig.* 2*b* in which a varying load device is in series with the control resistor. Here the effect is that of varying inversely as the load, assuring a uniform load reflected back on the generator. *Fig.* 2*d* is an extension of the principle of *Figs.* 2*b* and 2*c* in which several loads are "evened up" so that the generator sees a constant impedance.

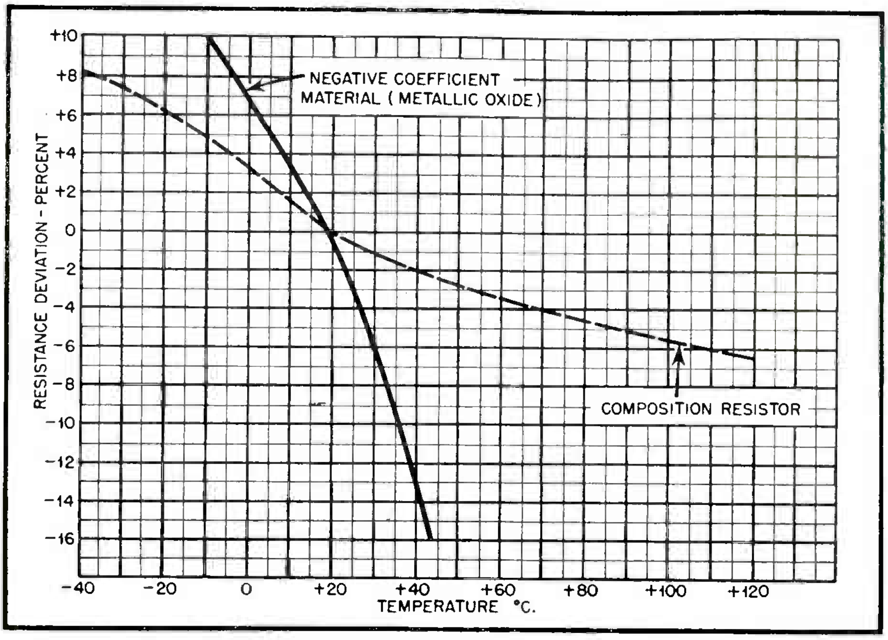


Fig. 3 — Comparative curves of negative temperature coefficient materials and composition resistors

An important consideration in each of the above applications is the circuit in which the unit is to be used. Control, here, is not a simple matter of definition of the voltage-current relationships expected — it is also the result of a complete analysis of the ambient conditions.

IMPORTANT FACTORS

The following criteria are the basic ones to be applied in the selection of a current-sensitive resistor: cold resistance, resistance variation desired with variation of current, ambient temperature range, tolerance on both current variations and ambient temperature variations, ambient relative humidity and altitude, temperature rise allowed on the resistor surface, frequency of voltage to be impressed, maximum voltage range, and approximate sensitivity (response time).

To define these current-sensitive resistors as control devices is to limit their active field of operation. Certain other applications are suggested where the use of their current sensitivity is employed in various measuring devices.

The other group of non-linear resistors are those temperature-sensitive devices which are composed of ceramic or metallic oxide forms. It has been known that the ceramic forms identified as kaolin or rutile exhibit large temperature coefficients of resistivity and capacitance and, as such, are well suited for such purposes. Certain other experiments have been conducted using uranium and nickel sulphides to obtain the same results.

These materials are far apart from the iron-aluminum-chromium or carbon materials usually thought of as negative-temperature-coefficient materials, as *Fig.* 3 indicates.

As ceramic forms, they are fired in paste form at some temperature from 1000° F. to 3000° F. The resultant properties are a product of the mix and of the firing temperatures.

FORMS OF HEATING

Two forms of heating can be employed to utilize the negative temperature coefficient: internal heating by increased wattage dissipation or external stimulus. As such, these resistors present themselves as suitable for several uses: compensation of a positive coefficient of a circuit, part of a measuring device for current or temperature change, or for time delay circuits. Such circuits are shown in *Fig.* 4.

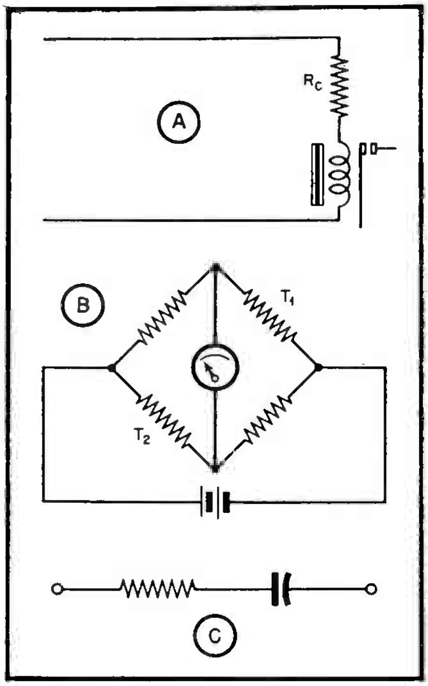


Fig. 4 Potential uses for temperature sensitive relay wound with copper wire; (B), bridge circuit to measure temperature differentials; (C), time delay circuit

It is apparent to the reader that, upon exploration of the field, the similarity between current-sensitive resistors and temperature-sensitive resistors is great. In many applications, the designer can depend upon either type to perform his work. Care must be exercised that the design is not so close that unproducible tolerances are imposed upon the manufacturer of the material.

EDUCATIONAL FILMS AND TELEVISION

Reprinted from Television

By Henry Clay Gipson

The important place of educational films in television is outlined by Mr. Gipson, general manager of Springer Pictures, producers of educational and industrial films. Mr. Gipson has directed many educational and training films and is the author of three photographic books.

TELEVISION is in its tin-type stage and the people before the cameras are having a lot more fun than those who witness the resulting contortions on the screen. In this field-day of experimentation, the important educational uses for television have been largely overlooked. Yet "how to do it" programs will have a wide appeal according to recent findings of the CBS Television Institute where studies by Oscar Katz and Ernest Dichter indicate that education is one of the gratifications television audiences will expect.

Perhaps I feel so strongly about the educational potentials of the television screen because I have been daily involved in the great educational development which the war has brought to another almost identical screen—that of the non-theatrical motion picture. A television set and a 16 mm projector are practically identical from the observer's point of view. The difference lies behind the scenes. In television, the audio and visual impulses come by air—in the movies, they are manually transported on a strip of film. Therefore, in considering the future of television, it might be well to temper our opinions with a short review of the development of the educational motion picture.

It is interesting to know that the early scientists, Muybridge, Marey, Edison and others, who developed the motion picture envisioned its future almost exclusively in the field of science and education. However, when American business men and showmen began to appreciate and exploit the tremendous entertainment possibilities of the screen, its value in the field of education was almost forgotten. It was not until after the first World War that any great amount of activity in audio-visual education took place. It was then that extensive surveys were undertaken to analyze the effects of the theatrical motion picture because civic and religious groups claimed that films were doing great harm with their frank portrayal of the flapper age. The results of these surveys shocked the nation, for it was demonstrated that films which glorified evil were definitely responsible for juvenile delinquency. The widely publicized and much discussed facts led immediately to a voluntary censorship of the motion picture industry. These facts also demonstrated, beyond the shadow of a doubt, the great educational power of the screen. If films could do harm, they could certainly do good, and educators began to realize that in this audio-visual medium, they had a means of communication without parallel for the transmission of thought in systematic educational procedures.

Gradually schools began to use films. Some idea of the progress made can be seen from the fact that the public schools of Chicago projected films 647 times in 1929-30 and 60,000 times in 1935-36. By 1940 there were approximately 15,000 sound projectors in use in colleges, high schools, and elementary schools in the United States. But if this advancement was rapid, an even more dramatic development in the history of education came with the second World War. The U.S.

Army and Navy faced with the necessity of training masses of men in the intricate problems of modern warfare, began to use films in unprecedented numbers. First hand experience showed that films were speeding training to an appreciable extent. They were multiplying the teaching skill of the best instructors and setting up standards of instruction in the many various widespread training centers. The size of the program can be judged from a report to Congress in June, 1943, which stated that the Navy had 830 reels of film in production; the Army, 1,250 reels; the Office of Education, 187 reels; and that the Department of Agriculture had released 39 reels during the preceding year. Navy film production alone was costing more than the expenditures of any two Hollywood studios at their peak periods. Each month from 30 to 60 thousand prints of Navy subjects were being shipped to bases at home and abroad. Experience indicated that training time was often cut as much as 40% over the time required for similar work in the last war when practically no films were used for training. All of this points to a greatly expanded post-war future for the educational film.

While the use of films is largely confined to group instruction, television will make it possible for individuals or family groups to obtain the benefits of audio-visual instruction which it is now impractical for them to get since it takes considerable effort and a good deal of expense to obtain and project a sound motion picture. In the future, one need only to flick a dial for a choice of entertainment or educational programs.

It is not my contention that educational or how-to-do-it films will ever lead in any "Crossley" poll of television. The big audience programs will undoubtedly be those which cover important news or sporting events or the expensive theatrical type productions. However, there are not going to be enough advertisers with enough money to use more than a fraction of the television time for high grade audio-visual program which can meet the entertainment standards Hollywood has created. This is where the great opportunity for educational television rests, for educational programs can be well done at relatively little cost—a cost compatible with the market.

As the world grows older, people are bound to have more and more leisure. Industrial production has already magnified the productive capacity of man—up to ten thousand times in some industries—and improvements are constantly being made in practically all fields of human endeavor. Thus people must find something to do with their non-productive time. Some will want to study the arts; others will concentrate on improving their ability at sports; while the practical minded will want to learn a new trade or improve their education. Almost everyone will have a hobby and want to learn something. Through television we can give these people the proper know how. We can acquaint them with the skill required to use many varied products. *And what could be finer advertising than to actually show the use of a product!*

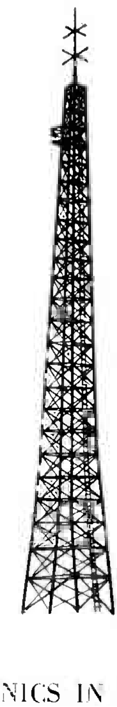
RADIO PHILOSOPHY

Perhaps the present "radio" philosophy which seems to dominate television is responsible for the lack of interest in educational programs. But radio is a very different medium from television. Psychologists estimate that 90% of our learning comes through our eyes and only 5% through our ears and the remainder through our other senses. This is why radio has seldom been used for instruction—and why television may find a large future in educational programs. It may well be that certain stations will devote themselves exclusively to educational programs.

Films will undoubtedly be extensively used as a basis for television programs. They will be especially designed for the purpose and they will, undoubtedly, be as different from regular movies as radio transcriptions are from phonograph records. In fact, they will even be taken at a different number of frames per minute. We all know the advantages of films for many television uses—to telescope the time angle; to provide repeat performances where networks are not available; to insure perfect performances on split second timing; to present many locations in one continuity; to provide a record for legal purposes; and to permit careful selective editing, utilizing the best of several takes. When we consider educational television, the advantages become more important.

For example, the obvious fact that a telecast from a film original can easily be repeated is most important from a cost angle. Educational audiences will be comparatively small and even though the selling job done is exceptional, it may be difficult to realize a suitable return from one telecast. By working from a film original we can use the same program not only in different localities, but also after a suitable time lapse repeat it over the same station, perhaps with minor changes to bring it up to date. In this way a new audience can be started with the fundamentals of a subject and gradually carried on through its more complicated phases. Such a use for educational films will be especially important if television stations are erected for the sole purpose of disseminating education.

The average person who views a present day educational film doubtless does not realize the immense amount of planning and supervision that goes into these productions; the script conferences, the photography, the editing, the recording; the involved process by which the educational film producer translates the ideas of educator and subject expert to the language of the screen. We, of the educational film producing fraternity, know by intimate experience of the many problems involved in audio-visual education. It seems highly probable that educational programs which are presented by live action will be easy competition for our carefully planned and perfectly executed film product.



ELECTRONICS IN INDUSTRY

An ever-widening field of electronic applications is revealed by a survey of 796 companies, representing virtually every type of industry. This group is served by 16,805 electronic devices, the basic applications of which include heating, control, power conversion, counting, sorting, weighing, inspection, molecular vibration, measurement, analysis and safety.

VOLTAGE REGULATORS

Reprinted from Radio-Craft

By Jack King

GOOD voltage regulation is important in many radio circuits. A radio transmitter's frequency may shift if the plate supply voltage swings. Changes in voltage may cause instability and oscillation in some receiving circuits. A few types of electronic instruments require supply voltages fixed as closely to the predetermined value as human ingenuity can achieve. This voltage regulation may be attained in three chief ways: by careful attention to apparatus used in construction of power supplies; by use of special voltage regulating and ballast tubes; and by the use of special power supplies with built-in circuits which act to oppose and neutralize any tendencies to change in the supply voltage.

A basic diagram of a source coupled to a load is shown in Fig. 1. If the source resistance is kept very low, the voltage regulation will be good. With an incorrectly chosen source resistance, varying the load resistance between two limits above and below the resting value will mean an abnormally large swing in the current through R_1 (internal resistance). The varying current flowing through R_1 will produce a variable voltage drop across the source resistance. Since the output voltage is equal to the internal voltage minus the drop in the internal resistance, it will fluctuate too much. If R_1 is very low in value, clearly the variation in potential across it will be low and the output voltage will be quite steady for reasonable changes in load resistance. This points to the desirability of low-resistance chokes and transformer windings in power supplies.

Voltage regulation may also be tied in with the storage of energy in a reactance. In a radio transmitter with the key open, the load resistance connected to the power supply in effect is made much higher in ohmic value and the load current is decreased. Referring to Fig. 2, the circuit current through the choke may be low in value with the key open. The output voltage across B plus and B minus is then high, and the filter condensers are charged up to high values of potential and store energy.

When the key is pressed, a load is put on the supply and the output voltage tends to drop. The choke's resistance causes power dissipation and reduction of output voltage. As the output voltage drops with increased load, it becomes lower than the potential of the output filter condenser. Energy from this condenser is then returned to the circuit. Electrons flow from that condenser into the tube (the load resistance), tending to maintain the output voltage constant in value and thus serving as a voltage regulator. Ordinarily, we don't think of a condenser as a voltage regulator; yet in reality, it may act as one. By using large values of C and L, not only the A.C. ripple can be reduced in compliance with the radio law and F.C.C. regulations, the voltage regulation can be improved, aiding in getting a "clean" note in radio code transmission.

The circuit of Fig. 2 may be simplified for our purpose into the circuit of Fig. 3. If a steady current is bled through R_1 due to the presence of R_B a steady voltage drop will be developed across R_1, tending to maintain the output voltage constant, since that output voltage is always equal to the internal source potential minus the voltage drop in the internal resistance R_1. Then, if the load resistance swings between reasonable limits above and below some normal resting value, the percentage change in current through and voltage across R_1 will be relatively smaller.

In Fig. 2, a bleeder resistance R_B is connected across the output filter condenser and helps not only to stabilize the output voltage but also allows charges to leak off the condensers when the transmitter is not in operation, an important safety feature in high-voltage equipment. The same circuit may be used with a voltage regulator tube. The tube acts to maintain a constant voltage across the load. The regulator resistance is R_R and the load is R_L.

In some radio receivers, a shunt resistance is used for voltage stabilization of the screen grid potential of a tube. A typical I. F. stage is shown in Fig. 4. Again the basic circuit of Fig. 3 applies. We substitute R_2 for R_R and R_3 for R_1. When the control grid of the tube (nearest the cathode) is made highly negative due to the automatic volume control bias potential, the screen grid current decreases and there is a reduction in the voltage drop across R_3. A reduced

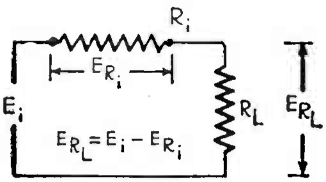


FIG. 1

drop across R_3 would mean an increased screen grid potential at resonance. Rise in the screen potential is limited by the action of R_2. As the voltage across R_2 rises, the current through it tends to rise. This increased current flowing in R_2 and R_3 will tend to produce an increased voltage drop in R_3, which works against any rise in voltage on the screen providing a stabilizing action.

The series resistance of a supply may be made *either* very high or very low to secure a stabilized output voltage. In both cases, what is sought is a stabilization of the voltage across the element in series with the load circuit in order to obtain a stabilized output voltage, since the output voltage is the internal source voltage minus the drop in the internal resistance.

High-resistance supplies may be used with devices which draw very little current. By having more than 90% of the total circuit resistance in R_1 (Fig. 1) any change in the load impedance can only have a 10% effect on the circuit as a whole.

In some communities trouble may be experienced due to excessive line voltage at certain times of the day. Tubes may fail in the receiver prematurely or may even be burned out. By putting a resistance in series with the line, a measure of protection may be gained. As the line voltage rises and the circuit current tends to rise, the increased current flow through the series protective resistance develops an increased voltage drop which subtracts from the line voltage applied to give the receiver working voltage. A special form of this regulator is the "ballast resistor." This is constructed to work on a critical point of its temperature-resistance curve. If current through it increases slightly its resistance rises greatly, thus holding down the voltage supplied to the load.

A more refined device is that of Fig. 5, which may be a part of an industrial control. A saturable reactor T is used. A bias potential E_C is applied to the grid of a control tube, and a certain amount of plate current, determined by the tube design, the bias, load impedance, plate potential, etc., flows through the winding L_1. The magnetic flux due to this D.C. current circulates in the core of the saturable reactor transformer T. As long as this plate current does not become too large, saturation and decreasing of the primary inductance L_2 does not take place. When the line potential E rises, an increased signal voltage at the line frequency is applied through condenser C_1 to the grid of the control tube, which is so biased that any increase in signal voltage due to E will cause a linear rise in the

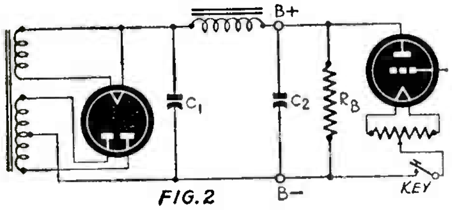


FIG. 2

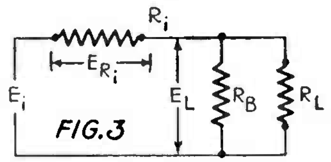


FIG. 3

current through the plate circuit and L_1. With increased D.C. current in L_1, the core flux rises and the core approaches saturation, causing a decrease in the effective inductance of L_2 and the impedance of L_2. We have, in effect, a variable impedance connected across the load. Decreasing the value of the impedance reduces the load voltage and increasing it causes the load voltage to rise. By suitably choosing operating parameters the circuit conditions can be set.

A different form of control action is used in Fig. 6. A D.C. potential is applied to the grid of the tube. If the output voltage of the supply rises, there will be a tendency for the grid to go more positive. When this happens, an increased amount of current tends to flow in the plate circuit of the tube and through the cathode resistance. Any increase in the voltage drop across R_3 will tend to reduce the plate current since, with increased drop across R_3, the grid is made more negative with respect to the cathode. Accordingly, a certain amount of degenerative action and stabilization may be expected. In effect we have a shunt resistance across the output of the B supply, between the B plus and B minus

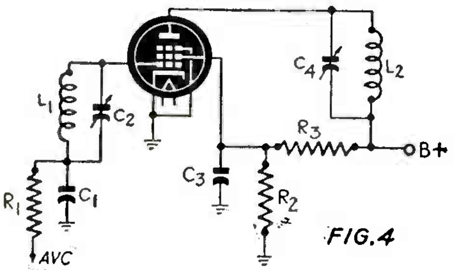


FIG. 4

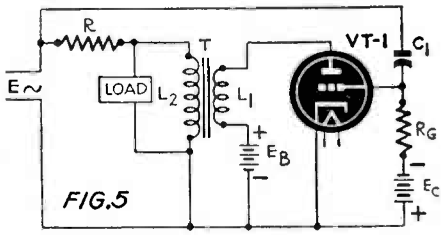


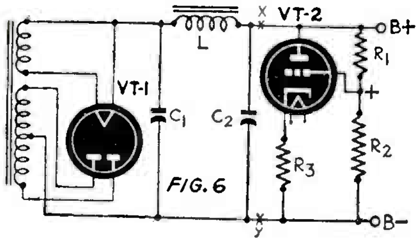
FIG. 5

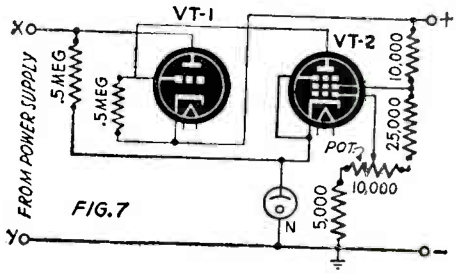
terminals, consisting of the tube's plate-cathode resistance in series with R3. Somewhat better regulation may be obtained by substituting a special bias battery for R_2, thus maintaining constant voltage between grid and negative terminal.

A completely electronic voltage-regulator is shown in Fig. 7. The voltage-regulator tube of Fig. 6 is used in conjunction with another, VT_1, which acts as a variable resistor. The action is the same as Fig. 6, as far as the voltage-regulator tube, VT_2, is concerned and may be substituted for it at points X and Y. An increase of output voltage increases the voltage on the grid of VT_2 thereby increasing its plate current. This current is drawn from the output voltage terminal through the half-megohm resistor between grid and cathode of VT_1, increasing the voltage drop across it and proportionately dropping the grid voltage of VT_1. This reduces current through that tube and increases the voltage drop across it, effectively reducing the output voltage. VT_1 is an electronically variable resistor.

A neon-tube, N, or a battery may be used to maintain the cathode voltage at a predetermined level above ground. The half-megohm resistor between it and the rectifier output causes the tube to remain "struck" at all times, thus avoiding oscillator action sometimes experienced otherwise.

Instead of connecting the control-tube grid to a fixed point on the resistor





network as in Fig. 6, a potentiometer is inserted and the grid attached to its movable arm. Thus the output voltage may be adjusted within certain limits.

This type of voltage regulator has been widely used by experimenters. For voltages in the order required for receiver-type apparatus, the constants shown in the figure are correct. VT_1 may be one or two 2A3's or other heavy-current low-resistance triodes, and VT_2 a 6J7 or equivalent. The neon tube N is usually of the small 1-watt or 2-watt type, the kind with no built-in resistor. A voltage of approximately 60 is maintained across it.

Necessity for special voltage regulation systems is confined to circuits or devices in which voltage must be kept within very narrow limits. For most work, careful attention to keeping the source resistance low, by using large transformers, filter chokes and condensers, as described in the earlier part of this article, will be sufficient.

Beaten paths are for beaten men.

ERIC JOHNSON

HIGH GAIN 112-MC BEAM ANTENNA

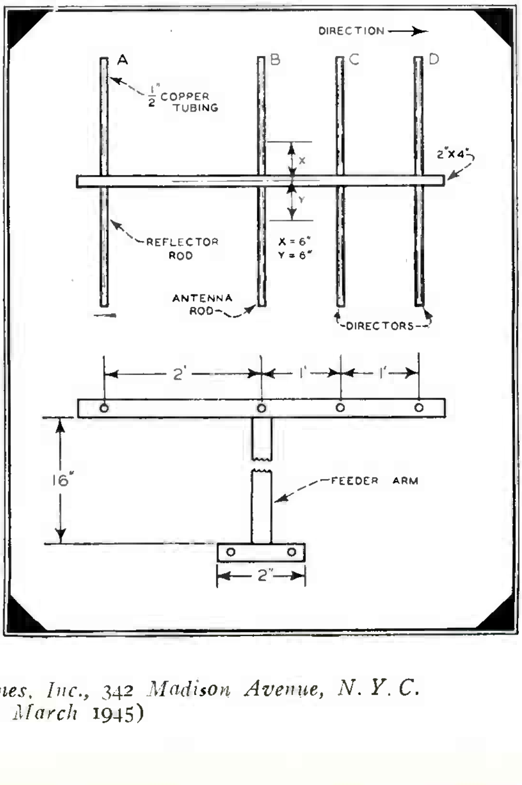
Reprinted from CQ

By Robert Y. Chapman, W1QV

Economy and simplicity of construction are features of this directional radiator

This four-element beam antenna is readily adapted to portable use, and is rotatable within a reasonable arc. While the dimensions can be followed exactly, some experimentation may be desirable in permanent installations, particularly when the antenna is mounted in the proximity of a metal roof.

THE TYPE of beam described and illustrated is probably the most popular used by the "dx" boys on the 112-megacycle band. It offers many advantages—electrical and mechanical. As will be observed from the sketches, *Fig.* 1, 2 and 3, it can readily be adapted for permanent installation or portable operation. Dressed 2 x 4 lumber is generally used when the antenna is going to stay put, while lighter material is employed by the boys who tote it around. In the portable job, the holes in the main arm are drilled just slightly larger than necessary to pass the ½-inch copper-tube elements. Small holes (about ¼-inch) are drilled in the elements, just above the half-length mark, and wooden pegs inserted to



Figs. 1 and 2. Main constructional details. The elements are of one-half inch copper tubing. Element A is 51" long, B 49", and C and D 46" long. Leads to feeders connect to element B 6" each side of center. You can use "dressed 2 by 4s." On a portable job drill holes for elements slightly larger than tubing. Wooden pegs in tubing, just above center, keep elements from slipping through.

prevent the elements from slipping through the holes in the support. Clips are used to attach the feed line to the off-center position on the radiator element. This antenna system can be erected in a very few minutes on any convenient base, such as a fence post, and will be found far more effective than a car antenna. The time and effort are well worth while.

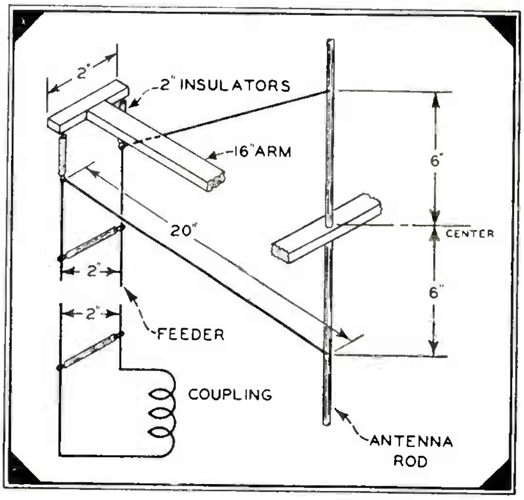


Fig. 3. Details of feeder arrangement. The space between the 2-inch feeder spreaders should not be more than 24 inches

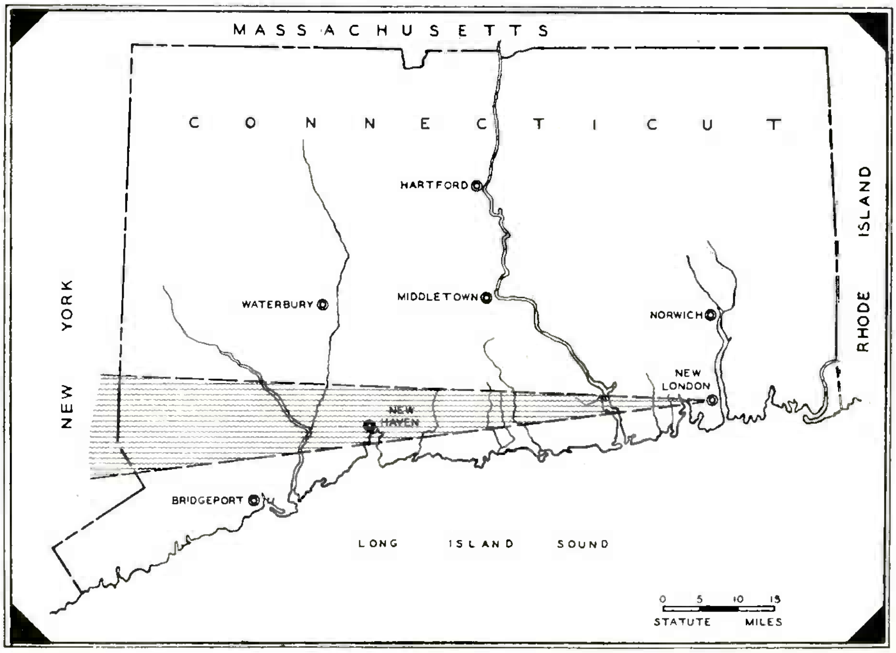


Fig. 4. A general idea of the sharpness of the beam. This is not, of course, a true field strength pattern. Both concentration and cut-off are very pronounced

CONSTRUCTIONAL NOTES

About the only care that must be observed in the construction and operation of this type antenna is the space between the radiator and the first bend in the feeders. This must be a minimum of 20 inches which can be readily obtained by attaching a light arm or stay to the main antenna support. The feed line should be carefully spaced, with spreaders not more than two feet apart. Number 12 wires, spaced two inches, provide a good match to the antenna.

RESULTS

We have worked over seventy miles with this antenna, and when comparison was made with the usual vertical installation, the difference was so great that the single vertical pole was discarded on the spot! The map of the State of Connecticut (*Fig.* 5) will give a rough idea of the effectiveness of this beam. This pattern is drawn from actual transmission and reception tests over a period of three years, and represent the concensus of the boys who are using the antenna day and night in WERS work.

Excellent bearings can be taken on local and distant stations. Our objectives, high gain, runs about 6 db, and in operation the results are impressive. The writer has experimented with additional directors and reflectors, but has always returned to this number of elements. Considering ham requirements, it is probably better not to make the beam too narrow for general communications.

Last but not least, this antenna is for vertical polarization, and hence should be mounted vertically.

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STUDIO FACILITY EXPANSION

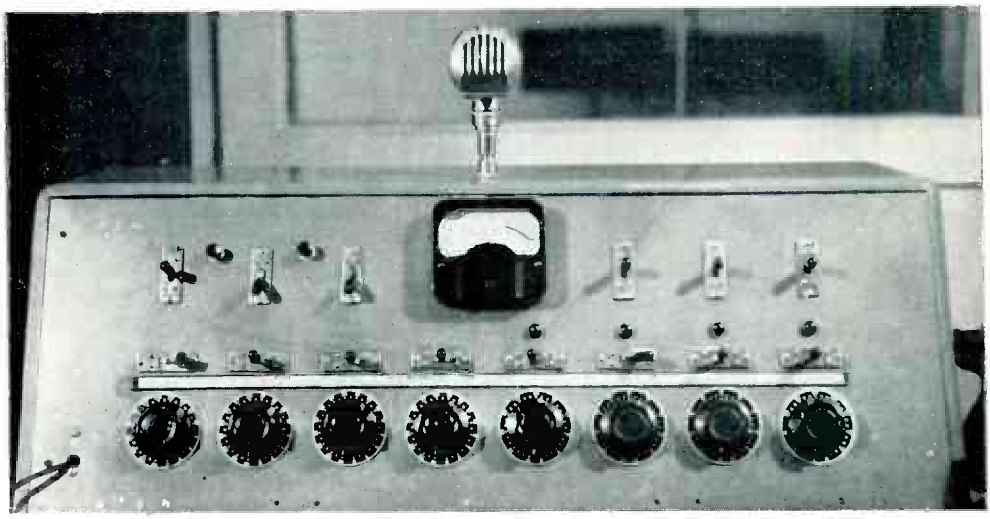
Reprinted from Communications

By Lawrence A. Reilly
Chief Engineer, WSPR

Using spare parts and converted equipment

THE descriptive OWI slogan . . . "*Patch it up; wear it out; make it do; go without,*" . . . has served as the basic engineering program of all of our broadcasting stations, since Dec. 7, 1941. At some stations the program presented a variety of knotty problems. In many instances the difficulties increased as the months went by, particularly where expanded operations required enlarged engineering facilities. The latter was the problem we faced in 1942.

In 1936 we received our license to operate as a limited-time local station. Economics demanded a minimum of equipment. In 1942 we became a network affiliate of the Blue system, requiring full-time operation. The control-room setup



was far from adequate for this added service. A new layout was necessary but priority regulations made it impossible to buy new equipment. And the MRO rating didn't help much either.

That meant a rearrangement of equipment on hand. An inventory of equipment in use, spare parts in the bins and what could be legally purchased indicated the possibility of a flexible three-channel system that would last for the duration and perhaps past that period, too. The system that resulted from this plan is shown in Figure 1.

Four factors governed the system requirements. They were: (1)—Technical reliability and sound design; (2)—Simultaneous use of three channels; (3)—Patch-cord-less routine operation; and (4)—Simplicity of operation for inexperienced wartime personnel.

Although a few later additions have been made since WPB authorized the $500.00 maximum single-project purchase, the setup has remained the same for almost three years.

Naturally, some substitutions were necessary. These included a masonite panel for the mixers and a wooden console cabinet. These should be supplanted by aluminum as soon as possible.

We decided to use an eight-position mixer. This appeared to fulfill our needs and was not too awkward to handle. Experience indicated that when the control operator has more than eight faders to manipulate, confusion results. The eye can easily encompass eight, however.

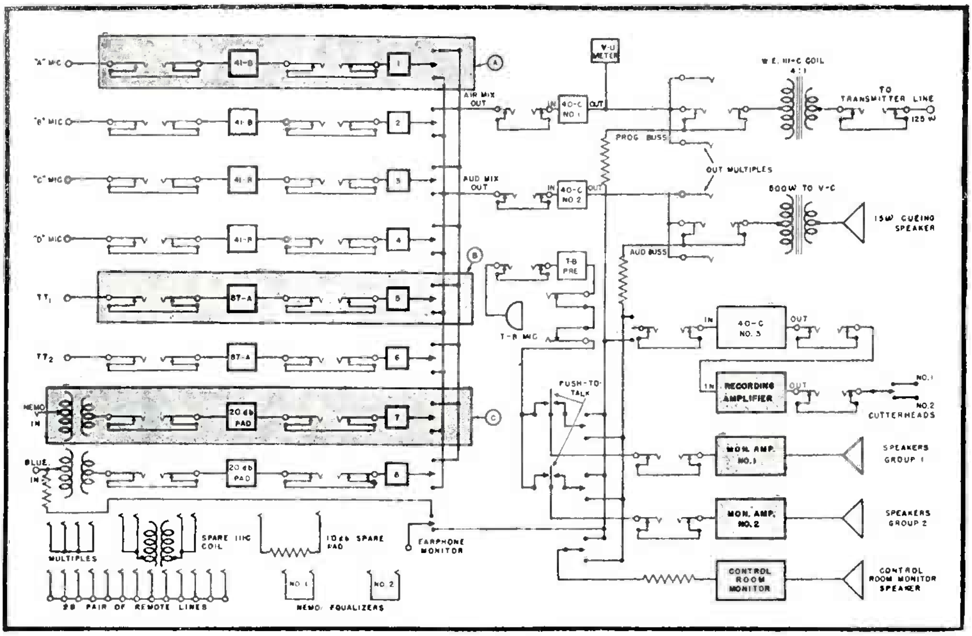


Fig. 1 Block diagram of the WSPR mixer-amplifier. Detailed Design of sections A, B and C, appear in Figures 2, 3 and 4.

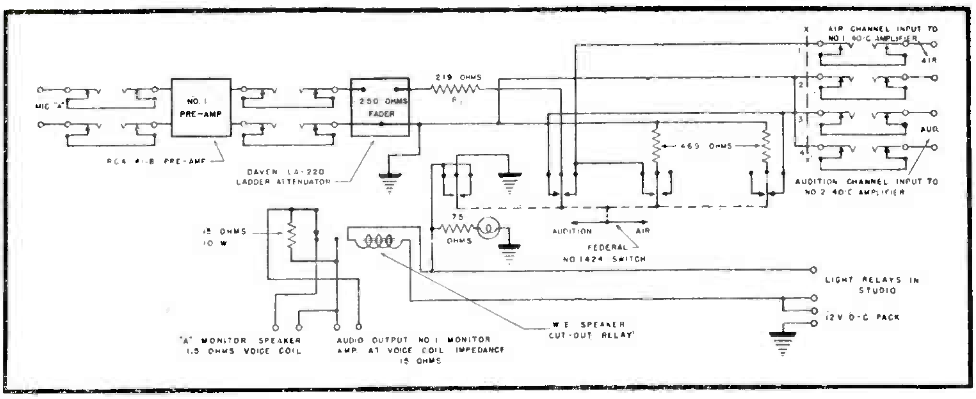


Fig. 2. Details of A microphone mixer circuit. Mixers A, B, C and D are identical

The eight positions (from right to left in page 20 illustration) are: Microphones 1, 2, 3 and 4; turntables 1 and 2; remote pickup; and network. Of course, by patching, any desired combination can be had, but that procedure is rarely necessary.

Each microphone has an RCA-41-B two-step pre-amplifier while each turntable has an RCA 87-B two-step booster-amplifier. Thus, the level delivered to the mixer from microphones and turntables is about—30 db, Figure 5. This requires a 20-db drop between the incoming network and remote lines, before their respective faders.

UNBALANCED LADDER ATTENUATORS

Unbalanced ladder attenuators are used; to permit their use with one side of each grounded, a parallel mixer is used. It was found essential to have but one point of grounding and all audio circuit grounds fed to this common point. The faders have a resistance of 250 ohms (Daven LA-220). Each fader goes to a multi-pole switch. The switches are Federal 1424 type having 12 *springs*. Although

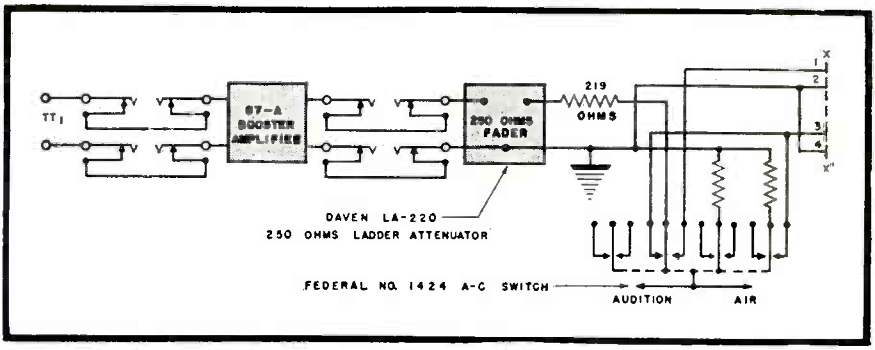


Fig. 3. Details of unit B; turntable 1 pickup mixer circuit. Circuit 2 is identical to 1.

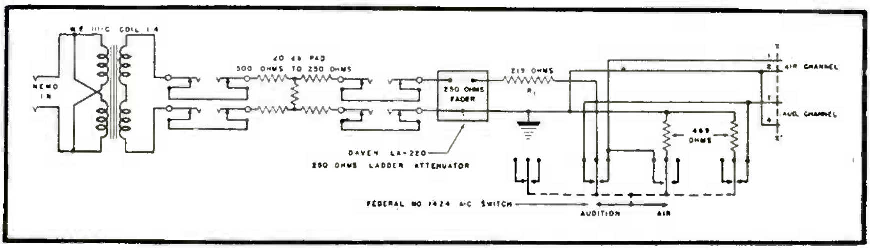


Fig. 4. Details of C unit; mixer circuits for nemo and the Blue network. Both these circuits are identical.

in some positions a few of the springs are unused, it seemed wise to standardize on the 12-contact switch to provide for the addition of signalling or interlocking circuits at some later date.

To avoid feedback from monitor speakers to microphones, we provided a speaker cutout relay that operated before the microphone was inserted into the system. By bending the springs on the key switches one way or the other it is possible to secure any desired sequence of opened or closed position. The springs connecting the 469-ohm dummy resistors were bent so as to be normally closed when the switch is in neutral and open individually when thrown to air or audition, Figure 2. These resistors maintain the correct input load conditions at all times.

COMPUTATION OF MIXER CONSTANTS

We applied the equations of Slaybaugh (*Broadcast News*, March 1940) to find the values for the series resistor, R_1, and the proper terminating impedance, Z_2, for the eight-position mixer with 250-ohm inputs, Figure 6.

The 59-ohm value indicated that a special mixing transformer would be necessary to match the output impedance of the mixers to the input of the program amplifier at 250/500 ohms. Since it was impossible to buy such a custom-built item, an alternate method was introduced.

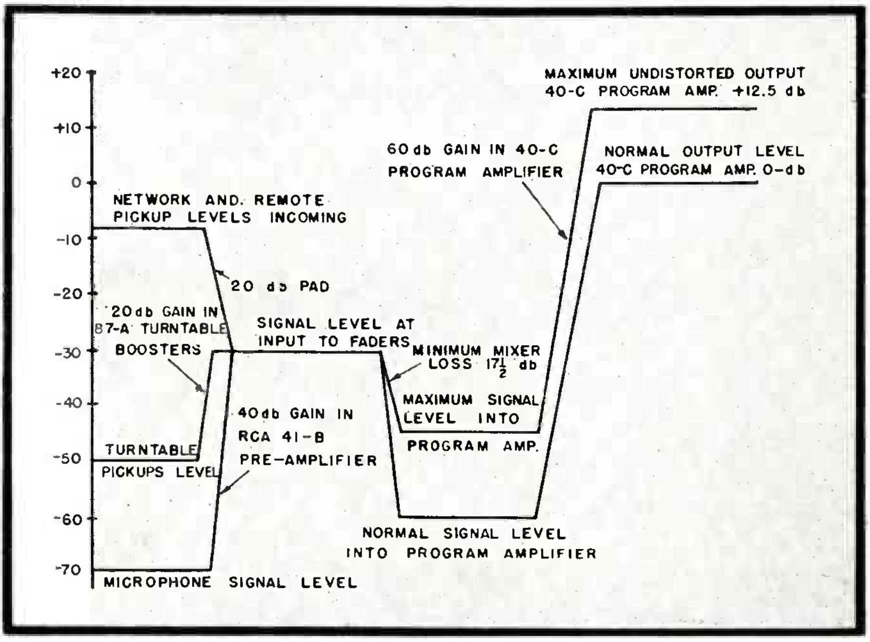


Fig. 5. The signal level chart for the modified WSPR studio facilities.

We selected the split primary input transformer of a RCA 40-C amplifier (RT-248). By unsoldering and reconnecting as shown in Figure 7, we secured a primary resistance value of 62½ ohms. Feeding a 59-ohm source into a 62½-ohm load did not introduce any mismatch problems. Frequency response runs (Figure 8) proved that.

No 219-ohm resistors were available, either. However, a search of the bins with an ohmmeter provided several 20% tolerance ½-watt carbon units of that value. We located 469-ohm dummy load resistors by the *bin-search* method too. These resistors are switched in when the keys are in neutral.

NORMALING JACKS

All inputs and outputs to each component are connected through normalling jacks to permit substitution and flexibility. For regular operation, however, no patching is used for channel 1 (*air*) or channel 2 (*audition*). Channel 1 feeds the transmitter at 0 *db* over a 1½-mile line, equalized to 8,000 cycles, but good to 10,000. The 2 channel is identical in every way up to its output. A small p-m speaker, with narrow frequency range, is kept across channel 2 for cueing purposes, or for monitoring auditions without interfering with aural monitoring of channel 1 on the large control-room speaker. To prevent confusion when the speakers are used simultaneously, a marked difference in tone quality between the regular monitor and the small cueing speaker is provided.

The second channel, which can be used to feed the transmitter in an emergency, serves as an audition channel for feeding any of the offices or monitor speakers in any studio as well as the control room. It is used also to record one program while another is on the air.

The third channel is generally used to record network programs for delayed broadcast without interfering with the full use of channels 1 and 2. The recording amplifier is normally bridged across the output of channel 3.

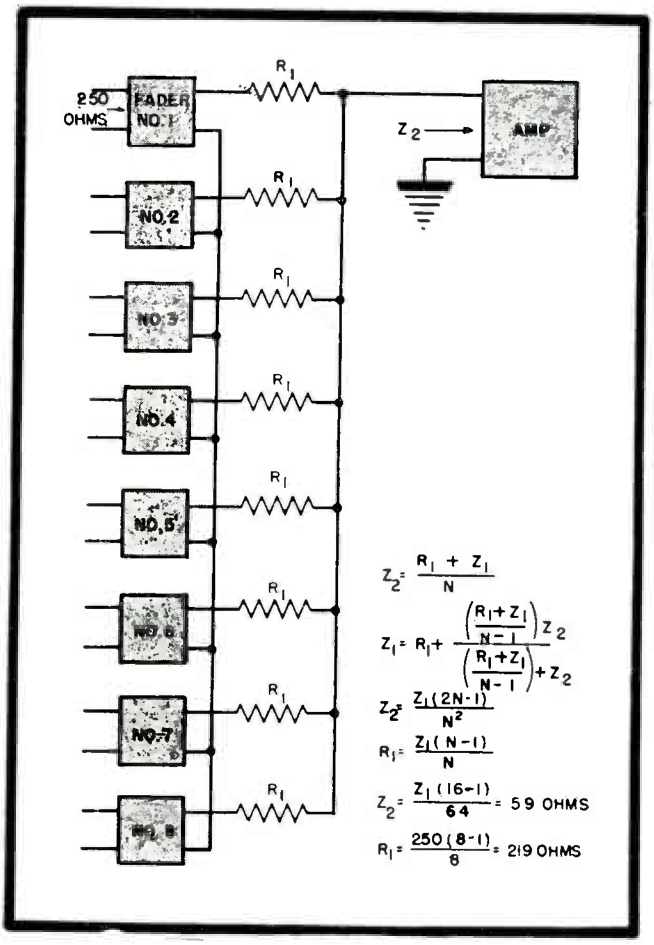
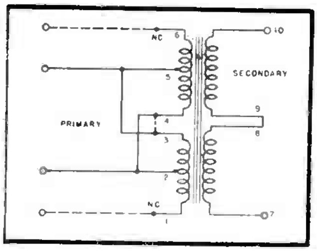


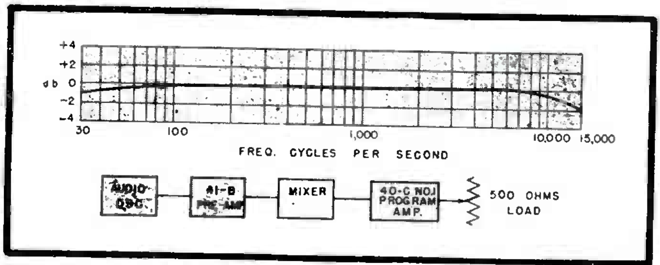
Fig. 6. Fundamental parallel mixer-circuit for 8 to 250-ohm sources

To drive the cutting heads, a power amplifier had to be built of available parts. Since the amplifier would bridge a program source at about 0 level ($12\frac{1}{2}$ milliwatts at 500 ohms), we used but one stage, Figure 9. Type 2A3 tubes were selected for their high G_M and good damping factor. This is important since the cutterhead impedance will vary almost 10 to 1 over their useful audio range. Low frequency deemphasis is provided by an RC circuit in the output. In addition, a small degree of inverse feedback (about 5 db) helps to equalize cutter response peaks and dips.

To accommodate our increased recording work a separate recording shop is now under construction. This will house two rim-drive turntables with improved cutterheads. When ready, it will supplement, not replace, the present facilities.

Talkback to any studio or other point in the building equipped with a monitor speaker is provided by a dynamic microphone located atop the console. Two push-buttons located at the upper left of the console are connected so that when the first is pushed the input to monitor amplifier 1 is lifted, and the microphone is connected across it. When the second button is pushed, the input-to-monitor amplifier





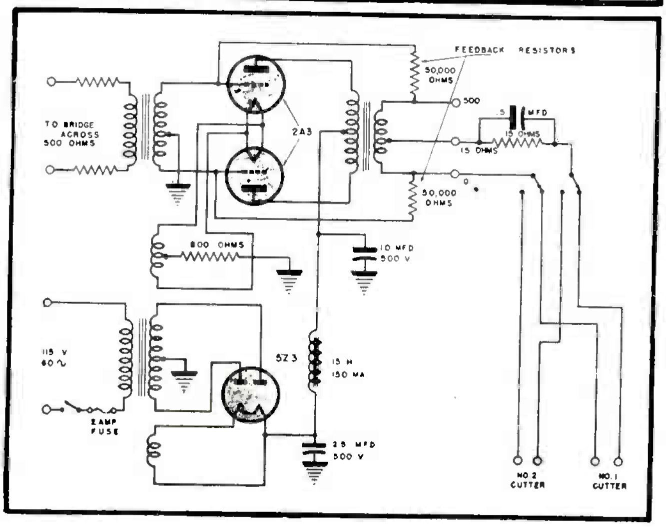


Figure above. Input connections to program and audtion amplifier transformers. The dotted line indicates a normal 500-ohm input; solid line as altered, for approximately 59 ohms, with jumper from 3 to 4 removed

Figure 8, (Right Top). The overall response of the WSPR amplifier system

Figure 9, (Right). Single stage recording amplifier

2 is lifted and the talkback microphone appears across it. Both buttons may be depressed to provide talkback to all points for studio paging. Of course any studio that may be on the air has its speaker cutout and is inoperative for talkback while in use. To obtain sufficient level a single stage pre-amplifier had to be provided in the talkback circuit. It is labelled *TB-pre* in the diagram.

Speaker cutout relays and warning or signalling lights as well as the indicator lights on the console are operated by a 12-volt, 5-ampere d-c pack with a dry-disc rectifier. A 2,000-mfd, 15-volt capacitor prevents hum being fed into audio circuits. The induction field around this pack proved a very serious matter. We therefore oriented the pack to minimize hum pickup in all input circuits.

HIGHER FIDELITY BROADCASTING

Reprinted from Radio News
Radic-Electronic Engineering Edition

By Harold E. Ennes
Station Eng., Station WIRE, Indianapolis

Analyzing the potential capabilities of broadcasting and what the paying audience can absorb

SINCE the earliest days of broadcasting, even at the time when the novelty of hearing voice and music over the wireless was entirely sufficient for the layman, engineers have striven for a "distortionless system" of transmission and reception characterized by true fidelity. That the state of the art has now advanced to a point where this condition may be realized for all practical purposes throughout a reasonable area of the country is well known to most engineers abreast of the recent field developments and potentialities of well advanced techniques in the laboratory. The progress of the science of "high fidelity" AM broadcasting, as well as the most recent FM installations, together with advances in receiver design that would have been almost unbelievable some ten years ago, have combined to bring a realization of "true-fidelity" that may well realize the ultimate in what the human ear appreciates as faithful reproduction.

LOSS IN SENSITIVITY OF THE EAR AT VARIOUS FREQUENCIES WITH ADVANCING AGE

Table 1.

Frequency	60-1000	2000	4000	8000
Ages 20-29	0	0	6	6
Ages 30-39	0	0	16	11
Ages 40-49	0	2	18	16
Ages 50-59	0	5	30	32

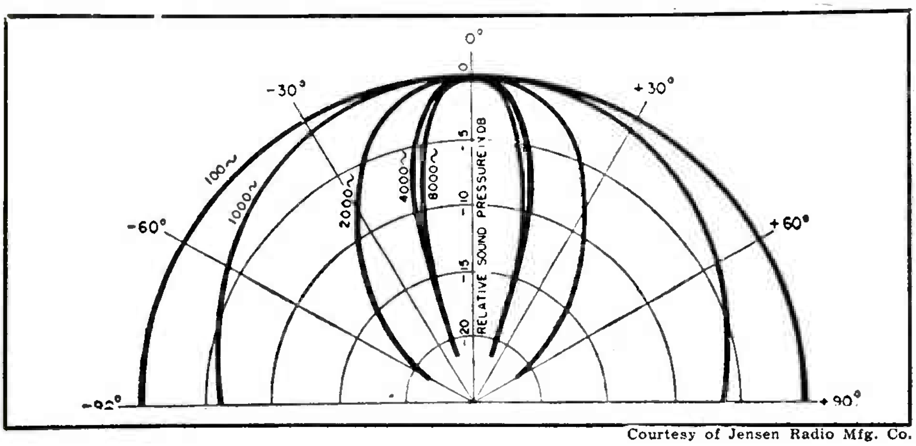
The engineering advances have been so marked that an era in technical history is now approaching where the economic advisability of further advances requiring obsolescence of certain equipment involving hundreds of thousands of dollars, as well as investment of considerably more thousands of dollars in new equipment, is being seriously questioned by some engineers in the field. The objections are numerous and carry considerable weight, most of them concerning the shortcomings of the so-called "average listener" who comprises the vast majority of the audience which pays the bill of broadcasting services and receiver production. It is, of course, to this audience that the fate of higher fidelity service must be entrusted, since no small section of the listening audience can possibly support the tremendous expense involved in the contemplated expansion of such service.

In the light of this knowledge, it is interesting to list and analyze the facts concerning the balance between what this paying audience will absorb, and the potential capabilities of higher fidelity broadcasting. It is the intent of this article to analyze the known factors, and discuss some of the unknown quantities which are involved in the study. It will be shown that regardless of what conclusions may be reached, the most important factor to the ultimate acceptance of higher fidelity will be in the engineering cooperation given to the public promotion of this class of service.

At the outset it must be realized that the organ of hearing, with all of its psychological as well as physical complications, is the final judge of "fidelity" in spite of readings on mathematical measuring instruments which dictate "true fidelity." It is this one fact that has caused the most concern among those interested in selling high fidelity service to the public. Some results obtained by leading investigators in the field of the physical properties of the human ear are presented here for the purpose of correlating this material with practical application to the engineering problems involved.

SENSITIVITY

An electrical circuit analogous to the human ear would consist of a combination of resistance, inductance and capacitance with the distribution of the elements such as to form a band-pass filter of negative reactance at low frequencies, positive reactance at high frequencies, with relatively small reactance at the middle frequencies from 1000 to 4000 cycles. Fig. 3 illustrates the deviation from 0 db.



Courtesy of Jensen Radio Mfg. Co.

Fig. 1. Theoretical polar characteristic of 12 in. speaker under out-of-doors conditions.

(where 0 db. equals the threshold of hearing: 10^{-16} watts/cm^2) necessary to maintain the just audible sound to an observer listening binaurally, and assuming a diffuse sound field; *i.e.*, a sound field not dependent on directional effects. Table 1 illustrates the falling off of a sensitivity at the higher frequencies with the advancing age of the listener.

The effect of direction on ear sensitivity when a diffuse sound field does not exist is illustrated in Fig. 2. This graph is based on data obtained by Sivian and White on the variation in monaural Minimum Audible Field with the azimuth of the vertical wave front. In other words, the subjects were listening with only one ear, the other ear having been closed. These tests were run in a comparatively reflectionless room. Zero degrees is considered to be that point where the subject is facing the sound source, and 90 degrees (to the right) is that point where the open ear is toward the source of the sound. A study of this graph will reveal that room acoustics, and loudspeaker design and placement have an important effect on fidelity characteristics. As an example, Fig. 1 shows the theoretical polar characteristics compiled by Jensen Mfg. Co. on a twelve-inch speaker under out-of-door conditions. It may be seen that radiation at high frequencies is far more directional in effect than at lower frequencies, explaining the phenomena experienced by many listeners, that of a falling off of high frequency response at increasing azimuth angles from the front of a speaker cabinet.

The effect of the intensity level of sound at various frequencies on the sensitivity of the ear is shown in Fig. 4. The lower curve is the response curve at the lower limit of hearing, and is contrasted with the response curve at the upper limit of hearing. At this upper limit a sensation of "feeling" is experienced rather than a sensation of tone. This falling off of the low frequency response of the ear

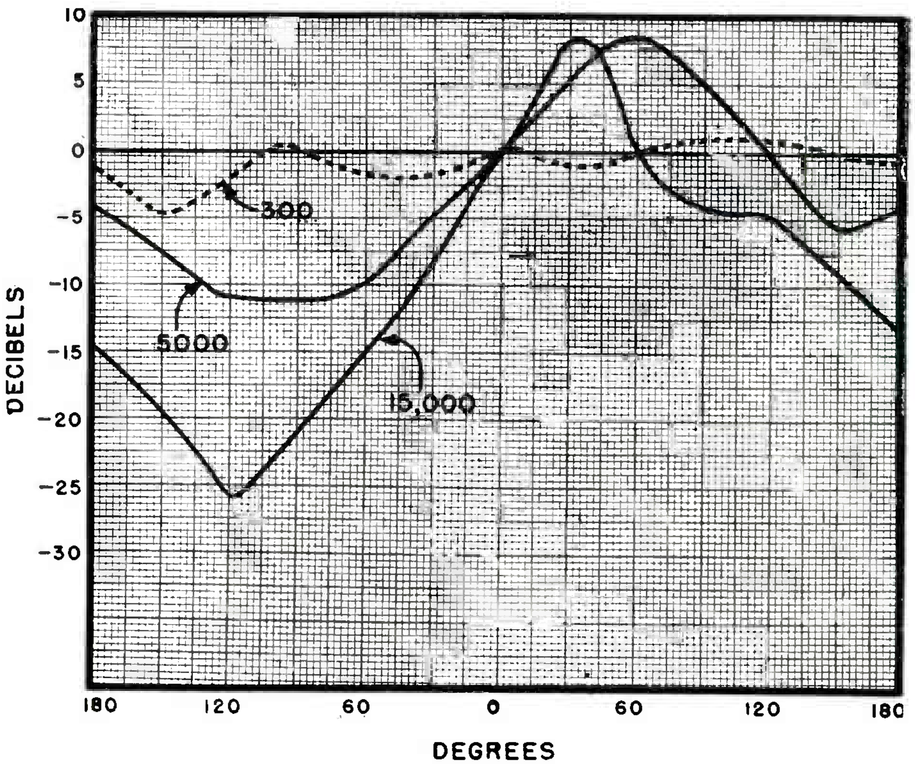


Fig. 2. Graph illustrating effect of direction on ear sensitivity at various frequencies

at lower intensity levels is a well-known factor among receiver designers, and has resulted in the popular "bass compensation" circuit used in conjunction with volume controls in modern receivers.

COMPLEX WAVES

Thus far, only the effects of pure tones of single frequencies on the response of the human ear have been discussed. Although this is an excellent means of determining a basic response characteristic of the ear, actual program conditions will create a series of circumstances which involve psychological reactions as well as purely physical ones.

From a purely physical point of view, the loudness sensation may be compared to actual intenstiy level by using a 1000 cycle reference tone of a given intensity level and adjusting the level of the complex sound being compared to the reference tone until the two sounds are equally loud to the listener. It has been determined by numerous experiments that where complex waves are involved, loudness sensation will depend not only upon intensity level but also upon the manner in which the intensity is distributed in the frequency range. Fig. 5 shows the effect of complex tones of widely separated frequencies upon loudness level as compared to the loudness levels of each component tone.

Some psychological effects of loudness cannot be illustrated by means of charts or graphs. Perceptible change in loudness, for example, will depend upon preceding and succeeding stimulation of the ear, intensity of average operating level, and the acoustical conditions, such as dispersion of sound and amount of reverberation existing both in the broadcast studio and the home in which the listener is situated.

REQUIREMENTS FOR HIGH FIDELITY

A true definition of "high fidelity" has not been determined as yet because several schools of thought exist on this subject. One point, however, is conceded by all; *i.e.*, a range of 20 to 15,000 cycles will reproduce all audible fundamentals and overtones of any musical program or sound effect. The question is whether such a range of frequencies is desirable.

It is the opinion of the writer that in view of the generally recognized fact that a transmission and reception system with a range of from 20 to 15,000 cycles can be manufactured almost as economically as one of 20 to 8,000 cycles (considered by some to be entirely adequate for high fidelity), thus, argument is somewhat superfluous. Tone controls will always be a part of radio receivers, and they will be operated by the listener at his own discretion. The argument is advanced that the general public will not be "sold" expensive receiving sets on the strength of reproduction of extremely high frequencies. This is an abstruse problem and one not readily answered, but only predictable in the light of general trends. It is apparent that the so-called "general public" is more "tone" conscious today than when radio broadcasting was young. The matter of fidelity seems to lie more in what the listener has become accustomed to hearing than in the actual response

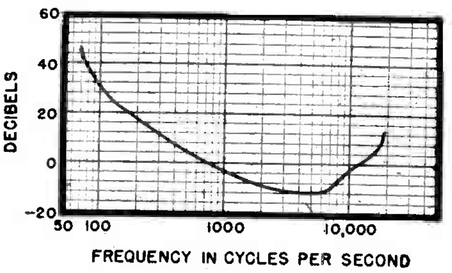


Fig. 3. Threshold of hearing vs. frequency

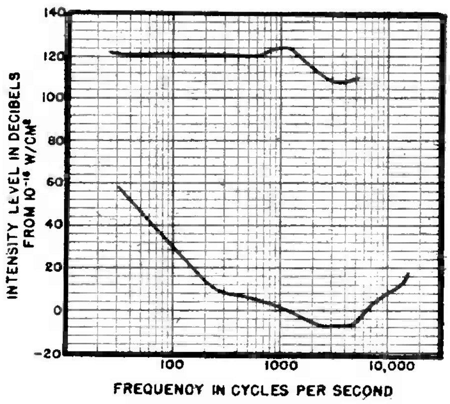


Fig. 4. Effect of intensity level on sensitivity of the ear at various frequencies.

of his hearing mechanism. There have been numerous cases where listeners have thoroughly enjoyed musical programs on old radio sets until continued listening to a modern high-fidelity receiver changed their appreciation values radically. This is true even among listeners in the higher age brackets whose appreciation of higher frequencies is very slight, but whose response to lower frequencies (down to 20 cycles) is not impaired. The nerves of the ear attempt to supply frequencies not present in a sound wave of musical tones, and continued listening to a narrow band receiver actually tires the nervous system due to this condition. Many listeners unaccustomed to high fidelity sets have remarked about the "easy listening" afforded by the wide tonal range reproduced. This appreciation, however, usually comes only after a period of continued listening to a good receiver, and an almost unconscious comparison with the old receiver. High pressure salesmanship will probably do no good in this kind of an educational process.

VOLUME RANGE

To meet the full practical definition of the term high fidelity, volume range as well as frequency range must be considered. This dynamic range actually causes more troublesome engineering problems than the problem of frequency range, yet is probably more important to higher fidelity broadcasting than extension of the frequency range above 8,000 cycles.

The reception of a wide dynamic range in program content imposes low noise and hum level requirements on transmission and reception systems which have only recently been achieved in practice. Frequency modulation, with the elimination of wire line studio-to-transmitter links and the inherent rejection of atmospherics and man-made noise components in the receiver has, no doubt, a distinct advantage over AM in realizing high signal-to-noise ratios. Listeners to FM at the present time and possibly for some time to come are composed of a group already highly appreciative of wide tonal response, and the type of programs popular with this group are of the variety that require a wide dynamic range for faithful reproduction. It is apparent that this volume range should receive the careful consideration of engineers responsible for the transmission of FM programs of this type. This potential audience who can appreciate wide tonal response and volume range will form a very substantial unit with which to launch the new high fidelity service. Abuse of good operating practice would do immeasurable harm to the progress of such service.

PUBLIC PROMOTION OF HIGHER FIDELITY

As pointed out, the deficiencies of the hearing organ are such that a transmission of 20 to 15,000 cycles within several db. of the 1000 cycle reference is not

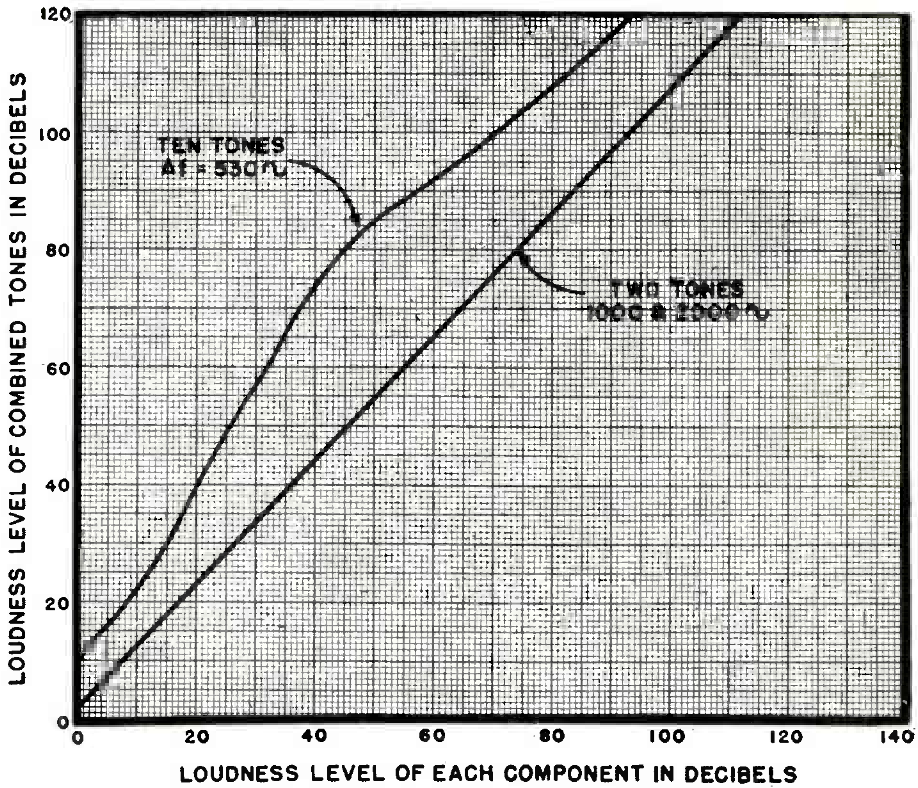


Fig. 5. Effect of complex tones of widely separated frequencies upon loudness level as compared to loudness levels of each component tone.

what the ear appreciates as "high fidelity." It is obvious that this kind of transmission should be achieved at the transmitter, with controls at the receiver that will convert the response curve to one which compensates for the hearing faults of the listener. This perspective dictates a strong need for both bass and treble adjustments which may be controlled by the receiver operator. Another examination of Fig. 4 makes it obvious why a great boost in both low and high frequency response is necessary for this compensation. The popular type of "tone control" in use today is possibly one of the major factors in contributing to the distinctly faulty appreciation values which the so-called "average listener" affixes to tonal response. A good high frequency response is apt to be actually painful to a listener unless a decided bass boost accompanies the high frequencies. Separate bass and treble controls will be advantageous if incorporated in high fidelity amplifiers and they are a virtual necessity to a successful public promotion of high fidelity service. Experience has shown that approximately 20 db. of both bass and treble boost has a most pleasing effect on the majority of listeners.

Wide dynamic range is a feature of the higher fidelity service to which a great majority of radio listeners will not have to be educated. This is due mainly to the fact that the listener who appreciates classical music will immediately recognize the advantage of such a feature, although public demonstrations of both narrow and wide volume ranges will do much to hasten a recognition of the difference. Other types of programs, such as dance music, will require less volume range and would not be a factor to be considered in wide dynamic range.

Loudspeaker design and placement will probably undergo revolutionary changes in the decade to come. It is very possible that the speaker unit will be separated from the amplifier cabinet, and oriented in such a way as to eliminate, as much as possible, the directional effects of present-day loud speakers. It would be entirely feasible, for example, to design a loudspeaker suitable for the home with 360 degree radiation characteristics, and suspend it from the ceiling of the room. It is not outside the bounds of possibility that speakers of this type may be designed into ceilings of rooms in future architectural practice. At any rate, the loudspeaker will share a great burden in the final proof of performance of higher fidelity broadcasting to the public.

In spite of the apparent restrictive qualities of the average ear, and the habits acquired in listening to a greatly restricted frequency and volume range, there is every evidence that with sensible engineering cooperation in the re-education of the public to high fidelity appreciation. a greatly expanded use of higher fidelity broadcast services will be achieved. America seems to be coming into a musical age, as witness the tremendous increase in attendance to musical programs of all types. It is almost inconceivable that a radio system of greatly extended fidelity characteristics would not be absorbed, albeit gradually, by a music loving nation. If broadcast studios and operating techniques are modernized to the fullest extent, and good receivers with genuine tone controls are properly designed and installed, the public's acceptance of this media will justify the stand taken by the proponents of higher fidelity service. The promotion of this class of service will depend as much on the engineer as on the advertising copy-writer. The engineer has created this potential market. He must also assist directly in the promotional program necessary to the life of this market.

WHAT'S BEING READ THIS MONTH

COMMUNICATIONS (June 1945)

V-H-F ANTENNAS
Microwave Model Antennas .... *M. A. Honnell*
SOUND ENGINEERING
Electrical-Acoustical Equivalents........ *Charles E. Harrison*
AERONAUTICAL COMMUNICATIONS
A Crystal-controlled 75-mc Signal Generator........ *Walter C. Grasel*
MATERIAL
Thermoplastics for Electrical Conductors...... *H. C Crafton, Jr. and H. B. Slade*
EMERGENCY MARINE EQUIPMENT DESIGN
A Simplified Auto-Alarm Selector........ *Lt. Samuel Schiffer*
UTILITY COMMUNICATIONS
Emergency F-M System in Toronto
V-H-F RECEIVERS
V-H-F Receiver and Converter Design........ *R. E. Samuelson*
RESISTIVE NETWORKS
Resistive Attenuators, Pads, and Networks (Part V) .... *Paul B. Wright*

CQ (July 1945)

A GOOD POINT-TO-POINT ANTENNA
Complete constructional data on an 8-element array for 112-116 mc which has worked out well in Civil Air Patrol applications........ *Arthur H. Lynch,* W2DKJ
PUSH-TO-TALK HANDIE-TALKIE
This neat little job is easy to build and its constructional details can be applied in CRS apparatus as well........ *Athan Cosmas*
A MATTER OF TIME
Translating local, zone, daylight, and war times into GMT for ham working and logging........ *Lawrence LeKashman,* W2IOP
QUARTZ CRYSTAL FINISHING FOR HAMS
Equipment and technique required to get on spot post-war frequencies........ *Richard F. Nebel,* W2DBQ-WLNB
PARALLEL RESISTANCE CHART
This handy chart gives accurately the resultant of two resistors in parallel........ *C. J. Merchant*
BENT ANTENNAS
How to modify a horizontal half-wave antenna for operation in limited space........ *David M. Sanders,* W2HSY
RADIO AMATEUR'S WORKSHEET, NO. 2—SUPER-REGENERATIVE RECEIVERS
A SIMPLE CONVERTER FOR FM RECEIVERS
This converter has many ham applications in addition to adopting pre-war f-m sets to the new frequency allocations........ *Engineering Dept., Hallicrafters Co.*
SHOCK-PROOF MOUNTINGS
Proper shock mounting makes your rig last longer and work better. This article tells how it should be done........ *L. W. Lawrence*

ELECTRONICS (July 1945)

FINAL FCC 25-30,000 Mc ALLOCATIONS
Assignments proposed in January are made effective, with 44-108 Mc temporarily unassigned
BROADCAST BAND SATELLITE TRANSMITTERS
Unattended boosters fed by r-f line or space radiation can fill in dead spots or extend coverage........ *Ross H. Beville*

ELECTRONICS (July 1945) *continued*

PHOTOTUBE-CONTROLLED FLAME CUTTER
Scanning of small master drums guides oxyacetylene cutting of large steel sheets with high accuracy.......*David S. Walker*
GRID EMISSION IN VACUUM TUBES
Tests which resulted in the development of a special grid minimizing grid emission....... *Harold E. Sorg and George A. Becker*
DUAL-TRIODE TRIGGER CIRCUITS
Non-mathematical step-by-step description of the operation of the Eccles-Jordon circuit.......*Byron E. Phelps*
MEASUREMENT OF STRESSES IN ROTATING SHAFTS
Resistance-wire strain gages facilitate vibration analysis and fatigue strength calculations.......*W. F. Curtis*
MAGNETOSTRICTION COMPASS
Electronic compass employing crystal pickups and vibrating magnetostrictive rods ....*R. G. Rowe*
SUPERSONIC BIAS FOR MAGNETIC RECORDING
Measurements of the factors governing noise level, linearity and frequency response.......*Lynn C. Holmes and Donald L. Clark*
IMPROVED VACUUM-TUBE VOLTMETERS
Methods for increasing power available to operate an indicating instrument ....*J. T. McCarthy*
STABILIZED NEGATIVE IMPEDANCES—PART I
First of a three-part article on theory and application of negative impedances ....*E. L. Ginzton*

ELECTRONIC INDUSTRIES (July 1945)

FEATURES OF CATHODE FOLLOWER AMPLIFIERS
Characteristics and applications of such units together with practical design data covering special conditions.......*Herbert J. Reich*
REMOTE CONTROL TUNING
Simplex circuit controls solenoid operated capacitor
TELEVISION SYMPOSIUM
Engineers discuss relative merits of direct view as compared with refractive and Schmidt systems
MODERN MEASUREMENT OF PROJECTILE SPEEDS
Numerous electronic devices aid ordnance design and permit checking ammunition at Aberdeen and in field.......*T. H. Johnson*
PHONOGRAPH DYNAMICS
Groove spacing restricts amplitude of reproduction while cutter, stylus shape, and mechanical Q limit fidelity.......*W. S. Bachman*
CAPTURED ENEMY RADIO EQUIPMENT
MEASUREMENT TECHNIC
Methods and equipment that will be used by FCC and industry engineers in determining FM and tele interference.......*Howard D. Evans*
COMPUTING DOUBLE-STUB LENGTHS FOR LINES
The chart permits ready evaluation of stub lengths in double-stub impedance testing of transmission lines.......*Robert C. Paine*
PRESET INTERVAL TIMER
The establishment of precise interval controls for industrial processes has been made possible by combining precision electronic counters with frequency standards.
DETONATION INDICATOR FOR AIRPLANE ENGINES
Important fuel savings obtained in plane operation by monitoring gasoline explosion during flight
ELECTRONIC OPPORTUNITIES FOR VETS
RAILROAD RADIO LAB

ELECTRONIC INDUSTRIES (July 1945) *continued*

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Laboratory technics for discovering the cause and cure of fungus growths — Practical application of preventatives........*Wilfred F. Horner and F. Russell Koppa*
SELF-FORGING WELDER
Damped oscillatory discharge using air core welding transformer prevents residual magnetism difficulties........*C. H. Strange*
TUBES ON THE JOB
ELECTRONIC CONTROL OF AUTOMATIC RIVETER
Sequence control unit permits increase in efficiency of 20 per cent and saves 35 per cent in cost of parts........*Thomas A. Dickinson*

FM AND TELEVISION (June 1945)

FM ON THE ROCK ISLAND........*Norman Wunderlich*
FCC DELAY THREAT TO RADIO INDUSTRY
Texts of opinions expressed by executives
FM HANDBOOK, CHAPTER 5........*René T. Hemmes*
CIRCULAR ANTENNAS, PART 2........*M. W. Scheldorf*
LENS SYSTEM FOR PROJECTION TELEVISION........*John P. Taylor*
SUN, EARTH & SHORT-WAVE PROPAGATION........*Henry E. Hallborg*

PROCEEDINGS of the I.R.E. (July 1945)

SURVIVAL OF THE TECHNOLOGICALLY FIT........*The Editor*
WILLIAM C. WHITE
THE PRESENTATION OF TECHNICAL DEVELOPMENTS BEFORE PROFESSIONAL SOCIETIES........*William L. Everitt*
WIDE-RANGE TUNED CIRCUITS AND OSCILLATORS FOR HIGH FREQUENCIES........*Eduard Karplus*
SILICONES—A NEW CLASS OF HIGH POLYMERS OF INTEREST TO THE RADIO INDUSTRY........*S. L. Bass and T. A. Kauppi*
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ANALYSES OF THE VOLTAGE-TRIPLING AND -QUADRUPLING RECTIFIER CIRCUITS........*D. L. Waidelich and H. A. K. Taskin*
THE PERFORMANCE AND MEASUREMENT OF MIXERS IN TERMS OF LINEAR-NETWORK THEORY....*L. C. Peterson and F. B. Llewellyn*
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BASIC THEORY AND DESIGN OF ELECTRONICALLY REGULATED POWER SUPPLIES........*Anthony Abate*
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"A Theoretical and Experimental Investigation of Tuned-Circuit Distortion in Frequency-Modulation Systems........*D. L. Jaffe*
DISCUSSION "REFLEX OSCILLATOR"........*J. R. Pierce*

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New methods for increasing utility and dependability........*McMurdo Silver*
POSTWAR STATION CALLS
Proposed changes in call areas and assignments for future expansion ....*Charles A. Service, Jr.*, W4IE

QST (July 1945) *continued*

MILITARY RADIO OPERATING PROCEDURES
Traffic-handling practices in use by the Allied Armed Forces .... *Lt. Col. Robert Hertzberg,* SC,W2DJJ
BASS BOOST
Design data for determining performance .... *George Grammer,* W1DF
A CRYSTAL-CONTROLLED 112-Mc. *MOBILE TRANSMITTER*
Stability in addition to mobility .... *Robert A. Waters,* W2JST
CALCULATIONS FOR ANTENNA ORIENTATION
Mathematical formulas for azimuth and distance calculations .... *W. E. Marquart,* W9CKT

RADIO (June 1945)

RADIO INSULATING MATERIALS
One of a series. This article deals with the characteristics and applications of phenolics in radio design .... *Albert H. Postle*
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Useful data for the receiver designer .... *A. C. Matthews*
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Design, construction, and operation of various types of time delay relays. Methods of testing and their application are described .... *Geoffrey Herbert*
NOTES ON ALIGNING AND TESTING SUPERHETERODYNES
Useful short-cuts in familiar operations .... *W. H. Anderson*
OPTICAL PATH CHART (*Grazing Distance*)
FINAL FREQUENCY ALLOCATIONS
This FCC report covers assignments for the portion of the spectrum between 25 and 30,000 mc, with the exception of the 44 to 108 mc region, which is left unassigned pending further tests of FM transmission
RADIO DESIGN WORKSHEET, No. 37:
Thévenin's Theorem; Note on Self-Excited Oscillator Circuits
RADIO BIBLIOGRAPHY: 17—*AIRCRAFT RADIO, Part* 10. 18:
Velocity Modulation, Part 1 .... *F X. Rettenmeyer*

RADIO CRAFT (July 1945)

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YESTERDAY'S CIRCUITS .... *J. W. Straede*
PARASITIC OSCILLATIONS, PART I .... *Dean Stockett Edmonds, Jr.*
NEW LIFEBOAT RADIO .... *Charles J. Pannill*
BIGGEST "PORTABLE" RADIO
BATTLE RADIO TRICKS
OSCILLOSCOPES FOR TRAINEES .... *"Scotty" Keillor*
BROADCAST EQUIPMENT, PART X .... *Don C. Hoefler*
RADIO FILTER CIRCUITS .... *John Kearney*
A "JEWELL" OHMMETER .... *R. S. Havenhill*
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REMOTE CONTROL FOR YOUR RECEIVER .... *Edwin Bohr*
MIDGET AMPLIFIER .... *W. A. Ricvely*

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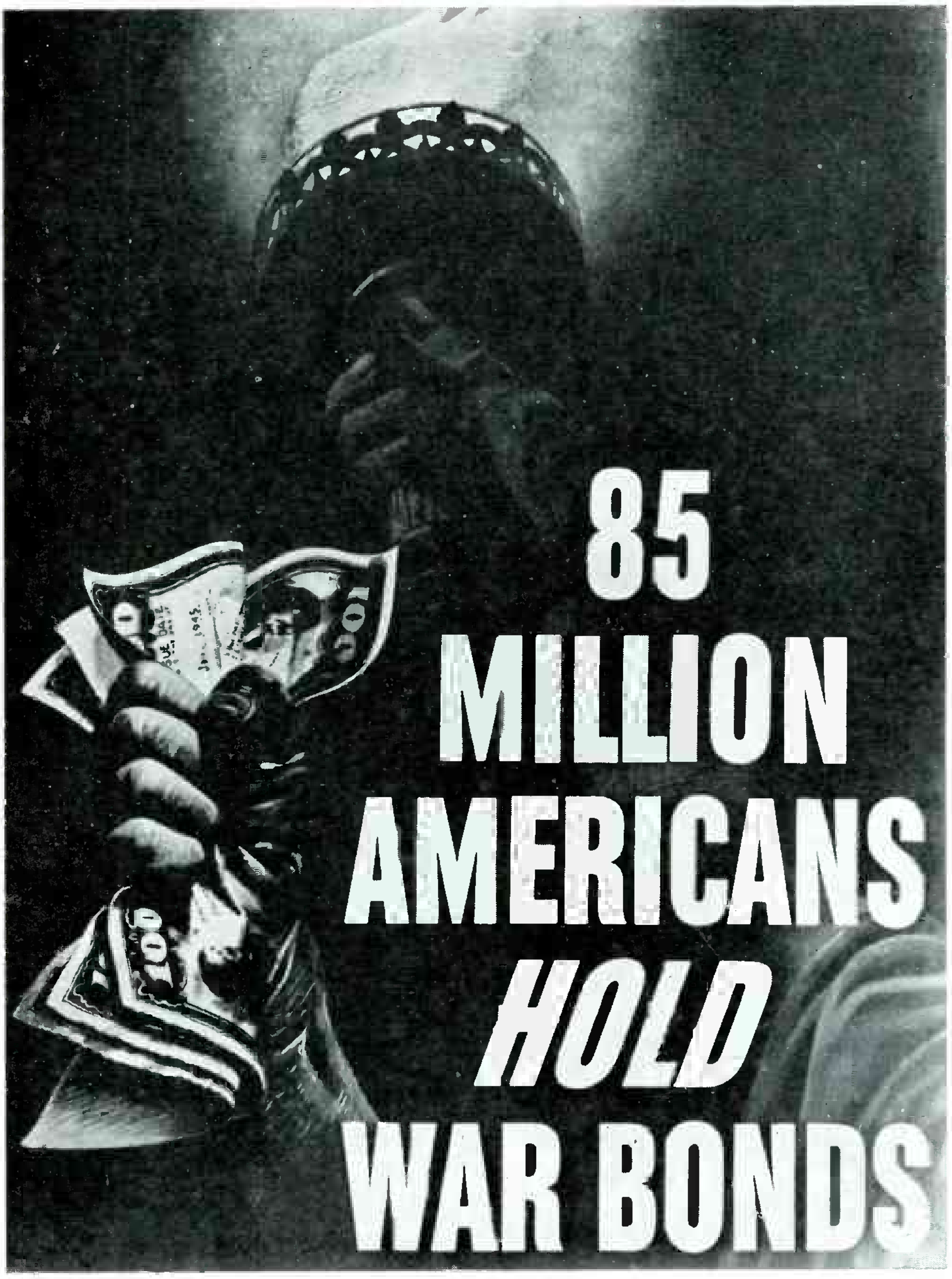
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