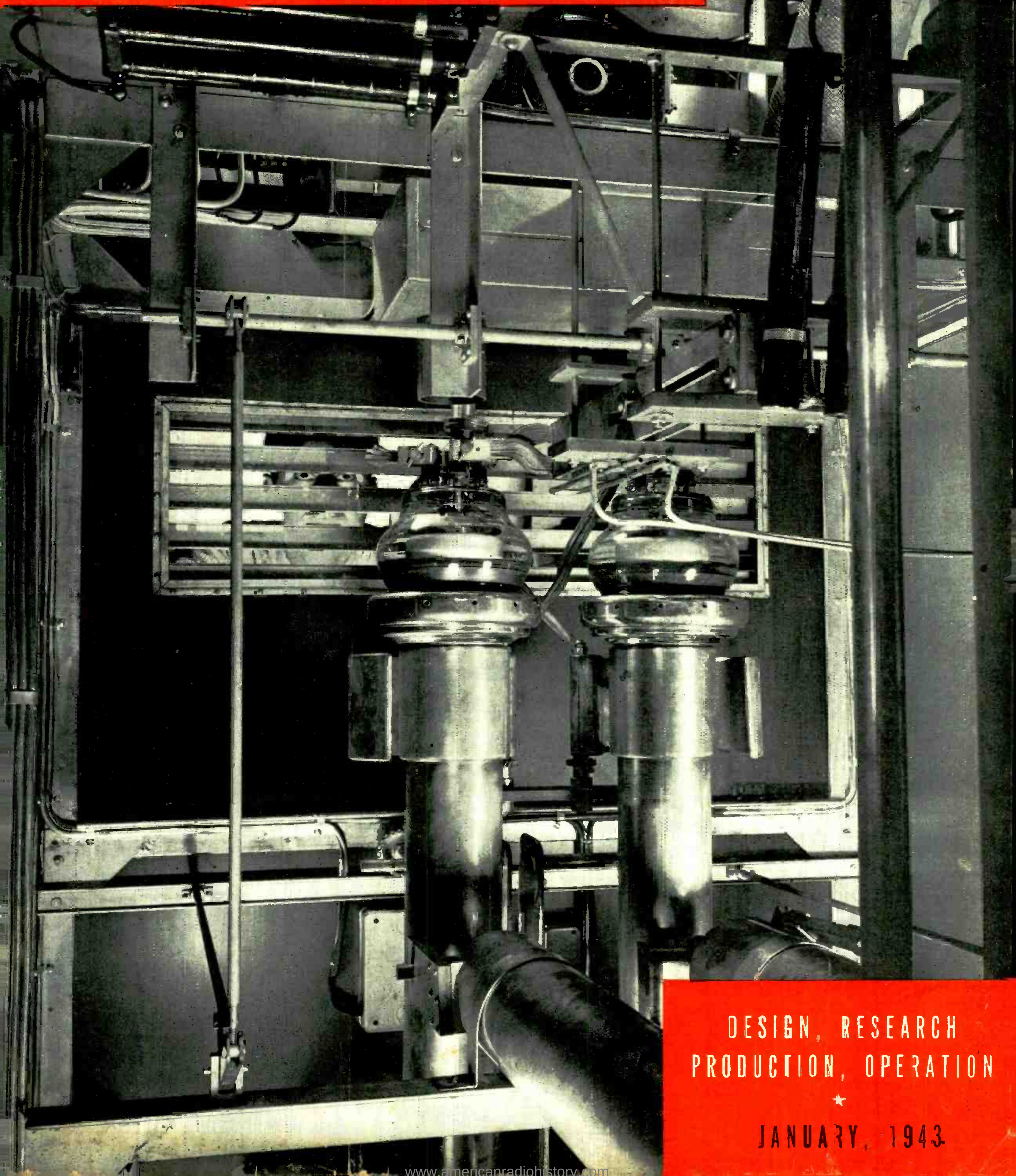
# RADIO

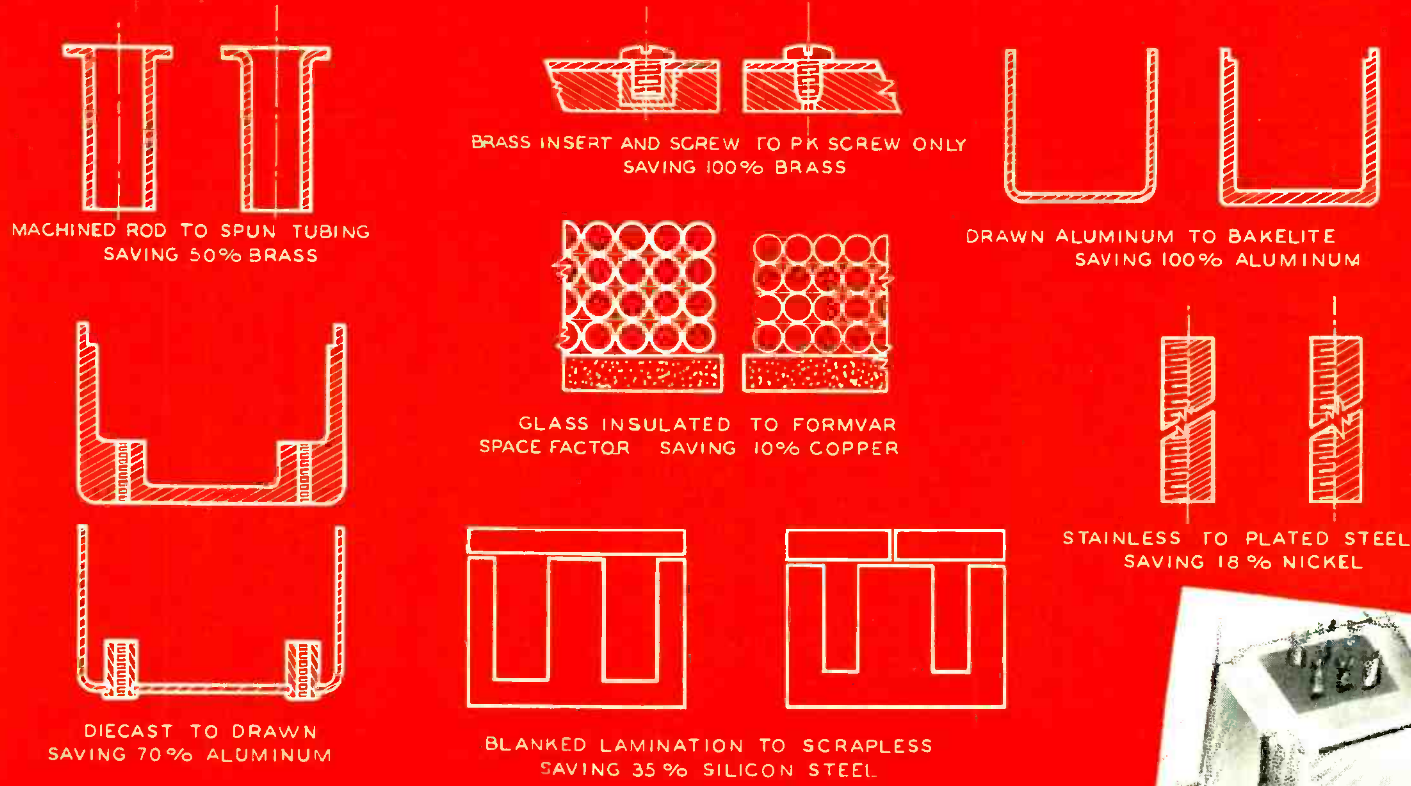
ESTABLISHED 1917

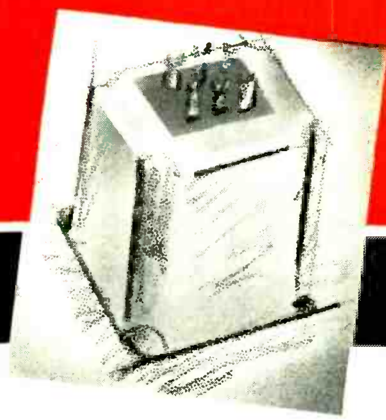


DESIGN, RESEARCH
PRODUCTION, OPERATION

★

JANUARY, 1943



# "and it can win or lose the war...

We all know that our greatest problem today lies in material shortages. The bulk of this problem . . . and it can win or lose the war . . . lies in our hands. A waste of materials, particularly critical materials, in an engineering design today, is as damnable as sabotage.

**Here are a few cases in our organization:**

1. **On one job our redesign combined two pieces of apparatus. The resultant unit, while more efficient, is smaller than either of the individual units. On the basis of projected requirements, the saving in aluminum alone is 500,000 lbs.**
2. **On this job our delivery schedule would have been delayed five months for the nickel iron core material and shielding cases required. Redesign made possible a unit using silicon core material and silicon shields with actually 10 DB less hum pickup than the original.**
3. **In this job substitution of a drawn aluminum housing for a die casting effected an aluminum saving of 70%.**

Designs must be improved constantly. Take a look at that job you have been running and see whether an extruded rod or a spun bushing won't save the scrap involved in a screw machine part. Check with the Government Engineering Bureau involved as to whether they would not allow a change in material to something lower on the critical list. You will be surprised at their cooperation.

**Only when you can say to yourself, "There isn't one of my designs left that can be reduced in amount of material or to less critical materials," can you feel that your share in the War Program is effective.**

# UNITED TRANSFORMER CO.

**150 VARICK STREET ★ NEW YORK, N. Y.**

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# A Better FM Receiver!

. . . better because Hallicrafters are pioneers in FM. Model S-27 (illustrated) was the first general coverage U.H.F. Communications receiver to incorporate both AM and FM in one receiver. Hallicrafters, through continuous research, both for our armed forces and civilian use, have become the authoritative source for FM Communications receivers.

Hallicrafters Model S-27 FM-AM receiver, 15 tubes, 3 bands, cover 28 to 46 mc., 45 to 84 mc., 81 to 145 mc. Switch changing from FM to AM reception.

**hallicrafters**

CHICAGO, U.S.A.

# RADIO

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JANUARY 1943 No. 276


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### COVER

The final amplifier of Zenith's frequency-modulation station W51C, in the Field Building, Chicago. Note antenna coupling loop and final tank.

### ARTICLES



### MISCELLANEOUS




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# TECHNICANA

### SCHEMATICS

★ The British have an eye for little things that sometimes prove bigger than one would have supposed. The art and technique of drawing schematic diagrams, for instance.

What may or may not prove of some importance in the war effort is contained in a letter from Geoffrey Bocking, appearing in the November 1942 issue of the journal *Electronic Engineering*.

Mr. Bocking is of the opinion that there are certain definite advantages in looped cross-overs as against direct cross-overs in the drawing of circuit diagrams. As a support to this opinion he offers the following practical and psychological points:

1) It is sometimes difficult in printing processes to prevent the possibility of a direct cross-over blurring into a dot, (thus falsely indicating a connection) especially when the diagram is on a reduced scale.

2) In general, a draftsman will tend to omit loops less frequently than he will omit dots, and in the use of looped cross-overs the omission of a dot will be a matter of negligible consequence.

3) In a diagram containing both direct cross-overs and dots the eye tends to "see" dots at every cross-over.

Mr. Bocking concludes with the notation that the results of experiments conducted by workers of the Gestalt school of psychology confirm the last two points.

★

### SIGNAL CORPS AMERICANA

★ The criterion of dullness is the knife that "won't cut hot butter." Veterans of World War I might wish to add another example: "Nothing was so dull as the language used in army regulations and instruction books." However, fathers of the American doughboy, Model 1942, would hardly recognize some of the official language now used in military terminology. It sounds human. Leaders of our modern Army have learned that if the maximum amount of training is to be given our soldiers in the minimum of time, it becomes necessary to talk the language of the average soldier.

The Signal Corps has set the example in presenting instruction in plain, every-day Americanese. Instructional pamphlets using cartoons, slang,

[*Continued on page 8*]

# INTELLIGIBILITY

Built to Civil Aeronautics Administration specifications, CAA-515, the Electro-Voice Model 7-A microphone is widely used for airport landing control and is highly suitable for many other sound pick-up applications.

The smooth frequency curve, rising with frequency, gives extremely high intelligibility even under adverse conditions. Desk mounting incorporates easily accessible switch which can be operated by thumb of either right or left hand. Microphone may be moved without danger of pressing this switch.

## SPECIFICATIONS

**SWITCH:** Push-to-talk Acro-switch, SPDT, for relay operation; positive action; slight pressure required for actuation; 1/16" over-travel; connections terminate on terminal strip in base.

**OUTPUT IMPEDANCE:** 25 ohms.

**CABLE:** Eight feet, 4 conductor, shielded, overall rubber jacket, equipped with MC4M connector.

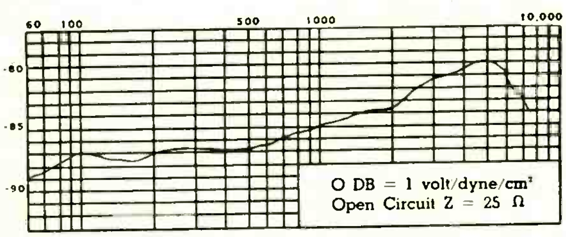
**DISTORTION:** Not exceeding 5% for sinusoidal sound waves from any direction from 100-4000 cps, up to 50 dynes/cm$^2$.

**INSULATION:** Leads from the moving coil are insulated from the microphone housing and stand, and are capable of withstanding 500 volts RMS, 60 cps.

**STAND TUBE:** Wear resistant, 1/8" XXM bakelite.

**CORROSION RESISTANCE:** The entire microphone is completely inhibited against corrosion and will successfully withstand a 20% salt spray atmosphere for 100 hours at 95° F.

**NET WEIGHT:** 3½ lbs.; Shipping wt.: 5 lbs.




This Model 7-A Desk Mounting Communication Microphone supersedes our previous Model S-7. Our Engineering Department may be able to assist you with your microphone problem. *Electro-Voice Manufacturing Co., Inc., 1239 South Bend Avenue, South Bend, Indiana. Export Division: 100 Varick Street, New York, N. Y., U. S. A.—Cable Address: "Arlab"*

*Electro-Voice* MICROPHONES

# TECHNICANA

and typical Yankee terms have been issued to Signal Corps radio operators and maintenance men which supplement the formal, standard Army texts. These pamphlets are in use at Ft. Monmouth, N. J., home of the Signal Corps, and are being issued also to operators and technicians of other arms and services in the field.

Tank radio operators are instructed not to try to get more range out of their transmitters than they are designed for: "Some radio operators after experience with the tank radio discover that by smart spot-picking (i.e., from a high hill) they can set up a long distance record of say umpty-five miles . . . Then there's hell to pay. The umpteen mile sets are suspected of the worst and promptly sent back to Maintenance for an injection of something or other . . . Don't let the rumor that so-and-so's set will do a regular umpty-five miles fool you. Someone is shooting what is known in polite circles as 'the bull'."

Tank radio operators are cautioned to familiarize themselves with their equipment and learn how to use it properly: "There's one thing about this radio business that sort of gripes the old timers. Nobody expects to start shooting a 75, a 37, a machine gun, or even a pistol until he's been taught a lot. But when it comes to a radio set—*that's different*, and any healthy American over 18 (and not dead drunk) is, for some reason or other, supposed to be able to walk up to the near side of a radio set, look it squarely in the eye, rapidly twist all the knobs in a different direction, stick a couple of plugs inside, and presto—have it talking both ways. But the above is pretty near 100 per cent baloney, and don't let it fool you."

Operators of mobile radio stations are cautioned against exposure to death-dealing high voltages, and are taught the use of safety devices. The Signal Corps pamphlet whimsically observes that "broadcasters need these devices to keep half-canned announcers and over-fed sopranos from sitting on their tank-coils."

In order to keep extraneous noises out of the microphone, operators are told to speak directly into the instrument, and not to "sit comfortably back like a sports announcer and proceed to talk a foot from your mike. Your signals at the other end will sound like four skeletons on a tin roof around the first of June."

Sometimes, when a mobile radio unit

[*Continued on page 10*]


Translation: —"*When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge.*"—Confucius

# "This is Knowledge" *said the Sage . . .*

Through the ages, the most learned have always been the most aware of their limitations.

Why is milk white? . . . Scientists admit that they do not know. They say, as did the late great Thomas Edison, that the total of man's knowledge is pitifully small.

In the vast field of Electronics, IRC certainly does not profess total knowledge. But in one small part of that field—the construction and application of Fixed and Variable Resistors—we do know many of the answers.

Because of our specialized research, we have succeeded in developing a line of resistance devices "Preferred for Performance" throughout the Electronic industries. Today IRC Resistors are so vitally essential for war equipment that we must concentrate our production efforts on caring for the needs of the Armed Services.

Though we may not be able right now to supply you with the Resistors you need for other than war uses, our Engineers and Executives are at your service for counsel, without obligation, to help you in the solution of Resistor problems. Please feel free to consult them in your search for the best obtainable resistance devices under existing conditions.

You will find a source of complete Resistor information here.

IRC

FIXED & VARIABLE RESISTORS

*Preferred for Performance*

**INTERNATIONAL RESISTANCE COMPANY**

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A Wire Wound Resistor Isn't Modern UNLESS It's Wound With CERAMIC INSULATED WIRE!


Voice of the Flat Tops!
. . . require unfailing performance! Jensen speech reproducers provide the authoritative Voice of the Flat Tops with unerring accuracy and dependability.
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RADIO MANUFACTURING CO., 6601 S. LARAMIE AVENUE, CHICAGO

RADIO

JANUARY, 1943

# EDITORIAL

## MR. IBID. GOES TO WAR

★ Technological Synergism—which, resolved into simpler words, means "Cooperative Industrial Science" —has become a vital factor in the national war effort. Its finest expression is probably found in the ranks of the National Defense Research Council, where history is being made in no uncertain terms; but raw necessity has brought it to life in the automotive and aviation industries, to name but two production groups.

Technological Synergism is being applied in two ways; first, through the free interchange of ideas and trade secrets, and, second, through the direct swapping of raw materials and finished parts, by way of centralized pools. Both factors are means of getting things done faster and better.

The synergetic mind of the aviation industry, for instance, is so well-developed that normally competitive organizations in this field have no secrets left with which to trade on in the post-war period. Everything has been put into one pot, with the result that we have the interesting picture of an industrial entity operating almost on a socialistic basis.

This, of course, is a good thing so long as the war lasts; and there is no time for one to have qualms over what may happen thereafter; but a projection of the thought would suggest that the present synergetic process will not endanger the future position of any industry or organization, and may even bring about fresh ideas relating to the aspects of free enterprise.

As a by-product of synergism, we find the release of industry's stockpile of ideas and patents for the furtherance of the war effort, to the extent that there no longer exists a normal backlog of improvements upon which future plans can be projected. However, coincident with this complete exhaustion of engineering improvements in industry's "bank," there arises a new generation of ideas and patents born of the war effort itself. And by this steady process of regeneration in ideas and ways of doing things, industry's original stockpile just as steadily becomes obsolete, and as steadily replaced. Thus, from the principle of a war device may come a major improvement in, say, television; and who can say, then, that *anything* has been lost to the wartime principle of synergism?

There is probably no occasion for the radio industry to go to the extremes that the aviation industry has, for the sake of getting things done on time; after all, the production problems are altogether different. But, from the viewpoint of pure engineering, it would seem that a great deal more could be accomplished by the radio industry if the principle of synergism were embraced. One cannot escape the impression at times that our industry, as patriotic as it is, operates on the basis that technological isolationism is a good thing. And if we are not wrong, and some do feel that it is a good thing, then the question naturally arises: Good for whom?

In these times, hoarding ideas or ways of doing things is about as silly as hoarding butter—neither will keep. On the other hand, both ideas and butter can aid the war effort if they are put into circulation.

## PATENTS

★ The Utopians don't like our patent system. It presumably stinks. Well, it does, in some ways, as so many things do.

Patents, of course, are two-faced; they protect the inventor and at the same time make him a monopolist. Which puts the inventor in the position of being a stinking benefactor.

All the Utopians have to do is to work things out so that an individual or a corporation gains the protection a patent affords, but at the same time prevents the patent rights from constituting a monopoly, which is quite simple—or is it?

The trouble is, if you cut off a dog's head to prevent him from biting, the tail stops wagging.—M. L. M.

*TWO AND ONE-HALF YEARS' PROGRESS IN*

# FM EMERGENCY EQUIPMENT

D. LEE CHESNUT
General Electric Co.

★ It is safe to say that no single development in the police radio field, or in the associated emergency communication uses, has met with such rapid wide public acceptance as has frequency modulation. Today, approximately two and one-half years after the initial commercial installation, "FM" as a communication tool is more widely accepted than was the idea of police radio itself in the same period of time after its initial introduction.

The foregoing facts are attested to by at least three conditions which are evident to those closely associated with the industry today; first, an actual study of current production records of AM and FM equipment; second, the relatively small amount of customer-contact time that is consumed in "selling" the idea of FM; and third, the actual ratio of FM to AM emergency communication radio equipment authorized for the "Radio Reserve Pool" recently established by the War Production Board.

This article will therefore deal, not with why FM should be chosen for the majority of emergency communication services, but rather with what two and one-half years of actual progress has accomplished in the way of making a better communication tool available. This progress will be presented, not as a detailed technological change in circuits, components, accessories, etc., but rather will be keyed to the relatively few basic functions which a communication system is expected to accomplish. These are:

*1—We want intelligible two-way communication over the greatest possible radial distance.*

*2—Within that distance, we want 100% coverage; that is, no "dead spots."*

*3—We want to achieve the lowest possible nerve-strain for the operator of the equipment, for whom two-way radio is simply a tool by which he can increase his effectiveness several-fold.*

*4—We want the equipment to withstand continuous normal use, plus the occasional severe punishment inevitable in mobile service.*

*5—We want to provide those features which make the equipment easily installed and easily serviced, so that all the foregoing functions may be continuously maintained.*

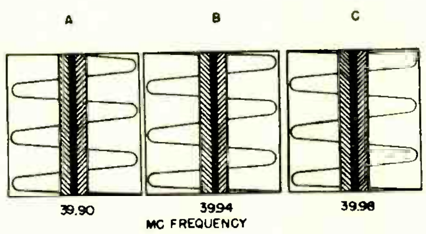



**Fig. 1. The three emergency service carrier channels, spaced 40 kc apart.**

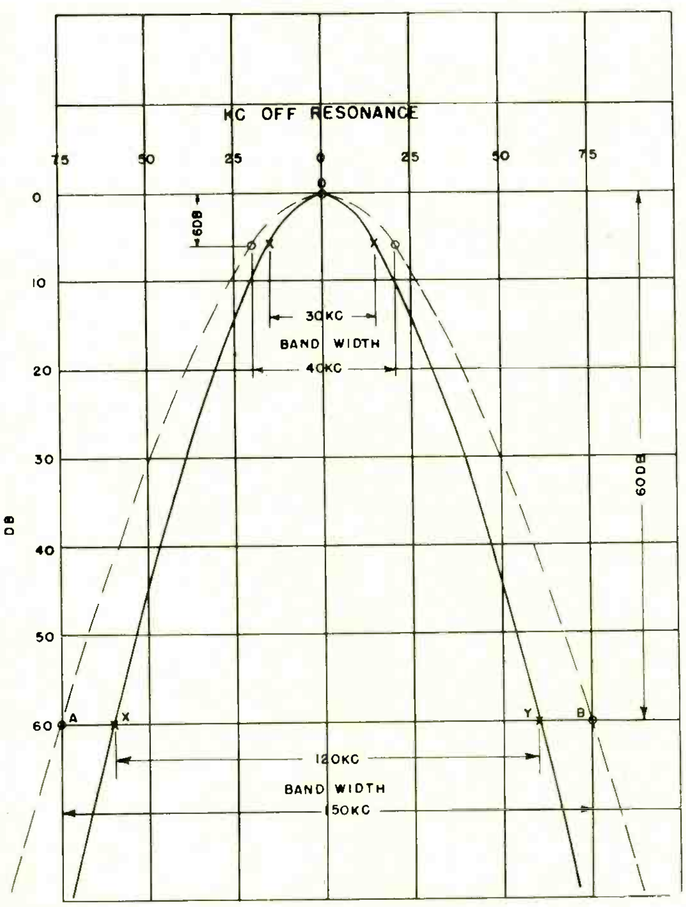



**Fig. 2. Comparative selectivity curves of early and late model frequency - modulation receivers.**

### 1—Extended Communication Range

The major development in extending the range of FM emergency communication equipment, has, of course, been in the receiver. Given a certain amount of antenna radiated power, a carrier with a frequency tolerance that meets the Federal Communications Commission specification of plus and minus 0.01%, and given transmitter carrier modulation free from "hash" and hum and distortion, the quantitative value of signal strength at any receiver location is a function of natural physical laws. These natural laws, to be sure, are not as definite as those governing the distribution of electrical energy over metallic circuits, but the conception of the problem will be clarified if we think of it as a problem in distribution where a given signal voltage is available adjacent to the antenna, reducing in inverse geometric ratio to substantially zero-voltage signal level at some point beyond the service range.

Now we quote the actual statement from our earlier receiver specification and show, in comparison, the current specification.

*Earlier:* "The receiver limiter tube is substantially saturated when the signal input reaches 1 microvolt."

*Current:* "20-db noise quieting will occur at a signal input of not more than 0.4 microvolt."

We have here a dual improvement; the first, actual increased sensitivity, since the 0.4-microvolt signal strength used to define the new sensitivity represents what might be called "substantial limiter saturation." Both designs, of course, have a margin of safety beyond the specification value. For example, the earlier unit could work successfully on received signal strength of the order of 0.5 microvolt, and the current design similarly on received signal strength of 0.1 microvolt. This increase in receiver sensitivity can readily account for extensions in communication range of from 10% to 35% under varying conditions of interference static level. An absolute specific statement cannot be made without fully classifying the type of static interference. It is well known that static, which is amplitude modulated in nature, is over-ridden with the FM signal when the limiter circuit is fully saturated. However, static which is frequency modulated in nature is not rejected by limiter action, but is nullified in proportion to the amount of carrier swing, rather than by the degree of limiter saturation. Herein lies the inherent value of the Armstrong method of frequency modulation, which includes both the principle of the "limiter" and of wide-band modulation. This has been the subject of much discussion in the industry, but has now been thoroughly substantiated by actual experience.

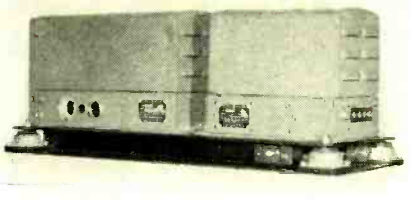


Fig. 4. Special shock mounting and vibration-damping base, for application to locomotives.

It will be evident that the foregoing comparison of receiver specifications typifies not only an improvement in receiver sensitivity but also represents a clarification of the actual method of statement itself. Both are important from the standpoint of industry-consumer good-will. We substitute now the definite quantitative statement of "20-db noise quieting will occur at a signal input of not more than 0.4 microvolt" for the previous rather general statement that "the receiver limiter tube is substantially saturated when the signal input reaches one microvolt." Both receivers are basically double-conversion superheterodyne units. The earlier receiver accomplished limiting with a single limiter tube. The new receiver employs two limiter tubes providing cascade limiting.

## II—Reliable Communication

The more important basic elements of this problem are taken care of by the same design improvements covered by Section I. An additional "enemy" of reliable communication is the possible presence of interfering signals from other similar communication systems. Certain proclivities of the "squelch" circuit might also be likened to "Fifth Column" activities from within, as being particularly destructive of uniform coverage.

It is well known, of course, that the FM receiver has remarkable ability to discriminate against the weaker of two signals on the same frequency, by the limiter action of the receiver. For best all-round performance, however, it is desirable to take advantage of every possible circuit improvement.

We refer you now to *Figs. 1* and *2,* in order to discuss the problem of receiver "acceptance bandwidth" which is a contributing factor toward eliminating interference from other signals as well as cutting down the amount of static that has to be over-ridden.

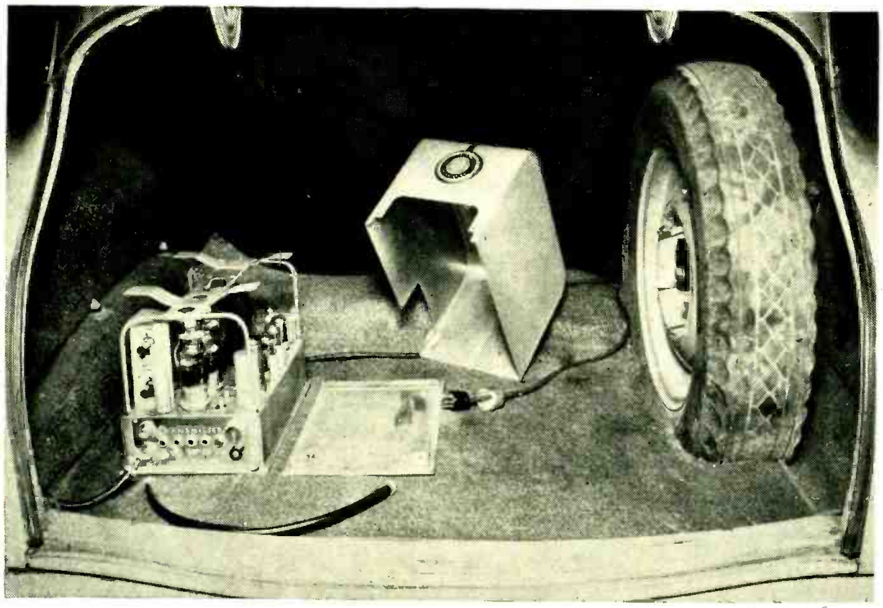


Fig. 3. Maximum life of equipment is obtained by bolting transmitter and receiver sub-bases to trunk compartment.

*Fig. 1* represents three FM "Emergency Service" carriers *A, B* and *C,* as established by the Federal Communications Commission, spaced 40 kc apart. The three heavy lines represent the theoretical carrier frequencies of 39.90, 39.94 and 39.98 mc respectively. The shaded portions to the right and left of each carrier represent the limits of the carrier variation in accordance with FCC requirements of ± 0.01% frequency stability. Now we illustrate by typical modulation waves a modulation of ± 15 kc required in this service, imposed upon the ± limits of each of these carriers. Thus, adjacent channel frequency overlap is prevented.

It is obvious that the perfect receiver would have an "acceptance bandwidth" exactly equal to the theoretical transmitted signal shown, 30 kc wide at all levels of incoming signal strength. It would probably be possible to approach this in a laboratory model of a receiver designed to receive signals of a very narrow range of signal strength. But we have here the problem, first, of receiving signals of perhaps 10,000 microvolts up close to the antenna—occasionally even much stronger signals—and as low as 0.1 microvolt out at the limits of communication range. We must, of course, also build a receiver that can be reproduced by quantity production methods at a price that will warrant its use by the intended users.

*Fig. 2* now illustrates the receiver condition. The apex of the diagram corresponds to a certain maximum desired signal strength and the height is proportional to signal strengths of decreasingly lower intensity. Two such signal strengths of 6 db and 60 db "down" from the established apex level are shown, since these are commonly used reference points approximating normal and low signal strengths dealt with in this service.

The area *OAB* represents the earlier design of receiver with 40 kc bandwidth at 6 db down and 150 kc bandwidth at 60 db down. The area *OXY* shows in comparison the acceptance bandwidth of the current design of receiver. The areas between the two represent possible interfering signals that earlier receivers would have accepted that the current design would reject. The reduction in load imposed upon the receiver is obvious.

The discussion of the "squelch" circuit in total logically belongs under the next section of this article. Under this heading of "Reliable Communication" within the service area, we would state here that the early squelch circuit did not completely solve this problem because of the newness of the problems presented. The type of squelch circuit used on AM receivers could not be used since they were sensitive to AM noise, and since the FM receivers would operate on such low signal strength. The objective should be that for any particular adjustment of the squelch circuit that it remain either open or closed; that is, leaving the receiver in position to accept the desired message, or keeping the receiver muted because of high prevailing noise level and low signal strength. Early FM receivers were not perfect in this regard. There were tendencies under some conditions to allow intermittent reception and blanking of reception, commonly referred to as "clipping." It may be safely said that the new design removes this obstacle to reliable communication coverage.

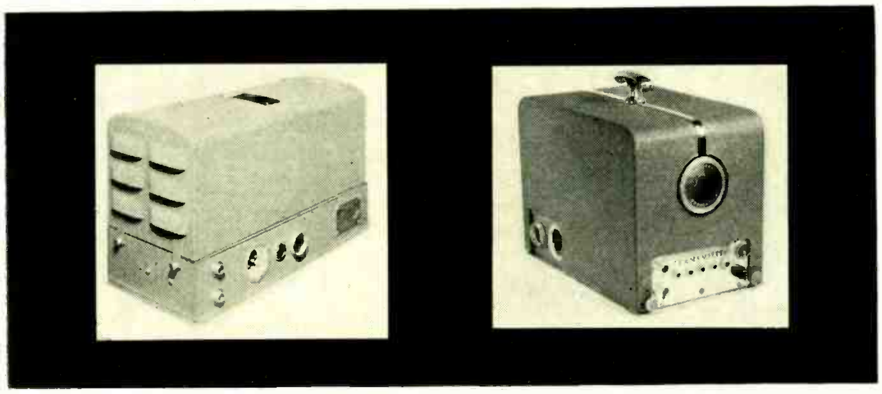


**Fig. 5. Modern dust-proof unit (at right) as compared to the earlier unit with louvres. The new design is also more compact.**

### III—Minimum Nerve Strain

Just as Section II built upon Section I, so now we may say that the accomplishment of this third objective builds first upon the degree to which the problems discussed in Sections I and II are solved.

Under Section II we referred to that part of the squelch circuit design related to a possible "clipping" of messages. We refer here to the over-all squelch circuit performance. As in Section I, progress is indicated by definiteness of the statement of our respective receiver specification. We quote:

*Earlier Unit:* "The carrier-off noise suppression circuit is so designed that it discriminates against amplitude-modulated signals (such as random noise) and passes constant-amplitude, frequency-modulated signals. This device prevents audio output from the receiver except when a carrier is present on the frequency to which the receiver is tuned."

*Present Unit:* "With no carrier on, the receiver will remain muted on all random noise. The squelch circuit automatically opens the receiver on a signal input as low as 0.1 microvolt, if desired, adjustable up to 0.4 microvolt."

Again dual progress is indicated. While the earlier specification did not state a quantitative value at which the desired signal would open the squelch circuit, this would actually happen at a signal strength of about one-half microvolt. The current design now reduces this to 0.1 microvolt, which is practically the threshold of audible reception. The earlier design provided only an on-off switch for the squelch—it was either in operation, or it was inoperative. We now provide a squelch adjustment on the control unit for both fixed station and mobile type units. The level of interfering static is by no means a fixed quantity for either station or mobile service, obviously much more variable for mobile units. The operator may now, therefore, provide for maximum sensitivity of his receiver, and yet keep it silent and thus greatly reduce the day in and day out nerve strain, because of the remote adjustment feature. We have purposely set the upper limit of this squelch adjustment at 0.4 microvolt, since this point corresponds with the point of substantial noise-quieting and should therefore provide for good signal reception.

### IV—On-the-Job Reliability

We have approached the problem of "shock mounting" without any preconceived idea. We were at first inclined to believe that shock mounting would definitely be required in order to protect this type of equipment from the effects of rough usage over the roads. Our early experimental installations were made with "shock mounting bases" and the first thing we learned

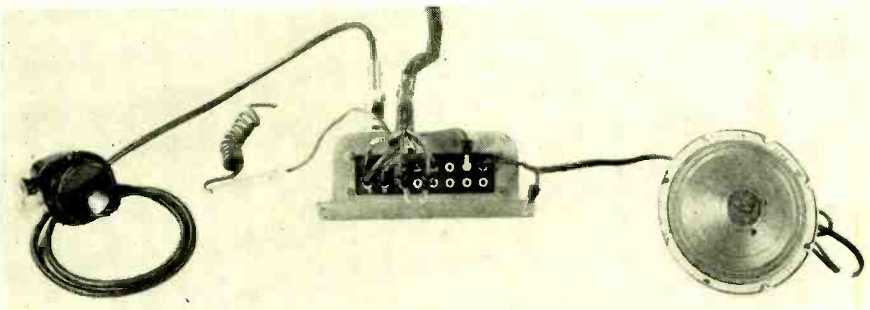


**Fig. 6. Plug-in type of interconnection. This provides for easier testing, and smaller cable holes in car body.**

**Fig. 7. Side-by-side mounting, and with largest dimension towards the rear, leaves usable prowl-car trunk space.**

was that the problem actually divided itself into two distinct studies: one of "shock mounting," and the other of "vibration damping." Actually, the early attempts at shock mounting produced an effect which might be described by using the term "vibration amplifier." True, the mounting used to reduce the effect of sudden shock, such as a car dropping into a rut in the road, might slightly reduce such an effect, but under many circumstances the natural period of vibration of the equipment came into play, and what would have been a single shock blow of certain proportions became a sustained series of periodic vibrations that were more destructive to the equipment than the initial blow that we were trying to protect against.

This study was continued in both road vehicles and in elaborate laboratory shock and vibration testing equipment. We came to this definite conclusion that when this type of equipment is mounted in vehicles as used by police departments, the maximum life will be obtained by bolting the transmitter and receiver sub-bases solidly to the trunk compartment of the vehicle. Such a typical installation is indicated in *Fig. 3*.

The foregoing statements do not apply when this equipment is used for other services, such as mounting in Diesel-electric locomotives where shock or vibration mounting is not inherent in the vehicle itself. We refer you now to *Fig. 4*, which shows a specific design of this FM emergency communication equipment, mounted on a special "shock mounting and vibration damping" base developed for the application of this equipment to Diesel-electric locomotives. The dual nature of the problem previously described is illustrated in the features included with this base. The flexible foot mountings at the corners of the base take care of the problems of shock mounting which is desirable for this service, where the locomotives are pounding over steel rails constantly; are subject to severe shocks when coupling to and uncoupling from cars; and where the locomotive spring suspension is such as to provide absolutely no shock mount in terms of the requirement of this class of equipment. Because of limited space in locomotives, the communication equipment is often mounted on a shelf affixed to the side of the locomotive cab which thus multiplies the vibration effects. We therefore include vibration damping features illustrated on both the side and the end of the base which are effective in reducing both lengthwise and sidewise vibrations. Such bases are fully justified for this class of service in terms of the longer life and less servicing required.

Any successful approach to this problem of two-way communication when one end of the circuit is in a mobile vehicle must take into account the power-supply limitations within the vehicle itself. To emphasize this problem, it is probably safe to say that in the normal life of any passenger automobile, used for normal personal or business service, more failures to start will be caused by battery trouble than by any other single factor. Again to emphasize the problem, we should not overlook the fact that the total battery drain required to support the emergency communication receiver, plus the stand-by or idling drain of the transmitter, is roughly two-thirds of the battery drain required for the combination of headlights plus tail light, or is about double the requirement to operate the average car heater at maximum speed.

It is obviously short-sighted policy to accomplish the utmost in receiver sensitivity and selectivity and squelch performance if such a design results in a battery drain which would cause undue failures in the car power plant. Furthermore, such finely developed and sensitive characteristics are only maintained if the receiver is supplied with approximately normal voltage, and such gains may be more than offset by low voltage delivered by the car power plant if the battery drain is excessive.

Our initial receiver design was a deliberate choice based on the then-known factors affecting sensitivity and battery drain. Battery drain at that time with a dynamotor power supply on the receiver was approximately 8.0 amperes, and the sensitivity as explained heretofore provided for "substantial limiter saturation at 1 microvolt signal input." It was well known then that sensitivity could be increased to a value approximating that of today's receiver, but to have done so at that stage of the development of the art would have increased the battery drain to approximately 11 amperes. Therefore, in the interest of well-balanced design and with complete respect for the limitations of the car power plant, we deliberately postponed the use of the greater receiver sensitivity until design knowledge had made improved over-all performance available at no increase in battery drain. As a matter of fact, the sum of the battery drain for our earlier designed equipment with dynamotor type power supplies for both transmitter and receivers was eight amperes for the receiver, plus three amperes idling drain for a 25-watt transmitter, a total of eleven amperes at six volts. The comparable figures for the current design are 7.5 amperes for a far more sensitive re-

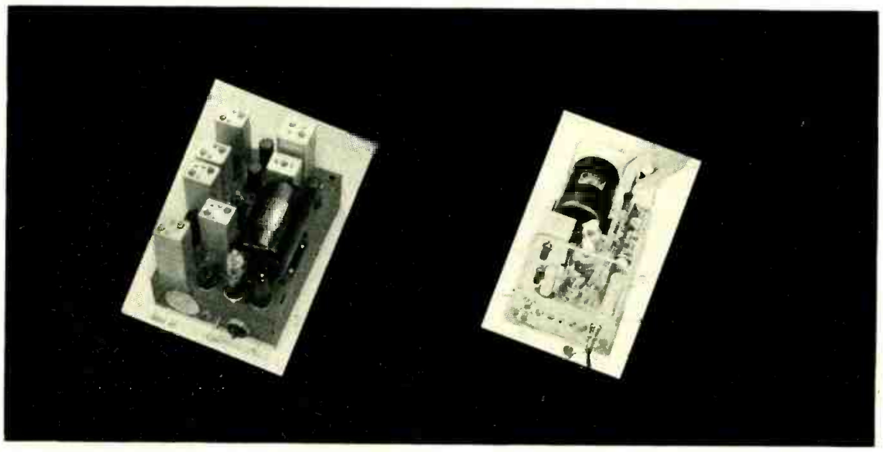


**Fig. 8. The new unit, at right, with iron-core tuning, as compared with the earlier model with air condenser tuning. New unit is smaller and easier to align.**

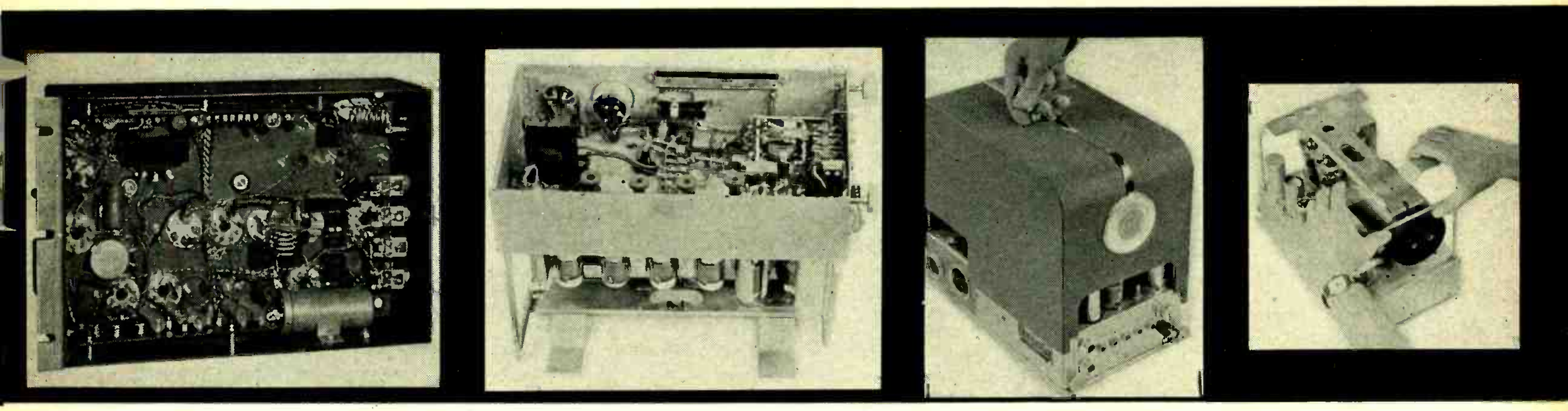


**Fig. 10, A, B, C, and D, showing old and new designs. Workbench support in new units facilitates servicing.**

ceiver plus 2.1 amperes for a 30-watt transmitter instead of the previous 25-watt unit, representing a total of 9.6 amperes, but with definite improvement in both transmitter and receiver. Then, because of the extreme importance of this question of battery drain, we added a mobile receiver with vibrator-type power supply as a standard unit of our line, with a reduction in receiver battery drain from 7.5 amperes to 5 amperes at six volts. The latter accomplishment has a further advantage in connection with sustained reliable communication and low maintenance expense because of the reduced load on the vibrator contacts.

Everyone knows that the trunk compartment of an automobile is not a place that can be noted for its cleanliness. *Fig. 5* shows the evolution from the earlier design with ventilated louvers on each end, to the current model with solid unventilated enclosures. Since heat generated within the unit varies as the square of the current drawn, it will be seen here that low battery drain again has its effect in terms of lower temperature within the enclosures. The advantage of solid enclosures in terms of keeping road dust and dirt out of equipment is obvious.

### V—Easily Installed and Serviced

The basic features that would be classified under this section and which were included in the earlier design have proven to be wisely chosen and therefore they have been continued into the current design. Such features include transmitters and receivers built on separate chassis, so that either one could be removed for servicing without disturbing the other. This results in a minimum of time for servicing a particular unit or a minimum amount of spare equipment on the shelf. It includes also the removable base plate construction as illustrated in *Fig. 3*. The base plate is bolted solidly to the trunk compartment and the chassis is held to this base plate by an angular clamp on the back end, held in place by thumb screws on the front. It is not necessary to reach around behind the unit to remove the chassis with this construction.

In the mobile unit the control unit serves to interconnect the major parts of the equipment. *Fig. 6* illustrates the construction which is now being used, showing that all connections are of the plug-in type. The multiple connections of the control cable terminate in individual plugs rather than in a multiple plug jack, so that this end of the control cable may be passed through holes drilled in the car chassis or body sections from the trunk compartment to the control unit, such holes thus being required of a diameter just large enough to pass the cable itself.

Another feature of convenience to the prowl car operator is illustrated in *Fig. 7*. Here we see a transmitter and receiver mounted side by side in a trunk compartment, the long dimension of the unit pointing from front to back. This arrangement is made possible by locating the base plate thumb screws, the microphone jack and the test receptacles on the narrow end of the units. It will be seen that this leaves a relatively large amount of usable trunk compartment space to the right of the equipment.

Reference to *Fig. 8* will reveal one complete departure from earlier designs that has resulted in easier alignment of the equipment both initially and during its life. The air-trimmer type of capacitor has been almost universally used for tuning adjustments in this class of service. The new design has adopted the inductive tuning method, commonly referred to as "iron core" tuning or "plug tuning." With this method the changes in circuit constants are accomplished by moving a soft powdered iron core vertically in and out of a small inductor or coil held

[*Continued on page 55*]

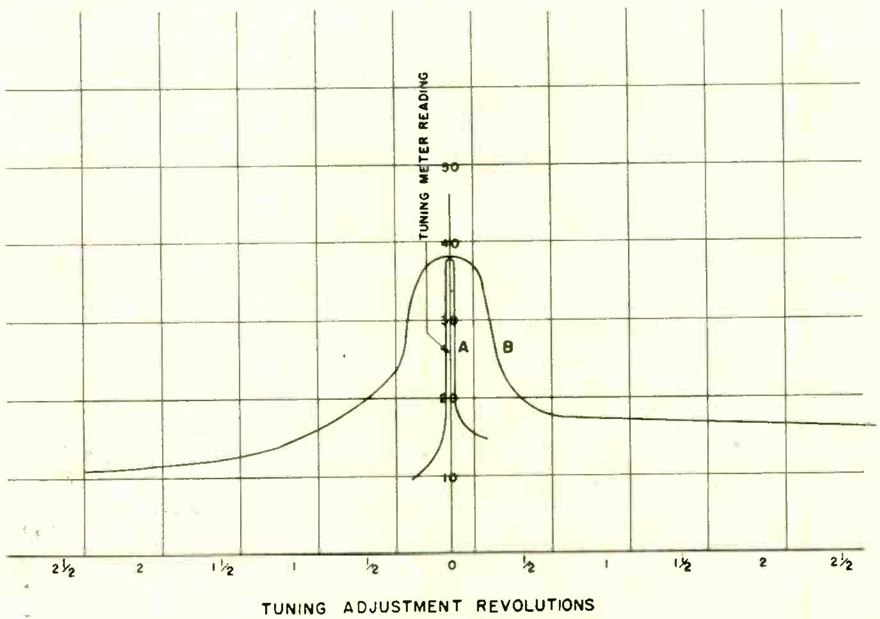
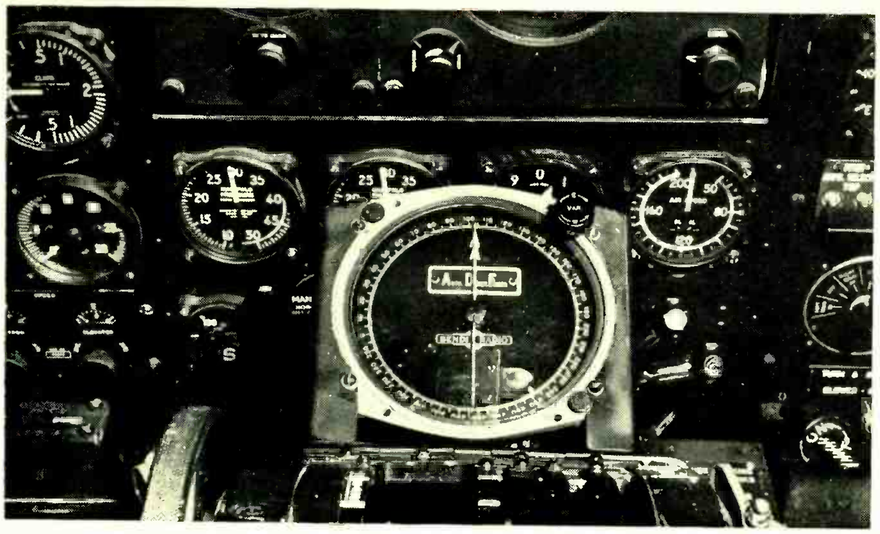



**Fig. 9. Curves showing comparison between air-condenser and iron-core tuning. For one thing, the latter is less critical and not as subject to drift effects.**



**Azimuth indicator of ADF type of radio range receiver. When station is tuned in, needle points a true bearing so that pilot can beam in. (Photo by Western Air Lines).**

points. The radio compass or loop dial reading is observed and deviations from the pelorus are plotted on a correction curve. In most ADF's this compensation may be done in the receiver or compass and direct readings are thus available.

DF error introduced by natural phenomena is by far the most serious problem in accurate navigation by radio. Night effect; coast-line effect and directly related to the latter, terrain effect, are the commonly encountered causes of poor or inaccurate bearings. Terrain and coast-line effect may result in erratic bearings, but usually there is no aural indication that the bearing is other than normal. Terrain effect causes poor bearings because of physical obstructions, such as mountains, etc.

Bearings on stations behind obstructions should be avoided if a signal source over clear terrain is available. By visual angle measurement, error caused by nearby objects may be calibrated in the case of a ground DF taking bearings on a plane (See DF loop calibrating procedure.) It is generally not practical to transmit this error to a plane taking a bearing and it becomes a difficult task for the radioman to discriminate against good and bad bearings taken on a terrain effected station. The error that may be caused by physical obstructions can be of such a magnitude that the bearing will have little value. Because of the variable factors involved in taking bearings on stations behind obstructions some general knowledge of the signal source's general characteristics is definitely necessary. Often stations behind hills, etc., are not even effected whereas others have a consistent error which, if known, can be readily compensated for. For homing, terrain error may cause a lengthened flight, but signals will lead to the station. When terrain-affected bearings are used off the tail, care must be taken that they do not lead the plane hopelessly off its course. Most charts used for both types of navigation, radio and celestial, will indicate, either by imprints or contour lines, elevation of all land surrounding a radio station. Terrain effect may also affect bearings taken on inland stations even though the signal path is over relatively level ground. Coast-line effect is due entirely to refraction of radio signals because of their proximity to the coast. It is least when the bearing is at right angles to the coast and greatest when the bearing is parallel, as outlined in *Fig. 1.* Necessity will dictate the stations to be used for DF, but in the event a choice exists, bearings of over 30° are preferable. If the bearings taken are entirely over land, no coast-line refraction will be introduced in the reading.

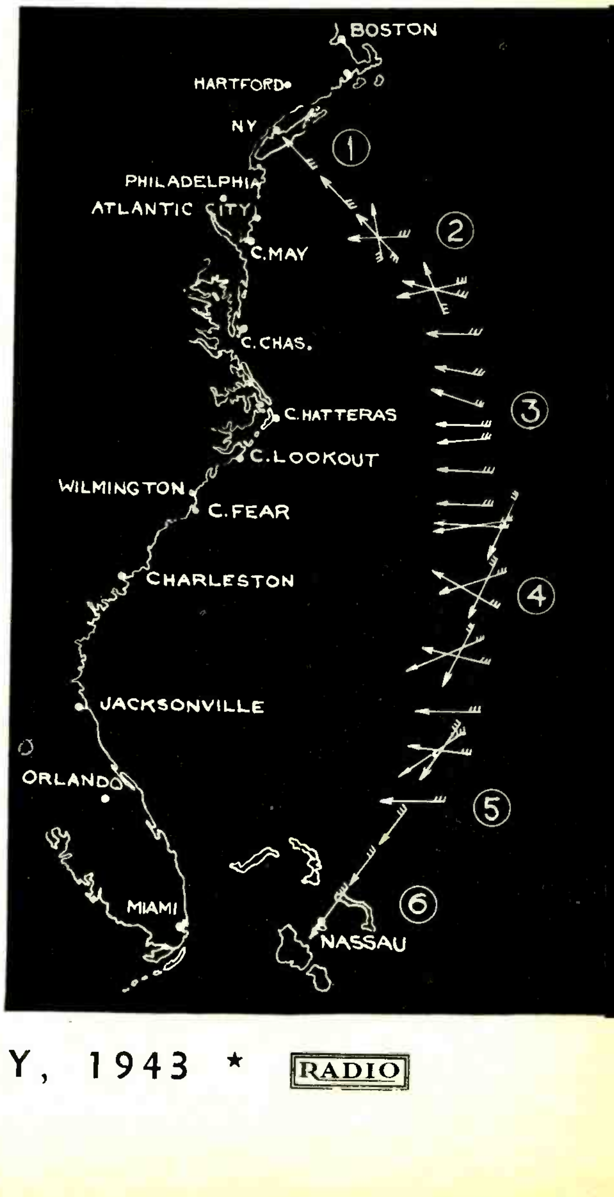



**Fig. 3. Course plotted by radio bearings on theoretical patrol flight New York to Nassau. Chart normally used would include latitude and longitude lines; magnetic variation lines; and mercator corrections if chart was mercator type.**

**(1) Track bearings off tail. (2) Three station fixes. Unusually good because of excellent relationship of plane's position to stations. (3) "Abeam" and speed check bearings. Used here without track bearings because no source is available. (4) Three station fixes showing normal error which is gradually reduced as plane gets closer to stations. (5) Combination of "Fix", track and abeam bearings showing number of ways position can be checked. (6) Track bearings off nose with ship finally homing in.**

## Night Effect

Night effect is extremely serious in DF work and is generally experienced at any hour from two hours before sunset to two hours after sunrise. The presence of a strong downward-traveling horizontally-polarized wave induces an e.m.f. in the loop other than the vertical component of the signal. As a result the null or minimum signal of the loop will not occur when it is perpendicular to the signal. In theory, a signal with no vertical component will introduce an error of 90° in the loop. Night effect will often cause an indistinguishable null, but more serious even than that, it will result in a false minimum. A null may be obtained which will soon start to shift. The minimum may creep back and forth or even jump over a considerable portion of the loop scale.

It is this complete undependability which calls for the utmost caution during hours when the sky wave has a tendency to be stronger than the ground wave. As previously mentioned, and emphatically repeated, it is because of night effect that the low-frequencies are better for DF, since their

[*Continued on page 50*]

# Thermal Radio

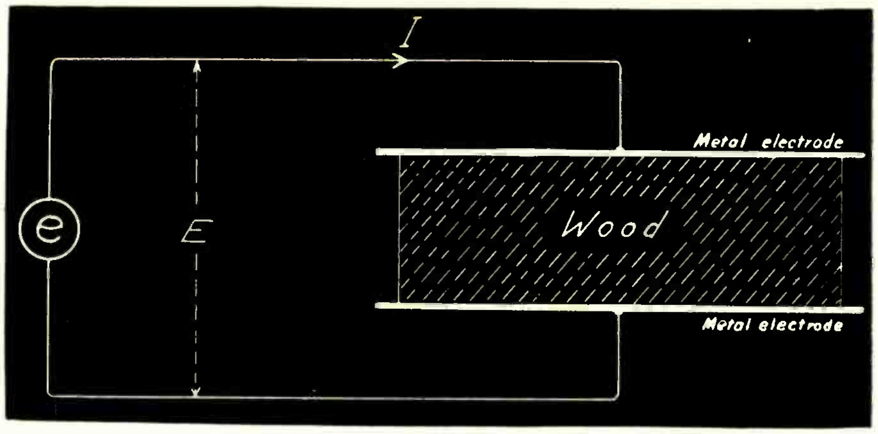



**Fig. 1. Fundamental circuit used in heating wood with radio-frequency power. The wood is placed between metal electrodes which are connected to a generator (e). Resistance to passage of the current I causes the wood to heat.**

# HEATING WOOD WITH R-F POWER


JOHN P. TAYLOR*


★ Radio-frequency power has been used to overcome what seemed an insurmountable problem in the production of airplane propellers made of compregnated wood. Radio frequency is being used to expand the production of laminated and box spars, truss-type rib constructions, bomber floors, bomb bay doors and other aircraft parts. It is being tested for use in making various molded plywood forms such as wing elements and fuselages. Experimentally it is being used for seasoning wood, drying aircraft-quality plywood and curing various types of impregnating resins. In all of these applications the desired effect is obtained as a result of the heating developed in the wood by the use of radio-frequency power.

Obviously these applications are important—and this lends importance to the questions which naturally arise: How is radio-frequency power applied? What makes the wood heat? Why is radio-frequency current used? What advantages does the process offer? What limitations does it have? How do results compare with those of other methods?

Actually the method is too new to give final answers to all of these questions; however, enough work has been done to make it worthwhile to review the information which is available.

## Application of Power

Heating wood with electric power is (aside from the strictly application problems which arise) a relatively simple operation. Theoretically, at least, it is only necessary to have a generator of suitable characteristics and to connect the same by means of wires or other conductors to the wood which it is desired to heat.

Such an arrangement is illustrated by *Fig. 1.* A generator *(e)* is connected to two metal electrodes. The wood which it is desired to heat is placed between these plates. The reason for the plates can be understood by inspection of *Fig. 2.* In this illustration the dotted lines represent current paths and the number of lines in any particular part of the wood block is an indication of the current density in that section.

If connections to the wood are made at single points, or by means of small contact plates, the current distribution will be approximately as shown in *Fig. 2 (a).* In this case the corners of the block, since there is less current through them, will be heated very little—and the parts of the block which are close to the contacts will be overheated. In some cases such a distribution might be desirable, but ordinarily a more even distribution of heating is desired and this can most easily be obtained by using large electrodes as in *Fig. 2 (b).* With such an arrangement the voltage generated at *(e)* causes a current *I* to flow around the circuit, through the wood and back to the generator as shown. The magnitude of this current will be determined by the voltage available from the generator and the resistance presented by the wood.

## Heating Process

In the case of the poorer conductors, such as wood, the resistance to the

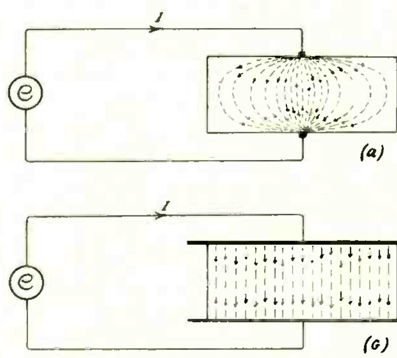



**Fig. 2. The distribution of current paths through the wood (a) when only small contact points are used; (b) when large metal plates, called "electrodes" are used.**

* RCA Manufacturing Company, Inc., Camden, New Jersey.

† Abstracted from a paper presented at the Annual Fall Meeting, Rochester, New York, October 12-13, 1942, of the American Society of Mechanical Engineers.

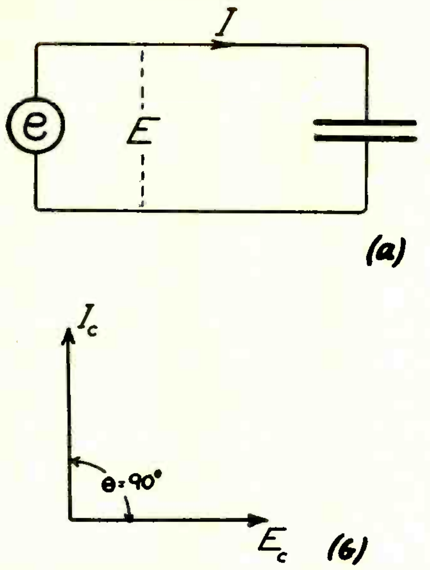



**Fig. 3. Schematic (a) and vector (b) diagrams for a circuit in which a generator is connected to a "perfect" condenser. The current and voltage are 90° out of phase; hence, no power is consumed.**

passage of direct or low-frequency current is very high. The voltage which would be required to cause an appreciable 60-cycle current to pass through these poor conductors would be out of practical reach (of the order of millions of volts). However, as the frequency of the current is increased the equivalent resistance of these materials drops almost inversely. At frequencies in the range of what we normally call radio frequencies it becomes low enough that it is practical to force through these poor conductors enough current to heat them as we desire.

Although some writers on the subject have taken the opposite view, there is no essential difference between high-frequency heating and low-frequency heating. For a purely practical reason—viz. that the required voltages are lower—it is preferable to use radio frequency for the heating of poor conductors. The mechanism of heating is exactly the same.

Physicists picture the heating which occurs as being due to "molecular friction" caused by the passage of current through the materials. They visualize this current not as a stream of electrons each of which flows all the way across the material, but rather as the net effect of the motion of all the electrons. Normally these electrons have random orbits. When a voltage is impressed across a section those electrons which are not too tightly bound change their paths somewhat so as to produce an overall effect of a charge moving from one side to the other. This displacement of the paths of the electrons represents work done and this work appears as heat.

The difference between good conductors and poor conductors is represented by the degree of freedom of the so-called "orbit electrons." There is no fundamental difference in the heating effect. In either case it is due purely to the "conduction loss" which occurs due to actual passage of current through the material.

### Effect of Frequency

Where the dimensions of the "package" of wood to be heated are known it is relatively easy to calculate the voltage which will be required to obtain a certain heating effect. Electrically the metal electrodes between which the wood is placed form a condenser. If these electrodes were separated by air they would form a so-called "perfect condenser." Such a condenser would be represented schematically as in *Fig. 3 (a)*, and the voltage across and the current through this condenser by the vectors of *Fig. 3 (b)*. In this case the voltage and current are 90 degrees out of phase and the average power dissipated in the condenser is zero.

When, however, the wood is placed between the electrodes, we no longer have a perfect condenser since the wood presents a leakage or "conduc-

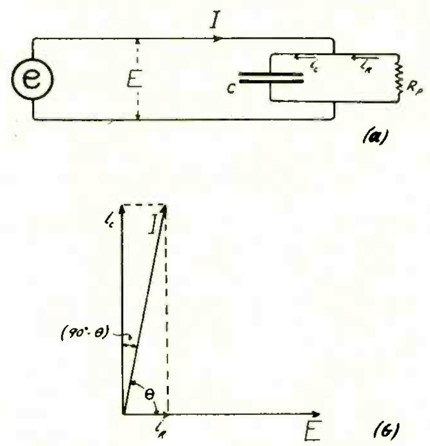



**Fig. 4. Schematic (a) and vector (b) diagrams for a similar circuit in which the condenser has a poor dielectric such as wood. The current $i_R$ flowing through the equivalent resistance $R_p$ represents the power expended in heating the wood.**

tion" path. The imperfect condenser thus formed can be represented schematically by a perfect condenser paralleled by a resistance $R_p$ as shown in *Fig. 4 (a)*. The capacity of $C$ is the same as the capacity of the imperfect condenser, and hence is a constant. $R_p$, however, is purely an "equivalent" resistance and is not independent of frequency. It is, therefore, necessary to calculate $R$ after the frequency of operation has been chosen.

The relations of voltage, current, power and frequency of the circuit shown in *Fig. 4 (a)* can be obtained directly. *Fig. 4 (b)* is the vector diagram. In this case the total current $I$ leads the voltage across the load by something less than 90 degrees. The total current $I$ is made up of two components, viz., the capacity or "out-of-phase" current $i_c$ and the resistive or "in-phase" current $i_R$. Since the first does not represent any power furnished to load, we are not interested in it, but only in $i_R$ and the resistance $R_p$ through which it flows. In order to calculate $R_p$ we note that:

Power factor $= \cos\theta = \sin(90° - \theta)$

for small angles

$\sin(90° - \theta) \cong \tan(90° - \theta)$

Hence:

$$P.F. \cong \tan(90° - \theta) \cong \frac{i_R}{i_c}$$

$$i_R = \frac{E}{R_p} \qquad i_c = \frac{E}{X_c}$$

$$P.F. = \frac{X_c}{R_p}$$

$$R_p = \frac{X_c}{P.F.} \qquad (1)$$

The value of $X_c$ can be calculated from:

$$X_c = \frac{1}{2\pi fc} \qquad (2)$$

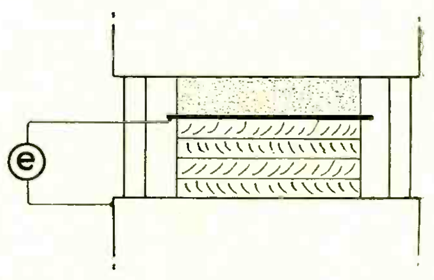
where: $C$ (in farads) $= \dfrac{KA}{4\pi d}$

$K$ = dielectric constant;
$A$ = area of plates in cm²;
$d$ = separation of plates in cm.

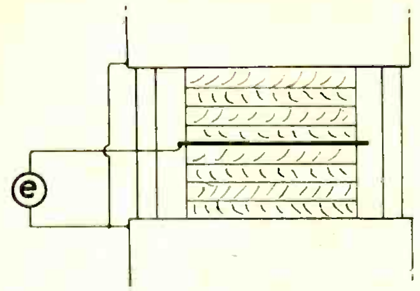
The value of the power factor $P.F.$ can easily be measured by means of a radio-frequency bridge or Q-meter. The power factor of a material is usually thought of as a constant. (However, recent measurements show that $P.F.$ varies considerably with frequency, moisture and impregnation.) For the calculation as here an approximate value will suffice.

Having determined $R_p$ it now remains to note that the power delivered to the wood and which appears as heat is given by:

$$P = i_R^2 R_p \qquad (3)$$




**Typical setup of gluing one assembly at a time. The insulator must have good loss characteristics if a large waste of power is to be avoided.**



**The "sandwich" method whereby two assemblies are made at once. This setup requires no insulating material and insures high efficiency.**

If we have calculated (as described below) the amount of power required to heat the material, we will know $P$ and from (3) we can calculate $i_R$. Then, since:

$$E = i_R\, R_p \qquad (4)$$

we also obtain the value of $E$ which is the voltage which will be required to force through the wood the current necessary to heat it in the desired amount.

If we now substitute some actual values in the above calculations we will immediately perceive the reason for using high frequencies.

**Example 1:** It is desired to use 60-cycle current to heat a test propeller to 240°. By the method shown below it has been calculated that a power of 6000 watts is required to do this in a time of eight minutes. By calculation $C$ was found to be 150 micromicrofarads; hence, from (2):

$$X_c = \frac{1}{2\pi f c} = \frac{1}{6.28 \times 60 \times 150 \times 10^{-12}}$$

and from (1):

$$X_c = \frac{17{,}700{,}000}{.05} = 354{,}000{,}000 \text{ ohms} \quad (\text{taking } P.F. = .05)$$

and from (3):

$$P = i_R^2\, R_p$$
$$P = 6000,\ R_p = 354{,}000{,}000$$
$$i_R^2 = \frac{6000}{354{,}000{,}000}$$
$$i_R = 4.13 \times 10^{-3} \text{ amp.}$$

and from (4)

$$E = i_R\, R_p = 4.13 \times 10^{-3} \times 354 \times 10^6$$
$$= 1{,}460{,}000 \text{ volts.}$$

In other words, the desired heating could be accomplished with 60-cycle current only by the use of an entirely impractical voltage.

**Example 2:** Now assume that the same block is to be heated with current at a frequency of 1 mc.:

from (2):

$$X_c = \frac{1}{2\pi f c} = \frac{1}{6.28 \times 10^6 \times 150 \times 10^{-12}} = \frac{10^6}{943} =$$
$$X_c = 1010 \text{ ohms}$$

from (1):

$$R_p = \frac{1010}{.05} = 20{,}200 \text{ ohms}$$

from (3):

$$P = i_R^2\, R_p = 6000$$
$$i_R^2 = \frac{6000}{20{,}200} = .297$$
$$i_R = .545 \text{ amp.}$$

from (4):

$$E = i_R\, R_p = .545 \times 20{,}200$$
$$E = 11{,}000 \text{ volts}$$

In other words, if we use 1-megacycle current we can operate with 11,000 volts across the load. We might go still higher, say, to 10 megacycles, in which case the required voltage would drop to 3480 volts. In order to show this effect of frequency graphically the values of $X_c$, $R_p$ and $E$ for a large range of frequencies have been plotted in *Fig. 5*.

As can be seen from this figure, the voltage required for a given power input (i.e. a given heating effect) is inversely proportional to the square root of the frequency. This means that, generally speaking, the higher the frequency the better, although a practical limitation is encountered due to the fact that the efficiencies of some types of tubes fall off at the higher frequencies. There may also be difficulties due to current distribution at the higher frequencies. The actual maximum voltage that can be tolerated will depend chiefly on the thickness of the load. For very thin materials not more than a few hundred volts can be used before arc-over occurs. In thicker sections as much as 15,000 volts can be used. Generally, voltages much above 15,000 cannot be used, no matter what the thickness, due to corona effects which become evident at higher voltages and which are only partially dependent on electrical spacing.

Averaging these various factors together, it has been found that the range of 1 megacycle to 10 megacycles presents the best immediate possibilities. Some very thin sections, however, will require higher frequencies—and looking to the future (when a wider choice of high-frequency tubes will presumably be available) it seems very prob-

[*Continued on page 57*]

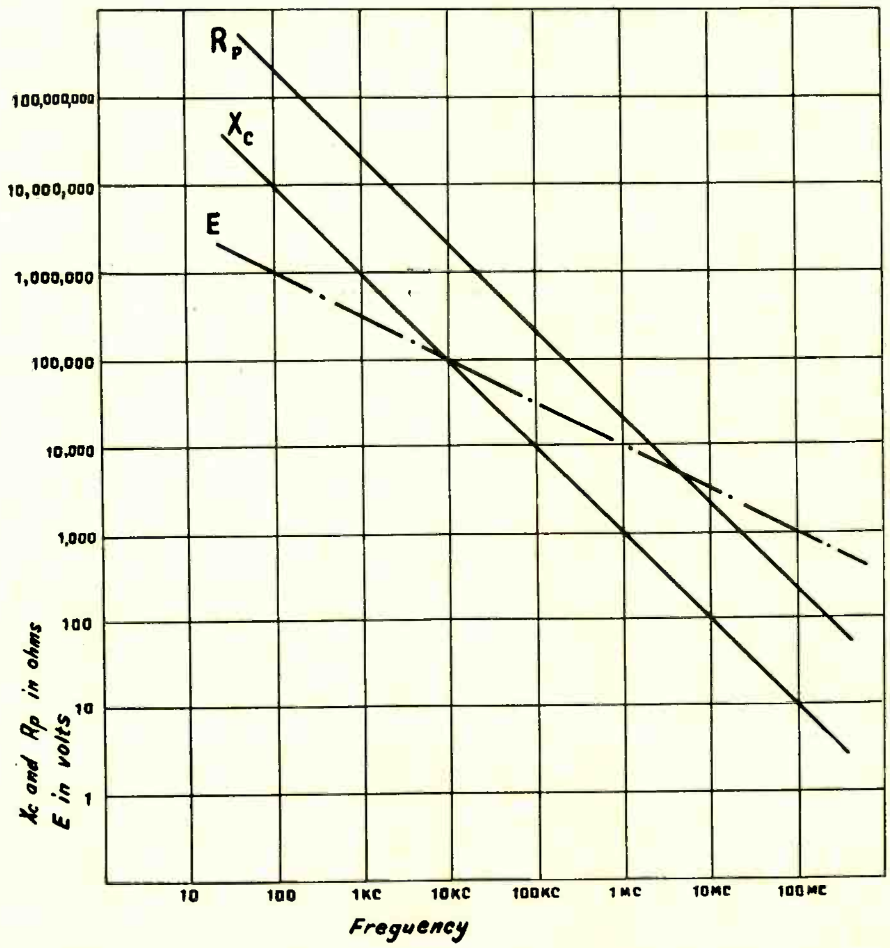



**Fig. 5. Variation with frequency of the reactance $X_c$, the equivalent resistance $R_P$ and the voltage E across the load for a typical radio frequency heating setup. Note that the voltage E varies inversely as the frequency; hence, higher frequencies mean less danger of voltage flash-over.**

# THIS MONTH

### W. E. LICENSE CONTRACTS

T. K. Stevenson, Vice President of the Western Electric Company, announces that contractual notice has been given of the Company's intention to terminate two years hence its license contracts with the motion picture producers in this country operating under Bell System sound recording patents. This is the well-known Western Electric sound system.

Mr. Stevenson said that early in 1941, as the time approached when notice of cancellation could first be given under existing contracts, Western Electric advised its licensees that if and when it terminated the present contracts there would be available to its licensees another form of contract which would continue to make available Bell System patents for sound recording in the motion picture field. The new contract, a draft of which will shortly be presented to licensees, will run to the end of 1954 and will provide for substantially lower recording fees.

★

### RCA UNIFICATION

The RCA Manufacturing Company, wholly-owned subsidiary of Radio Corporation of America, has been consolidated with the parent company, David Sarnoff, RCA President, announced following a special meeting of the RCA Board of Directors.

The RCA Manufacturing Company has approximately 30,000 employees, and is now chiefly engaged in producing radio equipment vital to the war effort. The manufacturing organization will be known as the RCA Victor Division of Radio Corporation of America. The management, personnel, operations and sales policies will continue as heretofore.

★

### ACTIONS BY FCC

The Commission en banc Dec. 8 and 15 took the following action on Rules and Regulations:

#### Amateur-Commercial

Adopted Order No. 77-B, suspending from January 1, 1943, until further order of the Commission, but in no event beyond January 1, 1944, Sections 12.26, 12.66 of the Rules Governing Amateur Radio Service and Section 13.28 of the Rules Governing Commercial Radio Operators, in so far as the required showing of service in connection with renewal of license is concerned. This Order continues in effect the provisions of Order No. 77-A, issued December 3, 1941 to expire not later than January 1, 1943.

#### Police Radio

Amended Part 10 of the Rules Governing Emergency Radio Services:

(a) Section 10.41—State and municipal police stations (frequencies below 2500 kilocycles.) The amendment does not change the frequencies available or the method of assignment to state and municipal police stations. Power authorizations for municipal police stations operating on frequencies below 2500 kilocycles will continue to be based on the official population figures of the Department of Commerce in accordance with the present table in Section 10.121. The maximum power normally to be assigned to state police stations operating on these frequencies will be limited to 500 watts. Authorizations for both state and municipal police stations involving the use of power in excess of that specified would be granted only on the basis of a showing of need made by the applicant.

(b) Section 10.42—State and municipal police stations (30,000 to 40,000 kilocycles)—The amendment does not alter the present allocation of frequencies or the assignment of frequencies to the various classes of stations. The amended rule normally establishes a maximum power of 250 watts. Power in excess of the 250 watt limitation may be granted only on the basis of a showing of need submitted by the applicant.

(c) Section 10.122 permits municipal and state police stations to communicate with Government stations, stations in the War Emergency Radio Service, or with other stations which are authorized to communicate with municipal and state police stations.

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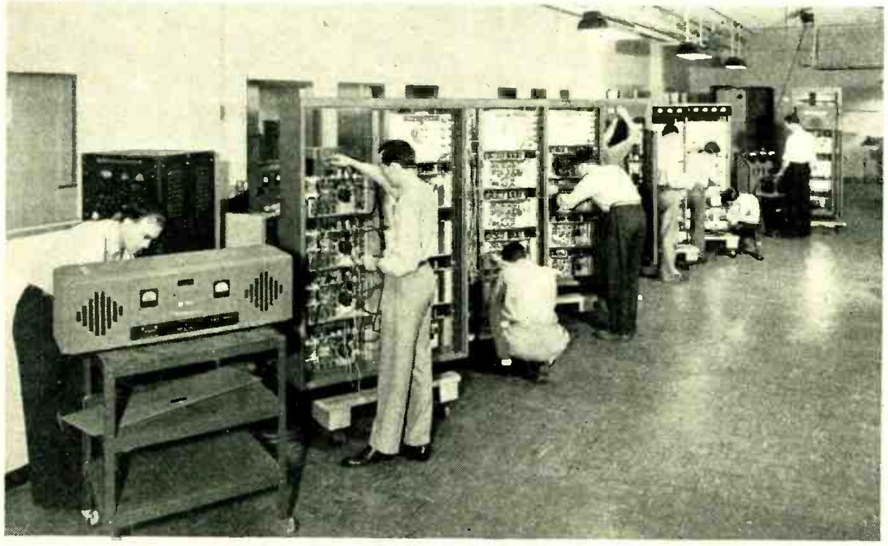
**James Watson, vice president of Meissner Manufacturing Co., and Captain Robert Henderson, examining the 5-millionth Meissner coil produced since "Pearl Harbor."**



**A research production line in the new Motorola Engineering Building. Motorola Engineers are at work on special radio problems assigned to them by U. S. Government.**

# RADIO DESIGN WORKSHEET

## No. 9—IMPEDANCE RELATIONS; COUPLED CIRCUITS

### IMPEDANCE RELATIONS

**Problem 1:** *Determine the relations between the impedances of the circuit of Fig. 1 so that the current flowing through the load R will be independent of the value of R.*

**Solution:** First we may determine the value of $I_3$ by Thevenin's Theorem, which has been given before*; whence impedance $Z$ looking back from $R$ into the network with $E$ short-circuited is:

$$Z = \frac{AB}{(A+B)}$$

The open-circuit voltage $V$ across terminals *1* and *2* with $R$ removed is:

$$V = BI'$$

But

$$I_1 = \frac{E}{(A+B)}$$

Whence

$$V = \frac{BE}{(A+B)}$$

$$I_3 = \frac{V}{(Z+R)} \quad \text{But } Z+R = R + \frac{AB}{(A+B)} = \frac{AR+BR+AB}{(A+B)}$$

Whence

$$I_3 = \frac{BE}{(A+B)} \times \frac{(A+B)}{AR+BR+AB} = \frac{BE}{R(A+B)+AB}$$

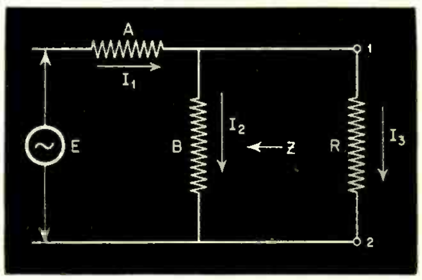



FIG. 1

Now if $A$ is an inductance and $B$ is a capacitance, we have at resonant frequency: $A + B = 0$

Whence:

$$I_3 = \frac{B}{AB} E$$

This indicates that the current through impedance $R$ is under conditions of series resonance for $A$ and $B$ independent of the magnitude of $R$ and dependent only on the voltage $E$ and the magnitudes of impedances $B$ and $A$.

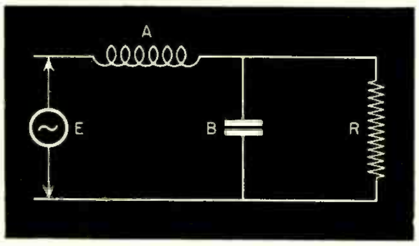



FIG. 2

*Fig. 1* then becomes *Fig. 2*, wherein $A = j\omega L$ and $B = 1/j\omega C$. This is a circuit that has had extensive use in series arc-light systems as well as in wire-line communication systems. In the latter case the line impedance varies with weather and if power supply current for tubes in unattended repeaters, or radio receivers or transmitters, is to be supplied over the line, a constant-current circuit is necessary. Of course, $A$ or $B$ may be either a capacitance or an inductance so long as $A$ and $B$ are in resonance. Thus, if $A = 1/j\omega C$, then $B$ must equal $j\omega L$. Thus the relation becomes $j\omega L = 1/j\omega C$, or: $\omega^2 LC = 1$.

### COUPLED CIRCUITS

**Problem 2:** *Establish the relations between the circuit constants and bandwidth of critically coupled (inductive) and over-coupled circuits.*

**Solution:** Let *Fig. 3* represent the inductively coupled circuits.

$$Z_1 = R_1 + j(\omega L_1 - 1/\omega C_1) = R_1 + j\omega L_1(1 - 1/\omega^2 L_1 C_1)$$

Let $F = \omega/\omega_o$

Where $\omega$ is $2\pi \times$ frequency under consideration,

$\omega_o$ is $2\pi \times$ frequency at resonance.

$\omega_o L_1 = 1/\omega_o C_1$

$1/\omega_o^2 L_1 C_1 = 1$ by definition of resonance.

Substituting:

$$\frac{\omega^2 L_1 C_1 - 1}{\omega^2 L_1 C_1} = \frac{\omega^2 - \omega_o^2}{\omega^2}$$

Simplifying:

$$\omega^2 = \omega^2 \omega_o^2 L_1 C_1$$

Whence:

$$1 - 1/\omega^2 L_1 C_1 = 1 - 1/F^2$$

Therefore:

$$Z_1 = R_1 + j\omega L_1(1 - 1/F^2)$$

Also

$$Z_2 = R_2 + j(\omega L_2 - 1/\omega C_2) = R_2 + j\omega L_2 (1 - 1/\omega^2 L_2 C_2) = R_2 + j\omega L(1 - 1/F^2)$$

$$I_2 = jE\omega M \div R_1 R_2 - (1 - 1/F^2)^2 \omega^2 L_1 L_2 + \omega^2 M^2 + j(1 - 1/F^2)(\omega L_1 R_2 + \omega L_2 R_1) \qquad (1)$$

Let: $Q_1 = \omega L_1/R_1$, $Q_2 = \omega L_2/R_2$, $M = \sqrt{L_1 L_2}$, $K = M/\sqrt{L_1 L_2}$

Multiplying (1) by $\dfrac{\omega^2 L_1 L_2}{\omega^2 L_1 L_2}$ we have:

$$I_2 = -jEK \div F\omega_o \sqrt{L_1 L_2}\,[K^2 + 1/Q_1 Q_2 - (1 - 1/F^2)^2 + j(1 - 1/F^2)(1/Q_1 + 1/Q_2)] \qquad (2)$$

Conditions for maximum secondary current are: circuits 1 and 2 are in resonance

$$(\omega M)^2/R_2 = R_1 \text{ or } \omega M = \sqrt{R_1 R_2}$$

This condition is called critical coupling:

$$K = M/\sqrt{L_1 L_2} = 1/\sqrt{Q_1 Q_2}$$

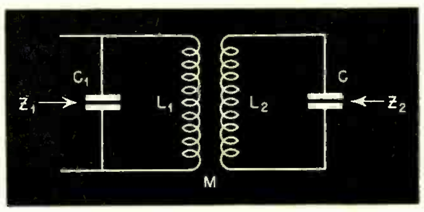



FIG. 3

Whence (1) reduces to:

$$I_2 = \frac{-jE_1 K}{\omega_o \sqrt{L_1 L_2}(K^2 + 1/Q_1 Q_2)} = \frac{-jE\sqrt{Q_1 Q_2}}{2\omega_o \sqrt{L_1 L_2}} = -j\frac{E}{2\sqrt{R_1 R_2}} \qquad (3)$$

If the coupling exceeds the critical value the response curve will depart from the single hump and two humps will appear, as in *Fig. 4*. The secondary current at each hump will be equal to resonance secondary current with critical coupling. The spacing of the humps is a function of the ratio of coupling to critical coupling. When the coupling is considerably above critical, then the humps occur at prac-

[*Continued on page 28*]

* Thevenin's Theorem, page 23, October, 1942.

tically the same frequencies as if $R_1 = R_2 = 0$.

Assume $R_1 = R_2 = 0$, or $Q_1 = Q_2 = \infty$ (i.e., zero losses). Then, from (2):

$$I_2 = \frac{-jEK}{F\omega_o\sqrt{L_1L_2}[K^2-(1-1/F^2)^2]} = 0$$

$I_2$ will equal infinity if

$$F\omega_o\sqrt{L_1L_2}[K^2-(1-1/F^2)^2] = 0$$

or:

$$K^2 = (1-1/F^2)^2$$

$$K = 1-1/F^2 \qquad (4)$$

Whence:

$$F = \omega/\omega_o = 1/\sqrt{1 \pm K} \qquad (5)$$

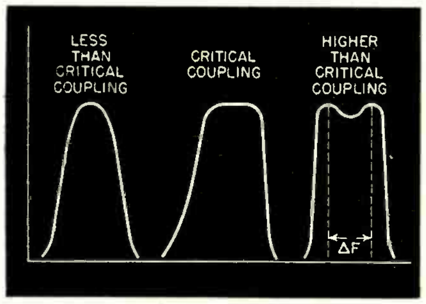



FIG. 4

From (5) the bandwidth $\Delta F$ between humps is related to resonance frequency $\omega_o/2\pi = f_o$ by:

$$\frac{\Delta F}{f_o} = \frac{\sqrt{1+K}-\sqrt{1-K}}{\sqrt{1-K^2}}$$

If $K$ is very small, as is generally the case in practice, then

$$\Delta F/f_o = K$$

Also, at critical coupling: $E_2/E_1 = Q_1/2 =$ circuit voltage step up if $Q_1 = Q_2$. From this it is obvious that the Q of the combination is less than the Q of either circuit. If $Q_1 = Q_2$ the effective Q of the coupled combination is $Q_1/2 = Q_2/2$. Obviously the response of the coupled circuit at critical coupling if $Q_1 = Q_2$ is down 6 db on the response of either circuit used alone.

#### TRANSFORMER PRIMARY INDUCTANCE

**Problem 3:** *Determine from a practical design standpoint the relative magnitude of the primary inductance of an interstage audio transformer to prevent undue loss of low-frequency response.*

**Solution:** Let *Fig. 5* represent the equivalent circuit of an input or interstage transformer, and in which $Z_1$ is the primary impedance with secondary open circuited, and $Z_2$ the secondary impedance with primary on open circuit.

The transformer turns ratio is:

$$N = \sqrt{L_2/L_1}$$

At low frequencies, the input impedance of the tube fed by the transformer is large, so that to a first approximation the impedance looking into the primary is:

$$Z_1 = R_1 + jX_1$$

Whence $I_1 = E_1/R_o + jX_1$ nearly.

At low frequencies, it is justifiable to neglect $Z_2$ in comparison with $Z_3$. Then:

$$I_2 = \frac{\omega M E_1}{(R_o + jX_1)Z_3} \text{ approximately.}$$

Now, the coefficient of coupling of the transformer is:

$$K = \frac{M}{\sqrt{L_1L_2}}$$

If $K = 1$ $\quad M = \sqrt{L_1L_2}$

and $\quad \omega M = \sqrt{X_1X_2}$

when $\omega = 2\pi \times$ frequency in question.

By definition:

$$N^2 = \frac{X_2}{X_1}$$

Or $\quad N^2X_1^2 = X_2X_1$

$$NX_1 = \sqrt{X_1X_2} = \omega M$$

Whence:

$$I_2 = \frac{NX_1E_1}{(R_o+jX_1)Z_3}$$

And:

$$E_2 = Z_3I_2 = \frac{\omega M E_1}{(R_o + jX_1)}$$

Let: $A = E_2/E_1$

Then:

$$A^2 = \frac{\omega^2M^2}{(R_o+jX_1)^2} = \frac{\omega^2M_2}{R_o^2+X_1^2} = \frac{N^2X_1^2}{R_o^2+X_1^2}$$

From practical considerations let:

$$\omega^2M^2/X_1 = N^2X_1 = B$$

Whence:

$$A^2 = \frac{N^2X_1^2}{R_o^2+X_1^2} = \frac{N^2B^2}{N^4(R_o^2+X_1^2)} = \frac{N^2B^2}{N^4R_o^2+B^2}$$

Setting $\delta/\delta N\ (A^2) = 0$ to solve for maximum.

We have:

$$N^2B^2(4N^3R_o^2) = 2NB^2(N^4R_o^2+B^2)$$

That is:

$A$ is a maximum when:

$$B = N^2R_o$$

or $\quad R_o = X_1$

For any higher frequency, say, $\omega_1 = 2\pi f_1$:

$$X_1 = \omega_1L_1 = \frac{\omega_1}{\omega}R_o$$

And

$$A^2 = \frac{N^2R_o^2\ \omega_1^2/\omega^2}{R_o^2(\omega^2+\omega_1^2/\omega^2)}$$

And $A = N$ when $\omega_1 \gg \omega$

Therefore the frequency at which $X_1 = R_o$ holds should be well below the desired low-frequency cutoff.

As a practical case, assume that it is required that the response of an interstage transformer be relatively uniform down to say 60 cycles (i.e., $\omega_1 = 2\pi \times 60$).

If $\omega_1 = 3\omega$

$$A = \frac{N^2R_o^2\ 9\omega^2/\omega^2}{R_o^2(\omega^2+9\omega^2/\omega^2)} = \frac{9N^2R_o^2}{10R_o^2} = 0.9N^2$$

$$A = .95\ N$$

If $R_o = 10{,}000$ ohms, then:

$$L_1 = R_o/\omega = 10{,}000/2\pi \times 20 = 80 \text{ henrys.}$$

Had ten times 80 henrys been employed the gain in response would have been something less than .5 db, and had three times 80 henrys been used the gain at 60 cycles would have been about .25 db.

The relation of $\omega_1 = 3\omega$ is a fair value in all ordinary cases. However, in some especially critical transformers, a higher value might be justified. To illustrate, assume: $\omega_1 = 6\omega$.

$$A^2 = \frac{36}{37}N^2 = .97N^2$$

$$A = .985N$$

$$L_1 = 10{,}000/2\pi \times 10 = 160 \text{ henrys.}$$

Obviously the loss due to primary impedance alone would amount to about 0.1 db at 60 cycles.

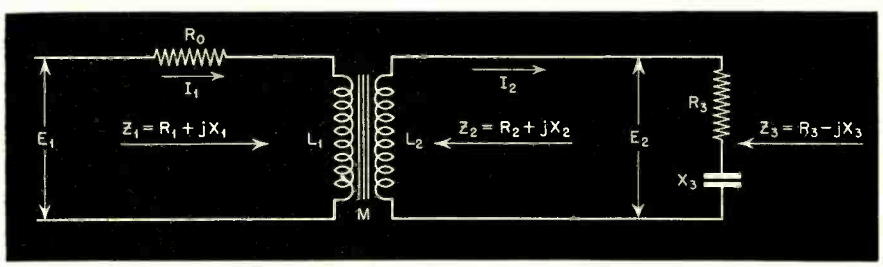



FIG. 5


Dear Mom-Thanks for sending me an Echophone EC-1 it has certainly kept me from getting lonely!
PVT. KILDAY
CAMP LEE

# AIRCRAFT RADIO MAINTENANCE

GERALD O. CROWLEY

★ The maintenance of aircraft radio equipment differs radically from the ordinary type of radio servicing. This is due in part to the advanced design of aircraft radio and the severe usuage to which such equipment is subjected. But more unique is the cardinal rule that aircraft radio equipment, like aircraft engines, *must not fail in service.*

A dependable communications system is an important essential to any form of flight activity. In peace or war, the conduct of operations above the surface of the earth is controlled by this thin bond with the ground below. With the speed of our latest pursuit ships already surpassing that of sound waves, radio alone can provide such a means of communication.

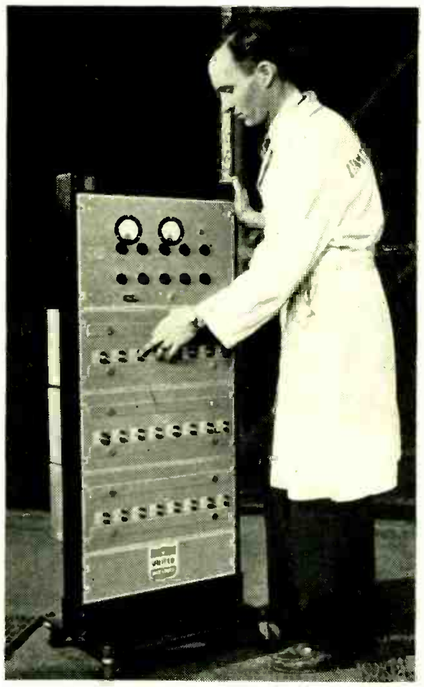
Shake tester, for jogging transmitters, receivers, mikes, etc., to show up mechanical or electrical faults. (Photo courtesy United Airlines).

Removed from the living room and installed in an airplane, a radio receiver loses its common identity as a means of entertainment. Aside from its value as a communications unit, in its new role it has also become a vital adjunct to the plane's complement of flight instruments. When a household radio sputters and goes dead a portion of a football game or news broadcast may be lost to the listener. But when aircraft radio equipment fails in service the results are not pleasant to contemplate: A torpedo bomber—searching vainly for its carrier—crashes into the sea out of fuel. Or an airline transport with its human cargo becomes a flaming pyre on a desolate mountain top.

Aircraft radio engineers, specialists in their field, have made a persistent and methodic study of the causes of aircraft radio equipment service failures. Their practical findings provide a solid foundation for the service routine followed by airline radio maintenance departments. "Pre-failure radio maintenance" — periodic overhauling of equipment while still in satisfactory operating condition—has proved to be the one really successful means of preventing radio failures in flight. Such a system, of course, depends upon rigid adherence of maintenance personnel to established testing and maintenance procedures.

### Maintenance Routine

As practiced by one major airline, radio equipment receives a daily check, a thirty day (250-hour service) removable equipment overhaul, a ninety day (750-hour service) complete equipment overhaul and a 5000-hour major overhaul. Maintenance routine is firmly established for each of these service periods and technicians follow procedures to the letter. The practicability of this company's system is attested to by their remarkably low record of radio service failures.



Crystal-controlled push-button signal generator for test and alignment purposes. (Photo courtesy United Airlines).

A typical radio installation in an airline transport plane will include the following pieces of equipment:

1—Two-way radio-telephone communications unit.

2—Long-wave radio range (beam) receiver.

3—A.D.F. range receiver or radio compass.

4—Ultra-high-frequency marker beacon receiver.

5—Pilots' interphone amplifier.

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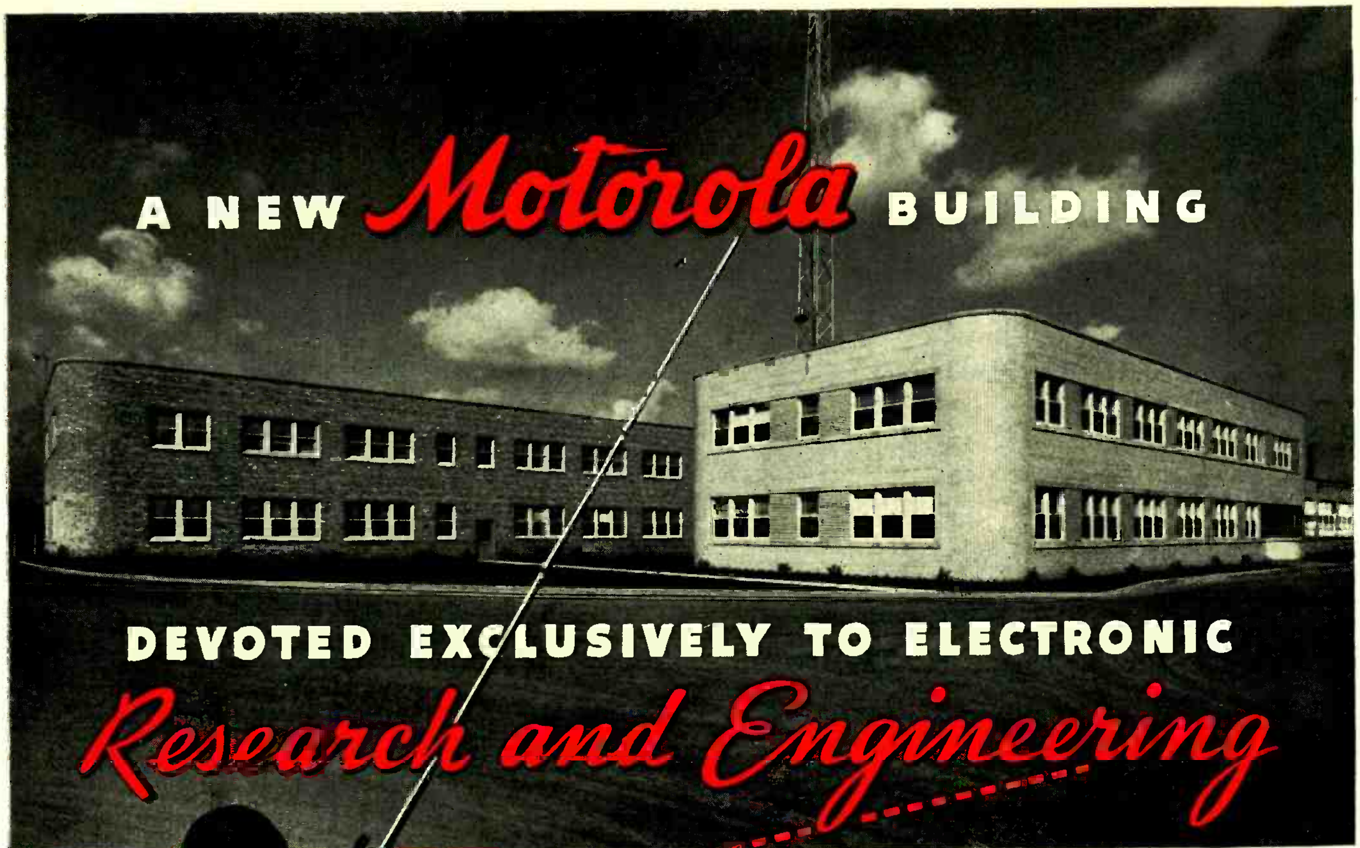


When war came, Motorola research and engineering was already at work around the clock on special assignments for our Armed Forces. Now in its new home, the Motorola staff of engineers and technicians is by specific government assignments at work on problems which embrace many important phases of electronic knowledge. This new Motorola engineering building increases many times our capacity for service of the highest order.

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**Awarded for excellence in the production of Communications Equipment for America's Armed Forces**


*Photo Courtesy U. S. Army Signal Corps*

**Motorola Radio Communication Systems**
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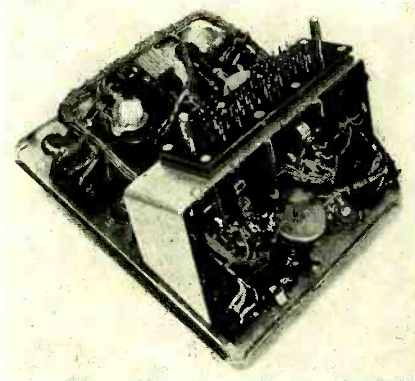
**GALVIN MFG. CORPORATION · CHICAGO**

In addition to the above units are numerous pieces of auxiliary equipment. Under this heading is found transmitting and receiving dynamotors, antennae, microphones, headsets, control panels, jack boxes, range filters, marker beacon visual indicators, control heads and cables, azimuth indicators, antistatic cartridges and relays. To keep this imposing array of radio apparatus in perfect operating condition is the formidable task of the radio maintenance department.

The daily radio check takes the form of operational tests of each piece of equipment prior to and at the completion of each flight. The pilot's log book furnishes a record of radio performance in flight. When a report of radio malfunctioning is noted, the suspected piece of equipment is replaced with a tested unit and sent to the shop for complete overhaul. Visual inspections are also made daily of antennae, microphone and headset cords and other easily accessible accessories.

At the thirty-day check period each major piece of radio equipment is removed from the ship for a complete bench overhaul. Service benches have complete facilities necessary for the repair and alignment of all units. A double-screened test room is fitted with testing instruments equaled only by those found in engineering laboratories. A complete overhaul procedure for each unit is available to the technician in a handy reference file. Liberal stocks of replacement parts encourage personnel to replace doubtful or worn components.



**Rear view of main radio control panel. Multiple plug allows for easy service removal. Leads and resistors are tied down. (Photo by Western Airlines).**

### Test Procedure

Overhaul of transmitters and receivers begins usually with a careful visual inspection of all parts and connections. Following this all tubes are tested. Particular care is exercised to reject any tube with a tendency to produce noise under vibration. Such tubes are detected by the familiar method of tapping them with a small rubber hammer while the set is hooked up on the bench with gain controlling adjustments set to a point of high sensitivity. Tuning condenser wiper contacts, range switch contacts and relay points are thoroughly cleaned with carbon-tetrachloride. Relay points are further attended with a burnishing tool and adjusted to operate with seventy-five per cent of normal operating voltage. Vibrators are given starting tests at reduced voltage and replaced if sluggish in action. The rubber hammer is used on all bypass condensers, sockets and other small parts to reveal poor swedged or soldered connections.

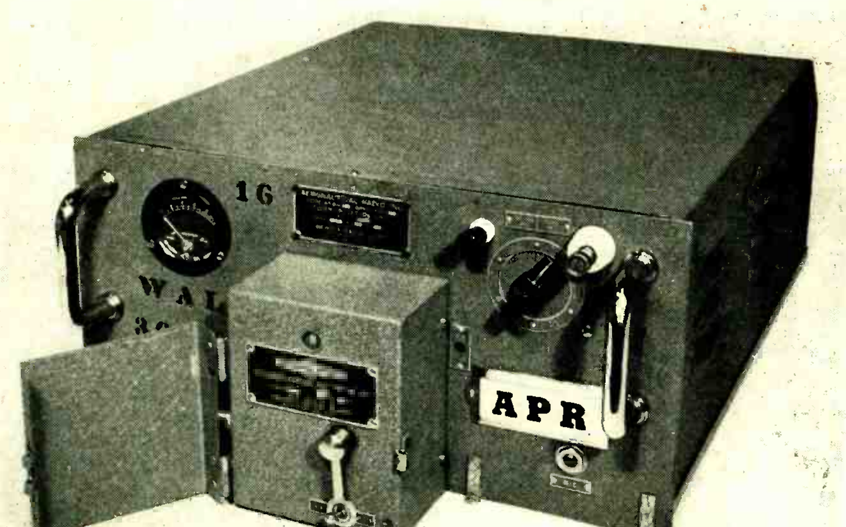
When replacement of a component is made, particular attention is paid to the fastening down of the part and to the soldering of its connections. Condensers or resistors cannot be hung by their leads as the vibration encountered in aircraft use would soon cause the leads to break off. The same is true of cold soldered connections. Aircraft radio technicians soon become masters at the too-rare art of soldering.

Having passed these preliminary vibration tests, the unit is given a ride on the bounce-table. Here in a few minutes it undergoes a jolting equivalent to hours of aircraft service. Surviving this with flying colors, the unit is ready for alignment. All aligning is done with frequency-modulated signal generators and oscilloscopes. Measurements are made of i.f. sensitivity and bandwidth, overall sensitivity, signal-to-noise ratio, image attenuation, a.v.c. action and power output. Exacting manufacturers' standards of performance must be met without compromise. Transmitters are further tested after alignment for oscillator starting, percentage of modulation and distortion, audio frequency response and sidetone. Radio compasses, in addition to the receiver tests, are checked for loop speed, orientation, accuracy and hunting. After a final air check units are ready to be installed in the ship.

### Shop and Service Records

An important detail is the record system used to keep tab on overhaul dates. In addition to shop records a permanent service record accompanies each piece of equipment. This is a small record book kept in the unit itself. It is referred to each time the unit is serviced. An easily identified card bearing the next overhaul due date is also fastened to the outside face of each unit. A glance at the radio rack will reveal instantly the pieces of equipment which are due for overhaul.

Other removable equipment serviced during the thirty-day check include headsets, microphones, dynamotors, control heads and drive cables. Headsets are checked for sensitivity and response and worn headbands and cords replaced. Microphones are repacked and push-to-talk switches are cleaned, burnished and adjusted. Dynamotor commutators are cleaned or, if necessary, lathe-turned and undercut. Brushes and solenoid contacts are replaced. Control heads and cables are checked for rough action and backlash and overhauled if more than a minimum of either is evident.




**Aircraft communications unit showing overhaul date card mounted on face. (Photo courtesy Western Airlines).**

During the ninety-day overhaul, all the foregoing is performed and, in addition, all the fixed equipment in the ship receives a thorough going-over.

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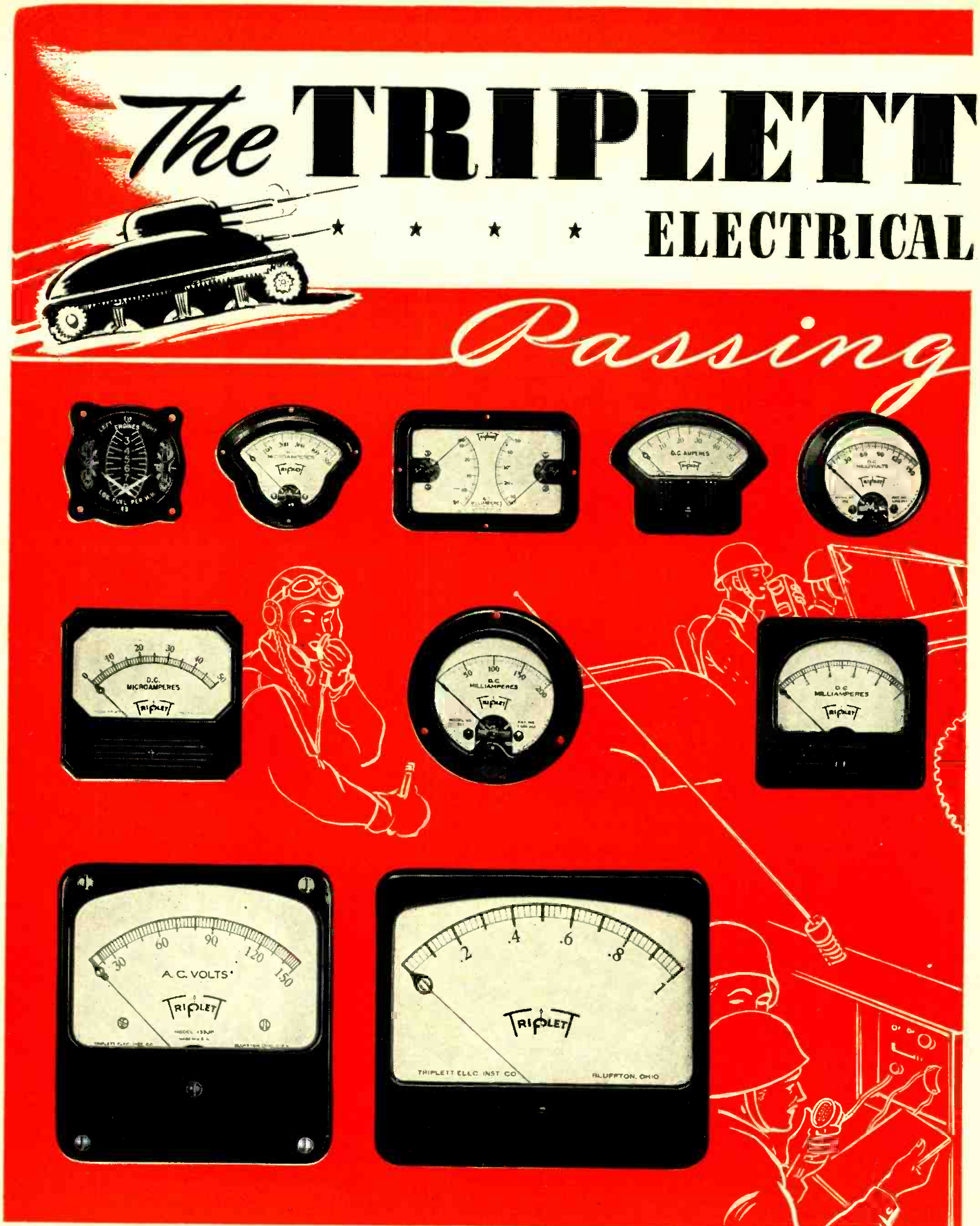
The TRIPLETT
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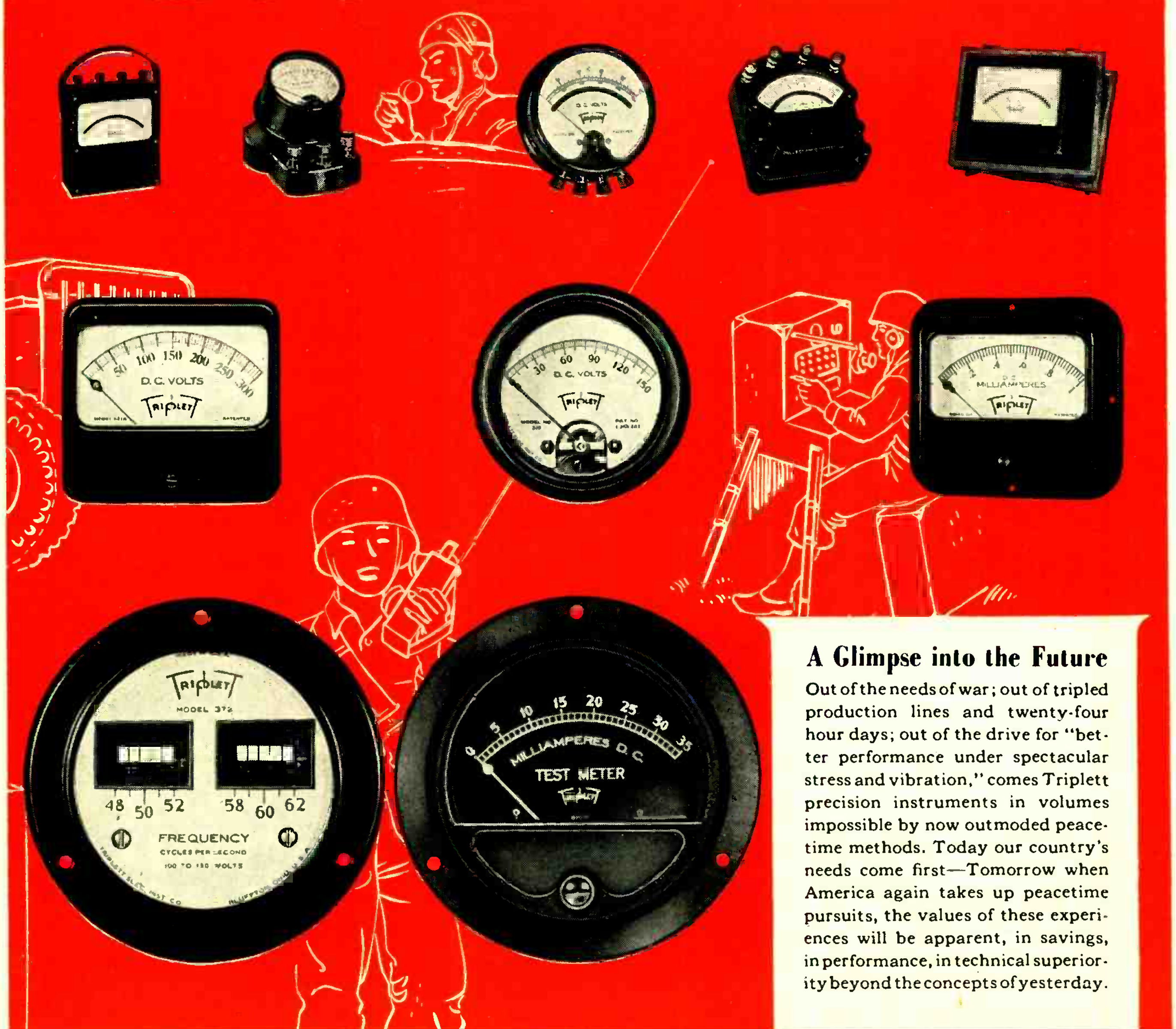
# Combat Line
# MEASURING INSTRUMENTS
# in Review

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TRIPLETT

# Q. & A. STUDY GUIDE

C. RADIUS
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## VACUUM TUBES—2

### TRIODE CHARACTERISTICS

*16. Describe the physical construction of a triode electron tube. (II-126).*

*17. What is the primary purpose of the control grid of a triode? (V-64).*

As the name implies, a triode contains three elements or electrodes, the electron emitter of filament or cathode type, a wire grid surrounding the emitter, and a plate enclosing the elements. By applying a varying potential to the grid it is possible to control the space charge which is made up of a cloud of electrons around the cathode, and thus control the flow of electrons from the cathode to the plate.

*18. What is the meaning of the term 'plate-saturation'? (II-147).*

*19. What is the meaning of plate impedance? (II-129).*

*20. What is the meaning of mutual conductance? Transconductance? (II-130).*

*21. If the plate current of a vacuum tube changed 5 milliamperes for a grid voltage change of 2.5 volts, what is the value of the transconductance? (II-284).*

*22. What is the meaning of amplification factor? (II-132).*

*Fig. 1* shows how the plate current, $I_p$, varies with the plate potential, $E_p$, when the grid potential is being held constant. It is apparent that beyond a certain plate potential the plate current ceases to increase. This is the condition in which all the electrons reach the plate and is known as 'plate saturation'.

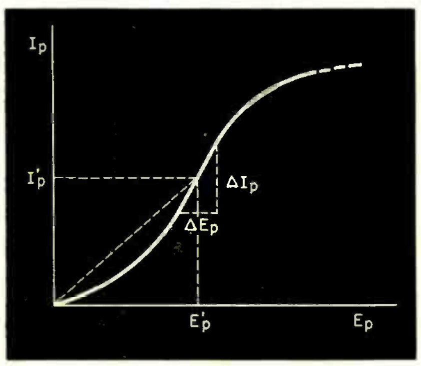


**Fig. 1. Showing how plate current varies with plate voltage when grid voltage is held constant.**

The plate impedance, $r_p$, is the effective plate-to-cathode resistance of the tube. It is given by the ratio of the plate voltage change $\Delta E_p$, to the plate current change $\Delta I_p$, for constant grid voltage. In the case of triodes $r_p$ ranges in value between 800 and 150,000 ohms. The ratio of $E_p'$ to $I_p'$ is the d-c resistance which would determine the voltage drop across the tube when no signal is applied to the grid.

*Fig. 2* shows how the plate current varies with the grid potential, $E_g$, when the plate potential is being held constant. The ratio of the change in plate current $\Delta I_p$, to the change in grid potential $\Delta E_g$, is known as the mutual conductance or transconductance $g_m$. It is frequently defined as the change of plate current for a change of 1 volt on the grid. If a change of 2.5 volts on the grid causes a 5-milliampere change in plate current, the transconductance is given by $\frac{0.005}{2.5} \times 10^6 = 2000$ micromhos. For triodes $g_m$ varies from 200 to 5000 micromhos. This is the important characteristic in the choice of power tubes.

Since the grid is located in the middle of the space charge its potenital is more effective in controlling the plate current than the plate potential. Ideally, the plate potential should not control the plate current. The real function of the plate is to collect the electrons. The ratio of $\triangle E_p$ to $\triangle E_g$ with constant plate current is the amplification factor, $\mu$, of the tube. For the most triodes the values of $\mu$ range from 10 to 100.

*23. What is the purpose of a bias voltage on the grid of an audio amplifier tube? (II-144).*

*24. What are the factors which determine the bias voltage for the grid of a vacuum tube? (II-170).*

*25. Draw a grid voltage-plate current characteristic curve of a vacuum tube and indicate the operating points for 'Class A', 'Class B', and 'Class C' amplifier operations. (II-152).*

*26. What is meant by a blocked grid? (II-141).*

All tubes used in audio-frequency amplifiers operate with the grid held at a negative potential ranging from zero to cutoff. When an alternating potential is applied between grid and cathode, the plate current will likewise contain an alternating component. If the tube is biased at point *A* in *Fig. 2*, the plate current variation will be similar to the grid potential variation; the $I_p$-$E_g$ curve being practically a straight line (linear) in this range. The maximum value of the signal should not exceed the bias voltage. This method of operation is known as Class A. It is obvious that plate current flows throughout the entire cycle in this mode of operation.

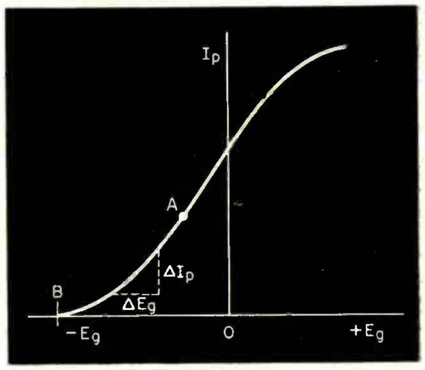


**Fig. 2. Grid-voltage plate-current curve, illustrating Class A, B and C operation.**

The tube may also be biased at point *B*. This is known as cutoff bias since plate current is zero with no signal. It is obvious that the plate current will flow only for one-half cycle. Therefore, in audio-frequency amplification, it will be necessary to use another tube to carry the plate current during the second half of the cycle. This is known as Class B operation. The degree of fidelity is below that of Class A; the efficiency, however, is greater, since no plate current flows until a signal is applied.

A third method of operation, known as Class C, is used in radio-frequency amplifiers where the grid may be biased anywhere from one and one-half to four times cutoff bias. Plate current will flow for only a small portion of the cycle during which time the LC tank circuit is energized.

If cutoff bias occurs in a circuit which is normally biased above this

[*Continued on page 46*]

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"War is Hell"—tough on men and equipment. Today, with radio fighting on five fronts, transformers are exposed to every conceivable climatic condition.

Thermador Transformers are Thermatite treated to withstand extreme temperatures and humidity—arid or moist heat—dry or damp cold do not hamper their efficiency. Thermatite is the name of a process of accurate heat controlled vacuum impregnation developed and improved by ten years of daily use by the same personnel and supervision.

Experienced engineers are at your service at Thermador. May we be of assistance in engineering and producing transformers to meet your requirements?

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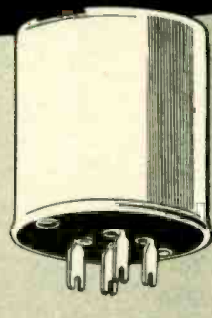

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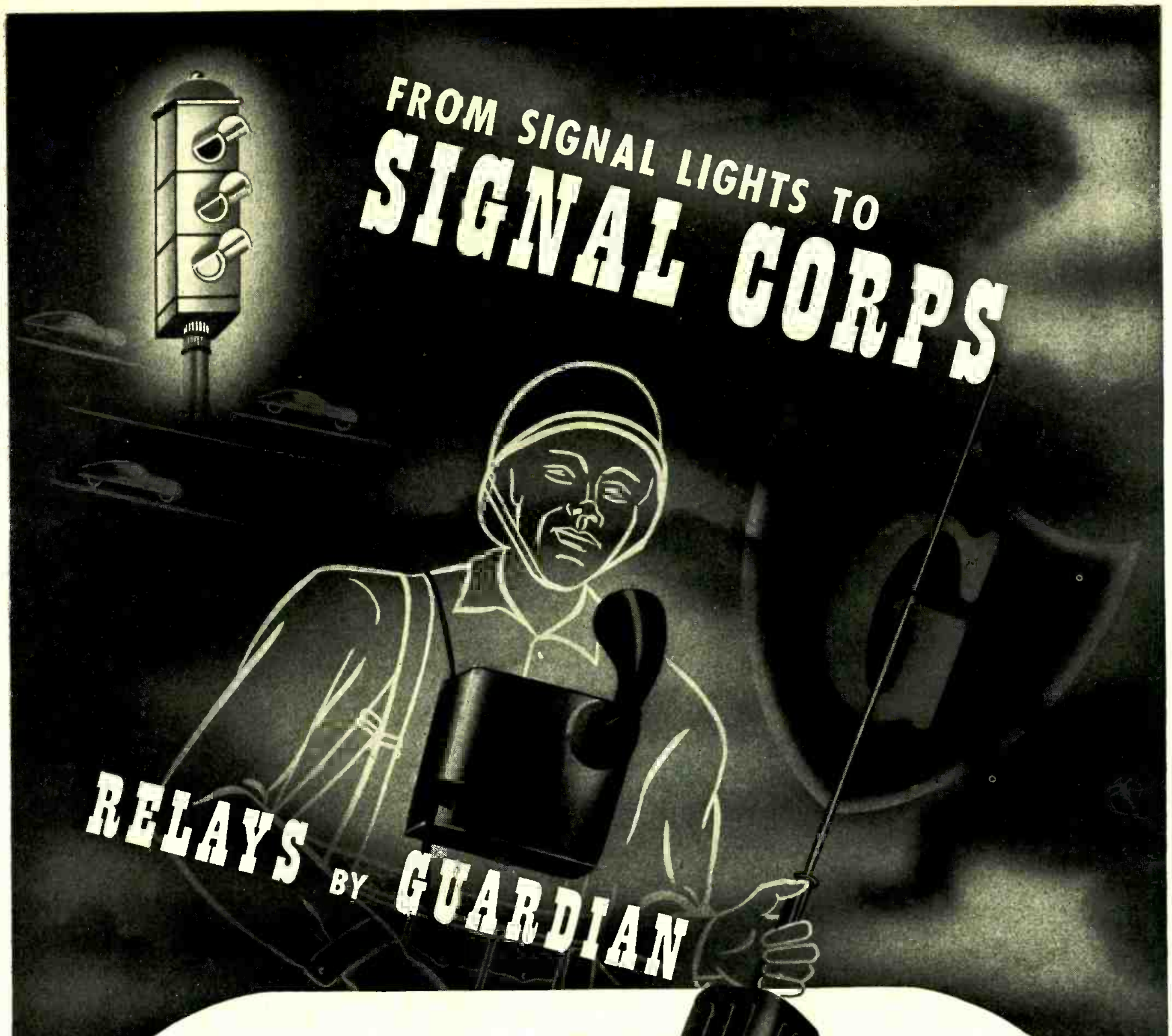


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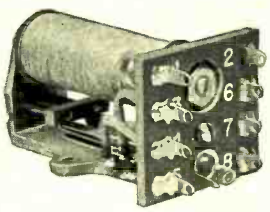

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#292,095 — Helling — Aug. 13, 1929, Filed May 19, 1928. (Canada)—Automatic tuning control mechanism for radio apparatus. Push button tuning with motor.

#289,163 — 1927-28 — Wilbourne (Br.) — Improvements in or relating to remote control mechanism for indicating and other purposes. Novel use of flexible shafts.

#289,162 — 1928 — Barber. (Br.) — Remote control mechanism. Uses turn cable.

#263,567 — 1925 — Holt (Br.) — Bowden cable to tune.

#248,821 — Mittell (Br.) — Relays at volume control point for turning set on or off.

#243,041 — 1924-25 — Barber (Br.) — Remote control mechanism. Novel use of flexible shafts.

#238,338 — 1924 — (Br.) — Uses preselected tuned circuits with relay to change from one to another.

#2,122,912 — 1925-38-Levy (Federal Tel. & Tel.) — Automatic Tuning. Broad on remote of volume-tuning.

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#1,942,587 — 1930-34 — Whitman (Hazeltine Corp.) — Control system. An a.c. balanced bridge, the unbalance being amplified and applied to thyratron grids in parallel. Plates supplied by a.c. 180° out of phase to operate one of two motor drive relays.

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#1,930,209 — 1927-33 — Alden (Radio Inventions) — Continuous tuning or step by step. Uses two tones or frequencies.

#1,926,383 — 1930-33 — Manson (Stromberg) — Remote control radio receiving system. Preselection and continuous.

#1,926,256 — 1931-33 — Barrett (Utah) — Remote control device for radio receiving system. Pull cable device.

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#1,808,916 — 1925-31 — Burkholder (W.E.)—Circuit control system. A ratchet step means for tuning receiver. Uses solenoids to determine direction.

#1,796,998 — 1928-31 — Hand — Remote control and indication of a loop.

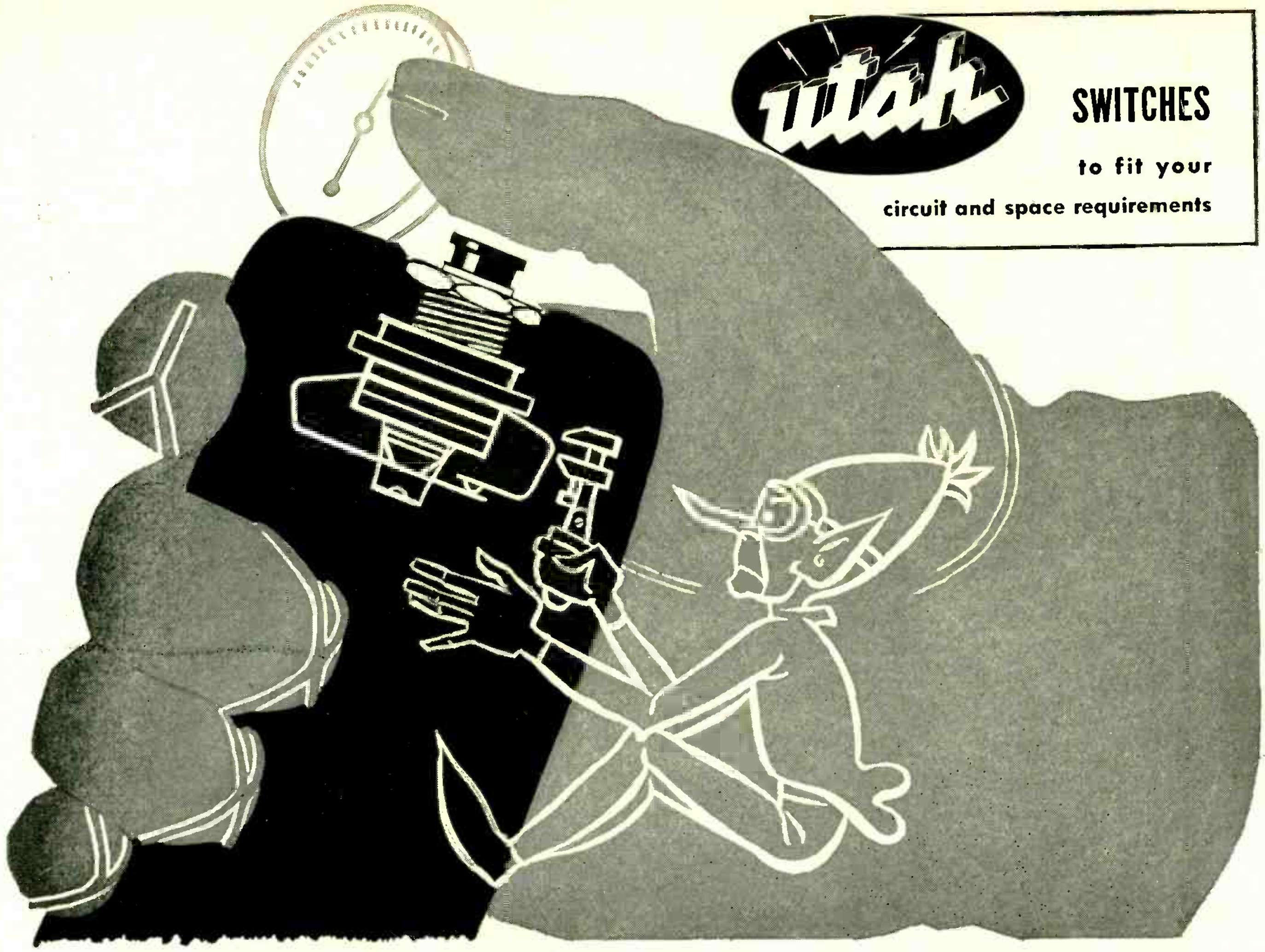
#1,780,669 — 1925-30 — Bruckel — A remote telemetering system by varying the frequency of a carrier current, using a tuned circuit (series) driving one tube across the capacitor and the other across the inductance.

#1,778,761 — 1924-30 — Heising (W.E.) — Remote control system. Uses step by step motor.

#1,769,256 — 1927-30 — Clark — Plug-in remote volume control.

#1,742,147 — 1926-29 — Renwick — Distant control for radio apparatus. Motor control of tuning with voltmeter indicator at remote end. Uses brake on motor.

[*Continued on page 46*]

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#1,738,262 — 1925-29 — Powell (Stromberg Carlson)—Method and apparatus for remotely controlling radio receiving systems. Uses bridge unbalance and motor tuning. Two wire control.

#1,718,497 — 1924-29 — St. Clair (G.E.) —Telemetric system. Remote control metering by variable frequency.

#1,706,968 — 1929 — Schlekher — Apparatus for control of movable member. Uses Wheatstone bridge.

#1,655,160 — 1922. Reissued #18,637—1932. Powell (Stromberg Carlson) — Radio selected and continuously tuned over telephone line. Audio fed back over same wires. Broad.

#1,626,449 — 1925-27 — Brown (G.E.) — Automatic antenna regulation. A means for retuning antenna when it is tuned above or below a master tuned circuit.

#1,600,204 — 1924-26 — Alexanderson (G.E.) — Means for transmitting angular motion. Operations of selsyn motors over radio circuit. Translates current flowing in each armature leg into impulses of different lengths. Impulses transmitted over three carriers.

#1,587,924 — 1921-26 — Round (RCA) — Wireless signaling system. Automatic tuning means that tends to keep a circuit tuned to a given frequency.

#1,586,233 — 1925-26 — Anschutz Kaempfe — Means for controlling rotating field motors. Uses an a.c. bridge to change the phase and direction of current in the second field winding of an induction motor.

#1,563,994 — 1921-25 — Kaminski (Siemens Halske) — System for adjusting devices at a distance. A system for rudder control, etc., that uses selsyn motors for indication.

#1,428,507 — 1922 — RE 15,924 — Sperry — Wireless repeating system. Uses control by sending three r.f. signals in sequence to operate step by step motor.

#1,296,440 — 1911-19 — Sperry — Repeater system for gyro-compasses. A step by step motor. Uses contacts that overlap to give greater number of steps per revolution.

#1,234,127 — 1915-17 — Bristol (Bristol Co.)—Automatically synchronized entertainment device. Selsyn principle.

#1,052,528 — 1910-13 — Sundh (Otis Elevator) — Inductive controlling apparatus. Uses an induction bridge unbalance to remotely control indicators, etc.

#811,539 — 1905-06 — Bates (Westinghouse) — Electric control system. For electric motors, by means of which the amount and direction of movement of the operated device may be accurately predetermined and governed.

#707,056 — 1/10/02 — Ehret — Auto selective system. A motor driven collator switch, a number of fixed tuned circuits, and means for stopping collator switch when it is connected to an energized tuned circuit.

#459,323 — 1890-91 — Weuste — Electric contact apparatus. Uses double ratchet for remote indication.

#406,830 — 1888-89 — Fiske — Method of finding range and position of distant objects. Wheatstone bridge.

#354,124 — 1930-31 — Kolster-Brandes — Improvements relating to remote control devices for radio receivers. Wheatstone Bridge with motor drive for tuning. Voltmeter indicator at remote point.

#341,464 — 1929-31 — Crilly (Canada) — Improvements in or related to control systems for radio instruments. Pre-selection, motor drive, remote volume control.

#287,191 — 1915 — Ratchet tuning of a variable condenser.

## Q. & A. STUDY GUIDE

[*Continued from page 36*]

point, the condition is referred to as a blocked grid. This technique is used advantageously to intermittently suppress operation in some continuous-wave (c.w.) transmitters.

*27. What is meant by the load on a vacuum tube? (II-142).*

*28 What is meant by the term 'maximum plate dissipation'? (II-140).*

*29. Draw a simple longitudinal cross-section of a water-cooled transmitting triode, showing the internal structure and labeling the various elements. (IV-110).*

*30. A 50-kilowatt transmitter employs 6 tubes in push-pull parallel in the final Class B linear stage, operating with a 50-kilowatt output and an efficiency of 33%. Assuming that all of the heat radiation is to the water-cooling system, what amount of power must be dissipated from each tube? (IV-126).*

Audio amplifiers must transmit a wide band of frequencies, all with the same amplitude. Therefore the load in the plate circuit of the tube must be an untuned, i.e., non-resonant, impedance. In all modes of operation this load is effectively a pure resistance in the middle frequency range. In radio-frequency amplifiers the load is usually a tuned circuit.

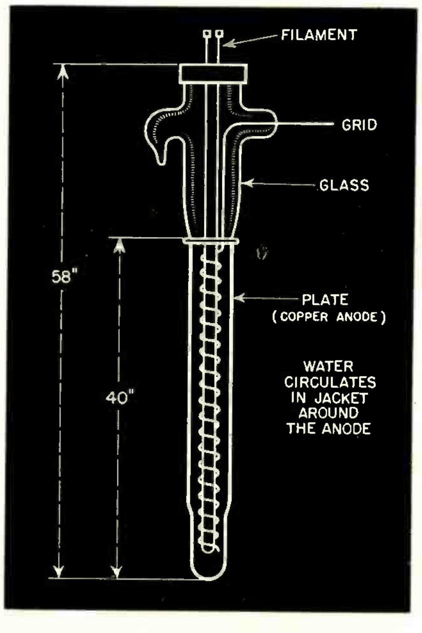
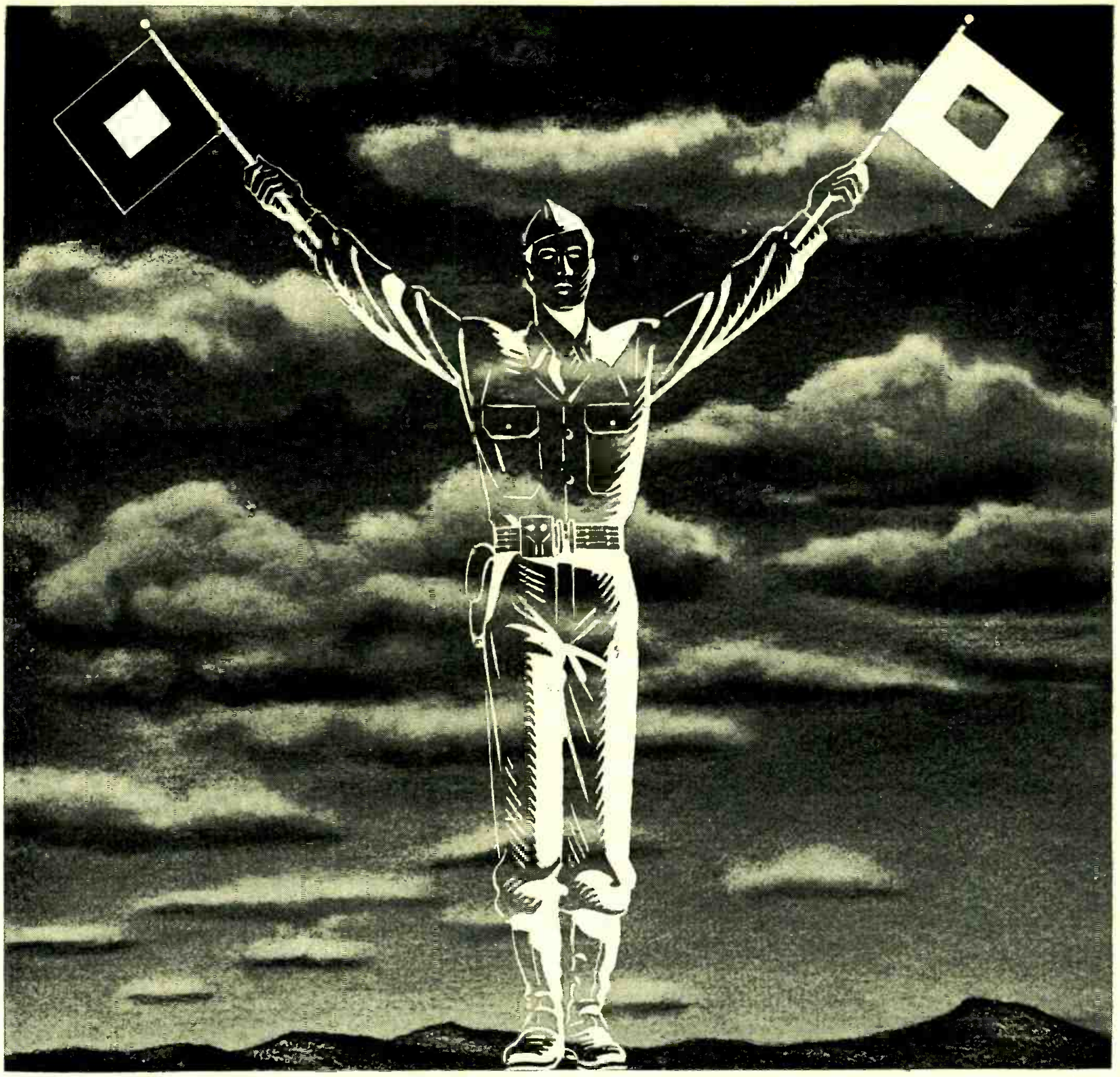



**Fig. 3. Water-cooled transmitting triode.**

As mentioned before, the plate of a vacuum tube functions as a collector of electrons. These electrons bombard the plate at very high velocities and their energy is liberated in the form of heat. When a tube is operating with a signal on the grid, part of the d-c power supplied to the plate circuit is converted into useful a-c power (audio- or radio-frequency). The remainder is dissipated in heat. With no signal applied to the grid and a bias above cutoff, all the power ($E_pI_p$) supplied to the plate circuit is dissipated in heating the plate. Each tube has a safe maximum plate dissipation which depends upon its construction. Referring to *Question 30,* the d-c power input is approximately 150 kilowatts. 50 kilowatts is useful output. Therefore, 100 kilowatts are dissipated in heat. Each tube then must dissipate around 16.67 kilowatts in the form of heat. Such large quantities of heat must be removed by circulating distilled water around the anode.

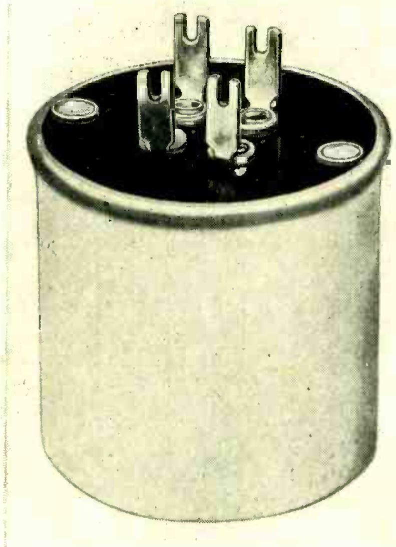
A longitudinal cross-section of such a water-cooled transmitting triode is shown in *Fig. 3.*



# NEW PRODUCTS

### THERMATITE TREATED TRANSFORMERS

Thermatite treated transformers, which constantly withstand extreme conditions of humidity and heat have been announced by the Thermador Electrical Manufacturing Company, of Los Angeles.



Now that radios and radio equipment often go into territories with extreme weather conditions, this new tested and approved form of impregnation is very important. Thermador manufactures Thermatite treated transformers in smaller sizes for radio use.

★

### R.C.P. CATHODE-RAY OSCILLOSCOPE

Radio City Products Company, Inc., announces its new Cathode Ray Oscilloscope Model 555. This instrument uses a 5″ cathode-ray tube operating on 2,000 volts. Maximum d.c. voltage at input to amplifier is 600 v. and direct to deflection plates 500 volts, rms. Input resistance is 3 megohms. Frequency response is ± 3 db from 20 cycles to 2 megacycles. Voltage gain is approximately 275 times. Ultra wide frequency range of sweep signal generator from 30 cycles to 350 kc, linear from 50 cycles. Unknown peak input voltage can be read on a direct indicating multi-range voltmeter. This is accomplished by a unique comparison method with an internal voltage source. Instrument operates from standard 115-230 volt, 50-60 cycle ac power supply.

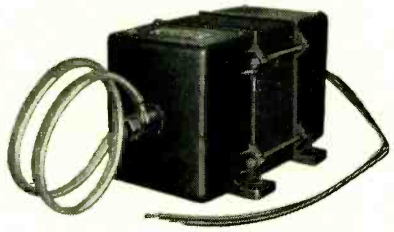
Model 555 is housed in a black crackle, non-corrosive, steel case, 14″ high, 12″ wide, and 19″ deep with convenient carrying handle.

★

### ISOLATING TEST TRANSFORMER

Testing of radio and communication equipment, especially for Signal Corps or other Service Branch use requires special accuracy. The usual practice is to test such equipment within a shielded test-room but even under such circumstances radio interference can enter shielded test-rooms by means of the power line.

To eliminate all interference that would affect the testing of equipment whose performance depends upon accuracy, the engineering department of The Acme Electric & Mfg. Co. of Cuba, New York, have designed the



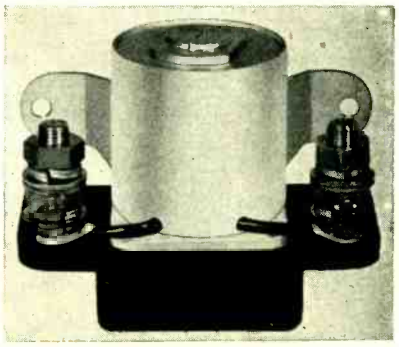
Acme Type T-4173 Isolating Transformer. This transformer makes use of a secondary completely enclosed in a copper shield. Secondary terminal connections are provided by means of a lead shielded cable, the sheath of which is integrally joined to the copper enclosing shield of the secondary winding.

The manufacturer claims that the Isolating Transformer, normally rated at 2 kva is capable of handling an overload of 50% or a total load of 3 kva. The regulation of the transformer is 1% at 1 kva. The lighting in the shielded test-room, the use of soldering irons, instruments and various types of test equipment may all be operated from the shielded secondary of the Isolating Transformer without causing objectionable voltage drop. The use of instruments or equipment may be used as the need requires, the load being switched on and off without affecting the relatively constant voltage necessary for accurate testing.

★

### AIRCRAFT SOLENOID CONTACTOR

Guardian Electric announces production of five types of approved solenoid contactor units built to U. S. Army Air Force specifications, for remote control of electrically actuated



aircraft armaments, instruments and devices. Among these, the B-4 type illustrated, originally designed for airplane starting motors, may be used for other applications of heavy current control.

The B-4 Solenoid Contactor operates on 24 volts, producing a coil current of 300 milliamperes. Contacts are rated at 200 amperes at 24 volts d.c. Unit has double pole, single throw, normally open contacts. It is claimed that unit resists acceleration and vibration over 10 times gravity and operates in any position. May be disassembled with pliers and screwdriver. Metal parts are plated to withstand 200-hour salt spray test. Weight of unit, 31 ounces. Descriptive circular and full details available from Guardian Electric, Dept. B-4, 1605 West Walnut Street, Chicago, Illinois.

[*Continued on page 64*]


# A date with Destiny

These two modern weapons of battle ...the electronic tube and the bombing plane ... have an important date with post-war industry. In the days to come Eimac tubes, like the airplane, will help achieve the better way of life for the common man.

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**RADIO AVIGATION**

[*Continued from page 22*]

sky waves are definitely limited in range.

There are no fixed rules for taking into consideration the night effect. Only experience can teach an operator to recognize all the forms of night effect. Care in taking a bearing and closely watching the minimum over an interval of time will help eliminate false readings. An ADF should "hunt"; that is, vary slightly on each side of the true reading, on a good bearing. Experience is the only teacher in detecting night effect in all cases.

### DF Procedure

Understanding the errors which are likely to interfere with good bearings reduces the procedure to straightforward DF work in flight. When navigating in normal flight the number of bearings will depend upon the stations available and necessity. A minimum reading is obtained and in the case of a broad split, maximum and minimum readings are noted and the mean reading taken.

At the same time the bearing is taken, or as soon as possible thereafter, the compass heading is noted. A correction curve will almost invariably be found for both the DF and the ship's compass[2]. For the compass, error is usually indicated as East or West, to obtain corrected compass reading. Easterly corrections are added and westerly corrections subtracted. DF corrections are generally indicated as positive or negative error, as in *Fig. 2.* The corrected bearing and corrected compass heading are added; should their sum equal more than 360°, this amount is subtracted. The result is the magnetic heading of the ship. The magnetic variation, observed from charts, in which the approximate location of the plane is known, is then added or subtracted, based on the rule that easterly variations are added and westerly variations subtracted to obtain the true bearing.

---

[2] Not discussed as a radio error, but nevertheless a controlling factor in accurate DF work, is the handling of the plane by the pilot, and reading of the compass. The airplane must be held on a constant course and at a level altitude. Serious "yawing" or turbulence make bearings inaccurate and impractical. In reading the compass to obtain the ship's heading, care must be exercised to make sure there is no compass lag. This is best determined by making sure the reading remains constant for a minimum of 20 seconds preceding the bearing.

[*Continued on page 52*]


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Since the position of the plane is not known on the operator's chart, it is impossible to plot the bearing without first taking the reciprocal (Bearing plus or minus 180°, depending upon its value; if bearing is less than 180° add 180°, over 180° subtract 180°). The reciprocal bearing must be plotted from the station. Bearings may be used to indicate the track of the plane, as a means of calculating the speed, or to locate the plane's position in a DF fix in *Fig. 3.*

As a check on speed, bearings which cross the track are taken at intervals. The time between the bearings and their point of intersection with the track is recorded and from this data the speed is readily determined. This procedure may be repeated several times to give an accurate check.

When a plane is reasonably close to the DF station the pilot may start to "home in." If an ADF is used, an "on course" relative bearing of 0° is flown, assuming no wind drift. Allowance for wind drift, if its velocity is over several knots, should be made. If only a loop is available, it may be locked in the zero position and the same procedure followed.

It is satisfactory in most cases, particularly involving the manual loop, to take bearings at frequent intervals, say around every 10 minutes. Right drift is subtracted and left drift added to the compass course. By neglecting drift the plane will home in on a parabolic course.

### Instrument Let-Downs

A number of types of instrument approaches exist, all of which are based on either relative bearings taken directly from the DF or QDM's, the magnetic bearing (Relative bearing plus compass heading equals magnetic bearing.) Approaches follow a definite sequence in which a certain bearing is flown for an allotted time, the course changed, again a bearing is flown for an allotted time, and the process repeated until the plane breaks through the overcast. The approach is entirely predicated on speed, time, and course from the instant the plane passes some given point; an abeam reading of 90° or 270°, or an overhead on the station, which is indicated by lack of aural minimum. Instrument approaches may also be made by boxing a station, which gives the exact position of the plane by a series of 90° turns around the signal source. Completely blind landings, except in the case of seaplanes which, because of larger landing areas are more easily handled, necessitate special equipment. [redacted] As in the case of fan-markers or the radio range apparatus, the equipment is in the hands of the pilot and as such is not a function of the radio navigator.

Should a plane be lost, or an operator unable to determine whether a station is 180° in error with his bearing, an "on course" or 90° or 270° should be flown, holding it until the observed bearing changes noticeably. If the bearing increases, the station is on the right; if it decreases, the station is on the left.

When bearings are being taken on an airplane from a ground station, whenever possible a trailing antenna should be avoided for transmissions. The trailing antenna introduces a noticeable error, once again due to excessive horizontal polarization, that does not seem to appear on a fixed antenna. This error is maximum when the plane is abeam of the station.

### Conclusion

It has not been the objective of this article to cover every phase of radio navigation for aircraft, but rather to introduce a science generally unfamil-

[*Continued on page 55*]

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iar to many radiomen. DF equipment has been so tremendously expanded and developed in the past several years that volumes would scarcely cover the subject. [redacted] Today, international carriers and aircraft ferries combine radio and celestial navigation to a degree of perfection that makes scheduled long-distance flights commonplace.

With the commercial future of international airplane flying assured as a major industry, the place radio navigation will hold in its future development and operations bears close watching by all technical men.

---

### FM EMERGENCY EQUIPMENT

[*Continued from page 19*]

securely in place beneath the chassis by a strong and neatly formed coil support.

Each transmitter and receiver is designed basically to operate successfully over the entire 30- to 42-mc band, and the "air-trimmer condensers" and "iron core tuning units" must obviously have sufficient range to accomplish the necessary changes to cover the whole band. It is evident that an air-trimmer condenser is either "all in" or "all out" with one-half turn of the adjusting screw driver. We have selected, however, a combination of iron-core tuning elements in the new design that provides for approximately thirty whole revolutions to cover the entire band. The comparative effect is as shown in *Fig. 9*. Curve *A* illustrates the variation in response of a particular circuit with the earlier design of equipment. The optimum performance point corresponds with the peak of the curve, and it is obvious that the initial setting must be extremely accurate, and that, similarly, any shifting of these tuning elements due to car vibration would be very critical. Now compare Curve *B*, which shows the variation in response with adjustments of the iron core tuning units near their proper setting. Since the optimum performance point is still at the peak, it is perfectly evident that the initial setting is far less critical, and, similarly, that changes due to vibration have less effect on ultimate performance.

A typical improvement of the modern unit, from the serviceman's standpoint is shown in *Fig. 10*. *A* shows the earlier unit lying on its side for servicing or inspection, whereas, *B* illustrates a substantial and rigid work bench support for the new unit. It will be noted that, as shown in *C*, the workbench support serves as the cover latch mechanism, the cover being removed by a quarter turn of a single handle; and from *D*, that the work-bench support is easily removed to facilitate servicing the top of the chassis.

Two other important factors should be mentioned: First, that this modern equipment which we refer to as the "All American" design, embodies many features suggested by hundreds of actual users who were contacted by means of a design questionnaire distributed by the General Electric Market Research Bureau. We hasten to pay tribute to the practical knowledge, the technical skill, and the thoroughly cooperative attitude of these hundreds of operators. Second, that this design is "keyed" to the war emergency period by having given special attention to the reduction in critical materials used. We mention three specific items.

*1—While this is a double-conversion superheterodyne receiver, we use a single crystal to control both heterodyning functions by making use of both the fundamental and the sixth harmonic of the crystal.*

*2—Air-trimmer condensers have been a serious limiting item for military equipment, and whereas our earlier unit used 22 of these per two-way equipment, we now use only five.*

*3—More than 50% reduction has been made in the amount of aluminum used.*

### Conclusion

By no means do we write "finis" to development work in this important communication field. Progress will be made in the future just as it has always been made in the past. We believe that it will be evident, however, that with "time" as the base of our curve, accomplished development put into action during these two and one-half years would now appear as a rapidly rising curve which has very materially levelled off into a period of refinement in circuit and component detail. We hasten to add that this last statement relates only to frequency modulation as now used in the 30- to 42-mc band for the emergency communication services. Much still remains to be done in the field of relaying equipment in the higher frequency bands and in antenna development. And furthermore, it is definitely not a function of this article to discuss developments in other parts of the spectrum, which work will, without question, receive tremendous acceleration due to the total war effort. Frequency modulation in the present 30- to 42-mc band has proven to be so valuable a communication tool, however, that whatever the developments which will surely expand the horizon of the emergency communication services, the present service will still be widely used.



### AIRCRAFT RADIO MAINTENANCE

[*Continued from page 32*]

Volume controls, fuses and switches are replaced. Jack boxes, control panels and rotatable loop gear boxes are removed from the ship for a complete bench overhaul. All connecting cables are given voltage breakdown and leakage tests. Radio racks and hold-down clamps are tightened and put into first class condition. At this time, in short, all radio and related equipment receives a complete overhaul.

### Major Check

The 5000-hour major check takes place during the complete aircraft overhaul period. At this time connecting cables otherwise inaccessible can be reached and replaced. Also replaced are antennae, insulators and fuse clips. When an aircraft leaves the hangar after a major overhaul it is as airworthy as the day it left the production line.

Pre-failure radio maintenance keeps the airlines' 170 transports flying an average of ten hours out of each twenty-four. In addition, radio equipment is constantly being modernized. As many as fifteen radio "projects" may be made during a one-year period as new ways are found to improve the operating efficiency of equipment. Records of service failures are carefully compiled and studied. Maintenance routine is altered accordingly. Radio maintenance is a big part of a big industry, and radio maintenance personnel can be proud of their contributions to the aviation art.

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## THERMAL RADIO

[*Continued from page 25*]

able that a higher range of frequencies will come into use.

### Calculation of Power Required

The amount of heat (in gram calories) required to raise the temperature of a certain quantity of wood—or any material—a certain number of degrees can be calculated from the relation:

$$H = pc\Delta t \bullet \text{volume}$$

where: $p$ = specific heat (cal. per gram per deg. C.)
$c$ = density (gram per cc.)
$\Delta t$ = change in temperature (deg. C.)
$v$ = volume (cc.)

The power required to produce this amount of heat in a given time is:

$$P\text{(watts)} = \frac{4.187 \times H}{\text{time(sec.)}} = \frac{4.18 \bullet pc \bullet \Delta t \bullet \text{volume}}{\text{time(sec.)}}$$

If we substitute cu. in. for cc., and deg. F for deg. C, and time in minutes:

$$P\text{ (watts)} = \frac{.637 \bullet pc \bullet \Delta T \bullet \text{volume(cu. in.)}}{\text{time(min.)}}$$

where: $\Delta T$ = degrees F.

In some cases it is more convenient to express this in terms of required power concentration, viz:

$$\text{power concentration (watts/cu. in.)} = \frac{.637\ pc\ \Delta T}{\text{time (min.)}}$$

In other cases where a limited amount of power is available it may be desired to know the time required to raise the material so many degrees. This is simply:

$$\text{time (min.)} = \frac{.637\ pc\ \Delta T}{\text{watts/cu. in.}}$$

### Advantages of the RF Method

The more obvious advantages of the

radio-frequency method follow from the fact that in this method heat is caused to be generated simultaneously and uniformly throughout the whole body of the wood. This means that (neglecting losses) the whole block of wood comes up to temperature evenly. It also means that the time required for a given increase in temperature is independent of the thickness of the wood. These effects are in marked contrast to those which occur with other methods of heating. In all other methods heat which originates outside the wood (as, for instance, in steam plattens) must travel into the wood by conduction. As a result, the outer layers of the wood come up to temperature much more quickly than the interior. Moreover, the time required to heat a section of wood depends entirely on the thickness. In the case of thick sections this becomes very long.

An important advantage where new press installations are considered is the fact that the presses themselves can be of much cheaper design, since the massiveness associated with steam plates and multiple openings is done away with. Moreover, the use of radio frequency makes it much easier to use "hot" gluing in conjunction with very large presses and presses of unwieldy dimensions. Presses designed originally for cold gluing are readily adapted for hot gluing.

There are also a number of minor advantages which vary in accordance with the job to be done. These include the convenience of not having to work in close proximity to hot plates; the fact that the heat can be closely controlled and can be turned off instantly; the possibility of making hot-glued joints on jigs designed for cold gluing; and others of a similar nature. The importance of these will become more evident as this process comes into more widespread use.

When making compregwood parts radio frequency has another very important advantage. This is the fact that since the whole mass of wood is heated uniformly the compression takes place uniformly. The contrast with what takes place when using a steam die only is very marked. In the latter instance the outer plies, of course, heat up very quickly and the resin in them begins to set up. Compression must, therefore, be started immediately. However, at this point the interior of the wood has not even started to heat. As a result the compression is very non-uniform and terrific internal stresses result. Such stresses can be partially relieved by very long cooking periods, but even then results are often unsatisfactory. Direct comparisons made between similar sections done with and without radio frequency show that in the latter these stresses have been 90% or more eliminated.

All of the above advantages are cited on the basis of work which has actually been done. In considering the use of radio frequency for making curved surfaces such as fully-stressed wing or fuselage elements, it should be noted that this is something which apparently has not yet been done in production. Should the radio-frequency process be found feasible, there would, of course, be marked advantages. While the autoclave method appears to be the most satisfactory found to date, it is unquestionably cumbersome, time-consuming and expensive. Use of r.f. might conceivably eliminate the cost of the autoclave, greatly reduce the time cycle, the quantity of jigs required, the number of operations and the inconveniences attendant on the present process. There are a number of problems to be worked out before this will be possible, but already the answers to some of these have been indicated.

### Limiting Factors

With all the advantages of radio frequency one wonders why it has not been more widely adopted. The answer seems to lie in the fact that there are definite problems in applying it to other than simple jobs. These problems have been too much for wood engineers to solve by themselves and—at least until very recently—radio engineers have not been interested. The present plywood plane and glider program has changed this situation overnight. The importance of this work, plus the necessity for quantity production, plus the desirability of using phenol glues have caused a sudden demand for radio-frequency equipment. This has revived the interest of radio engineers and they are now tackling these application problems on a wide front.

★

## THIS MONTH

[*Continued from page 26*]

(d) Section 10.123 Coordinated service — The amendment does not change the present licensing procedure but clarifies the agreements that must be submitted with the application for an instrument of authorization in those cases where it is proposed to render a coordinated communication service.

#### International Broadcasting

At the request of the Board of War Communications, the Federal Communications Commission allocated two additional frequencies to the international broadcast service for the duration of the war. These two frequencies, 7805 and 7935 kilocycles, are available for assignment to zone and inter-zone police stations under the provisions of Section 10.44 of the Commission's Rules and Regulations. On the basis that the broadcast transmissions will be intended for reception outside the continental United States and that most of the zone and inter-zone police communication on these frequencies occurs during daylight hours, it is not expected that the police service will cause any interference to the international broadcast service. Zone and inter-zone police stations now licensed to operate on 7805 and 7935 kilocycles will be permitted to continue the use of these frequencies, upon the express condition that these stations do not interfere with the international broadcast service, and subject to such pertinent orders, rules, and regulations as the Commission hereafter may deem necessary to prevent such interference.

★

### HE KEEPS 'EM ROLLING

Walter Schiller, coxswain on a U. S. battlewagon at Pearl Harbor, used to use Universal microphones in boat drills and other maneuvers. Now he is having a part in making the tiny precision instruments at the Inglewood, Cal., plant of the Universal Microphone Co. With more than two dozen bullet wounds, shrapnel cuts and scars, Coxswain Schiller has returned to civilian life.

Universal plans to extend its use of returned service men and rehabilitates for working on defense orders for all arms of the service.

★

### NEW NATIONAL UNION PLANT

With construction completed well ahead of schedule, the new plant of the National Union Radio Corporation at Lansdale, Pa., was formally opened with impressive ceremonies in which Army and Navy officers participated.

The new plant, representing the most advanced design and construction, is 40,000 square feet in area. Included in it are offices, laboratories, and complete manufacturing facilities. All activities are carried out on a single level.

★

### NEW SOLAR SUBSIDIARY

To assist their jobbers, the Solar Manufacturing Corporation, Bayonne, New Jersey, has transferred all jobber sales activities to a new subsidiary organization, which will be known as the Solar Capacitor Sales Corporation.

Solar Capacitor Sales Corporation, like its parent company, will be located at Bayonne, New Jersey, and will operate under the guidance of the same management, including W. C. Harter as general sales manager, Sy Wolin as sales manager, and A. Prosdocimi as manager of the Export Division.

★

### DR. POWER HONORED

Dr. Ralph L. Power, Los Angeles radio counsellor, on the eve of celebrating the end of 20 years in radio, has received notice that the Council of the Australian Institute of Radio Engineers has elected him to Companion grade. In recent years he has been engaged in radio exporting, but has continued to supervise advertising accounts for clients. His oldest client is the Universal Microphone Co.

★

### NEW LANGEVIN PLANT COMPLETED

The Langevin Company has just completed their new transformer plant at 37 West 65th Street, New York City. This plant will specialize in the manufacture of electrical transformers of all types for use in radio and Radar communication work. Area occupied totals approximately 16,000 sq. ft. Complete tool room facilities are incorporated in order to expedite fabrication of parts normally procured through outside sources.

★

### ARMY-NAVY "E" TO RADIOMARINE

The Army-Navy Production Award for achievement in manufacturing radio equipment for war was presented to Radiomarine Corporation of America by Rear Admiral William C. Watts, U. S. Navy (Ret.), and Brig. General Ralph K. Robertson, Commanding General, Metropolitan Military District, in a ceremony on December 19th at the company's plant, 75 Varick Street. Lieut. John D. Lodge, U. S. Navy Reserve, acted as chairman of the program.

★

### RMA-BEW EXPORT COMMITTEE

A special RMA-BEW Export Committee, for cooperation with officials of the Board of Economic Warfare on radio export problems, has been appointed by Paul V. Galvin, President of RMA. The special RMA committee was suggested recently by Assistant Director Hector Lazo of BEW in general charge of export procedure, and is headed by W. A. Coogan of New York, chairman of the RMA general committee on foreign trade matters. Other members appointed to the special RMA-BEW Committee are: Ad. Auriema of New York, Jay Cooke of Camden, New Jersey, D. McIntosh of New York and Arthur Rocke of New York. All members of the special RMA-BEW committee have traveled extensively in foreign countries and represent many RMA companies and interests in foreign sales of all radio products.

Many radio export problems, including the use of PD-1A application forms for export business, were discussed at an RMA-BEW-WPB conference December 15. Instead of using PD-1X forms, which have been found not adaptable for radio exports, the present procedure arranged is for filing of the PD-1A application covering each export shipment proposed. Other industry recommendations for further help to radio export departments were submitted and are under consideration.

RMA was represented at the radio export conference by the new Special Committee for Cooperation with BEW. Several BEW officials included Kenneth Campbell, George Donnelly and Albert Waterston. The WPB Radio and Radar Division was represented by Chief Frank H. McIntosh, Glen C. Henry and Ralph D. Camp of the Domestic and Foreign Radio Section. Another conference with the RMA committee will be held next month.

The shipping situation, according to information developed at the December 15 meeting, is not improving for several markets, and export licenses promise to be curtailed during early 1943.

Limited future assembly of sets and also kits, to be earmarked for export, was discussed tentatively at the December 15 meeting, but no definite conclusions were reached, partly because of uniformly unbalanced supplies of components in manufacturers' inventories. Several other plans on export matters included the possibility of tube shipments on a two-month quota basis, based on previous export shipments of manufacturers, and also adoption of PD-1A applications for domestic jobber exports. Lend-lease shipments also were discussed and will be a special subject for the January meeting.

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#### REPROOF

*Editor,* RADIO:

I note a serious technical error in your scientific article on the Gremlins in the November issue of RADIO. You refer to the reverse locomotion of the dodo bird. It is my understanding that the dodo bird is extinct and that it is the fillilu bird which flies backwards, due, of course, to a complete lack of interest in destination coupled with considerable concern as to his point of departure.

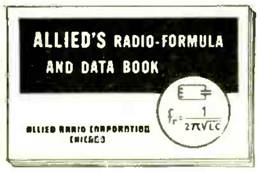
*C. W. Metcalf*
TOBE DEUTSCHMANN CORP.

We stand corrected. But there *are* Gremlins.—*Ed.*

#### ALLIED'S FORMULA AND DATA BOOK

Allied Radio Corporation, Chicago, announces the publication of a new handy, pocket-sized handbook of most frequently used mathematical formulas, tables, data and standards in the field of radio and electronics. This booklet, edited by Nelson M. Cooke, Chief Radio Electrician, U. S. Navy, eliminates time-consuming search through numerous books for information constantly used by radio and electronic engineers and maintenance men.

Available for instant reference are formulas, tables and data covering such subjects as Ohms Law; inductance; reactance; impedance; resonance; the use




of exponents, trigonometric relationships, logarithms, radio color codes, abbreviations, mathematical symbols, wire tables, etc. Included also is a condensed selection of formulas pertaining to meters and vacuum tubes.

This new Allied publication is priced at 10c. It may be obtained from Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.

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#### TRANSMISSION-LINE IMPEDANCE PROBLEMS

Harold A. Wheeler, engineer, Hazeltine Service Corporation, presented a paper on "The Hemisphere Chart for Transmission-Line Impedance Problems" at the meeting of the Radio Club of America, Thursday, January 14th, at Columbia University.

The chart discussed by Mr. Wheeler was proposed by P. S. Carter, and is useful in connection with transmission lines and impedance matching. The paper included the solution of a number of problems, such as the matching of antenna impedance to a transmission line. The speaker illustrated how this chart in itself gives the impedance of a transmission line when terminated by any impedance.

★

#### G. E. BOOKLET ON ELECTRONICS

"Electronics—A New Science for a New World" is the name of a colorful, pictorial booklet issued by General Electric presenting the general story of electronics—its past, its present, and its great possibilities for the future.

Colorful accounts by word and illustration are told of how the electron is working today in war combat to perform many marvelous functions; in research to reveal more of nature's mysteries; in industry to step up production, increase human efficiency, and reduce material waste; in radio and television to extend the range and quality of sound and sight over the air waves; in agriculture to improve quantity and quality; and in medicine to reveal more and more of the structure and behavior of the human body.

A copy of the new booklet may be obtained by writing the General Electric Company, Schenectady, N. Y., and asking for booklet GED-1024.

★

#### MEISSNER GETS ARMY-NAVY "E"

Meissner Manufacturing Company, Mt. Carmel, Illinois has been awarded the Army and Navy "E" for excellence in production. The award was presented to The Meissner Company at their plant on December fourth.

Among those who participated in the award were Major W. G. Mee and Major Robert Orr representing the United States Army, and Captain Robert Henderson and Lieut. Crabtree representing the United States Navy.

### KNOWLSON RESIGNS FROM WPB

Resignation of James S. Knowlson as Vice Chairman of the War Production Board was announced January 4th by Chairman Donald M. Nelson. In making the announcement Mr. Nelson said that he was retaining Mr. Knowlson within the WPB organization on a "when actually employed" basis, so that he could be called on as a consultant or special assistant from time to time.

Mr. Knowlson resigned in order to return to his duties as President and Chairman of the Board of the Stewart-Warner Corporation in Chicago. This firm has a large volume of war orders, and Mr. Knowlson — who came to Washington 15 months ago expecting to stay three months—felt that he could no longer remain away from its helm.

## NEW PRODUCTS

[*Continued from page 48*]

### SHALLCROSS WHEATSTONE BRIDGE

The new Shallcross No. 630 Wheatstone Bridge provides accurate, convenient, and direct electrical resistance measurement from 0.1 to 11,100,000 ohms. Its accuracy is 1% between 10 and 1,000,000 ohms. The galvanometer has a sensitivity of 1 microampere per millimeter division.

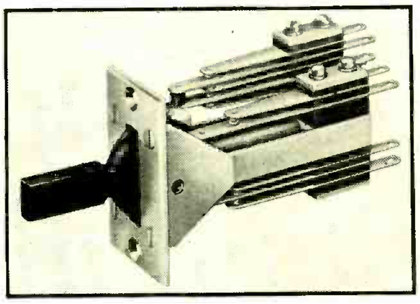

The three decades of the rheostat arm are connected to external binding posts, thus enabling the Bridge to be used as a resistance box from 10 ohms to 11,000 ohms in an external circuit. Each decade consists of 10 wire-wound resistors. These resistance units are wound with Manganin wire on a non-hygroscopic form. The switches are Shallcross standard high quality, having ceramic switch plates, brass contacts and multi-leaf phosphor bronze arms.

For detailed information, write the Shallcross Mfg. Co., Dept. 28, Collingdale, Penna.

★

### MOSSMAN LEVER SWITCH

Donald P. Mossman, Inc., 6133 N. Northwest Highway, Chicago, has published a General Data Bulletin No. 82 on their new O-42 Lever Switch.



The Mossman O-42 Lever Switch is primarily designed for use in Aircraft, Radio, Communication, Annunciator and Fire Alarm Systems, Testing Apparatus and a wide range of Industrial applications. It is available in an almost unlimited series of combinations of contact assemblies. Contacts, pile-ups and lever action is assembled to meet the specific requirement.

This switch has positive action—locking, non-locking (spring return to neutral position) and no throw stops. A large, well formed handle permits a firm grip by a gloved hand. Rating-maximum recommended — 5 amperes, 110 volt, a.c., (non-inductive).

Diagram and complete information is given in the General Data Bulletin No. 82, which will be furnished by the manufacturer, upon request.

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## BOOK REVIEW

*MICROWAVE TRANSMISSION, by J. C. Slater, 309 pages, McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Price $3.50.*

Microwaves are defined by Prof. Slater as those of wavelength between one meter and one centimeter. These waves are unique in that their wavelength is of the order of magnitude of ordinary laboratory apparatus, making possible experimental methods that are completely different from those used for any other type of electromagnetic wave. This book describes the general theory underlying the methods actually used for transmitting microwaves from point to point, from the generator in which they are produced to the receiver in which they are detected. Transmission in waveguides and coaxial lines are likewise treated in detail. The short wavelength of microwaves makes possible transmission in hollow pipes since in such cases only those waves whose length are comparable with the diameter or cross-sectional dimensions of the pipe are transmitted.

Essentially all of the scientific work on microwaves has occurred in the last ten years. Since it is such a new subject the technical literature is all too meager. In general, it may be said that microwave technique dates from the adaptation of hollow pipes and horns to microwave transmission. Not only is the transmission of microwaves possible with hollow pipes, it is practically imperative. Such waves transmitted along ordinary unenclosed transmission lines radiate more and more vigorously as the wavelength decreases, causing intolerably large transmission losses. Thus not only generation and detection but transmission of microwaves is unique.

Subjects treated in detail include Maxwell's equations, transmission lines, rectangular waveguides, the general transmission-line problem, antennas and radiation, directive microwave antennas, coupling of coaxial lines and waveguides, etc.

## ADDRESS CHANGE?

Notify RADIO's Circulation Department at 132 West 43rd Street, New York, N. Y., of your new address two or three weeks before you move. The Post Office Department does not forward magazines sent to a wrong address unless you pay additional postage. We cannot duplicate copies mailed to your old address. Thank you!



It cannot be said that the treatment is simple, yet it should not prove difficult for the engineer with a normal background of mathematics and physics. The discussions are logical and reasonably complete. The book requires study but it is well worth the effort of the engineer interested in this field.

This book deserves a place on the shelf of every radio engineer, and it is highly recommended both as a text and as a reference book.—C.F.N.

★

*THE FUTURE OF TELEVISION, by Orrin E. Dunlap, 194 pages, Harper & Brothers, 49 E. 33 St., New York, N. Y. Price $2.50.*

The author, who has had some twenty years editorial experience in the field of communications, and who has published some seven books on various phases of radio, is particularly well qualified to deal with the subject of television. It is estimated that some $30,000,000 has been spent on television research prior to 1942.

Mr. Dunlap deals with the financial, economic, legal and artistic problems confronting the television industry, rather than its technical aspects. What promises to be a billion-dollar industry is treated from the standpoint of television in the home, its role in the movies, news telecasts, its effect on the theatre, its place in instruction and teaching, program technique, etc.

Two of the most interesting chapters in the opinion of the reviewer are "The Speaking Eye Looks Ahead" and "Evolution of Television," either of which make this book most worthwhile. An interesting appendix is "Historic Steps in Television," starting with James Clerk Maxwell's prediction of the action of electro-magnetic waves in 1867, to publication of the first television advertising rate card in 1941. Such epoch events as Zworykin's filing of his original television patents, John L. Baird's first television demonstration, wire television demonstrations between New York and Washington, first transatlantic television transmission, demonstration of the kinescope, television of the English Derby at Epsom Downes, opening of W2XAB, and television at the World's Fair in New York are described.

Another timely topic is the logical discussion of "Will the Day Ever Come When Hollywood Will Take Over Television or Television Take Over Hollywood." The often-discussed topic of the effect of television on motion pictures is of as much interest to engineers as to financiers.

This book has an obvious appeal to businessmen and laymen. It is also recommended most highly to engineers in the communication field. It is well and interestingly written and as easy to read as are most of the author's works.—C.F.N.

★

Books received and to be reviewed next month:

*RADIO CODE MANUAL, by Arthur R. Nilson; McGraw-Hill.*

*MATHEMATICS FOR ELECTRICIANS AND RADIOMEN, by Nelson M. Cooke; McGraw-Hill.*

*A-C CALCULATION CHARTS, by R. Lorenzen; John F. Rider.*

*TELEVISION STANDARDS AND PRACTICE, by Donald Fink; McGraw-Hill.*

## ADVERTISING INDEX

## IF THIS WERE AN OFFICIAL ARMY OR NAVY PHOTOGRAPH...

If this were an official Army or Navy photograph it would be on the restricted list, with publication prohibited. Actually it is from the National Catalogue published before the war. Yet basically the receiver is the same. True, it is now built to government specifications rather than the amateurs'. There are new refinements that we cannot even tell you about, but which make it a better receiver than the one you have known. But basically it is still the same receiver.

When you turn to it after the war as to an old friend, you will find that it looks different, performs better and handles more easily. Yet you will find that it is still designed and built in the tradition that made a receiver engineered for peace meet the rigorous demands of war.

**NATIONAL COMPANY, INC., MALDEN, MASS.**

# RADIONICS

## THE MIRACLE INDUSTRY

### Goes full speed ahead for Victory


With the dawn of the New Year, we should all strive to excel—to better perform the tasks which will aid in shortening the war.

Zenith is proud to be a part of the great industrial force of this country which is producing War Radio and Radionic apparatus for our armed forces—and resolves to continue to do its utmost in producing the war equipment so vital to Victory.

Exactly what Zenith is making is a military secret, but we can tell you we are dealing with the thing we know best—Radio and Radionics exclusively.

To the millions of Zenith owners—to its many friends in the industry—to its distributors and dealers Zenith wishes the best of everything for the year to come.

**ZENITH RADIO CORPORATION**
**Chicago, Illinois**

**BETTER THAN CASH**
**U. S. WAR SAVINGS**
**STAMPS AND BONDS**

ZENITH
REG. U. S. PAT. OFF.
LONG DISTANCE RADIO
REG. U. S. PAT. OFF.
RADIONIC PRODUCTS EXCLUSIVELY—
WORLD'S LEADING MANUFACTURER