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MAY 1943

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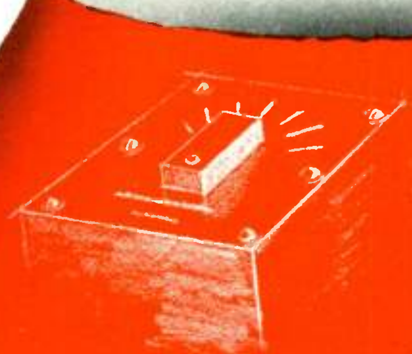

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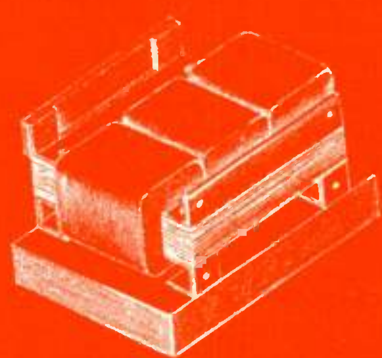

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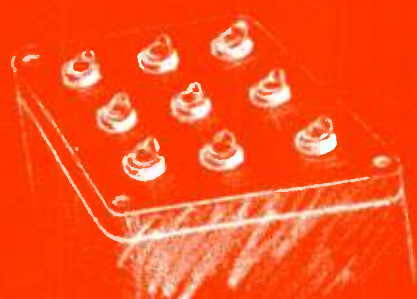

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FM RADIO-ELECTRONICS

COMBINED WITH: APPLIED ELECTRONIC ENGINEERING

VOL. 3 | MAY, 1943 | NO. 6

CONTENTS

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THIS MONTH'S COVER

Captain Jennings B. Dow, U.S.N., has devoted his entire career to Navy radio, from his first sea duty as Radio and Communications Officer to special duty as observer of Radio and Radar in Great Britain during the winter and spring of 1940-41. Graduated from Annapolis in 1920, he also holds an M.S. degree in electrical communications engineering from Harvard. Now Head of Radio Division, Bureau of Ships, he carries the executive responsibility for naval communications and for radio-electronics equipment.

WHAT'S NEW THIS MONTH

"THE BEST direction-finding equipment we have on C.N.A.C. planes is 8-year-old Telefunken apparatus, built in Germany." This statement was made by Captain Robert S. Angle who has just returned to the United States after six years of flying in China, the last two of which he spent carrying freight and passengers for the most part over the Calcutta-Chungking route.

C.N.A.C. is the China National Airways Corporation, ownership of which is shared by the Chinese government and Pan American. The Calcutta-Chungking route is notable for the dangerous mountain terrain and for the bad weather which prevails. At an altitude of 20,000 ft. which planes must maintain in crossing the Himalayas, the DC-3's cannot stay up if one motor quits. In the winter, ice is a constant hazard, and in summer rain and fog make it practically impossible to find a cleared valley in case of a forced landing.

Under these circumstances, pilots are absolutely dependent upon radio direction-finding. Capt. Angle's attitude toward radio, therefore, is not a consideration of comparative engineering, but of its usefulness as an adjunct to flying.

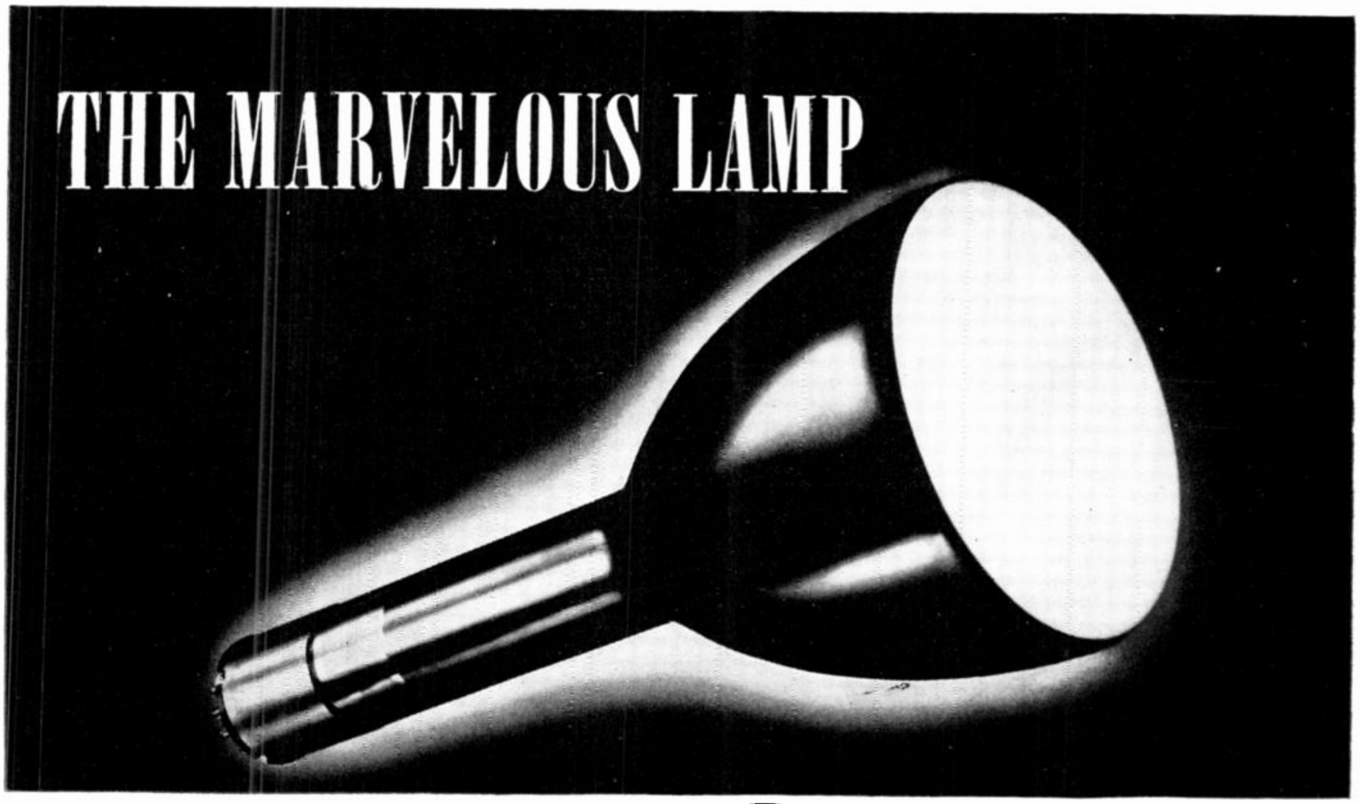
In view of the extensive research on DF equipment that has been carried out in the U.S.A., this comment came as a distinct surprise. As a statement of fact by a man who has staked his life on radio reception month in and month out, Capt. Angle's veracity cannot be questioned.

Radio engineers will answer: "The implication that German DF equipment is superior to American designs is not fair because Capt. Angle may not have had the opportunity to compare Telefunken installations against modern types made in the U.S.A."

Now, that brings up a most significant point. Capt. Angle, on the one hand, is not a radio engineer. He is not concerned with radio engineering and design as such. His job is to take his plane off the ground at the point of departure and to keep it in the air until he is ready to set it down at his destination. The radio equipment represents, to him, an essential aid to navigation. When he says that the Telefunken equipment is less subject to failures, and less affected by static, he is speaking only as a pilot, so that he cannot be cross-examined as if he were a radio engineer.

On the other hand, who among our radio engineers has sufficient knowledge of our American radio equipment under

(CONTINUED ON PAGE 43)



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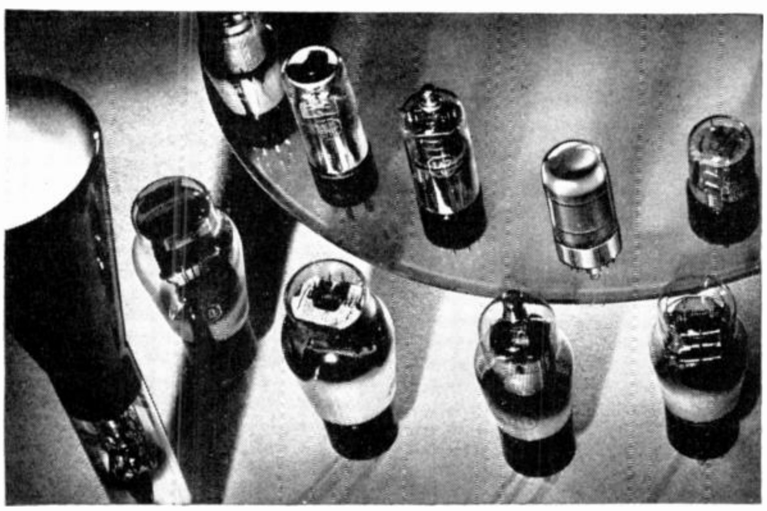

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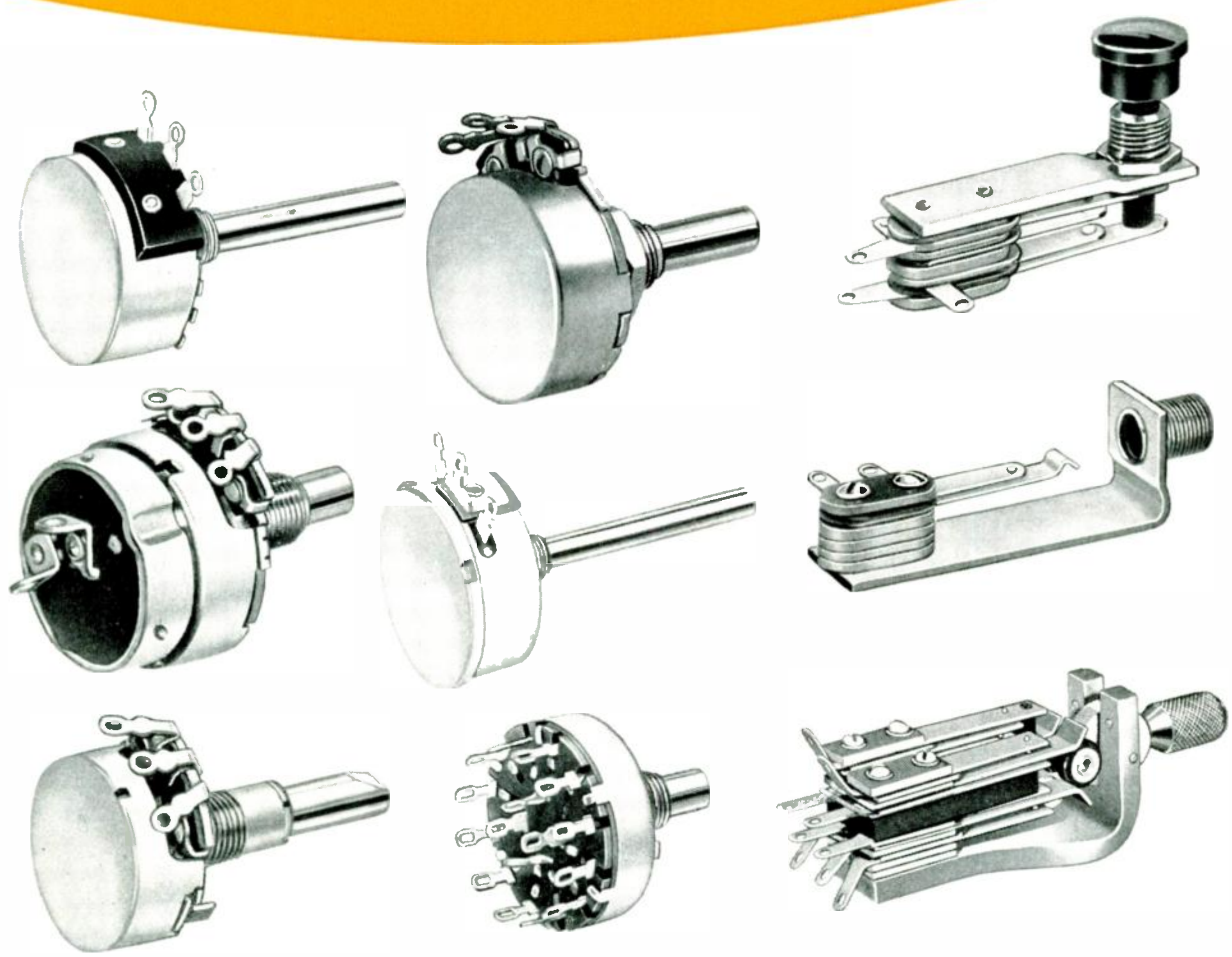

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SELLING NEEDS MORE ENGINEERING

How Civilian Radio Suffered from Control of Product Design by Sales Management

BY M. B. SLEEPER

AIRCRAFT and radio manufacturing rank among the leading examples of industry based on applied science and research, but they are as far apart as the poles in one basic respect: In the aircraft industry, sales effort has always emphasized the product, while in radio, it has featured the price.

This condition, suspended to be sure during the War, has so operated to the disadvantage of the radio industry that it deserves the most careful consideration in any program of post-war planning to build peacetime volume and employment.

Essential Differences ★ A defensive answer from manufacturers of civilian radio sets would be that the pre-war markets for aircraft and for radio were entirely different. The former was among air transportation lines and governments, while the latter was made up of the public in general Therefore, the same methods could not be applied.

Still, the net results of any method are what count, and the comparative sales curves from 1920 through 1940, omitting sales resulting directly from start of the war in Europe, show radio volume skyrocketing until 1929, followed by a steady drop year after year; while aircraft sales, discouragingly flat in the first part of this period, rose and maintained an accelerating rate until they outstripped the declining radio volume.

Just One Sales Idea ★ You will note that the period just referred to is limited to 1940. There is a most significant reason for that, which bears close examination.

Prior to 1929, when radio volume was showing annual increases, the sales effort in this industry featured the product, rather than the price. You remember them in their succession as they followed the original crystal sets: one-tube regenerative circuits, two-tube amplifiers, neutrodynes, AC operation, superheterodynes, all-wave receivers, and then, with the 1929 cataclysm, the midget!

That was the beginning of the decline — the midget mantelpiece radio that was purported to give big-set performance at the amazingly low price of $87.50!

It was then that sales management took the control of product design away from the engineering department, and radio engineers generally, from that time on, came into disrepute as not too necessary evils who were overpaid at ten dollars per week per degree.

The ensuing period produced the sales-managers and the war-cry, "Get the orders," shouted at salesmen who were inspired by it to put more heat on the dealers. They shouted at the engineers, too, when they addressed them at all: "That costs too much! You've got to make it cheaper!"

They all did the same thing. Thus price competition developed, and to meet it the floor-plan was invented — that device by which dealers were so enmeshed in financing one line that they could not take on another.

With an inexhaustible ingenuity, the sales managers met fire with fire. They lowered prices further, they tied the dealers tighter by setting up means to discount time-sales paper, made the floor-plans more complicated, and then, as a crowning achievement, they took a new one out of the hat: the dealer cruises.

This was essentially a scheme to take the dealers where they could feed them salt fish, and keep the bar locked up until, in sheer desperation, they were willing to sign any commitment in order to get a drink.

However, the time came inevitably, when prices had fallen to such a level that cruises were supplanted by watches, and then fight tickets or sets of dishes, and the industry landed with a loud thump at an all-time low from which no end of shouting by sales managers could raise it.

While all that was going on, radio's ranking inventor was very busy at a place called Alpine, New Jersey, and in 1940 he brought something out of his laboratory that began to do for the industry what all the sales managers combined had never been able to accomplish.

That is, he made it possible for manufacturers to sell the product once more, and to make the product so interesting that the public bought without regard for the price.

Almost overnight, in a market where twenty-odd dollars was the top average price, dealers could not get enough $250 and $350 models to keep them in stock. People even bought such sets in areas where there was not yet any use for the new feature, but they wanted it for the future, because our American public is always ready to put its money and its faith behind genuine scientific progress.

Renaissance of Engineering ★ By the time the War stopped off all civilian radio manufacture, the volume of radio sales had already taken an up-swing, resulting largely from the high unit cost of FM sets.

Now, it is true that the increased sale of phonograph combinations made a contribution too, but the reason for this is further proof of the failure of the sales managers as directors of product design. Reception from the kind of sets they were offering was so poor, so inadequate, and so ridden with interference that the public had turned to phonograph records as a source of entertainment. Radio, in many, many homes, was suffered only as a source for news.

Then came Pearl Harbor, and the call for manufacturers to convert their plants to military production. We can look back at this time, and evaluate the industry as it was set up when civilian production stopped.

We can see how painfully inadequate so many companies had become, under the sales managers' regime, as to engineering — inadequate qualitatively and quantitatively, lacking in talent, organization, personnel, facilities, equipment, and sound methods of procedure.

Suddenly the greatest weakness of the industry, fostered consistently during the last ten years, was disclosed. For more than a year desperate efforts have been made to repair that condition, and still there are few companies able to meet fully the demands put upon them to raise the standards and increase the output of their engineering departments.

After the War ★ When the War is over, the industry will be able to build home radio equipment of quality and performance such as the public has never known. This will be possible because, during the War period, the control of product design and production methods have been put where they properly belong — under the engineering departments.

Will the executive management of the established concerns permit this situation to continue, or will the old policies be restored?

New competition will exert considerable influence on their decisions. Many new plants have been created as a matter of military necessity. A number of these newcomers do not have any of the industry's bad habits, and they have brought progressive ideas from other sources.

Another fountain of new blood will come from engineers now in the Armed Forces who are already planning to enter the radio manufacturing business. Out of an initially large number, a few will be able to survive.

These factors may turn the tide of the whole industry. If so, engineers will continue to hold their newly-won positions. In that case, sales emphasis will be on the product, and the public will enjoy the fullest possibilities of the radio art.

(CONCLUDED ON PAGE 13)

DESIGN PLANNING FOR AIRCRAFT RADIO

Notes on Methods Which Have Proved Successful in Meeting Requirements of Service Conditions Aloft. Part 1—Preliminary Considerations

BY BURT L. ZIMET*

THIS paper is one of the most important contributions that has been made to the subject of modern apparatus. Although concerned directly with aircraft radio, it has application to the design of all types of radio-electronic equipment. It covers not only the practical aspects, drawn from personal knowledge and experience, but it also explains the significance and purpose of requirements which all too frequently are not given sufficiently serious consideration. A careful study of this paper is recommended to all engineers now engaged in radio development and design work, even though they are not specifically concerned with aircraft applications.

MOST radio engineers have had their first experience in building equipment according to specifications within the last twelve or fifteen months.

There are, in consequence, many who are still in that baffling and exasperating situation of trying to make specifications make sense, and generally thrashing around like the lad who is thrown overboard before he has learned to swim.

Then there is that relatively small group of engineers who have finally mastered the initial mysteries of specifications and contracts, and have progressed to the point where their designs have been actually approved and put into production.

Finally, there are a few whose length of service has been such as to have disclosed to them the simple but highly significant fact that meeting specifications and passing acceptance tests are only the first steps toward designing and producing equipment capable of standing up under service conditions.

Conditions in the Field ★ I wish that, in some way, the full importance of that statement could be brought home to the personnel of every radio laboratory. In saying this, I am drawing on my own experience as chief radio inspector for the Army Air Forces at Republic Aviation Corporation.

Thus, before undertaking the design of aircraft radio equipment, I had the opportunity of learning at first hand about the conditions which such apparatus must meet in service, to see what things failed and why, and how the faults were remedied.

This experience is behind the emphasis put upon the difference between meeting specifications and acceptance tests and meeting conditions of service.

There is no use denying the fact that equipment built in accordance with specifications sometimes fails to meet service requirements. So much equipment is being bought for entirely new purposes and for use under new kinds of service conditions that it may well happen that complete specifications cannot be written in advance. In many instances, only general specs can be written when contracts are let. The detailed requirements are then worked out as development and manufacture get under way. This may be true of test procedure, also.

Then, too, a certain amount of latitude is allowed in specifications so as to encourage original work on the part of contractors. That is why specs refer to some particular trade-marked product, for example, and add the words "or equivalent" or "or other suitable material."

What is equivalent or suitable? That can be worked out with the engineer representing the department placing the contract, or with the inspector. Experience soon gives the answers to what appear to be failures to write specific information into contracts and specifications.

The Human Factor ★ Undoubtedly the cost, in both time and money, of giving engineers a chance to gain experience in radio apparatus by their own efforts and errors will be paid back many times over through the overall progress of the industry.

Beside, it would not be practical to write every last detail into specifications, for there is no substitute for the human contribution of care and skill and experience in the laboratory, the drafting room, and the factory, or in the organization of step-by-step inspection.

The great need for knowledge and understanding which comes only from training and personal experience is illustrated by an incident at Republic Aviation. Very serious noise interference developed suddenly in the radio equipment, for no apparent reason, on a run of Thunderbolts. Everything had been going along smoothly, with the radio installations passing all tests as ship after ship came off the line.

Then came trouble — not with one or two but with each plane in succession. Experts were rushed in from all directions. Dozens of suggestions were made and checked, but to no avail. No reason could be found for the radio interference because no change had been made in the equipment or the method of installation.

While the experts continued in their frantic huddle, one of the men began to dismantle the apparatus on one plane to see if, from that angle of attack, he could locate the source.

Lo, and behold, when he came to the ignition shielding harness on the engine, he found that a washer of fibre instead of metal had been used where the two halves of the harness were joined!

A quick check showed that harnesses on all the engines received since the trouble started had the fibre washers. Someone at the factory had had one of those bright ideas, but not of the right kind.

This is an example of the errors which occur through lack of knowledge and experience and do not show up until the equipment is put into service. Still more dangerous, of course, are those that come to light only after an initial period of use.

There is no way, in fact, to cover all the details in written specifications which the designer must consider in planning a piece of new radio gear, nor will it ever be possible as long as development work continues on so many different types and models for so many different applications.

Apparatus Design Policies ★ It is possible, however, to set forth definite policies and procedures, and to supplement them with detailed notes. That is the purpose of this paper. With such a guide, the ability of the engineer is the remaining limitation on a successful outcome.

All too frequently, inexperienced designers, when confronted with a specification which appears hard to meet, are inclined to shrug their shoulders and say: "I guess this will be all right, and anyway I don't believe *this* apparatus will ever have to meet such a condition."

That is an extremely dangerous attitude from several points of view. First of all, no engineer who is willing to *guess* that something is good enough should ever be

*Design Engineer, Freed Radio Corp., 200 Hudson Street, New York City.

permitted to work on aircraft radio equipment. Aircraft projects should be entrusted only to men who have a realistic understanding of the axiom that nothing is good enough for aircraft service if it can be made better.

Second, to take a chance that some feature will get by is to risk time and money on a design which will probably be rejected during acceptance tests.

Third, it sometimes happens, particularly on new equipment, that a questionable feature is not caught on the pre-production sample, and only comes to light after production deliveries have started. This very thing has happened to more than one contractor, entailing not only great loss of materials and months of delay in bringing in new ones, but also the loss of confidence in the integrity and ability of the contractor's organization.

Finally, there is always the possibility that the result of negligence may not be known until it has resulted in disaster.

To show why such extreme thoroughness is necessary, and why an attitude of constant open-minded alertness is required of engineers engaged in aircraft radio work, some of the broad considerations will be discussed briefly at this point.

Heat and Pressure ★ The designer must draw upon every possible source of information which relates to his work. In that way, he can frequently learn of new requirements and anticipate the needs of the service in which his equipment is to be employed. There is, inevitably, a lag between the time a new condition is encountered in the field and its inclusion in specifications.

For example, while investigating the conditions under which a certain piece of apparatus was to be used, the fact was discovered that the temperature in the cabin of planes left out in the sunshine may rise to 150° F. Such a condition had not been specified, but the knowledge of it made possible its anticipation.

Extremes of heat and cold and barometric pressure do strange things to aircraft equipment, producing effects that are not encountered in any other applications.

Low temperatures of −50° F. are commonly encountered, and may range down to −80° F. Airplane cabins may or may not be heated. In the latter case, the crew wear electrically heated clothes, but the equipment is not protected against the cold. Dry batteries, if they are used, can be packed in insulated cases, but the remainder of the radio installation must be able to withstand exposure to low as well as high temperatures.

Because no avenue has been set up for transmitting information on field experiences to engineers in commercial laboratories, they know very little about the effects of temperature and atmospheric pressure changes on the apparatus they produce.

It is hard to understand why such information has not been made available to them. One result of this situation is that it has been found only recently that the methods generally followed in test-chamber observations did not reproduce service conditions accurately.

General practice was to make separate tests on temperature and atmospheric pressure. Apparatus which passed these tests still failed in the air. Checking back on these failures, it was learned eventually that, to reproduce actual operating conditions, it is necessary to reduce the temperature and pressure simultaneously.

The study of temperature and pressure effects is one of such wide ramifications as to constitute a highly specialized phase of aircraft radio design technique.

Hermetic Sealing ★ The latest reports continue to emphasize the failure of fine-wire transformer coils as the most serious source of trouble in the field.

Failures of fixed paper condensers have been practically eliminated since adoption of the practice of enclosing them in oil-filled, solder-sealed containers.

Now it appears that, of all the methods employed to protect small transformers, the only effective one is hermetic sealing.

So far, very few transformer manufacturers have undertaken to use this type of construction. In fact, this is a highly specialized subject about which there is very little information available.

In some cases, inspectors have put their approval stamps on transformers which were specified to be hermetically sealed, but were not sealed at all — not intentionally, to be sure, but because they had not been instructed in the method of testing transformers which were required to be sealed in that manner.

A transformer that is hermetically sealed is unaffected by complete immersion in salt water. That is literally going overboard in strictness of test requirements, but it is perfectly reasonable in view of service conditions.

Methods which expose potting compounds to the atmosphere have not proved adequate in the case of small transformers. The compounds may be said to breathe under changes in atmospheric pressure. Thus, when a plane drops from dry air at low pressure at great heights, moisture is forced into the compound by increased pressure at low altitudes.

After a few cycles of these conditions, moisture reaches the windings, and corrosion sets in. Test-chamber experiments show that more moisture may reach the windings under such conditions than by direct immersion in water at constant temperature.

From the foregoing it should not be assumed that only transformers are affected by temperature and pressure changes. On the contrary, these changes affect the insulating and mechanical properties of all materials, including air. Some are predictable, but none should be taken for granted without final determination in the test chamber.

Vibration Effects ★ Vibration test equipment is of the greatest importance in checking pre-production samples, yet it is available in only a few laboratories at companies building aircraft radio equipment. Some of the most unexpected faults develop on the vibration table in designs that are considered secure against such effects. Yet everyone who has been for a single flight knows that anything put into a plane is subject to continuous vibration.

The selection of vibration test equipment depends primarily on the weight of the units to be tested. For laboratory use, in handling weights up to 40 lbs. or even more, a very fine machine widely used by both the Signal Corps and the Navy is that produced by Vibration Specialty Company, Philadelphia. This type can be used without any special foundation to support it.

Machines to carry heavy loads must be set on concrete piers sunk into the ground. It is important that the construction of the machine be properly related to the load it is to handle. Otherwise, the machine, rather than the device under test,

MEETING SPECIFICATIONS
Is Only the First Step toward
MEETING SERVICE REQUIREMENTS

may be shaken apart. An important check to make on any type is to set the increment of movement at zero. If the machine has been designed correctly, under that condition it will be free of all vibration.

Power Supplies ★ Another operating condition that some designers are reluctant to treat realistically is voltage variation in the DC supply on aircraft. Even though 12 or 24 volts are specified as the supply voltage, the actual voltage in service may vary as follows:

Rated Voltage	*Service Voltage*
12 volts	11 to 16 volts
24 volts	22 to 32 volts

It is not enough, therefore, to design equipment for operation only at the rated voltage. It must still perform if the generator fails and the batteries run low, and it must be able to stand up if the voltage runs high.

You have seen photographs, no doubt, of planes that limped home with one or more engines dead, and large sections of the wings or tail shot away. They can do it because of the large factor of safety allowed in aircraft design. It is equally necessary to build ample factors of safety into radio equipment — doubly so, perhaps, because in many instances planes are able to get back only because they can fly straight home by radio guidance. Then that extra safety factor, so easily passed up in the laboratory, means the difference between saving or losing lives and planes!

Weight ★ Weight is another factor to which radio designers sometimes fail to give sufficiently thoughtful consideration. While sturdy mechanical construction must not be sacrificed under any circumstances, it is truly amazing to see how many pounds can be taken from a transmitter or receiver if every part of the design is checked and analyzed for possible weight reduction. Individually considered, the savings may be only a part of an ounce here, and another fraction there, but the total quickly runs into pounds.

In case you are not inclined to consider this subject seriously, let me tell you what happened on the P47 Thunderbolts. The design work was completed, and production was in full swing before all the details of the radio installation had been settled. When the final determination had been made and the first complete complement of radio apparatus installed, it was found increments of weight added here and there totalled up to an amount sufficient to make the planes tail-heavy.

This made it necessary to halt the production of Thunderbolts until design changes could be made in the mounting of the motor. The solution was to insert blocks between the frame and engine so as to move the engine forward sufficiently to restore the original center of gravity.

Extra weight can usually be distributed so as to avoid such a condition. However, every pound of equipment represents a corresponding reduction of speed unless it is offset by a reduction of fuel load.

Spare Parts ★ All too little thought and attention has been given to the matter of spare parts. They have been treated as the step-children of the industry. Definite provisions for spare parts have been worked out by both the Signal Corps and Bureau of Ships. Still there are sometimes errors and omissions in the spare parts groups which accompany requests for bids, particularly when the equipment under consideration has not been manufactured previously.

> ### Opportunity for Idealists
>
> **"TODAY, many engineers still cling to their familiar materials and methods, feeling that they should be good enough since they are so much better than what they were in the habit of using in the past!**
>
> **"To others, however, radio design work now represents a golden opportunity to draw upon and develop all sources which may contribute to better performance. There are no competitive conditions to limit product improvement, and it is the obligation of every engineer, during this period, to seek out every means which will raise the standards of performance under service conditions.**
>
> **"These considerations encompass materials, components, laboratory facilities, measuring and test equipment, mechanical and electrical design, production planning, adjustment of methods to accord with limitations of factory workers, inspection, and the adoption or design of improved manufacturing methods and equipment."**

It is the obligation of every project engineer to study the items listed in the spare parts groups with the greatest care, and to bring up for discussion any seeming errors or omissions. They usually come to light about the time deliveries start. However, at that late date, there may be serious delays in getting delivery of items not scheduled on the original spare parts groups. The result of such after-thought may be that the spares will not be on hand to accompany the first shipments, and they may never catch up with the equipment they are intended to supplement.

Lack of adequate spares has been one of the most serious complaints from men in the field. In fact, the failure of spare parts to accompany the related apparatus has made it necessary for maintenance men to resort to all kinds of extreme measures, even to the point of using components from captured enemy equipment, a practice now referred to as "cannibalism."

Packaging ★ The method of packaging equipment for shipping has become an engineering consideration, and one that calls for the most thorough investigation.

Many new packaging techniques have been developed to meet the severe treatment which radio gear may undergo en route to its ultimate destination.

Failure to give this matter the attention it deserves may result in the total waste of all the care and thought that has been put into the equipment itself, and in the failure of the mission it was intended to serve.

Achilles' Heel ★ The foregoing paragraphs are intended to present briefly the special nature of aircraft radio design problems. They would be simplified greatly if it were possible to assume that a given piece of apparatus would be subjected only to a limited range of operating conditions.

In these times, no such assumptions can be made. There is no telling what unexpected service it may be called upon to perform. Situations change, new applications arise, and the most suitable equipment at hand is used to fill some need which may not have existed when the instrument was originally designed.

If, therefore, a vulnerable spot can be found while the design work is still in progress, it should be eliminated right then, when it can be done most easily.

Design Planning ★ It is unfortunate that so many engineers now engaged in the development and design of military equipment gained their original experience on broadcast receivers. For several years prior to 1941, design work on new models of home radios meant little more than altering circuits to accommodate new tubes, and whittling down mechanical parts and electrical tolerances to still lower levels of sub-standard practice.

The succeeding work of production engineering thus became a matter of squeezing equipment through the narrow margin of tolerance between what was good enough, and what wouldn't work at all.

Today, such limitations have been removed, yet many engineers still cling to their familiar materials and methods, feeling that they should be good enough since they are much better than what they were in the habit of using in the past!

To others, however, radio design work now represents a golden opportunity to draw upon and develop all sources which may contribute to better performance. There are no competitive conditions to limit product improvement, and it is the obligation of every engineer, during this period, to seek out every means which will raise the standard performance under service conditions.

These considerations encompass ma-

"No engineer who is willing to GUESS that something is good enough should ever be permitted to work on aircraft radio equipment"

terials, components, laboratory facilities, measuring and test equipment, mechanical and electrical design, production planning, adjustment of methods to accord with limitations of factory workers, inspection, and the adoption or design of improved manufacturing methods and equipment.

The characteristics and variations of circuits are fairly well established. Original circuit development need not be undertaken at this time unless it is to be related to, or results from, the development of new tubes. This is seldom necessary or advisable because of the current policy of reducing tube types.

Therefore, development and design efforts are to be directed toward realizing maximum performance from familiar circuits through 1) refinements in the design of components, 2) increased stability of performance through the study of service conditions and means for meeting them, and 3) greater convenience of installation, operation, and service through refinements of mechanical design.

The first problems to be considered in designing a new piece of apparatus may be listed as:

1. A complete examination of the purposes and performance requirements to be met by the equipment.
2. A thorough study of the specified service conditions, together with all the implications of those conditions.
3. An accurate knowledge of the limitations and necessities imposed by the power source available, conditions of installation, operation, and maintenance, and the associated equipment.
4. A careful analysis of all factors covered not only by actual specifications but those included by inference or reference, and by contractural requirements.
5. A further detailed check of the specifications and the contract to determine 1) if any partly-disclosed requirements may require clarification, 2) if the obvious omission of any points might require revisions and changes.

These points are important because contracts are so often drawn by men without technical knowledge, and contracts may be revised extensively in the process of correcting errors or omissions.

Breakdown of Design Elements ★ The separate elements of aircraft radio apparatus design will be discussed in detail in the subsequent parts of this paper. They are:

1. Electrical circuit design.
2. Mechanical design.
3. Design considerations of components.
4. Wiring.
5. Mountings.
6. Inspection and test methods.

Although much of this material is applicable to all radio apparatus design, and is therefore of general interest, it has been planned specifically for application to aircraft equipment.

Editor's Note: Part 2 of this paper is scheduled for publication in the June issue of FM RADIO ELECTRONICS.

SELLING NEEDS MORE ENGINEERING

(CONTINUED FROM PAGE 9)

If not, the record of the past indicates that radios will fall back into the category of home electrical appliances, and the industry will bog down again in the mire of outmoded methods which nearly brought it to the point of self-destruction in 1939.

It would be a serious mistake to make plans now against the resumption of civilian business on the basis that the industry will simply pick up where it stopped in the spring of 1942.

Conditions will be very much more like those which developed after the last war, when the business of manufacturing home radio sets had its beginning. That is, dozens and dozens of new companies will be formed. To be sure, a large percentage of them will be inadequately capitalized, and they will disappear, their places taken by others who start a little later. All the mistakes of the early '20's will be repeated, and some new ones will be added.

The practically unlimited market for radio receivers will encourage anyone with a little experience to try his hand at radio manufacturing, and those with a little money will be tempted to finance friends who, perhaps, have had the benefit of radio training in the Army or Navy. This is to be expected in a country that will be crawling with radio experts and engineers, all seeking to establish themselves in civilian activities.

Furthermore, there will be enormous quantities of components thrown on the market which those with the right connections will be able to buy at advantageous prices. The only item of which a shortage can be expected is variable condensers, but even that lack may be overcome by the use of variable inductances.

The prediction has been made that the flood of quartz crystals will result in their use for fixed tuning circuits with pushbutton controls, eliminating the need for either variable condensers or inductances. That will probably not be the case, however, because the crystals manufactured for military use are not within the frequency ranges required for broadcast for FM reception.

But there will be plenty of parts to start off the newcomers as well as the established concerns which produced civilian sets before the war, and there will be a market big enough to absorb as many sets as are built by all sources.

During the initial stages of peacetime industrial reconstruction, engineers will still occupy pre-eminent positions, for the competition will be in performance and production. Sales management will be of secondary importance because selling will be easy, and there will be no price competition.

All this is a repetition of the setup in the early '20's. The great difference will lie in the knowledge and experience that was so lacking in those days. On the other hand, there will be changes and developments in the field of broadcasting, opening the way for the exercise of unlimited ingenuity and progressive thinking.

At any rate, the engineers will have their second chance to establish themselves permanently in their rightful places. If they can make capital of past experience, they can hold their own against sales management.

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

"C" Day: Next milestone of the radio industry will be Cancellation Day. Plans being drawn up at Washington against that time will probably provide for quick payment of 90 per cent of cancellation charges to be agreed upon, and an appeal for the balance.

New Tracing Material: No. 130 Dull Mat Tracing Medium is far more transparent than any tracing paper. It looks like Cellophane, with a mat finish on one side which takes ink or pencil as perfectly as the best Bristol board. Ideal for tracing indistinct prints or other difficult copy. Distributed by Arthur Brown & Bros., 67 West 44th Street, New York City.

Keraunophone: Ten to one you don't know the meaning of that word, although you have one or more of 'em in your home. Webster's New International defines it as: "an apparatus, essentially a radio receiver, for audibly demonstrating the occurrence of distant lightning flashes."

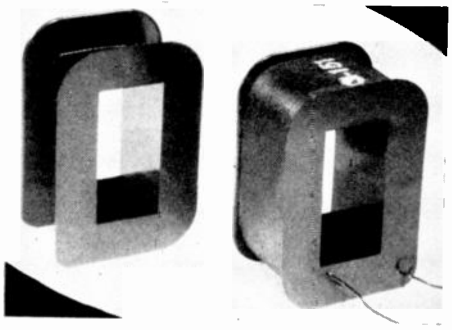
Don H. Burcham: Appointed representative for Standard Transformer Corporation, covering industrial accounts in Idaho, Montana, Oregon, and Washington. His headquarters are at 917 S. W. Oak Street, Portland, Ore.

Advertising: Released May 13th, Philco newspaper advertising in 121 key cities told the public: "Radar, the secret weapon, tells the sensational story of Philco at war! The story of Philco's vital contribution to victory is officially revealed. It's *Radar* — the fabulous secret weapon whose miraculous power seeks out the enemy '*through fog, clouds, storms or darkness!*'"

More Farm-Radio Batteries: WPB has eased up on battery limitation to permit manufacture of 425,000 batteries per month for farm radios. While this is below estimated need of 6,000,000 per year, it should provide for essential listening in homes where no electric supply is available.

J. M. Allen: Formerly works manager at RCA's Bloomington, Indiana plant, has been appointed works manager for Erie Resistor Corporation, Erie, Pa. He has had an active part in the radio industry during the past 20 years, starting as superintendent of receiver production for Fansteel Products Corporation, Chicago.

Stations Sold: FCC has approved the sale of three broadcast stations: KVAK, Atchison, Kans., 100 watts, 1,450 kc., $9,500, purchased by S. H. Patterson; WKBB, Dubuque, Ia., Blue Network affiliate, 250 watts, 1,490 kc., $25,000, purchased by Dubuque Broadcasting Company; WOSH, Oshkosh, Wis., 250 watts, 1,490 kc., $45,000, purchased by Oshkosh Broadcasting Corp.



LUMARITH COIL FORMS MOLDED IN ONE PIECE FACILITATE WINDING AND ASSEMBLY ON THE STEEL CORES

Replacement Parts Sales: An OPA notice calls attention to the fact that any store or repair shop which refuses to sell tubes except to a customer who brings in his radio and pays a service charge is violating the General Maximum Price Regulation, unless that was a customary practice with the store or shop prior to March 1942.

T. A. M. Craven: FCC commissioner: "Let us resolve now to coördinate our planning before embarking on a wild scramble of equipment manufacture for the use of new radio channels. Let us avoid in radio the possibility of retarding progress by poor planning in the radio frequency spectrum. It is both possible and practical to coördinate the broad phases of engineering equipment design with a scientific frequency allocation. In so doing, we can likewise avoid the pitfalls of premature standardization and its consequent regimentation of research."

Ithaca College: Is preparing to inaugurate courses in radio broadcasting, leading to the degree of bachelor of fine arts. The course will include radio station administration, sale promotion, announcing, script and continuity writing, production, and programming. The work will be correlated with courses in speech and dramatics. Eight semesters of work are required which, under wartime acceleration, can be completed in 2 years.

Induction Heating: General Electric is now using induction heating instead of gas for soldering quartz crystal units. Result is substantial drop in rejections due to damaged crystals. The crystal unit is placed in a fixture, which locates it with respect to a 2-turn coil and an air-blast nozzle. Current at 500 kc. is applied to the coil for a few seconds, melting the solder in the mounting ring. Then the air-blast is turned on for ten seconds. Using automatic timing for the heating and cooling cycle, perfect uniformity is assured, with considerable saving in time.

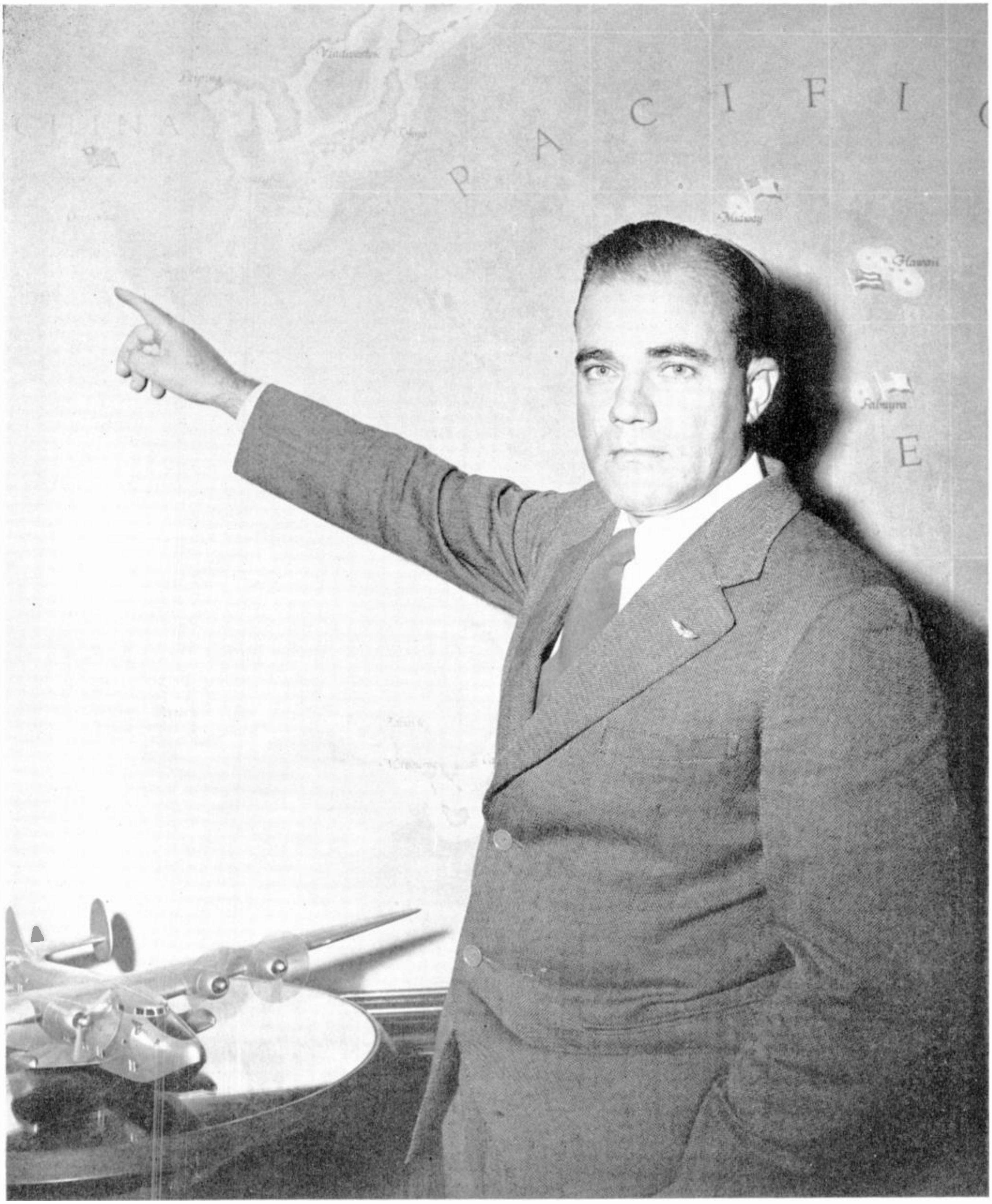
Henry Dressel: Appointed supervisor of electronic components engineering at Stackpole Carbon Company, where he has been a member of the engineering staff for several years.

Electronic Supplies: A new war order division has been opened by Lafayette Radio Corporation, Chicago, to speed the handling of orders from military contractors, according to an announcement from vice president S. W. Berk. The new division will be managed by David Muir.

Code Practice Records: RCA has issued an album of six code practice records. The records and accompanying instruction

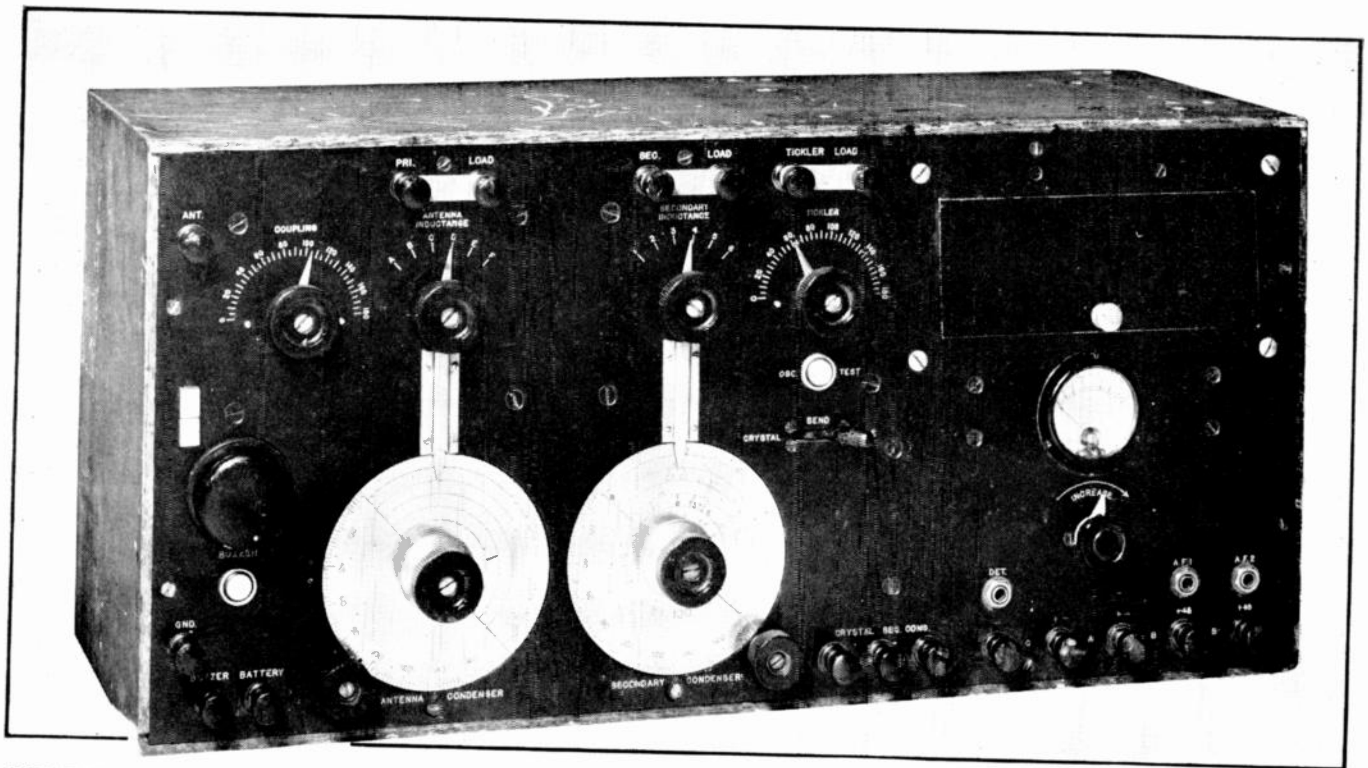
(CONTINUED ON PAGE 21)

FM-EQUIPPED SERVICE CARS OF THE CHICAGO SURFACE LINES ARE ROUTED FROM HEADQUARTERS BY TWO-WAY COMMUNICATIONS TO SPEED HANDLING OF EMERGENCIES. MAIN STATION AND CARS USE MOTOROLA EQUIPMENT



NEWS PICTURE

FROM his quiet manner, you would never know that Capt. Robert S. Angle, just returned to the U. S. A., had spent three years as flying instructor to the Chinese Army, and the last two years matching wits with the Himalayas, piloting C.N.A.C. transports. From this work he has gained a practical knowledge of aircraft radio performance that many engineers would like to share. Among other feats carried out with the aid of radio communication, he flew in and out of Hongkong on three nights between the time the Japs attacked and captured the City. Protected from Jap planes by the darkness, he carried out men, women, children, dogs, and flying equipment, including precious dural sheet. Since that time, he has been flying from Calcutta to Chungking, finding his way over the Himalayas on this fog-bound route largely by radio compass bearings. Without radio, this line could not operate.



THIS IP 501A WIRELESS SPECIALTY RECEIVER, AFTER 20 YEARS OF SERVICE AT SEA, IS STILL IN PERFECT OPERATING CONDITION, EVEN TO THE WESTON FILAMENT METER, WHICH STILL READS ACCURATELY. NOTE BUZZER TEST FOR AUXILIARY CRYSTAL

THE FAMOUS IP SERIES RECEIVERS

Performance of World War 1 Models Still a Standard of Comparison for Radio Designers

BY G. H. CLARK *

EDITOR'S NOTE: George Clark, who certainly needs no introduction to the old-timers of the Bureau of Ships and the radio industry, was kind enough to delve into the archives of his memory and his library for the following account of the famous series of IP receivers.

TYPE IP 501A Designed by Bu. of Steam Engineering. Manufactured by Wireless Specialty Apparatus Co. for Radio Corporation of America." So reads the name plate on one of the last of a remarkable series of radio receivers about which there is a most interesting history.

This particular receiver was intended for commercial service, as its name plate clearly indicates. However, it had a Naval origin, and the Company that made it had long experience in receiver design and manufacture.

The complete story behind this model takes us back to the early days of the wireless art. In 1907, the Wireless Specialty Apparatus Company, of Boston, Mass., made, among other specialties, an efficient, compact receiver designed by Professor G. W. Pickard. It was marketed under the designation "I-P-76, 1907 type."

*Historian, Radio Corporation of America, 66 Broad Street, New York City.

AFTER 20 years of service at sea, the IP 501A receiver shown in the accompanying illustrations found a berth in New York at a Canal Street junk shop, from which it was rescued. It is still in perfect operating condition.

Here, indeed, is a standard of design stamina by which engineers can judge the quality of equipment they are producing today.

Furthermore, it is ample justification for the high standards of radio design, materials, and workmanship established by the U. S. Navy, and the severe requirements of Navy inspection which, to those who lack a background of experience in the manufacture of military equipment, sometimes seem onerous and unreasonable.

A careful examination of the set disclosed only three faults after its 20 years of service: 1) binding post tops had been partly melted by the heat from a soldering iron injudiciously applied, 2) there was slight play in the gears of the vernier condenser drives, 3) the spring catch on the tube-access door was broken.

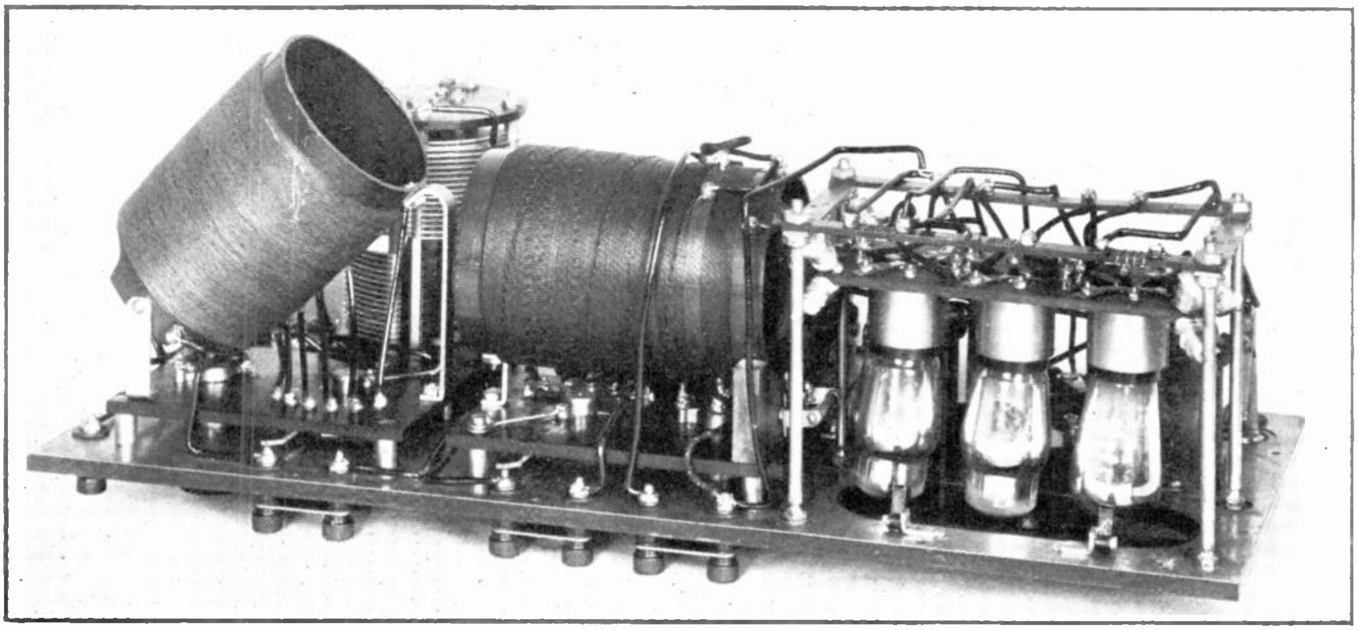
How much of our current radio equipment will rate as high as that in 1963?

The prefix "I-P", soon changed to "IP" by popular re-christening, was the identification mark for all Wireless Specialty products of those days. For example, there was the I-P-200 silicon detector and the I-P-306 audibility meter. The designation "76" was given to all receivers. Redesign took place every year, culminating in the "double-decker," a short- and long-wave receiver of an upper-and-lower-berth form, in 1914.

The chief features of the Wireless Specialty design were a units-and-tens switch on the primary, and the so-called "untuned" secondary of the tuning system. The former provided a means of cutting in one turn at a time on the units switch or ten turns at a time on the tens switch. The latter was an inductively-coupled secondary coil of fine wire, closely wound and hence with considerable distributed capacity, with a 5-point switch to cut in 20 turns or more per contact. This "tuned" the circuit by varying the natural period of the coil section in use.

The next series of developments belong to the Navy Department, Washington, where the writer, as the first Radio Aide of the Navy, began the design of new receivers for Navy service.

These models employed capacitative coupling of the so-called "Cohen" type, and were characterized by dials pre-calibrated in wavelengths, by bank-wound coils of litzendraht wire, and by heavy copper leads, covered with spaghetti, for all fixed inductors. This last was intended to prevent breakage due to vibration.



TOP VIEW. SECONDARY COUPLING COIL IS MOUNTED WITHIN THE LEFT END OF THE 45° ANTENNA COIL. TICKLER IS AT RIGHT END OF SECONDARY WINDING. SHIELDED PARTITION IN CABINET SEPARATES PRIMARY AND SECONDARY, AND CONTACTS PANEL SHIELD

Receiver types A, B, and C were built in relatively small quantities.

When the "Type Number" system of nomenclature was introduced in the Navy during the year 1915, receivers were given a different form of designation. This consisted of a series number, "the next number in line," preceded by two letters and followed, where necessary, by an alteration letter.

The preceding letters were SE when the design was of Navy origin, or C, followed by the company letter, when the work was done by one of the civilian manufacturers. For example, the CM 294 was a product of the Marconi Company.

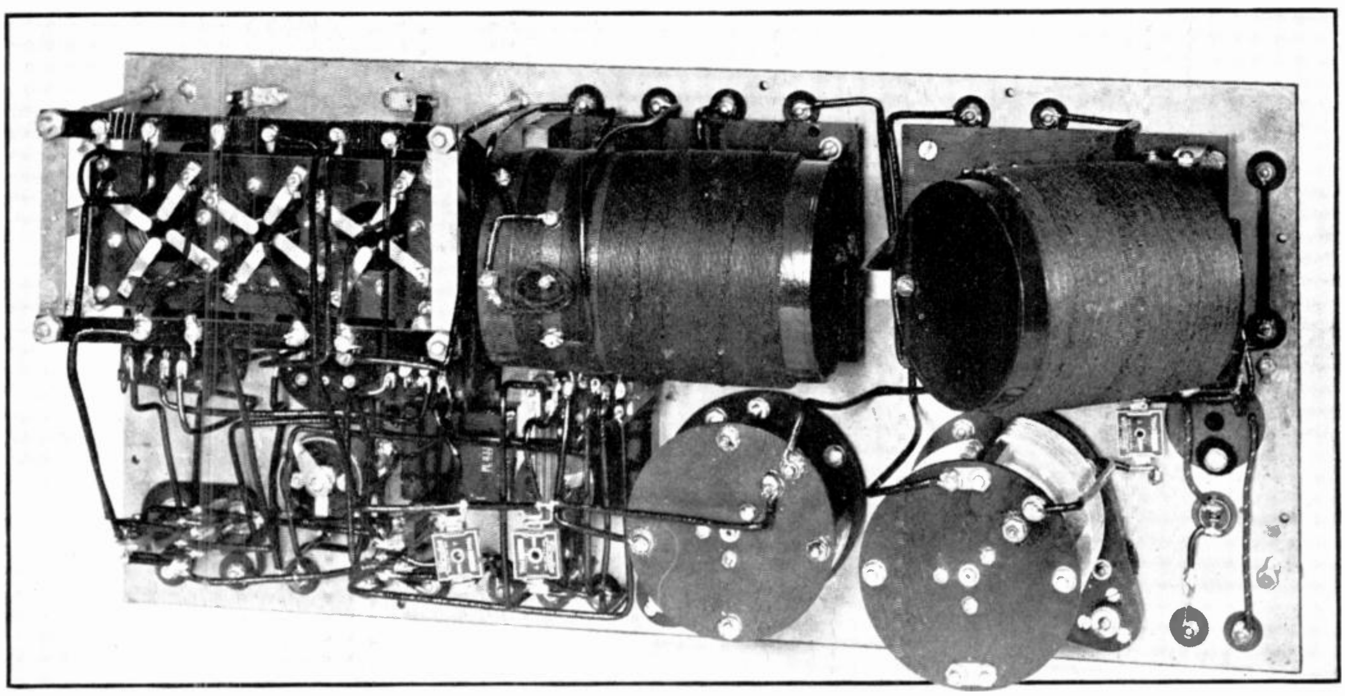
The designs of the IP series followed the earlier standard, with modifications as the art advanced and as other engineers brought new ideas into the Naval service. The coupling, in time, changed to combined static and magnetic — some remarkable results were attained by the correct use of this dual arrangement — and later was made magnetic only.

Better shielding and different forms of feed-back appeared as new designs were added to the Navy list. Also, in time, special forms for use in aircraft were produced. As these newer types succeeded each other in service, the writer had less and less to do with the actual work, his duties having become more administrative. SE 143 was the last of his own design.

One of the subsequent series of Navy-designed receivers was SE 1420, in which the impress of Radio Aides Priess and Lester Jones was very evident. That was a medium-wave receiver, with a range of 250 to 6,800 meters. It contained a built-in audion detector with inductive feedback or "tickler," to use a name of the writer's coinage, and a two-step amplifier.

This receiver had greater sensitivity and selectivity, and less bulk and cost than its predecessor, the type 143. It was thoroughly shielded against external interference and undesirable interactions in the receiver itself. It was characterized by the Navy, in an official publication, as

(CONTINUED ON PAGE 45)



NOTE THAT REAR OF PANEL IS SHIELDED. BOTH PRIMARY AND SECONDARY COILS ARE BANK WOUND, WITH LITZ WIRE. WIRING IS SOLID COPPER, COVERED WITH VARNISHED TUBING. FIXED CONDENSERS HAVE METAL CLAMPING PLATES, RIVETED TOGETHER

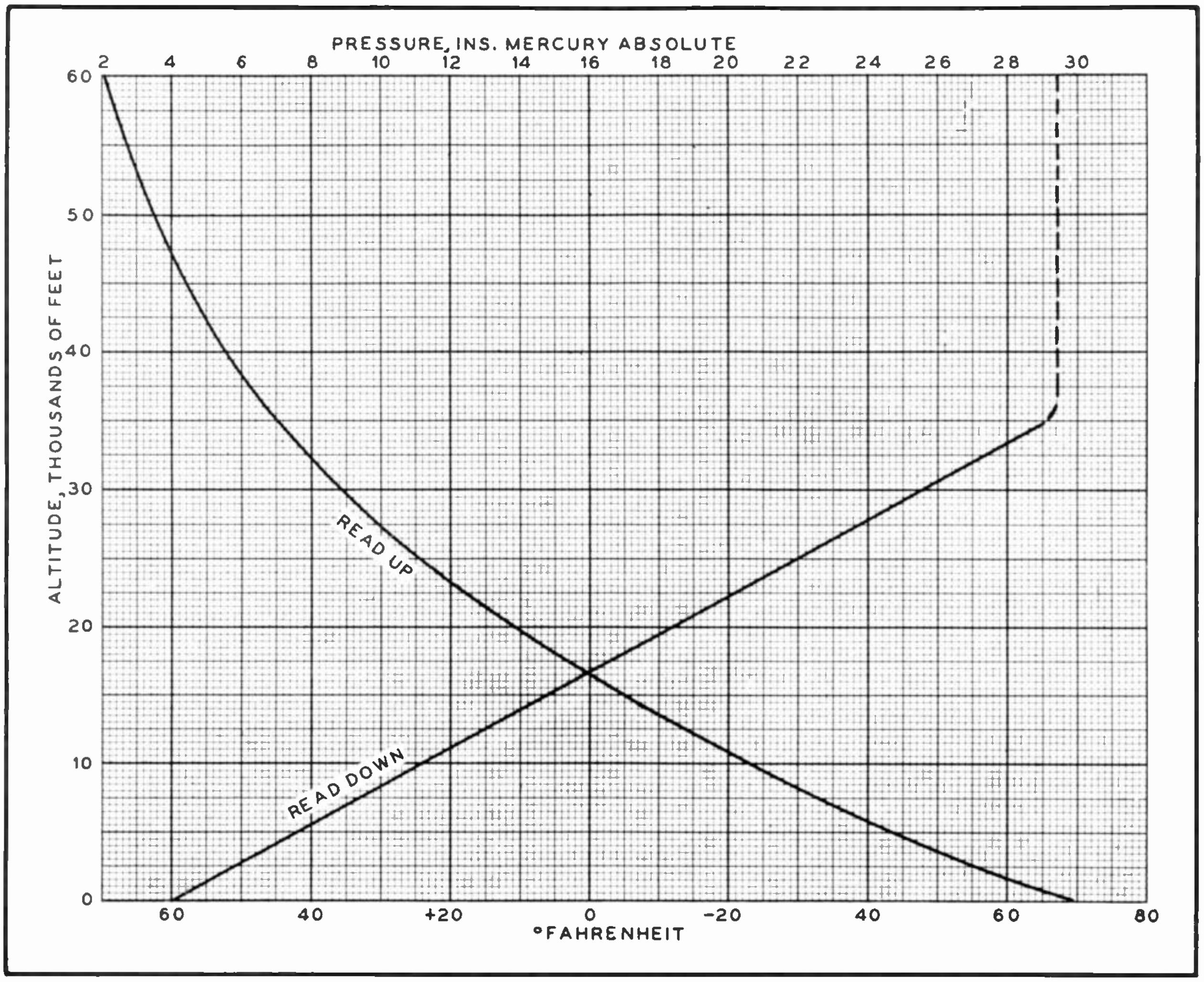


FIG. 1. RELATION OF TEMPERATURE AND ATMOSPHERIC PRESSURE TO ALTITUDE. TEMPERATURE ABOVE 35,000 FT. MAY DROP SUBSTANTIALLY BELOW −67 DEGREES FAHRENHEIT, BUT THE VALUES SHOWN ARE SUITABLE FOR ALL TEST PURPOSES

REPRODUCTION OF FLIGHT CONDITIONS

Solving Radio Problems Introduced by Low Temperature, High Altitude, and Variations in Humidity

BY JOHN ZALESKI *

ANALYSIS of the technical reports being sent in from our fighting forces all over the world indicate strongly that more stringent operational-condition testing during the development and construction of equipment is required to minimize equipment failures.

Our present methods of waging effective war require that we set up operations in locations where extreme and previously uncalculated conditions of temperature, humidity, and air density are encountered. A large number of the failures could have been eliminated by determining the effects of these and other operational conditions while the equipment was in the stages of development and before production, by the more extensive application of field-condition testing.

One of the more recent and acute problems is that of extreme low-temperature and high-altitude testing. During the past year, my own efforts have been devoted exclusively to the development and construction of operational-testing equipment. We have found, in general, that the problems of high-altitude, low-temperature, and controlled humidity testing are being considered by the manufacturers as necessary evils rather than as the integral parts of development and production which they actually are.

High-altitude and low-temperature testing of air-borne equipment has become a necessity as a result of the increased efficiency of antiaircraft fire and aircraft detection systems. In the effort to maintain the loss of personnel and equipment at a minimum, our aircraft have been flying higher and higher to get beyond the reach of accurate and damaging antiaircraft fire, and to avoid detection and interception by the enemy before objectives are reached. As the aircraft began to operate in the upper troposphere and the stratosphere, they encountered the extreme low temperatures and low pressures as shown in Fig. 1. The data of Fig. 1 is substantially correct, but there have been reported temperatures of −80° C. (−112° F.) at altitudes of about 40,000 feet.

A flood of reports from our fighting forces told of failures never encountered previously. Not knowing the causes of these failures, flight personnel jokingly re-

*Chief Engineer, Northern Engineering Laboratories, 50 Church Street, New York City.

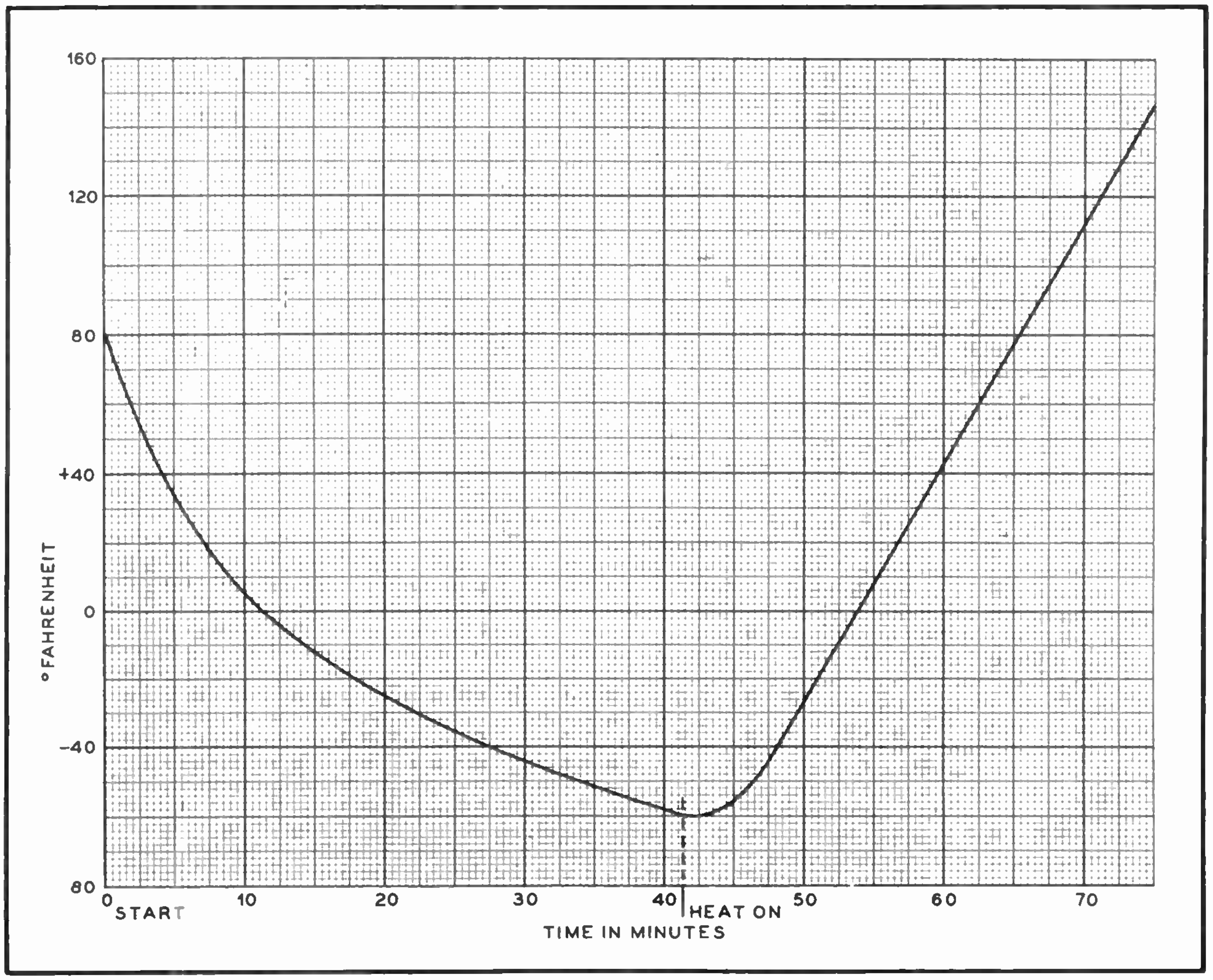


FIG. 2. TEMPERATURE CURVE OF OPERATING CYCLE TAKEN ON STANDARD TEST CHAMBER SHOWS DROP DURING FIRST 41 MINUTES, AND RISE IN SUBSEQUENT PERIOD. RATE OF CHANGE CAN BE CONTROLLED, AND ANY CYCLE SET UP CAN BE REPEATED AS REQUIRED

ferred to the causes of this phenomenon as the mythical "Gremlins." Many of these failures are of a type which cannot be discussed now, due to military restrictions, but quite a few can be outlined briefly.

Reports from our fighting forces told of failures of electrical systems resulting from changes in the dielectric characteristics of the air, of the extremely short life of brushes on commutating equipment, of breakdowns of standard insulation due to the extreme cold, and of lubrication failures due to stiffening of standard lubricants.

Further reports covered the failure of communications systems as a result of the change in the frequency characteristics of quartz crystals, due to temperature extremes and also to the rate of change of temperature.

In addition, failures of condensers and rectifiers resulting from changes in temperature and air density were reported extensively. General failures of indicating instruments, fire control mechanisms, fuel systems, oxygen systems, and many other points caused the issuance of entirely new test specifications.

The subject of operational-condition testing is most fascinating. At extremely low temperatures, for example, standard rubber insulation first loses its flexibility and then becomes actually brittle. Failures of thin-wall insulating materials are serious. Phenolics and the vinylite group stand up at temperatures as low as −65° C. (−85° F.).

Effects upon air as a dielectric are surprising. What is an adequate air-gap or spacing, as in the case of variable condensers, may not be sufficient at very low atmospheric pressures. This may call for the complete redesign of equipment which is entirely satisfactory at moderate altitudes. To be specific, an air-gap that is adequate to withstand 25,000 volts may break down at 2,500 volts under high-altitude conditions.

The performance of sliding contacts, all types of condensers and resistors, all the different insulating materials, relays, and batteries can be predetermined only by test-chamber investigation.

The most serious radio problem of all is due to humidity and condensation. A rapid drop from extremely low temperature and low specific humidity into the damp, warm air at low altitude sometimes drenches radio equipment, inside and out, from condensation. This causes losses so high that the apparatus is rendered ineffective for a considerable period of time.

Batteries are another source of serious trouble. Most dry cells are intended to operate at temperatures above −20° F., but even at −10° F. their useful life may be reduced sharply.

As these problems were passed on to the various manufacturers they were called upon to perform new and additional acceptance tests which were both costly and time consuming. Some manufacturers realized that the construction of suitable test equipment for these operational-condition or flight-similitude tests was a highly specialized field requiring specialists with a knowledge of thermodynamics, electronics, meteorology, mechanics, aeronautics, and electricity. Our work at Northern Engineering Laboratories, drawing upon our experience in these fields, has been to design and produce test equipment suited to the specific test requirements of various equipment which resulted in a considerable saving of manpower, in the scientific elimination of "bugs," and in a general increase in the quality of material and workmanship without costly research or previous high percentage of rejection.

Special test equipment for each phase of the required operational-condition testing has been and is being developed and constructed for the test laboratory and the production line, ranging in size from 1 cubic foot capacity for small instrument testing to large chambers of 4,000 cubic feet capacity for testing entire plane fuselages, entire gun assemblies, turret mounts and other bulky assemblies.

The performance characteristics of the test equipment must be such that they can accomplish tests either manually or automatically in complete accordance with specification requirements. Performance ranges of typical equipment are shown in Fig. 2. These curves were taken in a chamber developed for flight similitude testing, of a type suitable for radio apparatus.

The lower and upper limits of this performance can be extended to − 80° C. (− 112° F.) and equivalent altitudes of over 80,000 ft. if required. This particular flight-similitude chamber is a compact, self-contained piece of equipment which can be used by unskilled or semi-skilled operators in performing production or laboratory tests which previously required highly skilled technicians.

Users of this type of flight-similitude chamber have found that the combined effects of temperature and pressure changes cannot be determined by individual tests where temperature, pressure, and humidity are varied one at a time. The latter method frequently gives misleading results.

Another very important feature is that the chamber can duplicate conditions of temperature, pressure, and humidity in any combination as often as required. This permits the correlating of results and data taken over an extended period of time. Also, it permits the close observation of flight effects on equipment under test by highly trained individuals who could not stand the rigors of high altitude or low temperature conditions as encountered in actual flight.

Operational testing equipment has played and is playing an important part in the development of radio equipment capable of functioning efficiently under atmospheric conditions encountered any place in the world. Recently developed test chambers have made available means of determining the effects of not only climatic extremes on equipment but, what is even more important, the effects of the cycles of temperature and humidity through which field equipment must operate. Cycle-controlled equipment is now available which can produce simulated atmospheric changes in which it is possible to:

1. Cool and dehumidify simultaneously.
2. Cool and humidify simultaneously.
3. Heat and humidify simultaneously.
4. Heat and dehumidify simultaneously.

This wide range of functional control has made possible the accelerated weathering tests which are used to determine the useful life of equipment under operational conditions, and to eliminate "bugs" and equipment failures which can no longer be tolerated in service.

Research based on this ability to duplicate extreme and rapid weather cycles will result in the development of greatly improved materials, methods, and electrical and mechanical designs. Furthermore, this method of testing permits the designers to observe their equipment under field conditions without leaving the laboratory. In the case of production engineering, the use of this type of engineered test equipment assures uniform testing, accurate and complete, in the shortest period of time and for the lowest possible unit cost, by unskilled operators.

Operational-condition testing has become a definite part of any development or any type of production and such precision testing equipment has now become too complex a problem to be handled with improvised methods. Engineers will be interested to learn that much classified data has been accumulated on this subject, and is available to laboratories or producers of equipment requiring various seemingly impossible conditions. This data cannot be published for general distribution under the present restrictions, however, and is available only to individuals or concerns engaged in military production.

MUSICAL VITAMINS

Music in English Factories Found to Increase Production 6 to 11%

THE new resident inspector of an eastern war plant, on his first tour of the factory, stopped, listened, and snorted: "First thing I do, I'll have this nonsense stopped right away!"

He was referring to phonograph music piped into the production areas of the plant, and played at intervals during the day and night shifts. To many executives, no doubt, the idea of music during working hours doesn't make sense — or does it?

There is plenty of precedent for this practice, dating back to the earliest records of concerted action, of which sea chanties, sung by men when they manned the capstans, are a colorful example. More typical of current applications was the use of music to keep the negroes moving at a lively pace when they loaded cotton on Mississippi river-boats.

Thomas Edison recognized the possibilities of music's industrial application when he compiled a catalog of "mood music" to stimulate factory workers.

The Operadio Manufacturing Company, St. Charles, Illinois, has just published a very interesting study of the results of furnishing music to production and assembly departments during working hours.

English factories, according to this study, are making extensive use of recorded programs, selected and timed with great care to produce the effects desired. Data on scientific music tests, presented in Industrial Health Board Report No. 77 (London), show production increases of 6 to 11 per cent, in addition to increased efficiency resulting from reduction of errors due to mental fatigue.

Hard and fast rules cannot be laid down for the use of musical stimulus in different factories where the tempo and types of operations vary widely. However, it has been established that the results are on the positive and not the negative side, and that the remark of the inspector quoted above, actually made to the writer, was entirely unjustified.

Effects of musical programs engendered by related types of selections are:

1. Increased tempo of repeated hand operations requiring limited mental concentration.
2. Improved alertness and reduction of errors due to stimulation during pre-fatigue and fatigue periods.
3. Greater harmony among workers fostered by relaxation music during lunch and rest periods.
4. Promotion of good will between workers and management.

The Operadio report outlines a program schedule determined from production records checked under controlled conditions of comparison:

Ten minutes of brisk marches, starting at 6:55 A.M.; a half-hour of popular recordings at 9:30 and again at 11:30 A.M. This was followed by ten minutes of marches at 12:55 P.M. and a half-hour of popular music at 2:00 and again at 3:35. This last period, ending at 4:05, concluded with lively tunes, as it covered the opening of the shift coming to work at 4:00 P.M.

Experience showed selections with good swinging rhythm to be first choice. Slow, dreamy waltzes were on the "must not" list for working hours, but recommended for lunch and rest periods. An important point is that sustained vocal selections were found to be distracting because of the tendency of the workers to listen for the words.

Some of the most practical, as well as popular, selections were found to be selections from the current Hit Parade programs, with arrangements having a solid, definite rhythm.

SPOT NEWS

(CONTINUED FROM PAGE 14)

book were prepared by John N. Cose, director of instruction at the RCA Institutes. Any tendency on the part of the student to memorize the contents has been offset by the use of code and cipher groups which form unrecognizable groups. Speed of transmission can be controlled by regulating the turntable of the phonograph.

G. E. Gustafson: Announcement of his appointment to the position of vice president in charge of engineering at Zenith Radio Corporation has just been made by Comdr. E. J. McDonald, Jr. Joining Zenith in 1925, Gustafson became chief engineer in 1933, and assistant vice president three years ago.

Heatronic Molding: An important contribution to molding technique has been made by the Bakelite Corporation, New York City. It is the Heatronic process, used to preheat a roughly pre-formed pill of plastic material. The pill is put between metal plates connected to a high-frequency generator, setting up an electrostatic field. Although the plates stay cool, the pill is warmed uniformly throughout its thickness. Then the preform is quickly transferred to an ordinary mold, and heat and pressure are applied in the conventional manner. However, the material flows evenly to all corners of the mold, and sets in less time with less pressure because of the preheating. By this improved process, much larger parts can be molded, with thicker cross-section, weighing as much as 50 pounds.

Fred M. Lack: Elected a vice-president of Western Electric Company, New York. After a leave of absence during which he served in Washington as director of the Army and Navy Electronics Procurement Agency, he has returned to Western Electric to resume direction of the Company's radio division.

JK-37 Jacks: Now available from quantity production set up by Universal Microphone Company, Inglewood, Calif. This jack is a telephone switchboard extension type, of 3-way, heavy duty 3-prong design with a high-impact phenolic body and steel bracket attachments, approved by the Signal Corps.

UHF Instruction: Two courses in ultra-high frequency technique, one in theory and the other in laboratory work, are to be given by Columbia University, New York. Classes start June 21st. Information can be obtained at Room 313, Engineering Building. Tuition is free.

Coaxial Antenna: A new coaxial antenna, pretuned at the factory to the desired frequency, is being manufactured by the Victor J. Andrew Company, Chicago. It is intended for mounting on a mast, to which it can be attached with a simple clamp. It is a highly efficient and inexpensive half-wave radiator for use in the frequency range of 30 to 300 mc. Total weight is 48 pounds.

General Purpose Relay: A new series of relays, suitable for aircraft service, has been brought out by Guardian Electric Company, Chicago. Contact combinations range from single-pole, single-throw to three-pole, double-throw. Contacts, rated at 12 amps. at 24 volts, hold at over 10 G. acceleration, and withstand vibration in all positions. Coil resistances are .01 to 15,000 ohms. Overall dimensions are 2 3/8 by 2 1/32 by 1 1/16 ins. All parts are plated to resist deterioration under conditions of high humidity.

BETTER SOLDERING TECHNIQUE

FOR civilian production, Stromberg-Carlson used 65 sizes and shapes of soldering iron tips, and consumed many tons of tin annually in standard soft-solder alloys.

All this has been changed, according to Bill Schall, Stromberg's chief inspector. One of the first steps toward conservation of materials and time was to standardize on three styles of soldering iron tips. Then the practice of filing burned tips was stopped. Now, all tips are hammered. This hardens the copper tips and makes them last much longer, even under the higher temperature required for the harder soldering alloys now used. Elimination of filing is effecting an annual saving in copper of at least one ton in this plant.

Workers no longer take time off to reshape their irons. This is done for them by men who have been trained in this special job.

A new soldering iron holder has been developed to keep the iron hotter when not in actual use. It is a small, insulated chamber, designed to hold in the heat. The holder is mounted at an angle near the operator's knee. This saves space on the top of bench.

Although many Stromberg employees have been working on radio and telephone equipment since the days of War I, they have taken a special course of instruction in operations using the new, hard solder. Dramatic illustrations of communications equipment on the battlefield are used to show workers what tragedies can result from loose or noisy connections.

Inspectors have been given a two-weeks' course on quality workmanship. Particular stress is put on the inspection of soldered joints, upon which the continued performance of electrical equipment depends to such a large extent.

BOOK REVIEW

APPLIED ELECTRONICS, by members of the staff of the Department of Electrical Engineering, Massachusetts Institute of Technology. 772 pages, illustrated, cloth bound, 9 by 6 1/4 ins. Published by John Wiley & Sons, Inc., New York City. Price $6.50.

As Dr. Karl T. Compton explains in the foreword of this book, the staff of the Department of Electrical Engineering at the Massachusetts Institute of Technology have been engaged for several years in the work of revising its entire presentation of the basic technological principles of electrical engineering.

The present book is the third in a series of which three more volumes are in preparation. They comprise: Electrical Circuits, Magnetic Circuits and Transformers, Applied Electronics, The mathematics of Circuit Analysis, Applications of Lumped-Circuit Theory, and Theory of Transmission Lines, Wave Guides, and Antennas.

This comprehensive undertaking was born of the belief that the Department could effect a new synthesis of educational material in the field of electrical engineering, and evolve a set of textbooks with a breadth of view which could not be easily approached by an individual author. This provides an integrated coverage of the subject material that cannot now be obtained in the unrelated volumes already available.

No attempt will be given to review the book in detail here, for its complete presentation of applied electronics makes that impossible. In that particular respect, it might be compared to Flemming, of a much earlier period in the progress of the science of radio communications.

Briefly, however, the book deals, in the first part, with the physical phenomena involved in electronic apparatus. The second part is devoted to an explanation of the way the phenomena combine to govern the characteristics, ratings, and limitations of electronic devices. Applications common to several branches of electrical engineering are treated in the third part. Most of the functional methods by which electronics is employed in engineering are included.

The authors make the surprising statement that work on this book was curtailed by the war, and hence it is not as detailed as originally planned. The decision to publish it in its present form was made because of the need for books on electronics for use in the war-training program.

However, the treatment is so complete that the reference index of authors contains about 350 names, and twenty-seven pages are required for the subject index!

Even though the authors may have felt that their work is offered in a less complete form than orginally projected, it is still true that APPLIED ELECTRONICS is by far the most ambitious undertaking in its field to be published so far. And they are to be congratulated that, in spite of the urgent need for the book, they held to the best tradition in typography and printing.

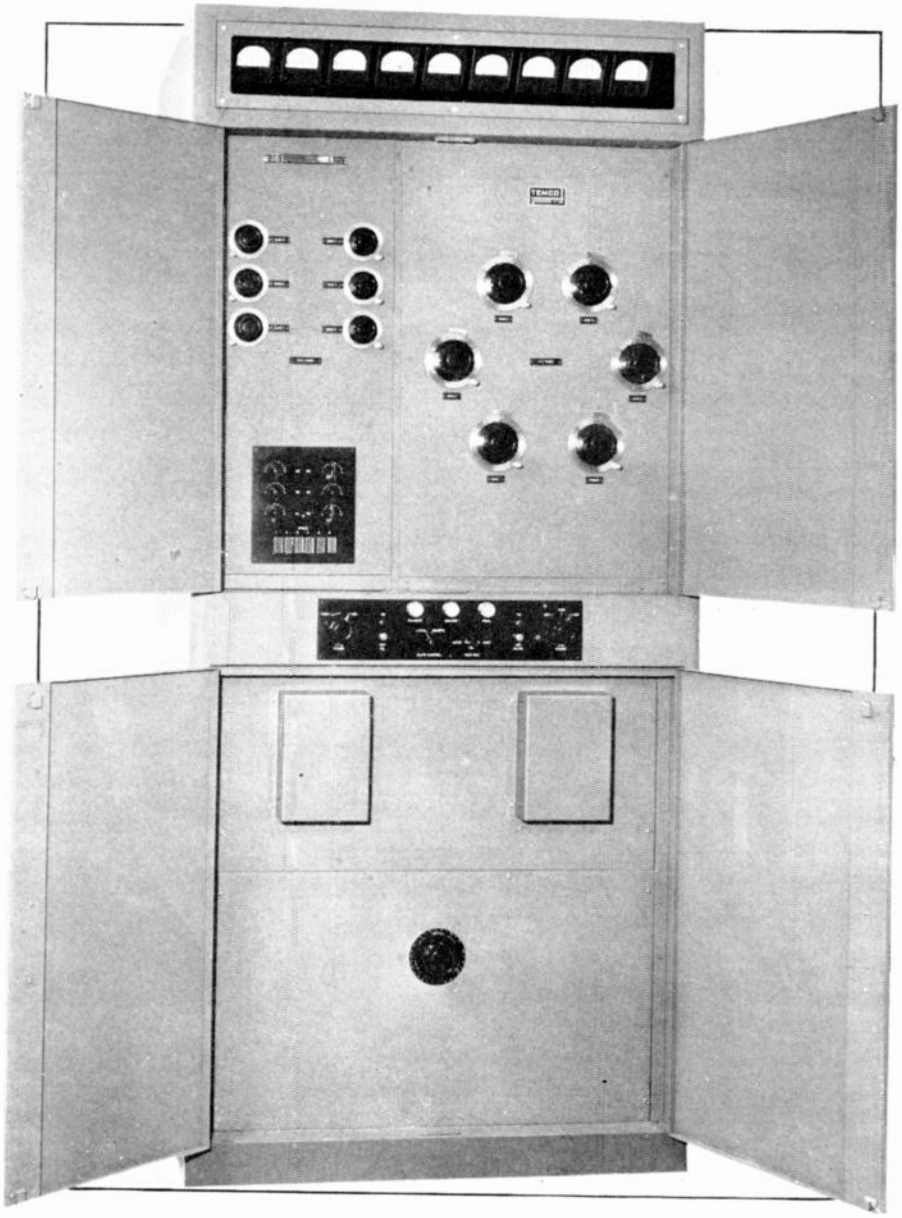


FIG. 1. TEMCO MODEL 1000 AG TRANSMITTER FOR CW TELEGRAPH COMMUNICATION

CW TRANSMITTER DESIGN

1-Kw. Temco Transmitter for 2 to 16 Mc. Uses Motor Drive to Select Six Operating Frequencies

BY MORTON B. KAHN*

BECAUSE there are so many more radio receivers than there are transmitters, the attention of radio engineers generally is focused on the former rather than the latter. However, since signals originate at the transmitters, their performance is the primary determining factor of the results obtained from receiving equipment.

Without discounting the work of receiver engineers, it is fair to say that the great strides which have been made by designers of transmitting equipment have played an important part in improving the overall performance of radio communications systems as recorded at the receiving end.

Although the number of receivers in use is far greater, there are more different types of transmitters and more models of each type because transmitter designs vary not only as to power output but in accordance with the service to be performed and the conditions under which they must be operated.

The result of this condition is that prewar transmitters were, for the most part, designed and built individually. Wartime demands, however, have called for quantity production of transmitters embodying all the quality of workmanship heretofore found only in custom-built apparatus. The Temco 1-kw. CW telegraph unit produced by Transmitter Equipment Manufacturing Company, Inc. is definitely of this category.

It seems to be true, within reasonable limits, that a transmitter is as good as the operators who handle it. This is borne out by the log books at some stations where skilled and patient operators have hung up astonishing records for getting heavy message traffic through consistently, in spite of their equipment rather than because of it.

The design of the model 1000AG transmitter was predicated, however, on its being handled by operators of limited skill and experience, in order to give them every advantage, rather than to add to their responsibilities at a time when they must meet so many emergencies.

General Description ★ Briefly, model 1000AG is a 1-kw. CW transmitter in a self-contained cabinet, arranged either for local or for remote control. It operates directly from a 60-cycle, 110-volt, single-phase supply. It provides facilities for transmitting by continuous-wave telegraphy on any of six pre-determined frequencies, selected by motor-driven switches, in the band from 2 to 16 mc.

AC operation is provided for all relay, bias, and power circuits, eliminating the use of batteries entirely. Power for the remote control unit is obtained directly from the transmitter.

Output power of 1,000 to 1,200 watts is delivered from the coupling link of the transmitter into an antenna tuning unit. This consists of either a balanced or an unbalanced pi-section network, fed into a quarter-wave Marconi antenna worked against ground, or a balanced, untuned transmission line having a surge impedance between 400 and 600 ohms.

Construction ★ Figs. 1, 2, and 3 show the front and rear of the assembled transmitter. The three decks, as seen from the rear, Fig. 2, are arranged as follows:

The bottom deck carries the high-voltage power supply, filament and plate contactors, power amplifier overload relay, auxiliary plate relay, variac for the intermediate and final output tube filaments, and all fuses.

The middle deck is fitted with rollers so that it can be pulled out for easy access. It carries the oscillator, buffer and intermediate power amplifier plate supplies, intermediate and final power amplifier bias supplies, relay supply, time delay relay, intermediate power amplifier over-

* President, Transmitter Equipment Manufacturing Company, Inc., 345 Hudson Street, New York City.

tactor and the contact arms of the time delay, final under-bias, IPA and PA overload relays, and automatic frequency-change relays, energizing the filament contactor coil is necessary in order to apply plate power.

The coil of the PA under-bias relay K7 is in series with the bleeder resistor of the final amplifier bias supply, and if this supply fails, the primaries of all plate power supplies will be opened.

Coils of the IPA overload relay K8, and the PA overload relay K12 are in series with the negative leads of their respective plate transformers. Depending upon the settings of the plunger of the PA overload relay and of the shunt resistor across the IPA overload relay coil, excessive plate current will break the plate primaries.

Contacts of the auxiliary plate relay K11 are in series with the holding circuit of the plate contactor K9 through the Local-Remote switch. When the switch is in the Local position, the holding circuit is closed, thus permitting the normal operation of the transmitter from the local position.

When the switch is put in the Remote position, the coil of the auxiliary plate relay K9 is energized from a DC source supplied by the relay power supply, provided that the switch at the remote position is closed. This closes the contacts of this relay and puts an AC source directly across the coil of the plate contactor through the plate switch button. At the same time, it opens the holding circuit of the plate contactor, thus making it impossible to apply plate power to the transmitter from the local position when switch S6 is in the Remote position.

Connecting the telegraph key across the remote telephone lines permits the energizing of the keying relay K1, and the operation of the transmitter.

The IPA and PA power supply plate switches S9 and S8 respectively are located on the transmitter control panel. With S9 in the Tune position, a glow coil is put in series with the primary of the IPA plate transformer, thus reducing the secondary output voltage to a safe level for tuning this stage. In the Operate position, the glow coil is cut out and full voltage is applied to the IPA tubes.

Switch S8 controls the line voltage to the primary of the high voltage plate transformer. It has three positions, as the diagram shows. In the Off position, it breaks the primary of the high voltage plate transformer; in the Half position it puts the primary input voltage across the full winding of the transformer to reduce the secondary voltage for tuning purposes; and in the Full position it applies the primary voltage across only a part of the primary, to give the full secondary output voltage. In order to control this transmitter completely from the remote control point, it is necessary that both S8 and S9 be in the Full and Operate positions respectively.

Filament variac VA1 controls the primary input voltage to the filament transformers of both the 828 and 833A tubes, after the filament contactor has been energized by pressing the filament start button. It is absolutely essential that the filament voltage, as read from the filament voltmeter on the meter panel, be set at 10 volts. This assures the application of the proper voltage to the filaments of the 828 and 833A tubes.

Key switch S7, on the transmitter control panel, permits preliminary tuning up and adjustment of the circuits. It has an intermediate and a fixed position.

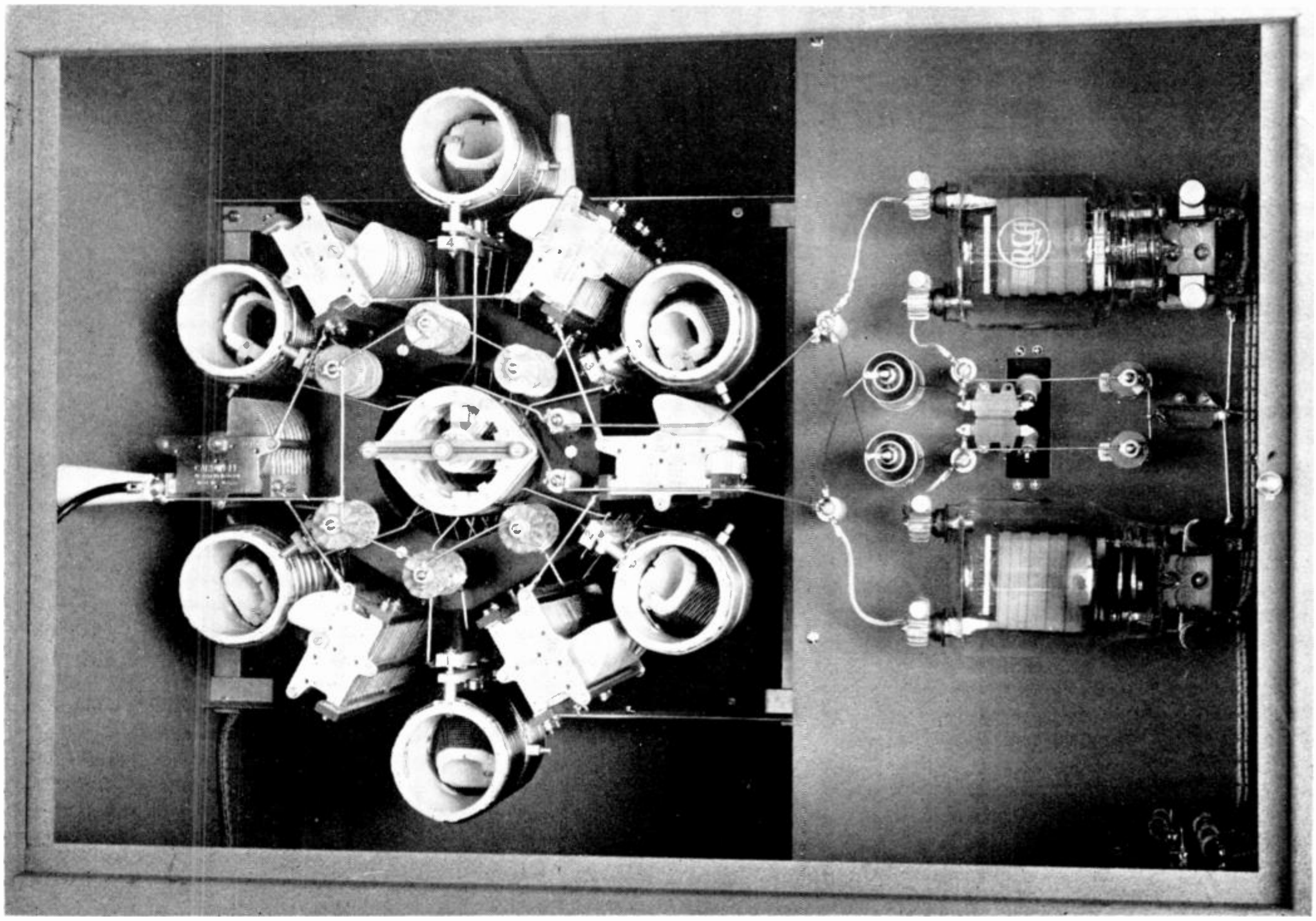


FIG. 6. CLOSE-UP OF FINAL AMPLIFIER TANKS, TUBES, AND FREQUENCY-CHANGE SWITCH AS SEEN FROM REAR OF THE CABINET

Characteristics ★ Further information is contained in the following specifications:

Dimensions: Cabinet 35 ins. wide, 28 ins. deep, 85½ ins. high
Weight: 2,200 lbs.
Frequency Stability: .02% or better over the entire frequency range

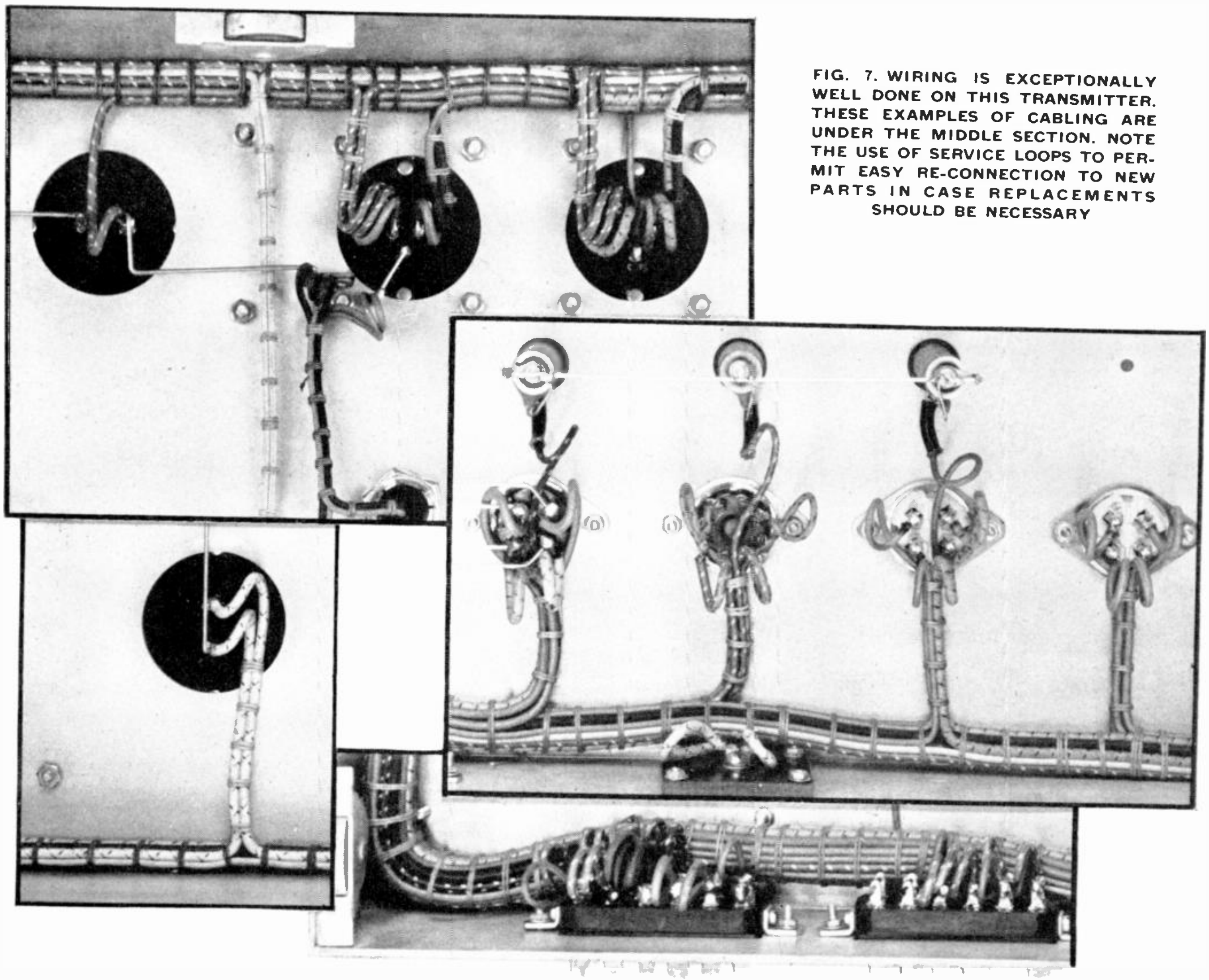


FIG. 7. WIRING IS EXCEPTIONALLY WELL DONE ON THIS TRANSMITTER. THESE EXAMPLES OF CABLING ARE UNDER THE MIDDLE SECTION. NOTE THE USE OF SERVICE LOOPS TO PERMIT EASY RE-CONNECTION TO NEW PARTS IN CASE REPLACEMENTS SHOULD BE NECESSARY

Remote Control: Key jack, band selector switch, filament START-STOP switch, plate START-STOP switch
Keying Speed: 50 words per minute
Power Input: Key down, 3,280 watts; key up, 1,600 watts; standby, 910 watts
Power Factor: 90% approximately
Duty Cycle: Continuous

Circuit Symbols ★ The explanation of the symbols which appear in Fig. 4 will make more clear the functions of the various circuits. Each individual wire entering a cable, indicated by the heavy lines, is marked by a letter and number at both ends, so that it can be traced from one terminal board to the other.

BLOWER
BL1. 12-in. draft fan

CHOKES
CH1. 828 supply filter
CH2. 828 bias filter
CH3. Osc. & buffer pl. filter
CH4. PA bias filter
CH5. High v. filter
CH6. High v. filter
CH7. Osc. & buffer filter

CONDENSERS
C1, 2. Coupling
C3 to C7. By-pass
C8, 9. Neutralizing
C10 to C15. Tuning
C16. Feed-back
C17, 18. By-pass
C19. Filter, key relay
C20. Plate blocking
C21, 22. By-pass
C23. Coupling
C24. By-pass
C25 to C30. Tuning
C31, 32. Coupling
C33. Buffer balancing
C34 to C40. By-pass
C41 to C46. Tuning
C47, 48. Coupling
C49. 828 pl. v. filter
C50. 828 bias filter
C51. 828 bias filter
C52, 53. Osc. & buffer pl. filter
C54. 833A bias filter
C55. 833A bias filter
C56, 57. High v. filter
C58 to C65. Meter by-pass
C67. PA balancing

FUSES
F1, 2. Main line
F3. Control
F4. Bias & filaments
F5. High v. pl. trans.
F6. 828 plate trans.
F7. All low pl. supply

INDUCTANCES
L1, 2. Grid feed RF choke
L3 to L8. Plate tank
L9. IPA plate RF choke
L10 to L15. Plate coil center tap feed RF choke
L16, 17. Grid feed RF choke
L18 to L23. Plate feed RF choke
L24. Osc. plate feed
L25 to L30. Buffer plate tank
L31 to L36. IPA plate tank

JACK
J1. Local key jack

METERS
M1. Osc. plate current
M2. Buf. plate current
M3. IPA grid current
M4. IPA plate current
M5. PA grid current
M6. PA plate current
M7. PA filament volts
M8. PA plate volts
M9. Line voltage

MOTORS
MO1. Band switch drive
MO2. Band switch drive

RELAYS
K1. Keying relay
K2. Time delay
K3. Band switch motor control
K4. Band switch motor auxiliary control
K5. Band switch motor control
K6. Band switch motor auxiliary control
K7. Under-bias
K8. Low volt. overload
K9. Plate auxiliary
K10. Plate
K11. Filament
K12. Plate overload

RESISTORS
R1. Osc. grid
R2. Key relay filter
R3. Buffer grid
R4. Grid
R5. IPA suppressor bleeder
R6. IPA suppressor dropping
R7, 8. 828 supply bleeder & sc. grid drop
R9. 828 bias bleeder
R10. Osc. keyer plate bleeder
R11. Final bias bleeder
R12. Final bias bleeder
R13, 14. Relay supply bleeder
R15. 828 plate trans. primary dropping
R16, 17. High v. bleeder
R18, 19. High v. meter bridge

SWITCHES
D5. Interlock circuit push button
PB1. Plate start button
PB2. Fil. start button
S. Blower control


electronic briefs: television
To produce a moving picture it becomes necessary to break down the action into a series of still pictures. Each still scene is flashed on the screen individually but done so rapidly that the human eye sees a smooth action. If the motion picture projector is slowed down the action becomes jerky. Each still picture is called a frame. The conventional movie projector flashes between 24 and 30 frames per second on the screen. Television is based upon the same principle but the problems involved are much more complex.
Television, using the same basis for creating picture action as the movies, breaks down the picture or scene to be broadcast into a series of still pictures called frames. But each frame must also be broken down into approximately 200,000 tiny segments, each segment being broadcast separately and reassembled at the receiving end so rapidly that 30 frames can be flashed on the screen every second. Thus some 6,000,000 separate signals must be transmitted per second. Furthermore each of these signals starts as light, is converted into an electrical impulse, broadcast and then reconverted to light again. To make television talk, a conventional sound transmitter must be coordinated and synchronized with the picture broadcast.
As with all things in the field of electronics, vacuum tubes are what make television possible. Remember; Eimac tubes enjoy the enviable distinction of being first choice among leading electronic engineers throughout the world.
EITEL-McCULLOUGH, INC., SAN BRUNO, CALIFORNIA
EXPORT AGENTS: FRAZAR & HANSEN, 301 CLAY ST., SAN FRANCISCO, CALIF., U. S. A.
Follow the leaders to
ARMY NAVY
Army-Navy "E" flag awarded for high achievement in the production of war material.
Eimac
REG. U. S. PAT. OFF.
TUBES

S1. Plate tank select.
S2. Plate tank index.
S3. Exciter index.
S4. Crystal buffer band switch
S5. IPA band switch
S6. Local-remote
S7. Test key
S8. PA tune-operate
S8. IPA tune-operate

TRANSFORMERS

T1. Fil. for V1, 833A
T2. Fil. for V2, 833A
T3. 828 filament
T4. 828 rectifiers fil.
T5. 828 rect. plate
T6. 828 bias rect. fil. & plate
T7. Osc. buffer rect. filament
T8. Osc. buffer rect. plate
T9. PA bias rect. fil. & plate
T10. Relay rect. fil. & plate
T11. Osc. & buffer fil.
T12. High v. rect. fil.
T13. High v. rect. pl.

TUBES

V1. Final amp. 833A
V2. Final amp. 833A
V3. Oscillator 6J5
V4. Buffer 6AG7
V5, 6. IPA 828
V7, 8. 828 plate supply rect. 866 866A
V9. 828 bias supply rect. 5W4
V10. Osc. & buffer pl. supply rect. 5Z3
V11. Final bias supply rect. 5Z3
V12. Relay supply rect. 5Z3
V13. Relay supply rect. 5Z3
V14. High v. rect. 872A
V15. High v. rect. 872A

VARIAC

VA1. Filament control

FM BROADCASTING STATIONS

Stations on the Air, and Which Have Reinstated Applications

The list of commercial and experimental FM stations presented here, together with the companies which have applied for reinstatement of their FM applications, is the first to be published since our issue of February, 1942.

Where an **E** precedes the company name, the station is operating on regular schedule, but under an experimental license. The **X** indicates that the company applied for a construction permit before all broadcasting construction was stopped, and has now requested reinstatement of application so that it can be acted upon immediately after the ban is lifted.

This list is substantially correct, although there may be omissions among the reinstatements. Since no official list has been published by the FCC, it was not possible to make an exact check.

If any errors or omissions are found, we shall be grateful to have them called to our attention so that corrections can be made in a subsequent listing.

It is interesting to note that twenty-two names are marked with an **X**, for this confirms the growing conviction that the broadcasting industry has not lost interest in FM but is, on the contrary, preparing to expand rapidly in this new field as soon as the whistle blows.

No one can venture a guess as to when that will be. However, it is no secret that the ban against broadcast station construction will be lifted as soon as military contracts are cancelled, so that this activity may serve to take up some of the slack in radio production and employment.

This construction will also make use of materials which the manufacturers will have on hand from cancelled government contracts.

Another interesting fact brought out by an examination of this list is that not one FM station in operation prior to Pearl Harbor has gone off the air. Instead, a number that were not completed then were able to carry on and finish their construction work. Actually, therefore, more FM stations are in regular operation now than before the freeze order was issued by the FCC.

CALIFORNIA

Los Angeles

K37LA **X** Earle C. Anthony
K45LA Don Lee Broadcasting System

San Francisco

KLAW Board of Education

CONNECTICUT

Hartford

W53H The Travelers Broadcasting Serv.
W65H WDRC, Inc.

DISTRICT OF COLUMBIA

W3XO **E** 43.2 mc. Jansky & Bailey
71 **X** Evening Star Broadcasting Co.

ILLINOIS

Chicago

W51C Zenith Radio Corp.
W59C WGN, Inc.
W63C **X** National Broadcasting Company
W67C Columbia Broadcasting System
W75C Moody Bible Institute
WBEZ Board of Education

Urbana

WIUC Board of Education

INDIANA

Evansville

W45V Evansville on the Air

Fort Wayne

W49FW Westinghouse Radio Stations, Inc.

KENTUCKY

Beattyville

WBKY University of Kentucky

Lexington

W51SL **X** Amer. Broadcasting Corp. of Ky.

LOUISIANA

Baton Rouge

W45BR Baton Rouge Broadcasting Co.

MAINE

Portland

71 **X** Portland Broadcasting System

MARYLAND

Baltimore

W59BM **X** Baltimore Radio Show, Inc.

MASSACHUSETTS

Boston

W35B **X** Columbia Broadcasting System
W43B The Yankee Network
W67B Westinghouse Radio Stations, Inc.

New Bedford

57 **X** E. Anthony & Sons, Inc.

Springfield

W1XSN **E** 42.6 mc. Westinghouse Radio Sta.

Worcester

W1XTG **E** 43.4 mc. Worcester Teleg. Pub. Co.

MICHIGAN

Detroit

W45D The Evening News Association
W49D John Lord Booth
W65D **X** James F. Hopkins, Inc.
W73D **X** King Trendle Broadcasting Co.

Grand Rapids

W69GR **X** Federated Publications, Inc.

MISSOURI

Kansas City

K49KC Commercial Radio Equipment Co.
W9XER **X** 46.5 mc. Midland Broadcasting Co.

St. Louis

K47L **X** Star-Times Publishing Co.
K47L **X** Globe-Democrat Publishing Co.
K55L **X** The Pulitzer Publishing Co.

NEW HAMPSHIRE

Mt. Washington

W39B The Yankee Network

NEW JERSEY

Trenton

99 **X** Mercer Broadcasting Co.

NEW YORK

Binghamton

W49BN Wylie B. Jones Advertising Agency

(CONTINUED ON PAGE 32)

EVERY MINUTE *Counts!*

PRODUCTION LINES MUST NOT SLOW DOWN!

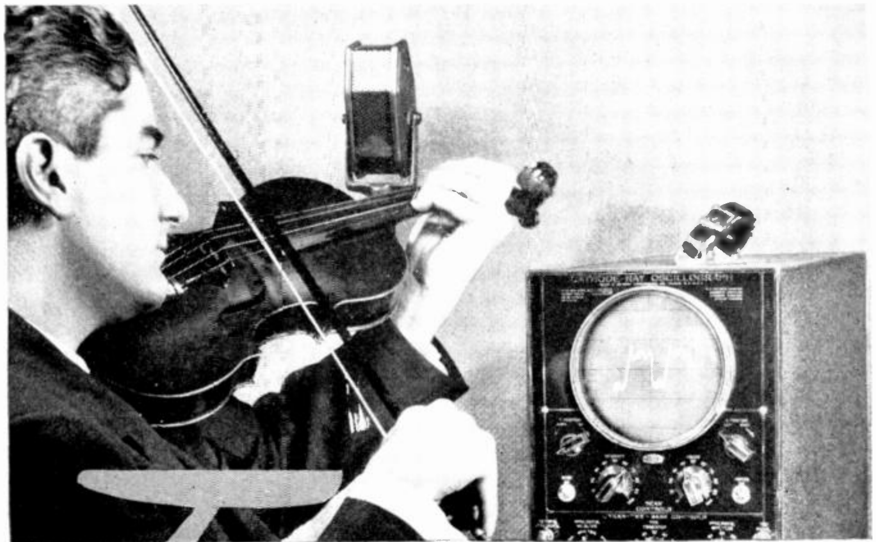
Lafayette Radio is strategically located to give you *quick* deliveries on radio and electronic parts and equipment. Millions of items have been shipped from Chicago, the shipping hub of the nation, to industrials, training schools and all branches of the armed services. Lafayette's procurement and expediting service has helped to prevent work stoppages on many vital war production lines.

Many instances are on record wherein Lafayette has made immediate delivery on hard-to-find key items, eliminating costly delays in giant armament programs. This is because Lafayette handles the products of every nationally known manufacturer in the radio and electronic field. A single order to Lafayette, no matter how large or how small, will bring prompt delivery of *all* your requirements.

Free — 130 page Catalog — "Radio and Electronic Parts and Equipment." Write 901 W. Jackson, Chicago, Ill. Dept. 5T3.

LAFAYETTE RADIO CORP. CHICAGO

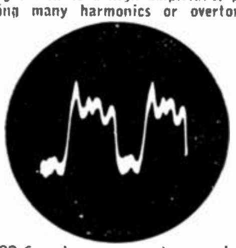
"Quick Delivery of Radio and Electronic Parts and Equipment"



Tone . . .

Sine waves of a tuning fork, A-440 cycles per second. Note the pure wave form absolutely devoid of harmonics. If secondary waves are superimposed on the fundamental wave, we have the harmonics or overtones which distinguish voices or instruments.

G-392 cycles per second as produced by a single reed of an accordian. Complex wave form is the result of reed being driven to a high amplitude, producing many harmonics or overtones.



E-392.6 cycles per second as produced by the D string of a violin, with first finger in position. Since the entire body of the violin resonates, the tone is rich in harmonics and wave form will vary greatly from note to note.

LET'S SEE THE DIFFERENCE BETWEEN A STRADIVARIUS AND A TEN-DOLLAR VIOLIN!

★ Good tone—the average ear demands just that. But how can we describe *good tone*—in precise terms other than mere personal opinion as to what "listens good?"

The DuMont oscillograph again comes to the rescue. Simply pick up the voice or instrument, and reproduce it as an oscillogram. Here we have a faithful portrayal of fundamental pitch and overtone components. If that voice or instrument is pleasing, then we have a veritable *electronic master blueprint* to be followed and matched in duplicating that desired tone quality.

Thus tone is no longer a matter of personal opinion. It is a precise *quantity* as well as quality to be duplicated. Which represents but another example of how the versatile DuMont oscillograph is employed today.

★ Write for Literature . . .

DUMONT

ALLEN B. DU MONT LABORATORIES, Inc.
Passaic • New Jersey
Cable Address: Wespexlin, New York

FM BROADCASTING STATIONS

(CONTINUED FROM PAGE 30)

New York City

W2XMN E 42.8 mc. Edwin H. Armstrong
W39NY Municipal Broadcasting System
W47NY Muzak Corporation
W2XWG E 45.1 mc. National Broadcasting Co.
W57NY X Frequency Broadcasting Corp.
W63NY Marcus Loew Booking Agency
W67NY Columbia Broadcasting System
W71NY Bamberger Broadcasting Service
W75NY Metropolitan Television, Inc.
WNYE Board of Education

Rochester

W8XAD E 42.6 mc. WHEC, Inc.
W51R Stromberg-Carlson Telephone Co.

Schenectady

W47A Capitol Broadcasting Co.
W85A General Electric Co.

NORTH CAROLINA

Winston-Salem

W41MM Gordon Gray

OHIO

Cincinnati

W8XFM E 43.2 mc. Crosley Corporation

Cleveland

WBOE Board of Education

Columbus

W45CM WBNS, Inc.

PENNSYLVANIA

Philadelphia

W49PH Pennsylvania Broadcasting Co.
W53PH WFIL Broadcasting Corp.
W57PH Westinghouse Radio Stations, Inc.
W61PH X Gibraltar Service Corp.
W69PH WCAU Broadcasting Co.
W73PH William Penn Broadcasting Co.
W77PH X WDAS Broadcasting Station, Inc.

Pittsburgh

W47P Walker-Downing Corp.
W65P X Pittsburgh Radio Supply House
W75P Westinghouse Radio Stations, Inc.

RHODE ISLAND

Providence

85 X The Outlet Company

TENNESSEE

Nashville

W47NV National Life & Accident Ins. Co.

TEXAS

Amarillo

K51AM X Amarillo Broadcasting Co.

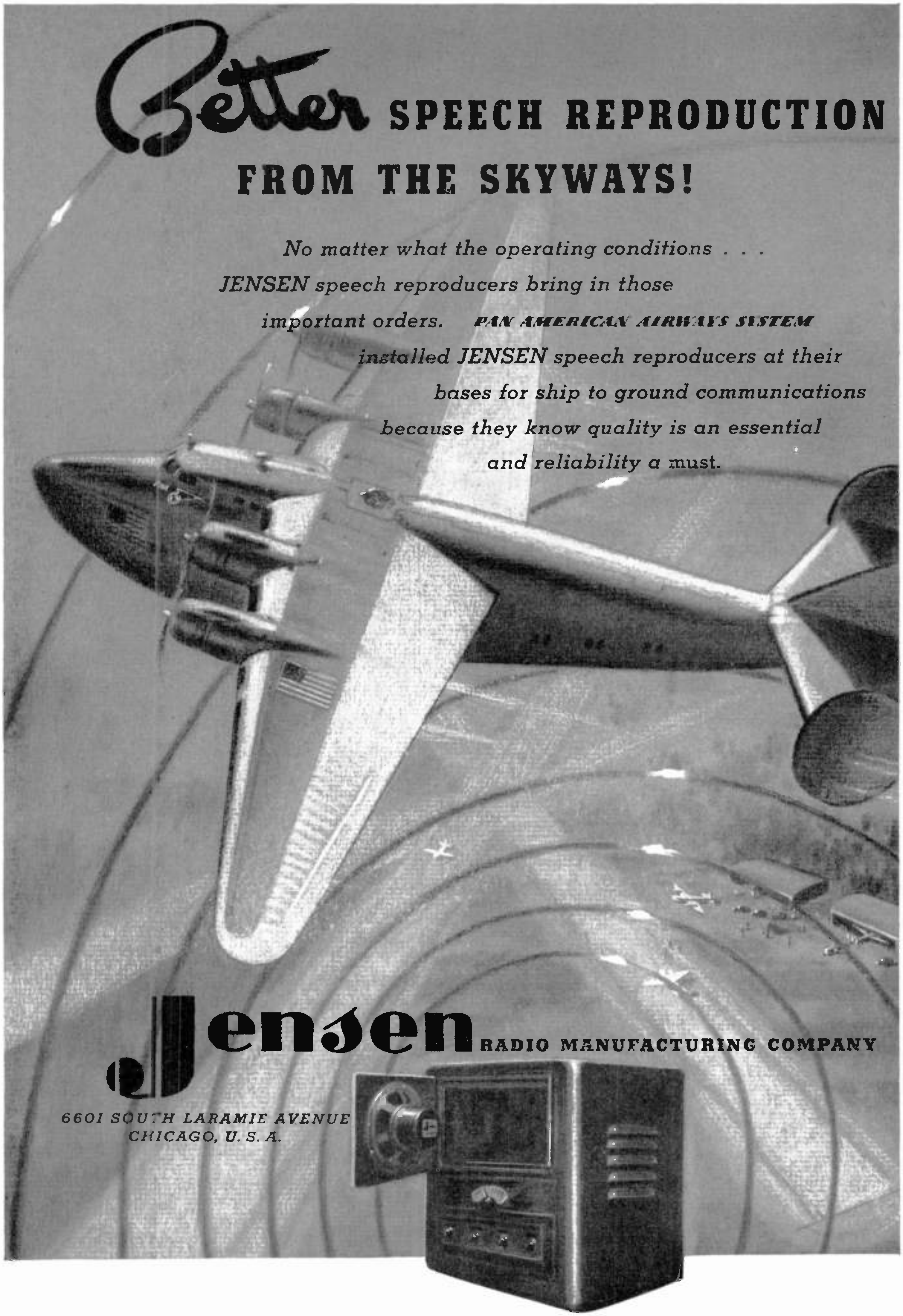
WISCONSIN

Milwaukee

W55M The Journal Co.

Superior

W9XYH E Head of the Lakes Broadcasting Co.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No matter what the operating conditions . . . JENSEN speech reproducers bring in those important orders. PAN AMERICAN AIRWAYS SYSTEM installed JENSEN speech reproducers at their bases for ship to ground communications because they know quality is an essential and reliability a must.
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RADIO-ELECTRONIC PRODUCTS DIRECTORY

The Radio Engineers' & Purchasing Agents' Guide to Essential Materials, Components, and Equipment

★ Indicates advertiser in this issue of Radio-Electronic Engineering

ANTENNAS, Mobile Whip & Collapsible

- Birnbach Radio Co., 145 Hudson St., N. Y. C.
- Brach Mfg. Corp., L. S., Newark, N. J.
- Camburn Elec. Co., 484 Broome St., N. Y. C.
- Galvin Mfg. Corp., Chicago, Ill.
- ★ Link, F. M., 125 W. 17th St., N. Y. C.
- Premax Products, 4214 Highland Ave., Niagara Falls, N. Y.
- ★ Radio Eng. Labs., Inc., L. I. City, N. Y.
- Snyder Mfg. Co., Noble & Darien Sts., Phila.
- Technical Appliance Co., 516 W. 34 St., N. Y. C.
- Ward Products Corp., 1523 E. 45 St., Cleveland, O.

ANTENNAS, Tower Type

- Blaw-Knox Co., Pittsburgh, Pa.
- Harco Steel Cons. Co., E. Broad St., Elizabeth, N. J.
- Lehigh Structural Steel Co., 17 Battery Pl., N. Y. C.
- ★ Lingo & Son, John E., Camden, N. J.
- Truscon Steel Co., Youngstown, O.
- Wincharger Corp., Sioux City, Iowa

BEADS, Insulating

- American Lava Corp., Chattanooga, Tenn.
- Dunn, Inc., Struthers, 1321 Cherry, Phila., Pa.
- Star Porcelain Co., Trenton, N. J.
- Steward Mfg. Co., Chattanooga, Tenn

BINDING POSTS, Push Type

- Amer. Radio Hdware Co., 476 B'way, N. Y. C.
- Eby, Inc., Hugh H., W. Chelten Ave., Phila.

BOOKS on Radio & Electronics

- Macmillan Co., 60 Fifth Ave., N. Y. C.
- ★ McGraw-Hill Book Co., 330 W. 42 St., N. Y. C.
- Radio Technical Pub. Co., 45 Astor Pl., N. Y. C.
- Rider, John F., 404 Fourth Ave., N. Y. C.
- Ronald Press Co., 15 E. 26 St., N. Y. C.
- Van Nostrand Co., D., 250 Fourth Ave., N. Y. C.
- Wiley & Sons, John, 440 Fourth Ave., N. Y. C.

BRIDGES, Percent Limit Resistance

- ★ Radio City Products Co., 127 W. 26 St., N. Y. C.
- Shallcross Mfg. Co., Collingdale, Pa.

CABLE, Coaxial

- American Phenolic Corp., 1830 S. 54 Av., Chicago
- Anaconda Wire & Cable Co., 25 B'way, N. Y. C.
- Andrew Co., Victor J., 363 E. 75 St., Chicago
- Belden Mfg. Co., 4673 W. Van Buren, Chicago
- Boston Insulated Wire & Cable Co., Boston
- Communications Prods. Co., Jersey City, N. J.
- Cornish Wire Co., 15 Park Row, N. Y. C.
- Doolittle Radio, Inc., 7521 S. Loomis Blvd., Chicago
- General Cable Corp., 420 Lexington, N. Y. C.
- General Insulated Wire Corp., 53 Park Pl., N. Y. C.
- Johnson Co., E. F., Waseca, Minn
- Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Coaxial, Solid Dielectric

- American Phenolic Corp., 1830 S. 54 Ave., Chicago
- Federal Tel. & Radio Corp., E. Newark, N. J.
- Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Microphone, Speaker & Battery

- ★ Alden Prods. Co., Brockton, Mass
- Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
- Belden Mfg. Co., 4633 W. Van Buren, Chicago
- Boston Insulated Wire & Cable Co., Dorchester, Mass.
- Gavett Mfg. Co., Brookfield, Mass.
- Holyoke Wire & Cable Corp., Holyoke, Mass.

CASTINGS, Die

- Aluminum Co. of Amer., Pittsburgh, Pa.
- American Brass Co., Waterbury, Conn.
- Dow Chemical Co., Dow Metal Div., Midland, Mich.

CERAMICS, Bushings, Washers, Special Shapes

- Akron Porcelain Co., Akron, O.
- American Lava Corp., Chattanooga, Tenn.
- Centralab, Div. of Globe-Union Inc., Milwaukee, Wis.
- Electronic Mechanics, Inc., Paterson, N. J.
- Gen'l Ceramics & Steatite Corp., Keasbey, N. J.
- Isolantite, Inc., Belleville, N. J.
- Lapp Insulator Co., Leroy, N. Y.
- Louthan Mfg. Co., E. Liverpool, O.
- Star Porcelain Co., Trenton, N. J.
- Steward Mfg. Co., Chattanooga, Tenn.
- Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
- Victor Insulator Co., Victor, N. Y.
- Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CHOKES, RF

- Aladdin Radio Industries, 501 W. 35th, Chicago
- ★ Alden Prods. Co., Brockton, Mass.
- American Communications Corp., 306 B'way, N. Y. C.
- Barber & Williamson, Upper Darby, Pa.
- Coto-Coil Co., Providence, R. I.
- D-X Radio Prods. Co., 1575 Milwaukee, Chicago
- Gen. Winding Co., 420 W. 45 St., N. Y. C.
- Guthman & Co., Edwin, 400 S. Peoria, Chicago
- Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
- Johnson Co., E. F., Waseca, Minn.
- Lectrohm, Inc., Cicero, Ill.
- ★ Meissner Mfg. Co., Mt. Carmel, Ill
- Miller Co., J. W., Los Angeles, Cal.
- Muter Co., 1255 S. Michigan, Chicago
- ★ National Co., Malden, Mass.
- Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
- Radex Corp., 1328 Elston Av., Chicago
- Sickles Co., F. W., Chicopee, Mass.
- Teleradio Eng. Corp., 484 Broome St., N. Y. C.
- Triumph Mfg. Co., 4017 W. Lake St., Chicago

CLIPS, Connector

- Mueller Electric Co., Cleveland, O.

CLIPS & MOUNTINGS, Fuse

- ★ Alden Prods. Co., Brockton, Mass.
- Dante Elec. Mfg. Co., Bantam, Conn.
- Ilsco Copper Tube & Prods., Inc., Station M., Cincinnati
- Jefferson Elec. Co., Bellwood, Ill.
- Jones, Howard B., 2300 Wabansia, Chicago
- Littlefuse, Inc., 4753 Ravenswood, Chicago
- Patton MacGuyer Co., Providence, R. I.
- Sherman Mfg. Co., H. B., Battle Creek, Mich.
- Stewart Stamping Co., 621 E. 216 St., Bronx, N. Y.
- Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

CLOTH, Insulating

- Acme Wire Co., New Haven, Conn.
- Brand & Co., Wm., 276-4th Av., N. Y. C.
- Endurette Corp. of Amer., Cliffwood, N. J.
- Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
- Irvington Varnish & Insulating Co., Irvington, N. J.
- Mica Insulator Co., 196 Varick, N. Y. C.

COIL FORMS, Phenolic, Cast without Molds

- ★ Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.

CONDENSERS, Fixed

- ★ Aerovox Corp., New Bedford, Mass.
- American Condenser Corp., 2508 S Michigan, Chicago
- Art Radio Corp., 115 Liberty, N. Y. C.
- Atlas Condenser Prods. Co., 548 Westchester Ave., N. Y. C.
- Automatic Winding Co., E. Newark, N. J.
- Bud Radio, Inc., Cleveland, O.
- Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
- Centralab, Milwaukee, Wis.
- Condenser Corp. of America, South Plainfield, N. J.
- Condenser Prods. Co., 1375 N. Branch, Chicago
- Cornell-Dubilier Elec. Corp., S. Plainfield, N. J.
- Cosmic Radio Co., 699 E. 135th St., N. Y. C.
- Crowley & Co., Henry, W. Orange, N. J.
- Deutschmann Corp., Tobe, Canton, Mass.
- Dumont Elec. Co., 34 Hubert St., N. Y. C.
- Electro-Motive Mfg. Co., Willimantic, Conn.
- Erie Resistor Corp., Erie, Pa.
- Fast & Co., John E., 3123 N. Crawford, Chicago
- General Radio Co., Cambridge, Mass.
- Girard-Hopkins, Oakland, Calif.
- H. R. S. Prods, 5707 W. Lake St., Chicago
- Illinois Cond. Co., 1160 Howe St., Chicago
- Industrial Cond. Corp., 1725 W. North Av., Chicago
- Insuline Corp. of America, Long Island City, N. Y.
- Johnson Co., E. F., Waseca, Minn.
- Kellogg Switchb'd & Supply Co., 6650 Cicero, Chicago
- Magnavox Co., Fort Wayne, Ind.
- Mallory & Co., P. R., Indianapolis, Ind.
- Micamold Radio Corp., Brooklyn, N. Y.
- Muter Co., 1255 S. Michigan, Chicago
- ★ Polymet Condenser Co., 699 E. 139 St., N. Y. C.
- Potter Co., 1950 Sheridan Rd., N. Chicago
- RCA Mfg. Co., Camden, N. J.
- Sangamo Elec. Co., Springfield, Ill.
- Solar Mfg. Corp., Bayonne, N. J
- Sprague Specialties Co., N. Adams, Mass.
- Teleradio Engineering Corp., 484 Broome St., N. Y. C.

CONDENSERS, Gas-filled

- Lapp Insulator Co., Inc., Leroy, N. Y.

CONDENSERS, High-Voltage Vacuum

- Centralab, Milwaukee, Wis.
- ★ Eitel-McCullough, Inc., San Bruno, Calif.
- Erie Resistor Corp., Erie, Pa.
- ★ General Electric Co., Schenectady, N. Y.

CONDENSERS, Small Ceramic Tubular

- Centralab, Div. of Globe-Union, Inc., Milwaukee, Wis.
- Erie Resistor Corp., Erie, Pa.

CONDENSERS, Tubular Ceramic Transmitting

- ★ Aerovox Corp., New Bedford, Mass.
- Cornell-Dubilier, S. Plainfield, N. J
- RCA Mfg. Co., Inc., Camden, N. J
- Sangamo Electric Co., Springfield, Ill
- Solar Mfg. Corp., Bayonne, N. J

CONDENSERS, Variable Receiver Tuning

- ★ Alden Prods. Co., Brockton, Mass
- American Steel Package Co., Defiance, Ohio
- Barker & Williamson, Ardmore, Pa
- Bud Radio, Inc., Cleveland, O.
- Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
- General Instrument Corp., Elizabeth, N. J.
- Hammarlund Mfg. Co., 424 W 34th St., N. Y. C.
- Insuline Corp. of Amer., L. I. City, N. Y.
- Meissner Mfg. Co., Mt. Carmel, Ill
- ★ Millen Mfg. Co., Malden, Mass
- ★ National Co., Malden, Mass.
- Oak Mfg. Co., 1267 Clybourn Ave., Chicago
- Radio Condenser Co., Camden, N. J.
- Rauland Corp., Chicago, Ill.

CONDENSERS, Variable Transmitter Tuning

- Barker & Williamson, Upper Darby, Pa.
- Bud Radio, Cleveland, O.
- Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
- Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
- Insuline Corp. of Amer., L. I. City, N. Y.
- Johnson, E. F., Waseca, Minn.
- Millen Mfg. Co., James, Malden, Mass.
- ★ National Co., Malden, Mass.
- Radio Condenser Co., Camden, N. J.

CONDENSERS, Variable Trimmer

- ★ Alden Prods Co., Brockton, Mass.
- American Steel Package Co., Defiance, O.
- Bud Radio, Inc., Cleveland, O.
- Cardwell Mfg. Corp., Brooklyn, N. Y.
- Centralab, Milwaukee, Wis.
- Fada Radio & Elec. Corp., Long Island City, N. Y.
- General Radio Co., Cambridge, Mass.
- Guthman, Inc., E. I., 400 S. Peoria, Chicago
- Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
- Insuline Corp. of America, Long Island City, N. Y.
- Johnson Co., E. F., Waseca, Minn.
- Mallory & Co., Inc., P. R., Indianapolis, Ind.
- ★ Meissner Mfg. Co., Mt. Carmel, Ill.
- Millen Mfg. Co., James, Malden, Mass.
- Miller Co., J. W., Los Angeles, Cal.
- Muter Co., 1255 S. Michigan Av., Chicago
- ★ National Co., Malden, Mass.
- Potter Co., 1950 Sheridan Rd., N. Chicago
- Sickles Co., F. W., Chicopee, Mass.
- Solar Mfg. Corp., Bayonne, N. J.
- Teleradio Eng. Corp., 484 Broome, N. Y. C.

CONNECTORS, Cable

- Aero Electric Corp., Los Angeles, Calif.
- ★ Alden Prods., Brockton, Mass.
- Amer. Microphone Co., 1915 S. Western Av., Los Angeles
- Amer. Phenolic Corp., 1830 S. 54th St., Chicago
- American Radio Hardware Co., 476 B'way, N. Y. C.
- Andrew, Victor J., 6429 S. Lavergne Av., Chicago
- Astatic Corp., Youngstown, O.
- Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
- Birnbach Radio, 145 Hudson St., N. Y. C.
- Breeze Mfg. Corp., Newark, N. J.
- Brush Development Co., Cleveland, O.
- Bud Radio, Cleveland, Ohio
- Cannon Elec. Development, 3209 Humboldt, Los Angeles
- Eby, Inc., Hugh H., Philadelphia
- Electro Voice Mfg. Co., South Bend, Indiana
- Franklin Mfg. Corp., 175 Varick St., N. Y. C.
- General Radio Co., Cambridge, Mass.
- Harwood Co., 747 N. Highland Ave., Los Angeles
- Insuline Corp. of Amer., L. I. City, N. Y
- Jones, Howard B., 2300 Wabansia, Chicago
- Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
- Mallory & Co., P. R., Indianapolis, Ind.
- Monowatt Electric Co., Providence, R. I
- ★ Radio City Products Co., 127 W. 26 St., N. Y. C.
- Remler Co., Ltd., 2101 Bryant St., San Francisco
- Selectar Mfg. Co., L. I. City, N. Y
- ★ Universal Microphone Co., Ltd., Inglewood, Calif.

CONTACT POINTS

- Callite Tungsten Corp., Union City, N. J.
- Mallory & Co., Inc., P. R., Indianapolis, Ind.

COUPLINGS, flexible

- Cardwell Mfg. Corp., Brooklyn, N. Y
- Johnson Co., E. F., Waseca, Minn.
- Millen Mfg. Co., James, Malden, Mass
- ★ National Co., Inc., Malden, Mass.

CRYSTAL GRINDING EQUIPMENT

- Felker Mfg. Co., Torrance, Calif.

CRYSTAL HOLDERS

- REC Mfg. Co., Holliston, Mass.

CRYSTALS, Quartz

- Bausch & Lomb Optical Co., Rochester, N. Y.
- Bliley Elec. Co., Erie, Penna.
- Collins Radio Co., Cedar Rapids, Iowa
- Crystal Prod. Co., 1519 McGee St., Kansas City, Mo.

Additions This Month

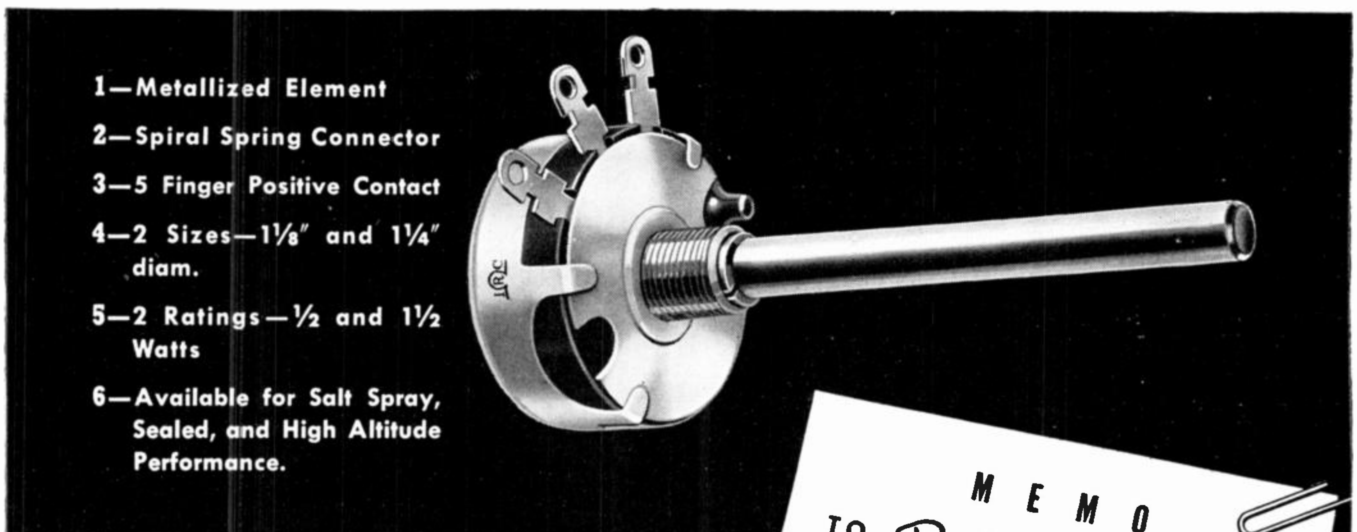
9 NEW LISTINGS

55 NEW MANUFACTURERS' NAMES

This Directory is revised every month, so as to assure engineers and purchasing agents of up-to-date information. We shall be pleased to receive suggestions as to company names which should be added, and hard-to-find items which should be listed in this Directory.

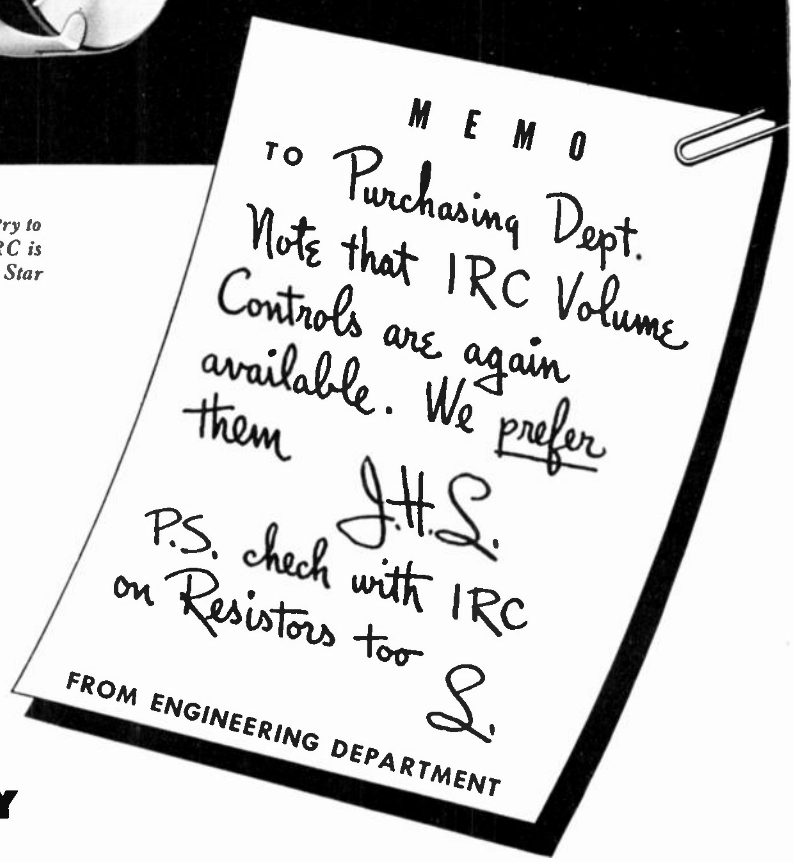
IRC VOLUME CONTROLS HAVE *All* THE FEATURES

No single attribute is responsible for the definite preference so often expressed by electronic engineers for IRC Volume Controls. Rather the fact that each unit embodies *all* the important factors which make for dependable operation has earned the regard of many of the largest users of potentiometers. . . . For preferred performance under severe conditions, for accuracy, stability and long life—specify IRC Volume Controls.



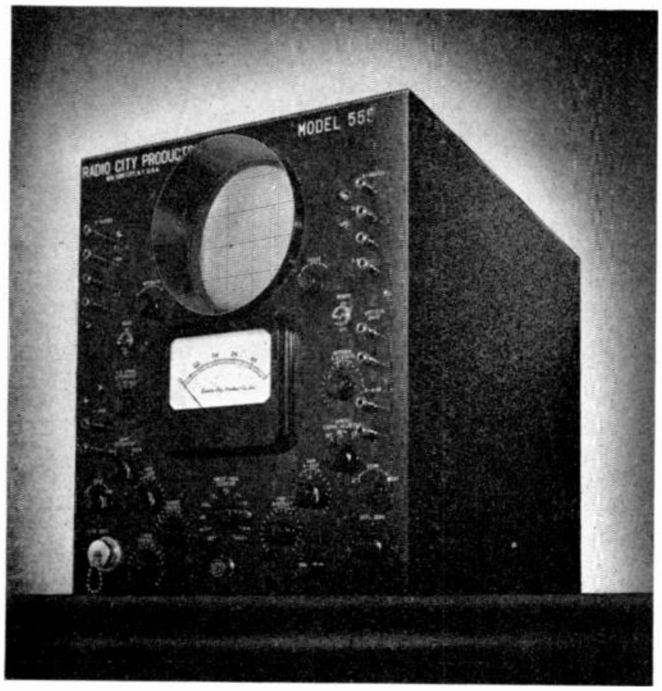
First in the industry to win an E flag, IRC is first also to win a Star for sustained production

PREFERRED FOR PERFORMANCE
IRC
FIXED & VARIABLE RESISTORS



INTERNATIONAL RESISTANCE COMPANY

429 N. BROAD STREET • PHILADELPHIA



Crystal Research Labs., Hartford, Conn.
DX Crystal Co., W. Carroll Ave., Chicago
Electronic Research Corp., 800 W. Washington Blvd., Chicago
Federal Engineering Co., 37 Murray St., N. Y. C.
★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Harvey-Wells Communications, Southbridge, Mass.
Hipower Crystal Co., 2035 W. Charleston, Chicago
Hunt & Sons, G. C., Carlisle, Pa.
Jefferson, Inc., Ray, Westport, L. I., N. Y.
Kaar Engineering Co., Palo Alto, Cal.
Meck Industries, John, Plymouth, Ind.
Miller, August E., North Bergen, N. J.
Peterson Radio, Council Bluffs, Iowa
Precision Piezo Service, Baton Rouge, La.
Premier Crystal Labs., 63 Park Row, N. Y. C.
Radell Corp., Guilford Ave., Indianapolis, Ind.
RCA Mfg. Co., Camden, N. J.
Scientific Radio Products Co., Council Bluffs, Ia.
Scientific Radio Service, Hyattsville, Md.
Standard Piezo Co., Carlisle, Pa.
Valpey Crystals, Holliston, Mass.
Zeiss, Inc., Carl, 485 Fifth Ave., N. Y. C.

DIALS, Instrument

Crowe Name Plate Co., 3701 Ravenswood Ave., Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St., Chicago
Mica Insulator Co., 198 Varick St., N. Y. C.
★ National Co., Inc., Malden, Mass.
Rogan Bros., 2003 S. Michigan Ave., Chicago

DISCS, Recording

Advance Recording Products Co., Long Island City, N. Y.
Allied Recording Products Co., Long Island City, N. Y.
Audio Devices, Inc., 1600 B'way, N. Y. C.
Federal Recorder Co., Elkhart, Ind.
★ Gould-Moody Co., 395 B'way, N. Y. C.
Presto Recording Corp., 242 W. 55 St., N. Y. C.
RCA Mfg. Co., Camden, N. J.

DYNAMOTORS — See Motor-Generators

ETCHING, Metal

Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago

FACSIMILE EQUIPMENT

★ Alden Products Co., Inc., Brockton, Mass.

FASTENERS, Separable

Camloc Fastener Co., 420 Lexington Ave., N. Y. C.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago

FELT

American Felt Co., Inc., Glenville, Conn.
Western Felt Works, 4031 Ogden Ave., Chicago

FIBRE, Vulcanized

Brandywine Fibre Prods. Co., Wilmington, Del.
Continental-Diamond Fibre Co., Newark, Del.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Mica Insulator Co., 196 Varick, N. Y. C.
Nat'l Vulcanized Fibre Co., Wilmington, Del.
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

FILTERS, Electrical Noise

Avia Products Co., 737 N. Highland Ave., Los Angeles
Com. Equip. & Eng. Co., N. Parkside Ave., Chicago
★ Freed Radio Corp., 200 Hudson St., N. Y. C.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Tobe Deutschmann Corp., Canton, Mass.

FINISHES, Metal

Alrose Chemical Co., Providence, R. I.
Aluminum Co. of America, Pittsburgh, Pa.
Ault & Wiborg Corp., 75 Varick, N. Y. C.
Hilo Varnish Corp., Brooklyn, N. Y.
Maas & Waldstein Co., Newark, N. J.
New Wrinkle, Inc., Dayton, O.

FREQUENCY METERS

Bendix Radio, Towson, Md.
★ Browning Labs., Inc., Winchester, Mass.
General Radio Co., Cambridge, Mass.
Lavoie Laboratories, Long Branch, N. J.
★ Link, F. M., 125 W. 17 St., N. Y. C.
Measurements Corporation, Boonton, N. J.

FREQUENCY STANDARDS, Primary

General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Quartz Secondary

Garner Co., Fred E., 43 E. Ohio St., Chicago
Hewlett-Packard Co., Palo Alto, Calif.
Millen Mfg. Co., Inc., Malden, Mass.

FUSES, Enclosed

Dante Elec. Mfg. Co., Bantam, Conn.
Jefferson Elec. Co., Bellwood, Ill.
Littlefuse, Inc., 4753 Ravenswood Av., Chicago

GEARS & PINIONS, Metal

Continental-Diamond Fibre Co., Newark, Del.
Gear Specialties, Inc., 2650 W. Medill, Chicago
Perkins Machine & Gear Co., Springfield, Mass.
Quaker City Gear Wks., Inc., N. Front St., Phila.
Thompson Clock Co., H. C., Bristol, Conn.

GEARS & PINIONS, Non-Metallic

Brandywine Fibre Prods. Co., Wilmington, Del.
Formica Insulation Co., Cincinnati, O.
Gear Specialties, Inc., 2650 W. Medill, Chicago
★ General Electric Co., Pittsfield, Mass.
Mica Insulator Co., 196 Varick St., N. Y. C.
National Vulcanized Fibre Co., Wilmington, Del.
Perkins Machine & Gear Co., Springfield, Mass.
Richardson Co., Melrose Park, Ill.
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

GENERATORS, Gas Engine Driven

Hunter-Hartman Corp., St. Louis, Mo.
Kato Engineering Co., Mankato, Minn.
Onan & Sons, Royalston Ave., Minneapolis, Minn.
★ Pioneer Gen-E-Motor, 5841 W. Dickens Ave., Chicago, Ill.

GENERATORS, Hand Driven

Burke Electric Co., Erie, Pa.
Carter Motor Co., 1608 Milwaukee, Chicago

GENERATORS, Standard Signal

Boonton Radio Corp., Boonton, N. J.
Ferris Instrument Co., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.

GENERATORS, Wind-Driven, Aircraft

General Armature Corp., Lock Haven, Pa.

HEADPHONES

Brush Development Co., Cleveland, O.
Conn. Tel. & Electric Co., Meriden, Conn.
Carrier Microphone Co., Inglewood, Cal.
Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen, Chicago
★ Chicago Tel. Supply Co., Elkhart, Ind.
Connecticut Tel. & Elec. Co., Meriden, Conn.
Consolidated Radio Prod. Co., W. Erie St., Chicago
Elec. Industries Mfg. Co., Red Bank, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Murdock Mfg. Co., Chelsea, Mass.
Permoflux Corp., W. Grand Ave., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Trimm Radio Mfg. Co., 1770 W. Berteau, Chicago
★ Universal Microphone Co., Inglewood, Cal.

HORNS, Outdoor

Graybar Elect. Co., Lexington Ave. at 43 St., N. Y. C.
★ Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago
Operadio Mfg. Co., St. Charles, Ill.
Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago
Racon Electric Co., 52 E. 19 St., N. Y. C.
RCA Mfg. Co., Camden, N. J.
University Laboratories, 225 Varick St., N. Y. C.

INDUCTION HEATING EQUIPMENT

Induction Heating Corp., 389 Lafayette St., N. Y. C.
Lepel High Frequency Labs., 39 W. 60 St., N. Y. C.

INDUCTORS, Variable Tuning

Barker & Williamson, Upper Darby, Pa.

INSTRUMENTS, Radio Laboratory

Ballantine Laboratories, Inc., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.

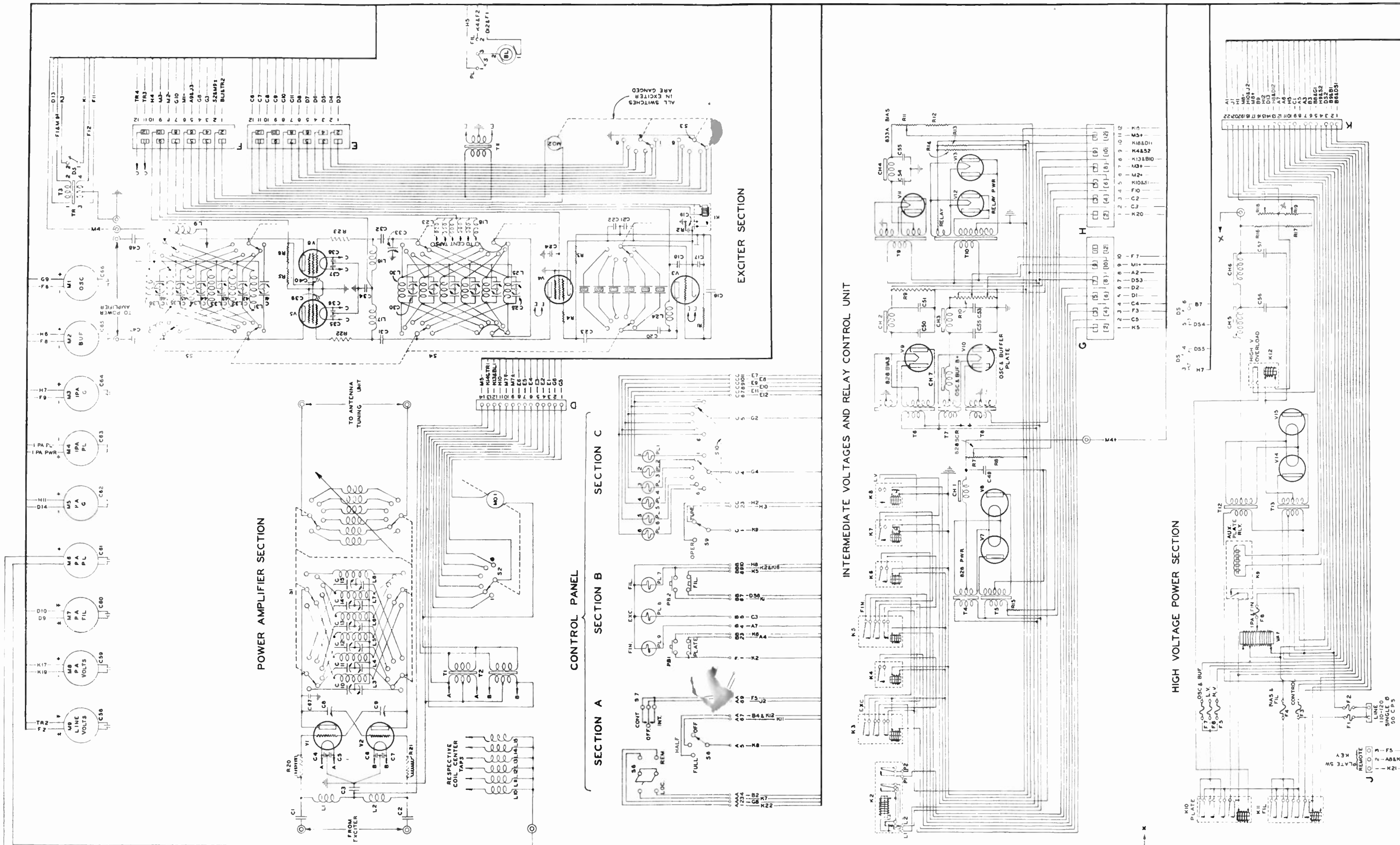


FIG. 4. COMPLETE WIRING OF THE 1-KW. TEMCO MODEL 1000AG TRANSMITTER WITH MOTOR-DRIVEN FREQUENCY SELECTION. CONTROLS CAN BE OPERATED REMOTELY OR FROM A PANEL MOUNTED ON THE FRONT OF THE TRANSMITTER CABINET. HEAVY LINES INDICATE CABLED LEADS

coupled to the plate tank circuit of the 6AG7 buffer.

Means are provided on the exciter unit for selecting any one of six predetermined frequencies within the operating range, through the use of six pretuned tank circuits in both the buffer and intermediate power amplifier stages. The oscillator circuit takes six crystals, making the exciter section a complete frequency-changing unit.

As Fig. 4 shows, two 833A high-power triodes are used in push-pull as a class C final amplifier. Six pretuned, balanced plate tank circuits, with their respective output coupling links, are provided to cover the desired frequencies. The grids of the 833A's are capacitatively coupled to the plates of the 828 IPA stage, and sufficient excitation is readily obtained to drive the PA tubes at full power output.

Isolation chokes in the center taps of each tank coil prevent undesired coupling between these tanks, and further stabilize the output tank circuit. The tubes are operated at approximately one-half their output capabilities, thereby insuring maximum life.

Separate power and bias supplies are used for each of the stages. The plate power of the oscillator and buffer is obtained from a well-filtered and well-regulated low-voltage supply, thus preventing the possibility of undesired coupling between these stages and the IPA or PA stages.

Similarly, the IPA is supplied from a completely separate full-wave rectifier, and the voltages for the screens and suppressors of the 828 tubes are obtained from a bleeder network across this supply. A separate bias supply furnishes the necessary fixed bias for the grids of the 828 tubes to cut these tubes off under the condition of no excitation. The same holds true for the final amplifier stage, which has its own bias and high-voltage supplies.

Automatic Frequency Changer ★ For those who are interested in the details of the automatic frequency changer, the following details are given: Referring to Fig. 4, the frequency selector switch S10, located on the remote control cabinet, Section C, provides the means for changing bands at a point removed from the transmitter. When the filament start button has been pressed and all the filament, bias, and relay transformers have been energized, the DC relay voltage is available to operate the frequency-change relays.

As the circuit shows, relay coils K4 and K6 are energized when the DC relay voltage is available and, therefore, their contacts are closed, thus supplying AC input voltage to the motors M01 and M02.

Assume that the selector switch S10 is moved to position three. Motors M01 and M02 will start to rotate. Switch S3, ganged to M02, will rotate until the contact arms of S3 coincide with position three of S10, thus energizing the coil of relay K3. The moment K3 is energized, the contact arm which controls the line voltage supply to M02 will open, stopping the motor.

Similarly, when switch S2, ganged to M01, reaches position three, the coil of relay K5 is energized and the contact arms controlling the line voltage to M01 open, breaking the motor circuit. As Fig. 4 shows, M01, which controls the final amplifier band changing switch cannot come to rest until M02, controlling the exciter band changing switch, stops rotating. This feature prevents the application of plate power to the final amplifier plates without excitation being supplied to the grids of these tubes.

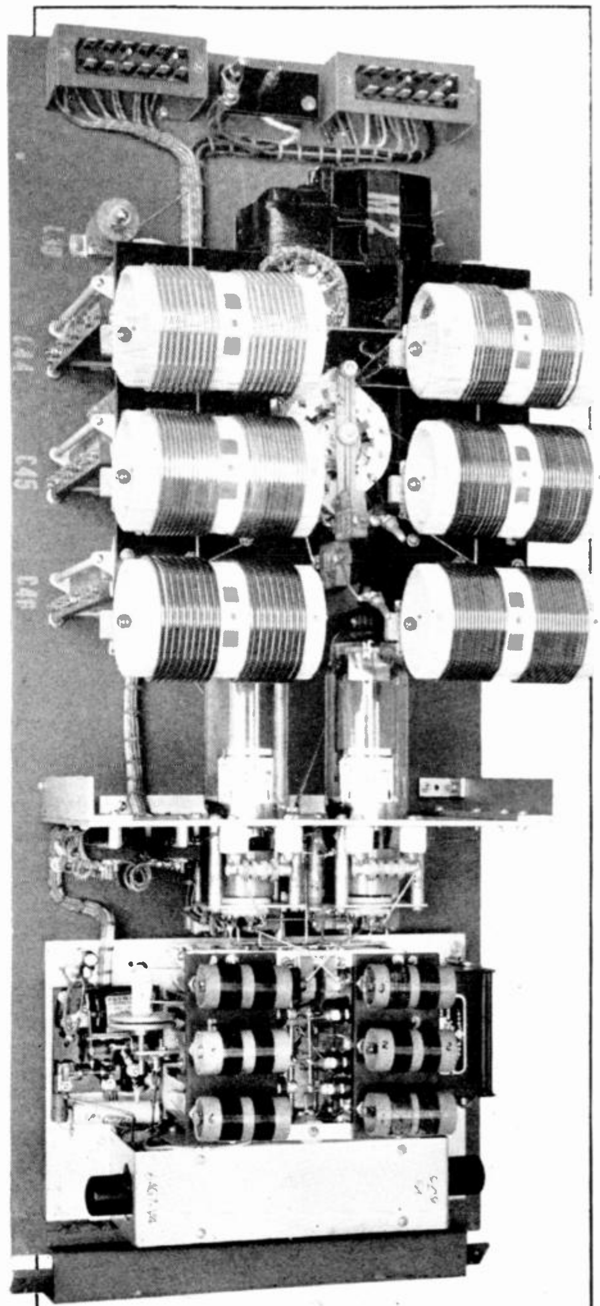


FIG. 5. REAR OF THE EXCITER SECTION. CIRCUITS ARE CLOSED THROUGH JACKS AT TOP WHEN PANEL IS IN POSITION

The contact arms of K3 and K5 are in series with the contact arms of the time-delay, underbias, and overload relays, and will not permit the application of plate power to the transmitter until the coils of these relays are energized, and the band switches of both the exciter and final have come to rest. Another contact arm on K3 and on K5 supplies DC voltage from the relay supply to the pilot lights located on the remote control cabinet which indicate the particular band for which the transmitter is adjusted.

Control and Power Circuits ★ An explanation of the control and power circuits of this equipment may be in order for the benefit of transmitter engineers. Fig. 4 shows the wiring of all the plate and filament contactors, time delay relay, final under-bias relays, IPA and PA overload relays, plate auxiliary relay, and keying relay, and indicates the functions of all the switches.

Of the three safety switches, two are located behind the rear doors of the cabinet and one behind the exciter panel. They control the application of line voltage to the filament and plate START-STOP switches. They also control the application of line voltage to the contact arms of the IPA and PA overload relays, final underbias, time delay, and automatic frequency-change relays.

If either door is opened or the exciter panel pulled forward, line voltage cannot be applied to the filament and plate contactors or, in consequence, to the primaries of the transformers or any of the circuit components.

Assuming the safety switches to be closed, the sequence of operation is as follows:

Pressing the filament switch START button energizes the filament contactor coil and closes the holding circuit, thus keeping the contactor coil circuit energized.

Line voltage is then applied to all filament and bias transformers, plate STOP-START switches, and the coil of the time delay relay. Since the plate STOP-START switches receive their line voltage from the holding circuit of the filament con-

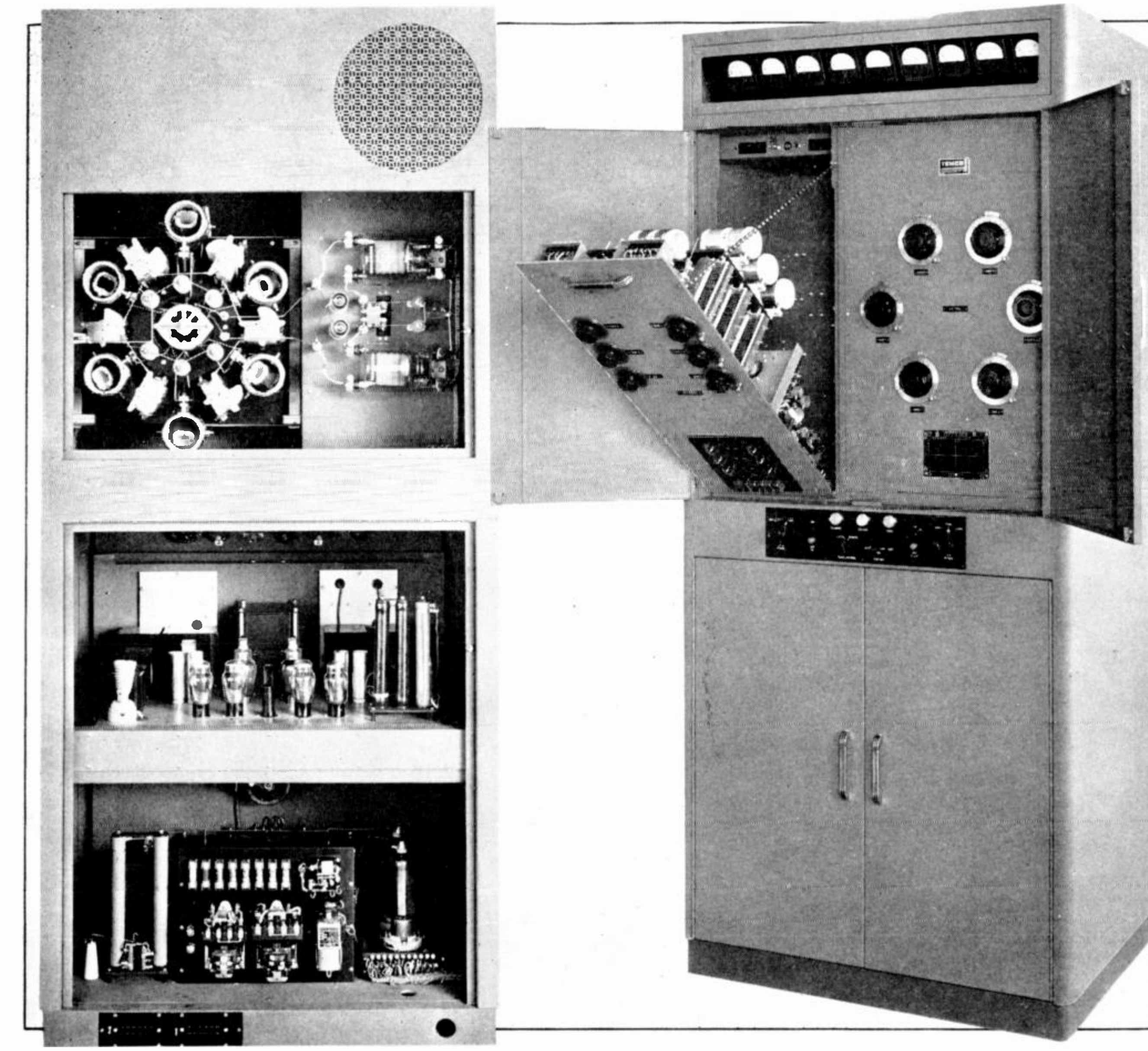


FIG. 2. REAR OF CABINET OPENED TO SHOW ARRANGEMENT, FIG. 3. EXCITER PANEL TIPPED FORWARD FOR INSPECTION

load relay, and all band-switching relays.

Two vertical sections comprise the top deck. One section, at the left in Figs. 1 and 3, contains the complete exciter unit, mounted on a hinged panel which can be dropped forward. Fig. 5 gives a rear view of this unit.

The second section can be seen in Figs. 2 and 6. This is made up of the six complete final amplifier tank circuits and the motor-driven frequency-change mechanism. In addition, there are the final amplifier tubes, also shown in Fig. 6, mounted on the back plate of the exciter compartment.

When the front doors are closed, only the operating controls and the meters are exposed. The antenna tuning unit, not shown, is mounted on the top of the transmitter cabinet, as a removable unit.

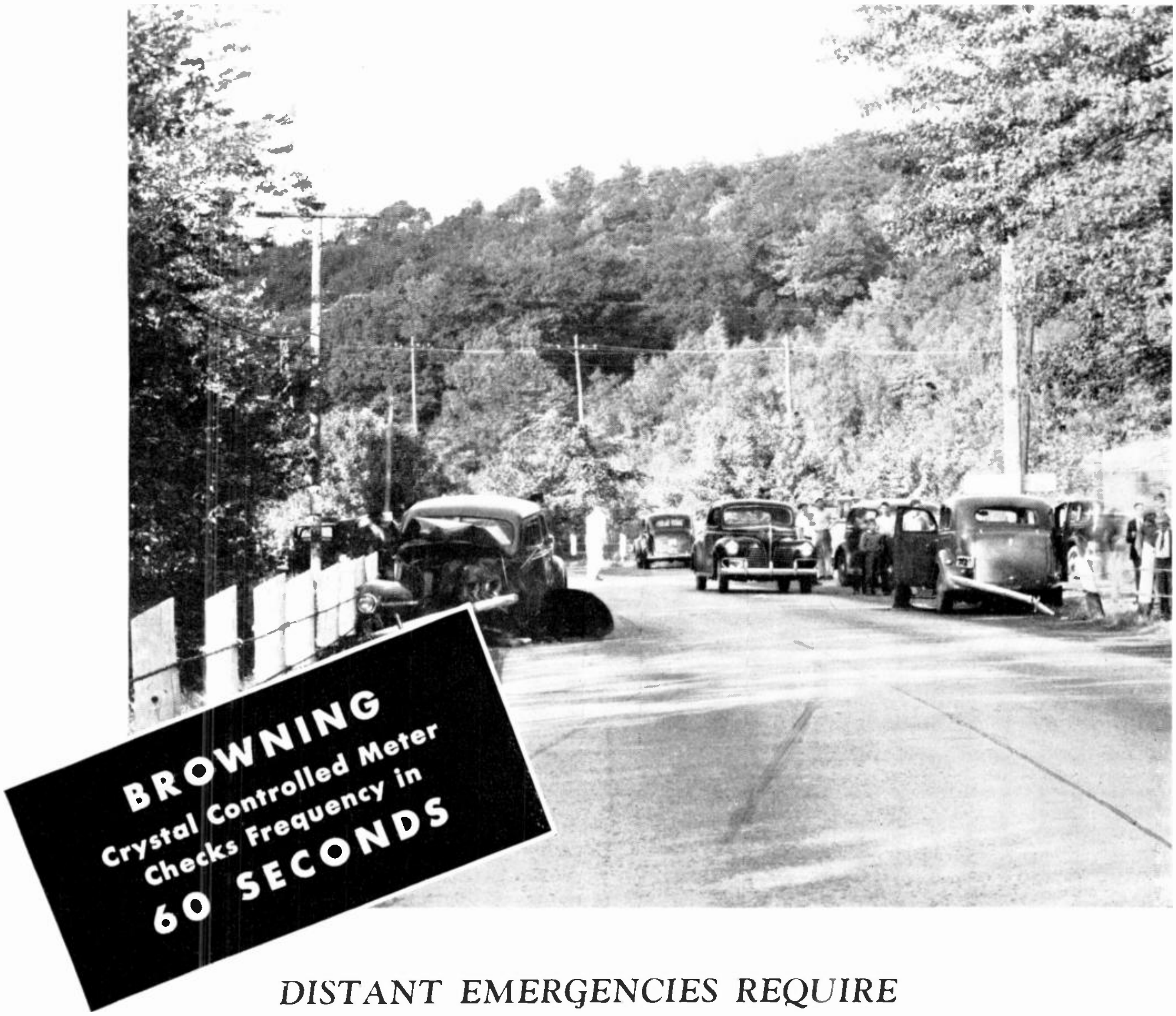
Transmitter Circuit ★ Fig. 4 gives the complete wiring of the radio and power circuits. The tubes employed are:

One 6J5	Oscillator
One 6AG7	Buffer
Two 828	Intermediate amplifiers
Two 833A	Power amplifiers
One 5Z3	Full-wave 400-volt oscillator buffer power supply
One 5W4	Full-wave 125-volt IPA bias supply
One 5Z3	Full-wave 400-volt PA bias supply
Two 866A	Full-wave 1,250-volt IPA power supply
Two 5Z3	Full-wave 110-volt relay supply
Two 872A	Full-wave 2,500-volt PA power supply

The 6J5 low-power triode is employed as a Pierce crystal oscillator. This has the obvious advantages that 1) no tuning elements are required, making it only necessary to plug in a crystal of the desired operating frequency, 2) the crystal oscillates more nearly at its fundamental frequency, and 3) varying oscillator loads have a negligible effect upon the frequency stability of the circuit.

This 6J5 oscillator is capacitatively coupled to the grid of a 6AG7 low-power pentode tube, used as a class C buffer, eliminating the need for neutralization and aiding to isolate the oscillator from the intermediate and final stages. Since the power required to drive the 6AG7 is low, negligible loading of the oscillator takes place, thereby enhancing the stability of the transmitter. Keying is accomplished in the cathode circuit of both the oscillator and buffer tubes, making for clean keying and the use of break-in operation.

Type 828 medium beam power tubes are used as the intermediate power amplifiers. Low excitation requirements, lack of need for neutralization, and comparatively high power output dictated their use for driving the class C final amplifier. The grids of these tubes are capacitatively



DISTANT EMERGENCIES REQUIRE

PEAK EFFICIENCY

WHEN accidents occur in rural districts, police radio equipment is put to the severest test. Failure to maintain peak efficiency may well mean loss of messages — and human lives.

Off-frequency adjustment results in poor noise suppression and in weak signals. These conditions may not be noticable when cars are near headquarters, but they become critical at distant points.

The time to discover frequency drift is on regular, weekly inspection — not when cars must be sent out on distant emergencies.

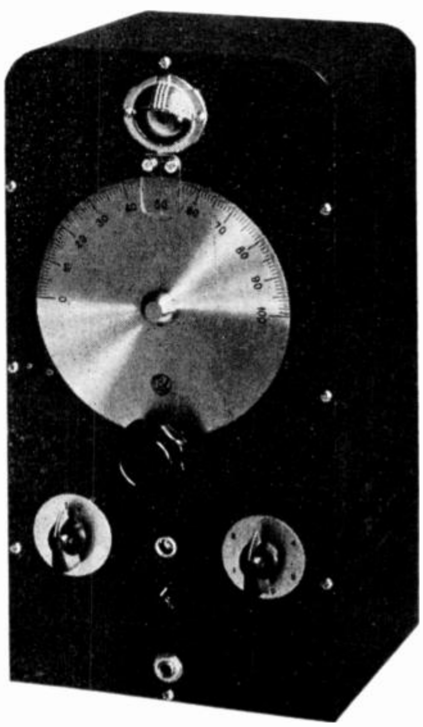
For this purpose, the BROWNING frequency meter is now used almost universally by radio supervisors of police, fire, and public utility communications systems, as well as by U. S. Government departments.

Using the BROWNING frequency meter, only 60 seconds are required to check a radio transmitter to the full degree of accuracy specified by FCC regulations. These meters, made in the four types listed below, are available for prompt delivery.

The Browning Frequency Meter, illustrated here, is used as standard equipment for police and public utility emergency radio systems throughout the USA. It Provides the greater precision now required by the FCC for all emergency transmitters.

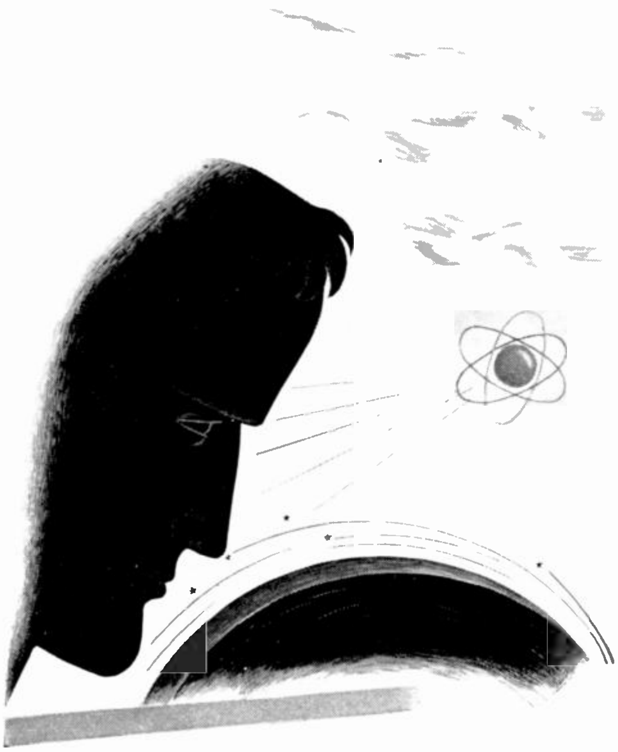
Suitable for both FM and AM, the Browning Meter is built with one to four bands, for any frequencies between 1.5 and 60 mc. Prices:

1 Band	$125	3 Bands	$165
2 Bands	145	4 Bands	185



BROWNING LABORATORIES, INC.

WINCHESTER • MASSACHUSETTS



INSULATORS, Ceramic Stand-off, Lead-in, Rod Types

America Lava Corp., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Clifton, N. J.
Isolantite, Inc., Belleville, N. S.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., Inc., Leroy, N. Y.
Locke Insulator Co., Baltimore, Md.
Millen Mfg. Co., Malden, Mass.
★ National Co., Inc., Malden, Mass.

IRON CORES, Powdered

Crowley & Co., Henry L., West Orange, N. J.
★ Ferrocart Corp. of Amer., Hastings-on-Hudson, N. Y.
Genl. Aniline Wks., 435 Hudson St., N. Y. C.
Gibson Elec. Co., Pittsburgh, Pa.
Mallory & Co., P. R., Indianapolis, Ind.
Pyroferric Co., 175 Varick St., N. Y. C.
Stackpole Carbon Co., St. Marys, Pa.
Western Electric Co., 195 Broadway, N. Y. C.
Wilson Co., H. A., Newark, N. J.

IRONS, Soldering

Acme Electric Heating Co., 1217 Washington St., Boston
Amer. Electrical Heater Co., 6110 Cass Ave., Detroit
Drake Elec. Wks., Inc., 3656 Lincoln Ave., Chicago
Electric Soldering Iron Co., Deep River, Conn.
★ General Electric Co., Schenectady, N. Y.
Hexacon Electric Co., Roselle Park, N. J.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles
Vulcan Electric Co., Lynn, Mass.

JACKS, Telephone

★ Alden Prods. Co., Brockton, Mass.
Amer. Molded Prods. Co., 1753 N. Honore St., Chicago
★ Chicago Tel. Supply Co., Elkhart, Ind.
Guardian Elec. Mfg. Co., 1627 W. Walnut St., Chicago
Insuline Corp. of Amer., Long Island City, N. Y.
Johnson, E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Mangold Radio Pts. & Stamping Co., 6300 Shelbourne St., Philadelphia
Molded Insulation Co., Germantown, Pa.
★ Universal Microphone Co., Inglewood, Calif.
Utah Radio Prod. Co., Orleans St., Chicago

KEYS, Telegraph

Amer. Radio Hardware Co., Inc., 476 Broadway, N. Y. C.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Mossman Inc., Donald P., 6133 N. Northwest Hy., Chicago
Remler Co., Ltd., 2101 Bryant St., San Francisco
Signal Electric Mfg. Co., Menominee, Mich.
Telephonics Corp., 350 W. 31 St., N. Y. C.
Winslow Co., Inc., Liberty St., Newark, N. J.

KNOBS, Radio & Instrument

★ Alden Prods. Co., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
Chicago Molded Prods. Corp., 1025 N. Kolmar Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St., Chicago
Imperial Molded Prods. Corp., 2921 W. Harrison, Chicago
Kurtz Kasch, Inc., Dayton, O.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Millen Mfg. Co., James, Malden, Mass.
★ Nat'l Co., Inc., Malden, Mass.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
Rogan Bros., 2001 S. Michigan, Chicago

LABELS, Removable

Avery Adhesives, 451 3rd St., Los Angeles

LABELS, Stick-to-Metal

Ever Ready Label Corp., E. 25th St., N. Y. C.

LABORATORIES, Electronic

★ Browning Labs., Inc., Winchester, Mass.
Hazeltine Electronics Corp., 1775 B'way, N. Y. C.
Sherron Metallic Corp., Flushing Ave., Brooklyn, N. Y.

LUGS, Soldering

Burndy Engineering Co., 459 E. 133rd St., N. Y. C.
Cinch Mfg. Corp., W. Van Buren St., Chicago
Dante Elec. Mfg. Co., Bantam, Conn.
Ideal Commutator Dresser Co., Sycamore, Ill.
Ilsco Copper Tube & Prods., Inc., Station M, Cincinnati
Krueger & Hudepohl, Third & Vine, Cincinnati, O.
Patton-MacGuyer Co., 17 Virginia Av., Providence, R. I.
Sherman Mfg. Co., Battle Creek, Mich.
Thomas & Betts Co., Elizabeth, N. J.
Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

LUGS, Solderless

Aircraft Marine Prod., Inc., Elizabeth, N. J.
Burndy Eng. Co., 107 Eastern Blvd., N. Y. C.

MACHINES, Impregnating

Stokes Machine Co., F. J., Phila., Pa.

MACHINES, Screwdriving

Detroit Power Screwdriver Co., Detroit, Mich.
Stanley Tool Div. of the Stanley Works, New Britain, Conn.

MAGNETS, Permanent

★ General Elec. Co., Schenectady, N. Y.
Thomas & Skinner Steel Prod. Co., Indianapolis, Ind.

MAIL ORDER SUPPLY HOUSES

★ Allied Radio Corp., 901 W. Jackson Blvd., Chicago
★ Burstein-Applebee Co., Kansas City, Mo.
Harrison Radio Corp., 12 W. B'way, N. Y. C.
Sun Radio Co., 212 Fulton St., N. Y. C.

MARKERS, Wire Identification

Brand & Co., Wm., 276 4th Ave., N. Y. C.
Ntl. Varnished Prod. Corp., Woodbridge, N. J.

METAL, Thermostatic

Baker & Co., 113 Astor, Newark, N. J.
C. S. Brainin Co., 20 VanDam, N. Y. C.
Callite Tungsten Corp., Union City, N. J.
Chace Co., W. M., Detroit, Mich.
Metals & Controls Corp., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut, Newark, N. J.

METERS, Ammeters, Voltmeters, Small Panel

Cambridge Inst. Co., Grand Central Terminal, N. Y. C.
De Jur-Amsco Corp., Shelton, Conn
★ General Electric Co., Bridgeport, Conn.
Hickok Elec. Inst. Co., Cleveland, O.
Hoyt Elec. Inst. Works, Boston, Mass.
Readrite Meter Works, Bluffton, O.
Roller-Smith Co., Bethlehem, Pa.
★ Simpson Elec. Co., 5218 W. Kinzie, Chicago
★ Triplett Elec. Inst. Co., Bluffton, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Weston Elec. Inst. Corp., Newark, N. J.
Wheelco Inst. Co., 847 W. Harrison St., Chicago

METERS, Q

Boonton Radio Corp., Boonton, N. J.

METERS, Vacuum Tube Volt

Ballantine Laboratories, Inc., Boonton, N. J.
Ferris Instrument Corp., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J
★ Radio City Products Co., 127 W. 26 St., N. Y. C.

METERS, Vibrating Reed

Biddle, James G., 1211 Arch St., Philadelphia
★ Triplett Elec. Inst. Co., Bluffton, O.

MICA

Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Macallen Co., Boston, Mass.
Mica Insulator Corp., 196 Varick, N. Y. C.
New England Mica Co., Waltham, Mass.
Richardson Co., Melrose Park, Ill.

MICROPHONES

Amer. Microphone Co., 1015 Western Av., Los Angeles
Amperite Co., 561 B'way, N. Y. C.
Astatic Corp., Youngstown, O.
Brush Development Co., Cleveland, O.
Carrier Microphone Co., Inglewood, Cal.
Electro Voice Mfg. Co., South Bend, Ind.
Kellogg Switchboard & Supply Co., 6650 S. Cicero, Chicago
Radio Speakers, Inc., 221 E. Cullerton, Chicago
Philmore Mfg. Co., 113 University Pl., N. Y. C.
Permoflux Corp., 4916 W. Grand Av., Chicago
Rowe Industries, Inc., Toledo, O.
Shure Bros., 225 W. Huron St., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Turner Co., Cedar Rapids, Ia.
★ Universal Microphone Co., Inglewood, Cal.

MONITORS, Frequency

★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.

FM AUDIENCE SURVEY

IN the Schenectady area, the average FM radio set owner tunes in 2.9 hours per day, and prefers classical music, according to a study announced by R. S. Pearce, manager of General Electric's broadcasting.

The study revealed that 76 per cent of FM set owners tune in frequently on the 7:00 to 10:00 p.m. program from W85A, while 37 per cent listen to the 6:00 to 7:00 p.m. period, and 15 per cent listen to the 3:00 to 6:00 period.

A check of program preference showed classical music first at 96 per cent, news and news commentators next at 89 per cent, followed by opera 72 per cent, and popular music 65 per cent. Variety shows, dramatic sketches, and quiz shows followed in that order.

Two basic reasons dominated among those given for preferring FM to standard broadcast stations. These were better reception and better programming. It was felt by 93 per cent that FM offered better tone quality.

SUPREME COURT VALIDATES NETWORK RULES

THE NETWORK regulations promulgated October 11, 1941, by the FCC, originally scheduled to become effective November 15, 1941, were finally affirmed and validated by the Supreme Court on May 10, 1943.

Commenting editorially on this decision, BROADCASTING says: "American broadcasting has a new business manager — the FCC. The sweeping and all-embracing decision of the Supreme Court affirms the philosophy of the FCC majority that, Congressional intent to the contrary, broadcasters are not competent to handle their own business affairs.

"It is a neat victory — its greatest — for the FCC majority. We think it constitutes the most dangerous blow yet struck to the freedom of American broadcasting. Worse than that, it sanctions a most hazardous experiment in the nation's hour of greatest trial. The FCC, as far as broadcasting goes, is now omnipotent.

"The decision transcends any mere question of network contracts. It invests the Commission with plenary powers over all station activities. The FCC appears to have a one-way street on almost every conceivable phase of station operation, save possibly direct censorship. Newspaper ownership, multiple ownership, rates, rebates and discounts, program policies — all conceivably fall within its regulatory pale. After the War, there will be other radio media — television, FM, facsimile — all subject to what the FCC may construe to be 'in the public interest, convenience, or necessity.' "

David Lawrence, writing in the NEW YORK SUN, had this to say: "The fact that five Roosevelt-appointed judges upheld the right of bureaucracy to supersede what has been supposed was a constitutional right of freedom of speech over the air means that the public will now be interested in the arbitrary method by which the FCC has drawn up regulations exercising a power of coercion over radio stations and networks amounting to intimidation.

"The licensing power, according to the Supreme Court decision, now can be used to revoke or threaten to revoke a station's license if the FCC thinks it is in the public interest to do so. What constitutes public interest is left wholly to the Federal Communications Commission to decide. All radio stations and networks now become the football of politics — they must stand in with the administration in power — they must give time on the air to political propaganda and generally do those things which in Europe have made radio the subservient tool of dictatorships.

The opposition to the FCC on the part of the broadcasters has been noticeably half-hearted and indifferently organized. Mutual has gone over to the FCC camp completely since Miller McClintock became president of that network, apparently hoping to curry favor with the FCC at the expense of his competitors, the larger NBC and CBS networks.

(CONTINUED ON PAGE 43)

MOTOR-GENERATORS, Dynamotors, Rotary Converters

Alliance Mfg. Co., Alliance, O.
Air-Way Mfg. Co., Toledo, O.
Bendix, Red Bank, N. J.
Black & Decker Mfg. Co., Towson, Md.
Bodine Elec. Co., 2262 W. Ohio, Chicago
Carter Motor Co., 1608 Milwaukee, Chicago
Clements Mfg. Co., Chicago, Ill.
Continental Electric Co., Newark, N. J.
Delco Appliance, Rochester, N. Y.
Diehl Mfg. Co., Elizabethport, N. J.
Dormeyer Co., Chicago, Ill.
Eclipse Aviation, Bendix N. J.
Elcor, Inc., 1060 W. Adams, Chicago
Electric Motors Corp., Racine, Wis.
Electric Specialty Co., Stamford, Conn.
Electrolux Corp., Old Greenwich, Conn.
Eureka Vacuum Cleaner, Detroit, Mich.
General Armature Corp., Lock Haven, Pa.
★ General Electric Co., Schenectady, N. Y.
Jannette Mfg. Co., 558 W. Monroe, Chicago
Knapp-Monarch, St. Louis, Mo.
Leland Electric Co., Dayton, O.
Ohio Electric Co., 74 Trinity Pl., N. Y. C.
★ Pioneer Gen-E-Motor, 5841 W. Dickens Av., Chicago
Redmond Co., A. G., Owosso, Mich.
Russell Co., Chicago, Ill.
Webster Co., Chicago, Ill.
Westinghouse Elect. Mfg. Co., Lima, O.
Wincharger Corp., Sioux City, Iowa

MOUNTINGS, Shock Absorbing

Lord Mfg. Co., Erie, Pa.
Pierce-Roberts Co., Trenton, N. J.
U. S. Rubber Co., 1230 6th Ave., N.Y.C.

MYCALEX

★ General Electric Co., Schenectady, N. Y.
Mycalex Corp. of Amer., Clifton, N. J.

NICKEL, Sheet, Rod, Tubes

Eagle Metals Co., Seattle, Wash.
Pacific Metals Co., Ltd., San Francisco, Calif.
Steel Sales Corp., 129 S. Jefferson St., Chicago
Tull Metal & Supply Co., J. M., Atlanta, Ga.
Whitehead Metal Prod. Co., 303 W. 10th St., N. Y. C.
Williams and Co., Inc., Pittsburgh, Pa.

NUTS, Self-locking

Boots Aircraft Nut Corp., New Canaan, Conn.
Elastic Stop Nut Corp., Union, N. J.
Palnut Co., Inc., Irvington, N. J.
Standard Pressed Steel Co., Jenkintown, Pa.

OSCILLOSCOPES, Cathode Ray

★ Du Mont Laboratories, Inc., Allen B., Passaic, N. J.
★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Millen Mfg. Co., Malden, Mass.
RCA Mfg. Co., Inc., Camden, N. J.
★ Radio City Products Co., Inc., 127 W. 26 St., N. Y. C.

OVENS, Industrial & Laboratory

★ General Elec. Co., Schenectady, N. Y.
Trent Co., Harold E., Philadelphia

PANELS, Metal Etched
(See Etching, Metal)

PANELS, Phenolic, Cast without Molds

★ Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.

PILOT LIGHTS

★ Alden Prods. Co., Brockton, Mass.
Amer. Radio Hardware Co., Inc., 467 B'way, N. Y. C.
Dial Light Co. of America, 90 West, N. Y. C.
Drake Mfg. Co., 1713 W. Hubbard, Chicago
General Control Co., Cambridge, Mass.
★ General Elec. Co., Lamp Dept., Nela Specialty Div., Hoboken, N. J.
Gothard Mfg. Co., Springfield, Ill.
Herzog Miniature Lamp Works, 12-19 Jackson Av., Long Island City, N. Y.
Kirkland Co., H. R., Morristown, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Signal Indicator Corp., 140 Cedar St., N. Y. C.

PHOSPHOR BRONZE

American Brass Co., Waterbury, Conn.
Bunting Brass & Bronze Co., Toledo, O.
Driver-Harris Co., Harrison, N. J.
Phosphor Bronze Smelting Co., Philadelphia
Revere Copper & Brass, 230 Park Av., N. Y. C.
Seymour Mfg. Co., Seymour, Conn.

PLASTICS, Cast without Molds

★ Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.

PLASTICS, Extruded

Blum & Co., Inc., Julius, 532 W. 22 St., N. Y. C.
Brand & Co., Wm., 276 4th Ave., N.Y.C.
Extruded Plastics, Inc., Norwalk, Conn.
Irvington Varnish & Insulator Co., Irvington, N. J.

PLASTIC SHEET, for Name Plates

Mica Insulator Co., 200 Varick St., N. Y. C.

PLASTICS, Injection Molded

Remler Co., Ltd., 2101 Bryant St., San Francisco
Tech-Art Plastics, 41 01 36th Ave., Long Island City, N. Y.
Universal Plastics Corp., New Brunswick, N. J.

PLASTICS, Laminated or Molded

Acadia Synthetic Prods., 4031 Ogden Av., Chicago
★ Alden Prods. Co., Brockton, Mass.
American Cyanamid Co., 30 Rockefeller Plaza, N. Y. C.
American Insulator Corp., New Freedom, Pa.
American Molded Prods. Co., 1753 N. Honore, Chicago
Auburn Button Works, Auburn, N. Y.
Barber-Colman Co., Rockford, Ill.
Brandywine Fibre Prods. Co., Wilmington, Del.
Catalin Corp., 1 Park Av., N. Y. C.
Celanese Celluloid Corp., 180 Madison Av., N. Y. C.
Chicago Molded Prods. Corp., 1024 N. Kolmar, Chicago
Continental-Diamond Fibre Co., Newark, Del.
★ Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.
Dow Chemical Co., Midland, Mich.
Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Formica Insulation Co., Cincinnati, O.
★ General Electric Co., Plastics Dept., Pittsfield, Mass.
General Industries Co., Elyria, O.
Gits Molding Corp., 4600 Huron St., Chicago
Imperial Molded Prods. Co., 2921 W. Harrison, Chicago
Industrial Molded Prods. Co., 2035 Charleston, Chicago
Kurz-Kasch, Inc., Dayton, O.
Macallen Co., Boston, Mass.
Mica Insulator Co., 196 Varick, N. Y. C.
Monsanto Chemical Co., Springfield, Mass.
National Vulcanized Fibre Co., Wilmington, Del.
Northern Industrial Chemical Co., Boston, Mass.
Printloid Corp., 93 Mercer St., N. Y. C.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
Remler Co., Ltd., 2101 Bryant St., San Francisco
Richardson Co., Melrose Park, Ill.
Rogan Bros., 2000 S. Michigan Ave., Chicago
Rohm & Haas Co., Philadelphia
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Stokes Rubber Co., Joseph, Trenton, N. J.
Surprenant Elec. Ins. Co., Boston
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

PLASTICS, Transparent

Celanese Celluloid Corp., 180 Madison Ave., N. Y. C.
du Pont de Nemours & Co., E. I., Arlington, N. J
Plax Corp., Hartford, Conn.
Printloid Corp., 93 Mercer St., N. Y. C.
Rohm & Haas Co., Washington Sq., Philadelphia

PLATING, Metal on Molded Parts

Metaplast Corp., 205 W. 19 St., N. Y. C.

PLUGS (Banana), Spring Type

Amer. Radio H'dw're Co., 176 B'way, N. Y. C.
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Eastman Kodak Co., Rochester, N. Y.
Eby, Inc., Hugh H., Philadelphia, Pa
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ucinite Co., Newtonville, Mass.

PLUGS, Telephone Type

★ Alden Prods. Co., Brockton, Mass.
American Molded Prods. Co., 1753 N. Honore, Chicago
★ Chicago Tel. Supply Co., Elkhart, Ind.
★ Guardian Elec. Mfg. Co., 1627 W Walnut, Chicago
Insuline Corp. of Amer., L. I. City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Av., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Remler Co., Ltd., Bryant St., San Francisco
★ Universal Microphone Co., Ltd., Inglewood, Calif.
Utah Radio Prod., Orleans St., Chicago.

PLYWOOD, Metal Faced

Haskelite Mfg. Corp., 208 W. Washington St., Chicago

RECTIFIERS, Current

Benwood Linze Co., St. Louis, Mo.
Continental Elec. Co., 903 Merchandise Mart, Chicago
★ Electronics Labs., Indianapolis, Ind.
Fansteel Metallurgical Corp., N. Chicago, Ill.

E·L IS OUT THERE, TOO...

Out where the "fighting front" becomes grim reality instead of a glib phrase, *E·L* units are powering the "Walkie-Talkie" that serves as the voice and ears of our advance forces.

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Such a power supply did not exist until Electronic's engineers designed a special, high-voltage vibrator power supply, combined with storage battery, in a single, incredibly light and compact unit.

Behind this and other *E·L* power supply achievements are years of intensive development of the technique of *vibrator type* power supplies, and the most extensive research anywhere on power supply circuits. They have not only produced amazing advances for many military purposes, but promise revolutionary benefits for products of peace.

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Power Supply using rechargeable, non-spill storage battery for operation of "Walkie-Talkie" radio equipment. Input Voltage: 4 Volts; Output: Numerous Voltages, supplying plate and filament requirements of the equipment. Width, 3½"; Length, 6½"; Height, 4⅜".

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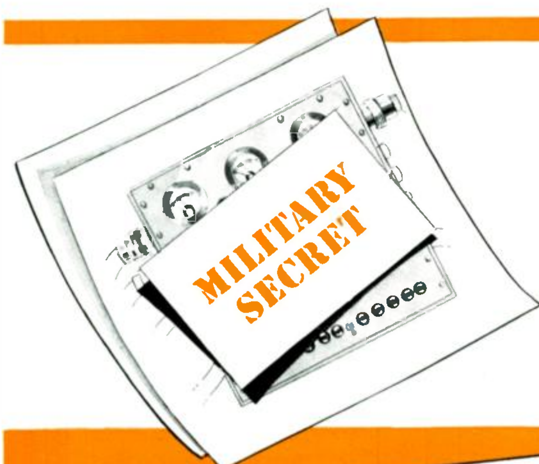

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Ever since radio became an amazing reality to the world, the Freed-Eisemann name has been identified with outstanding radio achievement. The first crystal sets were made by Freed-Eisemann, as were the first neutrodyne sets, and sets with self-contained speakers. Then, with the invention of Armstrong Frequency Modulation, Freed-Eisemann became the first to produce FM radio-phonographs *exclusively*.

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WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

flying conditions to say that this or that type of DF installation would prove superior to what Capt. Angle has been using?

In other words, we have pilots who know radio performance from its operational aspects, and we have engineers who know radio performance from laboratory tests, but where are the engineers who can appraise their own design work from having observed and checked it in action?

This condition prevails at a time when there are several thousand radio engineers at work on aircraft radio apparatus. Some of these men go up occasionally to make measurements and observations. Others fly more frequently to flight-check radio installations.

What we do not have is a group of radio engineers who have gained a broad working knowledge of equipment from actual flying experience under real service conditions.

This may be due in part to the fact that such engineer-observers would represent so much non-paying load. Moreover, radio manufacturers are reluctant to assume the responsibility for sending their engineers up, even for fair-weather flying. A third factor is the matter of getting clearance from the cognizant Government department for this work.

However, the personal risk and the cost and trouble are the price of practical knowledge of which the industry has all too little at the present time.

M. B. SLEEPER, *Editor*

NETWORK RULES UPHELD

(CONTINUED FROM PAGE 39)

There is nothing new about the power of coercion over the radio stations exercised by the FCC to which David Lawrence refers above. Broadcast station officials learned soon after James Lawrence Fly took over the reins that peace at any price would be less costly than opposition. Or, to put it differently, there would be no gain in winning an argument and losing a license.

On the other hand, Chairman Fly, who has so successfully developed an unfailing technique for attacking and bedevilling the broadcasters under the camouflage of protecting public interest, convenience, and necessity, has been quite content to sit back and let James Caesar Petrillo add further heavy burdens to broadcasting industry.

One thing is certain: the FCC has not finished its plan of re-forming the setup of radio broadcasting in this country. Unless Congress acts to reorganize the FCC and to limit the authority to be exercised by Commission, the public will have the opportunity of experiencing government control of radio in its most advanced and devastating stages.

★ General Electric Co., Bridgeport, Conn.
International Tel. & Radio Mfg. Corp., E. Newark, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Nothelfer Winding Labs., Trenton, N. J.
United Cinephone Corp., Torrington, Conn.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

RECTIFIERS, Instrument & Relay

Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles

REGULATORS, Temperature

Allen-Bradley Co., Milwaukee, Wis.
Dunn, Inc., Struthers, 1321 Cherry, Philadelphia
Fenwal Inc., Ashland, Mass.
★ General Electric Co., Schenectady, N. Y.
Mercold Corp., 4217 Belmont, Chicago
Minneapolis-Honeywell Regulator, Minneapolis, Minn.
Spencer Thermostat Co., Attleboro, Mass.

REGULATORS, Voltage

Acme Elec. & Mfg. Co., Cuba, N. Y.
Amperite Co., 561 Broadway, N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
★ General Elec. Co., Schenectady, N. Y.
H-B Elec. Co., Philadelphia
Sola Electric Co., 2525 Clybourn Av., Chicago
★ United Transformer Corp., 150 Varick St., N. Y. C.

RELAYS, Small Switching

Allied Control Co., Inc., 223 Fulton St., N. Y. C.
Amperite Co., 561 Broadway, N. Y. C.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago
Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Potter & Brumfield Co., Princeton, Ind.
Sigma Instruments, Inc., 76 Freeport St., Boston, Mass.
Struthers Dunn, Inc., 1326 Cherry St., Philadelphia
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.

RELAYS, Small Telephone Type

Amer. Automatic Elect. Sales Co., 1033 W. Van Buren St., Chicago
Clare & Co., C. P., 4719 W. Sunnyside Ave., Chicago
★ Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Wick Organ Co., Highland, Ill.

RELAYS, Time Delay

Amperite Co., 561 Broadway, N. Y. C.
Haydon Mfg. Co., Inc., Forestville, Conn.
Industrial Timer Corp., Newark, N. J.
Sangamo Elec. Co., Springfield, Ill.
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.

RELAY TESTERS, Vibration

Kurman Electric Co., Inc., 3030 Northern Blvd., L. I. City, N. Y.

RESISTORS, Fixed

Acme Elec. Heating Co., Boston, Mass.
★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., N. Y. C.
Carborundum Co., Niagara Falls, N. Y.
Centralab, Milwaukee, Wisconsin
Clarostat Mfg. Co., Brooklyn, N. Y.
Cont'l Carbon, Inc., Cleveland, O.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Jersey City, N. J.
Erie Resistor Corp., Erie, Pa.
Globar Div. Carborundum Co., Niagara Falls, N. Y.
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
★ Intern'l Resistance Co., Philadelphia
Lectrohm, Inc., Cicero, Ill.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy, Chicago
Sensitive Research Inst., Corp., 4545 Bronx Blvd., N. Y. C.
Shallcross Mfg. Co., Collingdale, Pa.
Speer Resistor Corp., St. Marys, Pa.
Sprague Specialties Co., N. Adams, Mass.
Stackpole Carbon Co., St. Marys, Pa.
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
White Dental Mfg. Co., 10 E. 40th St., N. Y. C.
Wirt Co., Germantown, Pa.

RESISTORS, Fixed Precision

Instrument Resistors, Inc., Little Falls, N. J.
★ Intern'l Resistance Co., Philadelphia
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Shallcross Mfg. Co., Collingdale, Pa.

RESISTORS, Flexible

Clarostat Mfg. Co., Inc., Brooklyn, N. Y.

RESISTORS, Variable

★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Instrument Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
Biddle Co., James G., Arch St., Phila., Pa.
Centralab, Milwaukee, Wis.
★ Chicago Tel. Supply Co., Elkhart, Ind.
Cinema Eng. Co., Burbank, Cal.
Clarostat Mfg. Co., Brooklyn, N. Y.
Cutler-Hammer, Inc., Milwaukee, Wis.
DeJur Amsco Corp., Shelton, Conn.
Electro Motive Mfg. Co., Willimantic, Conn.
General Radio Co., Cambridge, Mass.
G-M Labs., Inc., Chicago, Ill.
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors, Inc., Little Falls, N. J.
★ Intern'l Resistance Co., Philadelphia
Kellogg Switchboard & Sup. Co., 6650 S. Cicero Ave., Chicago
Lectrohm, Inc., 5125 W. 25 St., Cicero, Ill.
Mallory & Co., P. R., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Shallcross Mfg. Co., Collingdale, Pa.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prods. Co., 820 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
Wirt Co., Germantown, Pa.

RESISTORS, Variable, Ceramic Base

Hardwick, Hindle, Inc., Newark, N. J.
Lectrohm, Inc., 5125 W. 25 St., Cicero, Ill.
Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SCREW MACHINE PARTS, Brass, Steel

Ward Products Corp., E. 45 St., Cleveland, O.

SCREW MACHINE PARTS, Non-Metallic

Continental-Diamond Fibre Co., Newark, Del.

SCREWS, Recessed Head

American Screw Co., Providence, R. I.
Bristol Co., The, Waterbury, Conn.
Chandler Prods. Co., Cleveland, O.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
International Screw Co., Detroit, Mich.
Lamson & Sessions, Cleveland, O.
National Screw & Mfg. Co., Cleveland, O.
New England Screw Co., Keene, N. H.
Parker Co., Charles, The, Meriden, Conn.
Parker-Kalon Corp., 198 Varick, N. Y. C.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Mfg. Co., Chicago
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
Shakeproof, Inc., 2501 N. Keeler Av., Chicago
Southington Hardw. Mfg. Co., Southington, Conn.
Standard Pressed Steel Co., Jenkintown, Pa.
Whitney Screw Corp., Nashua, N. H.

SCREWS, Self-Tapping

American Screw Co., Providence, R. I.
Central Screw Co., 3519 Shields Av., Chicago
Continental Screw Co., New Bedford, Mass.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Parker-Kalon Corp., 198 Varick, N. Y. C.
Shakeproof, Inc., 2501 N. Keeler, Chicago

SCREWS, Set and Cap

Allen Mfg. Co., Hartford, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Parker-Kalon Corp., 198 Varick, N. Y. C.
Republic Steel Corp., Cleveland, O.
Shakeproof, Inc., 2501 N. Keeler Av., Chicago

SCREWS, Hollow & Socket Head

Allen Mfg. Co., Hartford, Conn.
Central Screw Co., 3519 Shields, Chicago
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Parker-Kalon, 198 Varick, N. Y. C.
Standard Pressed Steel Co., Jenkintown, Pa.

SELENIUM

Federal Tel. & Radio Corp., S. Newark, N. J.
Benwood Linze Co., St. Louis, Mo.
Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles

SHAFTING, Flexible

Breeze Corps., Inc., Newark, N. J.
Mall Tool Co., 7708 S. Chicago Ave., Chicago
Steward Mfg. Corp., 4311 Ravenswood Ave., Chicago
Walker-Turner Co., Inc., Plainfield, N. J.
White Dental Mfg. Co., 10 E. 48 St., N. Y. C.

SHEETS, Electrical

American Rolling Mill Co., Middletown, O.
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

FAMOUS IP SERIES RECEIVERS

(CONTINUED FROM PAGE 17)

"the best receiver for general radio reception that the Service, and probably the world, has ever seen." [1]

This well-designed model was manufactured, in general, by commercial concerns to whom the detailed blueprints and specifications were furnished by the Navy. One of these firms was the Wireless Specialty Apparatus Company, which built several hundred of these receivers for the Navy, and did a very creditable job. Having been receiver specialists for many years, they were in a good position to translate the Navy's design into well-built sets, and at the same time their experts received a little additional education in this class of work.

That the Company appreciated the worth of the design, and concurred in the Navy's opinion of it, is shown by the fact that directly after World War I they redesigned the receiver slightly, as by adding binding posts and links in the primary, secondary, and tickler circuits for the possible insertion of loading coils, and offered the modified set for sale commercially as type IP 501. It was first advertised in a Wireless Specialty catalog dated 1919, and later appeared in the RCA catalog "Radio Enters the Home" in 1922. The price quoted there was $550.

RCA used it for some years particularly for marine service. The "A" modification, shown here in detail, came out in November, 1922. It differs but slightly from the original design, the main difference being the addition of an output filter.

According to the catalog description, the 501 type consisted of a two-circuit, inductively-coupled receiver with primary and secondary circuits shielded from one another by heavy sheet copper boxes. The range was 250 to 8,000 meters. The coils were bank-wound with high-frequency wire, as the illustrations show. Condensers were of the balanced-rotor type, with heavy Bakelite discs for end plates. Varnished cambric tubing covered the heavy, rigid copper connecting wires. Tuning dials on the condensers were calibrated in 180 divisions on one half. The other half carried six semicircles, corresponding to the six positions of the switch-actuated pointers. They were used for hand calibration.

The foregoing is as descriptive of the SE 1420 as of its grandchild.

Although dated today in its appearance, this set is by no means a worthless relic. One of these has been in use by the writer up to recent years, and it gave as good service as when it was in its prime. While it does not measure up to current designs for specialized applications, the difference in efficiency, for the same class of service and frequency coverage, is not as marked as its great age might imply.

[1] History of the Bureau of Engineering, Navy Department, During the World War, pp. 117–118.

Follansbee Steel Corp., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Newport Rolling Mill Co., Newport, Ky.
Republic Steel Corp., Cleveland, O.
Ryerson & Son, Inc., Jos. T., Chicago

SHIELDS, Tube

Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.

SOCKETS, Cathode Ray Tube

Franklin Mfg. Corp., 175 Varick St., N. Y. C.

SOCKETS, Tube

Aladdin Radio Industries, 501 W. 35th St., Chicago
★ Alden Prods. Co., Brockton, Mass.
Amer. Phenolic Corp., 1830 S. 54th Av., Chicago
Amer. Radio Hardware Co., 476 B'way, N. Y. C.
Birnbach Radio Co., 145 Hudson, N. Y. C.
Bud Radio, Inc., Cleveland, O.
Cinch Mfg. Co., 2335 W. Van Buren St., Chicago
Cont'l-Diamond Fibre Co., Newark, Del.
Eagle Elec. Mfg. Co., Brooklyn, N. Y.
Eby, Inc., H. H., Philadelphia
Federal Screw Prods. Co., 26 S. Jefferson, Chicago
Franklin Mfg. Corp., 175 Varick, N. Y. C.
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia, Chicago
Micarta Fabricators, Inc., 4619 Ravenswood, Chicago
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., Los Angeles, Cal.
★ Nat'l Co., Malden, Mass.
Remler Co., San Francisco, Cal.

SOCKETS, Tube, Ceramic Base

Johnson Co., E. F., Waseca, Minn.
★ National Co., Inc., Malden, Mass.
Nat'l Fabricated Products, W. Belden Ave., Chicago
Ucinite Co., Newtonville, Mass.

SOLDER, Self-fluxing

Garden City Laboratory, 2744 W. 37th Pl., Chicago
Gardiner Metal Co., S. Campbell Ave., Chicago
★ General Elec. Co., Bridgeport, Conn.
Kester Solder Co., 4209 Wrightwood Ave., Chicago
Ruby Chemical Co., Columbus, O.

SOLDER POTS

Lectrohm, Inc., Cicero, Ill.

SPEAKERS, Cabinet Mounting

Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago
Crescent Industries, Inc., Belmont Ave., Chicago
★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
Magnavox Co., Fort Wayne, Ind.
Utah Radio Prod. Co., 842 Orleans St., Chicago

SPEAKERS, Outdoor Type

★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
University Labs., 225 Varick St., N. Y. C.

SPRINGS

Accurate Spring Mfg. Co., 3817 W. Lake, Chicago
★ American Spring & Mfg. Corp., Holly, Mich.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, O.
Barnes Co., Wallace, Bristol, Conn.
Cuyahoga Spring Co., Cleveland, O.
Gibson Co., Wm. D., 1800 Clybourn Av., Chicago
Hubbard Spring Co., M. D., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
★ Instrument Specialties Co., Little Falls, N. Y.
Muehlhausen Spring Corp., Logansport, Ind.
Peck Spring Co., Plainville, Conn.
Raymond Mfg. Co., Corry, Pa.
Standard Spring & Mfg. Co., Ind., 236-42 St., Brooklyn, N. Y.

STAMPINGS, Metal

Bud Radio, Inc., E. 55 St., Cleveland, O.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Insuline Corp. of Amer., Long Island City, N. Y.
Par-Metal Prod. Corp., Long Island City, N. Y.
Stewart Stamping Corp., 621 E. 216 St., N. Y. C.

SUPPRESSORS, Parasitic

Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SWITCHES, Aircraft Push

Square D Co., Kollsman Inst. Div., Elmhurst, N. Y.

SWITCHES, Key

Audio Development Co., Minneapolis, Minn.
★ Chicago Tel. Supply Co., Elkhart, Ind.
General Control Co., Cambridge, Mass.
Mossman, Inc., Donald P., 6133 N. Northwest Hy., Chicago

SWITCHES, Micro

Allied Control Co., Inc., E. End Ave., N. Y. C.
Aero Electric Co., 3167 Fulton Rd., Cleveland
Micro Switch Corp., Freeport, Ill.

SWITCHES, Rotary Gang, Bakelite Wafer

Mallory & Co., Inc., P. R., Indianapolis, Ind.
Stackpole Carbon Co., St. Marys, Pa.

SWITCHES, Rotary Gang, Ceramic Wafer

Oak Mfg. Co., 1267 Clybourn Ave., Chicago
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Shallcross Mfg. Co., Collingsdale, Pa.

SWITCHES, Time Delay

Haydon Mfg. Co., Inc., Forestville, Conn.
Industrial Timer Corp., 115 Edison Pl., Newark, N. J.
Sangamo Elect. Company, Springfield, Ill.

TERMINAL STRIPS

Cinch Mfg. Corp., W. Van Buren St., Chicago
Curtis Devel. & Mfg. Co., N. Crawford Ave., Chicago
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
Jones, Howard B., 2300 Wabansia Ave., Chicago

TEST CHAMBERS, Temperature, Humidity, Altitude, Salt Spray

American Coils Co., 25 Lexington St., Newark, N. J.
Industrial Filter & Pump Mfg. Co., W. Carroll Ave., Chicago
Kold-Hold Mfg. Co., 446 N. Grand Ave., Lansing, Mich.
Mobile Refrigeration, Inc., 630 5th Ave., N. Y. C.
Northern Engineering Labs., 50 Church St., N. Y. C.
Tenney Engineering, Inc., Montclair, N. J.

TRACING PAPERS, CLOTH, CELLOPHANE

Arkwright Finishing Co., Providence, R. I.
Brown & Bro., Arthur, 67 W. 44 St., N. Y. C.
Keuffel & Esser, Hoboken, N. J.

TRANSFORMERS, Constant-Voltage Power

Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
★ General Electric Co., Schenectady, N. Y.
Raytheon Mfg. Co., Waltham, Mass.
Sola Electric Co., 2525 Clybourn Ave., Chicago

TRANSFORMERS, IF, RF

Aladdin Radio Industries, 501 W. 35th St., Chicago
Amer. Transformer Co., Newark, N. J.
Automatic Windings Co., E. Passaic, N. J.
★ Browning Labs., Inc., Winchester, Mass.
Cambridge Thermionic Corp., Concord Ave., Cambridge, Mass.
Caron Mfg. Co., 415 S. Aberdeen, Chicago
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Essex Specialty Co., Inc., Broad St., Newark, N. J.
Gen'l Winding Co., 420 W. 45 St., N. Y. C.
Greyhound Equip. Co., 1720 Church Ave., Brooklyn, N. Y.
Guthman & Co., 400 S. Peoria St., Chicago
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
★ Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., Los Angeles, Cal.
★ Nat'l Co., Malden, Mass.
Sickles Co., F. W., Springfield, Mass.
Super Elec. Prod. Corp., Jersey City, N. J.
Teleradio Eng. Corp., 484 Broome St., N. Y. C.
Triumph Mfg. Co., 4017 W. Lake, Chicago

TRANSFORMERS, Receiver Audio & Power

Acme Elec. & Mfg. Co., Cuba, N. Y.
Amer. Transformer Co., Newark, N. J.
Amplifier Co. of Amer., 17 W. 20th St., N. Y. C.
Audio Devel. Co., N. Minneapolis, Minn.
Chicago Transformer Corp., 3501 Addison St., Chicago
Cinaudagraph Speakers, Inc., 3911 S. Michigan, Chicago
Dinion Coil Co., Caledonia, N. Y.
Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
Electronic Trans. Co., 515 W. 29 St., N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
Freed Trans. Co., 72 Spring St., N. Y. C.
Gen'l Radio Co., Cambridge, Mass.
General Trans. Corp., 1250 W. Van Buren, Chicago

Halldorson Co., 4500 Ravenswood, Chicago
Jefferson Elec. Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., N. Y. C.
Magnetic Windings Co., Easton, Pa.
Newark Transformer Co., Newark, N. J.
New York Transformer Co., 51 W. 3rd, N. Y. C.
Norwalk Transformer Corp., S. Norwalk, Conn.
Raytheon Mfg. Co., Waltham, Mass.
★ Standard Transformer Corp., 1500 N. Halsted, Chicago
Super Elect. Prod. Co., Jersey City, N. J.
Superior Elec. Co., Bristol, Conn
Thermador Elect. & Mfg. Co., Riverside Dr., Los Angeles
Thordarson Elec. Mfg. Co., 500 W. Huron, Chicago
Utah Radio Prods. Co., 820 Orleans St., Chicago
★ United Transformer Co., 150 Varick St., N. Y. C.

TUBE MANUFACTURING MACHINES

Hilton Eng. Labs., Redwood City, Calif.
Eisler Eng. Co., 7518 13th St., Newark, N. J.

TUBES, Cathode Ray

★ Dumont Labs., Allen B., Passaic, N. J.
Farnsworth Tele. & Radio Corp., Ft. Wayne, Ind.
★ General Elec. Co., Schenectady, N. Y.
Nat'l Union Radio Corp., Newark, N. J.
Rauland Corp., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
★ Sylvania Elect. Prod., Inc., Emporium, Pa

TUBES, Current Regulating

Amperite Co., 561 Broadway, N. Y. C.
Champion Radio Works, Danvers, Mass.
Hytron Corp. & Hytronic Labs., Salem, Mass.
RCA Mfg. Co., Camden, N. J.
★ Sylvania Elec. Prod., Inc., Emporium, Pa.
Western Electric Co., 195 Broadway, N. Y. C.

TUBES, Photo-Electric

Bradley Labs., New Haven, Conn.
Cont'l Elec. Co., Geneva, Ill.
De Jur-Amsco Corp., Shelton, Conn.
De Vry, Herman A., 1111 W. Center, Chicago
Electronic Laboratory, Los Angeles, Cal
Emby Prods. Co., Los Angeles, Cal
★ General Elec. Co., Schenectady, N. Y.
General Scientific Corp., 4829 S. Kedzie Av., Chicago
G-M Labs., 4313 N. Knox Av., Chicago
Leeds & Northrup Co., Philadelphia
Nat'l Union Radio Corp., Newark, N. J.
Photobell Corp., 123 Liberty St., N. Y. C.
RCA Mfg. Co., Camden, N. J.
Rectron Corp., 2159 Magnolia Av., Chicago
Westinghouse Lamp Div., Bloomfield, N. J.
Western Electric Co., 195 Broadway, N. Y. C.
Weston Elec. Inst. Corp., Newark, N. J.

TUBES, Receiving

★ General Electric Co., Schenectady, N. Y.
Hytron Corp., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Nat'l Union Radio Corp., Newark, N. J
Raytheon Prod. Corp., 420 Lexington Av., N. Y. C.
RCA Mfg. Co., Camden, N. J.
★ Sylvania Elect. Prod., Inc., Emporium, Pa.
Tung-Sol Lamp Works, Newark, N. J.

TUBES, Transmitting

Amperex Electronic Prods., Brooklyn, N. Y.
★ Eitel-McCullough, Inc., San Bruno, Cal.
Electronic Enterprises, Inc., 65 Sixth Ave., N. Y. C.
Federal Telegraph Co., Newark, N. J.
★ General Elec. Co., Schenectady, N. Y.
Heintz & Kaufman, S. San Francisco, Cal.
Hytron Corp., Salem, Mass.
Nat'l Union Radio Corp., Newark, N. J.
Raytheon Prod. Corp., 420 Lexington Av., N. Y. C
RCA Mfg. Co., Camden, N. J.
★ Sylvania Elect. Prod., Inc., Emporium, Pa.
Taylor Tubes, Inc., 2341 Wabansia, Chicago
United Electronics Co., Newark, N. J.
Western Electric Co., 195 Broadway, N. Y. C
Westinghouse Lamp Div., Bloomfield, N. J.

TUBES, Voltage-Regulating

Amperite Co., 561 Broadway, N. Y. C.
Hytron Corp., Salem, Mass.
RCA Mfg. Co., Camden, N. J.
★ Sylvania Elec. Prod., Inc., Salem, Mass.

TUBING, Laminated Phenolic

Brandywine Fibre Prods. Co., Wilmington, Del.
Formica Insulation Co., Cincinnati, O.
★ General Electric Co., Pittsfield, Mass.
Insulation Mfgrs. Corp., 565 W. Washington Blvd., Chicago
Mica Insulator Co., 196 Varick, N. Y. C.
Nat'l Vulcanized Fibre Co., Wilmington, Del
Richardson Co., Melrose Park, Ill.
Spaulding Fibre Co., 233 B'way, N. Y. C.
Synthane Corp., Oaks, Pa
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa
Wilmington Fibre Specialty Co., Wilmington, Del.

TUBING & SLEEVING, Varnished Cambric, Glass-Fibre, Spaghetti

Bentley-Harris Mfg. Co., Conshohocken, Pa
Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Electro Technical Prod., Inc., Nutley, N. J.
Endurette Corp. of Amer., Cliffwood, N. J.
★ General Elec. Co., Bridgeport, Conn
Insulation Mfgrs. Corp., 565 W. Washington Blvd., Chicago
Irvington Var. & Ins. Co., Irvington, N. J.
Mica Insulator Co., 196 Varick St., N. Y. C.
Varflex Corp., Rome, N. Y.

VARNISHES, Insulating, Air-Drying

John C. Dolph Co., Newark, N. J
Irvington Var. & Ins. Co., Irvington, N. J
Stille-Young Corp., 2300 N. Ashland Ave., Chicago
★ Zophar Mills, Inc., 112 26 St., Bklyn., N. Y.

VARNISHES, Insulating, Baking

John C. Dolph Co., Newark, N. J.
Irvington Var. & Ins. Co., Irvington, N. J.
Stille-Young Corp., 2300 N. Ashland Ave., Chicago
★ Zophar Mills, Inc., 112 26 St., Bklyn., N. Y.

VIBRATION TEST EQUIPMENT

Vibration Specialty Co., 1536 Winter St., Philadelphia

VIBRATORS, Power Supply

Amer. Telev. & Radio Co., St. Paul, Minn.
★ Electronic Labs., Indianapolis, Ind.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Radiant Corp., W. 62 St., Cleveland, O.
Turner Co., Cedar Rapids, Ia.
Utah Radio Prod. Co., Orleans St., Chicago

VOLTMETERS, Vacuum Tube

Ballantine Laboratories, Inc., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.
★ Radio City Prod. Co., Inc., 127 W. 26 St., N. Y. C.

WAXES & COMPOUNDS, Insulating

Western Elec. Co., 195 Broadway, N. Y. C.
★ Zophar Mills, Inc., 112 26 St., Bklyn., N. Y.

WELDING, Gas, Aluminum & Steel

Treitel-Gratz Co., 142 E. 32 St., N. Y. C.

WIRE, Bare

American Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Copperweld Steel Co., Glassport, Pa.
Crescent Ins. Wire & Cable Co., Trenton, N. J.
★ General Elec. Co., Bridgeport, Conn.
Phosphor Bronze Smelting Co., Philadelphia
Rea Magnet Wire Co., Fort Wayne, Ind.
Roebling's Sons Co., John, Trenton, N. J.

WIRE, Hookup

Bentley, Harris Mfg. Co., Conshohocken, Pa.
Gavitt Mfg. Co., Brookfield, Mass.
Lenz Electrical Mfg. Co. 1751 N. Western Ave., Chicago
Rockbestos Prod. Corp., New Haven, Conn.
Whitney Blake Co., New Haven, Conn.

WIRE, Magnet

Acme Wire Co., New Haven, Conn.
American Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Collyer Ins. Wire Co., Pawtucket, R. I.
Crescent Ins. Wire & Cable Co., Trenton, N. J.
Electric Auto-Lite Co., The, Port Huron, Mich.
General Cable Corp., Rome, N. Y.
★ General Elec. Co., Bridgeport, Conn.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Hudson Wire Co., Winsted, Conn.
Rea Magnet Wire Co., Fort Wayne, Indiana
Rockbestos Prods. Corp., New Haven, Conn.
Roebling's Sons Co., John, Trenton, N. J.
Wheeler Insulated Wire Co., Bridgeport, Conn.

WIRE, Rubber Covered

Crescent Ins. Wire & Cable Co., Trenton, N. J.
General Cable Corp., Rome, N. Y.
Hazard Ins. Wire Works, Wilkes-Barre, Pa.
Simplex Wire & Cable Co., Cambridge, Mass.

WOOD, Laminated & Impregnated

Camfield Mfg. Co., Grand Haven, Mich.
Formica Insulation Co., Cincinnati, O.

A.S.A. TRANSFORMER STANDARDS

FIRST aid for home radio receivers off the air because of defective transformers or chokes, is promised in the new war standard for replacements for these critical parts, just issued by the American Standards Association. This is the fourth of a series of standards for replacement parts for civilian radios being developed by the A. S. A. with the cooperation of all branches of the radio industry, the War Production Board and the Office of Price Administration.

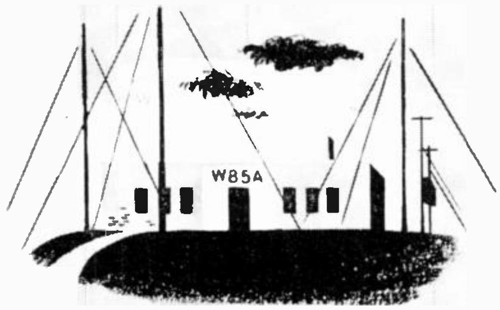
The new standard, "Power and Audio Transformers and Reactors, Home Receiver Replacement Type" covers the performance and quality requirements for a simplified list of 14 such units which, it is estimated, will be sufficient to service about 90 per cent of the radio sets now in operation. Use of the new standard will also assure that such critical materials as copper and transformer steel, allocated to the production of radio replacement parts, will be stretched as far as possible, with a minimum number of types to be carried in dealers stocks. Copies of the new standard can be obtained from American Standards Associations, 29 West 39th Street, New York City.

Do you remember when "radio experts" designed, built, sold, installed, and serviced home radios, did a little police or airplane radio work on the side, operated amateur stations at night, and read all the radio publications in their spare moments? . . . Time was when radio magazines could serve in the same Jack-of-all-Trades capacity, and include some industrial-electronics for good measure. . . . But not any more. Accelerated by the War, radio-electronics and industrial-electronics have been sharply divided into separate fields. The first employs vacuum tubes in association with radio components and radio equipment. The second uses vacuum tubes to operate mechanical devices and manufacturing machinery. . . . This progress has also high-lighted the radio sub-divisions of 1) amateur activities, 2) service, 3) sales, and 4) engineering. FM Radio-Electronics is performing an outstanding service to its readers because it is devoted specifically to the subject of radio engineering and design. The resulting effectiveness to advertisers is not duplicated by other publications

G. E. builds FM's future on these four facts

G. E. Builds Both FM Transmitters and Receivers

G.E. is the *only* manufacturer with experience in building the complete FM system — FM broadcasting equipment and FM home receivers. Radio research and volume production for war are yielding new possibilities for further improving FM equipment.



G. E. Has Program and Equipment Experience

Three years of broadcast experience in its own proving-ground Station W85A, Schenectady, will enable G.E. to help new FM stations get started quickly. General Electric's experience also includes equipping more than a third of the 36 commercial FM broadcast stations now in operation.

G. E. is Telling Public the Advantages of FM

A powerful G-E advertising campaign in the nation's big-circulation magazines and the thrice-weekly nation-wide G-E program over C.B.S.—Frazier Hunt and the News — are pre-selling the public on the advantages of FM — and are steadily building an expanding post-war market.

Survey Proves Vast Increase in FM Acceptance

An independent consumer survey reports that: The public already strongly approves FM; 85% call it a definite improvement over conventional broadcasting; present owners of G-E FM receivers are the most enthusiastic of all FM owners! . . . *Electronics Department, General Electric, Schenectady, N. Y.*

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COMPLETE STATION EQUIPMENT

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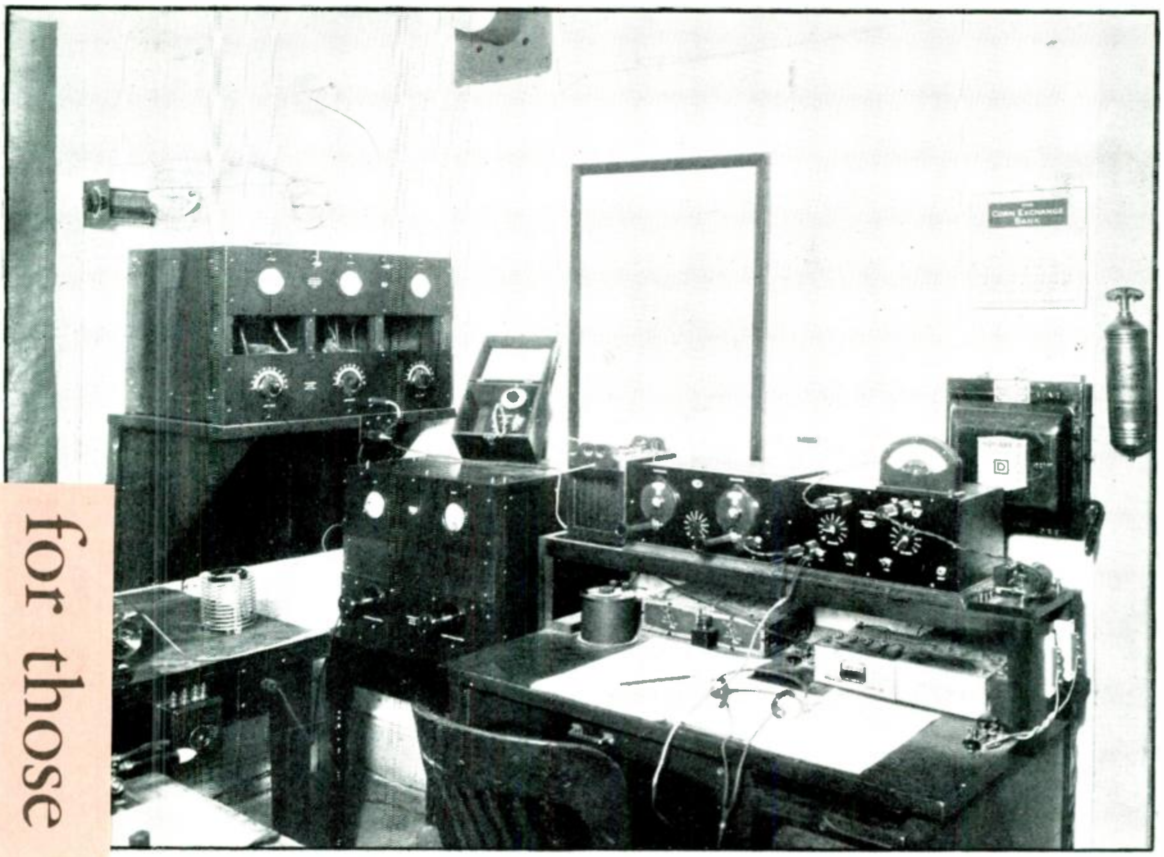

for those engaged in wartime radio-electronic work

REL *South American Circuit*

REL …s had a hand in some of radio's most interesting developments. During the last 20 years, we have been called upon to do for the first time many things which, much later, became commonplace.

Repeatedly, our success in meeting new problems has shown the way which others have followed.

For example, one of the earliest experimental short-wave circuits was built in 1926 for All America Cables. Installed at Manhattan Beach, Long Island, this station operated on 20 meters with Buenos Aires.

The log shows that signals were steady and strong enough to copy on an automatic ink recorder. Communication on this circuit was highly successful.

In this equipment, built more than 17 years ago, it is interesting to see how many features forecast design practices which characterize apparatus being manufactured now!

Today, under the pressure of war necessities, knowledge born of such long experience has a premium value. It will be equally valuable when new radio construction is again authorized for peacetime services.

LOOK TO REL FOR PEACETIME LEADERSHIP

Producing today for Victory, REL plans ahead for Peace. Before the War, this Company was the largest manufacturer of FM broadcasting equipment. Today, with engineering and factory facilities greatly expanded and improved for military production, REL is preparing to resume its leadership in the design and construction of broadcasting installations.

REL

RADIO ENGINEERING LABS., Inc.
Long Island City New York

Sales Offices:
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2040 Grand River Ave. W., Detroit, Michigan
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Link Men in Service

Constant Guardian of Life & Property

Northampton Station of Massachusetts State Police

TODAY there are so many F. M. LINK emergency communications in use that the products of this Company are generally thought of in connection with transmission on land, rather than on the sea.

That is not surprising because very little is known, or can be told about the sea-going applications of LINK radio apparatus, at this time.

The fact is, however, that the remarkable performance records of hundreds of LINK installations ashore have led to its wide adoption for service in the battles being fought on both the Atlantic and Pacific Oceans.

This is further evidence of the versatility of LINK designs, and the ability of LINK equipment and engineering to deliver dependable service under the most unusual and difficult circumstances, wherever radio communication is required.

The best-equipped police and fire departments ARMY E NAVY *use F. M. Link equipment exclusively*

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