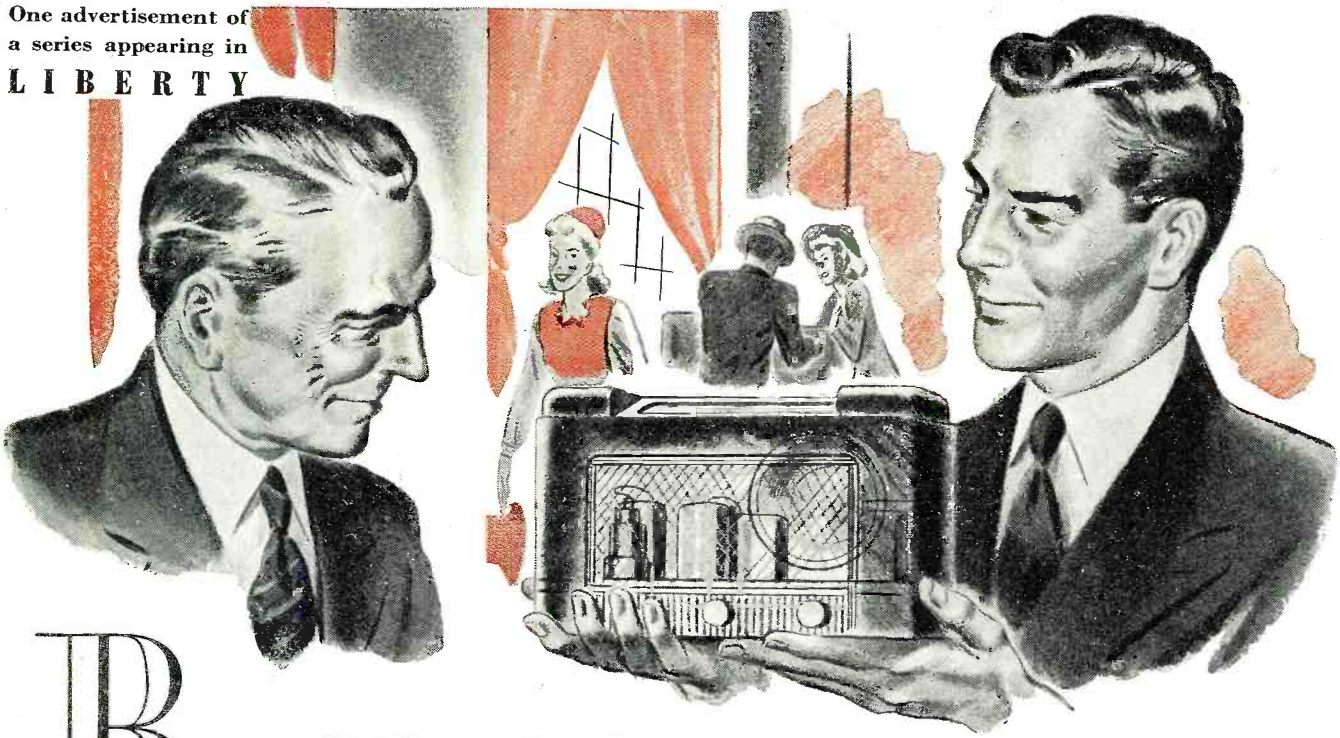
RADIO NEWS

JUNE
1945
35c
In Canada 40c

THE WAR BONDS YOU HOLD
ARE FIGHTING BONDS

One advertisement of a series appearing in LIBERTY



Buy Your New Radio from Your Radio Dealer

—HE KNOWS THE INSIDE STORY!

FIRST WIN THE WAR
BUY WAR BONDS

"You can buy trouble-free performance—as well as style, when you choose your new radio—for there is a man in your community who knows 'the inside story.' He is a specialist—your local independent radio dealer.

"As your dealer, I am one of the many men who have worked hard to keep your set and millions of others in service during the war. We know from experience what makes a good receiver—what kind of parts and workmanship stand up.

"That's why many of us dealers have already chosen *Meck* Radios. They offer you outstanding engineering advances, as well as a reputation for quality firmly established through years of building world-famed electronic products."

FACE TO FACE RECEPTION

Yours for good listening,

Your Radio Dealer

MECK RADIOS

EXCELLENCE IN MUSIC AND VOICE RECREATING INSTRUMENTS

JOHN MECK INDUSTRIES, Inc., PLYMOUTH, INDIANA

TABLE MODELS • PORTABLES • CONSOLE COMBINATIONS • PHONOGRAPHS

RADIO NEWS
Reg. U. S. Pat. Off.

JUNE • 1945

VOLUME 33, NUMBER 6

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FEATURES

DEPARTMENTS

COVER PHOTO
By Frank Ross
(Staff Photographer)

Multiple gas jets concentrate intense heat on the glass envelope of electronic tubes during this sealing-off operation at the Taylor Tube plant located at Chicago, Ill.

Editorial Offices: 185 N. Wabash Ave., Chicago 1, Ill.
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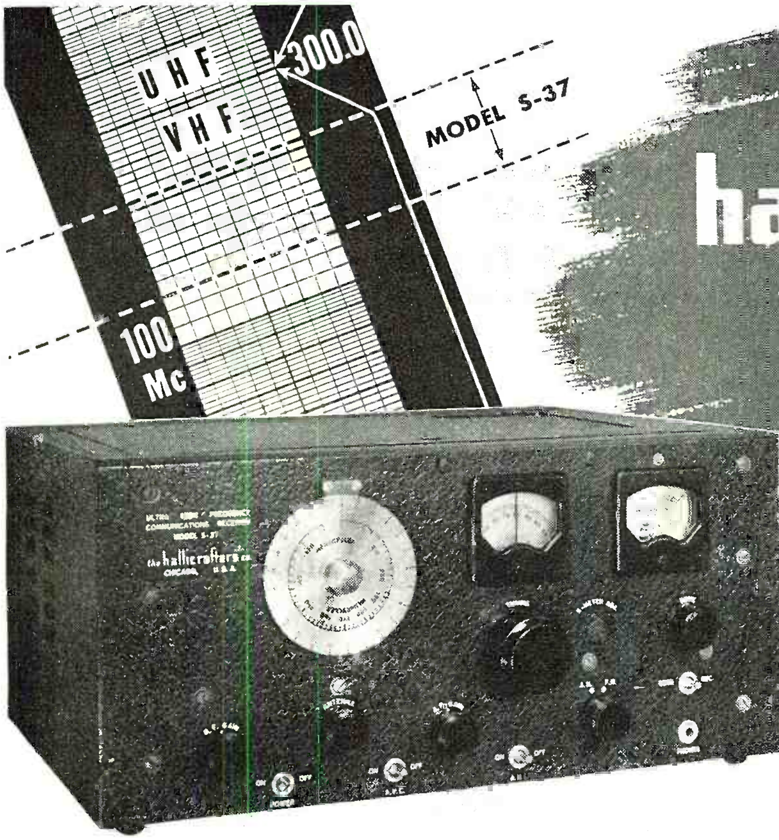


HOW hallicrafters EQUIPMENT COVERS THE SPECTRUM

Model S-37

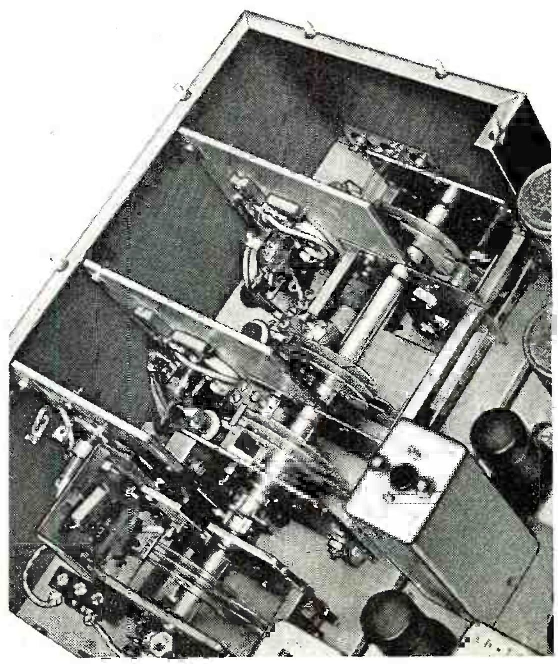
FM-AM

for very high frequency work

130 to 210 Mc.

THE new Model S-37 FM-AM receiver is an outstanding example of Hallicrafters pioneering work in the upper regions of the spectrum. Covering the frequencies between 130 and 210 megacycles, the S-37 provides VHF performance which is in every way comparable to that of the finest communications receivers operating in the medium and high frequency bands. The average over-all sensitivity of the S-37 is approximately 5 microvolts. The image ratio of at least 1000 times is achieved through the use of two pre-selector stages and an intermediate frequency of 16 megacycles. No band switching is necessary and exceptional ease of tuning is provided by mechanical band-spread with 2300 dial divisions between 130 and 210 megacycles. The pre-loaded gear train is completely enclosed and is equipped with a positive stop at each end of the tuning range. Hermetically sealed transformers and capacitors, moisture proof wiring, and extra heavy plating, all contribute to the long life and reliability of the S-37 . . . the only commercially built receiver covering this frequency range.

The amazing performance of the Model S-37 is largely due to the RF section shown at right. It is mounted as a unit on a brass plate ¼ inch thick. The two type 954 RF amplifiers and the type 954 mixer are placed in the heavy shields which separate the stages. The type 955 oscillator is mounted directly on its tuning condenser. Exceptional stability is assured by the use of individually selected enclosed ball bearings, extra-heavy end plates, and wide spacing in the oscillator condenser – rigid mounting of all components – and inductances of ⅛ inch copper tubing wound on polystyrene forms. All conducting parts are heavily silver plated.



Write for Catalog No. 36C, describing Hallicrafters complete line of high frequency receivers and transmitters.

BUY A WAR BOND TODAY!

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U.S.A.

THESE 10 CONTROLS REPLACE 95%

N. U. *Sav-a-Shaft* VOLUME CONTROLS

If you haven't already put in a stock of N.U. Save-a-shaft Volume Controls . . . order yours today from your N.U. Distributor. Here's a real time-saver he can deliver fast! Minimum investment in stock of only 10 types is all you need to get going. NATIONAL UNION RADIO CORPORATION, Newark 2, N. J.

7 REASONS WHY

1. 10 types handle over 95% of your volume control replacement needs.
2. Eliminates shaft sizing and knob fitting.
3. Adaptable to any standard shaft.
4. Controls are complete with switch.
5. If no switch is needed, use same control but don't pull switch lug.
6. Individually packaged with instructions.
7. All sizes $1.00 list price.

NATIONAL UNION RADIO TUBES AND PARTS

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


WHAT ABOUT FM?
Frequency Modulation poses obvious problems in the design and building of loud speakers and loud speaker systems. The answers to these problems are not simple; but research and precise engineering based on long experience in and knowledge of audio-acoustics, will result in a complete postwar line of JENSEN speakers to meet the most particular requirements of FM. Other new and special loud speaker applications will be met just as satisfactorily with other JENSEN postwar products, some of which will employ the new JENSEN ALNICO 5.
To help the service man, dealer and engineer solve the special problems of FM sound reproduction, JENSEN has made available technical Monograph No. 3, entitled, "Frequency Range in Music Reproduction." This Monograph, one of a series of four, is available for 25c.
Other Monographs
No. 1—"Loud Speaker Frequency–Response Measurement"
No. 2—"Impedance Matching and Power Distribution"
No. 4—"The Effective Reproduction of Speech"
Jensen
SPEAKERS WITH
ALNICO 5
Specialists in Design and Manufacture of Acoustic Equipment

FOR THE RECORD
by the editor

ONCE again the veil of secrecy surrounding basic applications of radar has been lifted. In the February issue of "Wireless World," a British publication, appeared the first in this new exploitation to the public of the miracles of radio location. Many radio trade magazines are now reproducing or quoting from that material.

As a matter of fact, almost the identical story appeared in the August, 1941 issue of Radio News. It is interesting to compare the statements contained therein and to refer to the artist's conception in that article. About the only things lacking are the technical details which at this time still cannot be revealed except from the fundamental aspects.

To quote from the Radio News article, our reporter stated as follows: "First, the system is essentially that of radio-signal transmission, reception and detection. The system is composed of hundreds of ultra-short-wave transmitters and receivers which cover the countryside. These transmitters broadcast a constant 'barrage' of radio 'feeler' waves which cover the country like a gigantic invisible tent. When an object such as an enemy airplane passes into this radio-tented area, the 'feeler' waves are reflected from the enemy plane and these feeble, minute signals are picked up by Radiolocator stations. By applying the principles of radio-direction-finding, and other basic radio principles, the position in the sky of the unwelcome intruder is plotted very accurately, and this information is used by defense fighter planes and anti-aircraft batteries with telling effect."

To get a bit more technical, the author goes on with the following: "With Radiolocator, a sharply-focused microwave is projected into space and 'scans' a certain section of the sky like a searchlight. When the wave strikes an enemy aircraft, it is deflected back to earth. This 'rebound' wave is picked up by the sensitive Radiolocator receiving device and the results used to calculate the position in space of the plane."

If we substitute the American term "radar" instead of the British term "Radiolocator," we find the basic operating technique almost completely explained. Almost four years have gone by since the original article went to press. Amazing developments, naturally, have taken place throughout the interim. There are many forms of radar. Basically, they operate on the very same principle.

Some of these new devices were recently shown at Ft. Meyer to some of the press on last minute orders of General Brehon Somervell, ASF Commander. One of these was a radar-controlled anti-aircraft searchlight. It is designated as the AN/TPL-1. It synchronizes the beam of a field searchlight with the direction-finding equipment. Four Signal Corps members sit in front of a control board and view four circular scopes looking very much like lenses. These scopes show the location and range of approaching aircraft. One of the larger scopes indicates the location of the plane by means of a variable line appearing across the radius of the screen. The smaller one shows the range and this is indicated by a series of "pips" appearing across a line dissecting the scope. When the two "pips" converge on the smaller scope, they give the antenna range-finding information.

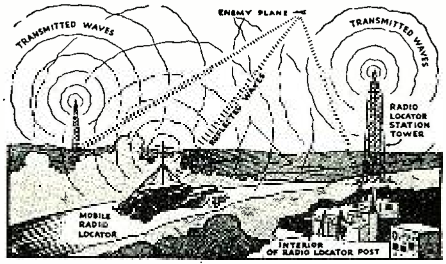
Another unit displayed was a very lightweight warning radar set. Utilizing two scopes it operates in much the same way as those of the radar searchlight sets. Two scopes give the position of a plane in relation to the set over an effective range of 100 miles.

Still another radar unit, this one of a heavier type, automatically computes the gun range of anti-aircraft apparatus with no attendant at the controls. It is a tremendous piece of equipment. It may be turned in any direction. These special radar antennas move with the unit. An operator sits on each side and the gun range can be determined very accurately from the information appearing on the radar scopes.

To give our readers an introduction to this new art, we present in this issue a new series of articles covering the basic fundamentals of radar. They

(*Continued on page* 141)

The original artist's sketch from the Aug., 1941, issue of Radio News.



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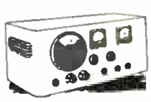
Communications Receiver
NOW

Allied Radio's New Plan Makes it Easy for You to be Among the First to Own and Enjoy this Celebrated Receiver!

MODEL SX-28A—This is the latest model of Hallicrafters famous *Super Sky-Rider* . . . the finest communications receiver built today! Has a frequency range of 550 kc. to 42 Mc. continuous in 6 bands. With crystal, less speaker, net..................$223.00



MODEL SX-25—The *Super-Defiant* ... long-time favorite of amateurs who want fine performance at a moderate price. Has a frequency range of 545 kc. to 42 Mc. continuous in 4 bands. With crystal, less speaker, net.........$94.50

MODEL S-20R—Popular *Sky-Champion* offers top performance in low cost field. Has a frequency range of 550 kc. to 43 Mc. continuous in 4 bands. With built-in speaker, net..............$60.00

MODEL S-39—*Sky Ranger* portable ... operates from its own self-contained batteries or 115 volts a.c. or d.c. Has frequency range of 540 kc. to 30.5 Mc. continuous in 4 bands. Net..........$110.00

MODEL S-36—Covers both old and new FM bands. Operates on FM, AM, or CW. Outstanding for sensitivity, stability, high fidelity and versatility in the *very high frequencies.* Range from 27.8 Mc. to 143 Mc. continuous in 3 bands. Less speaker, net.........$307.50

PM23 SPEAKER—For SX-28A, SX-25 and S-36 above, net.................$15.00

HALLICRAFTERS

Honored for its Role in War Communications

On all fronts . . . on land, sea, in the air . . . in jungle, desert and arctics . . . Hallicrafters sets have performed gallantly for the Armed Forces of the United Nations. The fifth Army and Navy "E" award flies from Hallicrafters roof tops! Hallicrafters, you know, are *builders of the famous SCR-299.*

ALLIED RADIO

833 W. Jackson Blvd. **Chicago 7, U.S.A.**

Over 20 Years of Service to the Nation

TODAY, communications receivers are obtainable only for war use. But as soon as conditions permit, they will again be available for civilian use.

Pent-up demand by short-wave listeners and radio amateurs for world-famous Hallicrafters receivers is *so great that you would be wise to reserve YOUR Hallicrafters NOW!* The record of Hallicrafters performance in war communications is outstanding. Hallicrafters sets have "stood up" almost unbelievably in the most impossible conditions of climate and weather. Vital war-proved features of these sets . . . PLUS new advanced engineering developments . . . will be incorporated in your post-war Hallicrafters!

Now, through close cooperation of the Allied Radio Corporation and the Hallicrafters Company, a plan has been evolved that *makes it easy for you to reserve your Hallicrafters at once* . . . and be assured of earliest delivery!

HERE'S HOW TO RESERVE YOUR HALLICRAFTERS

1. All you have to do is enter your order now with Allied.
2. You don't have to pay the full amount in advance.
3. A deposit of only 10% of the current price will put you among the first in line to receive delivery of a Hallicrafters Receiver.
4. When your set is ready, easy payment terms may be arranged.
5. Any communications receiver, in good condition, will be accepted for a liberal trade-in allowance instead of cash down payment.
6. Even after your reservation is made, you may have your deposit back if you wish.

(Prices subject to possible revision at time of shipment.)

★

ALLIED RADIO

"Arsenal of Supply"

for Everything in Radio and Electronics

Allied's complete service speeds vital needs to the Armed Forces and Industry. Concentrated here are the world's largest and most complete stocks of parts and equipment under one roof. And Allied has always been one of the leaders in the sale of communications receivers.

Just imagine how thrilled and proud you will be to rank among the *first* to have a Hallicrafters . . . "The Radio Man's Radio!" Picture the pleasure you'll have . . . for with a Hallicrafters at your fingertips . . . *all the world is your neighbor!* Certainly you want a receiver all your own! To be sure of earliest delivery, enter your order *at once* . . . without delay!

MAIL COUPON TODAY TO RESERVE YOUR HALLICRAFTERS

ALLIED RADIO CORP.
833 W. Jackson Blvd., Dept. 1-FF-5 Date________
Chicago 7, Ill.

☐ Please reserve Hallicrafters Model.... for me. Enclosed is my 10% deposit $........... (It is understood I retain right to cancel order any-time before delivery, and get my deposit back.)

☐ Please send further information on your Communications Receiver Reservation Plan.

☐ Please send latest free Allied Buying Guide on Everything in Radio and Electronics.

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ADDRESS..

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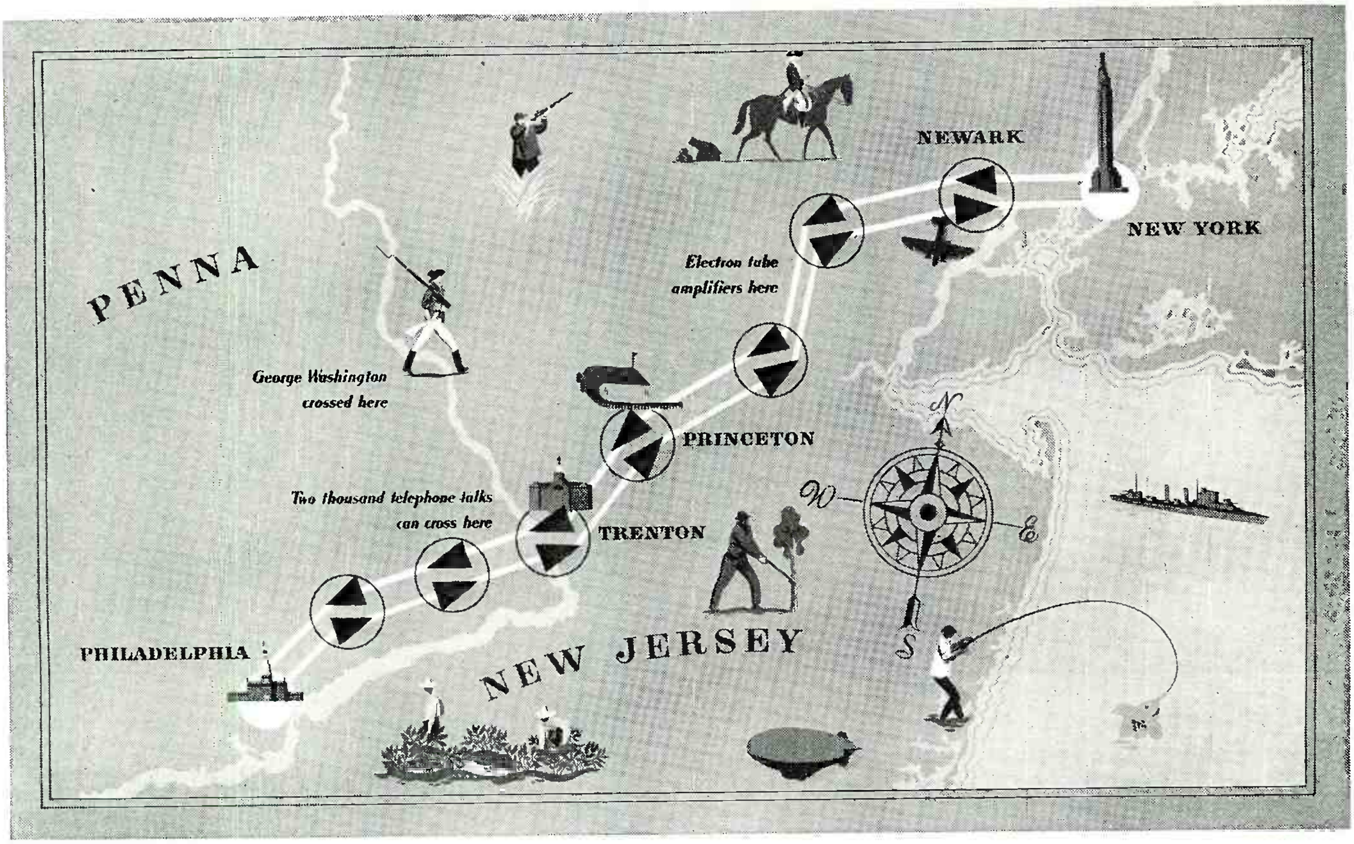
90-MILE LABORATORY

for Telephone and Television



BETWEEN telephone offices in New York and Philadelphia once stretched a strange sort of laboratory. Most of the way it was underground; engineers made their measurements sometimes in manholes. It was a lead-sheathed cable containing two "coaxials" — each of them a wire supported in the center of a flexible copper tube the size of a lead pencil.

Theory had convinced engineers of Bell Laboratories that a coaxial could carry many more telephone talks than a full-sized voice frequency telephone cable; that it could carry adequately a television program. Experimental lengths were tested; terminal apparatus was designed and tried out. Finally, a full-sized trial was made with a system designed for 480 conversations. It was successful; in one demonstration people talked over a 3800-mile circuit looped back and forth. Now the cable is carrying some of the wartime flood of telephone calls between these two big cities.

This cable made television history also: through it in 1940 were brought spot news pictures of a political convention in Philadelphia to be broadcast from New York. Bell System contributions to television, which began with transmission from Washington to New York in 1927, have been laid aside for war work. When peace returns, a notable expansion of coaxial circuits is planned for both telephone and television in our Bell System work.

Spot Radio News

By RADIO NEWS Washington Correspondent

Presenting latest information on the Radio Industry.

WITH THE TRAGIC PASSING OF OUR LATE PRESIDENT, Franklin Delano Roosevelt, radio has suffered a deep personal loss. His gallant leadership catapulted radio to world fame. Through radio the world echoed his brilliant strategy. His inspiring "fireside chats" brought cheer, hope, and faith to the globe's millions.

His death has brought sorrow to the broadcasters of America with whom he worked so closely. Paying tribute to this great man, Harold Ryan, president of the National Association of Broadcasters, said: "He gave historic evidence of the effectiveness of this medium of communications in the solution of national and international problems. . . . This beloved leader of the people will always live in this avenue of friendly human approach to men, women, and children throughout the world."

Our new President, Harry F. Truman, voiced the sentiments of the nation in his historic broadcasts to Congress and our troops throughout the world, during his first days in office. A nationwide audience of over 16 million listened to President Truman extol the late President and describe the future program of his administration. President Truman's Armed Forces' message was heard by over 41 million people. According to surveys made by C. E. Hooper for CBS, 32% of the nation listened in to the first of President Truman's addresses and 53.6% were in the listening audience during the second address. The highest daytime rating of all times, 60%, was achieved by the late President Roosevelt on December 8, 1941, in his historic speech on the attack at Pearl Harbor.

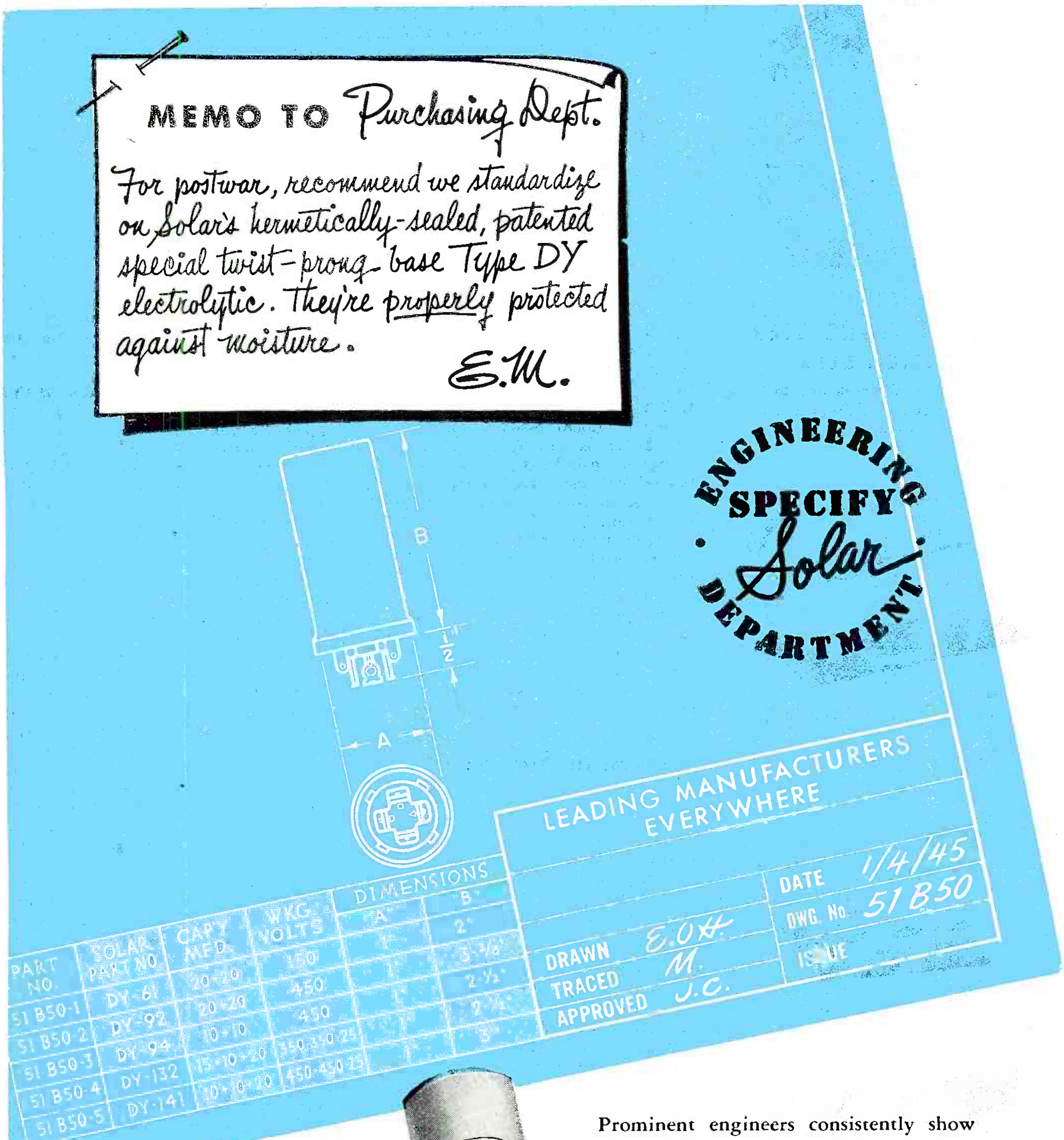
MANY COMPLEX PROBLEMS involving economics and engineering appeared to have delayed the final report on the 25- to 30,000-megacycle allocation program. Originally scheduled for release on April 1 and then the 15, the data may not appear until the middle of May. A last-minute interview with FCC officials indicated that several major questions remain to be answered. While it is important to complete the project quickly, the FCC believes that it is also imperative that the decisions made be thoroughly correct, all the way. The tremendous influence that the report will have demands this extremely close scrutiny. Indications of the deep concern the FCC has in the allocation program appeared in the speech of FCC Chairman Paul A. Porter, in Washington, recently. Appearing before the Washington-Virginia district meeting of the NAB, Mr. Porter warned against financial speculation in frequency modulation and television. He indicated that the FCC will carefully watch the progress of all forms of broadcasting, stressing that these new arts will play an important role in the communications picture of the future.

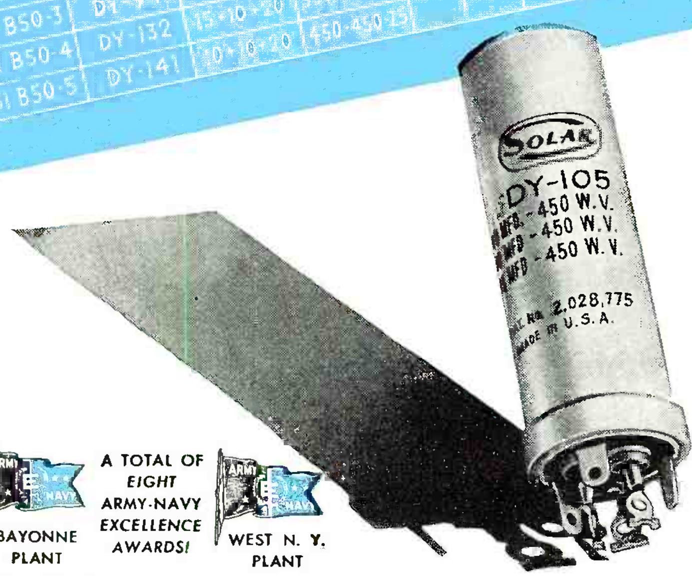
Mr. Porter's letter to Commander E. F. McDonald, commenting on Commander McDonald's telegrams to members of Congress which asked for congressional action in the FCC proposal to move FM up, further stressed the sincerity of the FCC program. Commander McDonald asserted in his telegrams that seven of the eight experts who testified at the closed hearings and during the oral hearings in Washington had pointed out that moving of FM from its present position was unnecessary and undesirable. Mr. Porter said that the final determination of the highly technical problem will be based upon the Commission's appraisal of the record of expert testimony. He added that the Commission's conclusion will reflect the determinations of the requirements of the public interest.

The Senate Interstate Commerce committee members supported Mr. Porter. The Senate said that the allocation of FM channels is a technical matter which is beyond the scope of Congress. They praised the FCC, pointing out that the members of the Commission were fully capable of determining the solutions to the allocation problems.

The FCC questionnaire on FM manufacturing costs which had been sent to all manufacturers stirred up critical comment in many quarters. The questionnaire asked for the relative costs of manufacturing frequency-modulation units for an 18-megacycle band beginning at 44 megacycles and an 18-megacycle band beginning at 84 megacycles. The questions were based on the 1945 cost conditions, production facilities, AM-FM combination models retailing at about $75, and receivers built to specifications for postwar. The manufacturers were also asked to state if the price difference would be the same for combination sets regardless of the price class of the set, and if the answer was no, how the price difference would vary with retail price.

Among those who criticized this questionnaire was John Shepard III, chairman of the board of the Yankee Network. In a letter to FCC Chair-





Prominent engineers consistently show their preference for Solar Capacitors. Solar pledges continued production of superior quality capacitors to merit that preference. Solar Manufacturing Corporation, 285 Madison Avenue, New York 17, N. Y.

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A TOTAL OF EIGHT ARMY-NAVY EXCELLENCE AWARDS!

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7759

man Paul Porter, he said that the questionnaire did not disclose the delay that might exist in producing the higher frequency FM sets. Mr. Shepard also said that no distinction had been made between so-called *genuine* FM sets and other types. At this writing the reports on the questionnaires have not been released. It is expected, however, that the information will be made available as soon as the allocation report is published.

THE CLEAR-CHANNEL PROBLEM is another allocation factor that has had a delay bearing on the allocation report. The decision made for FM will also develop the program for the clear-channel hearings. The report that will result from these hearings will be quite vital since many present channel allocations may be altered. The hearings will offer data on a variety of broadcast-station operation procedures including power program repeats, networks, and particularly the national service features of FM and television. In studying the allocation problems, the FCC will consider the fact that the channel structure precludes the possibility of primary coverage everywhere. Because of the number of channels available and geographic problems, primary service may be impossible in some areas. The FCC will attempt to provide coverage that will serve in as many sectors of the nation as possible.

A POSTWAR PRICE STRUCTURE for receivers, that calls for a 30% increase, was predicted by Mort N. Lansing of the specialties unit, Bureau of Foreign and Domestic Commerce. He said that because of increases in labor and material cost, receivers available in the first year after V-E day will cost 30% more than those made in 1941, for equivalent models. The sellers market which will prevail for a while will maintain this price structure. According to Mr. Lansing AM-FM postwar table model receivers will cost from $45 to $75, while consoles will sell for $100 to $350. Mr. Lansing also predicted that most television receivers will cost around $500 and more.

Examining the postwar annual volume of receiver sales, Mr. Lansing said that in the first V-E year, retail sales will come close to $1,410,000,000. In the second year the value will rise to $1,650,000,000; the third year will see a still further rise to $1,870,000,000; and the fourth year will see a slight recession to $1,430,000,000. Mr. Lansing said that several factors were considered in making these estimates: increased broadcast coverage, increased use of FM and television receivers, and general improvements in standard receivers. According to Mr. Lansing, FM will be much more important, at least for a short time, because of its more general utility. However, said Mr. Lansing, as television broadcast techniques are perfected, television sales will become increasingly larger.

Mr. Lansing believes that any tendency to approach saturation in the future will be counterbalanced not only by the improved broadcast activities, but by new services such as the citizens' radiocommunication service provided for in the recent FCC allocation proposal.

Commenting on the general postwar possibilities of the radio market, Mr. Lansing said that striking opportunities will prevail. He predicted that the radio industry will also play an important role in the development of other industries in this nation and other nations.

THE PAST FEW WEEKS HAVE SEEN surprise disclosures of many types of Signal Corps equipment, heretofore considered secret. The announcements were made by the ASF and Signal Corps units of the War Department. The ASF information was offered during a special three-day demonstration at Fort Meyer in Virginia, conducted under the supervision of General Brehon Somervell, ASF Commander.

Among many of the unusual devices shown was a radio-operated aircraft detection unit capable of spotting planes, 120 miles away. The equipment is portable and employs c.r. oscilloscopes which provide plane position. Another intensely interesting device shown was a radio detonator that can fire mines 20 miles away by simply dialing a frequency. It is said that there are over 20,000 code denominations possible. A range of 20 miles over water and about 8 on land was indicated.

The Signal Corps discussed its communications paratroop equipment in a special announcement. Three types of equipment are in use today: the well known "walkie-talkie" and the "handie-talkie" both of which are strapped to the paratrooper's side or thigh, and the third is a heavier instrument which is parachuted separately. The "walkie-talkie", weighing 35 pounds complete with batteries, is no more than 10% of the total weight which the paratrooper carries including himself when he makes his jump. Since the instrument is enclosed in a canvas case of heavy duck, completely waterproofed, landings in lakes, rivers, or streams do not affect operation. The "handie-talkie," weighing about six pounds with batteries, has been used with excellent results in organizing small battle groups and maintaining contacts with various division elements. The larger model which weighs around 250 pounds, is quite an effective transmitter and receiver. Since it offers many frequencies on which to operate, it is really more flexible than the other two instruments. This model also affords the transmission of c.w. signals, which is not possible with the other models.

(*Continued on page* 18)

★ *Utah Speakers: More than 20 million Utah speakers have been made for radio, and public address systems.*

NO GUESSWORK HERE!

The manufacture of electronic devices and radio parts is an exacting job. It's a precision job and Utah does it to a plus degree. Take the loud speaker for instance: Utah's "precision-plus" methods go 'way back to the buying of raw materials that make the speaker. They go even further.

The tools used in the manufacture of the speaker are likewise made at Utah, to Utah's specifications. You see, every single phase in the manufacture of Utah is guess-proof . . . tool making, welding, punch press, electroplating, and all the other steps, to the shipping of the final finished product. *Check, recheck, test . . . supervise* are Utah words. Here Utah workers (with Utalins* back of 'em) know their value. Know they make for "precision-plus" performance—the proof of Utah quality.

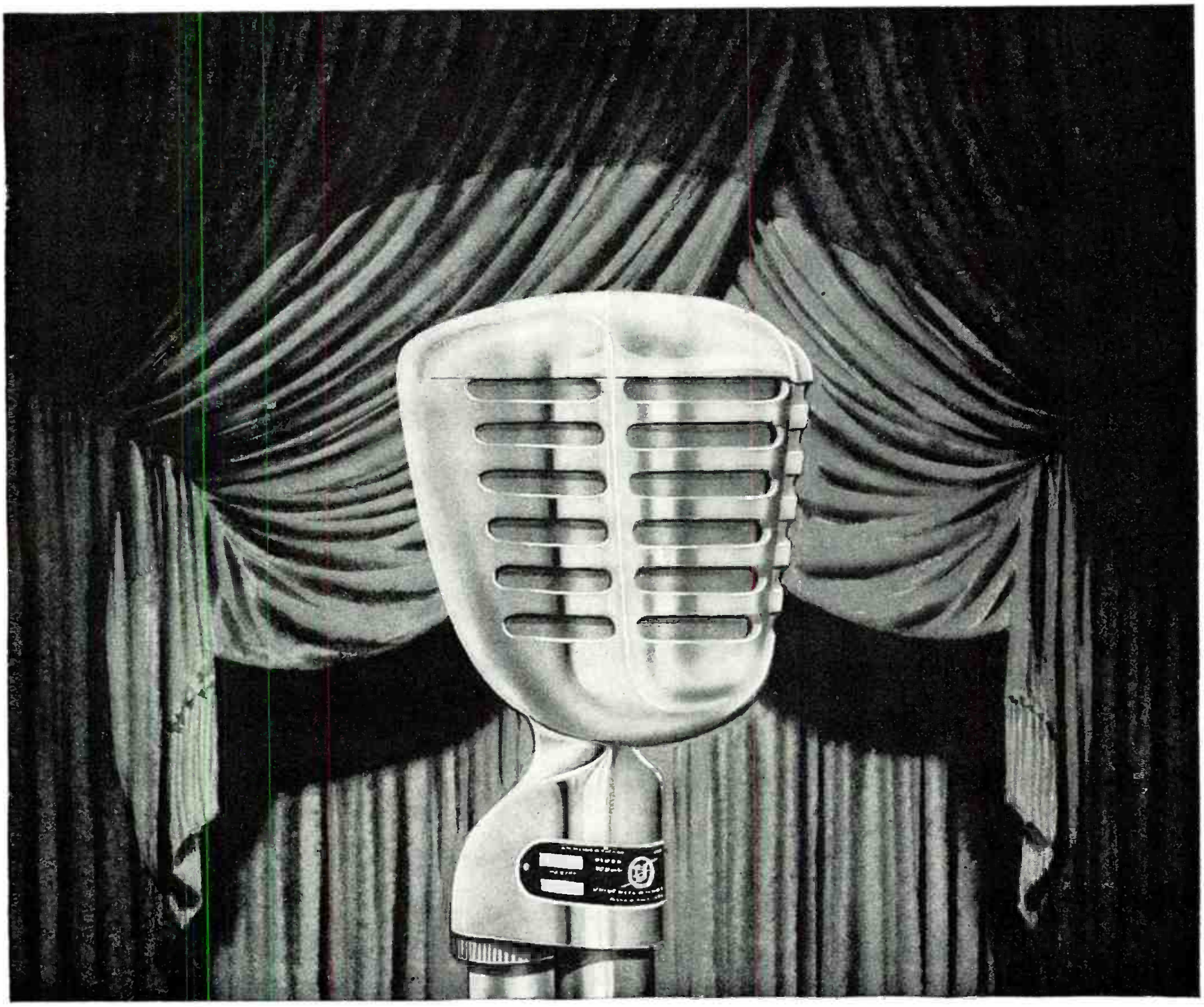
*Utah's Helpers

utah

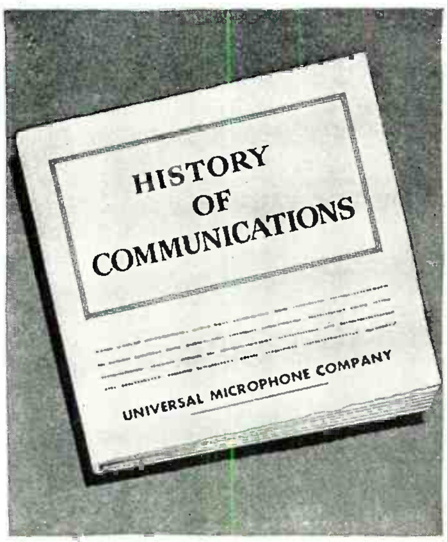
ARMY NAVY

UTAH RADIO PRODUCTS COMPANY, 820 ORLEANS ST., CHICAGO 10, ILL.

Utah Electronics (Canada) Ltd., 300 Chambly Road, Longueuil, Montreal (23) P.Q. • Ucoa Radio, S.A., Misiones 48, Buenos Aires



UNIVERSAL'S NEW D-20 MICROPHONE



The stage was set for something new and here it is. Universal's new D-20 Microphone . . . soon on your radio parts jobbers' shelves to fill your essential requirements . . . uses Universal's "Dynoid" construction . . . A dynamic microphone of conventional characteristics built to fill the utility requirements of war time plus advance styling of the many modern things to come. Orders placed now with your Radio Parts Jobbers will assure early delivery when priority regulations are relaxed.

Write for Bulletin 1458 covering this new microphone.

< FREE — History of Communications Picture Portfolio. Contains over a dozen 11" x 14" pictures suitable for office, den or hobby room. Write factory for your Portfolio today.

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

(*Continued from page* 14)

Three heavily padded cedar chests house the transmitter when it is parachuted to ground. This model is normally used for large scale operations.

RADIO RECEIVERS WILL NOT BECOME AVAILABLE IMMEDIATELY or even very shortly after V-E day, reported Frank S. Horning, Chief of the Field Service Branch of WPB, in New York recently. Appearing at a dinner in honor of Lt. Col. Arthur W. Tager, New York Regional Signal Corps Labor Officer, Mr. Horning said that many months will elapse before receivers are available. He declared that the war in Japan will demand a variety of communications equipment which will tax the facilities of most plants.

Supporting this viewpoint, Lieut. Col. Charles Ballon of the Army Service Forces said that the war in Japan may even demand an increase in material requirements. He pointed out that the ratio of needs for the Pacific and European area are nearly four to one.

WPB officials in Washington also support this view, forecasting that an Army of nearly 5,000,000 may have to be re-equipped when they are transferred from Europe to the Pacific. Several of the WPB officials said that there is little likelihood of any receivers being produced this year at all. The only possibility of production exists in the release of surplus material. Some government and private experts believe that the equipment needed for the Pacific will differ from the European type and thus provide the European material for surplus. However, the Army has not been too keen on this type of distribution.

They also feel that the equipment made for the military is of such a special design and construction that civilian application is impossible. To disassemble the military apparatus and reuse in civilian equipment, would be quite costly, according to the military officials. They point out that this practice was employed at the beginning of the war with very unsatisfactory results. Only a small percentage of the parts were usable, and the time involved in conversion was extensive and far from economical.

CONGRESS SEEMS DETERMINED to have its proceedings broadcast. Several weeks ago a proposal to broadcast not only the proceedings on the floor, but open hearings before Congressional committees, was offered by Senator Claude Pepper of Florida. This resolution supplants Senator Pepper's previous proposal introduced in the 78th Congress which did not authorize the broadcasting of proceedings of Senate committees.

In his new proposal, Senator Pepper asks for permission to install recording or transcribing equipment to provide a complete and continuous recording of proceedings. He also proposes that copies of these recordings be supplied to stations and networks requesting them, at cost price only. Senator Pepper emphasizes in his proposal that no station or network would be required to broadcast any proceeding. Provision is made in the proposal for the broadcasting of all meetings before the House or Senate, except where the meetings are not to the public interest. The arrangements for the installation of the equipment would be under the jurisdiction of the Architect of the Capitol.

THE INGENIOUS USE OF THE "WALKIE-TALKIE" as a communications bridge, linking wire lines in the Hurtgen Forest area, Western Germany, was revealed in a report recently filed by Lieut. Col. V. M. Kelly, Division Signal Officer of the Eighth Infantry Division. The link was developed to span a two-mile section from Germeter through Hurtgen to Brandenberg, which was being subjected to continuous and severe enemy shell fire. It had been impossible to lay wire circuits across country because of German observation in this area. Five days of dangerous mine sweeping to clear a path did not solve the problem either, for the line was still cut by shell fire and trouble-shooting teams were pinned down to small areas. The introduction of a radio link as an emergency channel solved the problem.

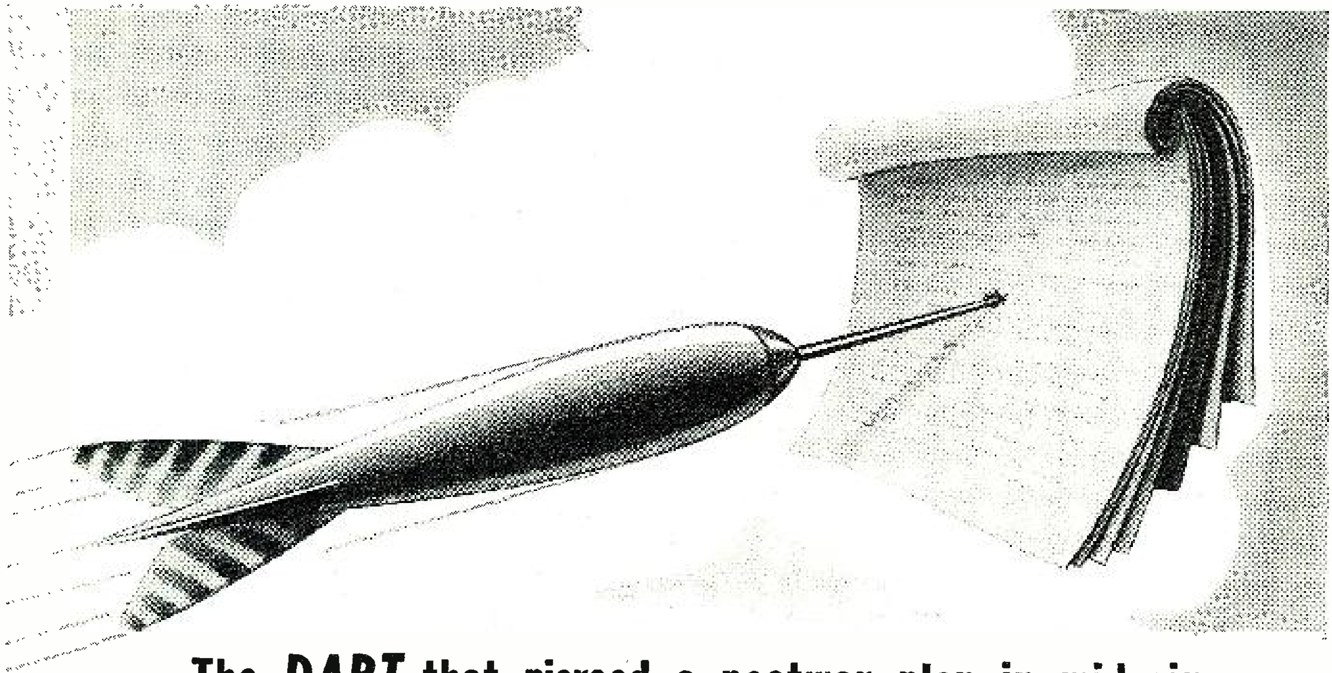
Two "walkie-talkies" were used at each end of the gap to provide a single-talking circuit connecting the ends of the wire link. Of the two radio sets, one was used for reception and the other for transmission. Separate channels were used to prevent interference.

Describing the use of this system the report said that when wire communications failed, operators stationed near each terminal turned on both transmitter and receiver and made the necessary contact. The equipment was located in an elevated position near the switchboard or test station. When the operator heard a party called from the other side of the radio link, the board was cued and the operator was given the necessary number of exchange desired. Since the circuit was a radio link, extreme caution was exercised during conversation. Coded messages and other Signal Corps intelligence methods of communication were applied.

A HISTORIC MEETING of officials of the United States and Canadian Radio Manufacturers Association was held at Montreal during the end of April. Discussed was the war production of radio-radar equipment here and in Canada, and the corresponding use of cooperative programs to expedite such production.

Among those who attended the meeting were Major General William A. Patterson, Chief of the Procure-

(*Continued on page* 136)



The DART that pierced a postwar plan in mid-air

Coming in to work on the bus each morning, the man read his newspaper. This morning was no exception. And he smiled to himself as he read the headlines. *Americans Hammering Germany from the West . . . Russians Closing In from the East.* That sounded good. The war would soon be over . . .

As he put away his topcoat and hat, the feeling of satisfaction clung to him. ". . . well, soon as we lick Germany . . ." and he mentally surveyed his own postwar plan.

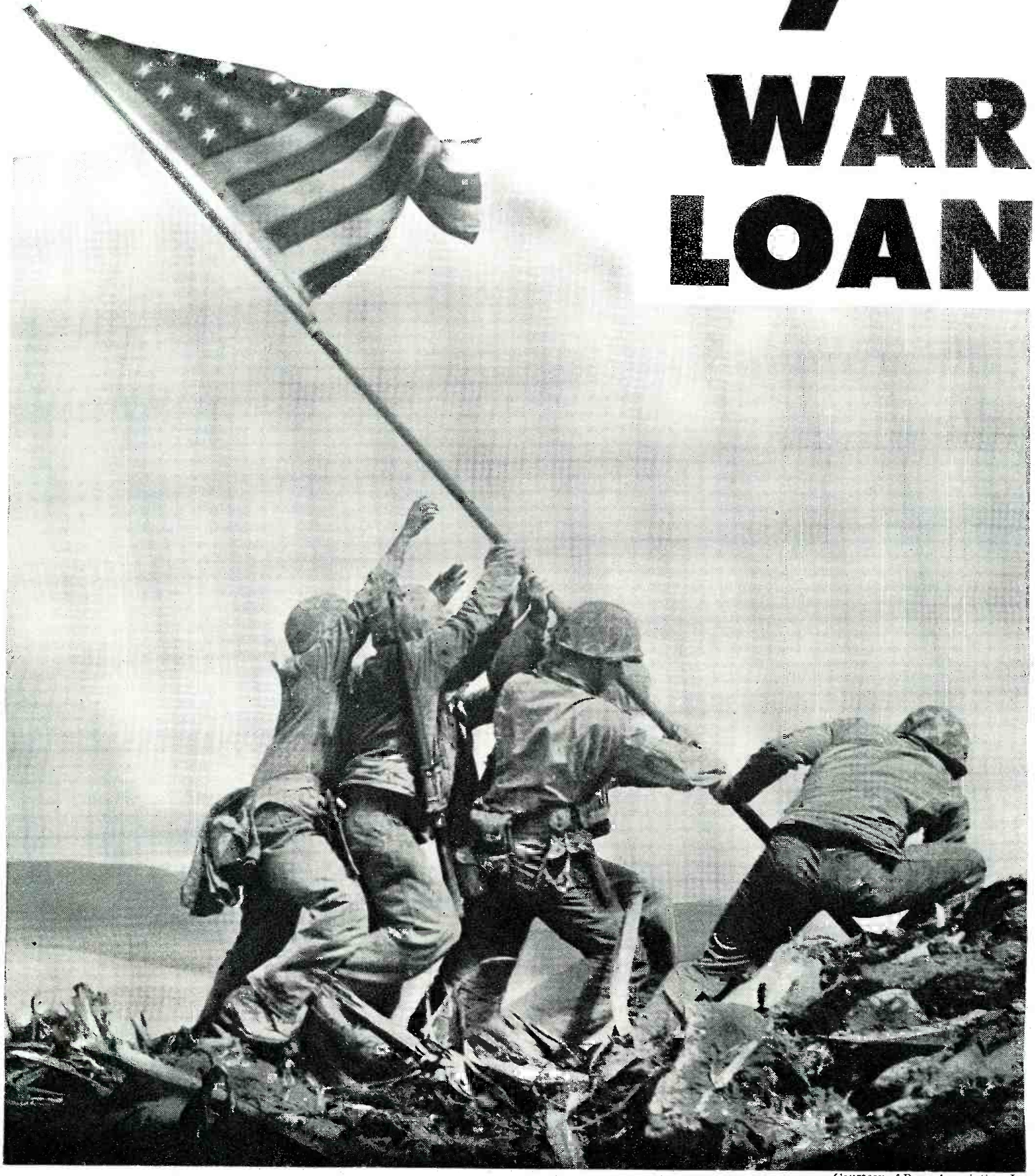
Even at noontime, when the people of the plant were to be addressed by a young veteran just back from the Pacific, the man was still optimistic. He listened attentively to the stories of brave men and strange lands.

- The khaki-clad youth told his audience about the islands and the jungles and the mountains . . . about fighting and living conditions.
- Calmly, he spoke of the basic nature of the Japanese . . . how they are taught that it is an honor to die for the Emperor . . . and why few Japanese soldiers have ever surrendered.
- And he told of the resentment among many of the men in the Pacific area about the feeling at home that the war would be over—as soon as Germany was defeated. If that was so, why did hell break loose around them every day?

To the man who had smiled at the headlines that morning, these words were the dart that pierced his postwar plans in mid-air. Of course, he had always been conscious of the fact that we were fighting Japan. But that seemed a matter of cleaning up details . . . and good old MacArthur would take care of them. But now, he wasn't so sure. And he began to think. There was more to go, he reflected solemnly, much more to go . . .

There are many people like this man . . . people who are tempted to forget that Germany's defeat won't mean the end of the war. Military authorities predict that the fight with Japan will be a long, painful struggle . . . perhaps more costly than any we have yet experienced. This, then, is no time for rejoicing. Final victory will be a hard-earned commodity purchased only by consistent working, fighting, sacrificing.

Get Behind THE MIGHTY 7TH WAR LOAN



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MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

The Future of U.H.F.

The u.h.f. region will become of utmost significance in providing channels for many miscellaneous services.

By A. LEON LADEN
London, England

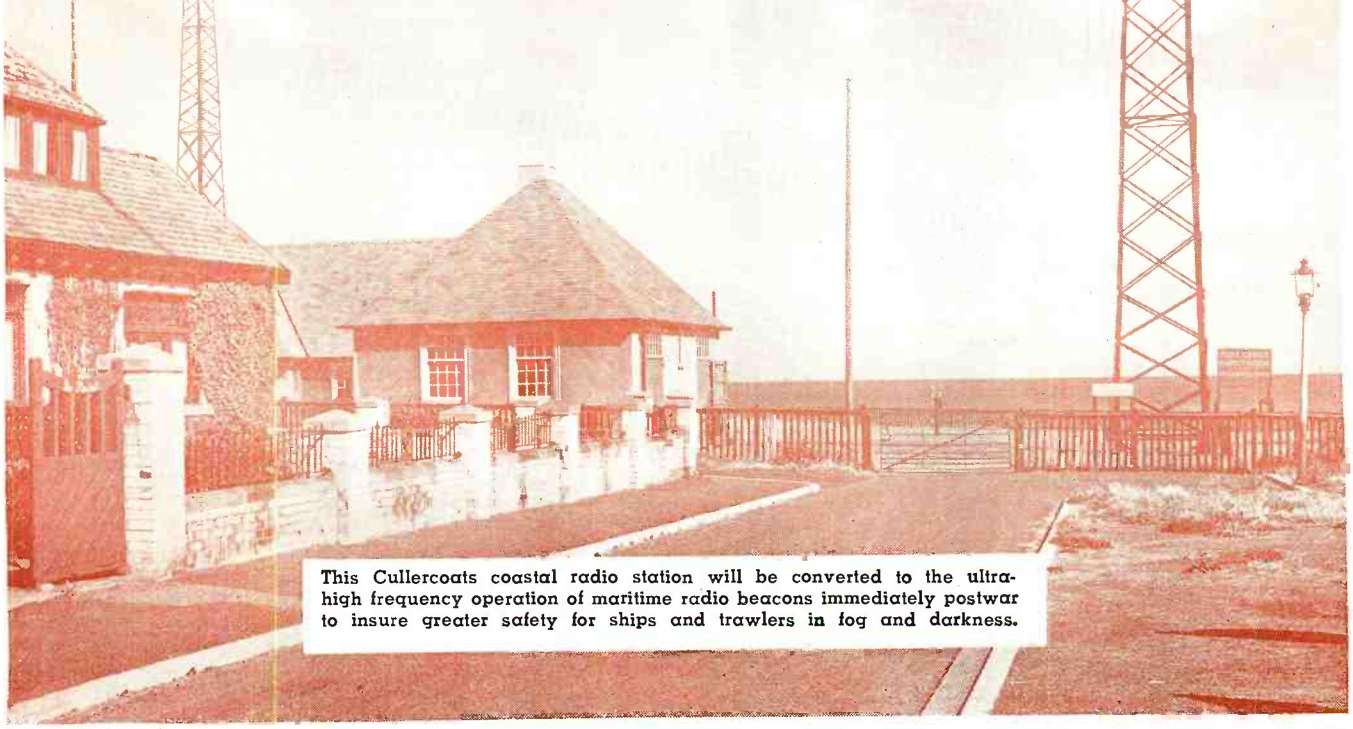
LOOKING at the electromagnetic spectrum chart comparatively simplifies the difficult task of forecasting with any reasonable degree of accuracy the role the higher frequencies are destined to play in the future. It shows the saturation reached in the traditional regions of the radio spectrum and indicates that any future expansion must logically proceed along stereotyped lines and follow the same upward course in the utilization of the metric, centrimetric and millimetric bands as was followed previously in the exploitation of the long-, medium-, and short-wave bands.

Moreover, the u.h.f. and microwave bands are ideally suited to meet the channel space requirements for the progressive relocation of existing familiar radio services congested on lower bands and the accommodation of legitimate new services without jeopardizing the scope or volume of tomorrow's brand-new services.

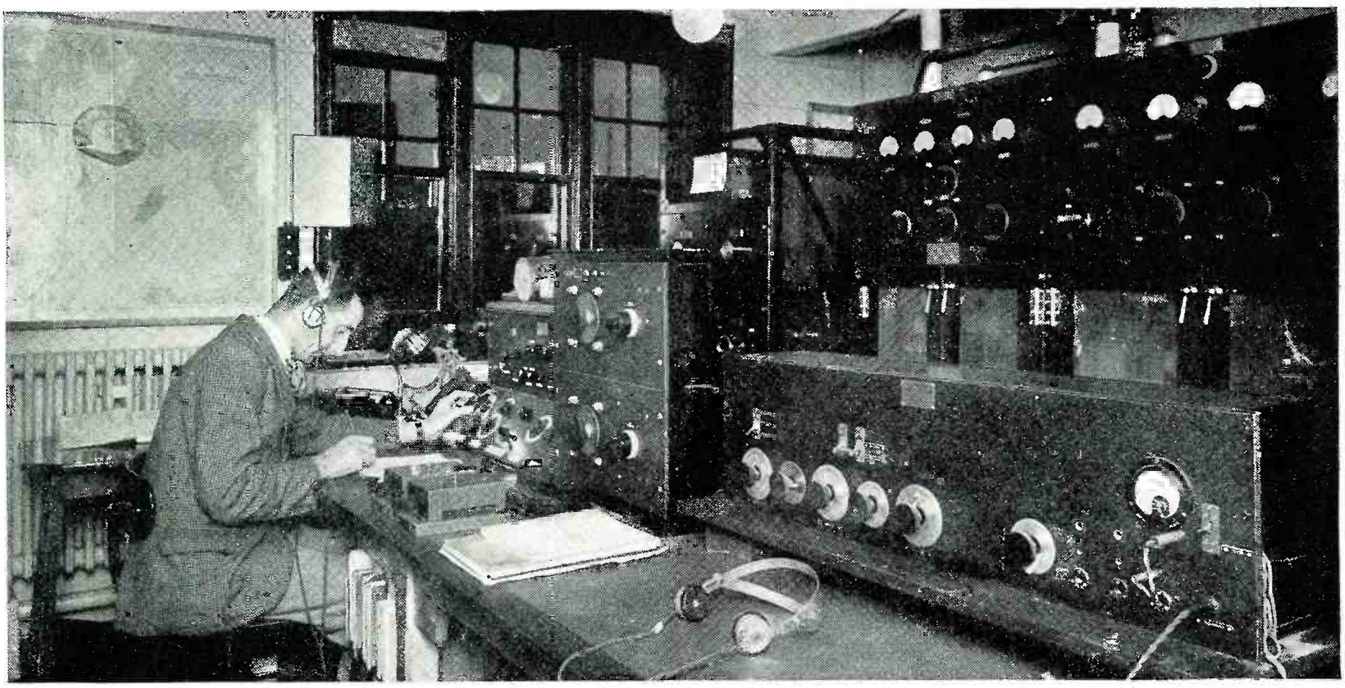
Conditioned by improvements in equipment and developments in operating techniques, infiltration into these bands will provide many times more frequency channel space than used at present by all the radio stations in the world or needed for some considerable time to come.

An idea of the prolific fertility of the meter and decimeter bands alone can be gathered from the fact that the span of frequencies extending from 30,000 kc. or 30 megacycles, corresponding to 10 meters, down to 3,000,000 kc. or 3,000 megacycles, corresponding to 10 centimeters, can accommodate the enormous number of 297,000 stations at the present rate of elbow room assigned to broadcasting stations on standard wavelengths.

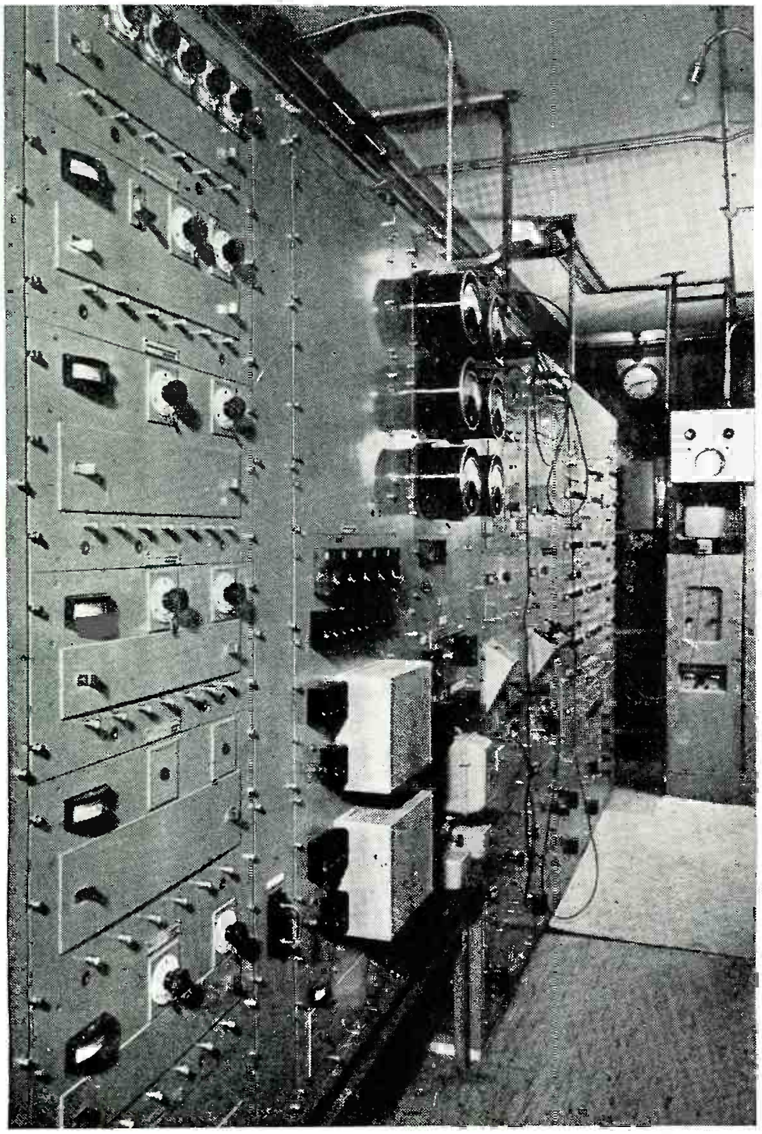
But even the frequencies contained in the ultra-high-frequency band, which can be defined as stretching from 30,000 kc. or 30 megacycles to 300,000 kc. or 300 megacycles or, ex-



This Cullercoats coastal radio station will be converted to the ultra-high frequency operation of maritime radio beacons immediately postwar to insure greater safety for ships and trawlers in fog and darkness.



This Port Patrick coastal radio station, erected in 1937, was the first in England to apply commercial u.h.f. multiplex radio-telephony.



Studio control room in the BBC's television station, London.

pressed in wavelength, from 10 to 1 meters, is impressive enough and can yield 1485 channels, each 200 kc. in width, for frequency modulation or 49 channels, each 6 megacycles in width, for television.

Nonetheless, the distribution of frequency bands for use by various services between various countries is extremely complicated and the devising of workable schemes of frequency allocation is not solely governed by mounted radio progress in the sparsely-occupied or barren regions of the electromagnetic spectrum.

Apart from a variety of technical considerations it must, necessarily, depend to a large extent on international good will and co-operation.

The very-short waves are neither as immune from interference nor as limited in radiation as sometimes assumed.

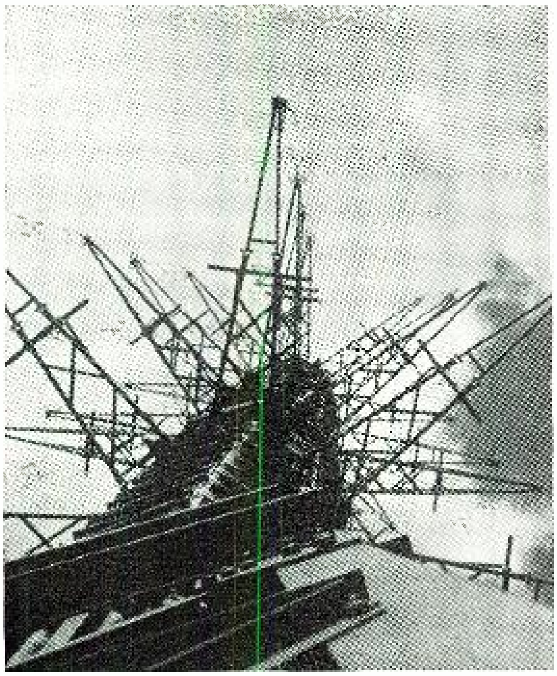
The effects of diffraction and ionospheric refraction can extend the service areas of transmitting stations operating on quasi-optical wavelengths enormously by returning signals to earth at distances up to thousands of miles.

(It is claimed that prewar BBC television transmissions radiated on a carrier frequency of about 40 megacycles, i.e. 7 meters in wavelength, from the London station covering nominally an area of some fifty miles, were received in South Africa and in the middle of the United States.)

But even on purely optical frequencies quickly absorbed by the water and carbon dioxide in the air, some international agreement will be necessary to avoid severe interference from radar, navigational, industrial, and similar equipment.

Undeniably, therefore, the distribution of frequency bands in Europe, based on the allocations as revised at the International Telecommunication Conference held in Cairo in 1938, is totally out of date and inadequate, as no provision was made at the time for police, aeronautical, radio beacons and direction finders, frequency modulation, or facsimile (which all have a place in the allocations agreed upon at the Santiago Conference in 1940 for use in the Americas).

Before the war, too, only the U.S.A., England, France, and Germany ran television services and the exploitation of u.h.f. for broadcasting, communication, and other services was very limited in scope of application.



BBC's omnidirectional vision transmitting aerial array.

It is reasonable to expect wartime radio progress to have contributed, moreover, materially towards enhancing the prospects of various countries claiming u.h.f. allocations for stations post-war, especially since a huge radio-engineering capacity will be available and skilled labor awaits employment.

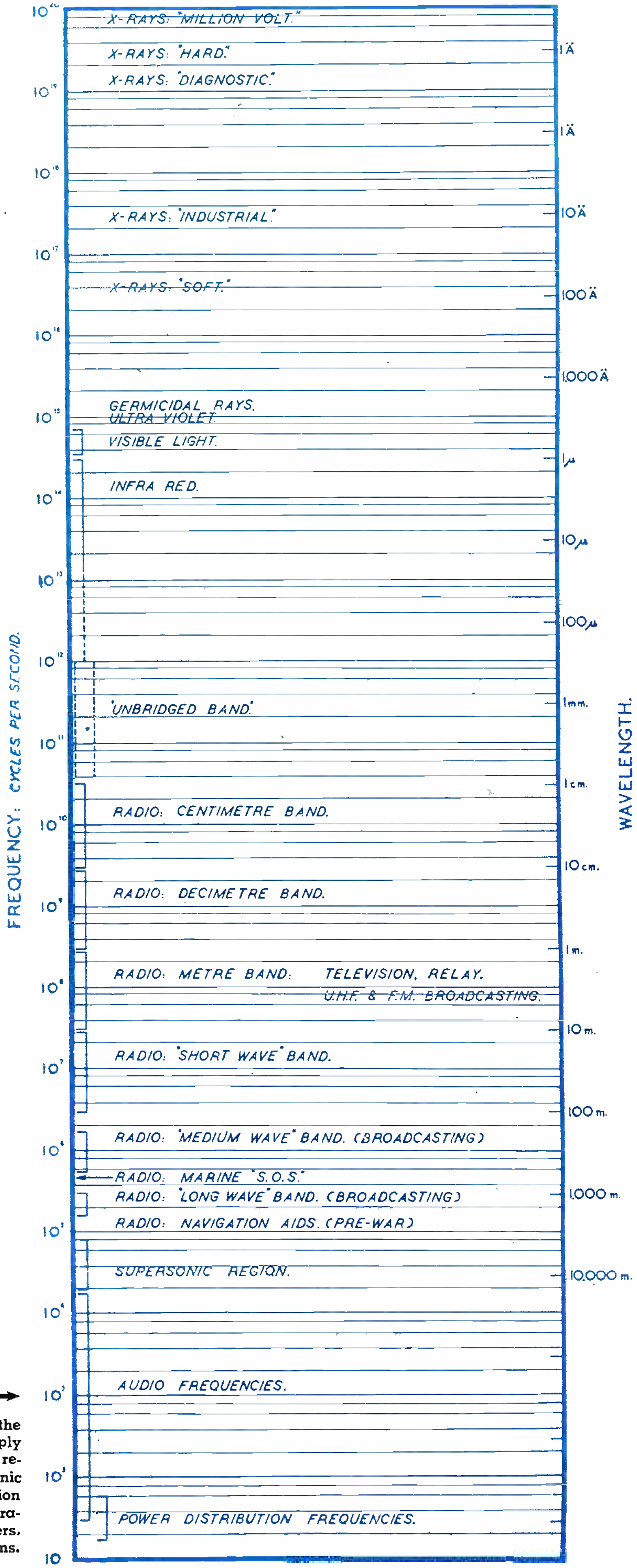
No one can, of course, prophesy future development but it can be envisaged that the internationally constituted governing body which will be set up at the next Telecommunication Conference to lay down requirements of radio governance throughout the world on a revised basis is bound to favor a framework of u.h.f. allocations schemes integrated as a constituent part into a general worldwide radio organization.

The vast spectrum area will be replanned and subdivided and radio services moved about as pawns on a chessboard to balance within the great pattern of a master plan.

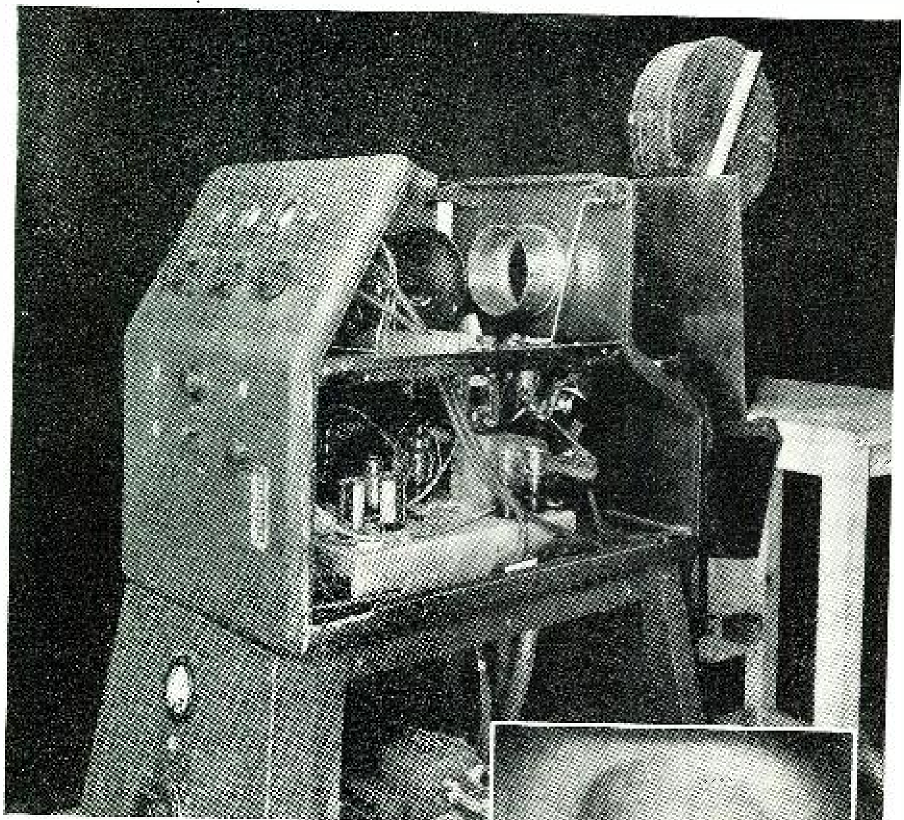
To facilitate discrimination, frequencies will probably be allocated in separate latitudinal and longitudinal bands on a global scale to countries grouped into regional zones bounded by natural and geographical limits.

Certain specifically defined groups of frequencies may well be reserved for international traffic and assigned to geographically-spaced-out, internationally-controlled, fixed units located in "free zones" or international civil aviation centers for operation on shared basis. Such an arrangement would ensure, throughout the world, standardized navigational aids, airport control, services for aircraft in flight, radio beacons and direction finders, press traffic, and certain other services.

Another group of frequencies might be assigned to fixed stations catering for countrywide distribution and include military, governmental, broadcasting, communication, and other services designed for internal consumption.



The spectrum utilization chart, reproduced through the courtesy of the British Institution of Radio Engineers, amply evidences the saturated state of the traditional frequency regions. It also indicates that progressive radio and electronic development is bound to necessitate increasing infiltration into higher bands and inaugurate the era of the ultra-short-waves. The wavelength units indicated are meters, centimeters, millimeters, microns (μ), and ängstroms.



John L. Baird's facsimile television apparatus, his latest invention, consists of a spool holding a roll of sensitized cinematograph film which is passed continuously in front of a gate upon which is focused the image of the television pictures reproduced upon the screen of a cathode-ray tube. Pictures are reproduced at the rate of 25 per second and each picture is thus photographed upon the continuously-moving film in 1/25th of a second. At the right is shown the first photograph transmitted by this equipment. It is made up of 200 lines; however, the number of lines can be increased to produce any desired picture quality.

Yet another group of frequencies could be allocated to fixed or mobile units for services exclusively restricted to local needs such as county, educational, police, fire, alarms, etc., making it possible to repeat channel assignments at close distances permitting more stations to operate on fewer radio channels.

U.H.F. and FM Broadcasting

Shared channel working is bound to facilitate multiplication of channels for ultra-high-frequency services comprising sound, vision, and other complementary or independent services in their initial stages of development.

High fidelity FM sound services reducing the level of every type of interference and providing noise-free and static-free reception will form an integral part of these u.h.f. services and replace in time common types of modulation.

Programs will be transmitted from stations with power outputs ranging from 50 kilowatts down to 5 kilowatts giving coverage over considerable distances free from mutual interference and overlapping between stations, the actual range, of course, depending on the nature of the terrain.

For example, Great Britain and Northern Ireland will probably have about twelve stations, separated on the average by less than 150 miles, to cater for the London and more populous districts in the Midlands and Northern and Southwestern areas.

Distribution to areas with dense populations will be by coaxial cable networks giving shorter maximum operating range than broadcasting stations on standard wavelengths but improved signal-to-noise ratios.

To reduce program cost-per-listener and extend territorial coverage to less populous areas, however, closed line distribution will be discarded in all probability as too cumbersome and expensive (coaxial cable costs about $10,000 a mile to install) and open aerial transmission used instead. In the course of time, this twin system of diffusion will assume countrywide proportions ensuring almost 100 per cent coverage.

Reception of FM programs will take place on low-priced automatic frequency-controlled sets of increased dependability and performance efficiency but decreased in size, containing a minimum amount of metal and fitted with a series of tube devices, brought down from the academic to the mass-production level, governing oscillation and amplification to a much greater degree than possible with conventional tube structures.

Cabinets will be made of smooth-faced, highly polished plastics without sharp corners and knobs laying flush with the streamlined body.

But the introduction of FM will not necessarily make obsolete conventional type sets; wavelength converters will enable such receivers to operate on the higher frequencies.

Television

Television will undoubtedly present a far more difficult problem than u.h.f. and FM broadcasting as very wide sidebands are essential for fidelity in the reproduced picture and the width of the band that can be transmitted increases as wavelength is shortened.

It may be anticipated, therefore, that the keynote of the television services of the future will be interchangeability. Related to the transition characteristics of the heights and densities of the ionized layers altering under the influence of solar radiation, such services will be capable of short-, medium-, or long-distance operation throughout the space of the year, irrespective of erratic conditions with average suitability.

525-line monochromatic services operating below 100 megacycles will probably be established first of all as part of the countrywide u.h.f. networks; the video portion of the distribution system connecting subscribers living in blocks of flats, housing estates, dormitory suburbs, and built-up areas directly with the transmitting stations as well as distributing to the remoter rural areas in the same way as the audio portion of the network.

The pattern of future television developments, however, will be determined by migration to higher frequencies called for by the lack of adequate channel space and the requirements of improved services of wider video bandwidth for color television.

The 300-500 megacycles or 500-1,000 megacycles regions will probably ultimately become the permanent home of television with definition of order of 1,000-1,500-lines, vision bandwidth up to 20 megacycles and the transmission of audio and video signals on the same wavelength.

Multipath distortion of pictures in transit, secondary images, and other "ghosts" will be eliminated completely as transmissions on these frequencies will be too high to be refracted by the ionospheric layers or interfere with other stations on same channels.

The practical difficulties associated with efficient operation with sufficient power output on increased frequency

(*Continued on page* 142)

Practical RADAR

By JORDAN McQUAY

Presenting the basic technical principles of the most outstanding development of this war—radar. Additional information on this subject will be published as censorship restrictions are lifted.

THE veil of secrecy has been lifted.

Now, for the first time, some of the basic technical aspects of radar may be discussed openly—in books, magazines, newspapers—and the secrets of this scientific discovery made known to everyone.

Millions of words will pour from the printing presses of the nation, screaming the wonders of radar in high-flown phrases and press-agent adjectives. Meaningless and long-winded attempts to explain the technical operation of radar already have made their appearance amid the general clacque and fanfare.

But what are the *practical* facts about radar? Stripped of all its tinsel and ballyhoo, what are the practical uses of radar equipment? What are the important fundamentals of radar theory and technique that concern the average radioman: the amateur, the experimenter, the radio serviceman, the businessman, the manufacturer?

This is the first article of a series on the basic principles of ultra-high frequency, of which radar is one. The basic concepts presented here will be developed further in future issues of RADIO NEWS covering, within the limits of Government security, the practical aspects of radar theory, technique, and operation—the practical things about radar, the things which you, the radio serviceman, the experimenter, the businessman should know.

The economic importance of radar should never be minimized. Today it is a major industry, but radar has an even greater postwar future. With the signing of peace, radar and aviation will experience jointly an industrial boom of revolutionary proportions. There will be an unquestionable need for trained and qualified personnel!

Here you will be provided with a complete and comprehensive education in the technical principles of radar—an education comparable in scope and thoroughness to the priceless training heretofore given only Government personnel.

Here, then, is the story of radar for the average radioman, the amateur, the experimenter, the serviceman, the businessman. Here is the story of *practical* radar for men with an eye toward the electronic future!

We have come to think of a radar set as a unique and very mysterious thing, an individual piece of secret apparatus performing miraculous feats of location. Actually there is

(ED.—*A pulse of high-frequency radio energy, timed and shaped by precision electronic circuits, is flung into space. It travels with the speed of light until it strikes some interfering object—an airplane, ship, or coastline—and then bounces back, rebounds to a receiver, all within a few millionths of a second! But in those few microseconds we know of the existence and exact location of the airplane, ship, or shoreline. For this is radar, the miracle of modern science; the greatest technical discovery of the war!*)

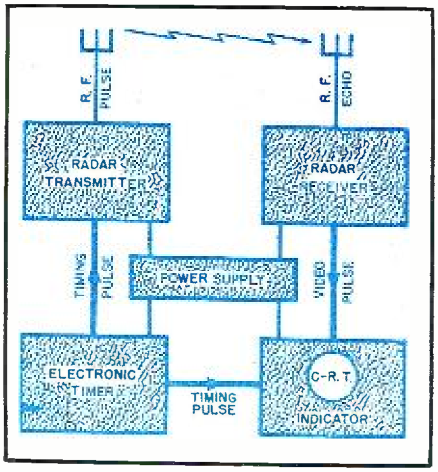


Fig. 1. Basic block diagram of a radar set. Although many types of radar equipment are in use, they all operate on the same basic principles.

nothing singular about a radar set. It consists of many units, many circuits, many separate components—all involving principles of electricity, high-frequency radio, electronics, optics, and physics.

And there are many types and kinds and sizes of radar sets, from the tiniest of the ultra-secret "black boxes" installed in bombers to the massive equipment weighing several tons, used for defending our coastlines.

Why all these sizes; all these kinds of radar sets?

Each for a specific purpose, each radar set designed for obtaining certain types of information.

The most common use of radar is in the protection and defense of shorelines, ships, and military or naval installations. Transmitting a protective screen of radio energy around an installation or area, it is impossible for enemy planes or ships to attack without being detected long before their actual arrival — regardless of bad weather or darkness. Thus, cities, islands, and entire coastlines can be forewarned of enemy attacks, artillery and searchlight crews can be alerted, and our own fighter planes can take to the air and meet the enemy in battle long before the enemy planes have even crossed the horizon.

But radar's job is not over when the enemy ship or aircraft has been detected and located. Radar is used to aim our naval guns, coast artillery, and anti-aircraft guns with almost infallible precision. Radar-controlled searchlights can follow enemy aircraft automatically.

Much of the credit for the defense of Britain during the German blitz was due to the use of thousands of radar sets, installed at every anti-aircraft and searchlight battery in England! In 1941 larger components of the Italian fleet were sunk in the Mediterranean in pitch darkness by radar-directed gun batteries aboard British cruisers. The famous *Scharnhorst* was destroyed by radar-controlled gunfire from battleships at an incredible range of many miles. In the Pacific many of our great naval victories over the Japanese fleet were due to radar control.

But the use of radar equipment is not restricted to land or shipboard installations. Airborne radar sets perform even more incredible feats of accuracy in detecting and locating other aircraft and ships at sea, and in directing the fire of aerial cannon.

Radar is used extensively aboard large bombing planes. One type of radar set sketches an accurate pictorial outline of the terrain over which the plane is flying—even when the surface of the earth is hidden by darkness or clouds. Other types of airborne radar sets are used in fighter planes to track down enemy night bombers, and radar is used by patrol aircraft to search for enemy vessels.

Since specific objects can be located by means of radar, the radar sets are in themselves a form of navigational aid. When objects such as shorelines or mountains can be recognized, the movement of the aircraft or ship can be guided accordingly. As a further aid to navigation, radar beacons are employed to guide aircraft and surface vessels. And still another form of airborne equipment, radar altimeters, is used to measure the exact height of a plane above the earth's surface.

These are only a few of the many uses of radar. Many cannot be discussed until after the war. But all of them—including the most secret—have a common virtue: their dependability of operation *in all kinds of weather and in darkness.*

A Complete Radar Set

Despite the large number of types of radar equipment and the many methods of tactical employment which we have discussed, it is significant to note that *all* radar sets operate on the same basic principles, the same fundamental theory. There are, of course, minor technical differences between a set designed to control gun-fire aboard a battleship and a set designed to detect and locate enemy aircraft in forward combat areas. But basically, all types and kinds of radar sets may be reduced in theory to the simple block diagram shown in Fig. 1.

A complete radar set consists of a radar transmitter and transmitting antenna, a radar receiver and receiving antenna, a synchronizing device known as an electronic timer, and a *visual* means of recording the information obtained by the rest of the radar set.

The radar transmitter is capable of generating extremely high-frequency radio waves in short *pulses,* or "wave trains" of energy, which are radiated into space by the transmitting antenna. The transmitter does not operate continuously, but is switched on and off thousands of times per second by means of the electronic timer.

The recurrent pulses of radio energy are radiated by the transmitting antenna in a narrow beam in any desired direction. An object or target within range of the radar set will reflect these r.f. pulses, a portion of the reflected energy returning to the set in the form of echoes. The echo signals are picked up by the receiving antenna and passed to the radar receiver where they are detected and amplified. The echo signals are then displayed on a cathode-ray tube indicator.

By computing the time required for the original r.f. pulse to travel out, strike the target, and then return to the radar set, it is possible to determine the distance from the radar

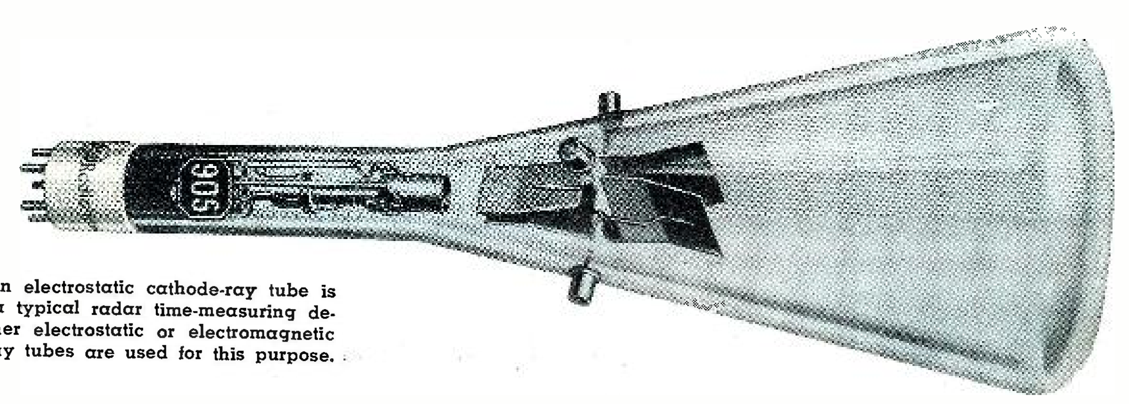


Fig. 2. An electrostatic cathode-ray tube is used as a typical radar time-measuring device. Either electrostatic or electromagnetic cathode-ray tubes are used for this purpose.

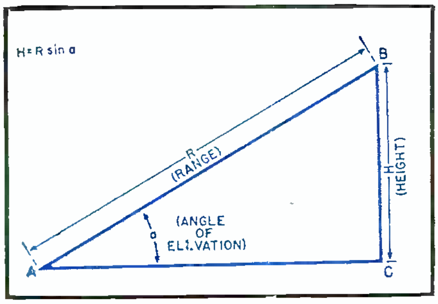


Fig. 3. Radar equipment determines R and the angle of elevation. With these two values known, the exact position of any object can be determined accurately.

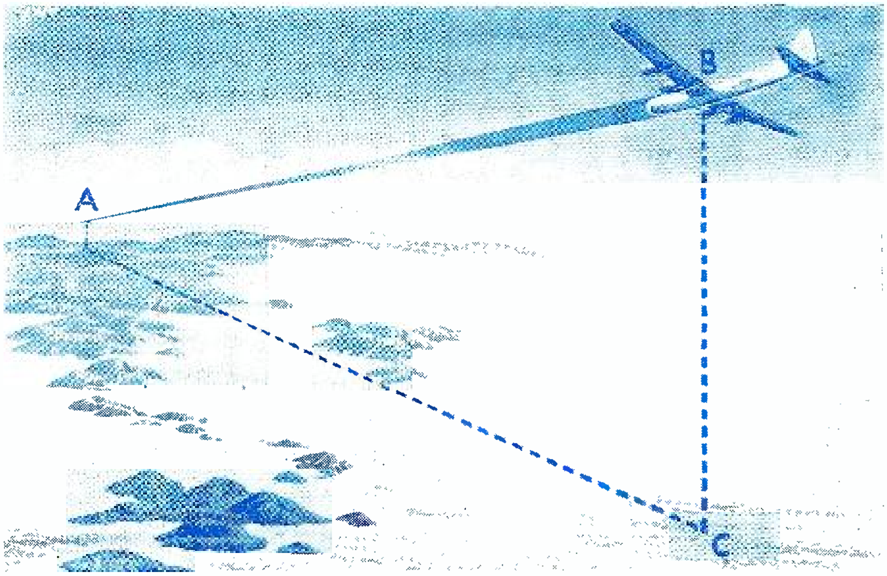


Fig. 4. The radar beam, when striking the plane, returns in the form of an echo signal, determining the exact position of the plane. Line-of-sight is essential, and trees, mountains, etc., will similarly produce echo signals. Drawn by RADIO NEWS' staff artist, Joe W. Tillotson.

equipment to the target. Shortly we shall see how this is accomplished in detail, by means of intricate electronic circuits capable of measuring time in millionths of seconds and then translating the result into terms of distance.

The precise timing, production, and radiation of r.f. pulses is known as *pulse modulation*—a fairly new radio-electronic term destined to one day become as common as frequency modulation, for *pulse modulation* is the key to the secret of radar, the basis of operation of one of the most complicated high-speed measuring instruments ever devised by science: *radar.*

But strangely enough, the fundamental principle underlying pulse-modulation radar is relatively simple and as uncomplicated as the principle of sound echoes or sound-wave reflection.

Analogy of Sound Waves

The sound of a voice echo is a familiar thing. Most of us have at some time shouted toward a cliff, canyon, or smooth wall, and heard our shout "echo" from the reflecting surface.

What actually happened, of course, was that sound waves generated by the shout, travelled through the air until they reached the cliff or smooth surface. Then the sound waves were reflected, part of them travelling back to the person who shouted.

Not all of the original sound waves returned. Most of them were reflected in other directions, a few of them may have been absorbed by the cliff or wall. Thus, the echo that came back to us was always weaker than the original shout.

But, regardless of its strength or intensity, a sound wave always travels through space at about the same rate of speed: 1100 feet per second. Thus, a given amount of time elapses between the instant a sound is originated and the instant a reflected echo is heard. This time interval will be

(*Continued on page* 84)

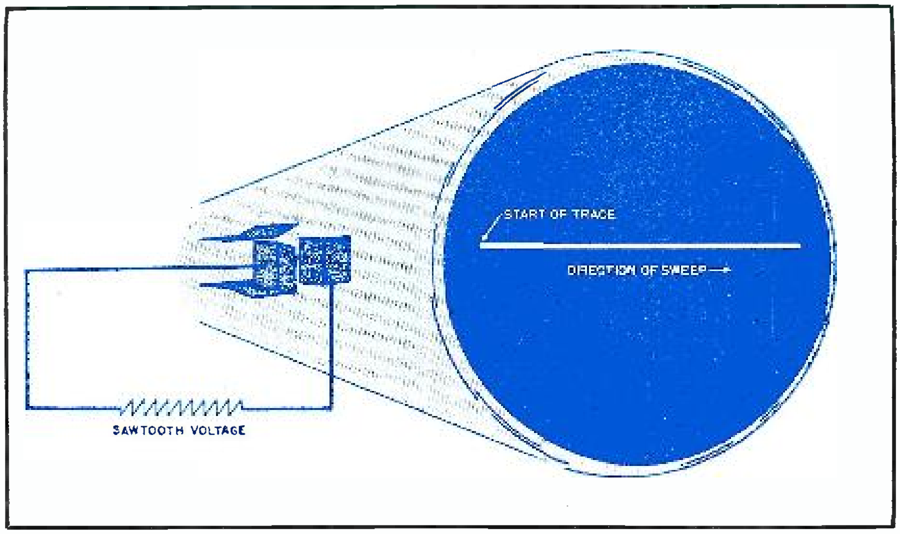
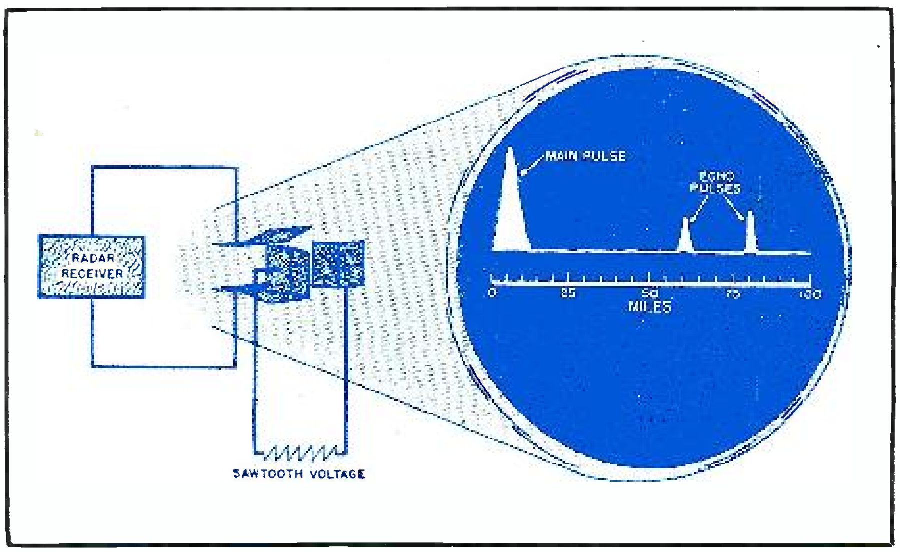


Fig. 5. Radar oscilloscope with only a time base. A sawtooth sweep voltage is applied to the horizontal deflecting plates of the oscilloscope, creating a linear and horizontal time base across the screen of the 'scope.

Fig. 6. Typical radar oscilloscope. The vertical plates of the cathode-ray tube are connected to the radar receiver. All echo signals detected by the receiver will be displaced on the oscilloscope and appear as vertical deflections.



MAGNETIC TAPE RECORDING

By

CARL E. WINTER

Resümé of the development of magnetic tape recording and a description of a modern recorder of this type.

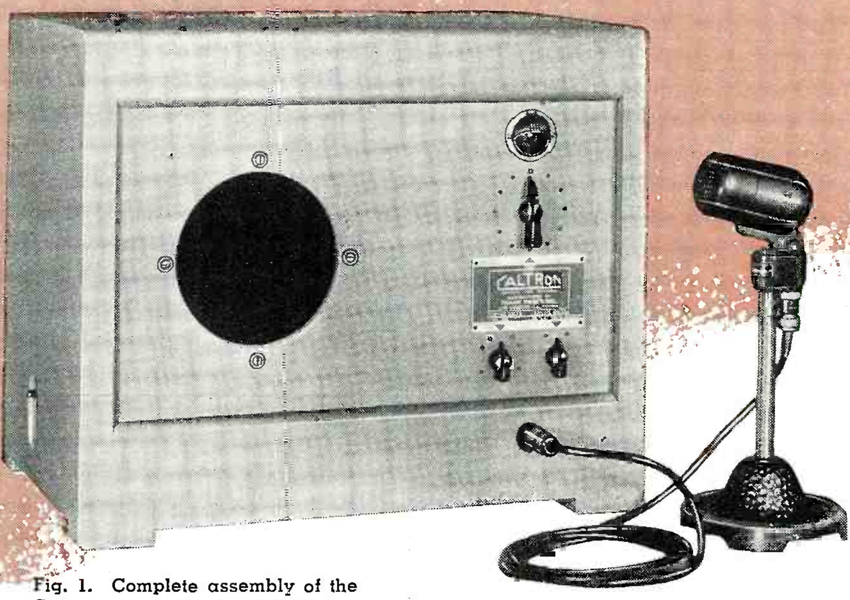


Fig. 1. Complete assembly of the Caltron magnetic tape recorder.

ALMOST a half century ago Victor Poulsen, well known in his day as a conscientious investigator of electronic phenomena, developed a method of magnetically recording speech upon steel wire. But it was not until scientific advances overcame some of the limiting factors encountered by Poulsen and his associates, that magnetic recording was able to take its proper place among the electronic equipment which is doing so much to speed the war's end.

The principle upon which Poulsen founded his "telegraphone" remains the basic principle used today in the several types of magnetic recorders. Essentially, his method was to draw a steel wire rapidly past a pair of pole-pieces surrounded by coils carrying the electrical components of audio speech impulses. Variations in these speech currents would impress a corresponding magnetic pattern upon the wire, and when the wire bearing this magnetic pattern was again drawn past the pole-pieces, a current, corresponding to the variations in the original speech current, would be re-induced in the coils surrounding the pole-pieces, and utilized for audio reproduction.

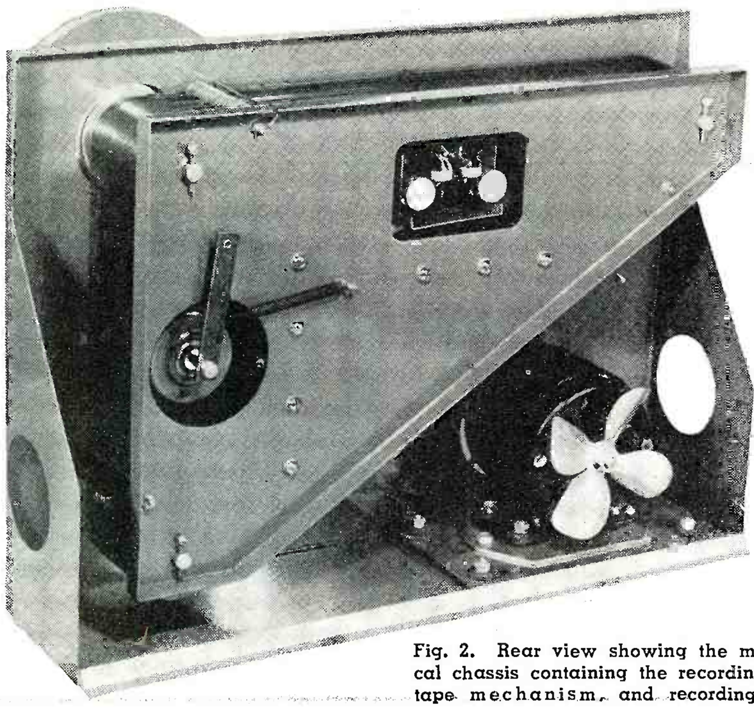


Fig. 2. Rear view showing the mechanical chassis containing the recording tape, tape mechanism, and recording head.

Recording Mediums

Steel wire was usually used as a recording medium in the earlier types of magnetic recorders. During its travel past the pole-pieces, the steel wire would tend to rotate about its axis, thus constantly altering the relationship of the wire's magnetic pattern to the recording and reproducing pole-piece faces. To minimize distortion occasioned by this effect, the recording and reproducing pole-pieces were placed rather far apart. This however, then made it necessary to draw the recording medium past the pole-pieces at a very high rate of speed in order to record and reproduce the higher audio frequencies which do not exert too definite current variations upon the coils surrounding the pole-pieces. Thus, excessive speed of the recording medium's movement became of primary importance.

In Poulsen's time this fact presented mechanical difficulties which were hard to overcome. The steel wire traveling past the pole-pieces at high speed soon wore the pole-piece faces away. Also, it was almost impossible to construct pole-pieces so that they

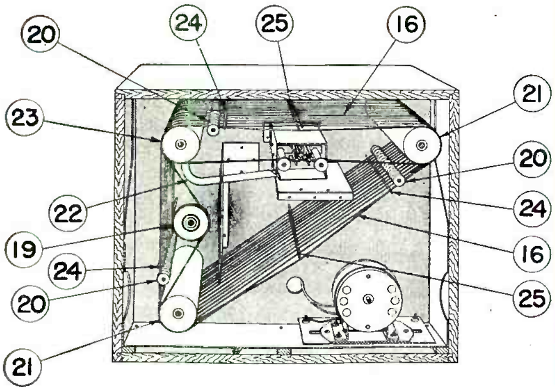


Fig. 3.

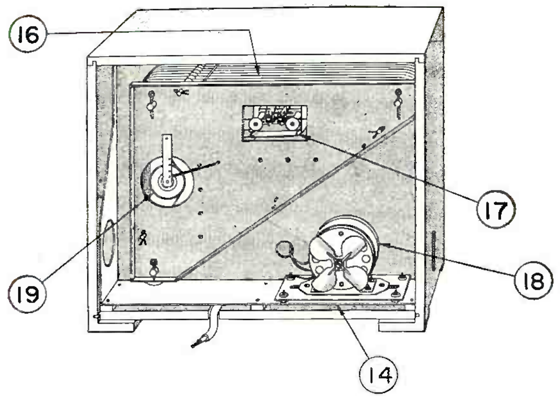


Fig. 4.

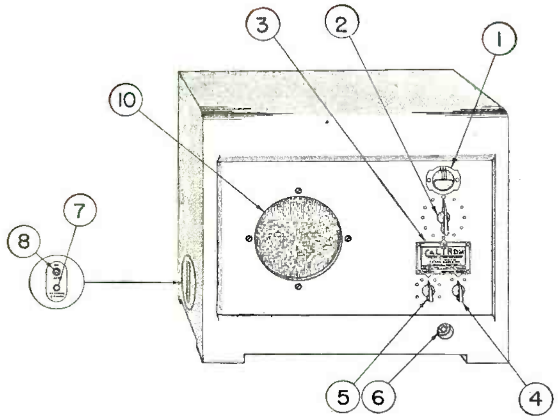


Fig. 5.

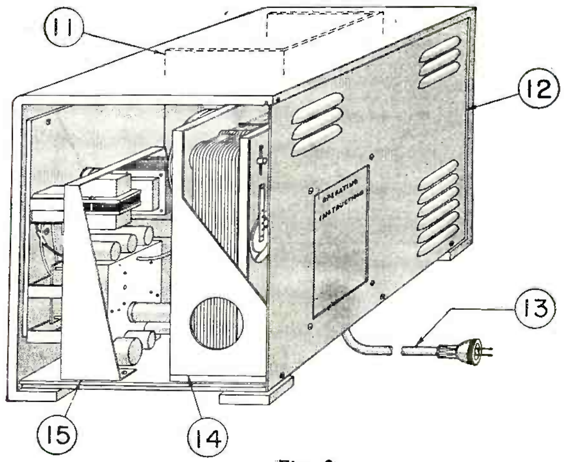


Fig. 6.

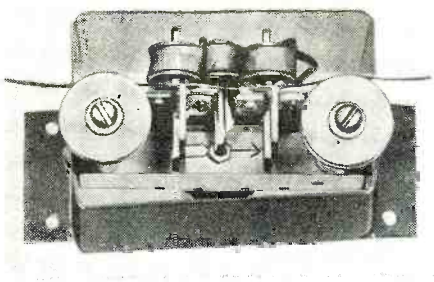
Various views of the Caltron magnetic tape recorder, showing position of all controls and component parts. Coded parts are, 1, "magic eye" indicator tube; 2, elapsed-time indicator; 3, nameplate; 4, selector switch; 5, power switch and volume control; 6, microphone jack; 7, remote-speaker phone-jack; 8, unit speaker "on-off" switch; 9, serial number plate; 10, loudspeaker; 11, speaker box; 12, back plate; 13, power input cable; 14, mechanical chassis; 15, amplifier; 16, recording tape; 17, recorder pole and housing; 18, tape drive motor assembly; 19, tape idler pulley; 20, tape spacer assembly; 21, idler drum assembly; 22, tape lubricating system; 23, tape drive drum assembly; 24, rod-guides; and 25, wire separators.

would ride securely against, and smoothly along, the wire. The tendency of the wire to rotate about its axis increased the difficulty of maintaining good contact and good contact was important for irregularities caused the magnetic reluctance of the wire's flux path to change so that the strength of the recorded signal varied and an excessive amount of noise was introduced.

In 1900 Poulsen secured a patent on the use of steel tape as a recording medium. The use of tape instead of wire eliminated many of the troublesome features of magnetic recording systems. Tape permitted the use of smaller guide pulleys than was advisable with steel wire, thus enabling over-all dimensions of recorder cases to be smaller without cramping, and without exceeding the bending fatigue limits of the recording medium itself.

Steel tape eliminated the snarling difficulties encountered with wire, and prevented the effects of the wire's tendency to rotate about its axis. Therefore, the most important advantage gained through the use of tape instead of wire as a recording medium, was that the magnetic patterns imposed upon the tape during the recording process would occupy the same position relative to the pole-pieces during reproduction. This one factor made excessive tape speed relatively unimportant and put magnetic recording well within the scope of sound mechanical design.

Fig. 7. Recording head showing magnetic steel tape passing through pole-piece contacts. The arrow between the pole-pieces shows direction of tape travel.



Advantages of Magnetic Recording

Magnetic tape recording differs from other methods in many respects. Since no processing of the recording medium is required, the record may be reproduced without delay. As the only effects upon the recording medium are electronic, the tape may be used over and over again for new records. It is only necessary to subject the tape to a strong neutralizing magnetic field to obliterate a record and prepare for another recording, and this is usually conveniently accomplished when a new recording is replacing an old one.

When temporary recordings are desired, magnetic tape recording has many advantages over other methods. It is very convenient for use where short delays in reproduction are desired, as, basically, the entire equipment is self supporting. All that is required is the tape, the recording and reproducing tone head, and audio amplifier, and the mechanical units needed to operate drive motors and other rotating components.

There are no moving parts in the modulating unit of a magnetic recorder. (The modulating unit corresponds to the cutting stylus of a mechanical recording system.) The difficulties of obtaining high-frequency response due to the effect of inertia of the cutting stylus is therefore eliminated, thus making great fidelity of reproduced tones possible.

Magnetic tape recording systems are subject to the same difficulties encountered in eliminating "flutter" which is present in other types of recording methods, but mechanical vibrations due to motor drives and other moving parts of the recording system need not be considered as they have no effect upon this purely electronic method of registering recordings.

The special alloy, high permeability steel tape used in modern magnetic recorders cannot be easily scratched; may be handled and exposed to any kind of light, and subjected to large temperature variations without decreasing its efficiency or adversely affecting it in any way. When the tape is properly wound and securely fixed in its operating position, it is not liable to damage or breakage during transportation of portable equipment.

The greatest demand for magnetic tape recorders is for use as training devices. In schools and veterans' rehabilitation centers, they record, for immediate analysis, accents, and dialects. Aircraft crews are trained by magnetic recorders to distinguish orders and instructions through the simulated din of gunfire and screaming, and other blasting battle noises. In rehabilitation centers veterans exercise unresponsive vocal cords with this "voice mirror," and many a man in the Armed Forces owes his life to a conditioned reflex action to a specific sound, developed by constant training with these devices.

Throughout this country and at many foreign bases which our Armed

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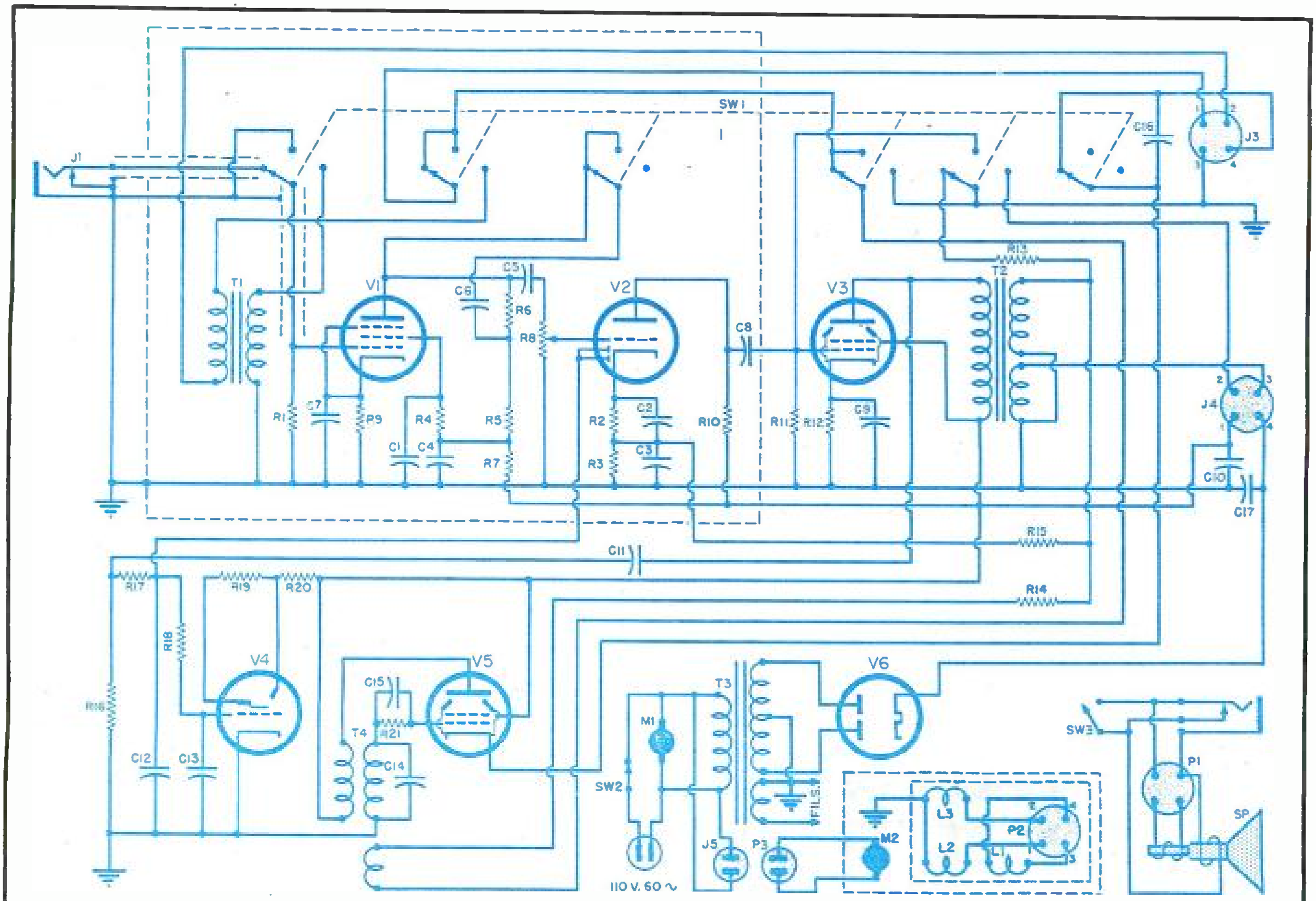
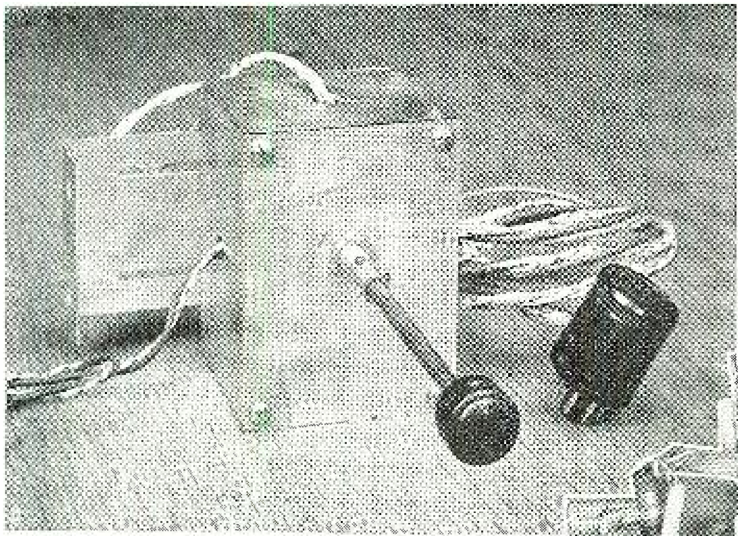
Fig. 8. Complete wiring diagram of the Caltron magnetic tape recorder. This unit is designed to record, reproduce, and erase sound impulses which are applied electronically to a magnetic steel tape.

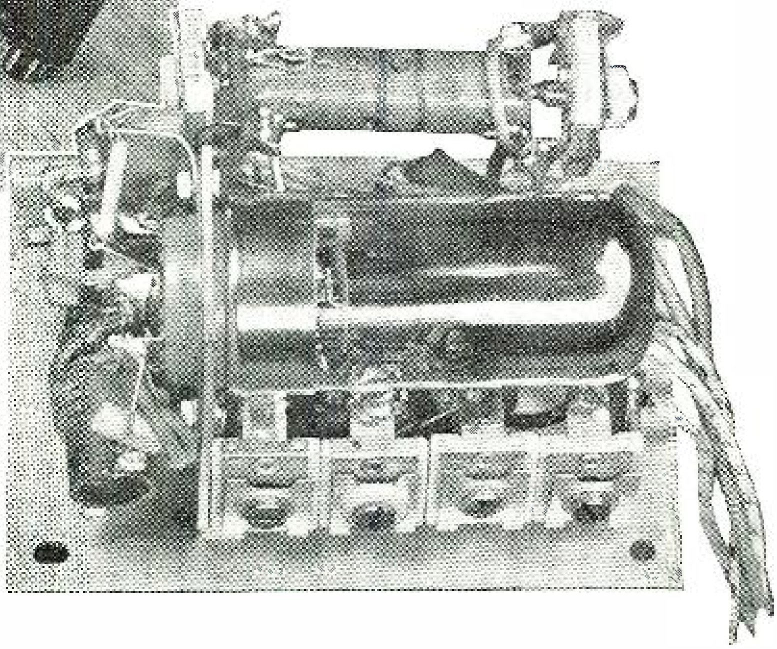


C_1, C_3—.1-μfd., 400-v. cond.
C_2, C_7—25-μfd., 25-v. elec. cond.
C_4—25-μfd., 250-v. elec. cond.
C_5, C_{12}—.005-μfd. mica cond.
C_6, C_{11}—.01-μfd., 400-v. cond.
C_8, C_{13}—.05-μfd., 400-v. cond.
C_9, C_{10}, C_{17}—3-section elec. cond.
C_{14}—.001-μfd., mica cond.
C_{15}—51-μμfd. mica cond.
C_{16}—8-μfd., 350-v. elec. cond.
R_1, R_{11}—500,000-ohm, ½-w. res.
R_2—2500-ohm, ½-w. res.
R_3—100-ohm, ½-w. res.
R_4, R_{18}, R_{19}—1-meg., ½-w. res.
R_5—50,000-ohm, ½-w. res.
R_6—200,000-ohm, ½-w. res.
R_7—51,000-ohm, ½-w. res.
R_8—500,000-ohm pot.
R_9—1000-ohm, ½-w. res.
R_{10}, R_{16}—100,000-ohm, ½-w. res.
R_{12}, R_{13}—500-ohm, ½-w. res.
R_{14}—1500-ohm, ½-w. res.
R_{15}, R_{20}—3500-ohm, ½-w. res.
R_{17}—150,000-ohm, ½-w. res.
R_{21}—300,000-ohm, 1-w. res.
J_1—Shorting-type microphone jack
J_2—Shorting-type external speaker jack
J_3—4-prong socket (recording head)
J_4—4-prong socket (speaker)
J_5—110-v. receptacle (drive motor)
L_1—Erasure coil
L_2—Voice coil
L_3—Hum-bucking coil
Sp—Loud Speaker
M_1—Motor (timing clock)
M_2—Motor (tape drive)
P_1—Speaker plug
P_2—Tone head plug
P_3—110-v. plug (drive motor)
Sw_1—6.p.3.p. selector switch
Sw_2—S.p.s.t. switch on volume control
Sw_3—S.p.s.t. switch
T_1—Input trans.
T_2—Output trans.
T_3—Power trans.
T_4—Oscillator trans.
V_1—6SJ7 tube
V_2—6SQ7GT tube
V_3, V_5—6V6GT tubes
V_4—6E5 electric-eye tube
V_6—6X5GT rectifier tube



Two views of the single-tube converter. The unit is completely enclosed in a metal housing and designed to mount within a present-day receiver.

NEW FM FREQUENCY CONVERTER



With the contemplated change of the FM band to 84-102 mc., this converter will prevent obsolescence of present-day receivers.

URING the recent preliminary hearings held by the Federal Communications Commission on the proposed frequency shift of the FM band, some of the testimony against the proposed shift concerned the obsolescence of existing FM receivers which would result should FM be moved into the 84- to 102-mc. band.

One of the companies which actively supported the proposed shift to higher frequencies was *Hallicrafters Company* of Chicago, who contended that existing FM receivers could be converted to the new band by means of a simple FM converter which could be installed easily and inexpensively.

At the request of the Federal Communications Commission, the company engineers designed and constructed a laboratory model of the FM converter.

There are two models of this unit, each serving a different purpose. The single-tube converter was designed for use in the primary service areas where the signal strength is high and the principal considerations are appearance and convenience. This unit may be mounted within the existing cabinet and it will not interfere in any way with the normal operation of the receiver. A simple switch on the front panel of the receiver will permit the converter to be tied into the receiver or cut out. at will. This unit permits the selection of two frequency ranges, 84-92 megacycles and 93-102 megacycles. All of the tuning-in is accomplished by the main tuning dial of the receiver.

This one-tube converter utilizes a single 7N7 tube. With this one-tube model, the r.f. input goes to a band-pass filter instead of the usual tuned circuit and the oscillator section is operated at a fixed frequency. The panel switch has three positions: one connects the antenna directly to the receiver to permit normal operation, while the other two positions connect different values of inductance and capacity in the band-pass and oscillator circuits. The FM receiver is used as a variable i.f. and with two fixed

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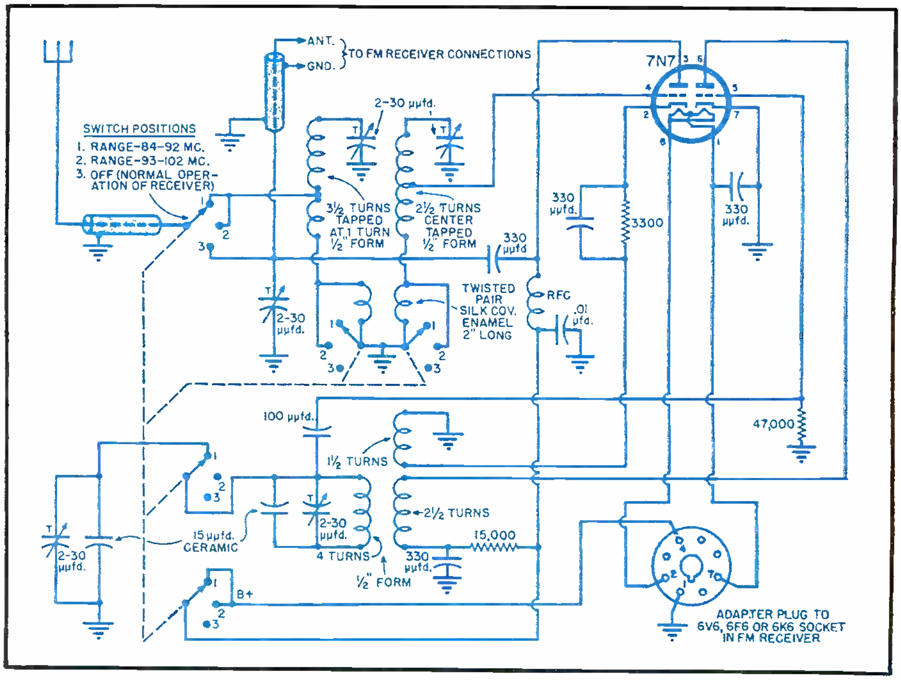
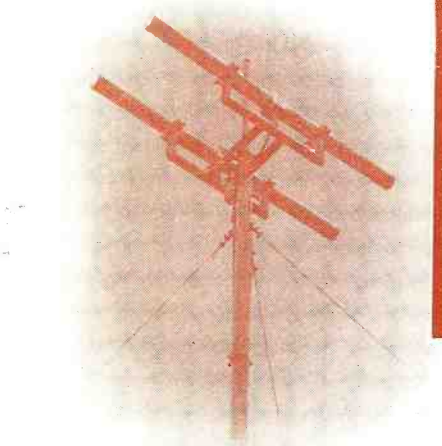
Complete diagram of the single-tube frequency converter. The adaptor plug shown is used to obtain proper voltages for this unit directly from the receiver.





FACTS ON FM Station Ownership

By P. B. HOEFER
Editorial Staff, RADIO NEWS

Some of the financial aspects of FM station ownership of interest to the small investor.

GE high-gain, S-T relay antenna.

BECAUSE of the increased interest evidenced by many of the readers of RADIO NEWS in AM and FM broadcasting as an investment and a profession, it was deemed advisable to furnish this information in the form of an article which would reach all of the readers and answer many questions which have arisen on the subject.

On the whole, the field of AM broadcasting has reached a saturation point, and with the possible exception of a few thinly populated areas in the West and Southwest, the frequency spectrum is fairly well crowded and the addition of stations of this type would be disastrous financially. It might be well to remember that if a radio station can be operated profitably in a certain area, there is undoubtedly a station already operating in that area, and the market may be incapable of supporting a second or third station.

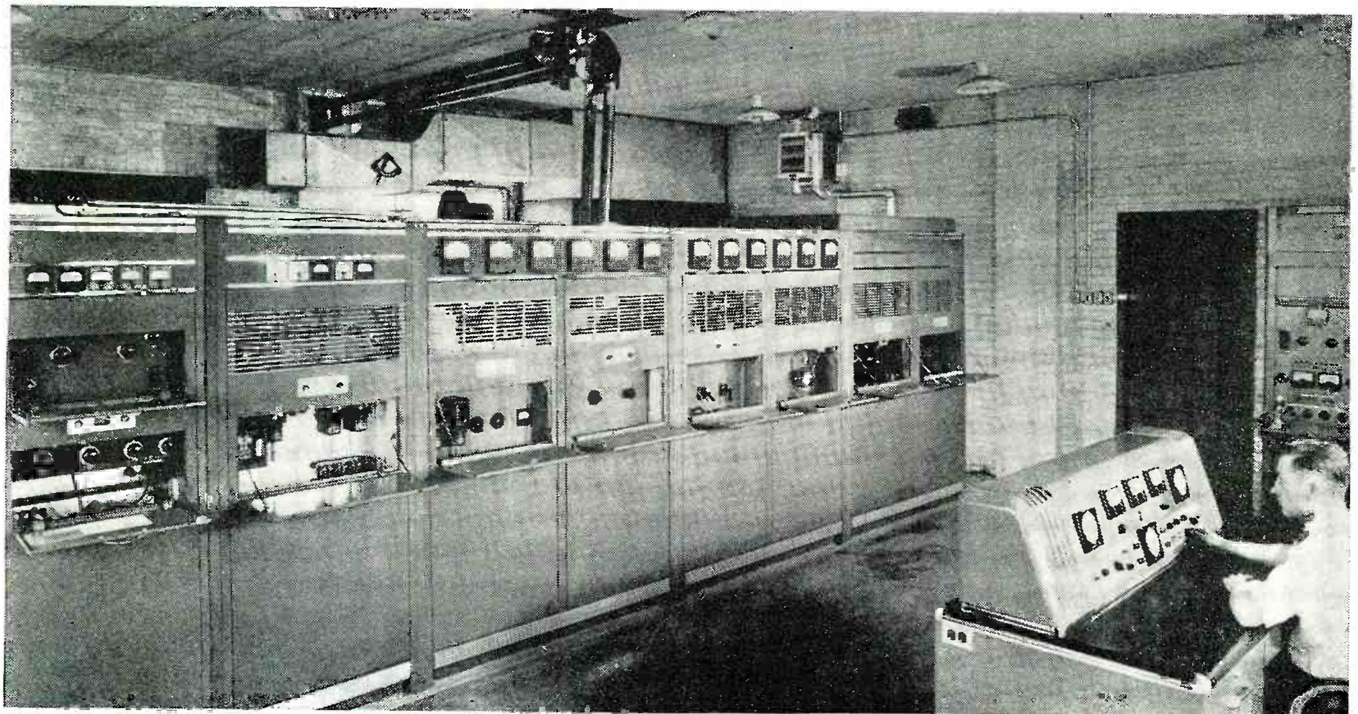
The FM broadcasting field presents an entirely different problem and it is the purpose of this article to present an over-all picture of the commercial and financial aspects involved in starting and maintaining an FM station. Engineering aspects or comparisons of technical advantages of the two systems of transmission will not be discussed inasmuch as a great deal of material of this nature is available in the literature.

Because of the inherent nature of FM transmissions, there is and will be room for literally thousands of FM stations in the United States before a saturation point is reached in this field. Because of the pioneer nature of the field, it is attracting the attention of many persons who want to get in on the ground floor of a new industry.

There is no doubt but what FM broadcasting will eventually be a profitable business for the small investor and the man with small capital, but *that time is from five to ten years away.* In order that there will be no confusion in the mind of the reader, the FM stations discussed in this article will be those in the 250-watt and 1-kw. range, which would be the size station normally operated by an individual or a small group of persons with limited capital.

There is one great deterrent to starting an FM station now, or immediately following the war, *e.g.* the general lack of sets capable of receiv-

Frequency-modulation (FM) transmitter and control console of GE radio broadcasting station, W85A, at Schenectady, New York.

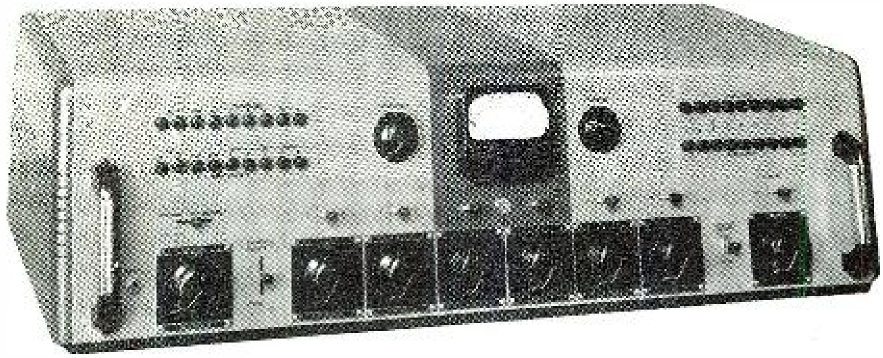


ing FM transmissions. This problem more or less resolves itself to the age-old problem of "which came first the hen or the egg." It goes without saying that the average consumer will not purchase an FM receiver unless there is a station broadcasting that type of transmission, and the prospective station owner will not go on the air unless a reasonable-sized audience is assured. On the other side of the picture, most of the radio manufacturers have indicated their intention of manufacturing a combination AM-FM receiver which could be sold to consumers in non-FM areas on the basis of the AM features in the receiver; hence, it may be possible to build up a *potential* audience without having a station in the vicinity. Here again, the time lapse, according to certain manufacturers, will amount to from three to five years.

When radio receiver manufacture was stopped in 1941, it was estimated that 60,000,000 radio receivers were installed in homes in the United States. The prewar production of receivers amounted to approximately 7,000,000 sets a year, of all types. If the postwar production of receivers should be stepped up to 14,000,000 a year, one-half of which were FM or combination AM-FM receivers, it would take approximately eight years of production to supply the same number of receivers capable of receiving FM as there are AM receivers now installed. It has been estimated that there are only 1/120 the number of FM receivers now installed as there are AM receivers.

This information illustrates a pertinent point which must not be overlooked by those planning to enter the FM broadcasting field. It is necessary for the station owner to be able to finance the station, virtually without revenue, during this period when FM broadcasting will be establishing itself as a sales and advertising medium. This "tiding over" period will cut deeply into capital and savings and the station operator who goes into the business without sufficient capital to cover this period, will find himself in the red before the first year of operation is over. This point cannot be emphasized too strongly, because according to all available records, *there is only one FM station in the entire United States at the present time that is operating without an actual dollars and cents loss.*

The question may justifiably be raised as to the reason why any business would operate at a loss. The answer is simple. The average FM broadcasting station now in operation is being operated either experimentally or as a prestige station for a sister AM station. According to a survey conducted by FM station *WGNB,* in July, 1944, of the 45 FM stations then operating in the United States, 9 stations were owned and operated by newspapers; 4 stations were owned by electrical manufacturers; 2 had department stores as owners; 2 were owned by insurance companies; and 1 station was the property of a motion picture company. Thus, twenty of the forty-five stations in July, 1944 were owned and operated by large concerns with sufficient financial backing to permit losses to be carried without bankruptcy.



A prewar model FM consolette, Type 76-B2, manufactured by RCA.

Of the forty-five stations in existence in July, 1944, 36 of the FM stations reported that their parent company operated an AM station in conjunction with the FM station, while 7 stations reported no AM affiliation, and 2 stations did not reply to this question. In almost all cases, a highly successful AM station is carrying the FM station during the "pioneering" period.

Other interesting information derived from the same survey revealed that only 13 of the 45 FM stations broadcast on a commercial basis, *i.e.* carried other than sustaining programs. Ten of these 13 stations reported an average *weekly* schedule of commercial programs of 3½ hours.

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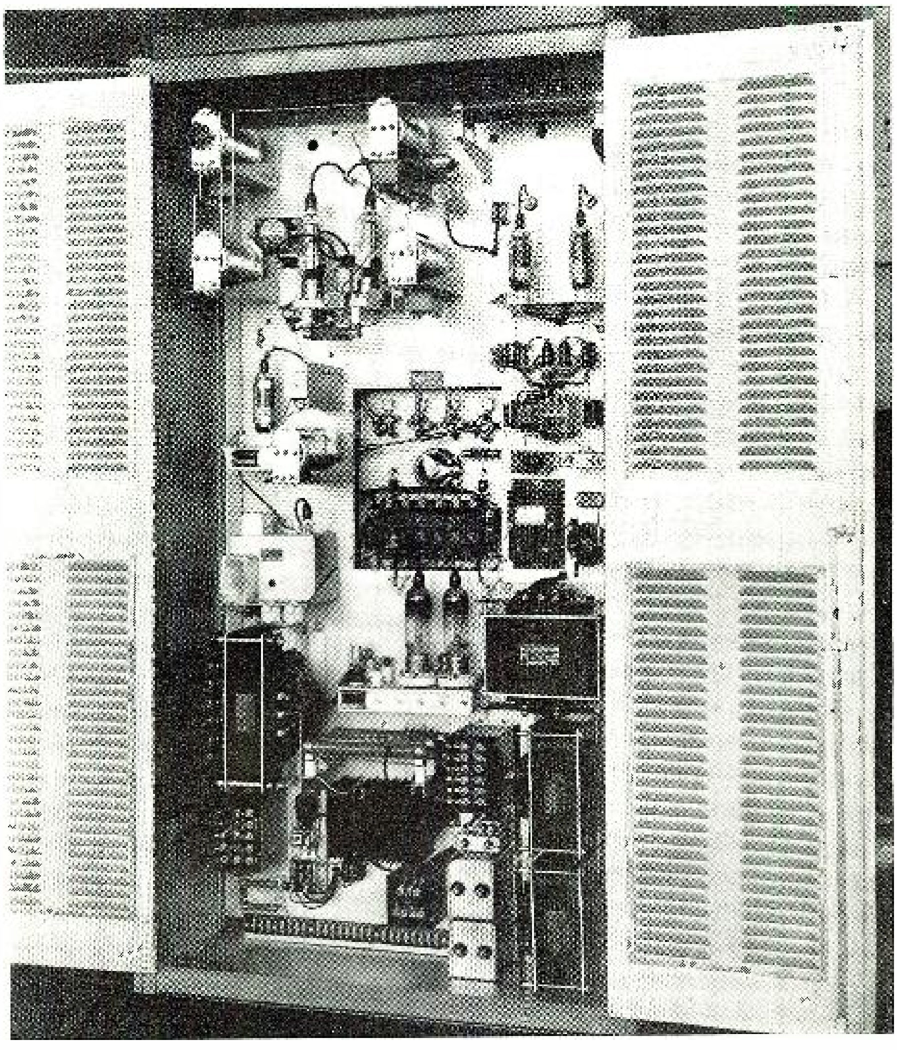
The 250-watt FM transmitter, showing some of the construction details.



FREQUENCY MODULATED TRANSMITTERS

The author presents a general discussion of the design and operation of equipment employed in present-day FM broadcast systems. Also included is a comparison between this equipment and that employed in AM systems.

By R. J. NEWMAN
RCA Victor Division
Radio Corp of America

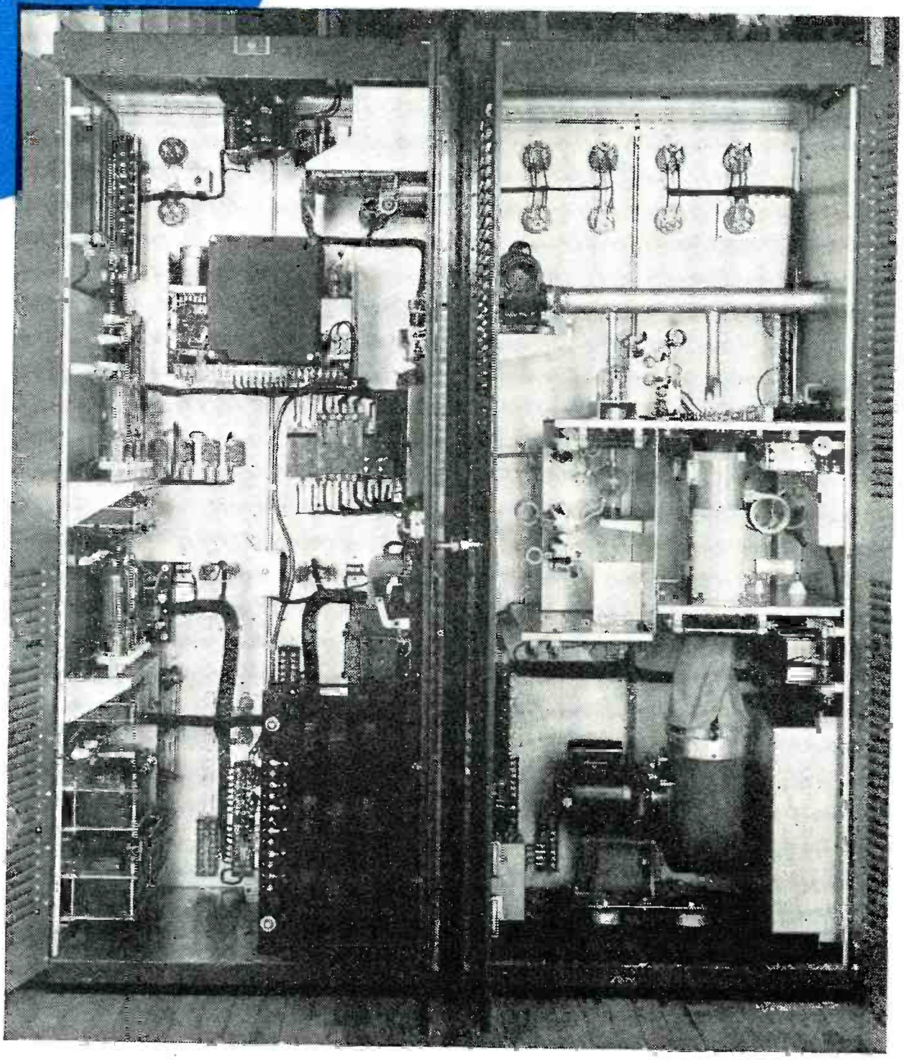


Fig. 1. RCA type FM-3A frequency-modulated transmitter, employing 24 tubes.

WIDESPREAD interest has been evinced in aural broadcasting employing frequency modulation. Equipment manufacturers are receiving many inquiries concerning FM broadcast systems. It is the intent of this article to present a general picture, comparing standard broadcast transmitters which use amplitude modulation and FM broadcast transmitters incorporating wide-range frequency-modulation methods.

What is the difference between frequency modulation and amplitude modulation? What types of equipment are required to create these signals?

In amplitude modulation the envelope of the radio-frequency, or carrier, wave is varied in accordance with the intelligence being transmitted. The extent of the variation in amplitude of the envelope of the wave is expressed in terms of the degree of modulation. The degree of modulation can never exceed unity on the negative peaks, since the amplitude of the envelope never can be less than zero. However, it can exceed unity on the positive peaks, and such a condition is known as overmodulation. When the degree of modulation is unity, the wave is completely or 100% modulated.

Intelligence in frequency modulation is transmitted by varying the instantaneous frequency of the carrier. The amplitude of the wave remains constant while its frequency deviates positively and negatively about the center, or mean, value. 100% modulation is defined by the FCC as a frequency deviation of 75 kc. For example, a 45-mc. carrier is frequency modulated 100% when it swings between the limits of 45.075 mc. and 44.925 mc. or 45 mc. ± 75 kc.

Fig. 10 illustrates both types of waves, modulated by sinusoidal a.c. signals showing (A) no modulation and (B) 100% modulation.

Standard broadcast stations operate in the 550- to 1600-kc. band and employ amplitude-modulated transmitters. These transmitters consist essentially of a radio-frequency section incorporating a crystal-controlled oscillator, buffer amplifier stages, a modulated amplifier, and an audio-frequency modulating system comprised of several stages of audio-frequency

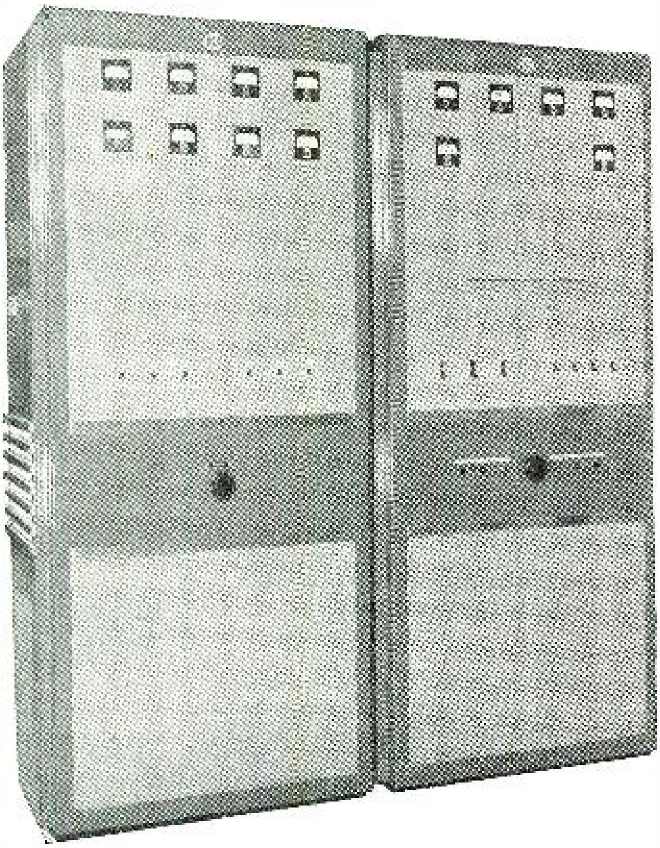


Fig. 2. Typical example of FM transmitting equipment, utilizing reactance-tube modulation (RCA type FM-3A unit).

amplifiers. Filament and high-voltage power supplies, control, and protection equipment complete the list of major components. Such a transmitter is illustrated by the block diagram of Fig. 4.

An r.f. signal equal in frequency to that of the transmitter output frequency is generated in a crystal-controlled oscillator circuit. It is then amplified by successive radio-frequency amplifier stages to a power level sufficient to drive the final amplifier. Intelligence is introduced through the modulating equipment, the output circuit of which is connected in series with the plate supply to the power amplifier. Instantaneous variations of the audio signal produce an a.c. voltage in the modulator output circuit which either adds to or subtracts from this plate supply voltage, depending upon its instantaneous polarity, to produce in the output circuit of the transmitter a modulated wave which carries the desired intelligence.

At the present time, the 42- to 50-mc. band is allocated to transmission of radio signals via frequency-modulated equipment. Two generally well-known methods of producing frequency modulation are used. One, the phase-modulation system of frequency modulation employs a master oscillator operating at constant frequency, and the second is the reactance-tube method of producing FM in which the master oscillator is varied in frequency by the signal to be transmitted.

E. H. Armstrong has previously described a phase-modulation system for producing frequency-modulated waves in the Proceedings of the Institute of Radio Engineers for May, 1936, and M. G. Crosby of *RCA Laboratories* has previously described reactance-tube frequency modulators in the *RCA Review* for July, 1940.

The phase-modulation system produces frequency modulation by wide-deviation phase modulation which is inversely proportional to the modulating frequency. A corrective network is used to produce constant deviation and is described later. The output of a low-

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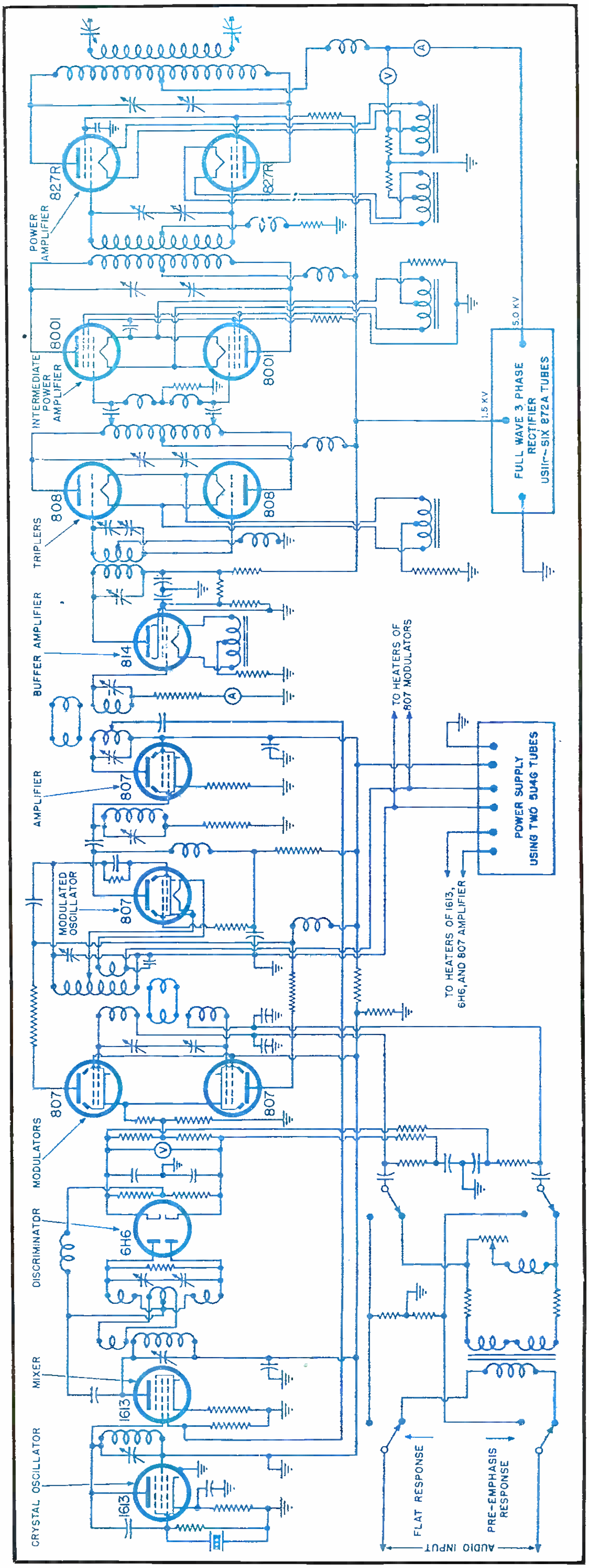


Fig. 3. Schematic diagram of the complete transmitter. An RCA 807 tube is used as the electron-coupled oscillator, which is modulated by two 807 reactance tubes to provide frequency modulation.

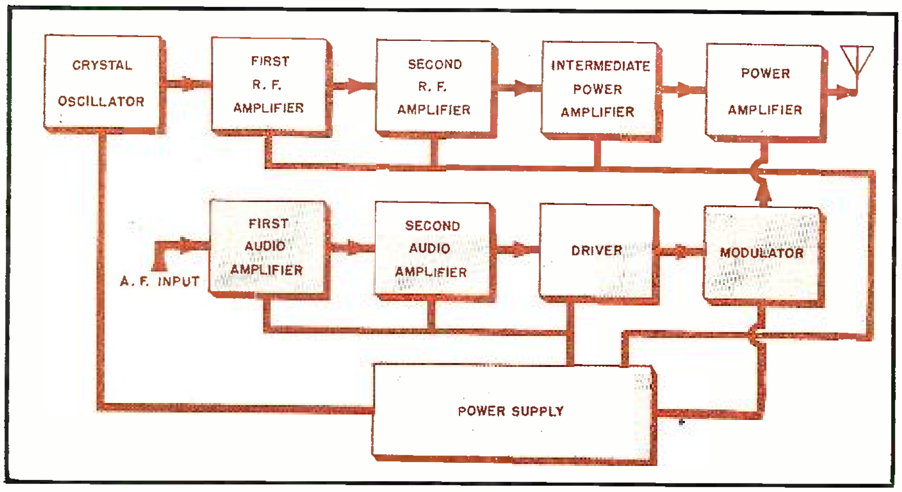


Fig. 4. Block diagram of a broadcast transmitter employing amplitude modulation.

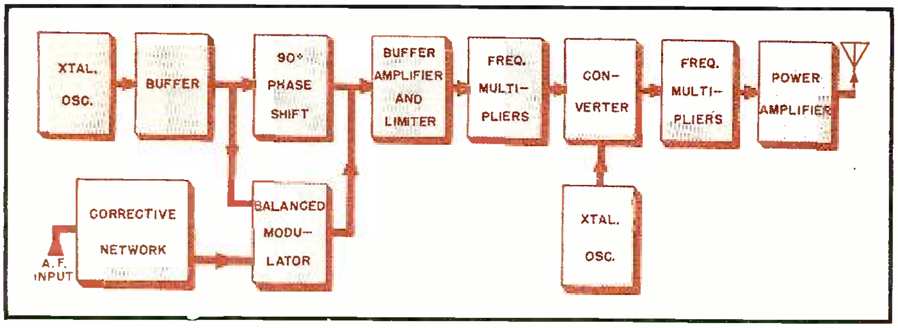


Fig. 5. Diagram of a transmitter, wherein phase modulation is converted to frequency modulation. A master oscillator operating at a constant frequency is used.

frequency crystal-controlled oscillator is divided into two parts: One part is passed through a network which shifts its phase by 90°; the second part is amplitude modulated by means of a balanced modulator which suppresses the original carrier frequency, leaving only the side bands. These side bands are recombined with the first part of the r.f. signal, thereby producing a phase-modulated signal which can be modulated up to a phase shift of approximately ±30°.

The resultant frequency swing is very small and requires several stages of frequency multipliers to produce 100% frequency modulation or a swing of plus and minus 75 kilocycles as defined by the FCC. In fact, the signal frequency variations are multiplied more than 3000 times. To obtain a multiplication of this magnitude without increasing the mean-carrier-frequency to an undesired high value, it is necessary, after a few stages of multiplication, to heterodyne the frequency of the signal down to a lower value and then multiply again to produce the desired combination of frequency swing and mean-carrier-frequency. Each multiplication increases the frequency swing in the same proportion as that of the mean-carrier-frequency, while heterodyning decreases the frequency of the carrier but not its deviation.

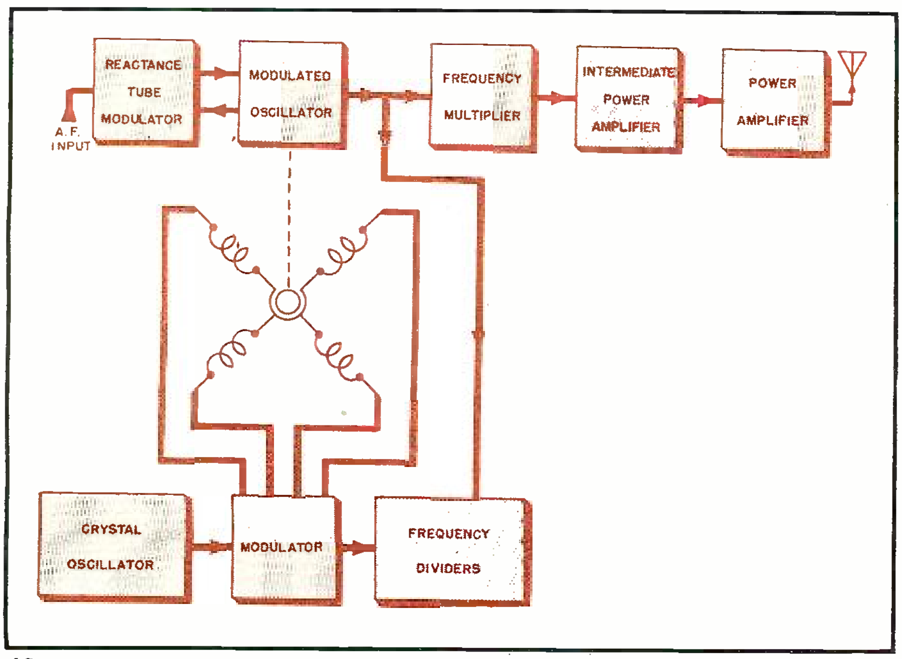
However, phase modulation must undergo additional treatment before it becomes true frequency modulation of the desired type. Its frequency shift is proportional to the modulating frequency and therefore a corrective network must be inserted in the audio input channel to make the amplitude of the applied audio signal inversely proportional to frequency, producing a flat over-all frequency response. A simplified block diagram of a transmitter wherein phase modulation is converted to frequency modulation is shown in Fig. 5.

In the reactance-tube modulation method, a highly stable oscillator operates in a conventional oscillator circuit across which is connected the plate and control grid of the reactance-tube frequency modulator. The insertion of a properly chosen network, consisting of a capacitor between the plate and grid and a resistor between the grid and cathode of the modulator tube, results in a change in modulator plate current which is 90° out of phase with the plate current drawn by the oscillator. Thus, the modulator functions as a variable capacitor across the frequency-determining circuits of the oscillator. The effective capacity varies in accordance with a voltage impressed on the grid of the modulator. Therefore, if an audio-frequency signal or voltage is applied to the grid of the reactance-tube modulator, the oscillator will be subjected to the effect of a varying capacitance across its frequency-determining circuits, causing the oscillator frequency to swing above and below the mean value at a rate determined by the frequency of the applied audio signal. In this method, the magnitude of the carrier-frequency shift depends only upon the amplitude of the modulating signal.

The reactance-tube method of frequency modulation is convenient for producing linear frequency modulation. In practice, the modulated oscillator is operated at a frequency in the neighborhood of 5 mc. This signal need only be tripled twice to produce the desired output frequency in the 42- to 50-mc. band. In order to secure the desired stability of the mean-carrier-frequency, an automatic frequency-control circuit is added.

Two types of center frequency control are employed, both using the

Fig. 6. Simplified diagram of a reactance-tube-type FM transmitter, employing mechanical frequency control. Fig. 9 shows an electronic frequency-control system.



feed-back principle. One consists of a crystal oscillator, a mixer, and a rectifier circuit, and develops a corrective voltage for the modulator tube when there is any change in the mean-carrier-frequency. This method is known as electronic stabilization. The second type is comprised of several stages of frequency dividers, a crystal oscillator, and modulator circuits. It also includes a synchronous motor, mechanically coupled to a variable capacitor in the frequency-determining circuit of the modulated oscillator which corrects, by the proper amount, any change in the mean-carrier-frequency. Figs. 6 and 9 are simplified block diagrams of reactance-tube FM systems. Fig. 9 illustrates the electronic frequency control and Fig. 6 pictures the mechanical frequency control.

The electronic system of automatic center frequency control is discussed in conjunction with the description of the RCA Type FM-3A transmitter later in this article. In the mechanical control method, the functions of modulation and center frequency control are separated. Modulation is effected by use of reactance tubes as described earlier and automatic frequency control of the center carrier frequency is accomplished as follows:

A sample voltage is taken from the output of the modulated oscillator and its frequency divided by a series of frequency-divider circuits to a value of about 5000 cycles. This signal is fed into a modulator along with the signal from a 5-kc. crystal oscillator. The output of the modulator is connected to the windings of a synchronous motor. The two signals fed into the modulator combine to produce a rotating magnetic field, the speed and direction of rotation corresponding to the amount and sense of the frequency difference of the modulated oscillator from its mean-frequency value.

Some saving in size of component parts and over-all cost of transmitting equipment is realized with frequency modulation. Standard broadcast transmitters operate on frequencies in the neighborhood of 1000 kc., whereas frequency-modulated transmitters operate in the 45-mc. band. The size and construction of the circuit components of a transmitter vary with the operating frequency. Thus, such components as inductors and capacitors are much larger physically at the lower frequencies. Inductances used in the plate and grid tank circuits of FM transmitters are usually self-supporting coils, fabricated from copper tubing, while the tuning condensers are of the variable air-capacitor type.

In frequency modulation some further advantage is gained because the carrier is of constant amplitude and the power output is fixed, while AM transmitters require an instantaneous peak power of four times that of the unmodulated carrier power in order to obtain 100% modulation. This additional power must be supplied by

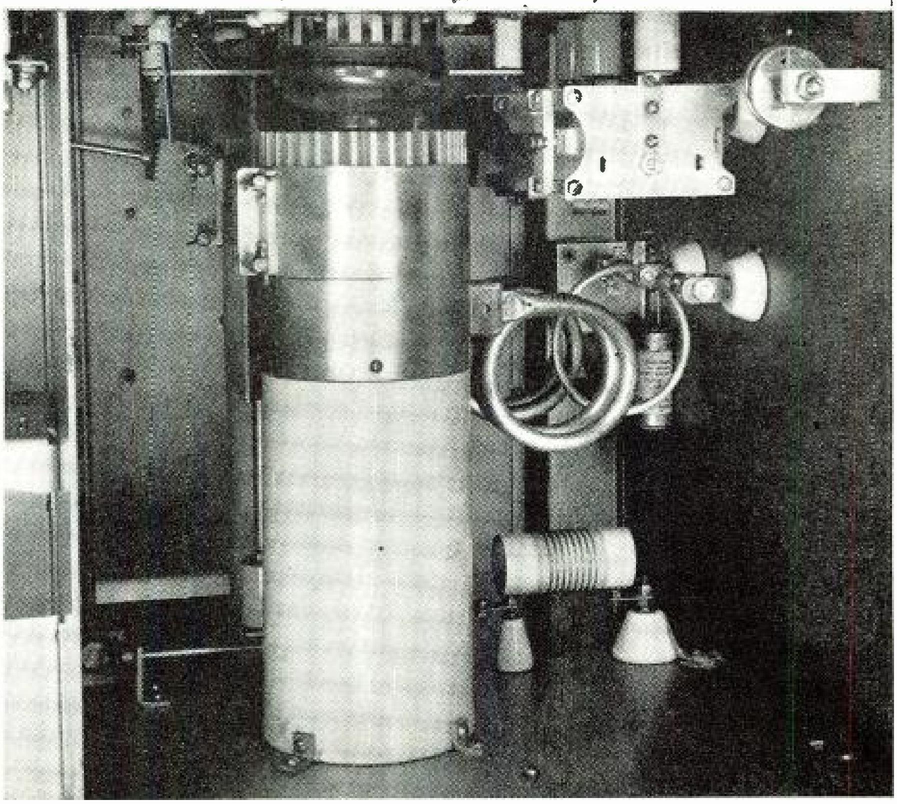


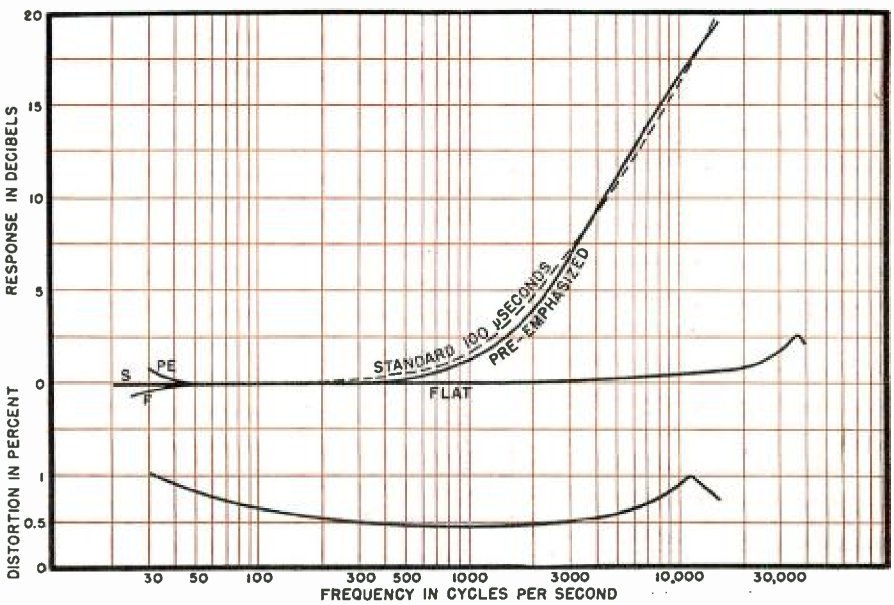
Fig. 7. An enlarged view of the power amplifier portion of the transmitter shown in Fig. 1. Plate-tank tuning is accomplished from the front panel by varying the capacitance between the metal shells into which the tube anodes are mounted.

large modulating systems and power supply units. A single stage modulator of low power consumption is all that is required to introduce the intelligence into an FM carrier. The component parts of the modulating system are of the receiver variety, and there are no bulky transformers, reactors, or condensers.

Output coupling circuits are basically the same for both types of transmitters. Inductive coupling, using either a series- or parallel-tuned circuit for matching the antenna to the plate of the final amplifier, is popular in the FM transmitter, the high operating frequencies permitting use of simple self-supported coils and variable air condensers. Pi networks may also be used for plate tank and antenna matching circuits. The use of high Q parallel tuned circuits employed in the FM transmitter elimi-

(*Continued on page* 124)

Fig. 8. These fidelity curves present a clear picture of the audio-frequency response and distortion characteristics of the FM-3A frequency-modulated transmitter.



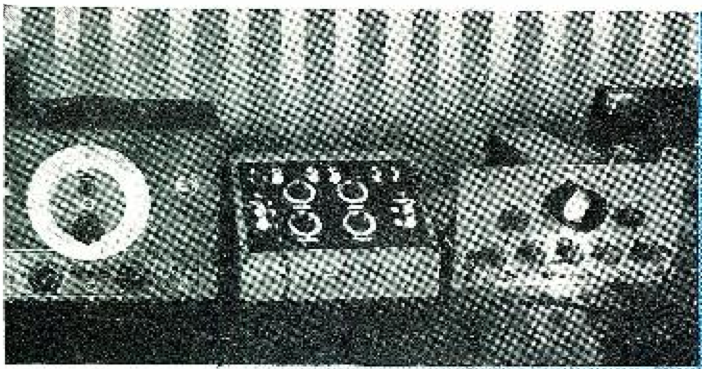


Fig. 1. Typical setup of audio oscillator, bridge, and oscilloscope. The 'scope makes an excellent null detector.

IMPEDANCE BRIDGE FOR L-C-R MEASUREMENTS

By **RUFUS P. TURNER**

Consulting Eng., RADIO NEWS

Constructional details of a versatile test instrument that can be used either in the lab or shop.

IT IS a common occurrence for the active experimenter, who seldom has either time or inclination to return unused components to their proper departments, soon to accumulate a confused mixture of resistors, coils, and capacitors, all requiring identification. When numerous mixed parts thus must be classified, the utility of a single instrument for wide-range resistance, capacitance, and inductance measurements is striking.

The value of such an instrument is fully appreciated likewise by the circuit experimenter who continually must check such characteristics as (1) inductance, equivalent series resistance, and Q of air-core and iron-core coils; (2) capacitance, equivalent series resistance, and power factor of capacitors of all types, including variable condensers; (3) d.c. resistance of coils and chokes; (4) resistance, inductance, and capacitance characteristics of transformers, both iron-core and air-core; (5) capacitance to ground and capacitance between parts mounted on a metal chassis; (6) inductance of resistors; (7) resistance and capacitance of shielded conductors, etc.

The most satisfactory single instrument for wide-range R, C, and L measurements of the kind just outlined is the *impedance bridge*. For general experimental use, where the highest order of precision is not required, this bridge may be reduced to an instrument of simple construction by adopting the skeleton scheme popularized sometime ago by the now discontinued *General Radio* Type 625-A. By dispensing with internal range switching, a considerable number of parts will be eliminated and the cost of the instrument substantially reduced. In an amateur version of the bridge, such as is described in this article, expensive precision resistors may be replaced with carbon resistors of the radio variety carefully selected for resistance.

The bridge described in this article is a skeleton-type impedance instrument. With it, the experimenter may measure resistance (either with a.c. or d.c. signal input) from .001 ohm to 1 megohm, capacitance from 1 micro-microfarad to 100 microfarads, and inductance from 1 microhenry to 100 henries. These ranges include all of the R, C, and L values encountered in radio and electronic circuits, except resistances higher than 1 megohm—but these high resistances may be measured indirectly on this bridge, as will be explained later in the article, by means of a parallel method and simple calculation.

The skeleton arrangement makes use of plug-in standards which may be placed in one or more of three different arms of the bridge. In this way, various bridge circuits may be set up rapidly for the more effective measurement of various characteristics. For example: a straight Wheatstone bridge is set up for resistance, Wien for capacitance, and Maxwell for inductance. Any convenient audio oscillator, including the 60-cycle power line, may be connected in as the signal source, while any convenient detector, such as headphones, v.t. voltmeter, or oscilloscope, may be connected in as a null indicator. These pieces of equipment serving as generator and detector are to be found in every shop or laboratory and would be duplicated unnecessarily if built into the bridge.

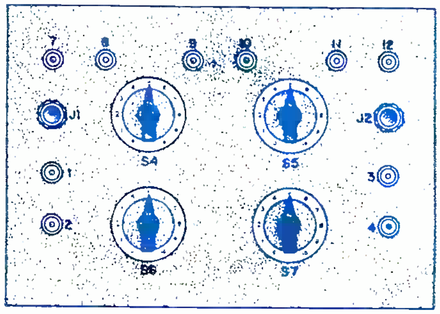


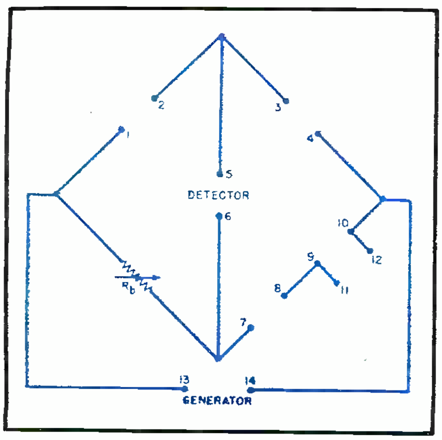
Fig. 2. Front panel layout.

The bridge, as shown on these pages, is small in size and, with its standards, takes up little space. Its arrangement is entirely conventional and its manipulations are simple and easily learned. Resistance is measured against a resistance standard, and both capacitance and inductance against a capacitance standard.

Skeleton Arrangement and Bridge Theory

Basic arrangement of the bridge is shown in Fig. 3. Terminals are provided in three arms for the insertion

Fig. 3. Basic circuit of the bridge.



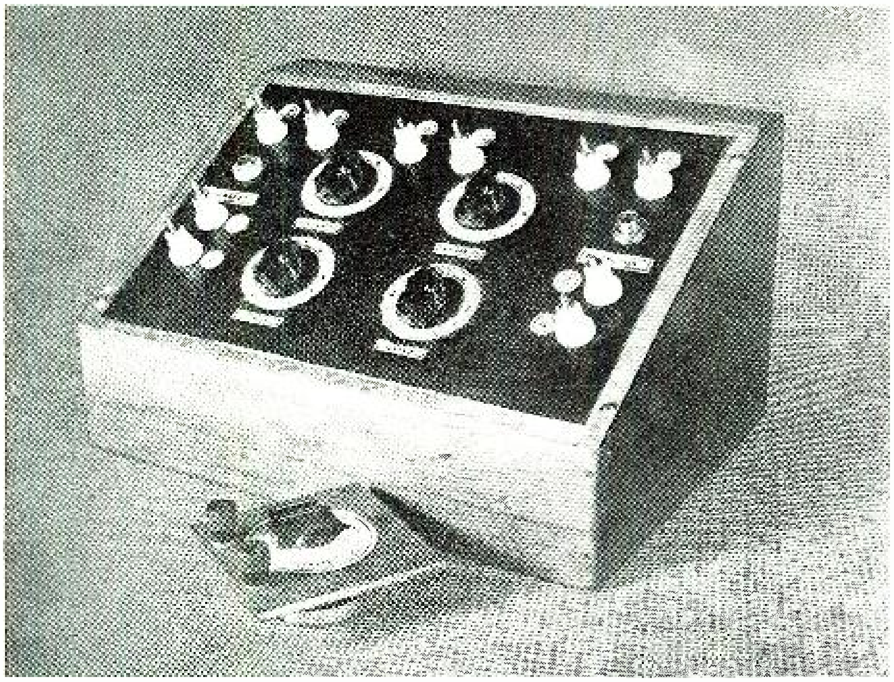


Fig. 4. External view of the bridge, showing proper placement of component parts. In the foreground is shown one of the "power factor" rheostats.

of standard and unknown components. The fourth arm contains a variable resistor, R_b, adjustable between 0 and 10,000 ohms, which is the main bridge adjustment. By plugging-in various standard resistors and capacitors, various common bridge circuits may be obtained. These are shown in Fig. 5 and are described in the following paragraphs.

Fig. 5A is the conventional four-arm Wheatstone bridge circuit obtained by plugging standard resistors into terminals 1-2 and 3-4, and connecting a jumper between 7 and 8. This bridge is used exclusively for resistance measurements. The unknown resistor is connected to terminals 11-12. A 6-volt battery may be connected to terminals 13-14 and a center-zero d.c. microammeter (not more than 100 microamperes maximum deflection each side of zero) to terminals 5-6; or an audio oscillator (any frequency from 60 to 10,000 cycles) to 13-14 and headphones, v.t. voltmeter, or oscilloscope to 5-6. At null, the unknown resistance may be computed from the following equation.

$$R_x = \frac{R_b R_2}{R_1}$$

Fig. 5B is a Wien bridge circuit obtained by plugging a standard fixed resistor into terminals 1-2, a standard fixed capacitor into 11-12, and a calibrated-scale rheostat into 7-8. This circuit is employed for capacitance measurements. The unknown capacitor is connected to terminals 3-4. An audio oscillator (any frequency from 60 to 10,000 cycles) is connected to terminals 13-14, and headphones, v.t. voltmeter, or oscilloscope to 5-6. The bridge is balanced for capacitance by means of R_b and for equivalent series resistance by means of R_2. At null, the unknown capacitance is equal to $C(R_b/R_1)$. The equivalent series resistance of the unknown capacitor equals $R_2(R_1/R_b)$. Power factor of the unknown capacitor equals $.000628 f R_2 C$ percent, for all power factor values up to 20%. (f is the generator frequency in cycles, R is in ohms, and C in microfarads). For power factor values higher than 20%, a different equation must be employed:

$$\text{P.F.} = \frac{100\,R_2}{\sqrt{R_2^2 + X^2}}\ \text{percent}$$

$$X = \frac{1.000.000}{6.28\,fC}$$

where f is in cycles and C in microfarads.

Fig. 5C shows a Maxwell bridge circuit obtained by plugging a standard fixed resistor into terminals 3-4, a standard fixed capacitor into 9-10, a calibrated rheostat into 11-12, and connecting a jumper between terminals 7 and 8. This bridge is employed exclusively for inductance measurements. The unknown inductance is connected to terminals 1-2. An audio oscillator (any frequency from 60 to 10,000 cycles) is connected to 13-14, and headphones, v.t. voltmeter, or oscilloscope to 5-6. The bridge is balanced for inductance by means of R_b and for equivalent series resistance by means of R_2. At null, the unknown inductance is equal to $C(R_b R_1)$, when C is in farads and the inductance is in henries. Equivalent series resistance of the unknown inductor equals $R_1(R_b/R_2)$.

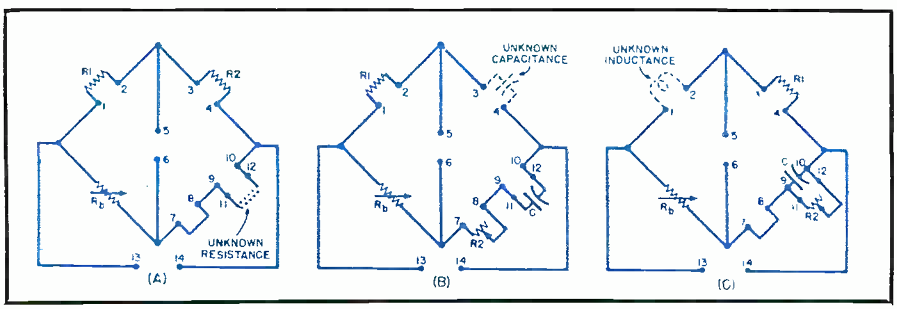
These three bridge circuits are at the immediate disposal of the experimenter simply by inserting resistors or capacitors (or both) and the unknown into the proper arms.

Bridge Constants

In order to obtain the resistance, capacitance, and inductance ranges mentioned in the fourth paragraph of this article, the following values were arrived at for bridge circuit components: Variable resistor R_b, 10 to 10,000 ohms; two sets of resistance standards, one embracing 1, 10, 100, 1000, and 10,000-ohm resistors and the other 100, 1000, and 10,000-ohm resistors; one set of capacitance standards embracing .001, .01, and 1-μfd. capacitors; and four calibrated-dial rheostats having individual ranges of 0-100, 0-1000, 0-10,000, and 0-100,000 ohms.

The bridge would have been capable of more rapid adjustment had it been possible to employ, as R_b, a rheostat with a direct-reading dial. But the rheostats generally available to the experimenter are of the radio volume control type, and these may not be set to the required closeness for use in bridge circuits. In order to obtain the degree of accuracy desired for this bridge, a decade resistance scheme has been employed. Thus, R_b consists of a combination of resistors which are cut in and out of the circuit by means of four rotary switches. (See Fig. 7.) Decade 1 consists of ten 1000-ohm resistors connected in series around a single-pole, 11-position rotary selector switch, S4. Decade 2 consists of ten 100-ohm resistors connected in series around a similar switch, S_5. Decade 3 consists of ten 10-ohm resistors, and decade 4 of ten 1-ohm resistors connected in series respectively around switches S_6 and S_7. By means of these

Fig. 5. Several common bridge circuits that may be obtained: (A) Wheatstone bridge, used for resistance measurements; (B) Wien bridge, for measuring capacitance; and (C) Maxwell bridge, for the measurement of inductance.



resistors and switches, the bridge resistance R_b may be adjusted from 1 ohm to 11,110 ohms in steps of 1 ohm. This permits very close adjustment of R_b. For a balancing resistance of 1947 ohms, for example, the following settings would be made: Decade 1: 1000; decade 2: 900; decade 3: 40; and decade 4: 7.

For greatest precision, all of the resistors in the decades should be precision, noninductive wirewound units having accurate ratings of 1% or better. However, if it is not possible to obtain resistors of this description, the experimenter may employ common 1-watt carbon resistors, provided they are selected with great care. A reliable ohmmeter or portable Wheatstone bridge should be taken to the store and the resistors picked from the complete stock, to have closest resistance to specified values.

The standards for resistance and capacitance are housed in separate plug-in boxes, as shown in Fig. 7. Each box is provided with a single-pole rotary selector switch in order that various values of standard resistance or capacitance may be cut into the bridge arms without having to plug in additional accessories. The first resistance standard box contains 100-, 1000-, and 10,000-ohm resistors connected around a single-pole, 3-position rotary switch, S_1. The second resistance standard box contains 1-, 10-, 100-, 1000-, and 10,000-ohm resistors connected around a single-pole, 5-position rotary switch, S_2. The capacitance standard box contains .001-, .01-, and 1-μfd. capacitors connected around a single-pole, 3-position rotary switch, S_3.

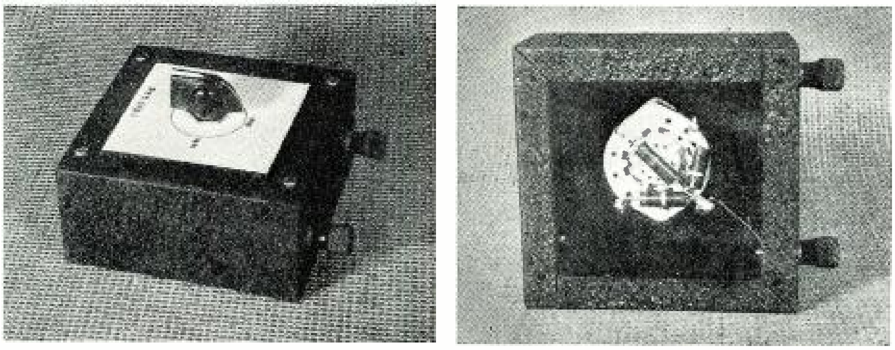


Fig. 6. Two views of the resistance standard No. 1, schematic of which is shown in Fig. 7. Note the simplicity of construction.

As in the decades of R_b, the standard resistors should be of the precision noninductive wirewound type, with accuracy ratings of 1% or better, if greatest bridge precision is desired. They may be of the ordinary 1-watt carbon variety if they are hand-picked carefully in the manner recommended above. The capacitors in the capacitance standard likewise must be chosen carefully as regards actual capacitance. The .001- and .01-μfd. units are of the mica variety, while the 1-μfd. capacitor must be of high-quality, oil-impregnated, oil-filled type. The mica units preferably will be of the silvered variety. In ordering the capacitors, specify 1% tolerance, or hand-pick them from a store stock for closest capacitance value and lowest power factor value. It is imperative that all capacitor power factor values be as low as obtainable if the bridge is to measure this characteristic accurately.

The four rheostats, also shown in a single diagram in Fig. 7, are employed for equivalent series resistance balance in capacitance and inductance measurements. These are made plug-in style like the resistance and capacitance standards and are provided with resistance-calibrated dials. They have the following maximum resistance ratings: Rheostat 1: 100 ohms (R_{49}); rheostat 2: 1000 ohms (R_{50}); rheostat 3: 10,000 ohms (R_{51}); and rheostat 4: 100,000 ohms (R_{52}). Each of these accessories should be of the wirewound variety. In some localities, however, it may be difficult to obtain a wirewound rheostat in 100,000 ohms, and in this case only a carbon type may be substituted. However, extreme care must be taken in the dial calibration of the latter rheostat.

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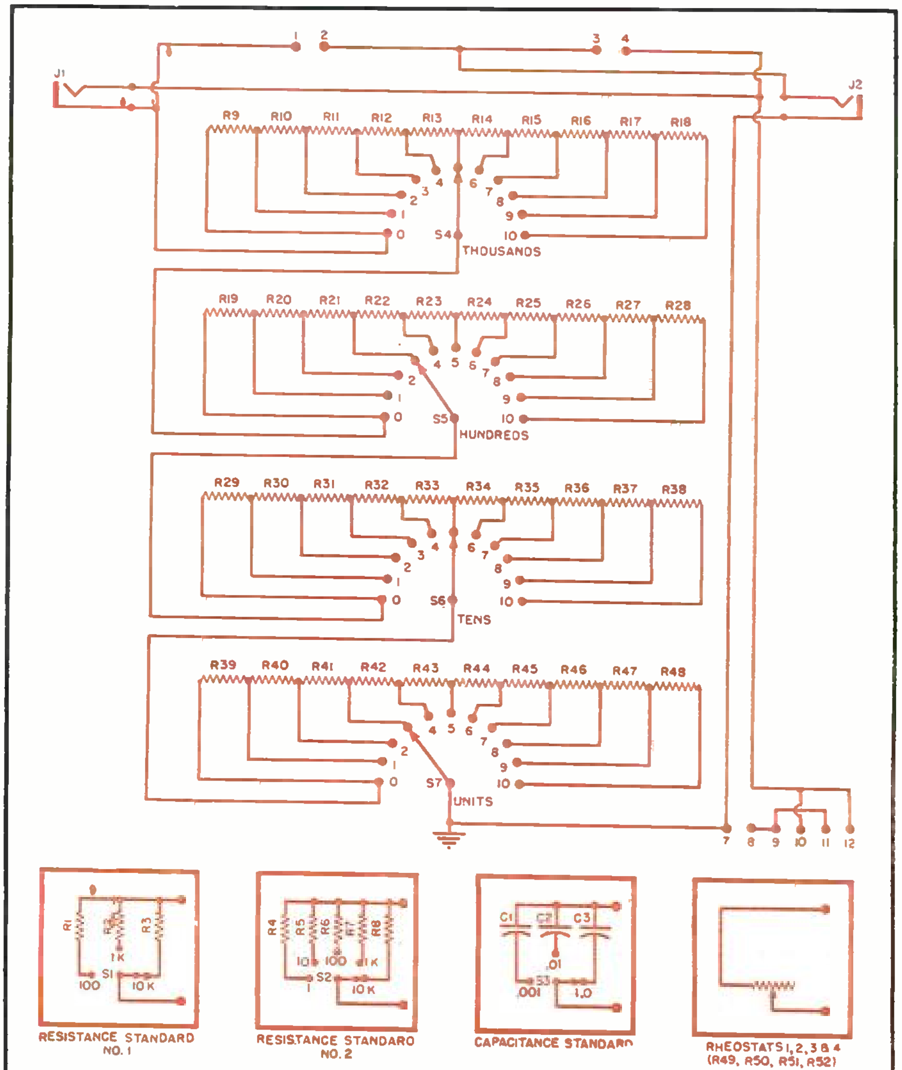
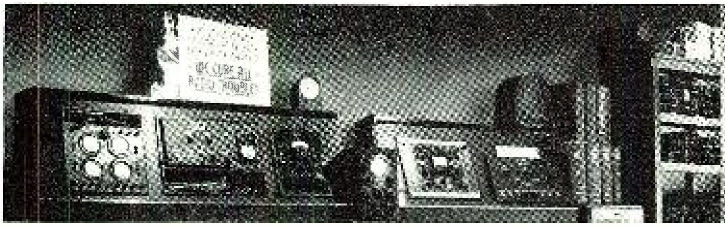
Fig. 7. Complete schematic of the bridge and its various accessories.



C_1—.001-μfd. silvered mica cond.
C_2—.01-μfd. silvered mica cond. (2-.005's in parallel)
C_3—1-μfd., oil-impregnated, oil-filled cond.
R_1, R_6, R_{19} to R_{28}—100-ohm, 1-w. res.
R_2, R_7, R_9 to R_{18}—1000-ohm, 1-w. res.
R_3, R_8—10,000-ohm, 1-w. res.
R_4, R_{39} to R_{48}—1-ohm, 1-w. res.
R_5, R_{29} to R_{38}—10-ohm, 1-w. res.

For the most accurate bridge operation, use precision, noninductive, wirewound instrument resistors (accuracy 1% or better) for R_1 to R_{48}.
For a practical bridge of somewhat lower accuracy, employ regular 1-w. carbon resistors.
R_{49}—100-ohm w.w. rheostat
R_{50}—1000-ohm w.w. rheostat
R_{51}—10,000-ohm w.w. rheostat
R_{52}—100,000-ohm w.w. rheostat



LET'S TALK SHOP

With JOE MARTY

Eastern Editor, RADIO NEWS

NUMEROUS letters have been received by the editors of RADIO NEWS regarding the future of industrial servicing. This article will attempt to give in some detail pertinent facts and figures regarding this important field.

Industrial servicing as such has been a direct outgrowth of the present war. Due to the tremendous advances made by electronics and also due to the enormous demands made upon the industry for delivery of materials to the armed forces, a whole new field of industrial electronics has been opened up. Those servicemen who have been in business during the war will no doubt have had their share of this servicing. The future in this field is bound to expand since most of the manufacturers who have installed some electronic equipment will no doubt extend its use after V day.

Many of the large manufacturers of industrial electronic equipment are planning for a large postwar market among manufacturers in most of the industries in the country. Naturally, the more of this equipment that is installed throughout the country, the more need there will be for good personnel to install it and maintain it in good operating condition.

If you, as a serviceman, are intending to stay in this field or to enter into this field, it will be necessary for you to learn an entirely new technique of operation. Heretofore, the average serviceman has had experience on equipment which could be removed and taken to his own shop for repair. Unfortunately, most of the industrial equipment is of a fixed nature. By that, we mean it is permanently installed in the plant and does not lend itself to be taken out of the plant for servicing. The associated circuits as well as the mechanism itself are very hard to duplicate on a service bench and therefore, this means that most of the work will have to be done at the point of installation.

This will require very good portable test equipment which servicemen can carry on to the job. This will mean that the serviceman will have to do repairs on the spot, working under all sorts of adverse conditions, such as noise and an interested but not always sympathetic audience. In most installations, unfortunately, electronic equipment is placed in some out of the way place which will mean a great deal of trouble for the serviceman. This means he will have to be prepared for instant repairs and will have to keep his kit well stocked with all necessary repair parts and tools. Also, the time element is important. The emphasis will be on repair in the shortest possible time so that manufacturing processes are not interrupted longer than necessary.

Since the production line that is stopped represents a total loss to the manufacturer in time as well as material, the strain on the serviceman will be much greater than any circumstances under which he has been called to operate. This means the serviceman will have to have a thorough grounding in all of the short cuts and methods of servicing as well as the most efficient way of performing any particular job.

In general, the fundamental principles of operation of any electronic equipment are based upon known principles which the average serviceman no doubt understands. However, in many cases of industrial control mechanisms, new operating features have been incorporated by manufacturers of this equipment and it will be necessary for servicemen to brush up on this equipment. A suggestion is made that the serviceman get a good text book on fundamental industrial electronics, of which several are available, to bring himself up-to-date on these new devices.

Contact also should be made with all manufacturers who are manufacturing industrial electronic equipment in order that the serviceman may obtain operating instructions and technical service bulletins on all this type of equipment. In many cases a contact can be made with the man now doing the work in manufacturing plants with a view in mind of getting as much information as is possible under the circumstances. Many of the in-plant men who are doing this servicing today do not intend keeping on doing it after the war. Most of the maintenance departments of the various plants do not have all the equipment, in many cases, to do the job. Certainly, no avenue of information should remain unexplored by the serviceman who intends to make a future of industrial servicing.

There is one advantage immediately apparent in doing industrial servicing now. The serviceman is able to buy equipment and materials for the servicing of this equipment when it is installed in war plants on priority basis. Since most service equipment has not been available for a long time, this offers the serviceman a distinct advantage in the tie-up with war plants.

In thinking of your future in this field, it might be well to touch briefly on the item of charges. Since most plants operate two and sometimes three shifts on a more or less 24-hour operation, the serviceman will, of necessity, be on 24-hour call. This means that probably the best way to handle such jobs would be on a contract basis whereby the serviceman will do the necessary work for a fixed fee each month. This can be made payable twice monthly, monthly, or however it is agreeable to the serviceman and the customer. Of course, any parts which must be

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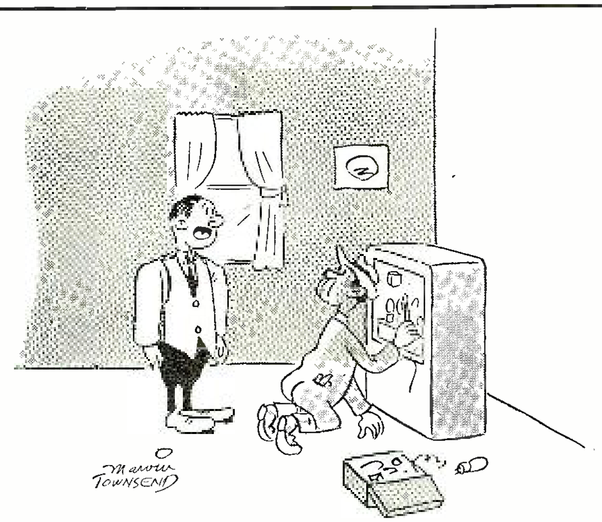


"You've got to fix it, Hank; I'm taking an exercise course and I start on my lower body in the morning!"

PRACTICAL RADIO COURSE

By ALFRED A. GHIRARDI

Part 35. Covering the electron-coupled oscillator and the methods employed to "track" the various signal-tuning circuits of the r.f. amplifier in superheterodyne receivers.

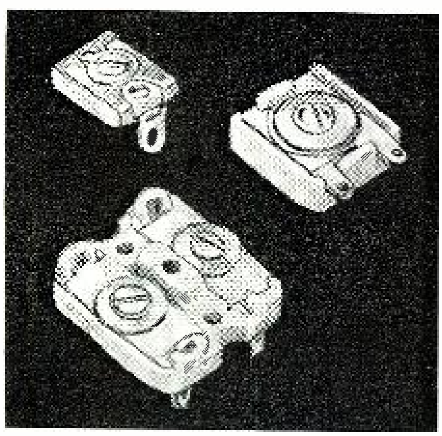
IN THE various triode-type oscillators, discussed in the past two lessons, the load must be coupled to the tank circuit either inductively, capacitively, or directly. Consequently, any variation in the value of the load reacts back upon the tank circuit, changing its impedance and thus shifting the frequency of the oscillator.

Tetrode Electron-Coupled Oscillator

An effective method for making the frequency nearly independent of load variations is to use an oscillator circuit in which the load cannot affect the tank-circuit impedance. The electron-coupled oscillator accomplishes this by supplying the output by means of an electron stream that passes right through the electrodes of the oscillator portion of the tube itself, and couples it to the oscillating circuit.

A typical arrangement, using the popular Hartley oscillator circuit and a screen-grid tube is shown in Fig. 1. As the screen grid has a positive potential applied to it by the voltage-divider resistor *R*, it serves as the plate of a triode oscillator composed of the tank circuit *LC*, the control grid, the cathode, and the screen-grid functioning as the plate. That portion of tank coil *L* between the cathode and ground functions as the tickler or feedback coil because it is in series with the cathode circuit. The screen grid is maintained at a *positive* potential sufficiently above that of the cathode so that enough of the electrons emitted by the cathode strike the screen grid to enable strong sustained oscillations to be generated in the control-grid tank circuit, just as in the case of the conventional triode Hartley oscillator. The frequency of the oscillations is determined mainly by the value of *L* and *C* in the tank circuit.

Fig. 2. Several compression-type trimmer capacitors for use in superheterodynes.



However, the larger number of electrons is attracted by the higher positive potential on the plate, so they pass right through the openings in the mesh of the screen grid and reach the plate, thereby causing current to flow also in the plate (load) circuit. Since the intensity of the stream of electrons getting through the screen to the regular plate also is being varied by the oscillating potential on the control grid (the frequency of this oscillating potential being determined by *LC*) the plate current, flowing through the load, is modulated at the oscillator frequency. This outer section of the tube really acts as a triode whose mu is varied at the oscillator frequency.

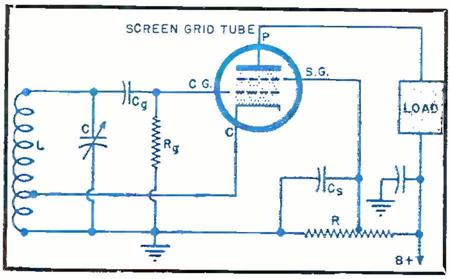


Fig. 1. Typical electron-coupled Hartley oscillator using a tetrode tube. The screen functions as the plate of the oscillator circuit, while the load, connected to the plate proper, is coupled to the oscillating circuit only by the stream of electrons.

Notice that the oscillator circuit and the output or plate circuit are coupled together only by the stream of electrons within the tube—hence the name *electron-coupled* oscillator.

In addition to serving as the plate for the oscillator portion of the circuit, the second grid also serves as a screen grid between the plate and the control grid of the tube. This is made possible by maintaining the screen at ground r.f. potential by means of by-pass capacitor C_s. Since the possibility of capacitive feedback occurring from plate to control grid is thereby largely reduced, variations occurring in the load circuit do not react strongly back upon the input grid circuit through any such a feedback path, and so do not appreciably affect the frequency of oscillation. Electron-coupled oscillators employing tetrode tubes in which the ratio of d.c. screen to d.c. plate potential is maintained at a suitable value, have excellent frequency stability as compared to the usual self-excited triode oscillator, and have been widely used in superheterodyne receivers.

Pentode Electron-Coupled Oscillator

Actually, a small amount of plate-to-control-grid feedback is still present in the tetrode type electron-coupled oscillator, so the oscillator frequency is not completely independent of load variations. By employing an r.f. pentode tube instead, such capacitive feedback can be eliminated and the frequency stability further improved.

A typical circuit using an r.f. pentode tube is shown in Fig. 3. The pentode is connected so that its first two (inner) grids constitute the control-grid and plate of a conventional triode Hartley-type oscillator, while the regular plate supplies the load. The electron stream flowing through the tube to the regular plate is varied by the oscillating potential on the control grid, so that the plate current, flowing through the load, is modulated at the oscillator frequency, just as in the case of the tetrode-type electron-coupled oscillator.

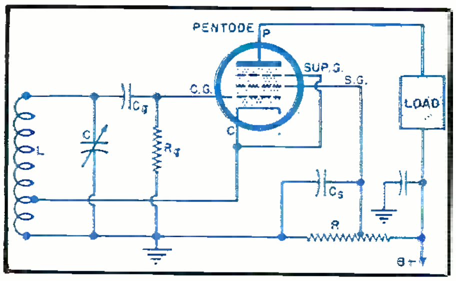


Fig. 3. Electron-coupled Hartley oscillator, employing a pentode tube.

The third, or "suppressor" grid (the grid nearest the plate), which is maintained either at cathode potential or at ground potential, acts as an electrostatic screen which shields the plate from the two inner grids and so practically eliminates any capacitance between the plate and the two inner grids of the tube.

Consequently, variations in the load will have no effect on the frequency of oscillation, since the electron stream that supplies the output is unidirectional and all internal tube capacitances (capacitive feedback paths) between the plate and the first two grids have been virtually eliminated. Of course, no external capacitances or other sources of coupling between the load and the oscillatory circuits must be allowed to exist, if maximum frequency stability is to be attained. While this type of oscillator is free of frequency drift due to variations in load, it is not free of frequency drift due to variations in plate-supply voltage. However, it is widely used—especially in superheterodynes that employ a pentagrid converter tube which performs the dual functions of oscillator tube and frequency-converter tube. Frequency conversion will be studied in a later chapter.

Characteristics of Electron-Coupled Oscillators

Electron-coupled oscillators possess excellent frequency-load stability, but since their waveform is not especially good, their output contains harmonics. These harmonics are advantageous for some oscillator applications; in others they are undesirable. Also, variations in tube temperature, plate-supply voltage and changes in the *L* or *C* of the tuned circuits affect the oscillator frequency as they do in a normal triode oscillator circuit. The limited power-dissipating ability of the screen grid restricts the oscillator output to 10 or 20% of that for the same tube in a conventional oscillator circuit.

Types of Oscillators Employed in Receivers

Due to the fact that various frequency-conversion systems and circuits are used in superheterodyne receivers, the oscillator arrangements employed appear at first to be quite varied. Careful checking of their circuits, however, soon reveals that actually they are but minor variations of the few fundamental types already described in this series. Of these circuits, most receivers use either the Hartley, Colpitts, or the tickler-feedback types. In many multiband receivers the oscillator will be found to employ cathode-circuit feedback on the broadcast band and a conventional plate-circuit tickler for the medium and short-wave bands because the latter arrangement provides stronger oscillator output at the higher frequencies.

Tuned Circuit Tracking Requirements in Superheterodynes

Most present-day superheterodyne receivers are designed so that only a single control must be operated to tune the receiver to the desired signal. (We will consider first only the conventional type of receiver in which station tuning is done by means of variable capacitors mounted on a common shaft to provide single control—permeability tuning will be considered later.) This creates two important tuning problems:

(1) There will be one or more signal-frequency tuned circuits in the r.f. section of the receiver (depending upon the particular preselector and r.f. amplifier arrangements employed), whose variable tuning capacitors must be ganged to rotate simultaneously and whose resonant frequencies must be closely similar for every setting of the tuning control over the entire signal tuning range of the receiver.

(2) The variable tuning capacitor of the oscillator must be ganged to rotate simultaneously with those of the r.f. circuits, and the oscillator circuit must be so arranged that for all tuning settings the *difference* between the resonant frequencies of the r.f. (preselector) and the oscillator tuned circuits very closely approximates the intermediate frequency employed in the receiver.

The resonant frequencies of the various tuning circuits in a conventional broadcast receiver employing a 455-

(*Continued on page* 104)

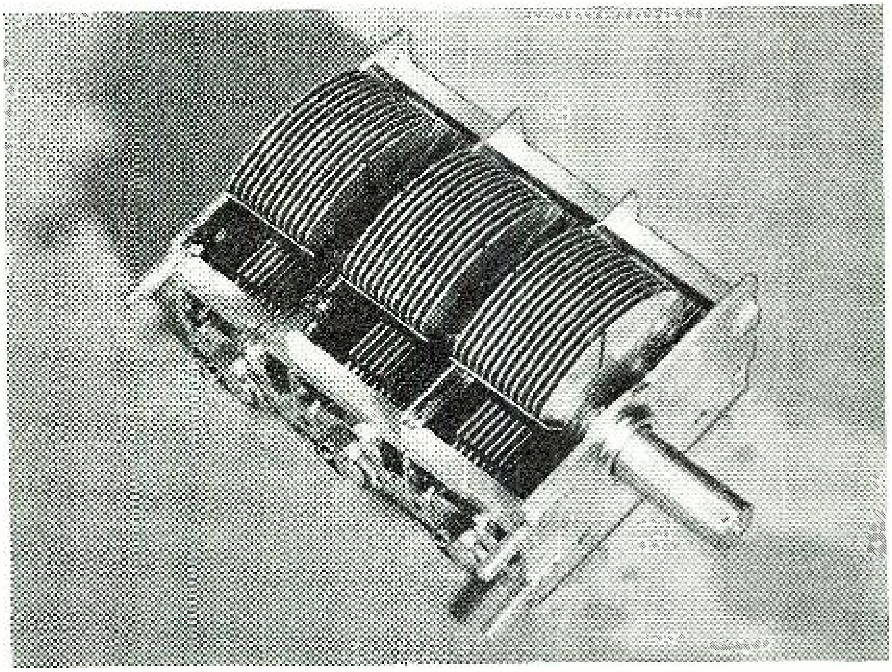


Fig. 4. Three-gang tuning capacitors with slotted end plates on each section, for aligning r.f. tuning circuits at low-frequency end of the tuning range.

Fig. 5. Trimmer capacitor systems for high-frequency alignment of signal-frequency circuits, generally employed in present-day superheterodyne receivers.

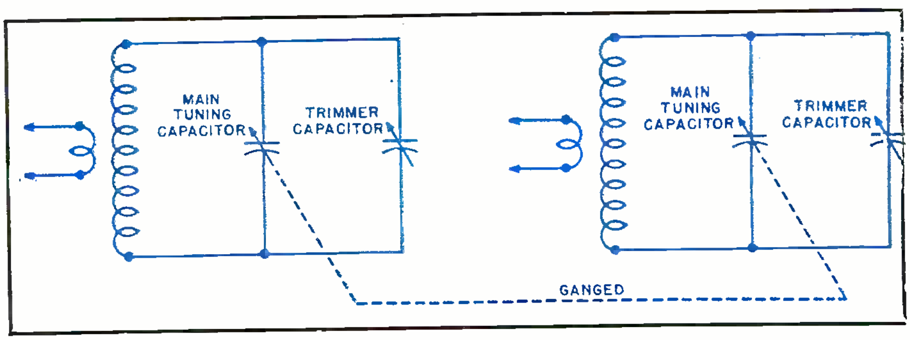
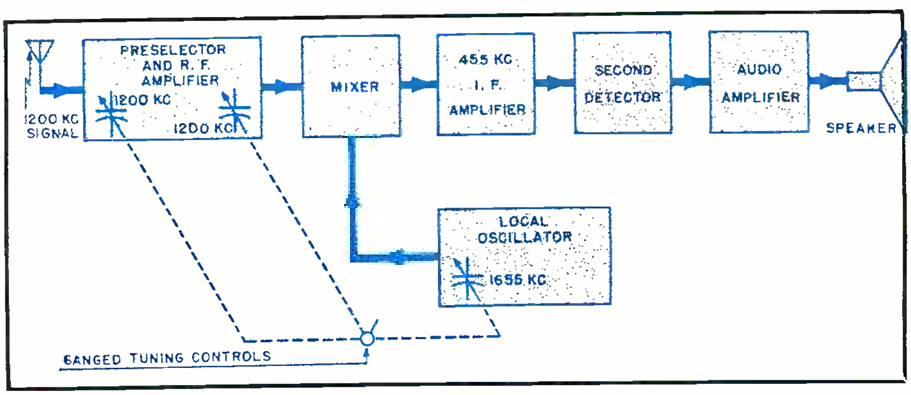


Fig. 6. Ganged tuning controls, and resonant frequencies, in a superheterodyne.



RADIO SPEARHEADS PATTON ARMOR

By OLIVER READ
Managing Editor, RADIO NEWS

Mobile communications proved to be the vital link in obtaining complete coordination of our ground and air forces over the Rhineland.

WHEN General Patton's famed Third Army plunged across the Reich, mobile radio units were spearheading the advancing Armor and, in conjunction with the 9th AF tactical air liaison, were setting the stage for our onrushing troops.

Attention has been directed many times to the important part that bombing and air support have played in our invasion of Germany. In fact, air power had been receiving most of the attention in the press. Without radio, however, air support, no matter how tremendous, could not fulfill its complete objective. It takes ground troops, and plenty of them, to win a war. So important is the part that mobile communications has played that a case history taken from the records of the Third Army indicates the effectiveness of this liaison.

In order to be completely effective, transmitters of sufficient power must be utilized so that vital information can be sent to planes in flight and to all other stations over whatever network is used. Small sets such as the "handie" and "walkie talkie" are far from satisfactory for any such operations. Correct information given by radio to pilots can result in the effective bombing of the target. Inadequate information can, and has, resulted in our own troops being bombed accidentally. Early in the war, it became apparent to our Generals that the effective range of communications would have to be stepped up at once. This has been done.

The original mobile radio units known as the *Hallicrafters* SCR-299 were first used almost entirely by the U. S. Army Signal Corps. Other military branches soon, realizing their effectiveness, adopted them for their own communications. For example, the 9th AF tactical air liaison section, cooperating with the U. S. Third Army, used many of the latest versions of the SCR-299 to spearhead their advancing Armor and troops. Later models known as the SCR-399 and SCR-499 now operate in all theaters.

Maj. Thomas R. Iverson, 9th AF tactical air liaison officer with the U. S. Third Army, uses radio to direct fighter-bombers to enemy targets obstructing units of Lt. Gen. George Patton's Army. P-47 Thunderbolts of Maj. Gen. Hoyt S. Vandenberg's 9th AF, responding to radio directions, are proving decisive factors in eliminating strong points to permit the advances of ground forces.

The newer versions of the now familiar SCR-299 incorporate one important change, namely, an increased frequency range. In the original model, the coverage was from 1,500 to 12,000 kc., while the SCR-399 and SCR-499 give a coverage from 1,500 to 18,000 kc.

The essential difference between the SCR-399 and the SCR-499 is in the housing. The SCR-399 is built into a shelter, while the SCR-499 is adapted for air transportation and is not mounted on a truck chassis. Two cabinets house the essential equipment for both of these units and the entire transmitter and receiving equipment may be removed from the truck as two units. The gasoline a.c. generator is supplied with all three units, but in the case of the unit designed for air transportation, the generator is mounted on skids rather than on a rubber-tired trailer. These units, like their predecessor, have a transmitter power of 450 watts c.w. or 325 watts for phone operation.

When Armor or Infantry of the Third Army was halted by a strong point, ground commanders asked for air cooperation. Minutes after the request, the air liaison officer, using his mobile truck and equipment, dispatched the required number of P-47 Thunderbolts to knock out the obstacle. The section coordinated and directed the use of P-47 Thunderbolts of Maj. Gen. Hoyt S. Vandenberg.

Additional support came from the use of radio-equipped L-5's (reconnaissance planes) of the 9th AF tactical air liaison section. Its job was to report on enemy targets during flights across the Rhine and other objectives. These planes were invaluable in locating enemy troop movements and strategic targets. They maintained constant communications with the mobile units operating in conjunction with the ground forces.

The unarmed reconnaissance plane flies at low levels and maintains constant communication with the ground

A radio-equipped L-5 of the 9th AF tactical air liaison section with the U. S. Third Army reports on enemy targets during a flight across the Rhine. The tactical air liaison coordinates and directs the use of P-47 Thunderbolts.

mobile transmitter. From the information derived from the reconnaissance pilots and from other sources, the coordinating officer in the mobile station can direct farflung operations involving air and ground forces.

The personnel operating the mobile units faced a constant danger from air and ground attacks. The enemy had a high priority on their destruction. They knew in no uncertain terms that their presence meant nothing but more trouble for them. They knew also that not too far away soon would come the onrushing Armor of one of our armies. The enemy, accordingly, was ever alert for the opportunity to destroy these versatile radio units.

That these mobile units were choice targets of the Nazi airmen is emphasized by the fact that several of their planes that had been shot down by our airmen carried photographs and "aerial views" of our mobile radio units displayed on the cowling of the plane to aid the enemy aviator in spotting these targets.

In future years, when students of military warfare look at the records, they will find that World War II was largely fought and won by the use of radio and electronic equipment of the highest order. Many postwar amateurs will recall the bitter days of war when they literally sweated blood in one of Uncle Sam's mobile units somewhere in Germany, Africa, or Italy and will be again using highly-refined equipment resulting from the perfection achieved on the battle field and in the laboratory at home.

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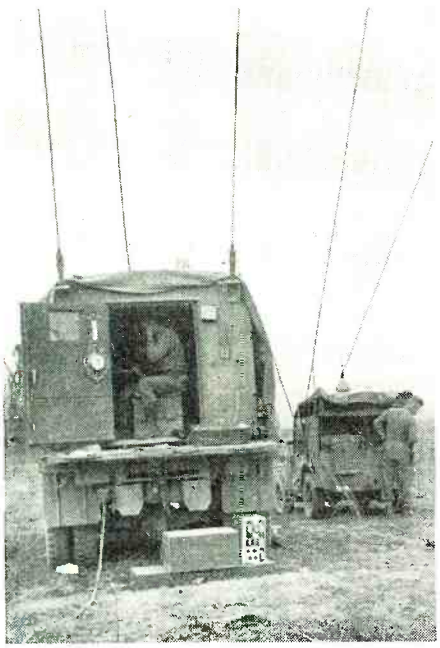
When Armor or Infantry of the Third Army is halted by a strong point, ground commanders ask for air cooperation. Air liaison officer dispatches P-47 Thunderbolts via this SCR-399 mobile radio truck.



Radio operators at work in the mobile communications truck of the 9th AF tactical air liaison section with the U. S. Third Army. The section coordinates and directs the use of P-47 Thunderbolts of Maj. Gen. Hoyt S. Vandenberg's 9th AF in eliminating obstacles holding up Armor and Infantry of the Third Army. Left to right, Cpl. Edward W. Matlock, Struthers, Ohio; and Pfc. J. R. Philpot, Salisaw, Okla.

TELEVISION R.F. and I.F. SYSTEMS

By EDWARD M. NOLL

Part 6. Theoretical design and function of the various r.f. and i.f. stages that make up a television receiver.

DuMont deluxe television receiver, with 20-inch teletron, providing 11 x 16-inch images that can be viewed by large groups.

THE r.f. section of the television receiver amplifies, and converts to a lower frequency, the high-frequency television signal coming through the transmission line from the antenna. This r.f. section consists of an antenna coupling circuit, r.f. amplifier (if used), mixer, and local oscillator. It is apparent that the r.f. section is conventional in number and types of stages; however, the r.f. section must have a broad flat band-pass characteristic, pass both picture and sound carriers, and separate picture and sound into individual i.f. systems.

The antenna-coupling circuit must match the transmission line to the r.f. amplifier, or more often, the mixer input. A simple antenna coupling system, Fig. 4A, consists of an untuned primary and a tuned secondary. A number of conditions must be met to transfer maximum signal of the proper bandwith from transmission line to input grid circuit:

1. The input transformer must properly match the transmission line to the input circuit. This match is accomplished by using a primary having less turns than the secondary and, therefore, a primary which has a negligible impedance as compared to the impedance reflected from the secondary. The actual value of the reflected impedance (almost entirely resistive when secondary is tuned to resonance) is dependent on the degree of mutual coupling between primary and secondary windings. Consequently, the physical position of the windings with respect to each other is designed to properly match impedances.

2. The tuned circuit must be sufficiently loaded to flatten the resonant peak of the tuned circuit and pass the required bandwidth. Loading can be done in three ways: (1) tight coupling or overcoupling between windings, (2) series resistance in the tuned circuit (can be high-resistance coil wire), and (3) resistor shunting the tuned circuit. Conveniently, at the higher r.f. frequencies, loading is not always necessary for the lower Q of the high-frequency coil and capacitor combination produces an inherent bandwidth which is sufficiently broad. At the lower i.f. frequencies it becomes necessary to load the tuned circuits with shunt resistors.

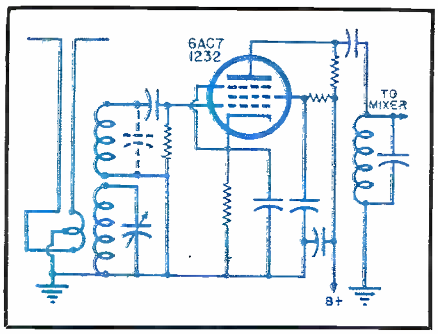
3. To obtain maximum transfer of signal, the tuned circuit is designed to have as high a Q as possible. Since Q is proportional to the ratio of inductance to capacitance of the tuned circuit when the resistance is held down, a tuned circuit with a high L-to-C ratio is desirable. Thus, although the Q of the circuit must be decreased more to attain the proper bandwidth

$$Q \text{ equals } \frac{f \text{ at resonance}}{f \text{ high end of band} - f \text{ low end of band}}$$

the secondary impedance at that point is considerably higher (Z equals ωLQ), for the inductance has been increased. This means that the resonant voltage in the grid will be higher and the coupling can be made tighter. Thus, the tuned circuits use a minimum of capacity to obtain the utmost in signal transfer and gain. For this reason, the tuned circuits often use inductors, having movable iron cores, which resonate with no physical capacitor, but with the total distributed circuit capacity (wiring capacity, parts' capacity to ground, and input and output capacities of the tubes). Thus, no physical capacitor must be added to the circuit for purposes of tuning.

Many of these factors are design problems but they are mentioned to inform the serviceman of how critically the r.f. circuit is evolved. Although the circuits appear very basic and simple, their design and position-

Fig. 1. Conventional r.f. amplifier.



ing are very critical. Accordingly, rearrangement of parts and wiring, substitution of poor-quality high-capacity tubes, or replacement with incorrect or poor-quality parts, can readily add more circuit capacity and upset the tuned circuits and band-pass characteristics.

4. The primary winding is center-tapped and grounded to cancel out undesirable signals picked up on the transmission line itself.

A second antenna coupling system, Fig. 4B, uses two tuned circuits and approximately doubles, for the same bandwidth, the amplitude of the signal applied to the input grid. In this type of circuit, the impedance matching is taken care of by properly proportioning the inductance and capacitance content of the tuned circuits. Thus, the secondary has a high L/C ratio and a high impedance (Z equals ωLQ); while the primary has a low inductance but is tuned to the same resonant frequency by a considerably larger capacitor. The latter primary circuit has a negligible impedance compared to the reflected resistance from the secondary. If the inherent resistance of the secondary is not sufficient to produce the proper bandwidth, a resistor may be shunted across the secondary.

Still another coupling system, Fig. 4C, uses an additional tuned link circuit which couples the tuned secondary to the untuned primary. The advantage of this type of circuit is its ability to drop sharply off at the extremities of the band-pass. The gain of this system is the same as in Fig. 4B, and the impedance match is influenced by the mutual coupling M1; however, the extremities of the band-pass and the sharpness of the cutoff at these points are influenced by the mutual coupling M2 between the two tuned circuits. The steep cutoff is instrumental in reducing pickup from adjacent channels and in reducing image response.

R. F. Amplifier

The r.f. amplifier, when it can be advantageously used, brings about the following improvements:

1. Improves receiver sensitivity, improving signal-to-noise ratio and reducing image interference.
2. Acts as buffer between antenna and oscillator, preventing radiation of the local oscillations.

In the prewar receiver, the above advantages could not be utilized to the fullest because no tubes were available which had sufficient gain with wide band-pass design to warrant the additional cost, and only slight improvement in signal-to-noise ratio. With the advent of miniature and lighthouse tubes, the postwar receiver promises to permit high-gain r.f. stages. The advantages of such a stage are understood when it is considered that, in a satisfactory location, the noise most dominant in the receiver is converter noise, and the larger the signal present on the converter grid, the higher the signal-to-hiss or noise

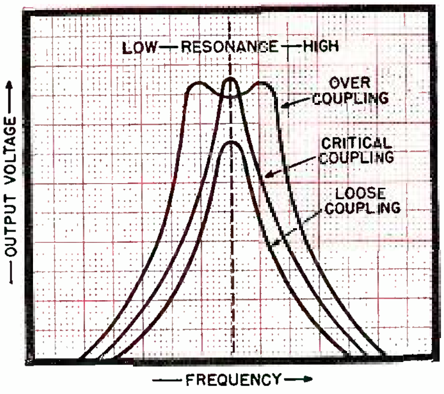


Fig. 2. Mutual coupling response.

level becomes. This high noise level can be traced directly to the low impedance of the grid circuit at high frequencies and wide-band characteristics of the signal. Here again, the need for maintaining a high L-to-C ratio to hold up the grid impedance is demonstrated. A typical r.f. stage as found in prewar receivers is shown in Fig. 1. These stages only had a gain of approximately 2, and therefore, if any improvement was to be realized, the input circuits had to be very carefully designed and the converter had to operate at its peak efficiency.

Mixer and Local Oscillator

Undoubtedly, one of the most carefully designed stages of the television receiver is the mixer, for it is here that the signal-to-noise ratio originates; the greater the signal on the grid of the mixer, the higher it will rise above the noise. Likewise, the more efficiently the signal is utilized by the converter, the more it will rise above the tube noises generated in the conversion. Demonstrated previously was the need for delivering as much signal as possible to the grid and the need for holding up the grid impedance.

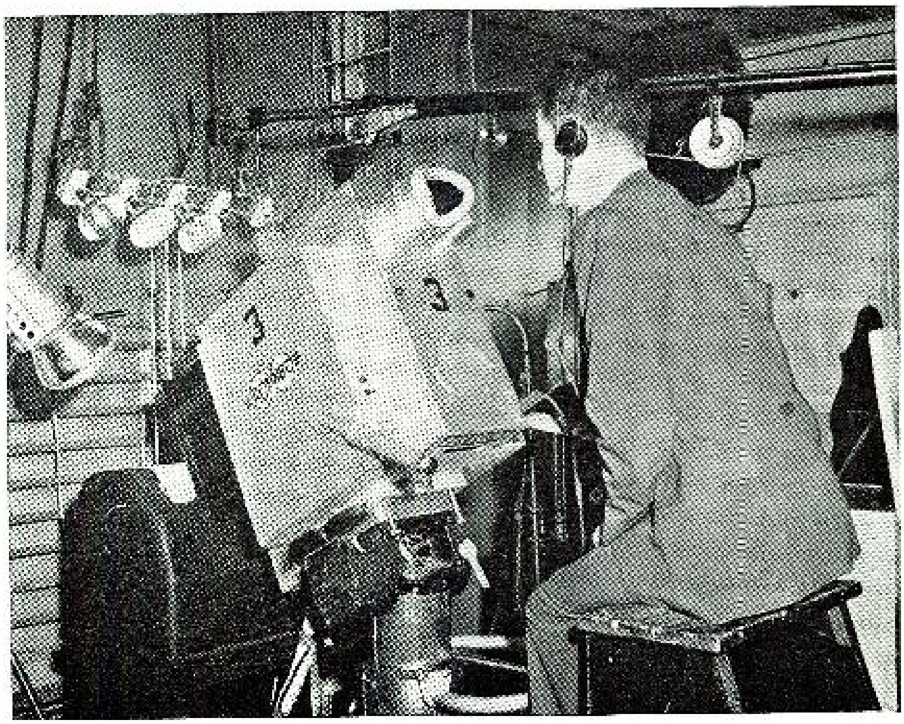
Now another factor, the conversion transconductance, is to be considered. Mutual conductance is a measure of how effectively a tube converts a change in grid voltage to a change in plate current, both changes occurring at the same frequency; conversion conductance, a measure of how effectively a mixer converts a change in grid voltage at the signal frequency to a change in plate current at the i.f. frequency. In determining the figure of merit of a tube at television frequencies, the input and output capacities must also be considered, as they are instrumental in reducing the L-to-C ratios of the input and output circuits. Thus, the figure of merit for a television mixer is:

$$\text{figure of merit} = \frac{\text{conversion conductance}}{\sqrt{\text{C input plus C output}}}$$

The mixer, therefore, if properly designed, will have the following characteristics:

1. Use a tube with a high conversion conductance. Typical tubes are 6AC7, 1232, or 6F8.
2. Have a high L-to-C ratio input circuit; wiring and other distributed capacities should be kept at an absolute minimum.
3. Use a mixer-oscillator combination giving peak conversion to noise. Such a combination is obtained by using a mixer with a high conversion conductance and injecting the local oscillations, of correct amplitude, directly into the signal control grid. Consequently, a separate oscillator is definitely preferable.

Latest stock market returns or news flashes can be televised directly from the ticker-tape machine to the awaiting public, providing instantaneous reports.



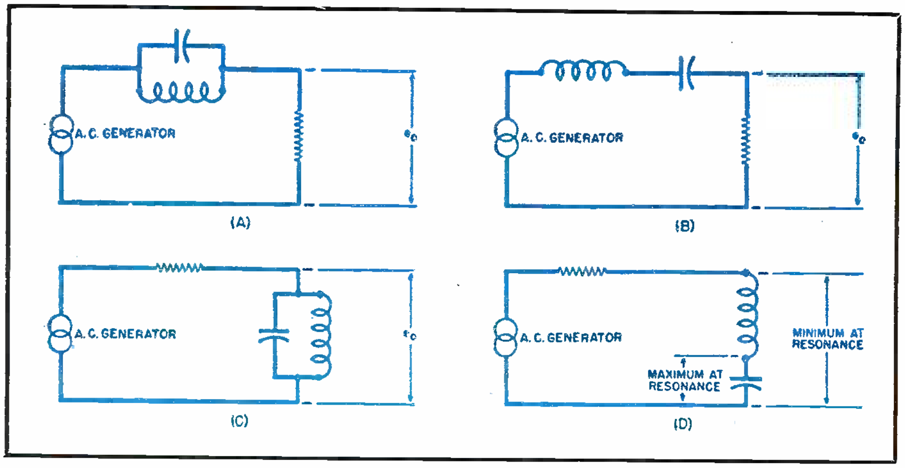


Fig. 3. Resonant circuits. (A) The output voltage e_o is minimum at resonance, increasing as the frequency departs from resonance. (B) The output voltage e_o is maximum at resonance, decreasing as the frequency departs from resonance. (C) The output e_o is maximum at resonance, decreasing as the frequency departs from resonance.

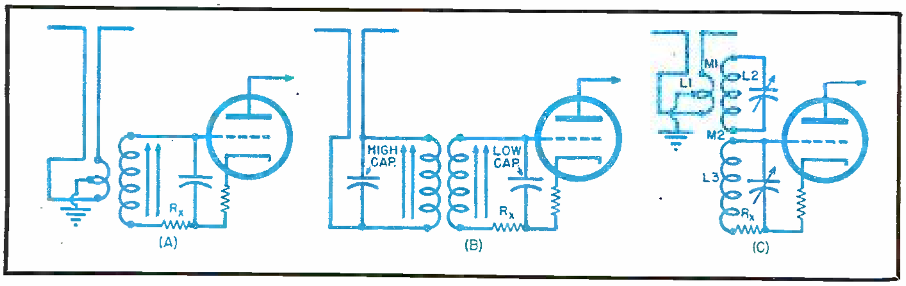


Fig. 4. Various methods of coupling an antenna to the receiver. (A) Employing untuned primary and a tuned secondary. (B) Employing tuned circuits in both primary and secondary. (C) Employing an additional tuned link circuit over that shown in (A).

4. Two typical mixer-oscillator combinations are shown in Figs. 5 and 6. Some of the features of these circuits, features which you will find are more or less typical, are as follows:

1. Use of band-switching. This feature is not only employed as a convenience for the televiewer in changing stations, but definitely improves the performance of the receiver. The optimum design of a tuned circuit depends on a number of variables: inductance, capacity, frequency, bandwidth, resistance, and mutual coupling. Since many of these variables depend on frequency, a tuned circuit of optimum performance can not be designed for one frequency or channel and still have the same optimum characteristics a few channels away. Consequently, continuous tuning is not used; instead, each band has its own circuit parameters inserted by a switching system which changes mixer and oscillator tuned circuits. In the circuit of Fig. 5, the secondary of the input transformer has various capacitors and inductors switched in to insure optimum performance on each band. The actual mutual coupling system between primary and secondary is not changed by the band-switching mechanism, but the various capacitors and inductors in series and shunt with the secondary are. In the circuit of Fig. 6, both the primary and secondary of the input transformer are switched when changing hands.

2. Fine tuning is accomplished on each band by a small vernier capacitor which tunes only the oscillator until the proper difference frequencies appear in the output. By frequencies it is meant both sound and picture, as explained in previous installments.

3. In transformer secondary, Fig. 6, use of inductance tuning permits the tuned circuit to resonate with the fixed distributed capacity. Tuning is accomplished by varying the circuit inductance to eliminate the added capacity of a variable capacitor which would reduce the L-to-C ratio.

4. Use of high conversion conductance tubes with low element capacities. Separate oscillator tube used with grid injection of mixer to raise conversion efficiency.

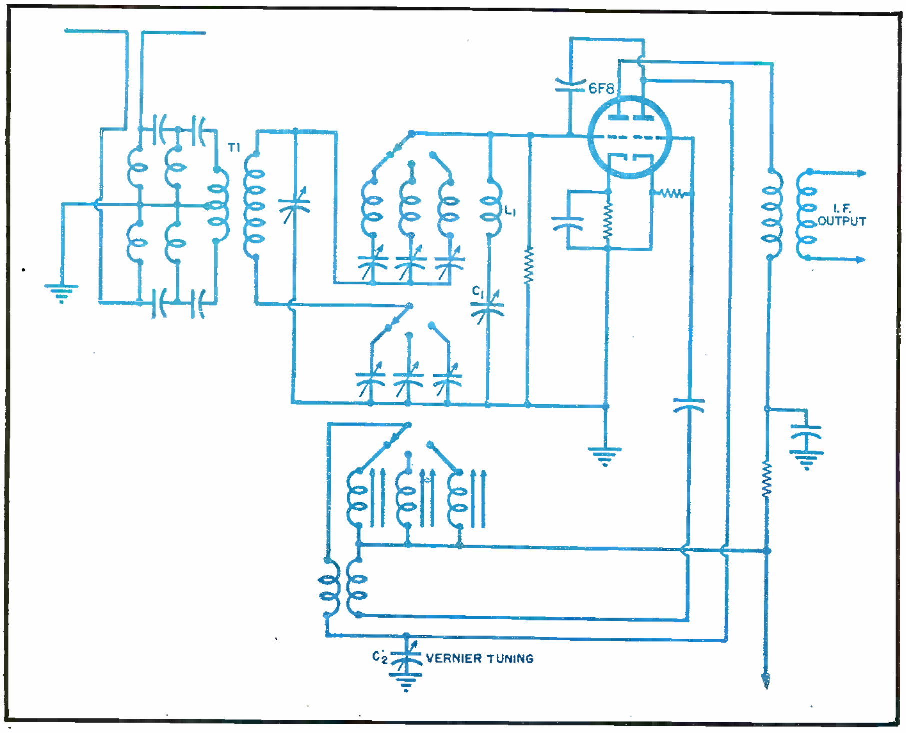
5. Use of a high-pass filter in the transformer primary, Fig. 5, to reduce sensitivity of receiver to lower frequencies, particularly the i.f. frequencies. This permits use of high-gain i.f. systems without danger of i.f. oscillations caused by feedback into the low-level stages. A series resonant circuit L1C1, tuned to the i.f. frequency, presents a virtual short circuit to ground for any i.f. feedback attempting to get on the grid of the mixer.

6. Relatively low-value grid resistors are used to load the tuned circuits and broaden the frequency response.

The local oscillator of the television receiver must also have a high mutual conductance to oscillate efficiently, and with stability, at the high frequencies. Tubes such as the 6J5 and 7A4, connected in modified Hartley or ultraudion circuits, function well as stable oscillators. To improve stability and reduce loading, at a small sacrifice in output voltage, the oscillator tuned circuit has a relatively small L-to-C ratio which means a tuned circuit that has considerable energy storage and reluctance to follow shifts in circuit constants. Oscillator tuning is also often a matter of changing inductance with a movable iron-core or a shorted

(*Continued on page* 96)

Fig. 5. A typical mixer-oscillator circuit, employing a 6F8 dual triode tube.



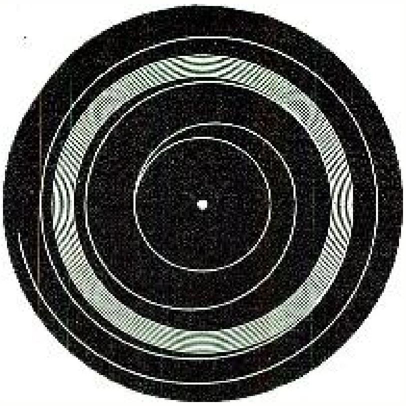


Fig. 1. Your home recordings should have run-in and -out grooves, as shown.

TALKING DOORBELL

By E. R. MEISSNER

The operation of this unique gadget may well be applied commercially to postwar announcing systems.

HAVE you ever dreamed of the things you could do with a talking doorbell? One that would speak right up, to the astonishment of the doorbell pusher, and leave him standing in amazement. For instance at Christmas time a special greeting could be recorded with appropiate background music that would greet your friends when the doorbell is pushed. Or at Halloween you could produce a talking ghost for the "Trick or Treat" guest.

How can all this be done? Well, if you have an automatic record changer you are willing to donate to the cause and a small amplifier, your problems are practically solved. With the addition of a relay and a limit switch you can work out your own design. The home recording must have a run-in groove and a run-out groove, as shown in Fig. 1, to make the recycling operation take place quickly.

Lacking these facilities you can build a simple recycling phono-player by simply making a disc, as shown in Fig. 2, to ride on top of the record. Traction to make this disc revolve at recycling time is secured by placing a washer of approximately two inches in diameter over the center pin, weighted so that when the needle passes point *A* the disc will begin to turn with the record. The author found that approximately eight ounces worked very well.

To better understand the operation let us follow a complete cycle of operation. The needle is normally at rest at the point *E*. Here the pickup arm rests against the limit switch which keeps the power from reaching the motor or the amplifier. When the push button is actuated, the limit switch is by-passed and the motor starts. The run-out groove quickly moves the needle to *A* where it enters the slot *A-B*. The celluloid disc starts to turn due to the friction between it and the record. By the time the needle has reached point *B* the disc has gained sufficient momentum so that the needle will ride up on top of the celluloid disc. Here it follows around in the spiral groove and drops into the slot *C*. The edge of the celluloid disc *D* then strikes the needle which stops it from rotating. All during the playing operation the disc drags. Thus, a fairly heavy motor is needed so that the playing speed is not cut down.

The run-in groove quickly runs the needle into the playing portion of the record. Finally the arm strikes the limit switch, which stops the cycle.

So that the amplifier will not have to be energized except when in use, a quick heating one, as shown in Fig. 3, can be constructed. Using a 5Z3 in the rectifier, it was found that the needle had completed its rough and noisy journey over the surface of the recycling disc and was in position to play by the time the tubes were heated. Thus, the noise of recycling was kept out of the loud speakers. Two speakers are used. One at the door and one in the house in place of a bell.

The limit switch must be one that the pickup arm will operate without making the needle jump grooves. The author used a coin switch from a juke box. These switches are normally open but by taking them apart one can turn the mechanism over to make a normally closed switch.

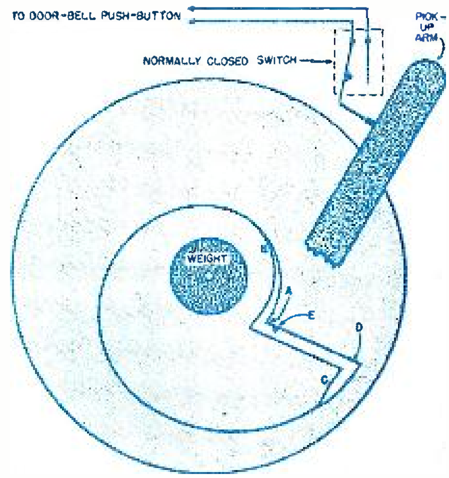
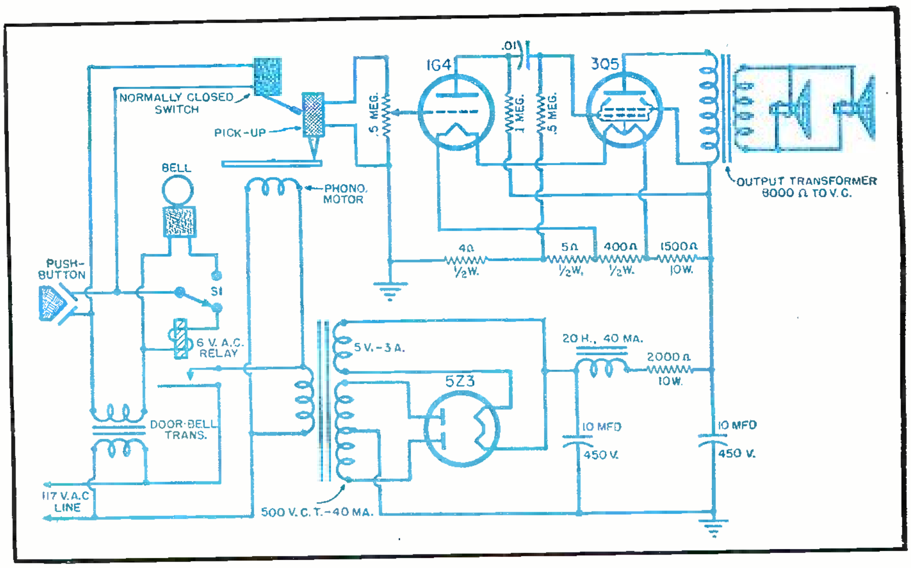


Fig. 2. The recycling disc, an important factor of this unit, should be cut out and grooved, as shown in the above diagram.

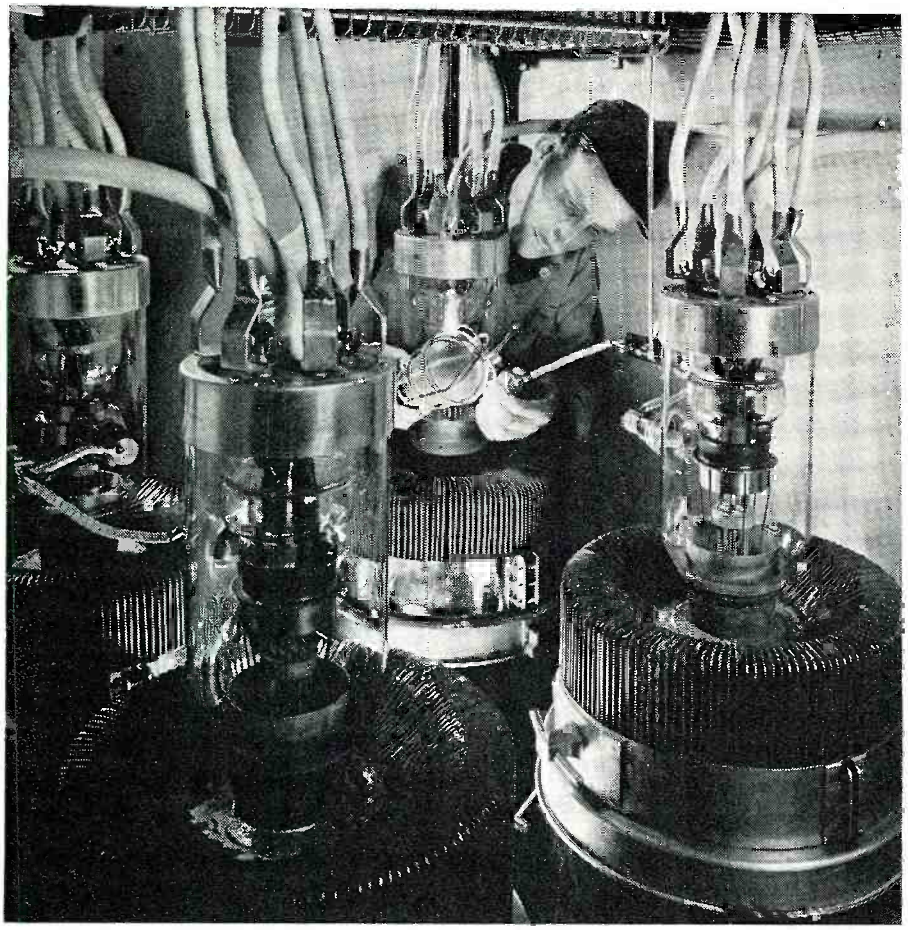
So that all the small children, and some of the larger ones, too, will not be continually calling you to the door it is well to include the switch S_1, which places the regular bell back in the circuit. —30—

Fig. 3. Circuit diagram of the complete unit. The limit switch is held in open position by the pickup arm at the end of an operation cycle and remains in this position until again actuated by the push-button.



ELECTRONICS-at Work

By GLENN BRADFORD



Two of these 50,000-watt air-cooled modulating tubes at KDKA are spares. By simply pushing a button, the operator can put them into service without interrupting transmission.

THE field of electronic application is in a furore, as can be seen by a casual survey of the advertising pages of any technical or semitechnical magazine—for that matter, any general magazine—popular or technical.

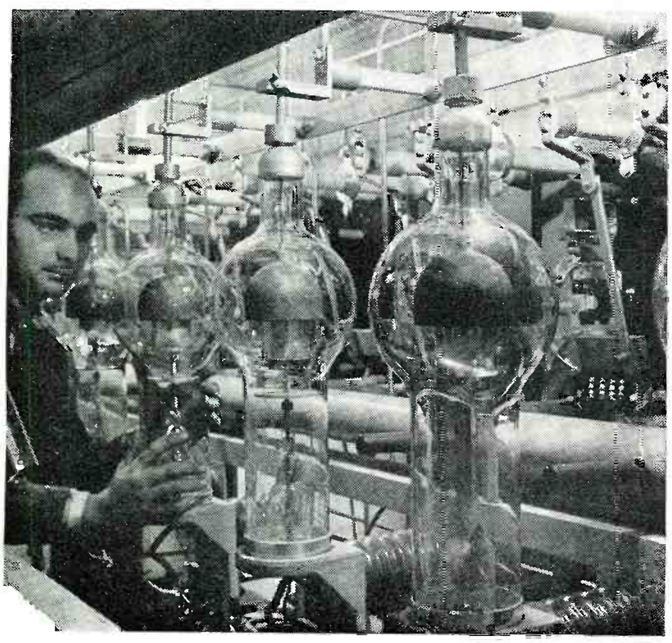
This condition has undoubtedly been promoted by the need for wartime secrecy—there is nothing that can be said about so much that our advertisers frequently say much about nothing! "Electronics" has become an advertising catchword and a magic cure-all which, after the war, is expected to reduce all work, both mental and physical, to the mere exertion of pushing a button!

In view of this situation, which to workers in other fields must appear positively baffling and before attempting to find a "place" for electronics in power generation, it seems desirable that the term "electronics" be defined, and discussed, to place it on a solid engineering basis. Men in other fields may then be in a better position to assay the future effect of electronics on their own field of interest, without becoming electronic engineers.

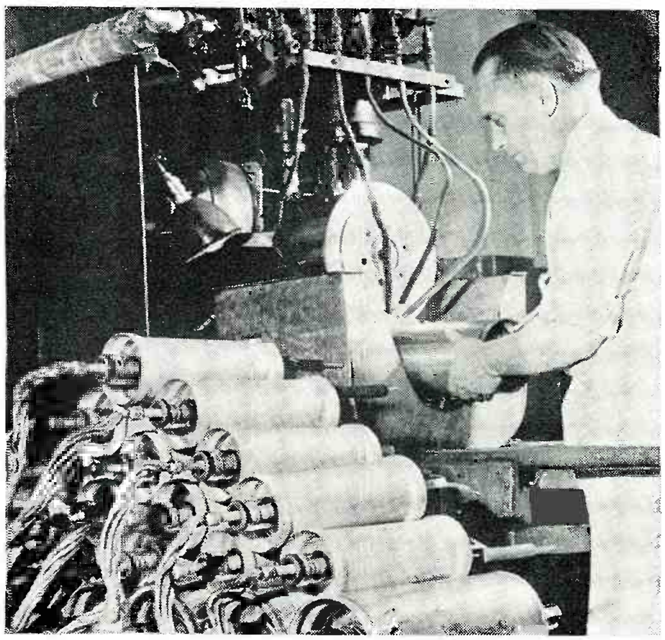
There are two ways in which electronics differs from power electrical engineering in its viewpoint of the electron.

First, in electronics we are con-

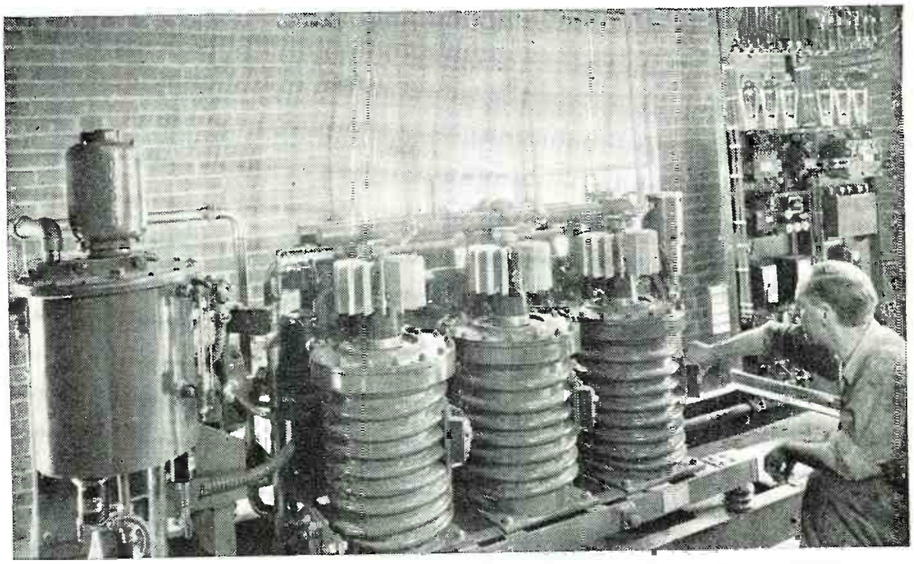
These high-voltage rectifier tubes change alternating current into direct current for radio transmission. Automatic relays are used for changing tubes without interrupting broadcasts.



These metal-encased Ignitrons convert alternating current into direct current needed to make aluminum for our fighting planes. Workman is shown seam-welding metal jacket to tube.



Electronic tubes and equipment for power conversion will play a leading role in postwar production.



This Ignitron installation, for changing alternating current into direct current, provides efficient conversion, is compact, and has high overload capacity.

cerned primarily with the actions of free or individual electrons relatively unaffected by their surroundings, while in power electrical engineering we think of these electrons en masse, obeying laws which are statistical averages of the behavior of the separate electrons. These large groups of electrons are affected by conditions in the conductors in which they flow, such as electrical resistance.

A second, and possibly more important difference in viewpoint, is with respect to the velocities at which the electrons travel. In electronics we are interested in devices in which electrons travel unimpeded at speeds of thousands of miles per second; in power electrical engineering the electrons rarely move at rates greater than a few inches per second.

Because of the close relationship of the individual electron to electronics we may well ask—what is an electron? Present-day knowledge on that point does not go far. We can predict what an electron will do under certain circumstances but know nothing of its shape, size, or internal construction. Combustion engineers would be in much the same situation if they knew only the British Thermal Unit value of their boilers, but would be at a loss to understand what went on in the combustion process.

We do know that an electron is the smallest particle of matter, and that all matter contains electrons. We know that it takes 5×10^{29} electrons to weigh a pound—an inconceivable number. Our most important knowledge is that an electron carries an electric charge, is in fact our smallest-known indivisible unit of electricity. This charge is so small, however, that it takes 6×10^{18} electrons passing through every second, to heat a 100-watt, 110-volt lamp to incandescence.

Since an electron is an electric charge, then a flow or movement of electrons constitutes an electric current, whether it be in an electron tube, a lamp filament, or a motor.

We have seen that an electric current is the same, regardless of the material through which it flows, but it is the difference in the "material" of the path that furnishes us with a rather simple definition of electronics.

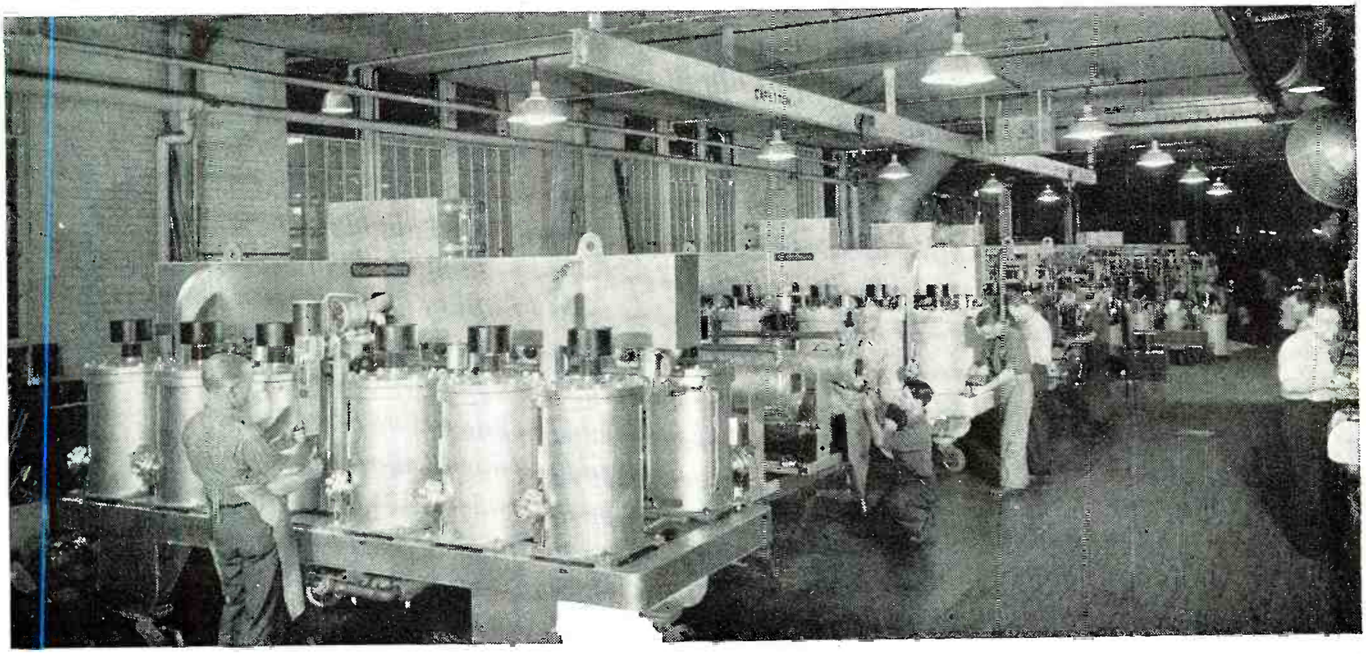
Electronics may be defined as the field of devices which function by reason of passage of electrons through gas or vacuum.

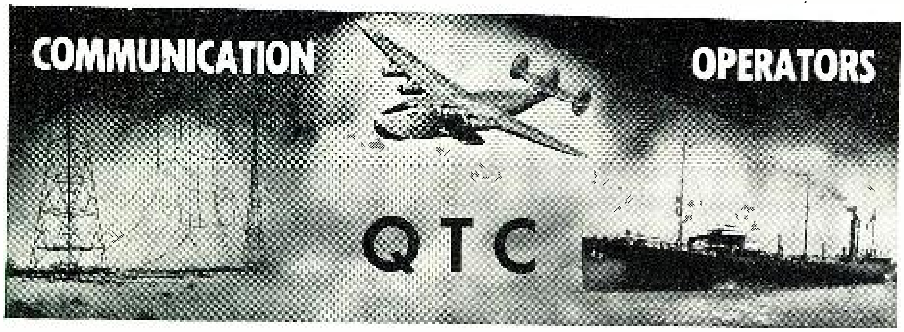
This definition establishes the fundamental distinction between power electrical engineering and electronics as a difference in the nature of electrical conducting path. It is seen to exclude conduction of electric current through solids or liquids, such as our power transmission and electrolytic processes, but to include all other cases of conduction of electric current (or electrons), such as our conventional radio tubes, gas-filled tubes, X-ray tubes, fluorescent lamps, neon lamps; and switches and circuit breakers in the power field.

While the latter are not usually thought of as electronic devices, yet

(*Continued on page* 151)

Having no major moving parts to require maintenance, the Ignitron delivers power continuously 24 hours a day. It is easily installed and can operate automatically and unattended. Ignitron rectifiers are today supplying dependable d.c. power for a great and growing number of America's vital electrochemical plants, and aluminum production processes.





By CARL COLEMAN

HARRY A. MORGAN, Vice Pres. of ACA's Marine Department, sends in the following comments regarding future possibilities, and points out that it is quite difficult under present conditions to forecast "things to come."

He says, "It is anticipated that the maritime industry will continue with an upward trend following the end of the war, and employment possibilities for merchant marine radio officers will continue at a peak for at least two or three years after the cessation of hostilities. The number of jobs which will be available for merchant marine radio officers will depend on whether or not three commercial radio officers are continued to be employed aboard merchant ships in peacetime.

"The ACA Marine Department shall encourage legislation intended to amend the Communications Act of 1934, as amended, to make it compulsory that a 24 hour, round-the-clock radio watch shall be maintained aboard all merchant vessels in peacetime as well as during the war. Recognition of the need for efficient communications in wartime has been given by our government by the establishment of a 24 hour, round-the-clock radio watch aboard merchant ships. Earlier in the war the ACA Marine Department urged that Congress and the War Shipping Administration place three commercial radio officers aboard all merchant ships. Since the very inception of the ACA in 1931, the union has sought a fair appraisal of the needs of efficient communications aboard all merchant ships in the interest of the promotion of safety of life and property at sea.

"It was only during this war that recognition of the need was given by our government. The ACA is convinced that efficient communications aboard merchant ships in peace and in war can be developed only through a 24 hour, round-the-clock watch aboard all merchant ships. During the course of the war, management, government and labor spokesmen have voiced the hope that a sound, efficient, and prosperous merchant marine shall continue in the postwar period. Efficient radio communications aboard merchant ships is a prerequisite to a sound, efficient and prosperous postwar merchant marine.

"It is my personal opinion that the U. S. Merchant Marine will afford broad employment possibilities to many of the war veterans in the postwar period. No doubt, many of the men now employed aboard our merchant ships will again seek employment ashore after the war. Under these circumstances war veterans will have an opportunity to seek training in radio communications in schools, both government and private, which no doubt will continue for some time."

A FINE letter has been received from Ero Erickson, Secretary-Treasurer of the Associated Police Communication Officers, Inc. Ero reports that H. Y. Gantt was at WQPC in Chicago until Christmas time and reportedly has been working the river boats and appears scheduled to return as Chief on the "South American" when the season opens.

"I hope you realize that not many employers would let you listen to the radio while you work!"

In contrast to previous reports by K. Green from the Gulf, Mr. Erickson would like more information from his seagoing friends and also to hear from the police radio oprs. He also sent along a copy of the report compiled on police radio which reveals among other things that over fifty departments intend to add c.w. equipment as soon as conditions permit and that there are already over 100 police radiotelegraph stations in operation. The report covers all points of the present systems in use and calls attention to the necessity of proper frequency assignment for this work giving a complete picture of the zone and interzone classes, bands required, etc.

"Wartime conditions stopped the expansion of the police radiotelegraph services, because of equipment shortages and radiotelegraph operator shortages. The equipment shortage needs no explanation. The radio operator shortage is serious. They have been absorbed by the Armed Forces, government jobs, and by more attractive jobs in war work, such as the merchant marine. Not only have additional operators been impossible to find, but the above named services have taken away many of the present operators. Tampa, Florida, for example, lost every c.w. operator but the Chief Opr."

The survey also points out, "Many departments have had to curtail c.w. operation on some shifts; some proposed stations have been held up by lack of operators. Immediately after the war there will be a great expansion of this already vital police radiotelegraph service. After the war there will be sufficient radiotelegraph operators available so that this will be no problem. Not only will the present ones return to civilian employment, but there will be hundreds of men trained as c.w. operators in the Armed Services, such as the Navy, who will obtain c.w. licenses, and thus be available.

"The expansion of the radiotelegraph service will begin immediately after the war. Because of traffic demands, operators being available, and because simpler, less expensive multichannel transmitters will be available, we expect the number of stations to increase to about 1000 in five years, an expansion factor of almost 10. Police officials are following a trend toward a policy that it is sound business to employ good, high-class radio operators, for they can obtain them at about the same salary as a regular officer. This not only frees an officer for regular police work but gives them better radio service. A station with good operators always has a better regular service. Good operators not only use better procedure, but can be used for necessary maintenance, technical construction, and other work when necessary. So police departments had just as well employ c.w. oprs."

Also received was a copy of the A.P.C.O. "Police Radio-'Phone" oper-

(*Continued on page* 155)

THEORY AND APPLICATION OF U.H.F

By MILTON S. KIVER

Part 11. The concluding article of this series, describing the operation of electromagnetic-wave travel through wave guides or space.

ALL the magnetic fields discussed so far were brought about by moving electric charges. Let us investigate the magnetic fields that are brought about by magnetic charges or magnetic substances.

To correspond to the field of electrostatics there is magnetostatics, which deals with magnetic charges and magnetic fields at rest. As far as is known today, there are no separate north and south poles corresponding to negative and positive charges. Wherever a magnetic north pole is found there is likewise found a south pole attached to it in some form or manner. Thus, if a magnet is taken and split in two it is found to have, at one end, north magnetism and at the other end south magnetism. However, it is possible to take a very long narrow magnet with the north and south poles relatively far from each other and in this way approximately separate north and south poles. (See Fig. 1.)

Analogous to the electric charge, it is also found that the north and south poles of magnets give rise to fields of force, called magnetic fields. By means of these fields, north poles will repel north poles and attract south poles. (See Fig. 2.) It is also found that these lines of force, also called magnetic lines of flux, start out from the north pole and go in through the south pole and then back to the north pole and so on around.

A difference is noted here between lines of electric force and those connected with magnets. If there was one electric charge in space then the lines of force would all radiate away from the charge and would continue indefinitely. In the magnetic case, the lines of flux must form complete rings since connected with every north pole there is attached to it, in some manner, a south pole. Any lines emanating from the north pole go back to the south pole and through the material to the north from which they started. Thus, they have no end and in this sense are said to be continuous. This is shown in Fig. 3.

Analogous to the electrostatic case, the fields and forces set up by these poles or magnets affect only other magnetic substances and nothing else. If a magnet were taken and placed in a field that contained stationary electrons it would be found that each had no effect on the other. As long as these two fields are at rest, relative to each other, there is no interaction. It is only when they move that these forces are found to clash.

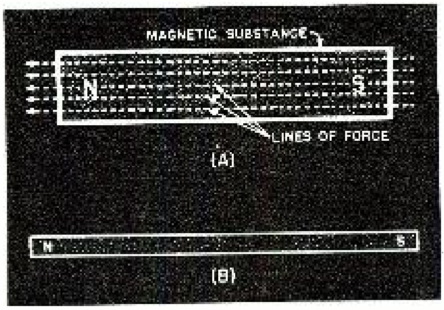


Fig 1. (A) The direction of magnetic lines of force through a magnet. (B) Showing how a long, thin magnet is generally used to approximate separate north and south poles.

Action of Magnetic Fields

It has just been pointed out that an electric current gives rise to a magnetic field and so it occurred to Faraday in 1831 that a magnet might, under some conditions, give rise to an electric current. While the magnet was at rest there were no effects noticed, but when this magnet moved relative to some piece of wire, a current was noted on a galvanometer, which is a current-measuring device. Moving the magnet in one direction produced a current which reversed when the magnetic field was reversed. Currents produced this way are called induced currents and the e.m.f's that caused these currents to flow are called induced e.m.f.'s. The formula by which Faraday stated these effects is known as Faraday's law and in words states that the electromotive force induced by changing the flux density through a fixed circuit is equal to the time rate of change of this flux.

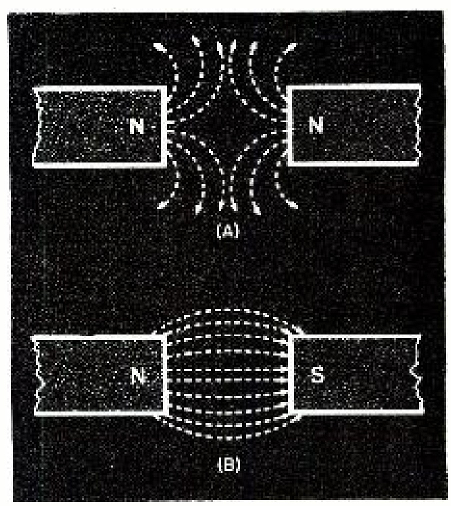
Faraday's results can be obtained by using the simple setup of Fig. 4. When the magnet is moved relative to the coil, there will be an e.m.f. induced in the coil of wire by the changing magnetic field or flux. If the wire is a good conductor, a certain amount of current will flow. Making the wire from a poor conductor will still give rise to the same e.m.f. but now a smaller current will flow since there is more resistance in the circuit and we know from Ohm's law that if the e.m.f. is constant, the current is then inversely proportional to the resistance.

Continuing in this direction, it can be seen that if finally a perfect non-conductor is used where the conducting wire was held formerly, there would still be found an e.m.f. induced even if no current flow resulted from it. The e.m.f. set up is the electric field and so it can be seen that a varying magnetic field will give rise to an electric field in a direction normal to itself. The electric field is constant if the rate of change of the magnetic field is constant and will vary in intensity if the rate of change of the magnetic field varies. The frequency of both fields is the same.

It is important to remember when mentioning the time rate of change of a magnetic field that several means may be used to bring about this change. First, of course, the magnet producing this flux can be caused to move and this was the illustration mentioned above. Next, the same results can be obtained by keeping the flux constant and fixed and moving the coil of wire across this field. In this case, the induced e.m.f. will be proportional to the number of flux lines cut per unit time, say a second (this is related directly to the speed the coil is traveling), and the angle at which the flux lines are cut. If the coil is moved parallel to the lines, then no e.m.f. will be induced. If the coil moves at some angle to the field then the induced e.m.f. will be proportional to the angle, the best results being obtained when this angle is 90°.

The above ideas should serve to

Fig. 2. Showing the repulsion and attraction between magnetic poles.



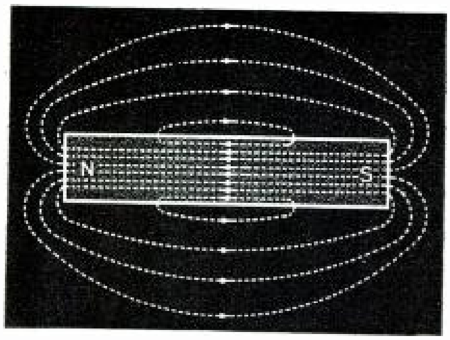


Fig. 3. Magnetic lines of force are continuous and form closed paths.

clarify the meaning of the phrase, time rate of change of the magnetic field.

Maxwell's Equations

The above discussion has given all the formulas necessary to state the complete set of equations that form the basis of all electromagnetic theory and which are so often referred to as Maxwell's equations. Although it has not been stated before, Maxwell took the laws stated above and generalized them so that they would be applicable to any set of coordinates. Most people are familiar with the simple rectangular coordinate system such as is obtained by having x and y axes at right angles to each other. For three dimensions a z axis is added which is at right angles to the above x and y axes.

However, when dealing with cylindrical pipes, it is easier to work with cylindrical coordinates whereby points in the system are expressed in terms of the radius of the cylinder and the angle that we must turn from the starting point. There may be other systems that could be used but there is no necessity for discussing these at this point. Fig. 5 illustrates the rectangular system and cylindrical system. Maxwell took Gauss' law, Faraday's law and Ampere's law and generalized them to fit these various three-dimensional systems.

Stated in words, instead of mathematical equations, the fundamental laws are:

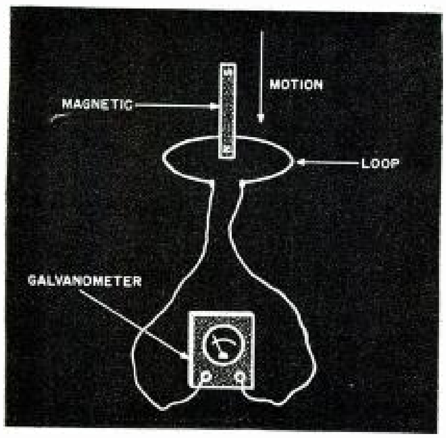
1. For free space where there are assumed to be no free charges, the number of electric lines of flux entering any region is equal to the number of lines leaving.

2. Lines of a magnetic field form closed rings.

3. An electric field that is varying will give rise to a magnetic field.

4. A magnetic field that is changing in value will develop an electric field that is normal to both the direction of motion of the magnetic field and the field itself.

Fig. 4. A simple arrangement which indicates the relationship between changing magnetic fields and induced e.m.f.'s.



The great significance of these equations lies in the fact that from them the properties of electromagnetic wave travel through space can be accurately predicted. With one clean sweep, they eliminate the need for electric currents to be actually in the immediate vicinity in order to explain the presence of magnetic fields that may be encountered. Electric fields that are changing in magnitude (with time) will readily accomplish the same result.

In ultra-high-frequency work, extensive use is made of wave guides in transmitting energy from one place to another. So long as the boundary conditions of these wave guides are taken into account when setting up Maxwell's equations, the correct results can be derived in advance. This not only serves to bring out the underlying equality of all radio waves, no matter how they are generated or transmitted, but it also provides us with a convenient means of determining in advance, whether one shape of wave guide will prove more suitable than another. This is very important in many of the present applications of high-frequency waves and will prove of inestimable value in the postwar era, when greater application of u.h.f. devices will be widely used.

It should be kept in mind that the set of equations put forth by Maxwell are, in a sense, generalizations of ordinary, everyday electric theory. Problems involving transmission lines can just as readily be solved using electric and magnetic fields as with the corresponding electric currents. The only reason this is seldom done is due to the greater complexity involved when fields are used than for electric currents. It might be added, too, that the general unfamiliarity with Maxwell's equations, even today, has tended to becloud them with an unnecessary air of mystery.

Electric Wave Travel Through Space

Some idea as to the way the waves travel may now be had from Maxwell's equations 3 and 4. If the changing electric field gives rise to a magnetic field and the magnetic field so produced gives rise to an electric field, all occurring in the same region, then it may be wondered just how the wave will be propagated through space. But, if, instead of the varying electric field producing the magnetic field just in the same region, suppose it also produced a magnetic field a little removed from it and the magnetic field so generated gave rise to another electric field, also a little farther on, then it is possible to see something of the way the propagation takes place. Each varying field gives rise to the other varying field a little farther on and so each sustains the other and the wave moves along with the velocity of light in free space. If conditions are such as to prevent the formation of one field, then the other will likewise be prevented from existing since the energy from one moves to the other. On the average, each field sustains half the total energy.

Another idea before Maxwell was the idea of speed. It is known that the moving charges give rise to a

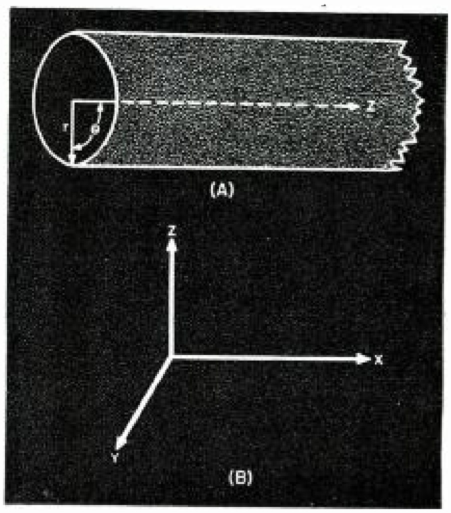


Fig. 5. Two commonly used systems of co-ordinates: (A) rectangular; (B) cylindrical.

magnetic field through their electric field, and that this magnetic field can be felt at some distance from the wire. The question that he wished to answer was whether this magnetic field was produced at some distance from the source as soon as the charges started to move, or whether there was some time lapse. Actual measurements gave no results since the apparatus involved could not cope with the extremely small time interval between the start of the charge and the appearance of the magnetic field. Maxwell showed on paper that by the use of his electromagnetic equations, the speed of these waves should be equal to the speed of light in free space and this is in the vicinity of 186,000 miles per second. Maxwell never proved this by actual measurement, but Hertz did 25 years later and his experiments led to the acceptance of Maxwell's theory. By means of further experiments it was immediately shown that all optical laws were obeyed by these electromagnetic waves and this, of course, led to the final conclusion that light was also an electromagnetic wave.

It might also be stated here that the ratio of the electromagnetic unit of current to the electrostatic unit of current is also equal to the velocity of light, and this was another fact that got Maxwell started on the trail of

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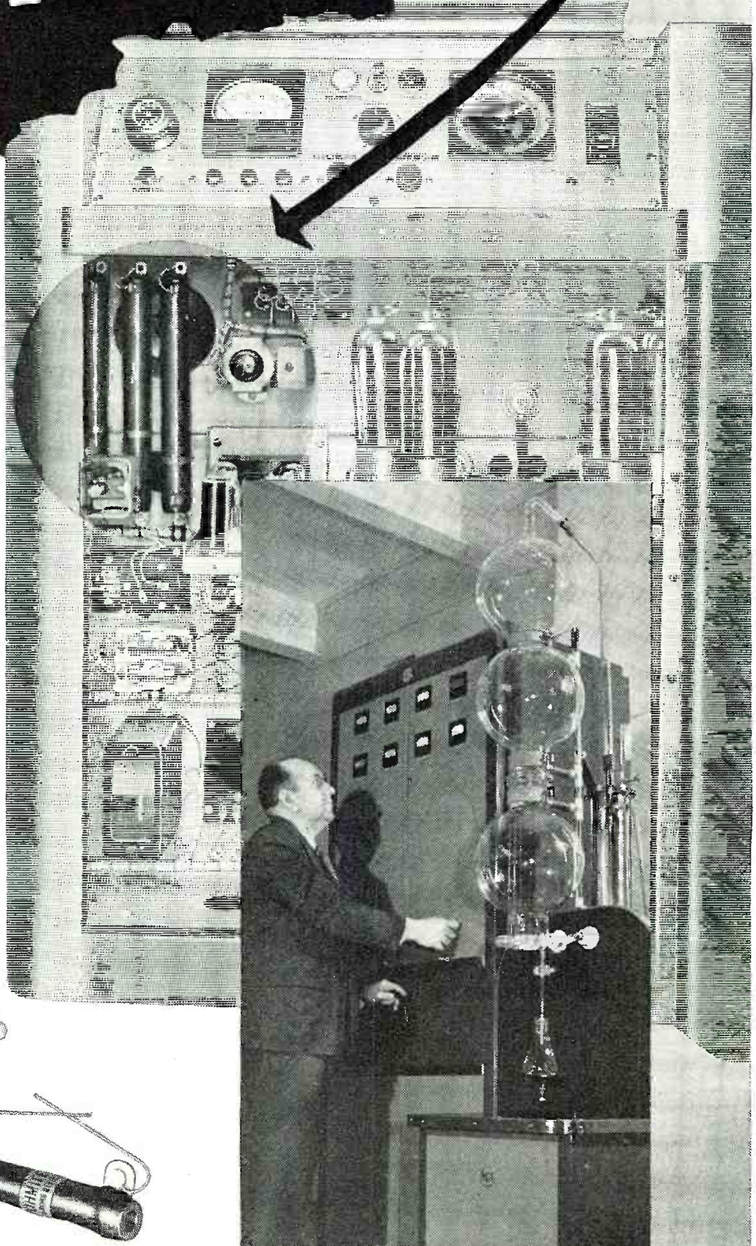

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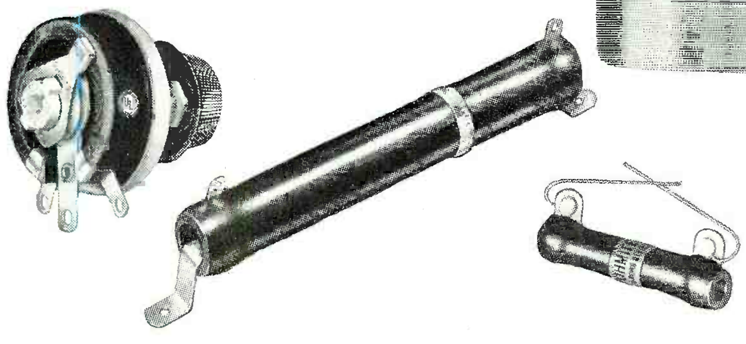

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his set of equations. The medium that Maxwell envisioned the waves to travel in—free space—was called the ether. His idea of the makeup of this nebulous substance, however, is not quite what we think of it today, but since the laws still hold, it is best to forget, or at least avoid, saying anything about the space or medium or ether that the waves travel in and just stick to the waves themselves. This is a question that still has not been answered to everyone's satisfaction.

This, then, is the electromagnetic theory as set forth by Maxwell, and which is receiving so much attention at the ultra-high frequencies. The laws were based on simple electrical phenomena and do not represent the work of one man alone. It is doubtful that any one person could evolve all this theory. It required the work of many men, a fact that is true of all fields of endeavor. It is hoped that by a better understanding of what underlies all this theory it will be possible to more easily visualize what goes on in our high-frequency apparatus.

Author's Note—In Conclusion

This series, which is now being concluded, has attempted to present the basic ideas of the operation of ultra-high-frequency radio apparatus in nonmathematical language. The simple radio circuits used in ordinary, everyday equipment are still present in ultra-high-frequency apparatus, but in a modified form that make these components suitable for the shorter wavelengths.

Of necessity, due to present war conditions, many advancements and refinements which have already been made in the various tubes described in these articles cannot be told now. Later, when conditions become normal again, restrictions will probably be lifted and the complete story will be available. For the present, best advantage may be taken of those articles and books that do appear, so that when this later information is released, it will fall into a familiar pattern. This is especially urged for those persons who intend to enter the ultra-high-frequency field after the war. A list of the available books is given at the end of this article with an added note as to the complexity of each one.

There have been two proposals advanced recently that pertain directly to the ultra-high frequencies. One is a proposal to allot ether space around 10,000 mc. to servicemen and women to be used by them without the necessity of applying for licenses, as is the custom at the lower amateur bands. The present amateur bands were quite congested before the war and they promise to become even more so after the war, what with the thousands of newcomers to the field of radio and radar. Sufficient ether space could be easily found at 10,000 mc.

The second proposal relates to the

(*Continued on page* 118)

TECHNICAL BOOK & BULLETIN REVIEW

"THE RADIO AMATEUR'S HANDBOOK," by The ARRL Staff. Published by *The American Radio Relay League, Inc.,* West Hartford, Conn. Twenty-Second Edition. 728 pages. Price $1.00.

The Radio Amateur's Handbook is so familiar to those in the radio industry, that a review of this new edition is almost superfluous. However, there are several new features and additions which should be mentioned.

This is the largest and most complete Handbook that the ARRL has ever published and in addition to the 728 pages of text material, a catalogue section and topical index is included. The book also includes 1278 illustrations, 133 charts and tables, and 240 basic formulas for ready reference.

The latest phases of radio development have been included to pave the way for postwar amateur development.

This new edition is divided into three main parts including, principles and design; equipment construction; and general information sections. The first section treats fundamentals, principles, theory and design considerations, written in a nonmathematical style. The ten chapters on equipment construction contain practical information on the design and construction of all types of amateur receivers, transmitters, antennas, and associated equipment. The general information section includes formulas and miscellaneous data tables.

The topical index and glossary of terms completes the book.

"INTRODUCTION TO MICROWAVES," by Simon Ramo. Published by *McGraw-Hill Book Company,* New York. 133 pages. Price $1.75.

In this book, Mr. Ramo has presented the fundamentals of microwave theory without resorting to the use of mathematics.

In the introductory material presented, the author has pointed out the similarities which exist between microwaves and the lower frequency electricity. From this point the book proceeds to the inherent differences of the two types of transmission.

Transit-time electronics, velocity modulation, radiation, transmission lines, resonant cavities and wave guides are covered in this text in a clear and understandable fashion. The use of large numbers of diagrams facilitates the reader's understanding of microwave techniques.

While it is not claimed that a thorough understanding of this book will endow the reader with an all-inclusive knowledge of microwaves, it is possible for the engineer and the layman alike to obtain a working knowledge of that portion of the electromagnetic spectrum known as microwaves.

—30—

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Naturally military demands could not be met without restricting civilian production. In spite of what this has meant to service engineers, we are glad to say that shortages have been understood and accepted.

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POSTWAR PLANS For the Radio Dealer

By EUGENE A. CONKLIN

A survey of what radio dealers and servicemen foresee and are planning for postwar.

RADIO dealers and servicemen are even now planning for the postwar period. While it is perfectly true that the war is far from won, nevertheless the various developments and projects mentioned below will make interesting food for thought for radiomen everywhere.

Let's take, for example, the question of television. It's agreed by members of the radio fraternity that it will be a number of months before television hits the smaller communities. But a number of dealers believe that this progress can be accelerated by certain planned promotions.

A Syracuse, New York, dealer plans, as soon as the war ends, to hold each Saturday afternoon a television discussion period. Anyone may attend and latest developments in this art will be discussed by the radio dealer. Communityites who attend these sessions will be given a chance to understand the fundamentals of television and to realize the various technical handicaps which have to be overcome before television can be brought to their home as a daily occurrence.

A Rochester dealer believes that if a number of community retailers got together and agreed to sponsor sufficient telecasts, a local television outlet might become an almost overnight reality. He plans, shortly after the war, to go into a huddle with fellow retailers and take all steps necessary to set in motion a daily telecast schedule, even if only for one or two hours daily at the beginning.

A Utica, New York, radio dealer believes that the returning war veteran will be interested in using some of his mustering-out pay for a new home television receiver. This dealer intends to hold a get-together party for returning warriors and their families, at which time actual television reception will be demonstrated. This dealer will recommend to veterans that they make a substantial down-payment on a television receiver which will be delivered to them as soon as it comes off the assembly line. During the waiting period the veteran will be advised to retain his present set, which will be accepted as a trade-in when television models actually become part of the dealer's stock in trade.

Which brings us to the second postwar problem—that of "What to do with radios of prewar vintage?" According to dealers' surveys, eight out of every ten individuals expect to park their present sets with the dealer at a substantial trade-in valuation towards a new postwar receiver. Just what dealers are expected to do with radios which no longer have sales appeal is a sixty-four dollar question and one which has been causing radiomen many a sleepless night.

A Buffalo, New York, dealer believes that the ideal solution is for the radioman to accept such sets at a low figure—pointing out frankly to customers that the set utility value is inconsiderable, to say the least. This dealer intends to accept such radios and present them to local orphanages, hospitals, etc.

Another solution is advanced by another Buffalo radio man who intends to ask his clients to retain their prewar radios as secondary house sets. He intends to run a series of ads urging community residents to keep their sets, pointing out that the dealer has no specific outlet for them.

Particularly of interest in the postwar period is the merchandising of records. Perhaps more than any other commodity, records have served as a wartime merchandise stopgap. In a survey of several hundred dealers the majority advised that their postwar record departments would be greatly expanded.

One dealer intends to design a complete record library with every recording arranged by title, recording artist, and brand. The librarian will be on duty to help advise young and old alike as to recordings for specific purposes. A number of individual listening rooms will open off the library so that any individual may have absolute privacy in selecting his or her recordings.

Another dealer expects that after the war there will be considerable interest in voice-recording on the part of the public. With compulsory military training for high school graduates a probability, thousands of young

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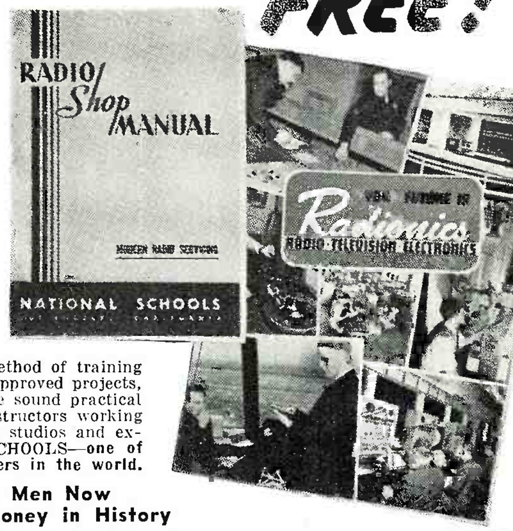

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Don't let your post-war ambitions lag. Don't let YOUR future depend on others. **Build a career for yourself.** Never in all history has the returning serviceman, or war worker been confronted with such a great future if he reaches out and grasps it NOW. Here is a new world opening before you. Get ready now while you are still in uniform—while you are **on** your war job. Then you can soon step into an essential, well paid position or, **with little capital,** GET INTO BUSINESS FOR YOURSELF. It isn't a bit too soon to start now. Radio men are vitally needed. Fill out and mail the coupon immediately and examine the NATIONAL SHOP METHOD HOME TRAINING COURSE carefully, without obligation.

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Examine the exclusive National Shop Method of Home Training. See for yourself how sound and practical it is. Be convinced that **you can learn Radio, Electronics, Television**—quickly and easily in your spare time. You can't tell until you try. This trial is ABSOLUTELY FREE. Fill out the coupon immediately while you are thinking about it and drop it in the mail at once.

Mail the coupon here for the books that tell you the complete story of the marvelous new system of training in Radio, Electronics and Television. Learn the facts of this exclusive shop-method of home training. **See for yourself!** DECIDE FOR YOURSELF!

This is the MODERN SYSTEM OF TRAINING; it matches the rapid progress constantly being made in Radio, Television and Electronics. It is TIME TESTED, too. National Schools has been training men for more than a third of a century. **It is the very same training that has helped thousands to more pay and greater opportunity.**

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Mail me FREE the books mentioned in your ad including a sample lesson of your course, without obligation. I understand no salesman will call on me.

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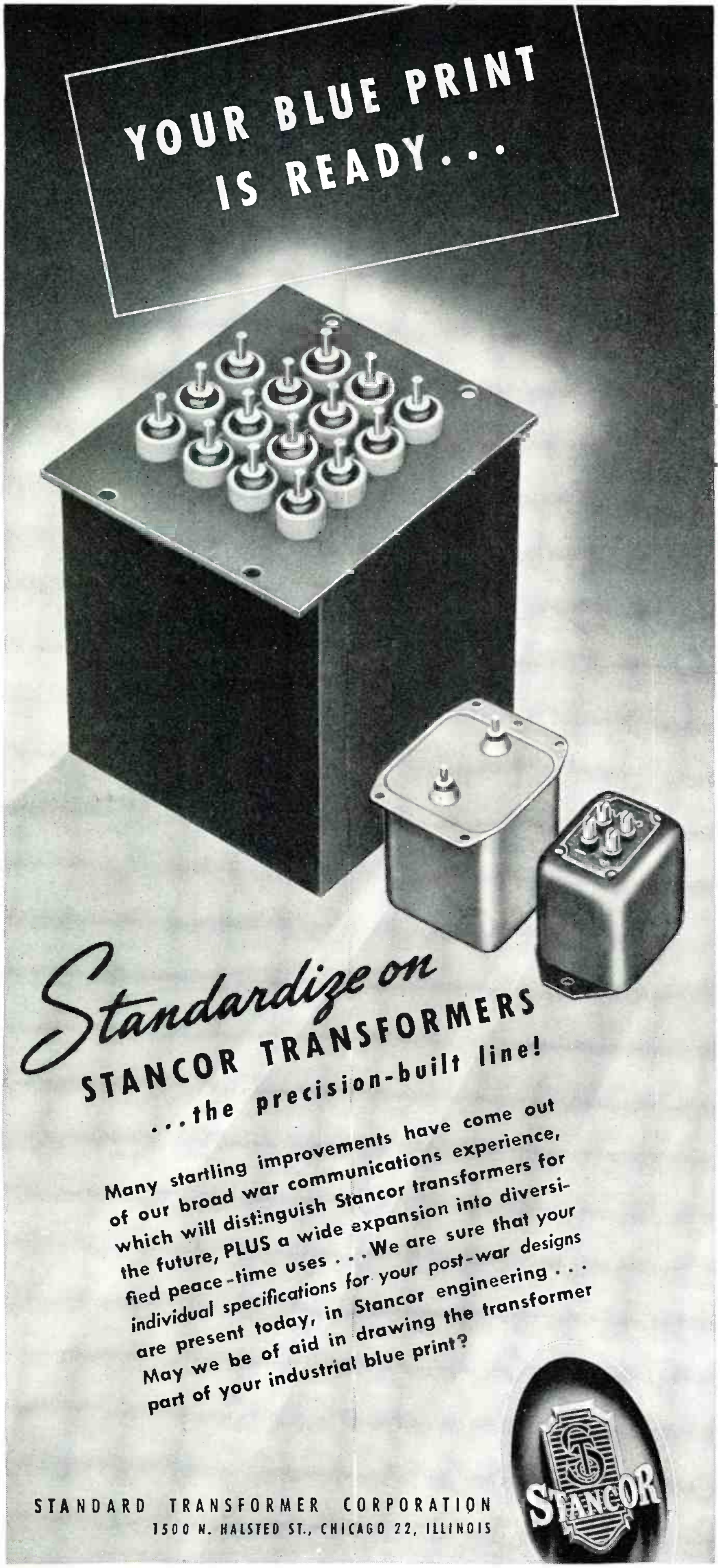


recruits will be marching off yearly. Their families will wish to make recordings to send to them.

Final entry in the postwar recording situation is that of a Lackawanna, New York, dealer who intends to gather wartime albums consisting of hit parade tunes popular during the war. These albums will find a ready sale it is expected, with war veterans who have ample cash to pay for same.

There is no doubt but that after the war the average American family will travel, and travel considerably. For that reason, at least a score of dealers plan to build drive-ins along well-traveled roads where motorists may stop and have their auto radio checked and serviced. These drive-ins will be staffed by U. S. veterans who have had Signal Corps training. At these drive-ins, auto radios will receive preferential treatment but home radios will be accepted for service as well. That will enable ruralists to have their sets serviced without going all the way into town. The drive-ins will not be elaborate affairs—being a one-man operating scheme. Signs of the neon variety will attract passing motorists.

These are only a few of the postwar plans currently being hatched by radio dealers. The radio serviceman has his own postwar plans as well.

For one thing, a number of service gentry are planning to use women after the war as radio technicians. It is pointed out that, as a result of the war, women have been used in the service shop with shining success. For that reason, after the war these radiomen expect to use the female of the species as receptionists, handling the customers and maintaining the serviceman's privacy. With this arrangement the feminine half of the service-shop team would attend to all correspondence, handle incoming and outgoing radios, and, in addition, prepare newspaper and radio advertisements. Because the woman of the house is usually the determining factor in selecting a radio serviceman, it follows that advertising copy prepared by a woman will be effective in the final analysis.

Another trend will be the discontinuance of home servicing. Pickups and delivery will be maintained, but servicing strictly in the shop will be the after-the-war procedure. The reason for this about face is that most servicemen were never sold on home servicing. And customers have become used to shop repair during the present conflict.

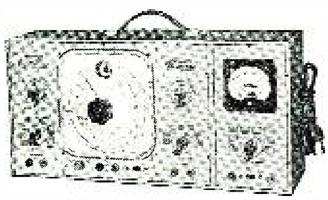
The final trend to be recorded concerns the licensing of radiomen. Many radiomen believe that State bodies, on the order of regents, should be set up to conduct written examinations —the passing of which would qualify the applicant to practice as a radio serviceman. In this way returning war veterans and present service folk would be treated alike on the basis of their knowledge and without prejudice.

—30—

SPRAGUE TRADING POST

A FREE Buy-Exchange-Sell Service for Radio Men

CONDENSER-RESISTOR TESTER *de luxe!*



EVERY basic characteristic of EVERY type of condenser and resistor can be read quickly and accurately on direct reading scales on the Sprague de luxe Tel-Ohmike. Measures capacitance from .000010 to 2000 mfd.; d-c resistance from .5 to 5,000,000 ohms; and insulation resistance to 10,000 megohms. Contains built-in d-c volt-milliameter. Power factor and leakage current of electrolytic condensers are read directly. Built-in power supply permits all characteristic measurements under actual working conditions up to 1,000 volts DC. A "magic eye" indicator shows bridge circuit balance.

Sprague de luxe Tel-Ohmikes are NOW AVAILABLE to Sprague distributors under W.P.B Form 3243 or AA-5MRO.

WANTED—Volt ohmmeter AC-DC and sig. generator covering 100 KC to 10,000 KC. Pvt. Wesley O. Jensen, 39196540, Co. 22, 134th Bn., 30th Trng. Regt., Camp Ellis, Ill.

FOR SALE OR TRADE—Thordarson T19P56 1800 v. 225 ma. power transformer, UTC Universal modulation transformer, 20 & 40 mtr. Johnson Hi-Q plug-in inductors, and 807, 812, and 2—866 tubes. Thomas H. Cherones, Tuscaloosa, Ala.

WANTED—Unrepairable radios, magnet wire, phonograph pickup, 45 v. "B" battery, and new or used tubes 70L7GT, 1A7GT, 1S5, 1T4, 3Q4, HY125, HY123 and 117N7GT. What have you in voltmeters and milliameters. Edward Jefferies, Rt. No. 1, Bradenton, Fla.

FOR SALE—Slightly used Philco audio sig. generator No. 044. Walter Wilkes, 3254 N. Central Pk., Chicago 18, Ill.

URGENTLY NEEDED—Rider manuals, service manuals, test equipment, meters, parts, tubes, wire, etc. Riverside Radio Service Co., 16 Sunbury St., Riverside, Pa.

FOR EXCHANGE—Dependable R.C.P. No. 305 tube checker. Want any Rider manual except 4 or 5, or tape type code machine with tapes. Harry E. Folwell, Box 52, Jefferson, Pa.

WANTED—Test equipment, including small multimeter, tube tester and sig. generator; also 6 12, 35, etc., tubes. Daniel H. Diamond, 55 Lanark Road, Brookline 46, Mass.

FOR SALE—New equipment—2 amplifier heavy duty power transformers, $5.50 each; 250 ma. 10 henry choke, $3; 1 input transformer, $3.50; 4 power transformers, $4.50 each; RCA 15 w amplifier complete with tubes and cover, $50; also Radio City volt ohmmeter No. 446, electrically perfect but case slightly scratched, $25. Robert Maxwell, 1312 East Washington Blvd., Fort Wayne 4, Ind.

WANTED—Tube tester for all tube types. Christopher Electric Shop, Flagler St., Stuart, Fla.

FOR SALE—Slightly used wireless phono-oscillator, with phono input and input for microphone. Cash—or will trade for Echophone EC-1. Chloe Stewart, P. O. Box 885, Gadsden, Ala.

WILL EXCHANGE—Rider manuals 7, 10, 11 and 13, new for 300 ma. 150 ma. series at wholesale price. Tubes must be new. Alphonso Noble, 1603 Fifth Ave., Pittsburgh, Pa.

FOR SALE—Hallicrafters SX 118 Sky Challenger with new matching speaker. A1 condition. Albert Aulbur, Martinsburg, Mo.

WANTED—Two gang 140 mmf. or 200 mmf. variable condenser, and 456 kc. B.F.O. transformer. R. Sikes, 121½ N. 4th St., Springfield, Ill.

WILL TRADE—Two 50L6GT's, in cartons, for two metal 6SJ7's in cartons; 6H6GT/G for 5X4G. Also have uncartoned tubes for exchange. Clifford Martellini, SYD47, 10 Dove Street, Newburyport, Mass.

FOR SALE—New tubes, in original cartons; 2—2A7-S, 4—85, 5—38, 2—2B7, 2—G-4-S, 2—81, 1 each 31, 32, and 55-S, 40% off list; also 15—35, 2—10, 1—50, 3—20, 3—22, 4—40 and 5—99 cheap. Albin Radio Service, Box 212, Eastport, N. Y.

FOR SALE OR TRADE—Tripplett portable lab., oak case, combination V-O-M AC-DC all wave oscillator and tester (new battery required); Delta 37D all-wave oscillator in metal case; Readrite 430 tube tester, Triplett meter, oak case, modernized to include up to 115 v. tubes, adapters and charts included; Superior channel analyzer and V.T.M. Want condenser analyzer, phono-motor, and record changer. R. Gerrish, 32 Park St., Dover, N. H.

FOR SALE—Clough-Brengle OC sig. generator, $40. Urgently need circuit diagram and service data for Philips Aachen super D-58, German radio. Will buy or rent. James Howard Jones, 1606 Asheboro St., Greensboro, N. Car.

FOR EXCHANGE—Audio amplifier using 6F5, 6SJ7, 6F6, and 5Y3G, with 6 ohm output transformer. Complete with tubes, less speaker. Michael Matchen, 960 Prospect Ave., Bronx, New York, N. Y.

WANTED—Inexpensive microphone to hook up on house radio T/Sgt. J. Bachinsky, Sq. "H", 127 A.A.F. BU. FAAF, Florence, So. Car.

URGENTLY NEEDED—1st I.F. coil for Majestic No. 460, 2nd I.F. coil for Majestic No. 55. I. A. Watters, Box 357, R.D. 2, Jeanette, Pa.

WANTED—Hickok sig. generator No. 188X, with AM, FM and television sweeps. Must be in good condition. Raymond Smith, Radio Technician, Sully, Iowa.

FOR SALE—Supreme No. 385 tube tester and analyzer, $45; Hickok OS-7 sig. generator (AC operated), $35. Kenneth Rummings, P. O. Box 263, Clearfield, Pa.

FOR SALE OR SWAP—Radio, amplifier, headphones, photo electric set, photronic cell, H.D. disc rectifier, small motors, ohmmeter, slide rule, adding machine calculator, parts, tubes, etc. Want EC-1 or similar and field coil, 1¾" diam., 1" high, ¾" mag. pole. O. H. Klinefelter, 42 Stephen St., Glen Ridge, N. J.

WANT TO TRADE—3" oscilloscope, Supreme No. 599 tube and set tester, Emerson radio, electric Hawaiian guitar with 15 w. amplifier, Sonora electric phonograph, and 50L6, 35Z5, and 35L6 tubes, for sound-film projector. Harry L. Parker, 112 W. Malta Road, Oak Ridge, Tenn.

WANTED—Rider manuals—also oscilloscope. Ken Seifert, 422 S. 3rd Ave., Sturgeon Bay, Wis.

WANTED—32 L7GT tube, or equivalent—also midget receiver. S/Sgt. V. Medvekus, Sq. T., Venice AAFLD, Venice, Fla.

FOR SALE—At 20% off wholesale price, almost new, Thordarson T-17S15, T-58A70, T-67A41, T-75C51, T-89R28, T-18C92; 4—T-60S48, lot for $22; 4—12" parabolic steel speaker baffles, $18; 4—12" PM 8 ohm Utah speakers, $15. All items C. O. D. Bobby R. Case, 618 West 4th St., Alliance, Nebr.

URGENTLY NEEDED—Echophone EC-1 model receiver. Please answer via air mail. PFC Antone L. Oliveira, 11034370, % Postmaster, San Francisco, Calif.

FOR SALE—10—.5 mfd. Aerovox condensers, 400 v. No. 430; 60—.0005 postage stamp condensers. $4 for lot. M. Klein, 4709 Homer Ave., Baltimore 15, Md.

WANTED—Tube tester, multimeter with highest ohmmeter range, and all-wave sig. generator, 110-120 v. AC power, with instructions. Clarence Nix, Box 725, Canadian, Texas.

WANTED—EC-1, Howard No 430 or early model 5 tube Sky Buddy. Sgt. Henry Mohr, 4505, A.A.F. B. C. Kelly Field, Texas.

FOR EXCHANGE—Rider manuals, test equipment, Remington portable typewriter, used tubes, etc. Want communications receiver, 2½ meter equipment, or Hallicrafter No. S-36. Frest Radio Service, 811 21st St., East Moline, Ill.

WANTED—Radio City or Hickok No. 530-P tube tester. Luther Thornburg, Kingsport, Tenn., Route 2.

FOR SALE—Slightly used Rider manuals 1, 2, 3, 4, 6, 7, 11 and 13—$60 f.o.b. Also Readrite sig. generator 554A in A1 condition, $10. F. Christian, 819 Blair St., Flint 4, Mich.

WANTED—Six to eleven tube radio receiver. Prefer short wave band or bands, but regular broadcast will do. Clarence O. Watkins, Dept. 49, Bell Aircraft Corp., Georgia Division, Marietta, Ga.

FOR SALE—Amplifiers, trumpets, Pioneer gene-motor, heavy duty Jensen theatre speaker, Western Electric 205D tubes, Western Electric units. John J. Levine, 625 Main St., Worcester 8, Mass.

FOR SALE—Superior osc. '42, and Weston VTVM 669, in excellent condition. John Lough, Carol Radio, 111 Witthoff St., Queens Village, L. I.

WANTED FOR CASH—Engineer requires certain issues of Proceedings of I.R.E. from 1939 to 1942 incl. Send dates and prices. Gus Shapiro, 43 Washington Village, Asbury Park, N. J.

WANTED—Good used signal generator for cash. Hugh McCullough, Nebo, Mo.

FOR SALE OR TRADE—One motor generator 6v DC to 350 DC, 12v DC to 700v DC; also Pilot reflex camera, etc. Greiner Radio, 114 Elmwood Ave., Buffalo 1, N. Y.

WANTED—Tube tester and voltohmmeter for cash. H. Hanauer, 2525 Church Ave., Brooklyn 26, N. Y.

WANTED—Will trade 7-tube t.r.f. receiver in good condition and a little cash for class A, B, or C gasoline model airplane engine. Can also use 12A8-G and 45 tube and any dope on radio control rigs. Don Anderson, 917 E. Kemp Ave., Watertown, S. D.

WILL TRADE—Triplett d-c milliammeter, 0-1, No. 321; also G-E microammeter 0-500 d-c. W. G. Graham, 1331-A Monterey St., Richmond, Calif.

URGENTLY NEEDED—Late model sig. generator and set analyzer. Cash. Benn's Radio Service, 2980 Carmen Ave., Fresno, Calif.

YOUR OWN AD RUN FREE!

This is Sprague's special wartime advertising service to help radio men get needed parts and equipment, or dispose of radio materials they do not need. Send your ad today. Write PLAINLY or PRINT — hold it to 40 words or less. Due to the large number received, ads may be delayed a month or two, but will be published as rapidly as possible.

Sprague reserves the right to reject ads which do not fit in with the spirit of this service.

HARRY KALKER, Sales Manager

Dept. RN-65, SPRAGUE PRODUCTS CO., North Adams, Mass.

Jobbing Sales Organization for Sprague Electric Company

SPRAGUE CONDENSERS
KOOLOHM RESISTORS

TM. REGISTERED U. S. PATENT OFFICE

Obviously, Sprague cannot assume any responsibility, or guarantee goods, services, etc., which might be exchanged through the above advertisements

Converting a Battery Set to A.C. Operation

By G. BOLES

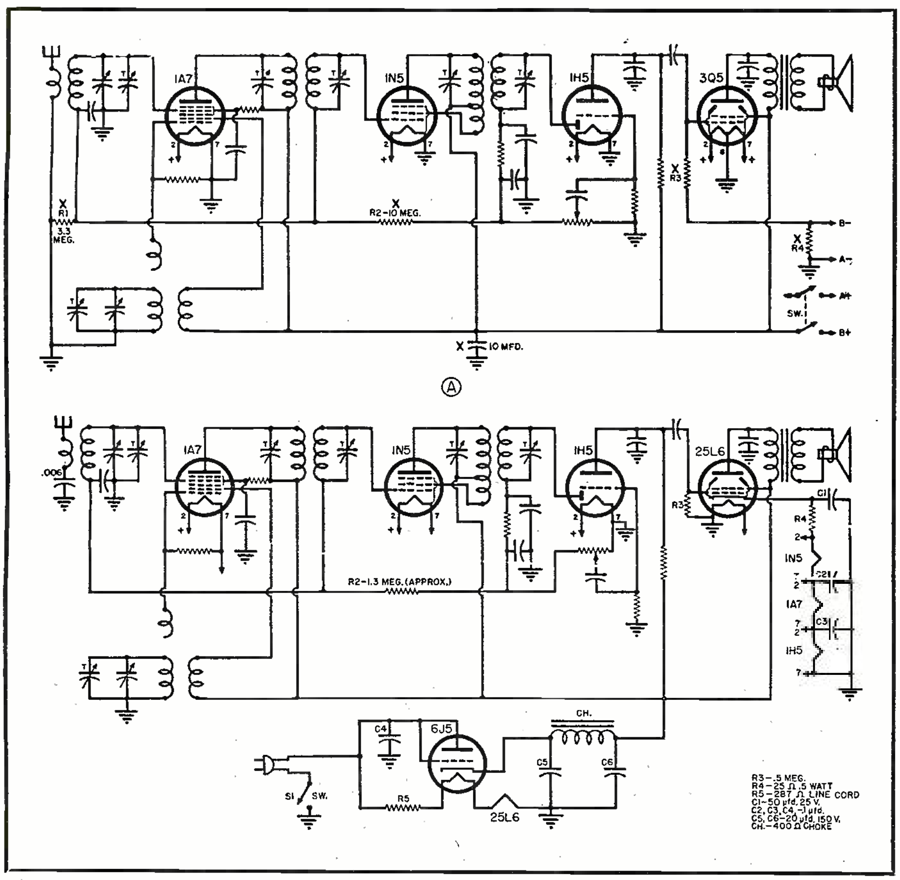
The principle of converting this portable receiver to a.c. operation may be applied to other sets that are of similar design.

A FRIEND of ours came into possession of a late-model RCA battery set and asked if there was something that could be done to make it work on the regular a.c. house current. Being in an amiable frame of mind, we decided to see what we could do.

The set was an RCA Model 24BT-1 and it utilized the usual tube lineup, namely, a 1A7 mixer-oscillator, 1N5 i.f. amplifier, 1H5 detector and first audio, and finally, a 3Q5 power amplifier. After considering several possibilities, it was decided to dispense with the 3Q5 and in its place, use a tube such as a 117L7. However, we found that 117L7's are quite scarce and so decided to give up the idea of using any of the 117-volt tubes.

After careful perusal of an RCA tube manual, there were several considerations for the power amplifier, among which was the 25L6, which has a combined plate and screen current totalling a little more than 50 milliamperes. Furthermore, there was no trouble encountered in getting hold of one.

Fig. 1. The schematic diagrams showing changes made in converting an RCA Model 24BT-1 portable receiver to a.c. operation. (A) Diagram of original receiver. (B) Diagram after the conversion to a.c. operation had been made.



Next came the problem of the rectifier tube. Since 25Z5's and 25Z6's are almost as scarce as the 117-volt series, no attempt was even made to obtain these. Too, a triode like the 6J5 is pretty easy to get and so that is what was used, solving our tube problems.

Now that the set was going to have one more tube than it was originally designed for, it was necessary to find a suitable place for this extra tube. Fortunately, there were two empty socket holes punched in the chassis in addition to the regular socket holes. Apparently the manufacturers used the same chassis for a number of different models.

The socket next to the oscillator coil looked good but we had to unsolder a short piece of busbar running from the oscillator anode to the coil, which would have been in the way. The busbar was replaced with a length of hookup wire and it was run around the back of the coil so as to be out of the way of the new socket. The problem was simpler with the 25L6 because it was merely plugged into the 3Q5 socket, after appropriate changes in heater wiring.

After the mounting of the sockets had been taken care of, a place had to be found for the filter choke. Unfortunately, the choke was a couple of sizes larger than the midget variety (or so it seemed). It makes no difference to the choke whether it is inside or outside the chassis, and so it was mounted on the outside. There were plenty of holes on the back wall of the chassis and they saved the task of drilling them out. That was another, and the best reason for putting the choke on the outside.

Before disconnecting all the leads in the filament circuit, it is a good idea to see how they are wired up and make only those changes which are necessary. In most cases, it will be found that only a few connections need be removed. For instance, the number 7 pin of the 1H5 was grounded and a lead run from there to the number 8 pin of the 3Q5. This latter lead had to be removed. Pins 2 and 7 of the 3Q5 had to be rewired as they were originally tied together and a lead run from them to the switch on the volume control. The number 2 pins of the 1A7 and the 1N5 were wired together and had to be rewired so the polarity on the tube filaments would be correct, as indicated in Fig. 1B.

Only one section of the switch on the volume control was needed and since one of the lugs was already grounded, the a.c. ground lead was connected to this particular section of the switch. The oscillator grid leak was connected to the negative filament terminal (number 7 pin) and the lead which grounded it to the chassis was cut.

On the antenna coil, the ground lead of the primary was removed and


BRIDGEHEADS
OF
TOMORROW
Yard by yard our armies advance, establishing bridgeheads, purchased by the sacrifice of thousands of lives. Yard by yard they advance against the enemies of civilization, guided by the marvels of wartime communications that are so vital to the success of our armed forces.
The bridgeheads of tomorrow will be won in all-out attacks on ignorance and poverty and disease. And, once again, FADA will resume its place in the development of the radio, television and electronic achievements that peace will bring.
You can look to FADA for the leadership that will establish new bridgeheads of progress in the field of communications.
PLACE YOUR FAITH IN THE
FADA
Radio
OF THE FUTURE
Famous Since Broadcasting Began!
FADA RADIO AND ELECTRIC COMPANY, INC., LONG ISLAND CITY, N. Y.

a .006-μfd. condenser put in its place. This condenser is insurance against the antenna becoming grounded. The 10-μfd., 90-volt condenser in Fig. 1A was cut out; we were not going to take any chances on its breaking down due to a surge. The grid resistors, R_3 and R_4, in Fig. 1A were also removed and in their place a single 500,000-ohm, ½-watt resistor (R_3) was connected, as in Fig. 1B.

The 25L6 requires a bias of — 7.5 volts. To find the value of the bias resistor (R_4 in Fig. 1B) it was necessary to subtract the drop across the tube filaments from the total cathode voltage desired. It figures in this manner: total bias desired, 7.5 volts; drop across tube filaments, 4.5 volts; therefore, $7.5 - 4.5 = 3$. The resistance in ohms of the resistor will be equal to $3/I_p$ plus I_s equals 3/.053 (.049 plus .004) = 57 ohms.

In our outfit it was found that this value was too high and we had to reduce the value of the resistor until approximately 50 milliamperes was drawn through the filaments. This may have been due to the particular 25L6 used and it would probably be wise to experiment with the value of the resistor in order to obtain maximum performance. If an insufficient amount of current flows, you will most likely experience trouble in getting the oscillator to function. The load impedance of the 25L6 is only 1500 ohms, and since the output transformer was designed to match a 3Q5 at 8000 ohms it was feared that there would be a considerable amount of distortion due to the mismatch. However, these fears were groundless because the quality was good, even to the critical ear of the builder.

The cathode by-pass condenser, C_1, (Fig. 1B) is essential to eliminate hum and increase the gain. We would like to have used a 100-μfd. condenser at this point, but the best that could be done was to use a single 50-μfd. unit. Even so, there is no trace of hum. The condenser, C_2, (Fig. 1B) was necessary to remove a slight tendency towards instability. Do not try to get along without C_2 (Fig. 1B) because it is absolutely essential.

The line-dropping resistor, R_5, must drop the line voltage down to the 31 volts, required by the 6J5 and 25L6 heaters in series. Since the tubes draw .3 amperes, the resistance of the dropping resistor should be about $(117—31)/.3 = 287$ ohms. A 50-watt resistor should be used because of the large amount of power dissipated.

After the job was completed and the set turned on for a trial, it was found that the set was overloading badly on practically all signals. The trouble was due to insufficient a.v.c. action. The culprit was a 10-megohm resistor (R_2 in Fig. 1A). This was changed to about 1.3 megohms by putting three 4-megohm resistors in parallel. Here again, a little experimentation will help to find the optimum value.

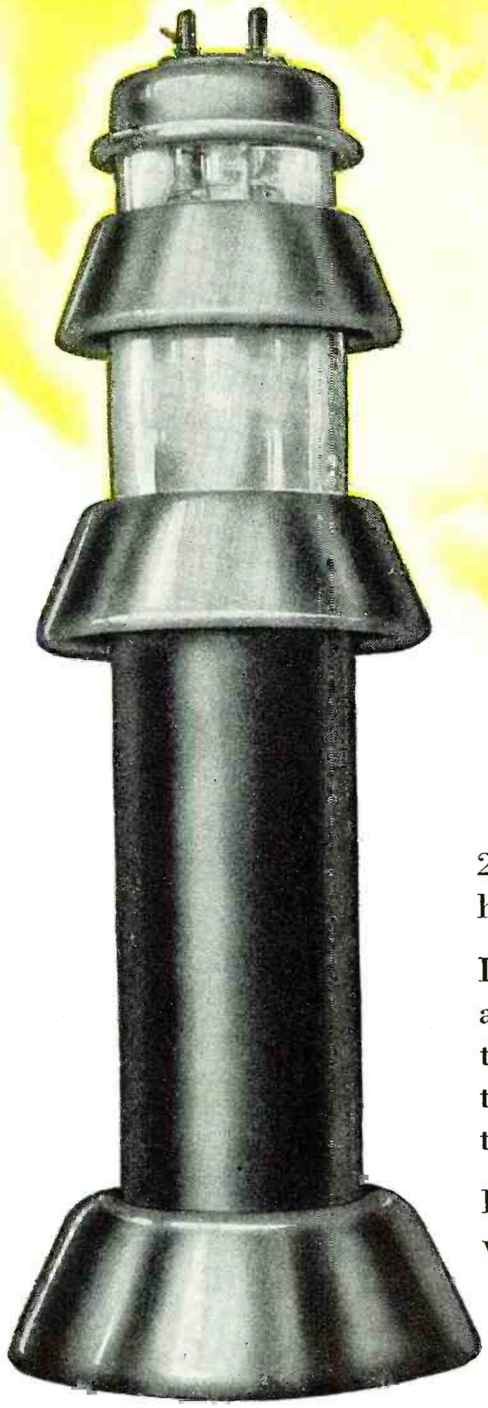
(Continued on page 74)

POWER

HIGH FREQUENCY HEATING

INTERNATIONAL BROADCAST

FM



The Most Powerful High-Frequency Tube

200 Kilowatts—developed especially for high-power, high-frequency broadcast and industrial applications.

Into this development has gone all the knowledge and experience of the tube-building art that make the name Federal stand for dependability—a reputation earned by more than 35 years of service in the electronics field.

Federal tubes are built for long life . . . produced with all the care and precision of fine craftsmanship.

Federal always has made better tubes.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

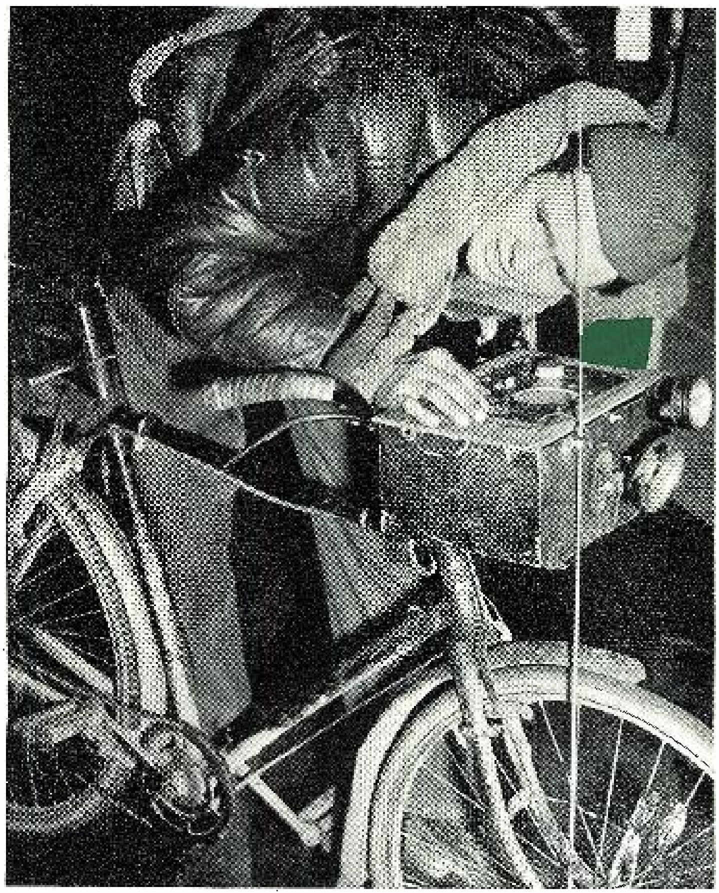
AN IT&T ASSOCIATE

Newark 1, N. J.

News from OVERSEAS

By KENNETH R. PORTER
RADIO NEWS War Correspondent

A compilation of some of the more interesting news items from the European Theater.



Cpl. L. Kindrick constructed this receiver from spare parts and is employing it merely as a form of entertainment.

ANGLO-AMERICAN radio experts unceasingly endeavor to improve airborne electronic equipment despite the undisputed superiority existing devices already possess over anything used by the enemy.

One of the more recent examples of this kind comes from the Armament Section of the U. S. Air Service Command—the men who put the sting into America's bombers and fighter-bombers, and concerns the installation in aircraft of special heaters to keep gunners' .50 calibers from jamming at high altitudes. These heaters resemble laundress' irons and are powered by the plane's main generator.

Placed at strategic points on the guns, this simple device prevents the low temperatures encountered in the substratosphere from freezing the .50's movable parts.

Wireless-Controlled Land Mine

Button-pressing warfare appears to have advanced a step further by the introduction of a remote-controlled land mine.

This new Allied invention is steered into position by wireless control from a distance and its explosive charge is detonated by the aid of relayed ignition.

Modified Microfilm Projector

"A cross between a magic lantern and a cinema" is the description given to the apparatus now being used in British military hospitals to enable wounded soldiers to read books and entertainment matter while in bed.

The apparatus is a modified version of the microfilm projector and throws images onto the ceiling or a screen that can be varied to suit the position in which the patient has to lie in bed by an electronic switch so located that it can be operated by hand, foot, or elbow.

Super-Secret Radio Unit

The existence of a unique military radio unit was recently disclosed for the first time by the British War Office.

A spokesman revealed that for over four years a specially-trained unit of exceptionally intelligent and politically acute radio expert-linguists had maintained close radio liaison between the Allied Forces outside German-occupied Balkan areas and isolated groups of guerilla fighters operating in Crete, Albania, Greece, Yugoslavia, and Bulgaria.

Too Many Wireless Operators

The British General Post Office has just announced that this country has now more trained wireless operators than there are jobs for them to fill.

Newcomers, the announcement said, have little prospect of obtaining posts either in the Merchant Navy or in the Services.

Miniature Recording Apparatus

A scheme has been launched by the British military authorities which will permit servicemen overseas to send 175-word gramophone record messages to their people at home.

It is based on the British-invented miniature apparatus weighing only 66 pounds, which records messages at tremendous speed by the aid of an ingenious pickup system using a novel crystal method.

B.L.A. Front-Line Transmitters

Mobile front-line transmitters are now attached to the British Liberation Army fighting on the Western Front.

These broadcasting stations on wheels operate on the medium-wave band, relaying to forward troops programs from Britain which are difficult to pick up direct, as well as originate and put out front-line programs of special local interest provided by teams of soldier broadcasters drawn from every branch of the services.

Popcorn to Pop by Itself

Another application of electronic heating for use in heavy bombers was described lately by Dr. Harold Jenkins, special adviser to the U. S. Air Service Command in France.

This method consists of plates installed inside the opposite walls of a cabin, heating uniformly all matter between them when the electrons are set in violent motion.

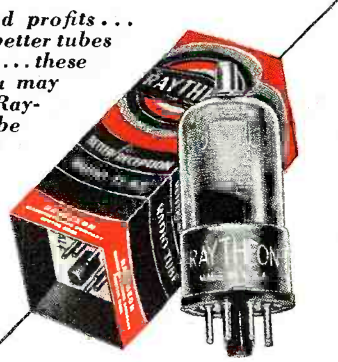
According to Dr. Jenkins, who is a former professor of electrical engi-

Feast your eyes on this mighty, 100-passenger airliner! When peace comes, a giant fleet of its sister ships will girdle the globe for Pan American World Airways. And in each of them will be the best electronic devices to come out of the war, equipped with famous Raytheon high-fidelity tubes!

Raytheon tubes have been used for years by Pan American, and it is because of their proven performance, fine reception and complete dependability that they were selected to play such a vital role in this great company's future operations. The assignment is but one of hundreds of postwar applications for which Raytheon tubes have been specified by America's radio and electronic industries.

When tubes are more readily available for civilian use, Raytheon will offer radio service dealers the *finest* tubes in its history . . . tubes combining long prewar experience with outstanding wartime development. And that's not all. They'll be backed by a Raytheon merchandising program that will be the most *beneficial* ever offered you. Keep your eye on Raytheon . . . for greater postwar profits!

Increased turnover and profits . . . easier stock control . . . better tubes at lower inventory cost . . . these are benefits which you may enjoy as a result of the Raytheon standardized tube program, which is part of our continued planning for the future.



Raytheon Manufacturing Company

RADIO RECEIVING TUBE DIVISION

Newton, Mass. • Los Angeles • New York • Chicago • Atlanta

Listen to "MEET YOUR NAVY" Every Saturday Night ENTIRE BLUE NETWORK Coast-to-Coast 181 Stations

RAYTHEON

High Fidelity

ELECTRONIC AND RADIO TUBES

All Four Divisions Have Been Awarded Army-Navy "E" With Stars

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES FOR THE NEW ERA OF ELECTRONICS neering at Swarthmore College, the same heating principle can be applied to heating rooms, pictures, chairs, tables, floors, and persons.

"Electronic heating opens up all kinds of possibilities," this electronics expert stated, adding that "even popcorn could be made to pop by itself if the electrons within the corn were set in motion, as the heat generated would cook the kernel from within until it literally popped."

Radio-Cum-Bike Corporal

Corporal Louis L. Kindrick of Pine Bluff, Arkansas, radio technician at an Air Service Command depot, has found a unique way of combining his two main hobbies—music and bike riding.

Using spare parts picked up from a salvage heap, Kindrick built himself a four-tube superheterodyne radio receiver, fitted it to the handle of his bike, and can now pedal along with song—sweet or hot.

Power for the radio is supplied from two ordinary flash light cells and a "B" battery contained in the set. By simply pressing a button on the handlebar dashboard, "juice" from a small generator operated by the rear wheel can be used to operate the radio, thereby saving the batteries.

Three lights, one headlight, one smaller light, and a tail light, are all controlled by buttons on the dashboard.

Oh yes . . . there is also a master switch which cuts off current throughout the entire bicycle!

—30—

Converting a Receiver

(*Continued from page* 70)

It should be noted that with this arrangement, the chassis is connected directly to one side of the line, and so will be at line potential theoretically half the time, if the line plug is inserted at random. This would represent a dangerous shock hazard, so the chassis, hold-down screws, knobs, etc., should be insulated carefully to prevent accidental contact and the possibility of a very severe shock. It may be suggested that some form of cement, shellac, or varnish be used for insulation.

In conclusion, it should be pointed out that all sets will not be like the one described, as each has its own individual problems. The fundamentals of changing a battery set to power-line operation were given with the hope that they might be of help to anyone contemplating this conversion job. Sets which have been converted usually operate better and have more volume. In some sets there is so little room that it taxes the ingenuity to squeeze the extra parts into the available space, but, there is no problem that cannot be solved by a little diligence.

—30—

HOGARTH AND ECHOPHONE

have plenty of postwar plans. These plans will see Echophone hit new heights of popularity in the Citizens Radio Communications Service bands—where anything might happen. The EC-1 covers from 550 kc. to 30 Mc. on three bands . . . Electrical bandspread on all bands . . . Six tubes . . . Self contained speaker . . . 115-125 volts AC or DC.

ECHOPHONE

"The Ears of the World"

ECHOPHONE RADIO CO., 540 NORTH MICHIGAN AVE., CHICAGO 11, ILLINOIS

WHAT'S NEW IN RADIO

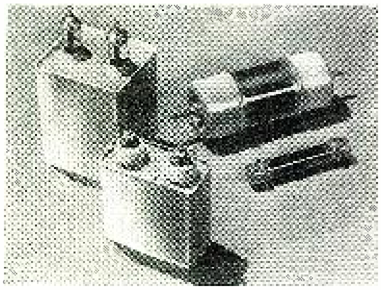
New products for military and civilian use.

The products described herein are available, in most cases, only through high priority ratings. It is suggested that readers apply for further information on company letterheads, stating full details as to priorities available.

SPRAGUE CAPACITORS

A special oil-impregnant, known as Vitamin Q, has been perfected by *Sprague Electric Company* for use in high-temperature, high-voltage capacitors.

These specially impregnated capacitors, when used on jobs where high-



temperature is not a factor, will operate at materially higher ratings for a given size.

Although these Sprague Type 25P capacitors are compact, by using the Vitamin Q impregnant, they will operate satisfactorily at thousands of volts at ambient temperatures as high as 105 degrees C. Leakage resistance at room temperature is 20,000 megohms divided by the capacity in microfarads, or at least five times higher than that of previous types.

Standard types include hermetically sealed rectangular metal container capacitors in styles for 95 to 105 degrees C continuous operations, and in d.c. rated voltages from 1,000 to 16,000 volts. Other types include Type 45P hermetically sealed in glass shells with metal end caps.

Complete details will be furnished upon request to *Sprague Electric Company,* North Adams, Massachusetts.

RECTIFIER TUBE

Taylor Tubes, Inc., is announcing the availability of a new high-vacuum, half-wave rectifier tube, known as the TR-40M. This tube is 9⅞" high with a maximum diameter of 3$^{13}/_{32}$".

The tube is equipped with a 4-pin jumbo base and the envelope is of Nonex. The filament is thoriated tungsten, assuring long life and trouble-free service. The plate lead is at the top and the filament leads are brought out to pins 2 and 4.

The electrical characteristics include: filament power, 5 volts at 10.5 amperes; peak forward volts, 25,000; peak inverse volts, 60,000; and average plate current .25 amperes.

Further details will be forwarded to interested persons requesting it from *Taylor Tubes, Inc.,* 2312 Wabansia Avenue, Chicago, Illinois.

UTAH WIRE RECORDER

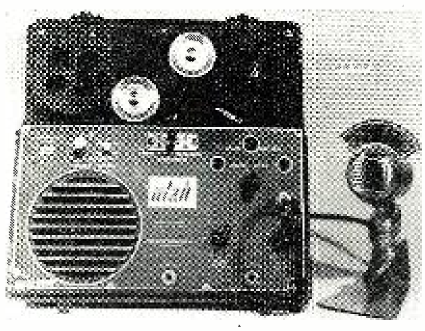
The magnetic wire recorder now being manufactured by *Utah Radio Products Company* of Chicago was used recently to record a speech given by President Harry S. Truman.

This unit is a portable recording device capable of making recordings on a moving steel wire and reproducing them immediately. The principle of operation is the use of small magnets along the moving wire which are activated by the frequency and intensity of the audio signal which then convert the "peaks" and "valleys" of the moving magnetic field into sound by suitable electrical and mechanical means.

The *Utah* unit is housed in an aluminum black lacquer case with a removable lid and separating hinges. It is designed to operate on 115 volt, 60 cycle a.c. Provision is made at the rear of the unit for connection to a source of power.

A full-wave rectifier tube, a three-stage audio amplifier, a 30-kc. oscillator tube, a record-listening mechanism, a drive motor and associated mechanism, make up the recorder and reproducer.

During the recording period the output of the audio amplifier is connected in series with the oscillator-transformer and to the coil in the unit on the front of the machine, called the record-listen head. This device produces the small magnets along the moving wire during recording operations and picks up those same mag-



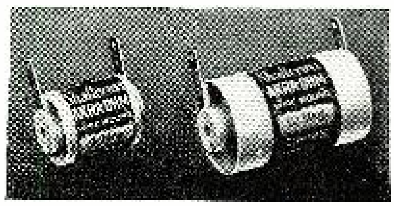
netic impulses for conversion into sound during listening periods. During a playback period, the audio output of the third stage is connected to the coil in the loud speaker. Earphones may be connected, if desired, to an audio output jack located at the control panel.

This unit weighs 37¾ pounds and the over-all dimensions are 13¼" x 11½" x 9". The wire recorder is currently being manufactured by *Utah Radio Products Company* of Chicago.

SEALED RESISTORS

The new Series 1100 hermetically sealed wirewound resistors are now in production at the *Shallcross Mfg. Company.*

These units are impervious to moisture, fungus, vibration and rough handling. They are constructed without glass, without the use of floating or stud-locked resistance elements, and without ferrule terminals or caps. The units use standard mounting facilities throughout. They are at present available in two designs and in all resistance values from 1000 ohms to 10 megohms. High ohmic value



noninductive resistances can be enclosed in this type of construction without danger of difficulties due to leakage.

Both the resistance form and the protective shell are made of sturdy ceramic. The resistance winding element and outer shell are a complete and integral unit without internal leads or floating wires, thus affording complete protection against severe vibration.

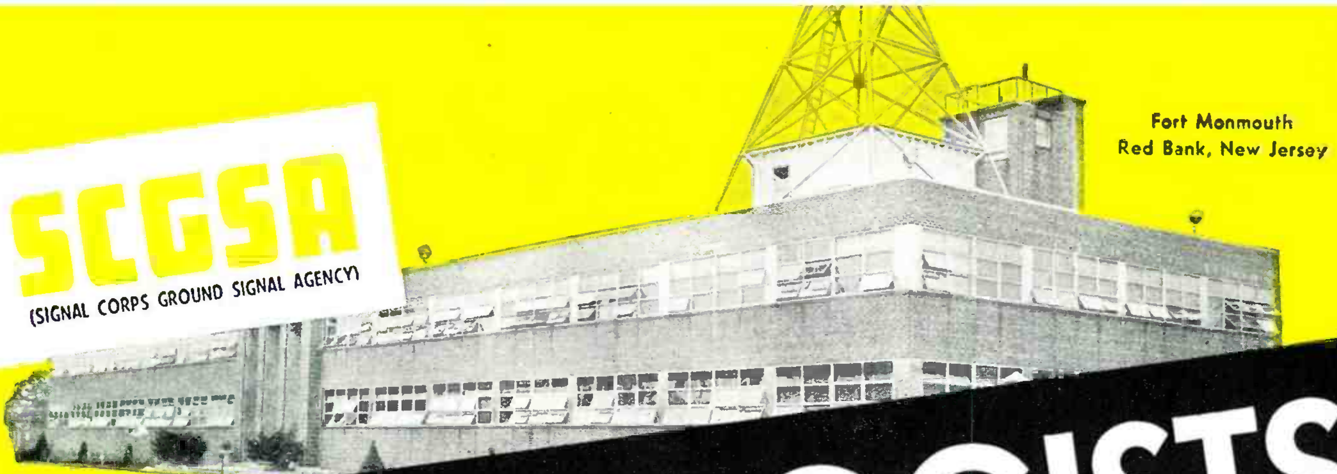
Windings are of the standard noninductive pi-type, thus permitting any resistance values possible in the comparative commercial units. Terminals are of the standard solder lug type.

Further details of these resistors will be forwarded upon request to *Shallcross Mfg. Company,* Collingdale, Pa.

CRYSTAL HOLDERS

A new line of crystal holders which meets all Signal Corps specifications is being manufactured in quantity by *National Electronic Manufacturing Corporation.*

Known as the *Nemco* crystal holder, this unit features new materials and designs, the most important of which is the property of the holder to pre-



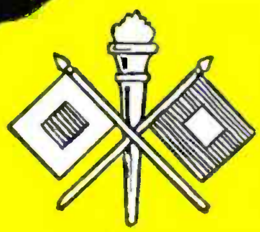
SCGSA

(SIGNAL CORPS GROUND SIGNAL AGENCY)

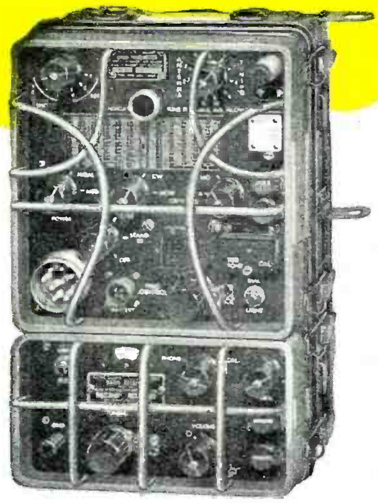
Fort Monmouth
Red Bank, New Jersey

*MYCOLOGISTS

***Mycologist:** A botanical scientist specializing in the study of fungi.



By the persevering research of Signal Corps Mycologists at Squier Laboratories, Fort Monmouth, the enemy's most powerful ally, fungus growth, was thoroughly whipped! When reports came in that myriad species of fungi were literally and quickly destroying our communications equipment, Squier Laboratories attacked the problem by duplicating jungle conditions at Red Bank, New Jersey. At the same time RAULAND became the first manufacturer to build its own jungle laboratory to study at first hand the destructive effects of fungus growth on electronic equipment. These efforts soon led not only to the correct "anti-fungus treatment" for communications equipment but to a complete tropicalization program which helped pave the way for the decisive victories which followed.



SCR-694 TRANSMITTER-RECEIVER

SCR-694 IS ANTI-FUNGUS TREATED . . . . .

Veteran of many U. S. invasions, the Rauland SCR-694 Transmitter-Receiver has battle-proved itself under all operating conditions. Compact, lightweight (22 lbs.), waterproof, fungus proof, this highly versatile and efficient two-way radio serves in vehicles, as a portable ground station or front line command post. Ideally adapted to either jungle or sub-zero operation.

EXCERPTS FROM FIELD REPORTS:

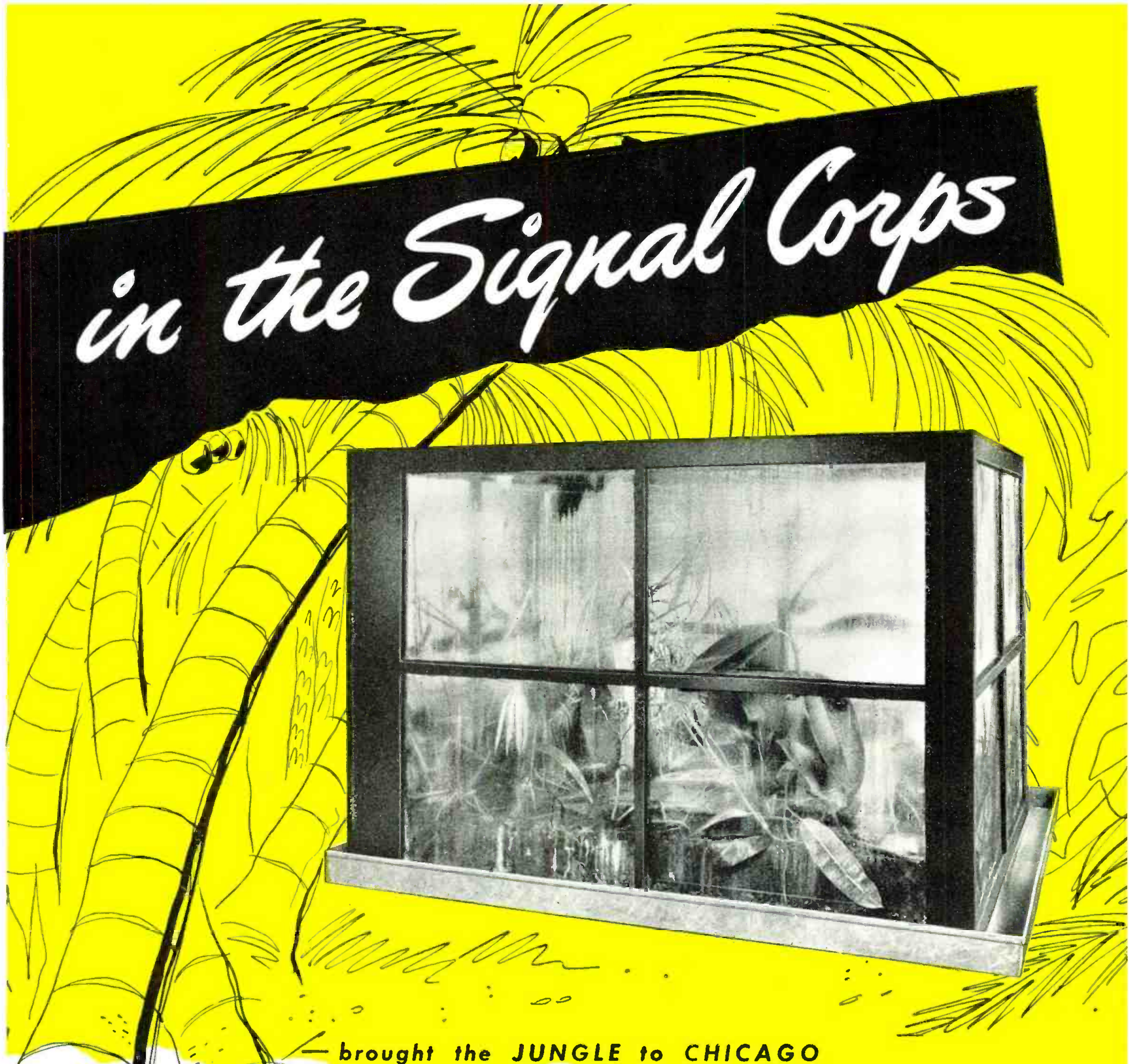
FROM THE PACIFIC: *"during a rainstorm the SCR-694's were the only sets in one section that remained operative"*

FROM ITALY: *"An SCR-694 set was mounted in a ¼-ton, 4 x 4, for demonstration purposes during instructional tours In the two months of travel over typically rough Italian terrain visiting various units to be instructed, at no time was this set found to be inoperative"*

FROM AIR-BORNE SOURCE: *"one set (SCR-694) landed in a stream of water and although completely submerged (time undetermined) worked normally"*

RADIO • • RADAR • • COMMUNICATIONS

in the Signal Corps



— brought the JUNGLE to CHICAGO

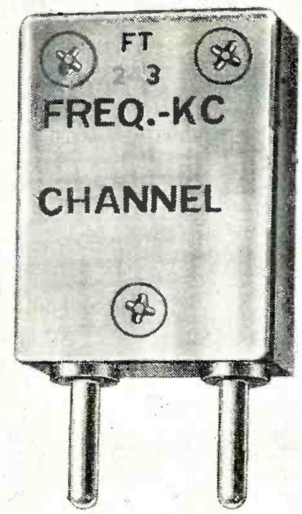
To study the vital problem of fungus destruction at close hand, RAULAND engineers created a miniature jungle in our own laboratories! Early in 1942 they built a large, glass-enclosed air-tight cabinet (pictured above) . . . filled it with the dripping wetness of saturated, super-heated jungle air, tropical plants and lush vegetation, deep rooted in mossy loam. Into this "torture chamber" went RAULAND Communications equipment . . . to finally emerge with the correct anti-fungus answers. A typical example of RAULAND engineering thoroughness in making certain that its precision electronic instruments serve dependably under even the most adverse conditions.

Electroneering is our business

SOUND **Rauland** **TELEVISION**

THE RAULAND CORPORATION • CHICAGO 41, ILLINOIS vent deterioration of the crystal by repelling water vapor under tropical conditions.

Further details, samples, and a com-



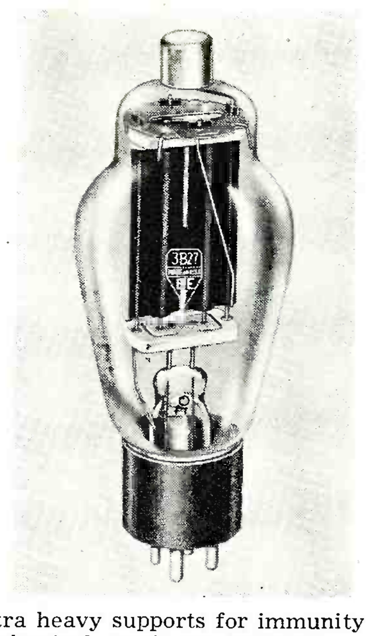
plete catalogue will be furnished upon request to *National Electronic Manufacturing Corporation*, 22-78 Steinway Street, Long Island City, N. Y.

NEW RECTIFIER

A new product has been developed by *Electronic Enterprises, Inc.*, and is now available for distribution.

The product is an EE Type 3B 27 rectifier which meets the need for a high-voltage rectifier of rugged construction for industrial and mobile transmitter use. The tube is a high vacuum type which provides good performance where disturbance from power supplies must be kept at a minimum.

Several unusual construction features, double heaters and cathodes, ceramic spaces for low leakage, and



extra heavy supports for immunity to mechanical shock are included.

Ratings for the tube include, peak inverse voltage, 8,500; peak plate current, 0.6 amperes; average plate cur-

Combining 1. SPECIAL PURPOSE ENGINEERING 2. RECEIVING TUBE TECHNIQUES

The 2C26A exemplifies Hytron's ability to build in soft glass, at high speed, and for economical prices, special purpose tubes. Hytron solved a tough problem for the Services by designing in the 2C26A a tube capable of performance and high ratings never before — or since — achieved in soft glass. This small tube — approximately the same size as the 50L6GT Bantam — is capable of delivering 2 KW of useful r.f. power at 200 megacycles. It replaces larger and much more expensive hard glass transmitting tubes which must be operated at much higher potentials.

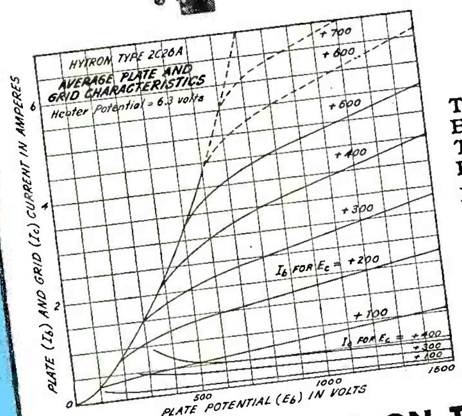
HYTRON TYPE 2C26A

VERY-HIGH-FREQUENCY TRIODE PULSE OSCILLATOR

The Hytron type 2C26A is a special triode for use as a grid or plate pulse oscillator up to 300 megacycles. Its cathode is designed and processed to provide the extremely high peak plate currents required in pulse operation. Special top cap design permits use of the maximum potentials, without external voltage breakdown, at the higher altitudes. Other notable features are: convenient size, standard octal base, high-voltage internal ceramic insulators, and extremely rugged construction.

ELECTRICAL

Coated Unipotential Cathode	
Heater Voltage	6.3 volts
Heater Current	1.1 amps.
Plate Dissipation	10 max. watts
Grid Dissipation	2.5 max. watts
Plate Potential (plate pulsed)	3500 max. peak volts
Plate Potential (grid pulsed)	2500 max. dc volts
Grid Bias	– 700 max. dc volts
Average Characteristics for	Eb:400V; Ec:-15V; Eh:6.3V
Plate Current	16 ma.
Amplification Factor	16.3
Transconductance	2250 micromhos
Average Direct Interelectrode Capacitances	
Grid-to-Plate	2.8 mmf.
Grid-to-Cathode	2.6 mmf.
Plate-to-Cathode	1.1 mmf.
Frequency for Maximum Rating	300 MC



MECHANICAL

Type of cooling	Convection
Base	Intermediate shell octal 8-pin phenolic
Top Caps	Skirted miniature with insulating bushing
Bulb	T-9
Maximum overall dimensions	
Length	3 11/16 inches
Seated Height	3 1/8 inches
Diameter	1 5/16 inches
Net Weight	1 1/2 ounces

2C26A IS ON THE ARMY-NAVY PREFERRED LIST

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON
RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS
PLANTS: SALEM, NEWBURYPORT, BEVERLY & LAWRENCE

FORMERLY HYTRON CORPORATION

rent, 0.150 amperes. Four tubes in full bridge deliver 5415 d.c. volts to filter with 6000 volts total input.

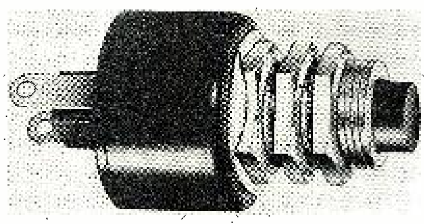
Details of this product may be secured by writing *Electronic Enterprises, Inc.,* 65-67 Seventh Avenue, Newark 4, New Jersey.

SNAP ACTION SWITCH

A new phenolic bodied snap action switch is being manufactured in quantity by *Grayhill* of Chicago.

Known as the *Grayhill* Snapit Switch, this unit measures ⅞" in diameter by 1⅞" high. The switch is mounted by a ⅜-32 bushing, 7/16" long and held by two mounting nuts. The fixed contacts are of fine silver overlay on phosphor bronze. These contacts are threaded and held securely in place, the electrical connection being made by brass screws which also hold and secure the two solder lugs. The moving contact which bridges the two fixed contacts is also of silver overlay on phosphor bronze which assures positive contact with the very minimum of contact resistance. The contact gap is .040" on each contact; therefore, the total contact gap which breaks the circuit is .080".

The switch carries a current rating of 10 amperes at 115 volts a.c. and 2 amperes at 115 volts d.c. Two types of operation are available, the normally open, single-pole switch and the



normally closed, single-pole switch.

Complete information and prices will be forwarded upon request to *Grayhill,* 1 N. Pulaski Road, Chicago 24, Illinois.

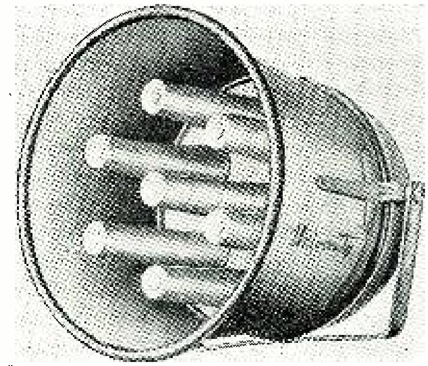
SUPER POWER SPEAKER

A new super power multireflex speaker, which was designed for extreme long-range sound projection over difficult terrain, has been announced by *University Laboratories.*

The AA-7 which is being used extensively in applications for ship-to-ship convoy and combat communications, has an audio capacity of 200 watts and is designed with a 250-cycle low-frequency cutoff for clarity in voice projection. The projection range of this speaker is 1½ miles.

The projector is reflexed for compactness and mounts a battery of seven Model PAH hermetically sealed, shock and blast-proof driver units. Rubber damped rim construction eliminates all trace of mechanical and acoustic resonance and rattle at full power.

The construction of this unit is such that it may be subjected to continuous severe atmospheric exposure with-



out damage. Because of these features, the manufacturers are suggesting its postwar use for stadiums, race tracks, ball parks, and other large arenas which must be covered effectively by the speaker system.

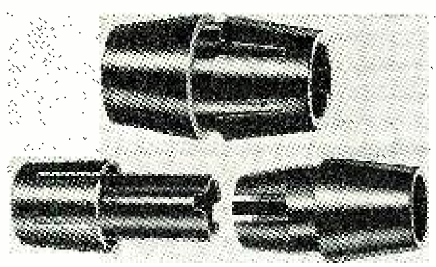
Details of this unit will be forwarded upon request to *University Laboratories,* 225 Varick Street, New York 14, New York.

PLASTIC GROMMETS

A noninflammable plastic blind grommet has been announced by the *Victory Mfg. Co.* for applications requiring good insulation and protection qualities.

The "Des-Grommet" is composed of two parts molded from a special noninflammable formula of Lumarith manufactured by *Celanese Corporation.* The two parts are so designed that they may be applied from one side only by means of a special tool. To install this grommet, it is slipped onto a special tool and thrust through a hole in the partition. As the grommet is drawn together, an undercut section on one half is engaged with a spring locking section on the other half. The tool then forces the two sections together, locking them into one integral unit at the point at which the partition stops further movement.

These units are furnished in a wide range of sizes to accommodate cables and tubes from ¼" through 2" in diameter. Two sizes for wall thickness are supplied, one to accommodate ⅛" to ½" and the second for bulkheads ½" to 1" in thickness. Unlimited color choice makes these grommets suitable for decorative applica-



tions. Colors may also be used for identification purposes.

For full engineering information and sample grommets address requests on company letterhead to *Victory Mfg. Co.,* 1105 S. Fair Oaks Avenue, South Pasadena, California.

—30—

SERVICE WITH METALS FOR MORE PROFIT

RCA was first to market and manufacture metal tubes back in 1935. Since then, RCA has made more than 150,000,000 metal tubes...more than all other manufacturers put together. After the war, RCA Preferred-Type metal tubes will offer both the stock-saving advantages of the RCA Preferred-Type Program, and the high performance assured by the greatest experience in producing metal types.

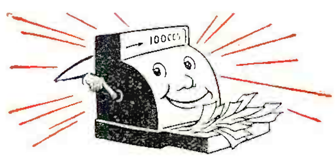
RCA *PREFERRED-TYPE* Metal Tubes make your servicing easier and quicker

DURING the war it's been hard to get metal types ...you have had to substitute glass types for metals. Result? We all realize, more than ever, how much easier metal tubes make servicing! And for good reason . . .

How many times have you had to add shields to sets...how many hours have you spent realigning . . . when self-shielding metal tubes would have done the trick pronto! How much time have you spent in grounding shields...when easy-to-work-with metal tubes are self-grounding?

Yes, metal tubes save trouble from the word "go." Even when you're just testing tubes, metal types are easier to take out and put in...without fooling with clumsy shield cans.

We hope it won't be long until plenty of RCA Preferred-Type metal tubes are available again. And they'll be welcome as replacements for unshielded glass types. For, the time metal tubes save in servicing means more money to you...bigger, better profits and more satisfied customers.



When *new* sets start rolling, look for RCA metal tubes in them. Sell your customers the sets you *know* are easier to service.

Listen to "THE MUSIC AMERICA LOVES BEST," Sundays, 4:30 P. M. EWT, NBC Network

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

RCA

62-6636-02

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION, CAMDEN, N. J.

LEADS THE WAY . . In Radio . . Television . . Tubes . . Phonographs . . Records . . Electronics

Practical Radar
(*Continued from page* 31)

greater if the person shouting is farther away from the cliff or reflecting surface; the interval will be very short if the person is standing close to the wall or cliff.

Since we know that the sound waves must make a complete round trip between the person who shouts and the reflecting surface, and since we know the velocity of sound in air to be 1100 feet per second, it is easy to determine the *distance* from the person to the reflecting wall or cliff.

For example, if we use a stop watch and note that it takes exactly one second for the echo to return after shouting, the person would be standing about 550 feet from the reflecting surface; if it takes two seconds for the echo to return, the distance to the reflecting surface would be about 1100 feet; if it takes four seconds for the echo to return, the distance would be about 2200 feet; and so on.

The distance from the person to the wall or cliff can be determined by multiplying one half the elapsed time in seconds by the known velocity of sound waves. This gives us a means of measuring *distance* or *range* from the person to the reflecting surface *by measuring the elapsed time between the transmitted shout and the reflected echo.*

The direction of the cliff or reflecting surface can also be determined by sound waves. If the person shouts several times, faces a slightly different direction each time, and each time notes the strength of the returning echo, the direction of the strongest returning echo will be the *direction* of the reflecting surface.

Thus, using the simple medium of sound waves, we have determined the *direction* of the reflecting surface, and the *range* or *distance* from the person to the reflecting surface.

Use of Radio Waves

Radar sets operate on a principle very similar to that of sound waves.

In radar sets, however, the sound waves are replaced by extremely high-frequency radio waves, and the entire process of echo reflection is speeded up nearly a million times!

The high-frequency radio waves are radiated in very narrow pulse-modulated beams of energy, like flickering pencils of light. Such radio waves are seldom longer than a few meters and often as short as a few centimeters. But their speed through space remains the same at any wavelength or frequency—approximately 186,000 miles per second, the speed of light.

In most respects, the radiation of the r.f. energy is accomplished by a radar set much in the manner of an ordinary high-frequency radio transmitter. But there are two important differences. The transmitter of a radar set does not function continuously, but transmits a series of recurrent pulses of energy. And after the set has transmitted a pulse, the radar set receives its own signal!

Let's consider a single one of these pulses of radio energy. The pulse is radiated by the radar transmitting antenna in any desired direction and travels in a straight line through space until it strikes an interfering object or target. Instantly, the radio waves are reflected or reradiated by the object in many directions. A portion of these reflected radio waves eventually reaches the receiving antenna and then the receiver of the radar set. By means of an intricate timing device within the radar set, it is possible to measure the exact travelling time of the r.f. pulse from the *microsecond* it left the transmitting antenna until the *microsecond* it returned to the radar set.

Since we know the elapsed time required for the pulse of radio waves to travel out to the target and back, and since we know the approximate speed of these radio waves through space (186,000 miles per second) the *range* or *distance* from the radar set to the target can be determined in the same manner we computed the distance for sound waves.

However, it will be apparent that the elapsed time between the transmission of a pulse and the reception of an echo will be an extremely short


WHAM!
"HE WAN'STA KNOW WHY THEY CALL THIS THA' PACIFIC THEAYTER"
SWISH
ZING

interval. In fact, this transit time is usually a matter of but a few millionths of a second and therefore can only be measured accurately by electronic means. The successful use of pulse-modulated radar systems depends primarily on this ability of the set to measure *distance in terms of time.*

The direction of the target from the radar set can likewise be determined much in the manner of sound waves. Radar transmitting and receiving antennas are highly directional in themselves. Since the antennas are rotated and moved so that they always face in the direction of the target being located, the resulting physical position of the antennas will indicate the direction of the target.

We have only considered the transmission, reflection, and reception of a single r.f. pulse. In actual operation, the radar set transmits a brief pulse, waits to receive any echoes from targets within range, then transmits another pulse, waits to receive echoes, transmits another pulse, waits, and so on. Although the process seems slow in description, complete transmission - reflection - reception cycles take place thousands of times per second.

But sufficient time is always allowed between transmitted pulses for echoes to return from distant targets *before another pulse is transmitted.*

The radar receiver has no trouble in distinguishing between the original transmitter pulse and the reflected echo from targets, since only one of the signals is ever present at one time.

Of course, if a pulse is transmitted into space and fails to strike an object or target, the radio waves will travel in a straight line out into space and be lost, and thus go unrecorded by the radar set.

Reflections of Radio Waves

All targets in the path of the pulsed radar beam do not reflect the same strength of echo signal. The echo signal will vary in strength according to the physical size of the target, the movement of the target, and the distance from the radar set to the target.

It is a simple phenomenon associated with ultra-high frequency radio waves, that a conducting or nonconducting surface of any type, size, or shape will always reflect *some* electromagnetic waves. Thus, no target can neutralize or escape from the probing finger of the radar beam; some portion of the transmitted r.f. pulse will always be reflected.

If the surface of the target is large and smooth, it will reflect radio waves much as a mirror or shiny surface will reflect light waves, and *most* of the radio energy may be returned to the radar set.

But if the surface of the target is not smooth, the radio waves will be reflected in different directions, and very little of the original radio energy may be returned to the radar set.

The latter case is usually true of radar targets. Ships at sea or planes in the air seldom present a smooth reflecting surface, and therefore much of the energy reaching the target from a radar transmitter is dissipated by reflection into space. However, a minute portion of the energy *will* return to the radar set. And although this echo signal from the target may be very weak and may vary in intensity, the sensitive radar receiver usually will be able to detect and amplify the echo.

To obtain a reflected signal of greatest intensity or strength, radar sets generally employ transmitters of very high power. Since the radar transmitter does not function continuously, it is possible to generate phenomenally large amounts of output r.f. power by the use of charged lines and highly efficient output tubes. Power outputs in the order of one-half to a full megawatt are generated by some radar transmitters, in an effort to cause extremely stronger reflected target signals.

A number of planes in close formation, or a number of closely spaced ships, will present a much greater reflecting surface than would a single plane or ship, and therefore stronger target echoes will be reflected back to the radar receiver.

Echoes will be received, of course, from any sort of object which comes within the pulsed radar beam. Trees, high buildings, water towers, coastlines, and mountains, all send back reflections of radio energy. But unlike moving targets such as planes or ships, the echoes from trees, buildings, etc., are always *fixed* and do not vary in strength.

All of the echoes, moving or fixed, collected by the receiving antenna, are detected and amplified by the radar receiver and become electronic signals. They appear not as sound signals as in ordinary radio, but as marks or indications of light on the screen of a fluorescent cathode-ray tube or oscilloscope. The face or screen of the scope is permanently marked with a suitable scale, and from the position of the echo signal on the scope we can determine at a glance all the information necessary to locate the target.

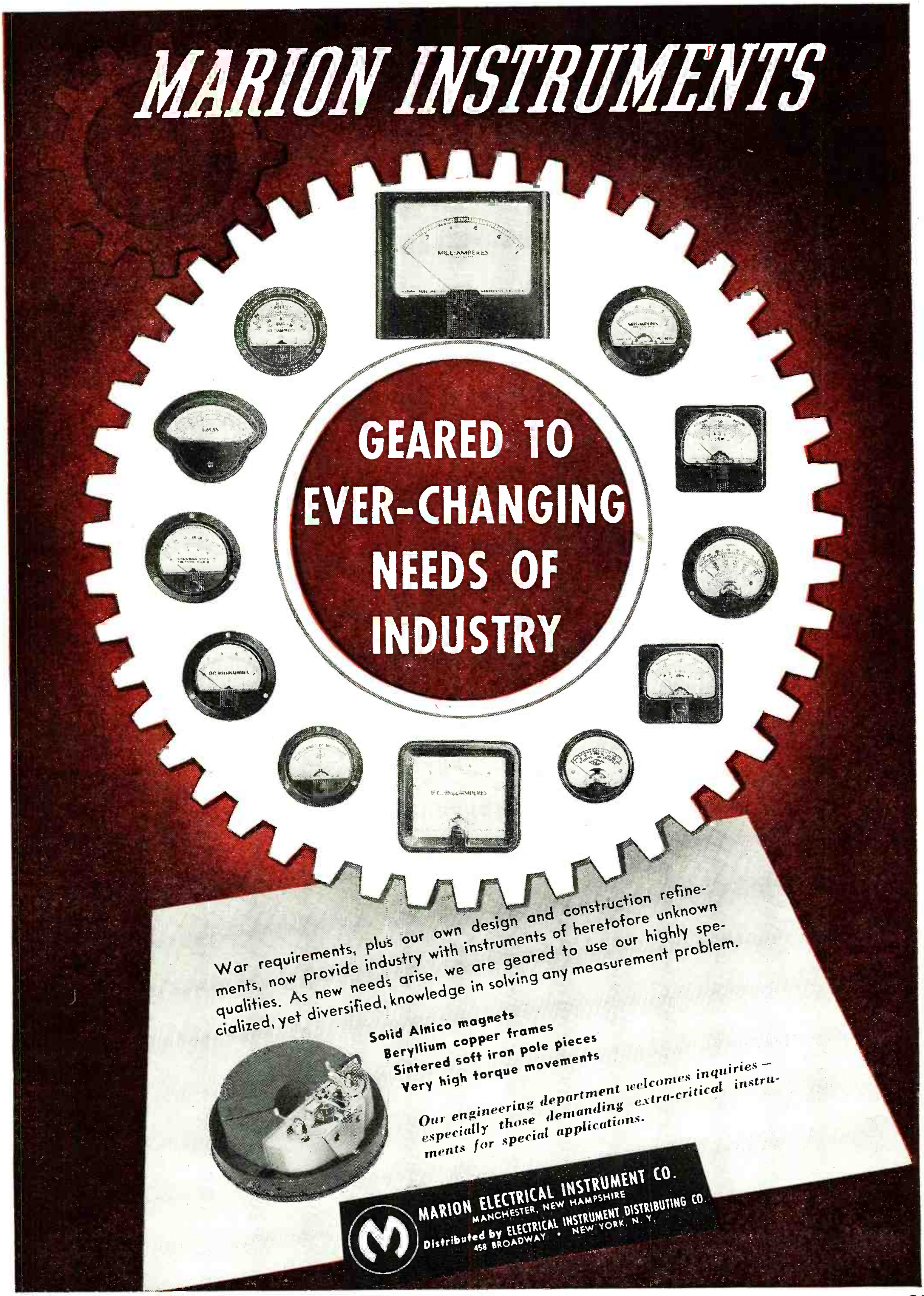
Locating Targets

What information do we need to locate the position of a target in space? And, what degree of accuracy is required?

Let's consider, for example, a ground radar station whose function it is to detect and locate the position of hostile aircraft. A representative situation is shown in Fig. 4.

The radar station at *A* has just detected the presence of an unknown aircraft *B*. The immediate concern of the station is to determine the exact position of the aircraft, and then determine the plane's course and speed.

To locate *any object* in space, three dimensions are always required. And the same is true for the aircraft at *B*. Referring to Fig. 4, we want to know,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therefore, the *distance* from the radar set to the plane (line A—B), the *height* of the plane above the earth (line B—C), and the *azimuth* or *angular bearing* of the plane with respect to the radar station (line C—A). With these three items of information we can locate the exact position of the plane in space. Certain of these dimensions are measured *indirectly,* as we shall see later, but the most important of the three items, *distance,* is always measured directly by the radar equipment.

Before we can determine the height and azimuth or bearing of the plane, we must know the direct air distance from the radar set *A* to the target *B* (Fig. 4). This distance is called the *range* of the aircraft with respect to the radar station, and is measured electronically.

The transmitting and receiving antennas of all radar sets are movable. The antennas can be rotated in azimuth or tilted back at any angle, so that the beam of pulsed energy may be radiated *in any direction.* When the transmitting and receiving antennas are facing full on the target, the indicator of the radar set registers the exact time (in microseconds) required for the transmission, reflection, and reception of each echo. The *range* or distance to the aircraft is computed electronically, as we shall see later, and the result is displayed visually on a cathode-ray tube, calibrated in yards or miles. As long as the radar antennas face in the direction of the target aircraft and echoes are received, the cathode-ray tube will give a *continuous* indication of the exact *range* of the plane.

When the transmitting and receiving antennas were tilted up and adjusted to measure the range of the target, each of the two antennas and the radar beam itself formed an angle with the horizontal plane of the earth. This angle, measured in degrees or mils, is known as the *angle of elevation.*

Knowing the *range* and the *angle of elevation,* an application of simple trigonometry will give us the distance from the ground to the plane, since this distance is equivalent to the length of the side of the "triangle" opposite the known angle of elevation. Thus, the *height* of the aircraft can be computed by formula (Fig. 3) when we know the *range* and the *angle of elevation.*

The actual determination of the *angle of elevation* is not a direct function of the radar transmitter or receiver. The information is obtained by an electromechanical arrangement which indicates the angle of elevation in degrees or mils and then automatically performs the trigonometry indicated in Fig. 3. This gives us an instantaneous reading of the height of the aircraft, at the same time that the range is being determined on the oscilloscope.

But we need to know one other dimension in order to locate our target in space: the azimuth or bearing of the aircraft, with respect to the radar station.

When the transmitting and receiving antennas were rotated to determine the range of the aircraft, the antennas and the radar beam itself pointed in a certain angular direction of azimuth or bearing. Since this was purely a mechanical movement, another electromechanical arrangement can be employed to indicate the direction the radar antennas point with respect to north. This angle of direction, in degrees or mils, will be the *azimuth* or *bearing* of the target.

Thus, we have determined the three dimensions necessary for locating the exact position of a target in the air: the *range* (in miles or yards), the *angle of elevation* (in degrees or mils), and the *azimuth* or *bearing* (in degrees or mils). A radar set supplies all of this information instantaneously and with a high degree of accuracy.

Referring again to Fig. 4, the plane's course and direction of flight can be determined easily by locating the plane's exact position at frequent intervals and plotting this information on a map. If the positions of the aircraft are logged at periodic intervals the speed of the plane can be calculated by simple arithmetic.

When surface vessels are located by means of radar, the angle of elevation is negligible, of course, and the position of the ship can be determined with only two dimensions: *range* and *azimuth* or *bearing.* Both of these dimensions are obtained in the same manner as for aircraft.

Measurement of Time

Determining the accurate range of a target is one of the most difficult electronic functions of a radar set, since it requires the precise measurement of time in *microseconds.*

For this task every component of the radar set must be perfectly synchronized, and the number of transmitted radar pulses must be rigidly controlled. These functions are performed by the electronic timer (Fig. 1), the true pulse source for the entire radar set. The electronic timer may be found to vary in physical size, number of functions, and even in name —since it is less popularly known as a synchronizer, modulator, pulse generator, or keyer. But regardless of name or size variations, the primary purpose of the electronic timer is the origination of a continuous series of *identical* control pulses, which occur at an exact and unvarying rate of repetition.

This rate of repetition is known as the *pulse recurrence frequency,* sometimes called the p.r.f. The voltage pulse generally recurs several thousand times per second. But the actual *duration* or length of the control pulse is extremely short, usually in the order of but a few microseconds, so there is a relatively long period of waiting time between the periodic, recurrent control pulses.

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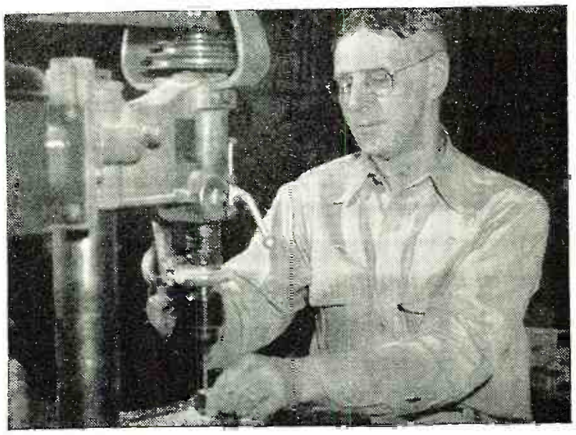
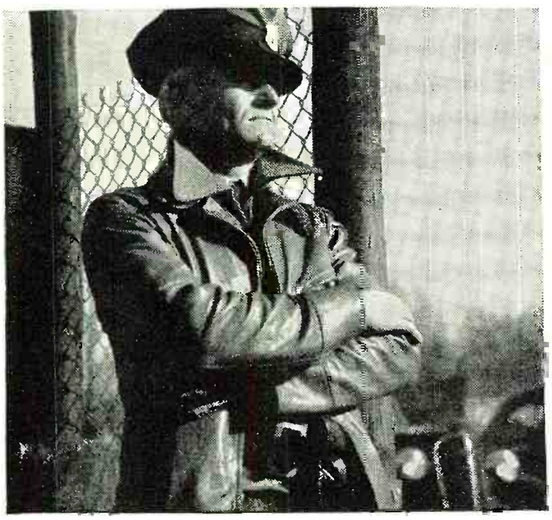
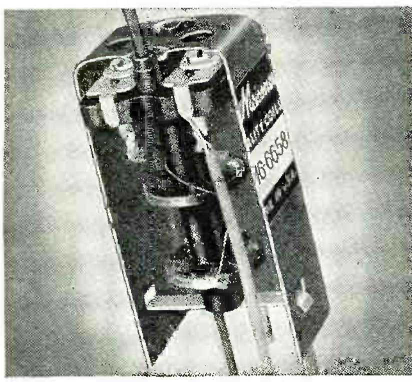


His Skilled Fingers have mastered many of the secrets of electronics. After victory, he and many of Meissner's "precision-el" like him will pass this knowledge and tradition of precision to a new generation.



His Smile is a Reflection of the hundreds of smiles he sees each day as the men and women of Meissner pass through the gates he guards. If you ask him, he'll tell you it's the smile that helps put precision into "precision-el."



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When this control pulse from the electronic timer is applied to the transmitter, the voltage pulse acts as a switch permitting ultra-high frequency oscillations to take place *only for the actual length or duration of the control pulse.* Thus, the radar transmitter radiates u.h.f. radio energy for a period of time exactly equal to the duration of the control pulse, and then ceases to function until another voltage pulse is received from the electronic timer.

During the time period when the radar transmitter is not operating, the radiated pulse of r.f. energy is moving through space with the speed of light. If the radar pulse strikes a target, part of the energy will be reflected back to the radar set in the form of a weak echo. After detection and amplification by the receiver, the echo is ready to be applied to an electronic device used for accurately measuring the out-and-back time of the r.f. pulse.

This all-important measurement of time is accomplished by a cathode-ray oscilloscope which plots the time interval as a function of voltage. Either electrostatic or electromagnetic cathode-ray tubes can be used for this purpose, and there are many variations of both types of indicator tubes. But for our purpose, we will use the simplest and most practical: the electrostatic cathode-ray tube with horizontal and vertical pairs of deflection plates. Such a typical scope is shown in Fig. 2.

Among the usual and normal control circuits of the radar oscilloscope, there is a sawtooth voltage generator directly connected to and controlled by the electronic timer.

This sawtooth sweep voltage is applied to the horizontal deflection plates of the oscilloscope, creating a linear and horizontal time base across the screen of the scope, as shown in Fig. 5.

The sawtooth voltage generator is triggered by a control pulse from the electronic timer, and therefore the linear sweep voltage crosses the oscilloscope screen *every time an r.f. pulse is radiated by the radar transmitter.* At the end of the traverse across the screen, the sweep "flies back" quickly and then, when again triggered by the electronic timer, the relatively slow sweep of the linear time base is repeated. In this manner the time base of the oscilloscope is synchronized with the *pulse recurrence frequency* of the radar set.

The physical length of the time base on the oscilloscope screen has no direct relationship to any time value or time scale. But the movement of the sweep is always linear, and proportional parts of the time base have a proportional relationship to the total time of the sweep.

The vertical deflecting plates of the cathode-ray tube are connected to the output of the radar receiver, so that all echo signals detected by the receiver will be displayed on the oscilloscope. These echo signals appear as vertical deflections of the time base, as shown in Fig. 6.

Converting Time into Distance

Let's consider the action of the oscilloscope during one complete out-and-back cycle of an r.f. pulse.

Every time a pulse of radio-frequency energy is transmitted into space by the radar set, a very small portion of this radiated energy "leaks" through the receiver and appears as a heavy mark at the start of the oscilloscope time base, as shown in Fig. 6. This is known as the "main pulse" or "transmitter pulse" and always appears at the beginning of the time base to indicate that an r.f. pulse has been radiated by the radar transmitter.

After the transmitter has been turned off, by action of the electronic timer, a relatively long period of quiescence follows—sometimes called the "listening period." During this quiescent period the time base of the oscilloscope continues across the screen of the tube at its regular, linear rate of speed. The instant an echo is received by the radar set, a sudden voltage on the vertical deflection plates of the oscilloscope causes a sharp deflection in the base line.

The individual actions involved in one out-and-back cycle of the r.f. pulse are, of course, much too fast to be seen by the human eye. And what we *really* see on the screen of the oscilloscope are the time base, main pulse, and target echoes being retraced thousands of times per second.

Since the time base repeats itself *linearly* every time an r.f. pulse is radiated by the transmitter, there is a proportional relationship between the linear sweep of the time base and the movement of the r.f. pulse through space.

Therefore, *the display of information on the cathode-ray oscilloscope is a miniature record of the transmission and reflection of the r.f. pulses.*

When an r.f. pulse fails to strike an object or target, there will be no indication on the oscilloscope. But all *reflected* signals will appear somewhere along the time base of the oscilloscope.

Allowing for twice the travel time due to the out-and-back journey of the r.f. pulse, the range of the echo target can be determined on the oscilloscope by measuring the distance along the time base between the main pulse and the echo corresponding to the target. This distance, as measured along the time base, will be in direct proportion to the actual space distance separating the radar set and the target. Therefore, it's not a difficult matter to calibrate the time base in terms of miles or yards and then attach an appropriate scale to the face of the oscilloscope (Fig. 6) for the quick determination of range anywhere along the time base.

Most radar sets have an established maximum range of operation, and the time base scale is calibrated to con-

form to the maximum range. However, this limitation is arbitrary. Any radar set can be calibrated to record target echoes up to any given maximum range, merely by changing the slope of the sawtooth voltage wave—thereby changing the speed of the time base sweep to conform to any desired range. For example, a scope calibrated to detect targets within a range of only 10 miles would have a fast time base, whereas the same scope calibrated for use up to 250 miles would have a relatively slower time base.

If several targets at different ranges come into the pulsed radar beam at the same time, they will each reflect their own echoes which will appear at different ranges along the time base of the oscilloscope. Referring to Fig. 6, for example, one target is located at a range of 60 miles and the other target is at 80 miles.

Target echoes never remain stationary on the scope screen. They move in relation to the actual movement of the target in the air or at sea, and, when the radar set is installed aboard a ship or plane, the target echoes also move in relation to the movement of the plane or ship on which the radar set is located.

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SURPLUS STOCK DUMPING

WITH the sale of surplus war materials getting into high gear, Charles Golenpaul, of the *Aerovox Corporation*, has issued a word of warning to jobbers about the financial risks entailed in handling this type of merchandise.

Mr. Golenpaul feels that for the average jobber with small working capital the risk involved is too great to be taken. Surplus sales are made in job lots of miscellaneous parts, some of which may have some resale value, but the most of which are nonstandard or electrically imperfect items.

This merchandise is sold to the surplus buyer as "salvaged parts—electrical condition undetermined and unknown. All parts visually good. No electrical tests have been made on any parts and description furnished is the best available." In addition, the materials are offered "as is" and "where is." To quote further from the government prospectus, "The Government makes no warranty, guaranty, or representation of any kind, expressed or implied, as to the material offered for sale."

It is obvious, according to Mr. Golenpaul, that resale of this material, as purchased, might jeopardize the laboriously achieved reputation of the seller for good merchandise and fair treatment.

Only those jobbers with long experience in handling this type of merchandise, and the ability and surplus cash sufficient to dabble in this, should attempt to enter the field, while the small jobber should stick to the job of selling standard merchandise through the usual channels, according to Mr. Golenpaul.

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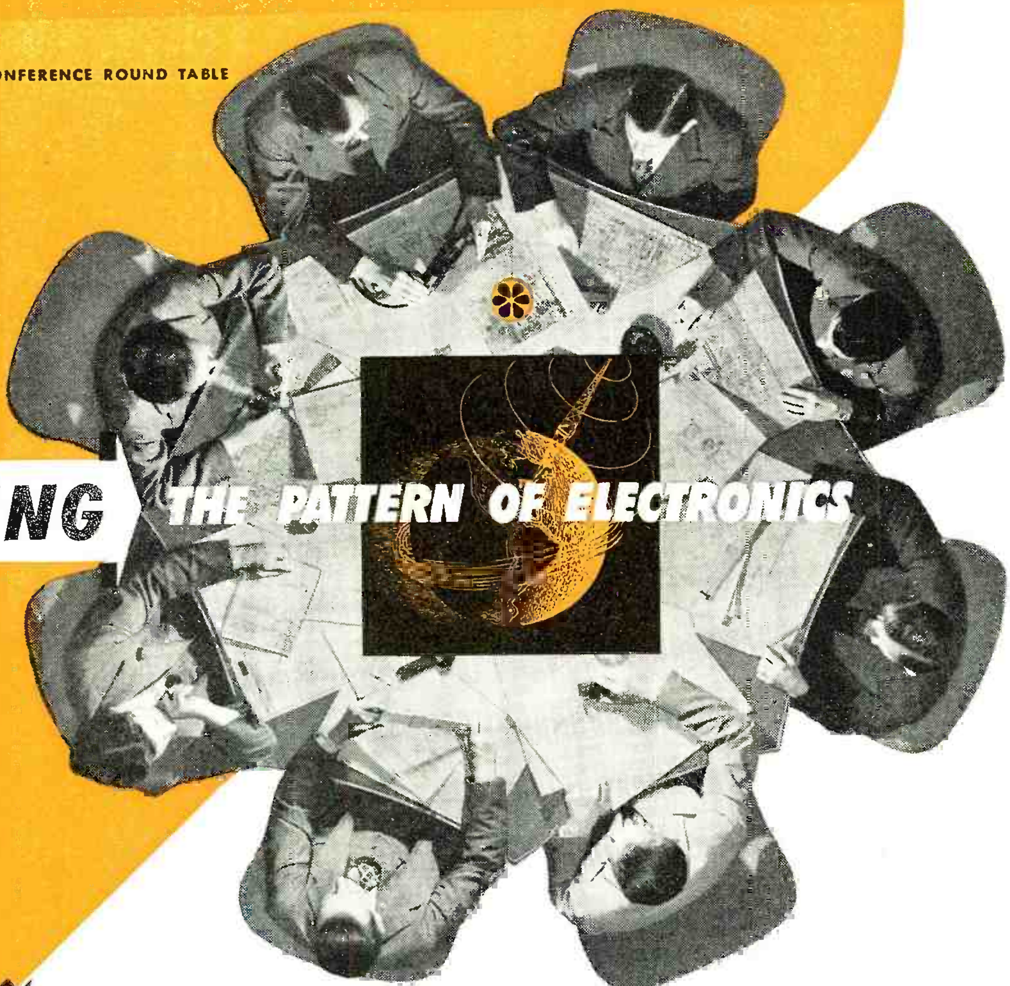
THE DETROLA CONFERENCE ROUND TABLE



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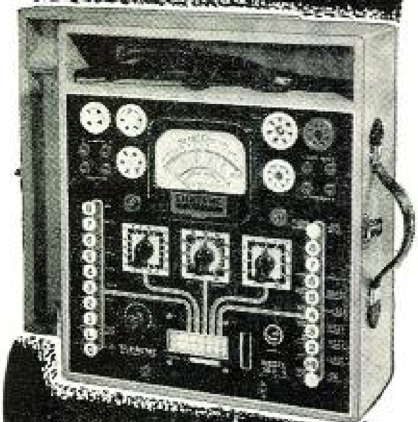

Standard Frequency Broadcast Service of National Bureau of Standards

Details and description of the entire broadcast service emanating from station WWV.

THIS service comprises the broadcasting of standard frequencies and standard time intervals from the Bureau's radio station WWV near Washington, D. C. Starting in Feb., 1945, the service was slightly extended by broadcasting 15 megacycles at night as well as in the daytime.

The service is continuous at all times day and night, from 10-kilowatt radio transmitters except on 2500 kilocycles per second where 1 kilowatt is used. The services include: (1) standard radio frequencies, (2) standard time intervals accurately synchronized with basic time signals, (3) standard audio frequencies, and (4) standard musical pitch, 440 cycles per second, corresponding to A above middle C.

The standard frequency broadcast service makes widely available the national standard of frequency, which is of value in scientific and other measurements requiring an accurate frequency. Any desired frequency may be measured in terms of the standard frequencies. This may be done by the aid of harmonics and beats, with one or more auxiliary oscillators.

Four radio carrier frequencies are used; three are on the air at all times, to insure reliable coverage of the United States and other parts of the world. The radio frequencies are listed in the table.

On the 59th second of every minute the pulse is omitted.

The audio frequencies are interrupted precisely on the hour and each five minutes thereafter; after an interval of precisely one minute they are resumed. This one-minute interval is provided in order to give the station announcement and to afford an interval for the checking of radio-frequency measurements free from the presence of the audio frequencies. The announcement is the station call letters (WWV) in telegraphic code (dots and dashes), except at the hour and half hour when a detailed announcement is given by voice.

The accuracy of all the frequencies, radio and audio, as transmitted, is better than a part in 10,000,000. Transmission effects in the medium (Doppler effect, etc.) may result at times in slight fluctuations in the audio frequencies as received; the average frequency received is, however, as accurate as that transmitted. The time interval marked by the pulse every second is accurate to better than 10 microseconds (-.000,01 second). The 1-minute, 4-minute, and 5-minute intervals, synchronized with the seconds pulses and marked by the beginning or ending of the periods when the audio frequencies are off, are accurate to a part in 10,000,000.

2.5 megacycles (= 2500 kilocycles = 2,500,000 cycles) per second, broadcast from 7:00 P.M. to 9:00 A.M., EWT (2300 to 1300 GMT).
5 megacycles (= 5000 kilocycles = 5,000,000 cycles) per second, broadcast continuously day and night.
10 megacycles (= 10,000 kilocycles = 10,000,000 cycles) per second, broadcast continuously day and night.
15 megacycles (= 15,000 kilocycles = 15,000,000 cycles) per second, broadcast continuously day and night.

Two standard audio frequencies, 440 cycles per second and 4000 cycles per second, are broadcast on the radio carrier frequencies. Both are broadcast continuously on 10 and 15 megacycles. Both are on the 5 megacycles in the daytime, but only the 440 is on the 5 megacycles from 7:00 P.M. to 7:00 A.M., EWT. Only the 440 is on the 2.5 megacycles.

The 440 cycles per second is the standard musical pitch, A above middle C; the 4000 cycles per second is a useful standard audio frequency for laboratory measurements.

In addition, there is on all carrier frequencies a pulse of .005-second duration which occurs at intervals of precisely one second. The pulse consists of five cycles, each of .001-second duration, and is heard as a faint tick when listening to the broadcast; it provides a useful standard time interval, for purposes of physical measurements, and may be used as an accurate time signal.

The beginnings of the periods when the audio frequencies are off are so synchronized with the basic time service of the U. S. Naval Observatory that they mark accurately the hour and the successive 5-minute periods.

Of the radio frequencies on the air at a given time, the lowest provides service to short distances, and the highest to great distances. Reliable reception is in general possible at all times throughout the United States and the North Atlantic Ocean, and fair reception throughout the world.

Information on how to receive and utilize the service is given in the Bureau's Letter Circular, "Methods of using standard frequencies broadcast by radio," obtainable on request. The Bureau welcomes reports of difficulties, methods of use, or special applications of the service. Correspondence should be addressed National Bureau of Standards, Washington, D. C.

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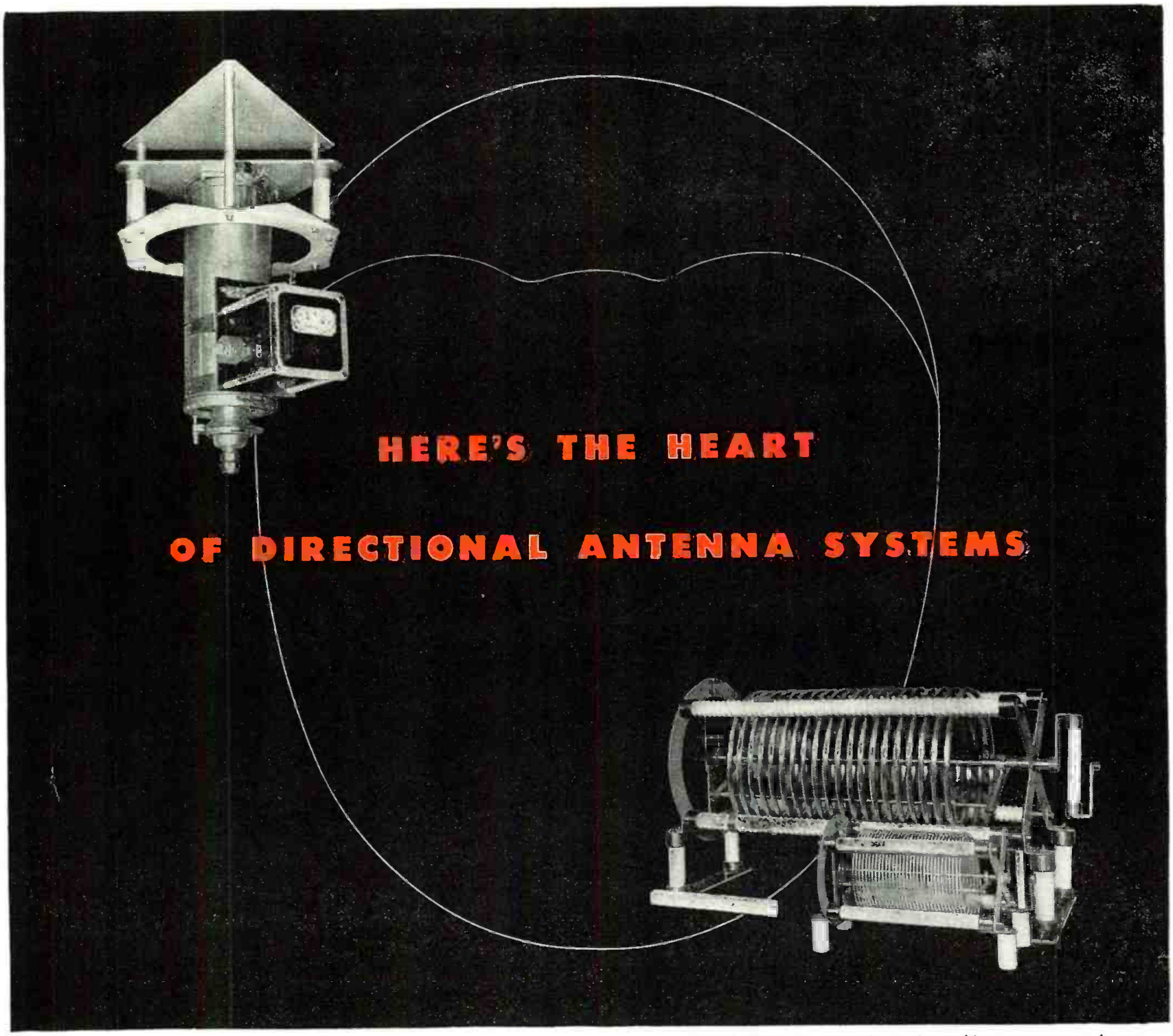

Westinghouse tower tuning and matching components shown above are a variable, gas-filled capacitor (top, left) and a continuously adjustable inductor (below, right).

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Electronics at Work

Television Systems
(*Continued from page* 52)

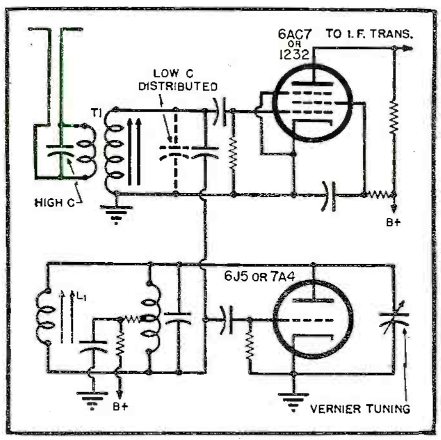
turn and an additional small variable capacitor for fine tuning. One typical set uses a solid metal slug which is moved away from, or toward, the oscillator coil.

I. F. System

The i.f. system of the receiver consists of two separate channels: sound and video. The sound channel is conventional with the possible exception that the i.f. frequency is higher than in the ordinary frequency-modulated receiver. Special resonant circuits are used to separate and prevent interference between i.f. signals. Since the picture or video channel is broad, the video i.f. system contains specially designed circuits which pass a wide channel and still permit a reasonable gain. In order to understand the i.f. circuits, a brief review of some of the fundamentals of resonant circuits follows.

In a parallel resonant circuit, the impedance is maximum and resistive at resonance, and the impedance becomes lower and reactive as the frequency departs from resonance. In the case of a series-resonant circuit, the impedance is minimum and resistive (equal to d.c. resistance in the circuit) and the impedance becomes larger and reactive as the frequency departs from resonance. Consequently, as shown in Fig. 3A, a parallel resonant circuit in series between an a.c. generator and a load prevents the resonant frequency from appearing across the load, but passes other frequencies. A series-resonant circuit in the same position, Fig. 3B, permits the resonant frequency to reach the load or output and rejects all other frequencies. Now, if the procedure is reversed and the resistor is placed in series with the generator and the resonant circuit, which now acts as the load or output, the conditions are reversed. The parallel resonant circuit, Fig. 3C, produces maximum output at resonance and a reduced output at

Fig. 6. A commonly used mixer-oscillator combination, employing a 6J5 triode as a separate oscillator.



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other frequencies; the series-resonant circuit, minimum output at resonance, and an increased output at other frequencies. An important exception to the latter is noted at this point, that if the output is taken off just one of the components of the series resonant circuit, either capacitor or inductor, the output is maximum at resonance and minimum at frequencies which depart from resonance. This is logical if we consider that at resonance the circuit impedance is resistive and low, permitting a high current flow through the circuit which develops maximum voltage across the capacitive reactance of the capacitor and the inductive reactance of the inductor. These two voltages are out-of-phase and neutralize each other when connection is made across both capacitor and inductor.

When two coupled circuits, tuned to the same frequency, are brought in close proximity to each other, the tuned primary circuit which is excited by a resonant current radiates lines of force which induce a resonant current in the secondary winding. The amplitude of the induced voltage at resonance (parallel resonant circuit in shunt with or acting as a load for an a.c. signal develops maximum voltage at resonance) or at frequencies off resonance, depends on the degree of coupling between winding. If the two tuned circuits are separated some distance, called loose coupling, the voltage amplitude in the secondary is low. When the coupling is increased to the optimum value, called critical coupling, maximum peak voltage is induced in the secondary (approaches a 1 to 1 transfer). If the coupling is increased beyond the critical value, a double-humped resonance curve appears in the secondary, Fig. 2, which has a dip at the resonant frequency and a peak on each side of resonance.

Normally, the secondary can be said to reflect pure resistance into the primary; thus, it only loads the primary and does not alter its frequency. When the coupling is tight, however, reactance is also reflected into the primary. This reflected reactance, at some frequency on each side of resonance, equals the normal primary reactance at this same frequency, simulating a new resonant point and a consequent rise in voltage. The double-hump or overcoupled transformer is used to advantage in television circuits to increase the bandwidth.

The use of resonant circuits, mutually coupled tuned circuits, and double-humped resonant curves in i.f. circuits will be discussed in next month's comprehensive article, which will also cover in detail the i.f. system of the *General Electric* model 90 receiver. Don't forget to review previous articles of the series, because each time you cover them, new pieces of information become evident or more firmly established. Television is an orientation problem and must be gradually assembled into an entirety.

(*To be continued*)

New Large-Screen RCA Television Receiver

RADIO Corporation of America has recently previewed their advanced development model large-screen home television receiver in cooperation with NBC.

This receiver incorporates four new engineering principles which were developed by the engineers of *RCA Laboratories* and the *RCA Victor Division* before the war.

The first important change, over the prewar receiver design, is the new reflective optical system. Instead of viewing the image directly from the face of the Kinescope, the television tube is mounted with the face of the tube downward. The image on the face of the tube is reflected into a special mirror which is shaped like a shallow bowl and with the reflective coating on the concave surface facing the light source. The image is then reflected from the mirror through the aspherical correcting lens. This lens brings the light reflected from the mirror to a sharp focus on the screen.

Formerly the cost of grinding and polishing the aspherical lens was prohibitive and its use was deemed impractical. Under the new *RCA* system, this lens is now molded from transparent plastic and the cost of fabricating this component has dropped sufficiently to permit its use in medium-priced receivers.

A flat mirror is placed directly behind the viewing screen and images passed through the aspherical lens are thrown onto the inclined surface. This mirror is so placed that the reflected image is distributed evenly over the large-sized screen which measures 21⅓x16 inches.

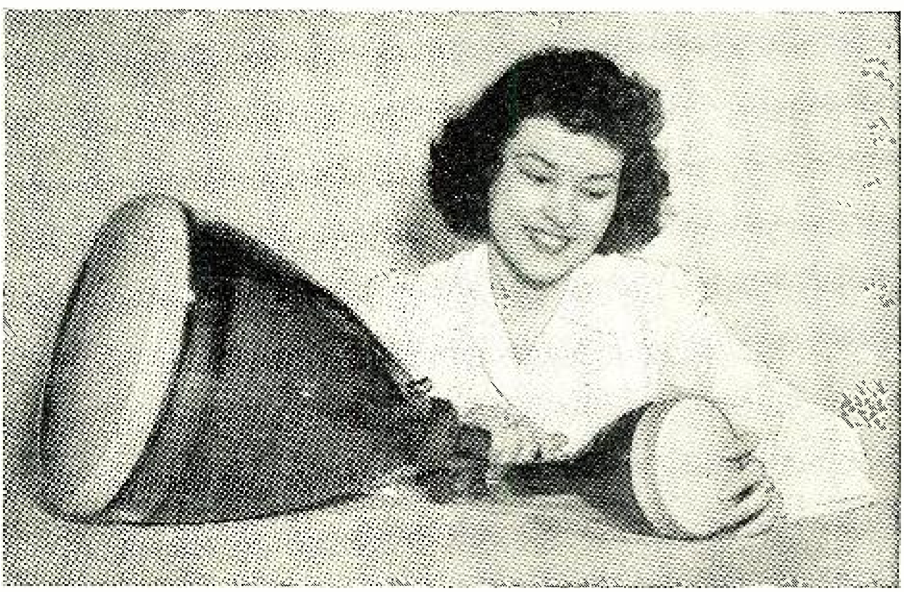
Two different optical problems were confronted in the construction and design of this translucent viewing screen. The main problem was that of eliminating the inherent tendency of the screen to develop a "hot spot" resulting in a glare in the center of the viewing screen and insufficient light in other parts of the image. The second problem was the need for distributing the major portion of the transmitted light to the area which the spectators would occupy in relation to the receiver.

These problems were solved by incorporating certain features in the molded design of the screen which assures both even distribution of light over the image and a proper distribution of transmitted light within the normal viewing angle.

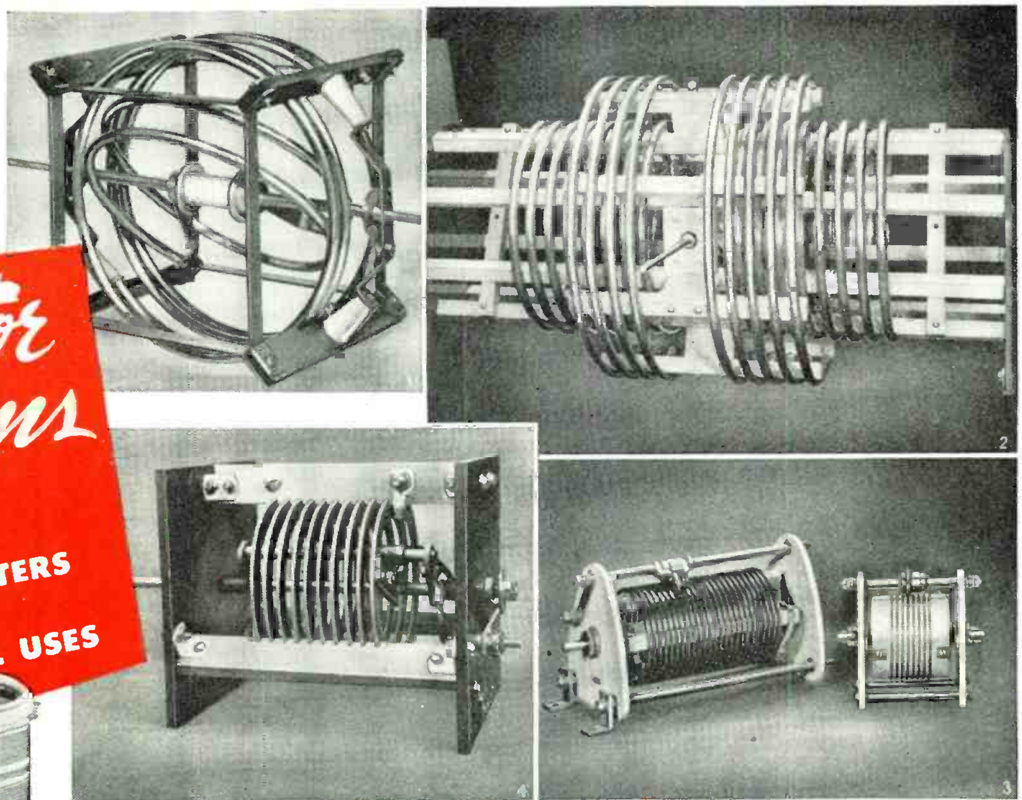
Automatic Frequency Control

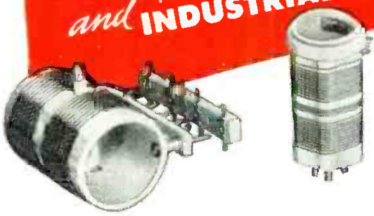
The third outstanding feature of this receiver design is the automatic frequency control which discriminates between transmitted synchronizing impulses and stray noise impulses, which might otherwise trigger the

This comparison of prewar (left) and developmental postwar (right) television picture tubes shows how RCA's development of the small-size, high-voltage cathode-ray tube will contribute toward smaller, lighter, and less costly home television receivers, as well as larger, brighter images. In the large-screen home receiver, the 5-inch high-voltage tube will be used in a unique reflective optical system to project to a built-in screen an image five times as large as could be obtained on the 12-inch prewar direct-viewing tube.



Inductor Designs for RADIO TRANSMITTERS *and* INDUSTRIAL USES





When you need an inductor for any purpose consult Johnson Engineers. Their files will probably contain a design for your required inductor, but if not, they can design one and make it to do your particular job.

Inductor design is quite a special study and no one conductor, no one insulator, no one type of construction is suitable for every requirement. Johnson may select a copper tubing conductor to handle high currents in one design, while edgewise strip is selected in another because of its narrow width and the ability to get a greater inductance in the same length. Other conductors are available too, such as solid wire, litz wire, flat strip, square Bars and special shapes, some plated, some polished and lacquered according to their use. In order to make contact to the conductor and bring off taps Johnson has produced a complete line of clips and connectors for use on fixed taps as well as sliders and rollers for continuously variable taps.

Insulation requirements vary. While steatite or mycalex may be used for low losses in a certain high frequency coil, plastics may be better for another because they stand more mechanical shock. Production facilities at Johnson provide for working any insulating material so the best one or the best combination, can always be selected to fit the special job.

Johnson inductors are designed and built for efficient operation and they have high Q. Some are fixed and some are variable. Some designs require special features such as rounded parts to minimize corona discharges at high voltages, water cooling, variation of inductance or variation of coupling.

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The control fixes a time interval for the synchronizing impulse and automatically shuts out those impulses which do not arrive on schedule.

Without a control of this type, noise interference could throw the scanning beam in the receiver out of synchronization with the one in the transmitter, causing the former to "black out" and return on some lines of the picture before they were completed. This results in "tear outs" and ragged-edge effects.

High-Voltage Cathode-Ray Tube

The fourth innovation to be incorporated in the new *RCA* television receiver is the use of the new high-voltage cathode-ray tube. This tube is substantially smaller and lighter in weight than the prewar direct-viewing picture tube. The application of this type of tube results in a smaller, lighter, and less costly home receiver and will ultimately mean lower replacement costs.

This tube which is only five inches in diameter, is designed to operate at a rated voltage of 27,000 volts, which is nearly four times the voltage used in prewar tubes. Because of the higher voltage, the new tubes produce a much brighter initial image. This high initial brilliance, in conjunction with the new optical system, produces a clear image on the screen which is five times as large as could be produced on a prewar direct viewing tube with a face diameter of 12 inches.

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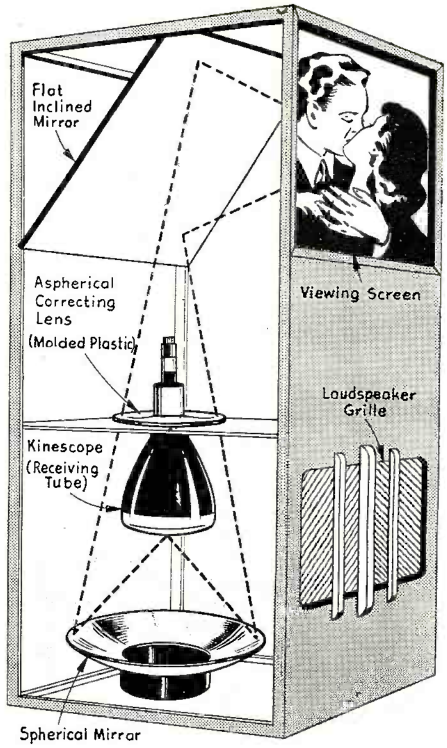
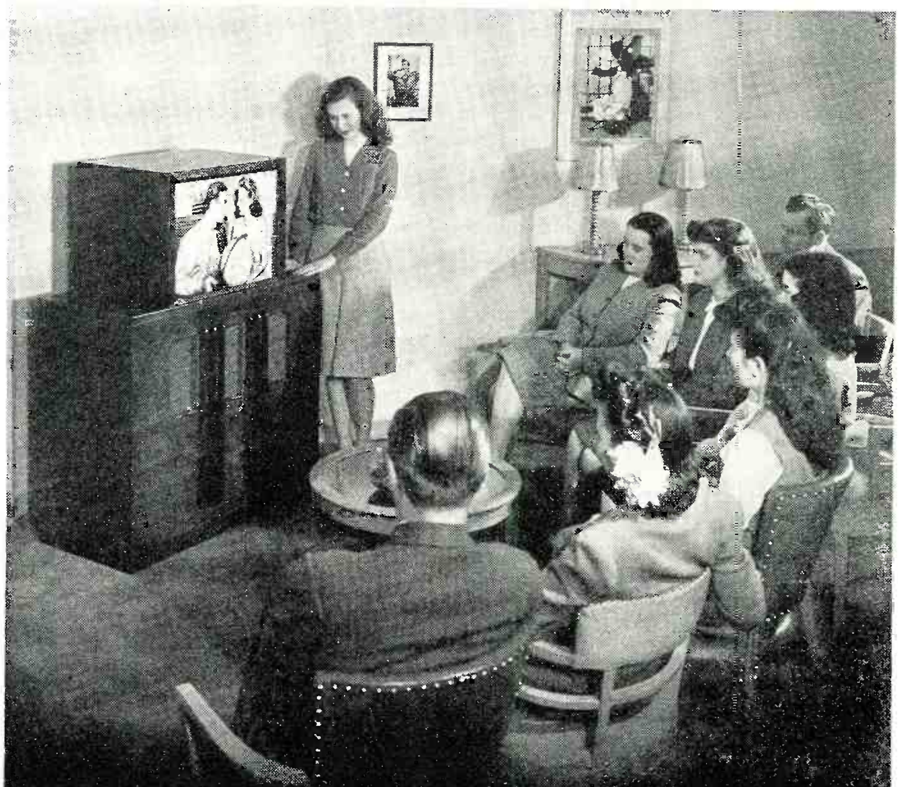
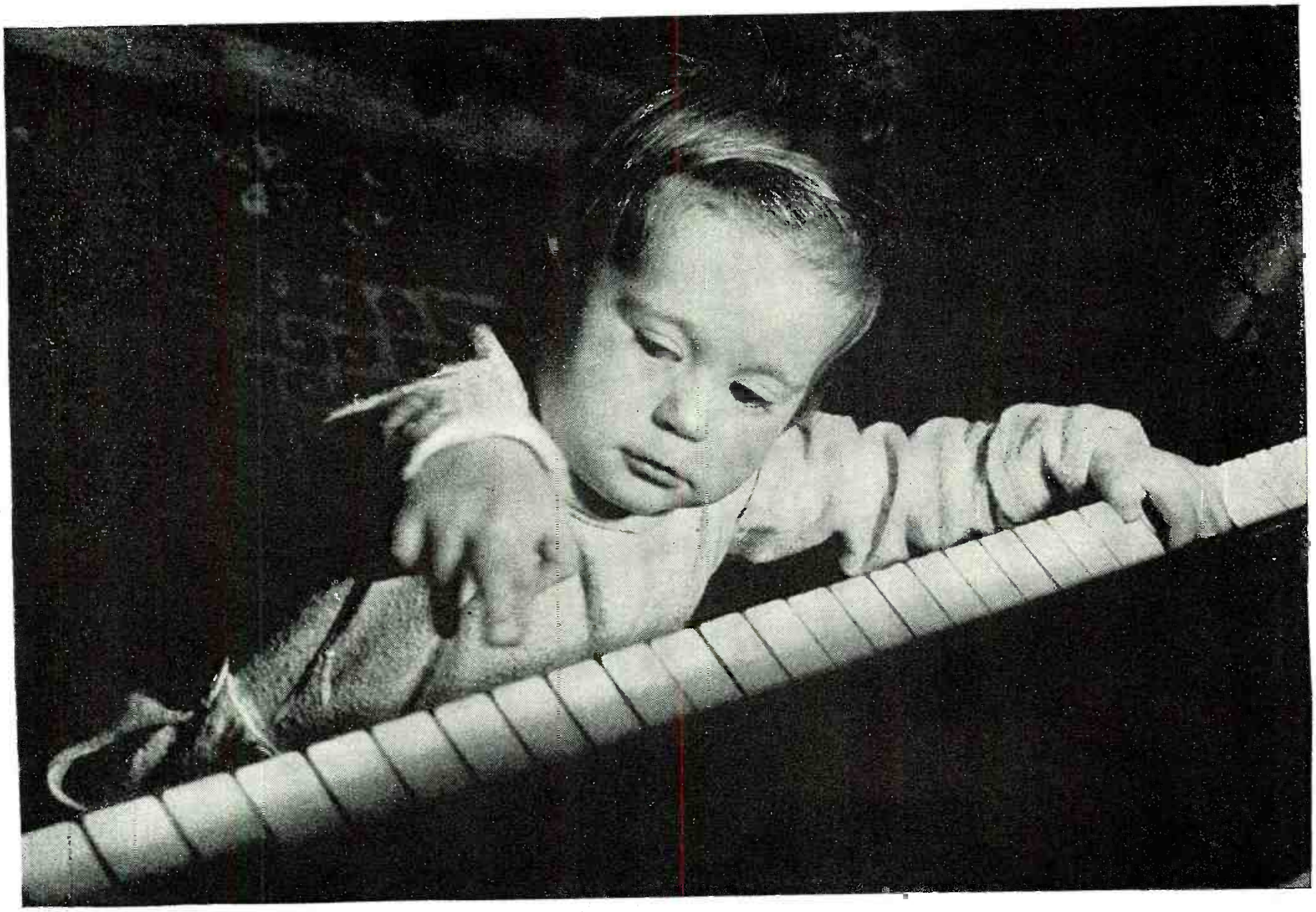


The broken lines show the path of light beams from a single picture element on the face of the cathode-ray tube to a corresponding point on the screen. A plastic lens is used to bring these light beams to a sharp focus. The combination of spherical mirror and correcting lens delivers about six times as much light as could be obtained if a conventional F:2 movie projection lens were used.

Large-screen television for the home, providing bright, clear, high-definition pictures 16 by 21⅓ inches in size, was demonstrated for the first time by RCA in the studios of the National Broadcasting Company.





Let's Talk Shop

(*Continued from page* 45)

used would be in addition to the fixed service fee. The fixed service fee charge has a number of drawbacks. One is that this fails to tell how many calls will be necessary to maintain the equipment until after several months experience with the particular plants in which you are operating. Some will have a very high service call rate during certain months of the year where the production schedule is heavy. Others will proceed along a regular course over a period of years. The other method of handling charges would be on a time and material basis. The only thing to keep in mind is that the charges must be acceptable to the war plant in order that the manufacturer does not tend to shop around when he needs service. If the time and material basis of handling material is used, the serviceman should be in contact with the distributor or manufacturer who is furnishing the necessary repair parts to service the equipment. This brings up another problem. Much of the industrial electronic equipment has been purchased directly from the manufacturer. In this case the serviceman will have to depend on the purchasing agent of the individual manufacturers to get for him a stock of repair parts necessary to do his job. Obviously, the serviceman will not be able to make any profit on parts supplied by this system. In fact, it will be extremely hard to realize any profit on the parts which go into the repair of industrial electronic equipment since most manufacturers are well aware of their cost on a wholesale basis. Since this work is highly specialized, it is better to increase the service charge in order that the serviceman may make a profit on his time and at the same time compensate himself in some measure for the loss of revenue from the sale of parts.

Many manufacturers have told us that they intend to take a junior engineer or laboratory assistant and keep him on the payroll and use him for this work of servicing. This, of course, poses a problem for the local outside serviceman and he will have to watch carefully and conduct himself strictly along business lines if he is to compete successfully along this type of operation. While, no doubt, a large number of manufacturers will employ their own servicemen on a full time basis, there still is left a large field for enterprising servicemen who desire to get into this lucrative field. The time to make your contacts is right now in order that you should be set for efficient postwar operation.

The serviceman who knows his industrial electronic equipment, who charges a fair price and performs his work in a business-like manner need have no fear of loss of business in the postwar period.

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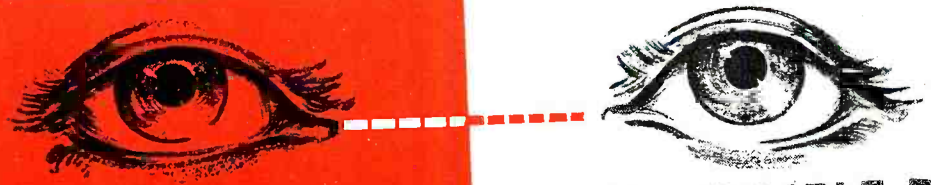
EYE • EYE



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Practical Radio Course

(*Continued from page 47*)

kc. i.f. and tuned to receive a 1200-kc. signal, and the ganging arrangement for the various timing capacitors, is illustrated in the block diagram of Fig. 6.

Tracking the R.F. Tuned Circuits

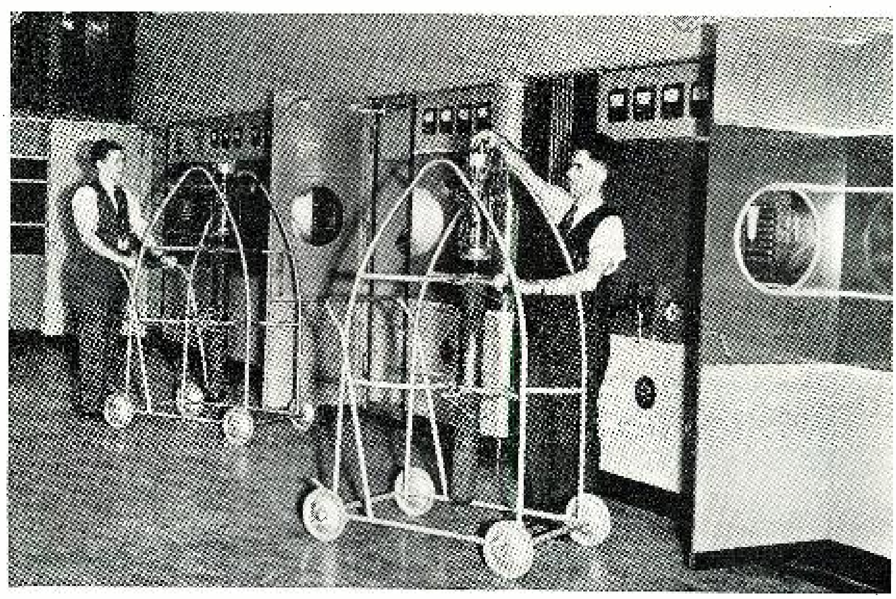
In the r.f. amplifier section of the receiver the tuning coils and variable tuning capacitors in each signal-tuning circuit are made as nearly alike as quantity-production manufacturing and matching will permit. In receivers designed to cover only a single-frequency band, exact alignment of these radio-frequency circuits at the *high-frequency* end of the tuning range is then attained by the use of an adjustable trimmer capacitor in shunt with each main tuning capacitor, as shown in Fig. 5. These trimmer capacitors are usually of the small postage-stamp mica-compression type, and in most cases one is mounted directly on the stator plate bar of each tuning capacitor section. In broadcast-band receivers, they usually are adjusted for correct high-frequency tracking at a frequency between about 1400 and 1700 kc., depending upon the design of the particular receiver.

In receivers designed to cover only a single-frequency band, it is possible to also align the r.f. tuned circuits at the *low-frequency* end of the tuning range (at about 600 kc. for broadcast-band receivers), and at several frequencies in between, by bending sectors on the slotted end plate of each variable tuning capacitor in order to cause the required slight increase or decrease in the tuning capacitance. The slotted end plate provided for this purpose in each section of a 3-gang tuning capacitor is illustrated in Fig. 4.

In multiband receivers, r.f. circuit alignment at the *high-frequency* end of each tuning range is accomplished by means of an adjustable trimmer capacitor connected across each separate tuning coil. Alignment at the *low-frequency* end of each tuning range is accomplished either by careful manufacturing control that ensures uniformity and close matching of the r.f. tuning coils and capacitors, or by individually adjusting the inductance of each tuning coil by shifting the position of one or two of the end turns toward or away from the rest of the winding until sufficiently close alignment is obtained.

(*To be continued*)

Canada's new short-wave station, CHTA, is now operating, beaming programs in several languages to Europe. This Government-owned CBC station was built at Sackville, New Brunswick, Canada, in the salt marshland area which was found to increase the station's efficiency. On the Great Circle Route to Europe, it is one of the few places in Canada free of the north magnetic pole influences. Towers and antennas are designed to resist winds of 120 m.p.h., even when covered with 2 inches of ice. It is equipped with two transmitters, each generating 50,000 watts, but a special beam antenna multiplies this 100 times, thus giving a total available power of 10,000,000 watts. Its signals are reported being received several times stronger in Europe than those of any other North American short-wave station. More than 26 miles of wire are used for the antennas and conducting lines between them and the transmitters. The antennas are strung up between towers varying in height from 170 to 380 feet. The photo shows engineers preparing to install the 100-kw. high-voltage tubes in the transmission panel. Special racks were designed to convey the tubes from storage vault to panel to protect them against breakage during handling and transportation.



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Specifications:

★ Tests all tubes up to 117 Volts including 4, 5, 6, 7, 7L, Octals, Loctals, Bantam Junior, Peanut, Television, Magic Eye, Hearing Aid, Thyratrons, Single Ended, Floating Filament, Mercury Vapor Rectifiers, etc. Also Pilot Lights.

★ Tests by the well-established emission method for tube quality, directly read on the scale of the meter.

★ Tests shorts and leakages up to 3 Megohms in all tubes.

★ Tests leakages and shorts of any one element AGAINST all elements in all tubes.

★ Tests BOTH plates in rectifiers.

★ Tests individual sections such as diodes, triodes, pentodes, etc., in multi-purpose tubes.

★ New type line voltage adjuster.

★ NOISE TEST: Tip jacks on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

★ Features an attractive etched panel.

★ Uses a 4½" square rugged meter.

★ Works on 90 to 125 Volts 60 Cycles A. C.

The Model 450 comes housed in a portable leatherette covered cabinet complete with all operating instructions. Size 13" x 12" x 6". Net weight 8 pounds. Our Net Price

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Impedance Bridge

(*Continued from page 44*)

For maximum readability of the graduated dials, the rheostats must have linear tapers. Logarithmic tapers give rise to crowding of the dial divisions at one or both ends of the dials, depending upon whether the logarithmic curve is at either or both ends of the resistance ranges.

The terminal post numbering in Fig. 7 corresponds to that in the three illustrative diagrams in Fig. 5. That is: 1 and 2 are in the upper left-hand bridge arm, 3 and 4 in the upper right-hand arm, 7-8-9 and 10 in the lower right-hand arm, and 11 and 12 in parallel with 9 and 10 for Maxwell connections of the rheostat. The generator jack, J_1, corresponds to terminals 13 and 14 in Fig. 5, while the detector jack, J_2, corresponds to terminals 5 and 6.

Construction

Bridge. The bridge proper (decades and terminals) is assembled on a 7" x 10½" metal panel to which all of the parts are mounted. The decade switches, S_1-S_5-S_6-S_7, are fastened directly to the panel, and the various decade resistors are soldered to lugs mounted on thin bakelite panels slung from the main front panel directly behind the corresponding switches. Fig. 2 shows the front panel layout.

In the author's version of the bridge, the panel is mounted on a sloping-front wooden case (See Fig. 2) 7½" deep, 6" high, and 10⅝" long. The interior of the box is lined with tin foil glued to the wood and connected by flat copper springs to the front panel. Any other convenient housing, such as a metal cabinet, may be employed with success.

No attempt is made to make the instrument over-compact. Rather, ample room is provided between parts—a necessity when high signal frequencies are employed. Connections between switches and between terminals are made with No. 12 tinned busbar. Flexible hookup wiring must not be employed.

The terminal posts are ceramic-insulated feed-through connectors (*Johnson* Type 44). Although more time is required when using the bridge to tighten the nuts on these terminals (when "plugging-in" standards and unknowns), more positive contact is afforded than is possible with faster-acting banana jacks, since the latter introduce serious contact resistance into the bridge circuit.

The switches are bakelite-insulated, single-pole, 11-position, nonshorting components. Nothing is to be gained at the bridge frequencies from use of more expensive and harder-to-get ceramic-insulated selector switches.

J_1 and J_2 are standard single-circuit (normally open) midget phone jacks. J_1 must be insulated from the metal panel, through which it passes, by means of bakelite or fiber shoulder-type washers. The frame of J_2, on the other hand, is grounded directly to the panel. Both generator and detector are connected to the bridge by means of shielded lines terminated by phone plugs inserted into jacks J_1 and J_2.

Standards. The resistance and capacitance standards, shown in Fig. 7, are built into small metal boxes, 4" x 4" x 2" in size. (*I. C. A.* No. 3810.) The switches are bakelite insulated and are of the nonshorting type. Flat strips of heavy copper, or short lengths of heavy copper wire connect the *standard boxes* to the bridge-arm terminals.

Rheostats. The calibrated-dial rheostats in the author's version of the bridge are mounted on 2½-inch-square bakelite panels with insulated binding posts to receive the wires or strips used to connect them to the bridge-arm terminals. (See Fig. 6.) Individual experimenters may prefer to mount these rheostats in small cans for increased neatness, however this step did not seem necessary to the author, since the rheostat construction (being already of an enclosed nature) protects the resistance winding against damage in the "open-work" type of mounting shown in Fig. 6.

Scales and Name Plates. Scales and name plates on the bridge section, standard boxes, and rheostat panels are made from white Bristol board, and are lettered with black India ink and covered with transparent celluloid sheet. These have proven highly readable, as well as neat in appearance and easy to make. The individual builder may satisfy his own tastes in this direction, however, utilizing other scale making facilities at his disposal.

Adjustments

Bridge Section. The bridge section requires no adjustment or calibration aside from a careful selection of the decade resistors in the first place. The wiring scheme shown in Fig. 7 must be followed. Each decade name plate is then graduated in the manner indicated in Fig. 7, reading 0 to 10 from left to right. The fourth division in the thousands group will then indicate 4000 ohms; the sixth in the hundreds group, 600 ohms; the zero position in the tens group, 0; and the 9 position in the units group, 9 ohms; etc.

Standard Boxes. The resistance and capacitance standards likewise are carefully selected, with respect to resistance and capacitance, before wiring into the box circuits, and thus require no calibration after assembly. The wiring scheme shown in Fig. 7 must be followed. Then, the dial plate on resistance standard No. 1 will be inscribed to read 100-1000-10,000 ohms from left to right; the dial plate on resistance standard No. 2 to read 1-10-100-1000-10,000 ohms from left to right; and the dial plate on the capacitance standard to read .001-.01-1 μfd. from left to right.

Rheostats. The rheostat dials must be individually calibrated after the

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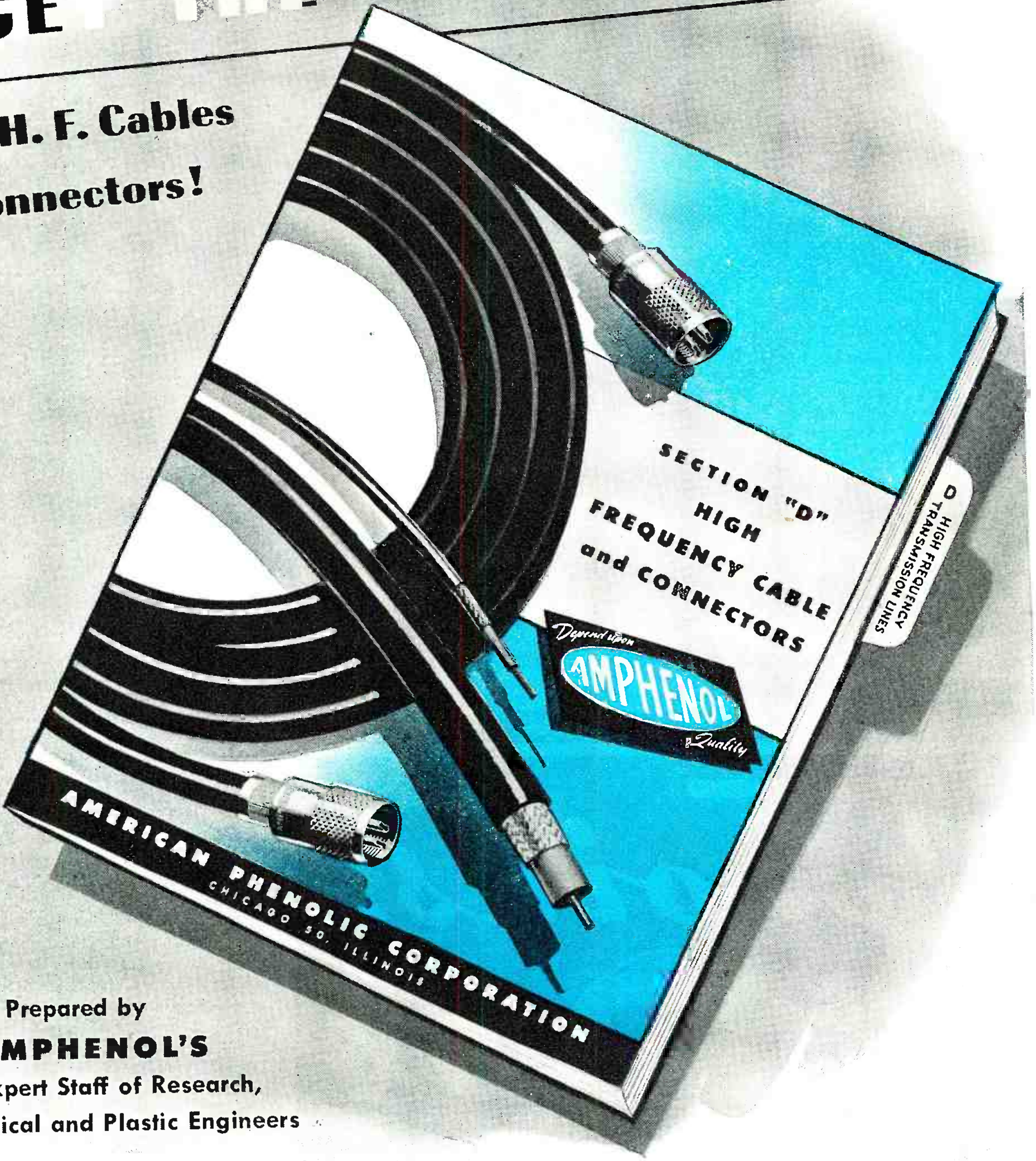

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Also send information on ____________________ units are mounted on their panels. The following procedure is followed:

1. Set the rheostat to minimum resistance (extreme left-hand position), and set the pointer of its control knob to the extreme left-hand position,

2. By means of a reliable ohmmeter or resistance bridge, measure the rheostat resistance at this setting and inscribe this value opposite the pointer on the rheostat dial,

3. Advance the rheostat until the ohmmeter or bridge indicates a next higher resistance value in convenient scale relation to the first reading, and inscribe this value on the rheostat dial (e.g., if the first reading was zero on the 100-ohm scale, the next reading would probably be 1 or 10 ohms),

4. Repeat the operation until a large number of calibration points have been obtained and inscribed on the rheostat dial,

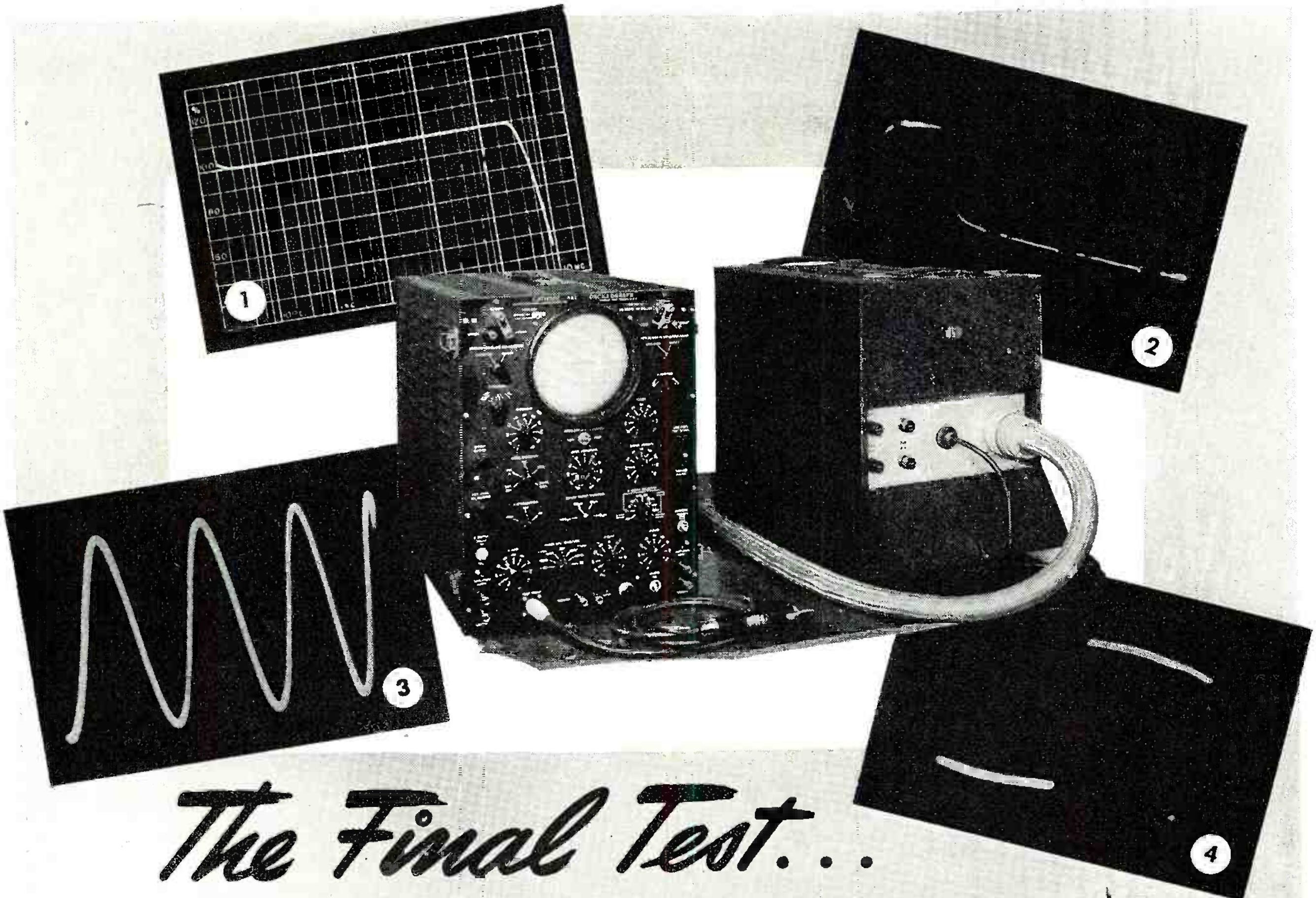
5. Remove the rheostat dial, ink in the calibration points and numerals, and remount on the rheostat panel with a celluloid cover. When remounting, line up the pointer and rheostat setting with a selected point on the dial, as verified by the reading of the ohmmeter or external bridge. All other dial points then will be in agreement automatically with the original calibration.

Methods of Using the Bridge

Resistance. (A) Connect *res. std. number* 1 (set at 10,000 ohms) to terminals 1-2; (B) Connect *res. std. number* 2 (set at 1 ohm) to terminals 3-4; (C) Connect unknown resistor to terminals 9-10; (D) Leave terminals 11-12 open; (E) Connect a jumper between terminals 7 and 8; (F) Connect generator to J_1 and detector to J_2. (If generator is 6-volt battery, detector must be 100-0-100 d.c. microammeter. If generator is audio oscillator, detector must be headphones, v.t. voltmeter, or oscilloscope); (G) Adjust the decades (R_b) for null; (H) At null, determine the unknown resistance value from decade and standard readings, as explained under "Bridge Theory" (Wheatstone Bridge); (I) If null is not obtained with *res. std. number* 1 at 10,000 and *res. std. number* 2 at 1, try other combinations of standard readings and repeat decade adjustment. Following are resistance ranges obtained with the various possible combinations:

STD. # 1	STD. # 2	RANGE(OHMS)
10,000	1	0.001-1
10,000	10	0.01-10
10,000	100	0.1-100
10,000	1,000	1-1,000
10,000	10,000	10-10,000
1,000	10,000	100-100,000
100	10,000	1000-1,000,000

Capacitance. (A) Connect *res. std. number* 1 (set to 10,000) to terminals 1-2; (B) Connect *cap. std.* (set to .001) to terminals 9-10; (C) Connect unknown capacitor to 3-4; (D) Leave 11-12 open; (E) Connect 100-ohm rheostat to 7-8; (F) Adjust decades (R_b) for null; (G) At null, determine unknown capacitance from decade and



The Final Test . . .

These unretouched Oscillogram photos of the DuMont Type 248 Oscillograph, tell the story best

ARMY E NAVY

This is the DuMont Type 248 Oscillograph. As is true of all other precision instruments, it must stand or fall by its performance. Because written specifications often give little indication of how well an oscillograph meets today's critical requirements, we believe the accompanying *unretouched* photos cover points of particular interest to those who work with modern electronic circuits. To wit:

(1) Sinusoidal frequency response curve of the vertical amplifier. Free from irregularities. No rise caused by over-compensation at high end. Fall-off is gradual.

(2) The excellent transient response of this instrument is shown by absence of overshoot or other distortion in this pulse having a rise time of about 1/10th microsecond. Here the driven (or "slave") sweep is triggered by the pulse itself, which is then delayed by a self-contained distortionless network so that the leading edge is not obliterated. The one microsecond markers (or others at intervals of 10 or 100 microseconds) are blanked into the trace by an internal marker oscillator. A beam-control circuit eliminates the bright spot of the beam rest position.

(3) Continuous sweep circuit has a range when free-running of from 15 c.p.s. to 150 kc. When moderately synchronized with a signal of higher frequency, however, it will operate at much faster rates. This oscillograph shows a one megacycle sine wave at a sweep frequency of approximately 300 kc. Return trace is normally completely blanked but may be seen if necessary by fully advancing the intensity control. Notice the good linearity of this time-base as well as that of the driven sweep in (2).

(4) Correct compensation at the low end of the frequency range is illustrated by almost distortionless transmission of a 30 cycle square wave through the vertical amplifier. Compensating circuits for both low and high frequencies are carefully adjusted for optimum phase characteristics.

• • •

All of which, together with other equally convincing characteristics, boils down to this: The DuMont Type 248 Oscillograph, used on the bench or mounted on its matching streamlined truck, is an instrument without equal for laboratory, shop or production line.

Write for Literature . . .

DUMONT *Precision Electronics & Television*

ALLEN B. DU MONT LABORATORIES, INC. PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEXLIN, NEW YORK standard readings, as explained under "Bridge Theory" (Wien Bridge); (H) If null is not obtained with *std.* settings given in (A) and (B), try other combinations. Following are the capacitance ranges obtained with the various possible combinations:

RES. STD. # 1	CAP. STD.	RANGE
10,000	.001	1-1000 μμfd.
10,000	.01	10 μμfd.-.01 μfd.
1,000	.01	100 μμfd.-.1 μfd.
10,000	1	.001-1 μfd.
1,000	1	.01-10 μfd.
100	1	.1-100 μfd.

(I) Notice that the null point is sharpened considerably by adjustment of the rheostat connected to terminals 7-8. If a definite resistive null is not so obtained with the 100-ohm rheostat, replace it successively with the next higher-range rheostat, until such a point is obtained; (J) Read equivalent series resistance of the unknown capacitor directly from the rheostat dial; (K) Determine power factor of the unknown capacitor from the latter's capacitance and equivalent series resistance readings, as explained under "Bridge Theory" (Wien Bridge).

Inductance. (A) Connect *cap. std.* (set to .01) to terminals 9-10; (B) Connect *res. std. number* 2 (set to 10) to terminals 3-4; (C) Connect 100-ohm rheostat to terminals 11-12; (D) Connect jumper between terminals 7 and 8; (E) Connect unknown inductor (coil or choke) to terminals 1-2; (F) Adjust decades (R_b) for null; (G) Adjust rheostat for sharper null; (H) At null, determine unknown inductance from decade and standard readings, as explained under "Bridge Theory" (Maxwell Bridge); (I) If null is not obtained with *std.* settings given in (A) and (B), try other combinations. Following are the inductance ranges obtained with the various possible combinations:

RES. STD. # 2	CAP. STD.	RANGE
10	.01	1 μh-1 mh
100	.01	10 μh-10 mh
1,000	.01	100 μh-100 mh
10,000	.01	1 mh-1 hy.
1,000	1	10 mh-10 hy.
10,000	1	100 mh-100 hy.

(J) If a definite resistive null is not obtained by adjustment of the 100-ohm rheostat, replace the latter successively with the next higher-range rheostat until such a point is obtained; (K) When a resistive null is obtained, read equivalent series resistance of the unknown inductor directly from the rheostat dial; (L) Determine Q of the unknown inductor by means of the formula $6.28fL/R$, where f is the bridge frequency in cycles, L the measured inductance in henries, and R the measured equivalent series resistance in ohms.

Operation Hints

In general, any convenient a.c. supply may be employed as the bridge generator. This will include single-frequency audio oscillators, variable-frequency audio oscillators of both the beat-frequency and resistance-tuned types, and the 60-cycle power line. Bridge sensitivity will improve with higher signal voltages. A voltage of about 100 is a good compromise. Most small audio oscillators, of all types, do not deliver a voltage of this magnitude, and accordingly must be followed by one or more audio amplifier stages in order to obtain the potential. Usually, the output transformer in the oscillator will act well enough as a coupling medium between generator and bridge. If this transformer is shielded between windings, so much the better. If the power line is employed, however, it is urged that an isolating transformer of 1 to 1 ratio be employed. This transformer should contain an interwinding shield.

Any generator frequency may be employed, although it is standard in the field to employ 60, 120, 400, and 1000 cycles as standard frequencies. The effects of stray capacitances, such as body capacitance, will become more pronounced as the bridge frequency is increased, becoming most troublesome above 1000 cycles.

Resistors which show any signs of being inductive should be measured with d.c., as described under resistance measuring procedure. All others may be checked at the regular bridge frequency. Resistors higher in value than 1 megohm may be measured on the bridge in parallel with a known resistor (not more than 1 meg.). Calling the resistance reading obtained for the parallel combination, R_t; the resistance of the known resistor, R_s; and that of the unknown, R_x, the unknown value is equal to:

$$R_x = \frac{1}{\frac{1}{R_t} - \frac{1}{R_s}}$$

The bridge detector may be either headphones, v.t. voltmeter, or oscilloscope, when a.c. input is employed. Headphones have the advantage of being both simple and sensitive. They have the disadvantage, however, that their use requires absolute quiet and the ear is not a sensitive detector of small differences in volume. The v.t. voltmeter is useful only on its lowest range—in no circumstance higher than 1 volt r.m.s. full-scale. The oscilloscope, particularly if the input amplifier has more than one stage, is extremely useful in that a number of patterns may be employed. It is sensitive, although not as much so as headphones unless sufficient amplification is provided ahead of the instrument, and it is visual in action. The bridge output terminals are connected to the vertical input terminals of the 'scope. The oscilloscope and v.t. voltmeter will offer uniform response throughout the audio-frequency spectrum in which bridge measurements commonly are made. Headphone diaphragm characteristics may suit that type of detector only for measurements, with greatest reliability, in the region of 1000 cycles.

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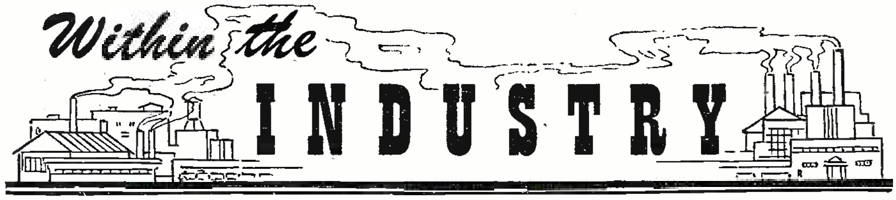


E. JOSEPH BABKES, formerly in charge of distribution of radio test equipment with the WPB, has been appointed Radio Purchasing Agent for *Lear, Incorporated,* according to a recent announcement made by Elmer R. Crane, General Manager of the Radio Division.

Mr. Babkes is a graduate of Brooklyn Polytechnic Institute and was employed by *Fada, Emerson,* and *RCA* before serving as a radio engineer with the U. S. Army Signal Corps at Fort Monmouth, New Jersey. He served with the WPB in Washington for three years.

In his new capacity, Mr. Babkes will have his headquarters at the downtown plant of *Lear* at Grand Rapids, Michigan.

* * *

TEMPLETONE RADIO MANUFACTURING CORPORATION of New London, Conn., has announced the appointment of two new distributors, through its president, Oscar Dane.

Associated Industries, Inc. of Detroit, Michigan will handle the company's products in the Detroit area, while the *Alabama-Florida Distributing Company* of Birmingham, Alabama will cover that southern territory for Templetone.

* * *

WALKER-JIMIESON, INC., has announced the appointment of two executives staff members for their Chicago office.

Richard R. Schlichter is the new buyer for the company. In his new post, Mr. Schlichter will be responsible for maintaining the *Walker-Jimieson* stocks. Mr. Schlichter is well-known in the radio electronic industry as he has served as sales production engineer for *Thordarson Electric Company* for several years. In addition, he has been employed by *Bethlehem Steel Company* and *Ericsson Construction Company.*

The second appointment brings Will Burge, formerly of *Crane Company* to *Walker-Jimieson, Inc.,* as Manager of Credits. Mr. Burge is one of the original stockholders of *Walker-Jimieson.*

* * *

RADIO CORPORATION OF AMERICA has just announced the appointment of Julius Haber to the post of Assistant Director of Advertising and Sales Promotion for the *RCA Victor Division.*

The company also announced the appointment of Edmund A. Laport to the post of Chief Engineer of the newly organized *RCA International Division* of the company.

Mr. Laport was previously connected with the staff of the *RCA Victor Division* in the post of Chief Engineer, working with the International Department.

The Board of Directors also announced that Joseph V. Heffernan has been named vice-president and general attorney of *Radio Corporation of America.* Mr. Heffernan joined *RCA* in June, 1940. He was granted a military leave of absence from the company from 1942 to 1944, during which time he served as a lieutenant in the U. S. Navy. He was released by the Navy to inactive duty in December of 1944 and returned to *RCA.*

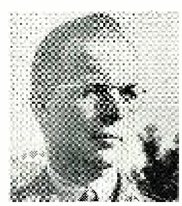
* * *

THE HALLICRAFTERS COMPANY of Chicago has announced the addition of William E. Six of Elmhurst, Illinois, to its engineering department staff.

Mr. Six has been a resident inspector for the Signal Corps at the *Hallicrafters* plant in Clearing, Illinois, for the past three years. He was formerly employed as an engineer for the *American Airlines,* radio station *WGN* and *Bendix Radio Corporation.*

* * *

HECTOR H. LYMAN, of Montclair, New Jersey, has been named to the post of district manager of Minnesota for the *Ediphone Division* of *Thomas A. Edison, Inc.*



Mr. Lyman, who will have his headquarters in Minneapolis, will assume the duties formerly handled by M. T. Williams who has resigned because of ill health.

Mr. Lyman has been in the office equipment business for a number of years. He first became affiliated with the Ediphone organization in 1938. During 1942, he spent six months with the Topographical Engineering branch of the U. S. Army.

* * *

HOFFMAN RADIO CORPORATION of Los Angeles has appointed D. D. Spence as public relations manager for the company.

Mr. Spence was formerly employed by the *Firestone Tire and Rubber Company* in various merchandising, sales promotion and personnel jobs.

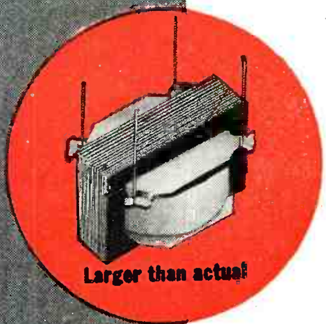
His initial work at *Hoffman Radio* will be to create a new employees' handbook to supersede the 1943 edition.

At the same time, H. Leslie Hoffman, president of the company, announced that Tommy Kearns of Honolulu has been appointed distributor in

FOR COMPACTNESS

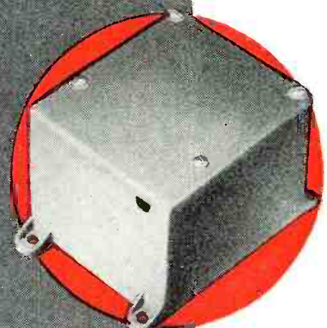
World's smallest transformer

These units, 7/16" x 9/16" x 3/4", are the optimum in small transformer design . . . they have been in production for five years.



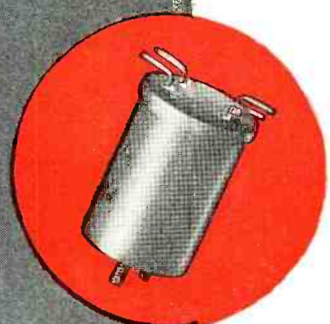
Weight reduction 95%

This dual purpose aircraft filter was reduced in weight through UTC design from 550 to 27 ounces.



Ouncer transformers-Hermetic

Hundreds of thousands of UTC Ouncers have been used in the field. Solder sealed hermetic constructions effecting the same weight and space savings are now in production.



May we cooperate with you on design savings for your applications . . . war or postwar?

ARMY E NAVY ALL PLANTS

United Transformer Corp.

150 VARICK STREET • NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB" the Territory of Hawaii for the company products.

The *Arizona Wholesale Supply Company* of Phoenix has been appointed exclusive distributor for the company's products in the state of Arizona; Needles, California; and Las Vegas, Nevada. The organization has been in business for many years and handles *General Electric's* household appliance line.

* * *

UNIVERSAL MICROPHONE COMPANY of Inglewood, California, has announced the appointment of two new representatives to handle their line of microphones and accessories.

Herbert Becker of Burlingame, California, will serve as factory representative for Fresno and the area north of Fresno, while S. H. Cohn of Los Angeles will handle the territory south of Fresno.

The company has also announced that its two-year old biweekly house organ, "Micro Topics," has changed its format and will now be published monthly. The jobber's edition of this paper, previously issued at frequent intervals will be discontinued and the news incorporated into the monthly issue of the house organ along with factory notes and personnel items.

A new feature will be added in the form of an engineering section for sound men with technical data furnished by a factory committee.

* * *

CAPTAIN ALBERT GOFFSTEIN has returned to the *American Television and Radio Company* of St. Paul, Minnesota, to resume his position as the firm's General Manager and Chief Engineer after more than three years in the Armed Forces.

Capt. Goffstein was called to duty on February 7, 1942, and was assigned to the staff of the Chief Signal Office in Washington, D. C. After nine months in the Capital, Capt. Goffstein was transferred to headquarters of the 11th Air Force in the Aleutians, where he served as Assistant Signal Officer.

Upon his return to the United States in December, 1943, he was assigned to the Equipment Laboratory, Engineering Division of the Air Technical Service Command at Wright Field, Dayton, Ohio, as Assistant Technical Executive, which post he held until his release from active service.

* * *

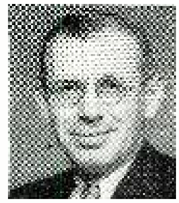
PREMIER ELECTRONIC PRODUCTS, INC., has recently been organized by J. R. Beebe for the manufacture of radio and radar transformers. Mr. Beebe announced that the company will be equipped to handle oil-filled and hermetically sealed units in addition to transformers of standard design.

Mr. Beebe was formerly associated with *Thordarson.* He served as vice-president in charge of sales during his ten-year service with the company.

Premier Electronic Products, Inc., is located at 4849 North Western Avenue, Chicago 25, Illinois.

* * *

ELLIS L. SPRAY has been elected to the post of vice-president of *Westinghouse Electric and Mfg. Company* by the Board of Directors.



Mr. Spray will be in charge of the elevator and air conditioning activities of the company at Jersey City.

A. W. Robertson, chairman of the board, announced that the *Westinghouse Electric Elevator Company* is being dissolved as a corporate entity and will henceforth be known as the Elevator and Air Conditioning Divisions of *Westinghouse.*

Until his election to his new post, Mr. Spray has been vice-president of the Elevator Company. He began his career with *Westinghouse* in 1918 and has held various posts since that date.

* * *

UTAH RADIO PRODUCTS COMPANY of Chicago has just completed a demonstration of their postwar products to many of their jobbers during an extensive tour made by the Sales Manager of the company, Robert M. Karet.

The initial postwar product of the company will be the wire-recorder which the company is manufacturing on license from *Armour Research Foundation.* Mr. Karet demonstrated the recorder to jobbers and dealers.

Besides demonstrating the equipment which the company will manufacture in the postwar period, Mr. Karet spoke to servicemen on combining tested business ideas with their servicing to improve the running of their service shops after the war.

Mr. Karet also announced a complete course on the fundamentals of "Sales Training for Electronic and Servicing Business" which would be made available in the very near future to Utah jobbers and distributors.

The company has also announced the appointment of L. Robert Evans, formerly manager of the *Victor Record Division* of RCA's Chilian subsidiary, as manager of the newly formed *International Division* of *Utah Radio Products Company.*

* * *

HARRY E. HARRIS has been appointed to the post of Sales Engineer in charge of distributor sales for the *Bell Sound Systems, Inc.,* according to the recent announcement made by F. W. Bell, president of the company.

Mr. Harris joined the company after 15 years experience in the appliance merchandising field. He was formerly associated with the Ohio subsidiary of the *Columbia Gas and Electric Company.*

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New Coast-to-Coast Television Network

A NEW West Coast television broadcasting chain and microwave relay system, appropriately called "Sky-top" because it spans the highest mountain peaks from Mt. Adams in Washington to Mt. Whitney in Southern California and continues eastward to Grays Peak in Colorado, is presaged by the application filed recently with the Federal Communications Commission by *Raytheon Manufacturing Co.*, of Waltham, Mass., New York City, and Chicago.

The system augments the Western link of the nationwide microwave communications project revealed in the previous application recently made by the company.

Initial permission from the FCC is sought for experimental stations to be erected on Mt. Adams in Washington; Mt. Shasta, Mt. Lassen, Mt. Tamalpairs, Mt. Whitney, and Mt. San Gorgonio in California; Wheeler Park in Nevada; Kings Peak in Utah and Grays Peak in Colorado. These mountain peaks range in height from 3,000 ft. to 15,000 ft.

Subject to approval, *Raytheon* envisions building on the summits of the mountains, stations to provide safety stations for commercial and private airplanes within a radius of 300 to 500 miles of the respective mountain tops; wide service area television; FM and AM broadcasting; a microwave relay system; public call systems; highway control systems and police-radio master stations.

The use of these facilities will be open to all licensees of the FCC.

Before the war Lt. Comdr. Temple V. Ehmsen, USNR, a native of Oregon and now on active duty with the Navy, conceived the idea of building a station on Mt. Adams. Meanwhile, company engineers had studied the entire "Sky-top" project as an adjunct to their proposed transcontinental relay system and Comdr. Ehmsen joined forces with them in their planning.

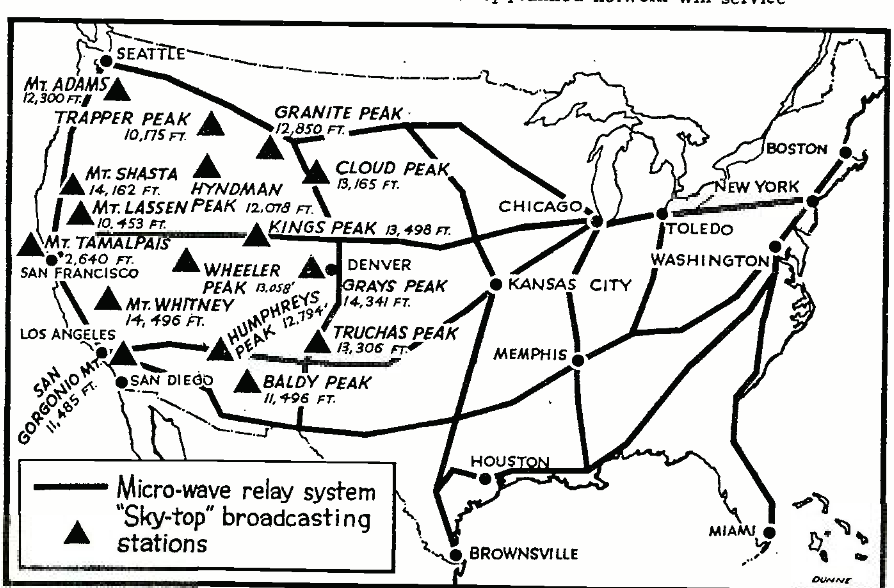
One objective of the project is to receive at the mountain top radio stations, televised news events as they occur at any point within their range and, instantaneously, to broadcast them to all points in the link. At the same time televised scenes of important events will be fed into the proposed transcontinental system for transmission through local stations.

Joseph Pierson, former President of Press Wireless, Inc., and now head of *Raytheon's* Communications Division, recently appeared before the FCC and outlined plans for the coast-to-coast system. It will be operated on superhigh frequencies, or microwaves, of the radio spectrum not now in public use and three groups, at 1,900, 3,900, and 5,800 megacycles, were requested.

Among the advantages in utilizing these microwaves, Mr. Pierson mentioned improved air safety and navigation systems for airline operations; the ability to transmit a very broad band of intelligence, thus opening a multitude of channels; and the ability to relay from city to city high-quality and natural-color television programs.

The first Eastern leg of the system will have terminals at New York, Boston, and Washington. Later on, the circuits will follow the airline routes via Cleveland, Detroit, and Chicago to the Pacific terminals at Los Angeles, San Francisco and Seattle. These circuits may be quickly expanded as new air routes are developed.

Map shows the area which the recently-planned network will service



The system contemplates terminal stations at each service point, with an automatically operated relay station every 30 to 45 miles between such terminal points. The system will be effective along a path from 15 to 25 miles on each side of a solid line beam, or a total coverage of from 30 to 50 miles in width.

When the necessary high-frequency radio channels have been allocated, *Raytheon* services will include:

1. Automatic warning for airplane pilots of approach to other aircraft, natural obstacles, or the ground, even in zero visibility.
2. Similar protection for ships against rocks, shoals, or collision, and for railroad trains and highway vehicles against collision.
3. Printing of newspapers by radio facsimile.
4. Greatly enhanced qualities of transmission for relay of broadcast programs, including high-definition television and motion pictures and, as a by-product, for public telephone, including regions now without telephone service.
5. Portable-radio transmitting units enabling reporters to file their stories in the home offices by facsimile and voice recordings.
6. Warnings of impending floods, breaking of reservoirs, forest fires, train wrecks and other disasters.

In its application for "Sky-top" stations in the Western States, the company has requested authority for its initial tests on 30.66, 39.55, 90, 200, 400, 900, 1,900, 4,000, 6,000, 10,000, 16,000, and 26,000 megacycles.

The stated object of conducting tests in the West Coast stratosphere is to develop the following types of public service:

1. Airways beacon systems for guiding aircraft safely over some of the country's most mountainous and treacherous terrain from an airplane operating standpoint.
2. Television and FM broadcast interstation relays forming a network to serve the area from Seattle through San Francisco to San Diego and extending eastward through Nevada, Utah, Idaho, Montana, Wyoming, and Colorado.
3. Forestry and conservation radio service and State police services, affording long-range communications for the prevention and fighting of forest fires, and for highway police patrol systems.
4. Weather Bureau observations, automatically or manually relayed to information collecting points as an aid in forecasting.

To avoid defacing the mountain sites, *Raytheon* plans to build all facilities, including living quarters, underground and the only part exposed will be the antenna systems. As antennas above 30 megacycles are quite short, it is planned to roof all communication antennas with a Quonset

hut type of construction. Access to the living quarters will be by tunnels below the mountain tops.

Shelter, heat, and cooking facilities will be available to mountain climbers, forest rangers and scientists.

In its applications *Raytheon* stated that it is in a position to initiate the first stage of the West Coast system and the first section of the Eastern circuit of the transcontinental system during 1945.

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U.H.F. Course

(*Continued from page* 60)

use of the higher frequencies by the television interests. The Television Panel of the Radio Technical Planning Board (RTPB) has advanced the following proposed allocations to be used for television relay service.

1. A group of 12-mc. channels extending from 162 to 294 mc.
2. A second group of twenty 10-mc. continuous channels to be located somewhere between 300 and 1000 mc.
3. A group of twenty 20-mc. continuous channels to be located between 1000 and 3000 mc.

In addition to the above, experimental stations are to be given space at other frequencies where they will be permitted to experiment with ideas in attempts to improve the present television methods.

With television and the present radio detection devices vying for use of the ultra-high frequencies, there promises to be plenty of work and jobs for all radiomen who have some knowledge of the operation of radio apparatus at these extremely short wavelengths. The old adage about a word to the wise is sufficient is even more applicable here. In closing, the editors of RADIO NEWS wish to add that future articles on u.h.f. radio will be presented as soon as the material becomes available.

References

U.H.F. Radio Simplified—M. S. Kiver. D. Van Nostrand Co., 1945.

This book merely assumes a simple knowledge of radio and then goes on from there to give word descriptions of the operation of ultra-high-frequency radio.

Fundamentals of Electric Waves—Hugh H. Skilling. John Wiley & Sons.

This book describes the operations of electric waves, showing the foundations of Maxwell's equations. While only a moderate use is made of mathematics, the examples found require a knowledge of calculus. U.h.f. radio apparatus is not described directly, but the travel of electric waves in wave guides is brought out.

Hyper and Ultra-High Frequency Engineering—Sarbacher and Edser. John Wiley & Sons.

Fields and Waves in Modern Radio—Ramo and Whinnery. John Wiley & Sons.

Ultra-High Frequency Techniques—Brainerd and others. D. Van Nostrand Co.

Electromagnetic Waves—Schelkunoff. D. Van Nostrand Co.

The last four volumes are excellent works on the subject but they all require extensive mathematical backgrounds and would be quite out of reach of the ordinary radioman.

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EVERYWHERE
the word is
going 'round...
Keep Your Eyes On Belmont
It is a matter of general knowledge that outstanding value distinguished the millions of radios that Belmont built before the war. It is an equally well known fact that Belmont now is one of the large-volume producers of electronic equipment for the Armed Forces. And it is no secret that Belmont expects to make important contributions to the development of the better radio and television reception of tomorrow.
With years of successful peacetime experience on which to draw . . . with greatly enlarged research and experimental laboratories . . . with new skills and methods perfected under the driving needs of war . . . Belmont has the facilities for doing big things in a big way. When the time comes for reconversion to peacetime production, these facilities will be applied full force to the manufacture of advanced FM radio receiving sets, greatly improved television receivers, and a complete line of phonograph, television and radio combinations. Belmont Radio Corporation, 5929 West Dickens Avenue, Chicago 39, Illinois.
Belmont Radio
RADAR * TELEVISION * FM * ELECTRONICS

FM Station Ownership

(*Continued from page* 37)

It takes only the most elementary arithmetic to figure that the revenue from 3½ hours of commercial broadcasting per week will not pay operating costs or give any return on capital investment.

Since broadcast rate cards (time cost for an advertiser) are made up on the basis of coverage, and since FM audiences, in general, are smaller than AM audiences, it is impossible to charge as high a rate for commercial programs carried on FM as for those on AM. Another feature of FM transmission which has a definitely commercial aspect is the limited range of this type of transmission. The effective coverage of the average FM station does not exceed 50 or so miles. While this feature of FM permits more stations working on the same frequency to be erected in a given area, it means that stations will have to be erected in thickly populated areas in order to provide a maximum audience for the programs.

Station Costs

Many of the inquiries received by RADIO NEWS are concerned with the cost of establishing an FM station. A survey among several leading manufacturers of FM transmitting equipment was made and the following price ranges based on prewar price schedules for 1-kw. stations were reached.

Before any order for equipment can be placed or a station site selected, it is necessary to file a request for a construction permit with the Federal Communications Commission. Such an application must be made on FCC Form No. 319 (as revised April 25, 1944) which is obtainable free of charge from the Federal Communications Commission, New Post Office Building, Washington, D. C., or from one of the district offices throughout the country. In addition to this form, it is well for the applicant to have on hand two other FCC publications, namely, FCC No. 41831, "Standards of Good Engineering Practice Concerning High Frequency Broadcast Stations" and FCC No. 42195, "Commission Requirements for Contour Maps in Establishing Service Areas for High Frequency Broadcast Stations." These publications are available only from the Washington office of the FCC.

Upon securing a CP (construction permit) application blank, the applicant will be expected to answer the first 17 questions which pertain to ownership structure (individual, partnership, corporation, etc.), citizenship, financial responsibility, and other personal data concerning the prospective owner of the station. The balance of the application should be filled out with the assistance of a consulting engineer, preferably one licensed to practice before the FCC. This point cannot be stressed too strongly as it is necessary for the engineer to "see the application" through the FCC. In cases of large stations and/or complicated organizational structures it is recommended that an attorney, licensed to practice before the FCC, be employed to facilitate the handling of the application. The cost of preparing this application will vary from $1,100 to $2,200 for both legal and engineering services. This service does not guarantee or in any way assure acceptance of the application by the FCC, hence if the application is turned down, *this sum represents a total loss to the applicant.*

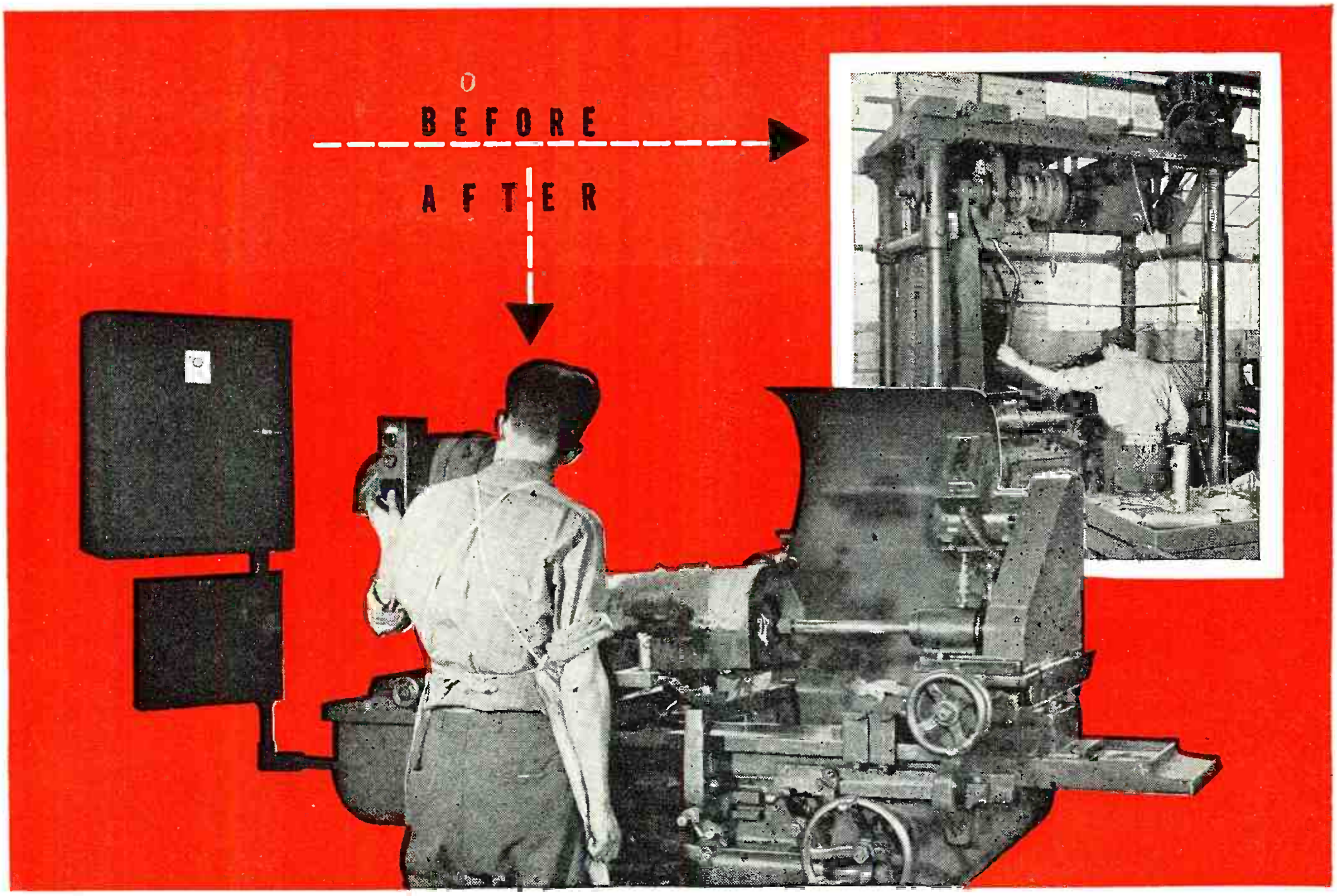
If, however, the application is approved, the applicant can then proceed to the next step, which is that of purchasing or renting a site for the station and signing a contract for station equipment. Some manufacturers of FM transmitting equipment will sell such equipment on a time basis, but the financial position of the prospective buyer will be scrutinized very carefully and all of the many factors regarding the possible success of the station will be taken into consideration in granting or withholding credit.

A 1-kw. transmitter will cost somewhere in the neighborhood of $9,500.00. This price includes two sets of tubes for the transmitter. Antenna costs, depending on the type of construction and whether construction costs and supporting structures are included, will range from $1,600 to $3,500 (for from 4 to 8 layers) without construction costs and without supporting structures, or from $3,500 to $6,000 for a 2-bay antenna with transmission line and support. A fair estimate of the over-all cost has been set at $5,250, a figure obtained from FCC records on FM applications for permits. This figure is based on 4-layer construction.

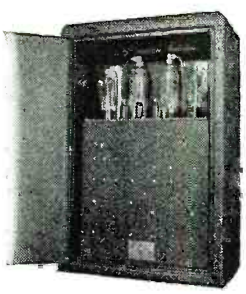
Studio and control equipment can be elaborated almost indefinitely, but the minimum equipment requirements, which include a console, turntable, remote amplifier pickup and microphones, will cost anywhere from $2,500 to $4,000. These figures are based on the assumption that the station will have two studios and an announcing booth.

Installation costs, of course, will vary with the locality. Much of the installation work can be done by the owner-engineer, or his employees. Laying of the coaxial cables and the installation of necessary wiring will have to be contracted at prevailing wage scales for electricians in the community in which the station is located. One manufacturer of equipment estimates the installation charges to run from $1,500 to $2,500.

Monitoring equipment, a requirement of the FCC, is priced variously at from $800 to $2,000 which brings the total cost of the capital investment, before going on the air, and exclusive of studio and antenna site rental, etc., at from $17,800 to $24,000. By including studio and office facilities, the cost is increased to approxi-



producing better than ever . . . after 30 years



ELECTRONIC MOTOR CONTROL

The Westinghouse Mot-o-trol . . . employing Thyratron tubes to convert a-c to d-c . . . provides wide-range stepless speed control through a 20 to 1 range, from an a-c *power source*. Pushbutton control station enables the operator to start, stop and control the speed while the machine is running. At any speed setting, variations in load cause little or no change in speed.

The Allies' urgent need for more oil recently created a demand for greatly increased production of hardened steel pump liners. To a leading West Coast manufacturer, this brought the problem of maintaining precision at a much higher production rate.

Internal grinding of these liners had been done on machines with overhead belt and pulley drives . . . providing only four speeds in definite steps. These grinders were unable to meet the stepped-up demand. Excessive vibration ground chatter marks into the liners. Subsequent honing became inaccurate. Setup time was high. To obtain delivery of a modern machine would require months.

Westinghouse engineers, working with the manufacturer, suggested modernizing the drives by applying Mot-o-trol, an electronic drive providing stepless speed control over a 20 to 1 range, with handy pushbutton control.

Result: the grinding operation showed immediate improvement. Vibration and chatter marks were eliminated. Setup time was reduced. And the new arrangement *saved 35% in floor space.*

This is typical of the modernizing possibilities with electronic equipment . . . not only in control, but in power conversion, processing methods, counting and sorting operations and countless other industrial tasks.

Your nearest Westinghouse office is ready to provide helpful assistance and information on electronic applications for *your* industry. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

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Electronics at Work

ELECTRONIC EQUIPMENT FOR INDUSTRY AND HOME—ELECTRONIC TUBES—RADIO AND TELEVISION mately $28,000 to $42,000. Included in this figure are several "first year" costs; engineering services for proof of signal coverage and proof of over-all audio performance and the Armstrong Patent Royalty which is payable directly to Major E. H. Armstrong.

Rent of studio quarters and antenna space is not included in the capital investment figure inasmuch as this item is listed under yearly operating expenses. The purchase of facilities would vary with the community in which the station is located and no attempt has been made to estimate real estate costs. It is necessary, however, that the antenna be located on the highest point in the coverage area, which means that location will have to be either on the tallest building in the city, if possible, or in the case the transmitter is located outside of the city, and is connected to the studio by S-T links, the highest land will have to be purchased or leased.

There are several disadvantages in having the transmitter located at a remote site. Probably the biggest argument against this type of operation is the increased cost of installation and maintenance of such equipment. It is necessary to select a transmitter site which is easily accessible during all types of weather, hence the transmitter should be located near a regularly traveled and state-maintained highway. Facilities for all utilities should be considered. The best location would include running water and power-line facilities, preferably from two different feeders which will insure uninterrupted service should power fail on one line. Added to these requirements is the all-important one of sufficient height of the selected site. From these minimum requirements for a suitable location, it is easy to see that the task of selecting such a site is not an easy one, and should be investigated thoroughly before preliminary steps are taken to file a CP application. The increased costs for S-T relay facilities will run from $9,600 to $12,530.

Thus, the estimated total capital investment, exclusive of studio and transmitter site has been estimated at from $27,450 to $54,730—sums which cannot be dismissed lightly when consideration of this type of business is given. Added to this fact, that this represents an outlay *before* the station goes on the air, it is easy to see that the FM broadcasting field is, at present, a "rich man's plaything" until such a time as construction and equipment costs can be lowered because of better production facilities, etc.

Annual Operating Costs

According to a *General Electric Company* release, the annual prewar operating and maintenance cost for a 1-kw. station amounted to from $33,850 minimum to an average cost of $52,500. These figures include space rental, salaries, advertising, social security, insurance, apparatus depreciation, insurance on equipment, and apparatus maintenance, as well as programming costs. However, the figure *does not* include taxes (federal, state, or local) or royalties, as these items are variable.

This brings the total outlay for the first year the station is in business to from $61,850 to $94,500 if the transmitter is located with the studio and from $71,320 to $107,230 if the transmitter is remotely located.

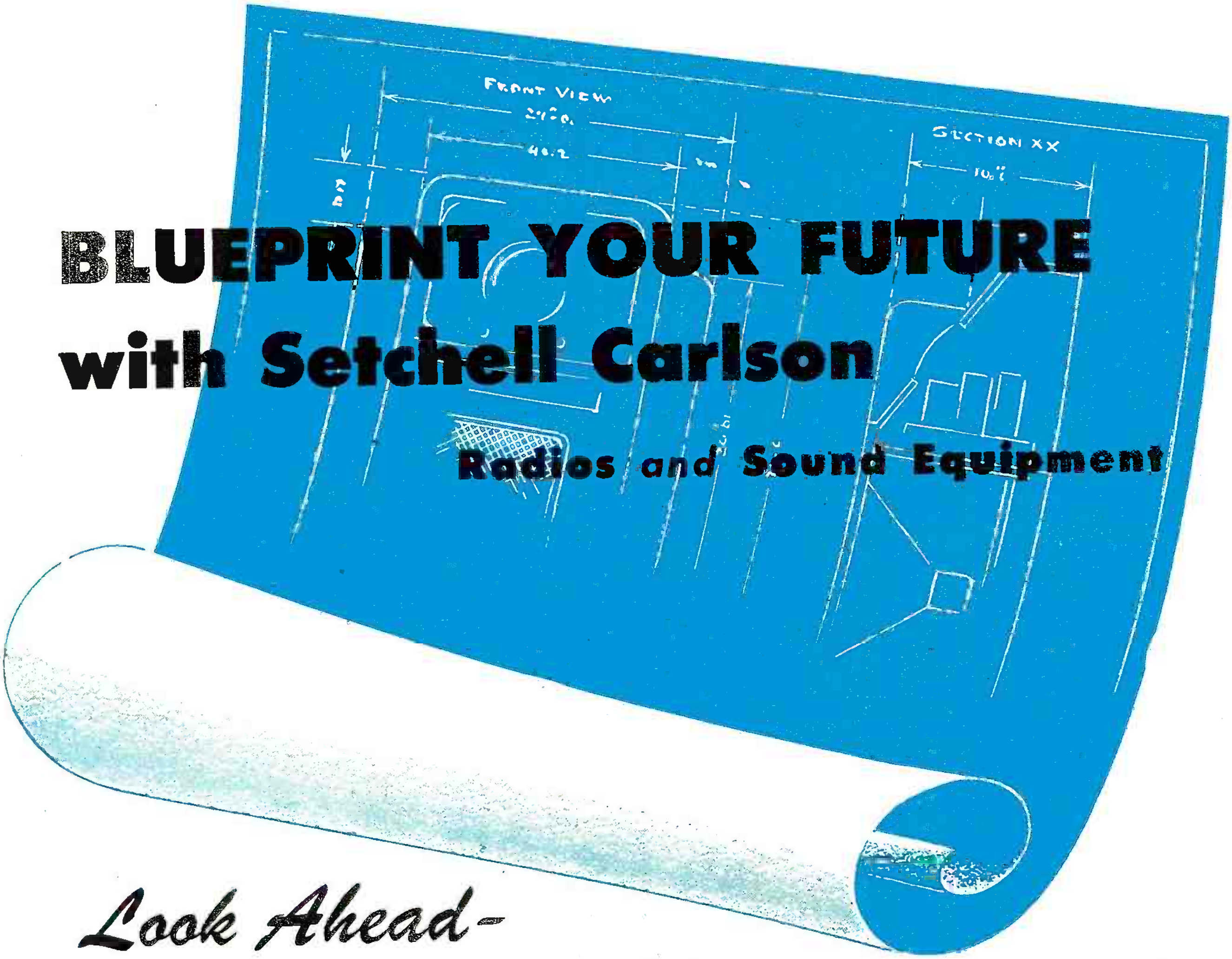
It should be remembered that this sum will probably be wholly derived from the monies paid in by the investor or investors, as little revenue can be anticipated from commercial programming.

Programming

For those interested in entering the FM broadcasting field, there are several other aspects of the problem other than the equipment and FCC regulations which must be considered. For the novices in the business, it is recommended that several excellent books on programming and the commercial aspects of broadcasting be studied carefully. One of the best over-all pictures of the production end of broadcasting is a recently published book entitled "Radio Production Directing" written by Albert R. Crews, Production Director of *National Broadcasting Company.* In this book,

BLUEPRINT YOUR FUTURE with Setchell Carlson

Radios and Sound Equipment



Look Ahead—

Start thinking today of plans for tomorrow. Choose your post-war radio and sound equipment from the drawing boards and laboratories of an established manufacturer with a background in the radio industry.

When the Army and Navy "discharge" us from the important war job we are doing, announcements will be made on our new post-war models. The exclusive nature of our cabinet designs do not permit information at this time. Watch for these releases. You will thrill to their eye-catching beauty.

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Mr. Crews has explained not only production and directing techniques, but also such problems as union rules and regulations governing performers and musicians, FCC requirements on the air, and other valuable data which should be memorized by the prospective station owner. The second book which treats that all important question of revenue, is C. H. Sandage's "Radio Advertising for Retailers." In this book are many excellent suggestions as to the market, type of program for selected markets, costs, revenues, etc.

It is not the intention of this article to discourage prospective station owners from going into the FM broadcasting field. It has been the purpose of the article to point out some of the varied problems which will arise and which will call for the expenditure of large sums of money. In addition to an adequate bank account which will stand the strain of large withdrawals and few, if any, deposits, the prospective owner of the FM station must possess certain personal attributes which would make him a combination of "Pollyanna," Marconi, Dale Carnegie, Bob Hope, and Santa Claus.

From a survey made by RADIO NEWS, the general consensus of opinion of the operators of existing FM stations is; that for the small investor or the returning serviceman, station ownership is not recommended at the present time, and if the prospective owner will abandon his plans and take employment with one of the regularly established FM stations, he will be in a better position to learn whether he could swing such an undertaking on his own at some later date.

There will be plenty of room for all in the FM broadcasting field; pioneering is an expensive proposition and it is an excellent idea to investigate all of the multifacets of this undertaking before making the plunge into station ownership.

The author wishes to acknowledge with thanks the assistance of the following companies in making much of the information contained herein available: *General Electric Company, Electronics Division; Radio Corporation of America; Victor J. Andrew Company; Mr. Paul Brines, Publicity Director, Station WGNB,* and the *Federal Communications Commission.*

It is especially important that persons with limited means investigate all of the financial possibilities with regards to station ownership, before investing in this type of enterprise. The pitfalls are many in this type of endeavor and it is desirable that time and study precede any action.

The following references are suggested as reading material for the prospective station owner, for information and guidance in determining a course of action.

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3. *Kelsey, Keith, "Do You Plan to Build an FM Station," FM and Television, December, 1944, and January, 1945.*

4. *Ennes, Harold, "Problems of Locating Broadcast Transmitters," Radio, January, 1945.*

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8. *RCA Laboratories, "FM Broadcasting," Radio Corporation of America.*

9. *Marquet, William F., "How W47A Did It," FM and Television, September, 1941. Reprints available from General Electric Company.*

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FM Transmitters

(*Continued from page* 41)

nates the need for a harmonic filter in the output circuit.

Power supply and control equipment are similar as to circuit design, the AM transmitter requiring slightly higher power, while the FM transmitter must have a closely regulated power supply for the modulated exciter unit. The regulation on the r.f. amplifier stages is the same for both equipments. Control equipment is similar, since it performs identical functions in both types of equipment.

Table I lists comparative operating characteristics of typical transmitters of the two types. These values are well within the requirements of the FCC, as specified in the Standards of Good Engineering Practice, and are representative for commercial equipment on the market prior to the war.

The FCC licenses a Standard Broadcast Station on the basis of the power output; its coverage or service area is determined by that power. For FM Broadcast Stations, the issuance of a license is based upon the extent of the area to be served; the power output of the transmitter is determined to satisfactorily provide that coverage.

The *RCA* type FM-3A frequency-modulated transmitter, shown in Figs. 1 and 2 is a typical example of FM transmitting equipment utilizing reactance-tube modulation. It employs a total of 24 tubes and consists essentially of six component circuits; a frequency modulated exciter and its power supply; an r.f. amplifier and its power supply; an audio-frequency monitor; and power control circuits. The complete transmitter is housed in two steel cabinets, with the FM exciter or modulator unit and power supplies contained in the left-hand cabinet (Fig. 1). The r.f. amplifiers and their associated blower equipment along with the FM monitor are housed in the right-hand cabinet.

Fig. 3, the simplified schematic diagram of the complete transmitter, will be used as a guide in describing the circuit. The FM-3A may be con-

meets special applications

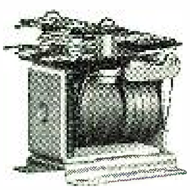
saves time . . . saves tooling . . . speeds delivery!

If your application requires a specially designed relay Guardian engineers can be of great help to you. But, as a result of their wide experience in designing "specials" they have evolved a standard design so flexible that it is now specified in numerous applications that would ordinarily require a specially designed unit. Perhaps you can use it in your "special" application . . . with a saving in money and delivery time. This unusually flexible relay is the SERIES 345. Its chief features are the large coil winding area, numerous contact combinations, the non-binding pin type armature hinge pin, its resistance to shock and vibration, and an ability to operate in extremes of temperature. It is now being used in aircraft, radio, and other exacting applications to insure dependable performance.

STANDARD SERIES 345—The ample coil winding area of the SERIES 345 gives you a wide range of windings for various voltages and currents. Coil winding area is approximately .75 cubic inches. Average power required is 3.56 watts with three pole, double throw contacts of 12½ amp. capacity. Coils are available for either A.C. or D.C. operation.

The maximum switch capacity of the Standard Series 345 is three pole, double throw. Contacts are rated at 12½ amperes at 110 volts, 60 cycles, non-inductive A.C. Moving contacts are attached to but insulated from the armature by a bakelite plate. Terminals are solder lugs. Weight is 6½ ounces.

VARIATIONS OF THE SERIES 345 RELAY


TIME DELAY

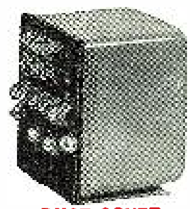
WINDING—Multi-wound coils are available for operation on two or more circuits. Or coil may be wound to operate on the discharge of a 3 mfd. condenser.

CONTACTS—Normal switch capacity is three pole, double throw; maximum switch capacity may be up to six pole double throw with 12½ amp. contacts, or any variation of contact combinations within this range, including the operation of contacts in sequence. The flexibility of the contact springs may be increased through the use of coil spring rivets.

TIME DELAY—On D.C. coils a time delay of 0.25 seconds on release or 0.06 second on attract may be achieved through the use of copper slugs which require these time intervals for saturation or de-energizing depending on whether they are used on the heel or head of the coil.

DUST COVER—For applications where this relay may be subject to injury or in atmosphere where dust may be present in sufficient quantity to impede operation, the SERIES 345 may be equipped with a metal dustproof cover.

SCREW TERMINALS—Screw type terminals are optional for applications where terminals must be disconnected occasionally or where solder lug terminals are not otherwise practical.


DUST COVER

INTERLOCKING—Here the series 340 a-c relay is coupled with the d-c coil of a series 405 short telephone type relay in an overload application. Under normal conditions the series 340 contacts are mechanically held in a closed position. Normal current flows through the series 405 coil and then through the series 340 contacts to the circuit for which overload protection is desired. Excessive current, however, energizes the series 405 coil, releasing the locking arrangement and breaking the series 340 contacts. Push button control resets to normal but is ineffective if current is still excessive.


INTERLOCKING UNIT

SERIES 345 RELAY DATA

Normal Volts	Minimum Volts	Normal M.A.	Minimum M.A.	Coil Resist.	Normal Wattage
6	4.8	600	480	10	3.56
12	9.8	300	245	40	3.56
24	18	148	111	162	3.56
32	25.6	112	89	287	3 56
115	92	31	25	3720	3.56

Minimum operating wattage........................2.3

If you will write us about your relay problems our engineers will be glad to make recommendations which may save you time and money. Should you desire a quotation, please mention quantity.

GUARDIAN ELECTRIC
1630-G W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

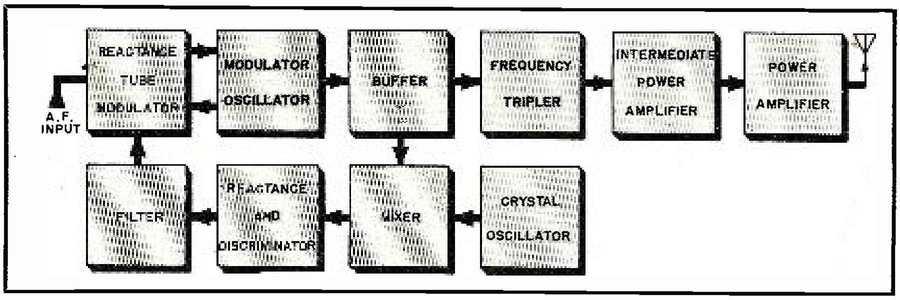


Fig. 9. Simplified diagram of a reactance-tube-type FM transmitter, employing electronic frequency control. Fig. 6 shows a mechanical frequency-control system.

sidered in two parts: the Crosby exciter and the FM-3A amplifier. Referring to Fig. 3, it will be noted that an *RCA* 807 tube is used as the electron-coupled oscillator. This oscillator is modulated by two 807 reactance tubes to provide frequency modulation. The plates of these modulator tubes are connected in parallel across the modulated oscillator tank while their grids are supplied inductively with push-pull excitation, shifted to be 90° out of phase with the oscillator tank circuit.

The audio-frequency modulating voltage is also introduced into the grid circuits in push-pull, so that under quiescent conditions the modulator tubes draw equal and oppositely-phased currents from the oscillator tank circuit. An audio signal upsets this balance, causing one tube to draw more current and the other tube to draw less, to produce an effective positive or negative reactance across the oscillator tank circuit, thereby modulating or varying its frequency in accordance with the amplitude of the audio-frequency voltage impressed on the modulator grid.

To maintain a high degree of frequency stability, an automatic-frequency-control circuit is provided which will hold the mean-carrier-frequency within .0025%. The output of a separate quartz crystal-controlled oscillator is combined in the plate circuit of the *RCA* 1613 mixer, with some of the signal supplied by a tap on the plate tank of the 807 buffer amplifier stage following the modulated oscillator. The difference between these two signals is one megacycle. The output of the mixer is coupled to an *RCA* 6H6 rectifier tube through a discriminator circuit and the direct current output is in turn connected into the grid circuit of the modulator tubes to provide differential correction bias.

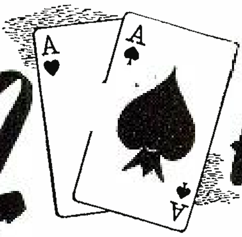
The discriminator circuit is so adjusted that no control voltage is obtained on the grids of the modulating tubes as long as the mixer output frequency is one megacycle. If the modulated-oscillator mean frequency varies, the beat frequency fed to the discriminator will vary in the same way, setting up a differential voltage on the grids of the modulator tubes which tends to counteract the frequency change. Although distortion is extremely low over the normal (±100 kc.) modulation range, the modulators are capable of swinging the frequency twice as far (± 200 kc.) with virtually no increase in modulation distortion.

An *RCA* 6J5 is used in an interlock circuit so arranged that failure of any component in the a.f.c. circuit actuates a relay which is used to sound an alarm and/or take the transmitter off the air.

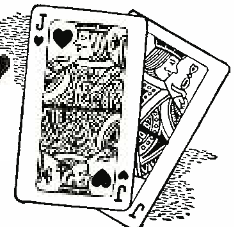
Two audio-frequency input circuits are provided, one following the stand-

Table 1. Comparative operating characteristics of typical AM and FM transmitters. The values given are well within the requirements of the FCC.

OUTPUT	FM	AM
Type of Emission	Frequency-Modulated r.f.	A-3 (Telephone)
Carrier Freq. Range	42-50 mc.	550-1600 kc.
Power Outputs	250, 1000, 3000, 10,000 and 50,000 w.	250, 1000, 5000, 10,000 and 50,000 w.
Carrier Freq. Stability	± 1000 cycles	± 10 cycles
R.f. Output Impedance	70 to 600 ohms	60 to 300 ohms
AUDIO CHARACTERISTICS		
Audio Freq. Response	30 to 15,000 cycles uniform within 1 db. of 1000 cycle ref.	30 to 10,000 cycles uniform within 1.5 db. of 1000 cycle ref.
Audio Distortion	less than 1½% RMS over entire audio range	less than 3% RMS from 50 to 7500 cycles
Audio Freq. Noise Level	70 db. below 75 kc. deviation	60 db. below 100% amplitude modulation
Audio Input Impedance	600 ohms	600 ohms



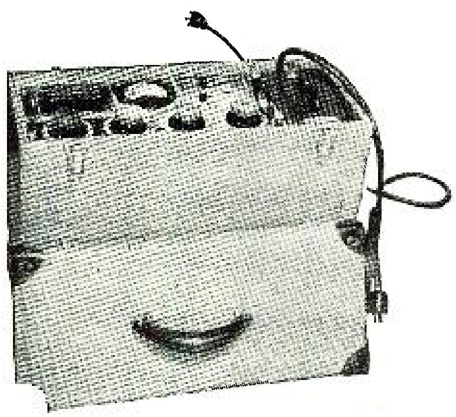
2 ACES... that are JACKS "of all trades!"



Gates

Remote Pick-Up Amplifiers

A FAMOUS PAIR



• THE GATES 3 CHANNEL PORTABLE REMOTE AMPLIFIER FOR ALTERNATING CURRENT OR BATTERIES.

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This famous pair is truly "a Jack of all trades" . . . for they have been "Aces" in doing an outstanding job of remote broadcasting from Maine to Pango Pango—from Macy's windows to Montana's mountains—from Sandlot ball games to World Series—from Presidents to Prime Ministers. For more than a decade Gates Remote Amplifiers have served broadcasters for every need and purpose. From year to year they have been modernized, but in efficient performance they still remain the same in name, type number and service.

Here's what one broadcaster writes about his Gates DYNAMOTE: "—My Gates Dynamote is so much superior to my studio speech system quality, that I have discarded my studio equipment until new equipment can be obtained."

Another wrote: "—I am using my Gates Dynamote as standard for overall frequency response for the entire transmitting plant."

This, plus the fact that Gates Remote Conditioners are used in nearly every U. S. broadcast station for single mike pick-ups, is proof that this famous pair has been engineered for efficiency and economy. This is why Gates Remote Amplifiers are now in use in every theatre of war, bringing to America's loud speakers the war events from the place where history's biggest news is taking place!

Wartime restrictions do not allow the sale of new broadcasting equipment without priority, therefore, this equipment is presented merely to acquaint you with Gates' current developments.

Ask About Our Priority Plan for Prompt Delivery When Gates Equipment Is Again Available.

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MANUFACTURERS OF RADIO BROADCAST TRANSMITTERS, SPEECH EQUIPMENT, ANTENNA TUNING AND PHASER UNITS, AMPLIFIERS, REMOTE EQUIPMENT, BROADCAST STATION AND TRANSMITTER ACCESSORIES

ard 100 microsecond RMA pre-emphasis curve from 30 to 15,000 cycles for high fidelity audio transmission and the other, flat from 30 to 25,000 cycles.

Field tests show that when high-fidelity transmission and reception systems are used in any type of modulation, a great proportion of the accompanying noise lies in the higher audio-frequency range, that is, between 5000 and 15,000 cycles. In all types of broadcast programs, the relative amplitude of these high frequencies is very low compared to frequencies from 30 to 5000 cycles. Consequently, any reception of the high frequencies is usually covered up by the high noise signals. However, if by means of pre-emphasis the relative modulation of the transmitter is increased at these higher frequencies, while a corresponding de-emphasis is employed at the receiver for the same frequencies, there will be a noticeable improvement in the desired-to-undesired signal ratio.

Filter circuits are provided in the a.f.c. circuit to give sufficient time lag so that fidelity will not be affected by the feedback modulation, nor will the a.f.c. be affected by the modulating signal. An automatic regulating transformer supplies all filament and plate voltages to the exciter so that line-voltage fluctuations as high as ± 15% have substantially no effect on the output frequency.

The output of the Crosby exciter feeds an *RCA* 814 buffer which in turn drives the push-pull *RCA* 808 tripler stage. The output of the tripler stage is coupled directly to the *RCA* 8001 intermediate power amplifier push-pull stage which in turn drives the *RCA* 827-R push-pull power amplifier.

The 827-R is a tetrode, (Fig. 11), designed specifically to meet the requirements of frequency modulation. Low-inductance leads minimize feedback and degeneration difficulties. Its plate structure is external and equipped with fins for forced air cooling. This type of cooling, provided by a suitably interlocked blower, permits high anode dissipations as compared with conventional air-cooled designs and also allows a smaller glass envelope than would otherwise be possible. A compact tube for high-frequency operation results, while retaining adequate power capability.

All electrodes are supported by the header of the tube alone, no solid insulation being used between the elements in the tube. Dielectric losses

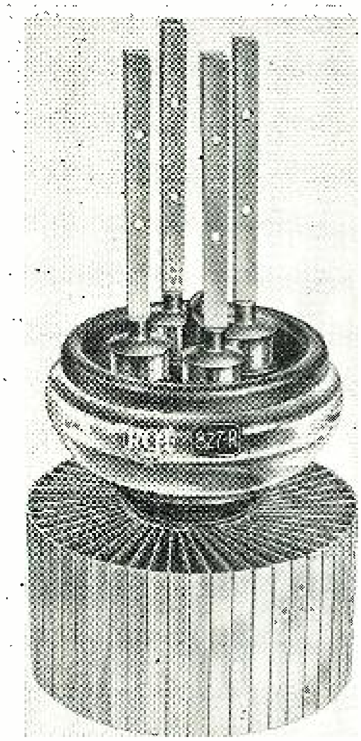
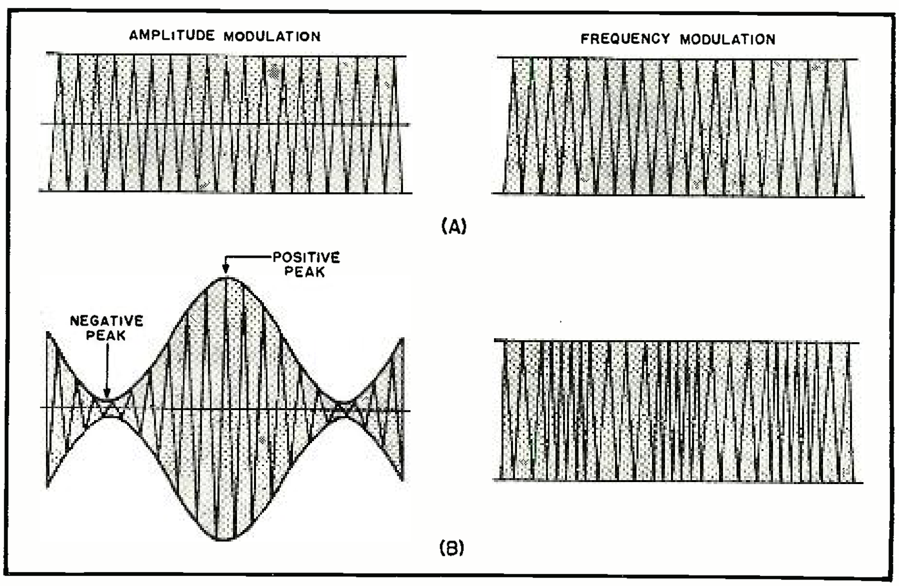


Fig. 11. An RCA 827-R tetrode tube, designed specifically to meet the requirements of frequency modulation.

Fig. 10. Illustrating both AM and FM types of waves: (A) with no modulation, and (B) 100 per cent modulated by a sinusoidal a.c. signal.



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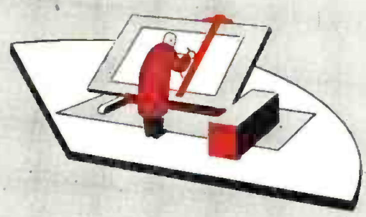

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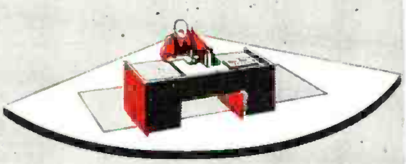

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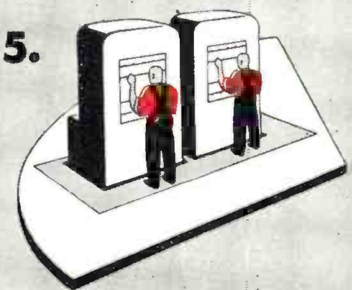

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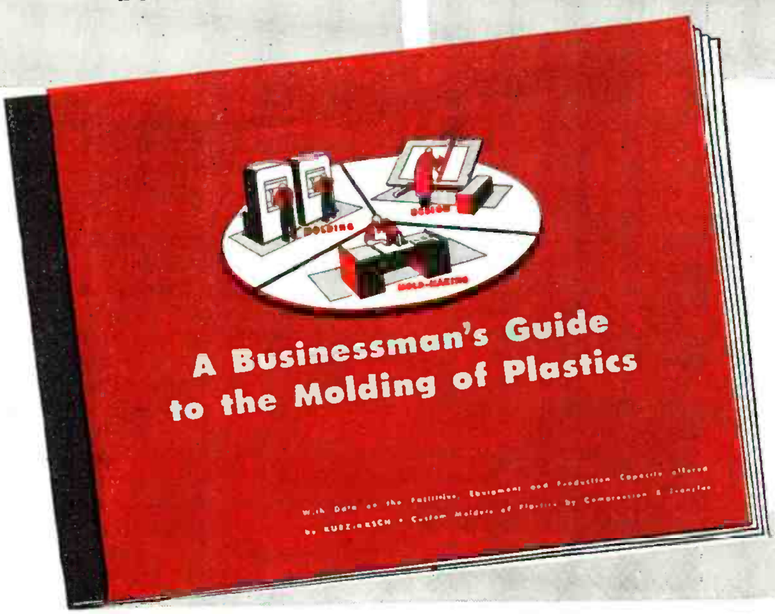

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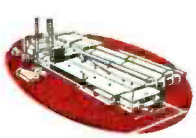

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OUTPUT

Power Output (into transmission line)	26 to 60 mc.—3000 w. 60 to 108 mc.—2000 w.	
Carrier Freq. Range—any single freq.	26 to 108 mc.	
Carrier Freq. Stability	within ± 0.0025%	
Maximum Carrier Deviation	± 100 kc.	
R. F. Output Impedance	70 to 600 ohms.	

AUDIO INPUT

Flat Freq. Response	within 1 db. of 1000 cycle ref. from 30 to 25,000 cycles	
Pre-emphasis Response	within 1 db. of 100 microsecond curve from 30 to 15,000 cycles	
Audio Distortion	less than 1½% RMS	
AUDIO FREQ. NOISE LEVEL		
(a) Freq. Modulated	70 db. below 75 kc. deviation	
(b) Amplitude Modulated	50 db. below 100% amplitude modulation	
	PRE-EMPHASIZED	FLAT RESPONSE
Sinewave Audio Level for 75 kc. deviation	± 12 VU	± 2 VU
Program Audio Level for 75 kc. peak deviation	± 2 VU	± 8 VU
Audio Input Impedance	600 ohms.	600 ohms.
Deviation Capability	100 kc.	100 kc.

POWER INPUT

Phase	3	
Voltage	230	
Regulation, Total Instant. and Slow-time	5%	
Frequency	60 cycles	
Power	8.5 kw.	

Table 2. A summary of the technical specifications of the FM-3A FM transmitter.

which would impair the performance of the tube at these frequencies therefore are eliminated. Control grid and screen grid wires are vertical and oriented so that the screen grid wires are located in the shadow of the control grid wires, forming electron beams which considerably reduce the current collected by the screen grid as compared with a structure having random alignment. Because a ring seal is used as a screen grid connection, it has been possible to build the tubes into the circuits with such excellent isolation between grid and plate circuits that perfect stability is obtained with only slight neutralization at 108 mc.

By careful positioning of the circuit elements, it was found convenient to use conventional lumped constants and circuits over the entire FM-3A output-frequency range of 26 to 108 mc. Plate tank tuning of the power amplifier is accomplished from the front panel by varying the capacitance between the metal shells into which the tube anodes are mounted (Fig. 7). The load circuit is inductively coupled to the power amplifier tank and will operate into a transmission line of any impedance between 70 and 600 ohms. A motor-operated load-coupling control is provided with front panel push buttons for accurate power output adjustment. All tuning controls are grouped together on the front panel and operated by a small wrench. This prevents any possibility of tampering with the essential controls by a casual visitor or other unauthorized person. A total of 14 meters is provided to indicate the performance of all circuits, including a volume level indicator for the Crosby exciter. The latter may be used for preliminary tuning adjustments and to indicate "deviation" during modulation.

A discriminator-type FM monitor is coupled to the power amplifier for continuous aural monitoring.

The rear doors are properly interlocked in accordance with good engineering practice to provide protection for the operating personnel.

Technical specifications for the FM-3A are summarized in Table 2. Its frequency range and power output make it readily adaptable to television for transmission of the sound channel. The fidelity curves of Fig. 8 present a clearer picture of the audio-frequency response and distortion characteristics.

From the engineering aspect, basic design incorporated in the two types of broadcasting systems is the same. The high-efficiency "Class C" amplifier, power supply, and control circuits are fundamental and form the backbone of transmitters. The distinctive features of FM inherent in the modulator unit and size of components exist because of its high operating frequency and the fact that the process of carrier-frequency deviation is not a power variation function.

Postwar FM transmitters will undoubtedly employ the two general systems of frequency modulation described herein. However, it is to be expected that the past several years of accelerated wartime engineering development will make itself felt in improvements in tubes and circuits resulting in transmitters of superior design.

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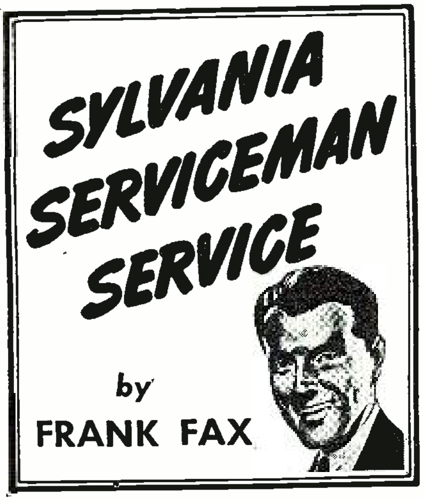
SYLVANIA NEWS

RADIO SERVICE EDITION

JUNE *Published by SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.* 1945



As another aid to servicemen, Sylvania offers its "Business Record for Income Tax Purposes" book—a simple, exact system of record keeping. (Many servicemen have been using this handy book for at least two years. Many probably wish they had.)

Two pages describe the best way to use your business record book.

Send for "Business Record for Income Tax Purposes" now—it can be started at once and will save time, expense and worry in the months to come. Your Sylvania distributor will be glad to show you a sample copy. Nominally priced at $1.00, your copy can be had immediately.

Sylvania's Survey Report Shows Postwar Need for More Servicemen

Thousands More Repair Shops and Men Required for Big Job Ahead

Once again Sylvania's nation-wide, independent radio survey—conducted by one of America's leading research organizations—reports facts and trends valuable to the radio serviceman. This is the second of a series of survey reports designed to aid servicemen in their present and postwar planning.

There are 60 million radio sets in use throughout America today. Sylvania's survey shows that as close as five to six years after the end of the war this number will increase to no fewer than 75 million home radio sets, plus a total of 25 million automobile radios. All of these millions of units are expected to be more complex in construction and will require more of the expert service radio repair men have been rendering.

Our survey reveals that present-day repair shops are well equipped, but servicemen fully recognize the postwar need for more and better instruments—more and better training—essential to the big task of servicing millions of phono-console combinations, F. M., and television sets.

In keeping with this recognized need, Sylvania Electric has developed a whole kit of bulletins and technical literature to aid servicemen with their problems.

SYLVANIA ELECTRIC

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

Manufacturers' Literature

Readers are asked to write directly to the manufacturer for the literature. By mentioning RADIO NEWS, the issue and page, and enclosing the proper amount, when indicated, delay will be prevented.

In view of the present paper shortage, a limited number of copies of the booklets described herein are printed. Manufacturers will endeavor to comply with all requests; however, if your copy is not received after proper request has been made, it most likely will indicate that the supply is exhausted.

RECHARGEABLE BATTERIES

The B. F. Goodrich Company has issued a new catalogue section covering their recently introduced charger for wet rechargeable flashlight batteries which can be operated from the ignition system of automotive vehicles.

This section describes the equipment, tells its functions and pictures methods by which it may be attached to the vehicle.

Copies of this catalogue section may be obtained from *The B. F. Goodrich Company,* Akron, Ohio. Specify Supplement Catalogue Section 12030.

EXPORT CATALOGUE

A complete catalogue of *Carter Motor Company's* line of dynamotors, generators, converters and rotary power equipment is now ready for distribution to export trade.

This booklet is available for use exclusively outside the United States and copies of the catalogue will be mailed without charge to anyone writing to the plant, providing the request is on the letterhead of a person or firm operating outside the continental limits of the United States. Requests should be addressed to *Carter Motor Company,* 1608 Milwaukee Avenue, Chicago, Illinois.

GHIRARDI BOOK DISPLAY

A new counter and window display for Ghirardi's books on radio and electronics is being offered to dealers by *Murray Hill Books, Inc.*

The display is a dramatic three-dimensional die-cut unit in three colors. Mounted behind the front card is a second card bearing full-size reproductions of the jackets of the three most popular books by Ghirardi.

A pair of these new displays, one for the window and one for the counter are available to jobbers free of charge by addressing the publisher direct at 232 Madison Avenue, New York 16, N. Y.

MOTOR SELECTOR GUIDE

An interesting and helpful booklet which provides design engineers with information on the proper selection of fractional h.p. motors has been issued by *The Dumore Company.*

The data included in the booklet is presented in outline form, completely illustrated. Comparative characteristics of the various types of motors is included to facilitate the selection of the correct horsepower, duty cycle and speed.

A free copy of the Motor Selector may be secured by writing to *The Dumore Company, Motor Division,* Racine, Wisconsin.

CONDENSED CATALOGUE

In order to facilitate the selection of suitable electronic components, the *North American Philips Company, Inc,* has issued a condensed catalogue covering eight of their *Norelco* Electronic Products.

Included in the catalogue are the cathode-ray, transmitting, power, and amplifier tubes; quartz crystal oscillator plates; Searchray inspection units; Geiger-Counter X-ray Spectrometer; X-ray diffraction equipment; quartz-crystal X-ray analysis unit; metallurgical products; and medical X-ray equipment.

A copy of this condensed catalogue will be forwarded upon request to *North American Philips Company, Inc.,* 100 East 42nd Street, New York 17, New York.

CONCORD GUIDE BOOK

Concord Radio Corporation of Chicago and Atlanta, Georgia, has just published a 68-page guide book for those using radio parts and electronic equipment.

The guide book features hundreds of items which are available either as single units or in large quantities. It lists and offers standard lines of condensers, resistors, transformers, tools, testers, tubes, and other essential components.

Copies of the guide book will be sent without cost or obligation to anyone who requests it from *Concord Radio Corporation,* 901 W. Jackson Boulevard, Chicago 7, Illinois, or from 265 Peachtree Street, Atlanta 3, Georgia.

HAMMARLUND CAPACITORS

A comprehensive brochure covering the company's complete line of variable capacitors has been issued by *Hammarlund Manufacturing Company, Inc.*

Written for the engineer, the catalogue covers the various steps in the manufacture of capacitors and then continues to a listing and illustration of the various available types. Designs for special applications as well as standard units are described. Engineering details are not included in

this brochure, but will be furnished upon request.

The brochure will be forwarded to those requesting it on business letterhead from the *Hammarlund Mfg. Company, Inc.,* 460 West 34th Street, New York, New York.

GULOW TRANSFORMERS

A four-page bulletin which covers the *Gulow* Vari-Former line of a.c. voltage control units is now available for distribution to interested persons.

Details of applications and engineering data are given fully to permit the engineer to determine the proper type of equipment for the job. Units for single-phase and three-phase operation are available from 2.5 to 15.3 kva. for the single-phase, and from 8.6 to 57.5 kva. for three-phase operation.

The data sheet will be sent to those requesting it from *The Gulow Corporation,* 26 Waverly Place, New York 3, N. Y.

PLATING DATA

Special Chemicals Company of New York has issued a data sheet covering their new plating material "Spekwite."

Because of the simplicity of application, this material is of interest to radio servicemen for plating of radio parts, etc.

Copies of the data sheet will be forwarded to those requesting it from *Special Chemicals Company,* 30 Irving Place, New York 3, N. Y.

CERAMIC BULLETIN

Engineers, designers and research men are invited to write in for a new bulletin recently published by *American Lava Corporation* covering the application of technical ceramics to radio and electronic equipment.

The material is complete, but presented in a concise, easy-to-use form which will be of particular value to the busy engineer. Typical designs are illustrated and property charts and other technical data is included.

Copies of Bulletin 444 will be forwarded upon request to *American Lava Corporation,* Chattanooga, Tennessee.

UNIVERSAL BULLETIN

A new bulletin covering *Universal Microphone Company's* D-20 Series Dynamic Microphones has been issued recently and is available for distribution.

The bulletin lists four available models from 50 ohms to 40,000 ohms and gives prices and technical information about the four types.

Copies of Bulletin 1458 will be forwarded upon request to *Universal Microphone Company,* Inglewood, California.

THICKNESS GAGES

General Electric Company has recently issued an eight-page booklet covering their line of thickness gages.

This unit which permits nondestructive measurement of coating thicknesses, plating, and the measurement of nonmagnetic materials such as glass, plastics, paper, cellophane, mica, etc., is available in three different types for varied thicknesses to be measured.

Bulletin GEA-4363 describes the various units and their applications. Copies of this booklet will be forwarded upon request to the News Bureau, *General Electric Company,* Schenectady 5, New York. Requests must identify the publication by the above number.

PROMOTIONAL MATERIAL

The *John Meck Industries, Inc.,* have begun the distribution of a series of die-cut folders illustrating their postwar products to their radio servicemen dealers.

The folders are approximately 3" x 4" and are printed in three colors. The folders are cut to outline two of the radio sets and a phonograph which the company is prepared to manufacture as soon as civilian production is resumed. One set is a 5-tube a.c.-d.c. superheterodyne and the other is a 4-tube a.c.-d.c. The phonograph is a 3-tube amplifier with a 4-inch electrodynamic speaker in an ivory plastic cabinet.

Space is provided on the back of each of these folders for the imprinting of the dealer's name. Servicemen dealers are invited to get in touch with the company by writing to *John Meck Industries, Inc.,* Plymouth, Indiana.

CAPACITOR CATALOGUE

A new 56-page catalogue covering the company's line of paper dielectrics has been issued by the *Sprague Electric Company,* North Adams, Massachusetts.

This catalogue has been designed to serve as a complete guide to the selection of these components for practically every industrial use. In addition, notes on capacitor selection and use, to meet the demands of the Armed Services, are included which add to its value as a reference book for designers and engineers.

Copies of Catalogue 20 will be sent to those requesting it from *Sprague Electric Company,* North Adams, Massachusetts.

MICA TRIMMERS

The Automatic Manufacturing Corporation's line of mica trimmers is covered in the new 12-page booklet which the company has recently released for distribution.

In this booklet are listed and illustrated all of the standard type trimmers manufactured by the company. Complete specifications are given for each type, including capacity curves and outline drawings showing essential dimensions.

Copies of the booklet will be forwarded to interested persons requesting it from *Automatic Manufacturing Corporation,* 900 Passaic Avenue, East Newark, N. J.

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Spot News

(*Continued from page* 18)

ment and Distribution Service, Signal Corps; Captain Jennings B. Dow, Chief of Electronics Division, Bureau of Ships, Navy Department; Louis J. Chatten, Director of WPB Radio and Radar Division; Ray C. Ellis, former Radio and Radar Division Director, and now a special adviser to the Johns-Hopkins University Laboratory at Silver Spring, Maryland; R. C. Cosgrove, U.S. RMA president; and R. M. Brophy, Canadian RMA president.

THE EXTENSIVE USE OF SUBSTITUTES IN RADIO equipment was revealed in Washington recently by the Signal Corps. Some of the substitutes developed or sponsored by the Signal Corps are low grade mica, for the low voltage capacitors; magnesium instead of steel, aluminum, or wood in radio chassis, antenna masts, and antenna mounts; plastic insulation for wires; plasticized ceramics, in place of mica for capacitors; and insulators made of glass instead of critically short ceramics.

Some of these interesting substitutions were displayed in the Pentagon Building a short time ago.

ENGINEERING TUBE WIZARDY of Americans has provided many remarkable developments. One such development, which will probably be discussed for many years, provided tubes which permitted the use of a vast German communications system in Belgium and France. Without these tubes, it would have been necessary to install new communications networks, a procedure that would have cost millions of dollars and many months of complex work. These tubes of special German design, which were used in amplifier circuits had been smashed by the Germans during their withdrawal, in an obvious effort to delay our movements. It was their belief that we would be unable to replace these tubes.

Fortunately, however, Brig. General Carroll O. Bickelhaupt, former vice president of Western Electric Co., on duty with the Signal Corps, located an undamaged tube. He felt certain that we could duplicate these tubes. Learning that Dr. Vannevar Bush, chairman of the National Defense Research Committee who had been in France, was returning to the United States, Gen. Bickelhaupt offered this tube to him, explaining that he was sure that American ingenuity could duplicate the tube and in quantities. General Bickelhaupt was right, for we did duplicate the tube. In fact, five weeks after the original had been delivered, a thousand tubes had been made.

The original German tubes were of the cathode-type pentodes made by Siemens-Halske. To shield the tube electrostatically, it had been sprayed with molten metal, a common practice in European production. We not only complied with this design requirement but improved upon it.

This record-breaking performance was praised by Dr. Vannevar Bush and particularly the officers and men of the Signal Corps in the European theater of operation, to whom this production meant so much.

STATIONS MAY NOT FIND IT TOO EASY to secure renewals of their licenses in the future. The FCC has decided to learn more about station operations, ratios of commercial to sustaining programs, and program types. It has been believed that too many stations were too heavy in their commercial programs . . . as high as 95% in some instances. Some of these stations had indicated in their applications that the ratio would be 70% commercial and 30% sustaining. As a result of this new activity, six stations received temporary licenses and a request for more information on their operation schedules. Sixteen stations were granted renewals, with a request for further data on their programs.

The detailed pattern of study instituted by the FCC may be simplified as the months go by, not only to ease the work of the legal staff, but to expedite license grants. Quite an extensive legal staff will be necessary if all of the 900-odd stations are asked to fill out the new forms.

SALES AND TRANSFER OF STATION CONTROL are also being studied very closely by the FCC staffs. In one case, involving the sale of WOV, the Commission refused to grant permission for the sale. They reported that the Commission was not satisfied from the record that the newly proposed buyers possessed the qualifications essential to operate the station in the public interest. Nor did they feel that these persons had shown that they were capable of being entrusted with the responsibilities and obligations expected of license holders.

The FCC was quite caustic in its conclusions, reporting that the transferees, in carrying on their edible oil business, had violated and disregarded regulatory laws of the states and federal government on numerous occasions, ever since they have been in business.

THE MONTREAL AREA OF CANADA will probably have FM coverage this summer. A 3-kilowatt station is scheduled for installation during the summer months. The installation will be under the supervision of the Canadian Broadcasting Corporation. At the present time only one FM transmitter is in operation. This is a low-powered unit, located in the Keefer Building, which is the headquarters of CBC. This service is being carried out to test receivers and study transmission coverage.

It is believed that the Toronto area may have an FM transmitter soon, too. At the present, surveys are being conducted to chart the areas for sites and coverage.

FOREIGN RADIO PATENTS may be investigated soon by the Senate, if the resolution introduced by Senator Homer E. Capehart, the former radio set and phonograph manufacturer, is adopted. The Senator has asked that the Senate authorize an investigation of the foreign ownership or control of radio patents. The resolution, of which Senator Wheeler is co-author, has been referred to the Senate Committee on Interstate Commerce.

The investigation, for which $10,000 to cover expenses is requested, would provide for the study of the relationship of foreign companies and persons to those in this country. Arrangements and agreements would also be covered in the study.

THE ONE MILLIONTH 16-inch recording for the Armed Forces was pressed a short while ago in Los Angeles. This historic recording was identified as the "G.I. Journal," and featured such radio stars as Bob Hope, Bing Crosby, Linda Darnell, Betty Grable, Frank Morgan, Kay Kyser, Jerry Colonna, and Abbot and Costello.

Six companies on the coast have been pressing these records for the Armed Forces for the past two and a half years. At the beginning, but 3,000 recordings were pressed a month. Today, over 70,000 are being pressed monthly.

The 16-inch record, which provides a half-hour show, is not only put on the air for rebroadcast, but played over sound systems on air fields, and public

(*Continued on page* 158)

New FM Freq. Converter

(*Continued from page* 35)

frequencies of the oscillator selected by means of the control switch, covers the new range of 84 to 102 megacycles in two bands.

The price of this unit, f.o.b. Chicago, based on quantity sales, is $5.60. This would permit retail sales below the $10.00 figure given in the company testimony before the FCC.

The second model is a three-tube converter which includes its own power supply. This unit was designed for areas where the signal strength is low and high performance is desirable. This converter is equivalent to the first two tubes of a normal broadcast receiver designed for these frequencies and provides comparable performance. This unit uses the 7V7 mixer, a type 7A4 oscillator, and a type 6X5GT/G rectifier. The output of the converter is fed into the antenna connections of the FM receiver which is tuned to 42 megacycles. The converter oscillator is arranged to track 42 megacycles below the mixer frequency and the entire device simply acts as the front end of a superheterodyne, using the FM receiver as an i.f. amplifier. This unit is provided with its own tuning dial. When connected to a prewar FM receiver, the receiver must be tuned to 42 megacycles and the stations in the new band tuned in on the converter.

In the event that a shift is made in FM frequencies, prewar FM receivers will be able to operate during the shift by switching the converter in or out, depending on whether the desired station is operating at its old frequency or has shifted to its new location.

The present plans of the company do not include the manufacture of these units, the development work having been done merely as an indication that such a unit is possible and could be manufactured in quantity should the frequency shift make the existing 390,000 receivers obsolete.

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Magnetic Recording

(*Continued from page* 34)

Forces occupy, magnetic tape recorders are in constant use for these, and other purposes. In any circumstance where only temporary recordings are required, magnetic tape recording is the best method available from the standpoint of high fidelity, economy of operation, and sturdiness.

Modern Magnetic Recorders

Modern magnetic tape recorders have reached a high degree of perfection in both design and construction for specific applications. The representative recorder shown in Fig. 1, is a portable unit designed to record, reproduce, and erase sound impulses which are applied to its recording medium consisting of a special alloy, magnetic steel tape. This tape is carried in an endless series of intricate loops around idler drums and past the recording and reproducing pole-pieces.

A full minute's recording can be applied to the tape, held intact, or played back. A recording upon the tape will be automatically erased upon beginning a subsequent recording but will be indefinitely retained until the new recording is applied to the tape. No servicing or adjustments between recordings is necessary.

All voltages required to operate the equipment are obtained from a built-in power supply and the equipment is designed to operate from a 110-volt, 60-cycle, single-phase, alternating-current power source.

Operation of the recorder illustrated is exceedingly simple. Four controls are provided; a 6E5 "magic eye" indicator tube is used to indicate the proper recording level at which a signal should be applied to the equipment's microphone in order to make a satisfactory recording. A dual-purpose power switch and volume control is used by the operator to turn the equipment on and off and also to control both recording and playback volume levels, and a three-position selector switch provides for the selection of recording, playback, or standby operation.

An elapsed time indicator which serves to indicate the amount of unused recording space available on the recording medium, consists of a revolving pointer index driven by a motor synchronized to the recording tape so that the pointer travels around a circular scale of twelve divisions as the tape passes the recording and reproducing pole-pieces.

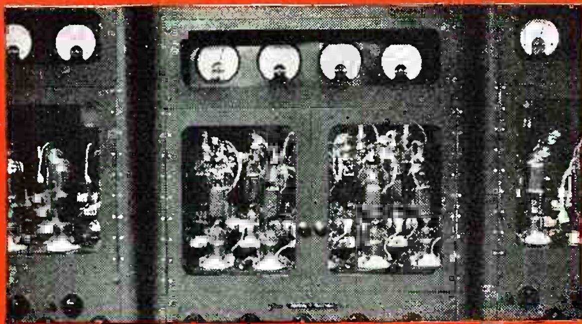
A closed-circuit microphone jack enables a high-impedance microphone to be connected to the equipment for recording purposes and a built-in electromagnetic loudspeaker, housed in a box lined with cellular acoustic insulation to minimize resonating effects, is provided to permit recordings to be played back. Provision is made through a closed-circuit phone jack for the connection of an external speaker or earphones. A switch connected across the speaker input lug permits the selection of either the built-in or external speaker.

Principles of Operation

Basic principles of operation of the recorder, shown in Fig. 1, are not very different from those used by Poulsen many years ago, but more specifically, the 6V6 oscillator tube of the recorder's amplifier circuit supplies a 25-kilocycle frequency which is applied through a pole-piece assembly containing two electromagnetic pole-pieces, to the recording medium, a steel tape carried in an endless loop past the pole-pieces. The purpose of this applied frequency is to return the tape to a neutral magnetic condition thus minimizing distortion and keeping the noise level at a low value.

During the recording process, electrical impulses from the equipment's microphone are amplified in the amplifier circuit and applied as an audio-frequency current to the coils surrounding the recording pole-piece. The variations of these audio-frequency electrical impulses cause corresponding variations in the magnetic field of the pole-piece. As the recording tape is subjected to the pole-piece's magnetic influence, these variations establish a magnetic pattern corresponding to the audio-frequency electric impulses in the recording tape. These impulses will be retained by the tape until erased.

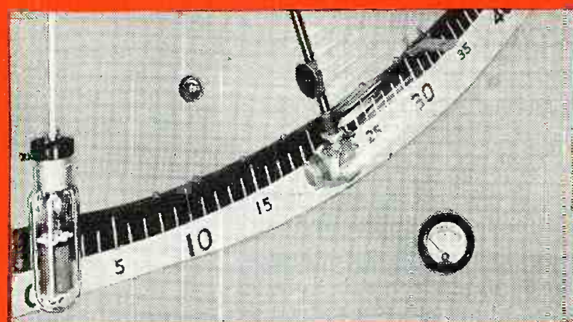
A second pole-piece assembly which has a d.c. potential applied to its coil, applies a unidirectional magnetic field to the recording tape as it passes. This field intensity erases the variations of the magnetic pattern in the tape, returning it to the correct condition for subsequent recording. The tape is subjected to this erasing process just before the recording process' impulses are applied to it and this may be considered the normal method of operation during recording.



*QST-1—Life testing is an important Quality Standard test of United. It is a strictly observed procedure whereby life expectancy is controlled in "run-of-production" tubes.

QST-2—A unique test is applied to every United tube to assure noise-free operation.

Who sets the *Quality Standard* FOR TRANSMITTING TUBES



QST-3—United tubes designed for very rough service have extra, built-in shock resistance proved by the severe Bump Test each tube must pass.

*Quality Standard Test.

Brilliant United craftsmanship is steadfastly verified and maintained by skillful and vigilant testing—truly representative of daily production. For this reason every United tube must pass through a series of critical examinations that do not permit any defects, no matter how minute they may be, to escape unnoticed.

By maintaining Quality Standard Tests of the highest order United engineers and technicians have achieved recognition for leadership. To engineers everywhere, the name United is the *trusted* standard by which other transmitting tubes are judged and measured.

For every electronic application including radio communication, physiotherapy, industrial control and electronic heating, standardize with tubes that are *the* Quality Standard. "Tube up" with United.

Order direct or from your electronic parts jobber.

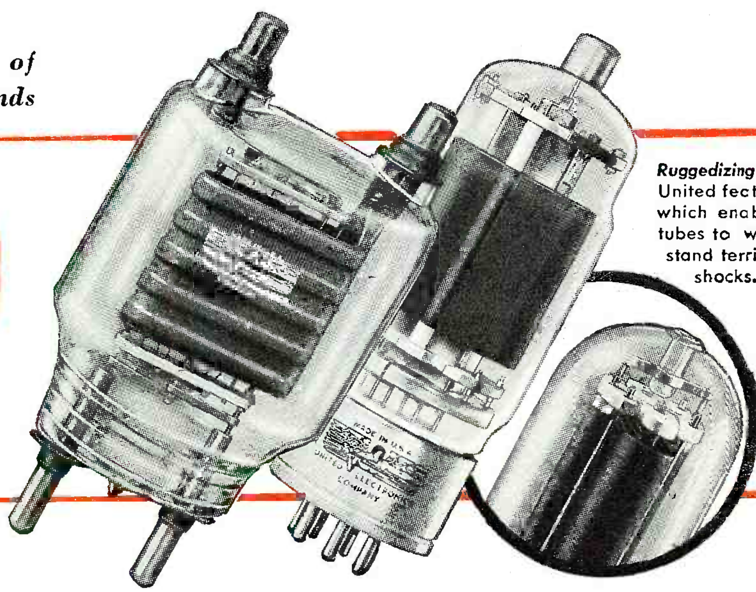
Masterpiece of Skilled Hands

UNITED

ELECTRONICS COMPANY

NEWARK, 2 NEW JERSEY

Transmitting Tubes EXCLUSIVELY Since 1934



Ruggedizing: A United feature which enables tubes to withstand terrific shocks.

The erasing process is automatic, and because the tape, being endless, will continue in its revolution past the point at which recording began, it will be seen that if a recording exceeding the limit of the tape's capacity (one full minute) is applied, the beginning of that recording will be erased and replaced with that portion of the recording which exceeds one minute. By observing the position of the elapsed time indicator's pointer, the operator can maintain a constant check on the unused time available during a recording and so prevent overlapping recordings.

During the process of playing back a recording, the variations present in the tape's magnetic pattern induce an audio-frequency current in the reproducing pole-piece as the tape passes by it. This audio frequency is amplified in the amplifier circuit of the recorder and fed through the speaker voice coil for audible reproduction. The action of a hum-bucking coil which is connected in series opposition with the reproducing pole-piece's coil, prevents extraneous a.c. fields from producing a hum in the playback.

When a recording is to be retained but the equipment must be left in operation, the recording and reproducing pole-piece assemblies and the erasing pole-piece assembly can be disconnected from the circuit while the tape continues to travel. The elapsed time indicator will continue to indicate the tape's movement and by observing the pointer's position the correct moment to commence recording or to play back a recording, can be determined.

Reference to the schematic wiring diagram, Fig. 8, will clarify details of the changeover switching arrangements.

Basic Mechanical and Electrical Components

As is true in the case of most electronic equipment, classification of major electrical and mechanical components is quite difficult due to the fact that each must be considered in direct relationship to the other. In the main, however, the major mechanical features of the recorder shown in Fig. 1 are concentrated in the tape recorder chassis. This chassis contains the tape drive motor assembly; lubricating system, recording tape, tape guide assemblies, and the heart of the magnetic tape recorder; the recorder pole and housing. The recorder poles and housing are usually referred to, as in the case of mechanical recorders, as the recording head.

A shaded pole induction motor is connected in parallel with the primary of the amplifier power transformer and the 110-volt power source. This tape drive motor's shaft rotates at a constant speed of approximately 1690 r.p.m. and drives the flywheel of the tape drive drum at a proportionate speed of 268.5 r.p.m. This flywheel thus imparts a speed of 140 feet per minute to the endless, special alloy, high permeability magnetic steel tape

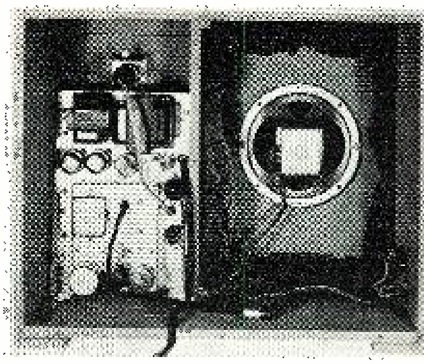


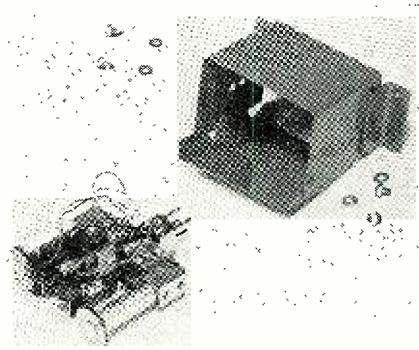
Fig. 9. Interior view of the recorder cabinet. The amplifier chassis is on the left, and the speaker unit and speaker box which is lined with acoustic insulation is on the right-hand side of the cabinet. The mechanical chassis, which houses the recording tape, tape mechanism, and recording head, is not shown.

upon when the recordings are impressed.

This tape, which possesses an extremely high bending fatigue limit, is .002 inch thick, 140.5 feet long, and .046 inch wide. It passes in an endless series of 38 loops around three idler drums, each of which is mounted on two "oiless" bronze bearings. The tape is guided in tracks during its rapid revolutions by three sets of tape spacer assemblies each consisting of 38 brass spacers and 39 phosphor bronze washers and a tape idler pulley is provided to maintain a constant tension on the tape to take up slight variations which would otherwise cause uneven recordings.

The recording tape is constantly lubricated by a system consisting of an oilpan and wick feed tube which oils the surface of the tape drive drum. Oil is applied to the recording tape as it passes around this drum and the oil accumulation is removed by the pole-pieces in the recording head assembly as the tape brushes past them. This surplus oil then drips into the oilpan and drains through the wick feed tube to be again reapplied to the drum and tape. This method of lub-

Fig. 10. Recording head removed from its housing. The guide washers which maintain the tape in its proper path through the pole-piece contacts can be seen clearly at the ends of the tubular spacer supports. The two coils in juxtaposition to these guide washers are the coils for the recording-reproducing pole-piece and the erasing pole-piece respectively.



rication serves to adequately lubricate the tape over long periods of time.

Recording Head

The recording head assembly contains the recording and reproducing pole-pieces and the erasing pole-piece. It is in this assembly that electric impulses received from the amplifier are converted into magnetic impulses and are impressed upon the tape during recording, and during playback, the tape's magnetic impulses are converted into electrical impulses. The erasing pole-piece erases the variations of the magnetic field in the tape, thus returning it to the correct condition for subsequent recording.

Each of these assemblies' pole-pieces consist of two sections. The upper section of the erasing pole-piece is constructed of 1/16-inch thick special high-permeability iron, and the lower section is of .005-inch thick brass. The upper and lower sections of the recording and reproducing pole-pieces are of laminar construction, .003 inch silicon steel against .050 brass. Each pole-piece bears a coil which, when current is applied to it, induces a magnetic field in its pole-piece.

A hum-bucking coil is connected in series with the recording head voice coils to counteract the effects of extraneous magnetic fields in the voice coils. This hum-bucking coil's magnetic field opposes that of the voice coils' and cancels out all undesired variations in the magnetic field intensity in and around the voice coils. In this manner the effects of outside interference are eliminated.

Amplifier Unit

The record's amplifier is a conventional resistance-coupled amplifier employing three stages of audio amplification. Its function is to supply power for recording operation and to raise the volume of a reproduced recording to convenient audio level.

The amplifier utilizes a 6SJ7 vacuum tube as the first stage of voltage amplification and a 6SQ7 as the second stage. As the 6SQ7 is a multiple purpose tube, its diode section rectifies the output voltage applied to the 6E5 tube which serves as the "magic eye" indicator tube. The power amplifier stage uses a 6V6 vacuum tube and another 6V6 tube serves as the oscillator supplying the frequency of 25 kilocycles which is applied to the magnetic coils of the recording head to maintain a field intensity in the recording tape sufficient to counteract distortion and reduce the noise level. A 6X5 tube is used as a rectifier in the amplifier's power supply.

The loudspeaker used in conjunction with this equipment has a field coil resistance of 2,500 ohms and its voice coil's impedance is 4 ohms. Either a high-impedance, matched-output, dynamic-type microphone or a high-impedance crystal microphone may be used.

While many refinements were added to the magnetic tape recorder discussed in this article, and many obstacles had to be overcome in the design and specification limitations of this equipment, the basic principles utilized are those developed by Poulsen during the early days of the twentieth century. It is a safe surmise that magnetic recording is even now a long way from its ultimate development and its applications are still mainly unexplored. But just as magnetic tape recording is still in the experimental stages of its evolution, just so is all recording still in its infancy, and who is to say that some day the spoken word, in the form of recordings, may not ultimately replace the written word for the transmission of ideas?

—30—

For the Record

(*Continued from page 8*)

are all being prepared, fully aware of restrictions set forth by the Army and Navy Security Boards, and even though lacking in certain technical discussions future articles will present highly authentic facts and will reveal other information which will enable the reader to gain considerable knowledge of the subject matter.

As far as security permits, we will endeavor to show how radar will be used by the postwar amateur and experimeter for his host of intriguing experiments and practical uses.

Our London representative is also gathering material from British sources and the English version will also be included in later issues. Throughout the present war there has been a very close liaison between the American and British military in the development of radar devices. Our tremendous military success has been due in great measure to the finesse of radar and Radiolocator systems.

Our readers will recall that there was a sudden reduction in the number of ships sunk by Axis submarines. While we cannot reveal the effective range of radar equipment used to combat enemy submarines, we do know that the use of radar has been highly successful. In fact, in the original RADIO NEWS story, August 1941, Page 40, is a statement by the author, "In fact, speaking about its use at sea, *Radiolocators may be the answer to the submarine menace!!*" Just what has happened since that prediction was made is now history. The answer can be found on the bottom of the Atlantic and Pacific Oceans.

MANY of our readers have written asking us to resume the International Short-Wave column. If the letters continue to come in at their present rate, we will again present information of specific interest to short-wave listeners. It is our policy to give our readers what they most desire. Therefore, we invite all those who are interested to drop us a postcard...O.R.

Future of U.H.F.

(*Continued from page* 28)

bands and the different conditions of propagation will involve the abandonment of single-area coverage from high-power transmitters and their replacement by several low-power stations fed by large numbers of substations and relays.

Dissemination of the large, clear, steady, detailed, all-electronic pictures radiated from these stations will take place without diffusion over the air by direct or line-of-sight reception on communal aerials distributing over local coaxial-cable networks of rigid frequency characteristics without attenuation of the very broad sidebands.

In time, the cloak of mystery enveloping the upper regions of the atmosphere will be torn away revealing the structure and properties of the Kennelly-Heaviside, Appleton, and various other ionized layers. Means will then be found to use the ionosphere as a transmission medium in all its moods. This, in turn, will make possible the setting up of a long-distance television service.

Such a service could operate around 1,500-2,000 megacycles and maintain perfect synchronization at the receiving end thousands of miles away at high rate of frames-per-second, providing 2,000-line interlaced, broadband multicolor pictures with much higher definition than at present.

New television receivers will be manufactured in quantity and put into the hands of the public at a fraction of the previous cost due to standardization of components and important developments in simplifying equipment.

Progress in the cathode-ray tube manufacturing art will bring down the price of these tubes to a few dollars (before the war, cathode-ray tubes cost about 60s in Great Britain; their present cost is about 20s); production facilities and improved workmanship making coaxial cables cheaper and more efficient.

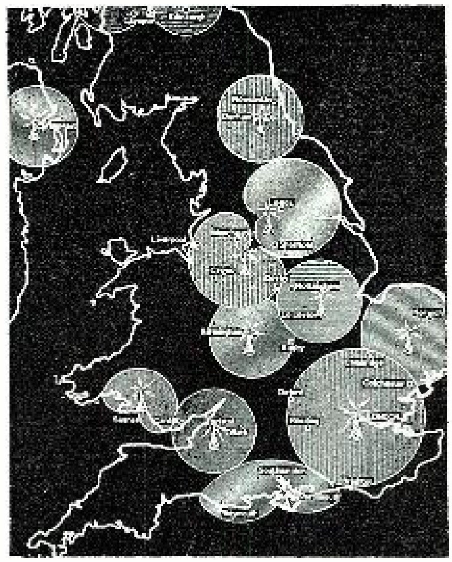
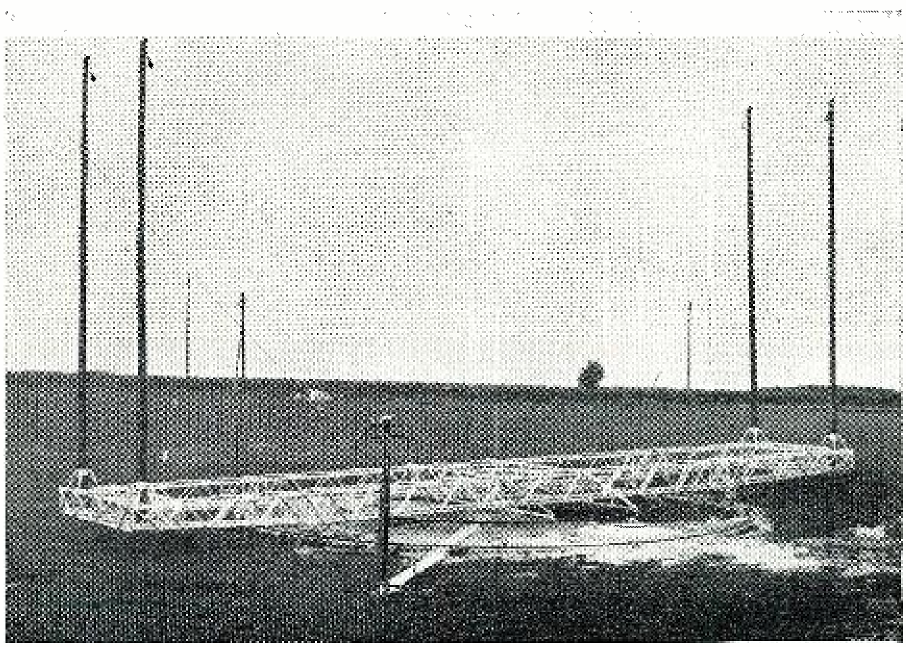


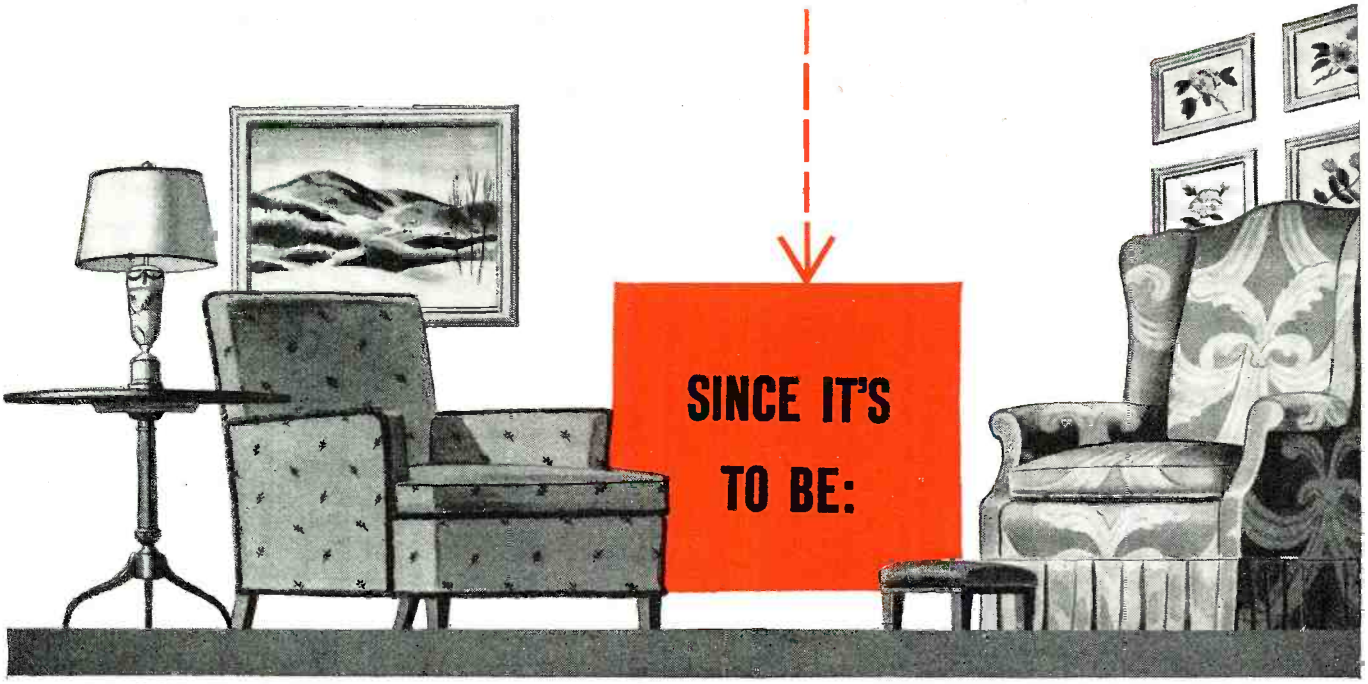
Diagram for British u.h.f. services, illustrating the way in which two British radio engineers propose to cover the populous areas of Great Britain and Northern Ireland with 12 stations, so placed that three separate carrier frequencies would suffice for television and FM services. The frequency bands to be used for various regions are distinguished on the map by different shading.

Relaying

Relaying is a relatively old branch of radio which in its various modern applications will undoubtedly play an ever-increasing part in tomorrow's u.h.f. network systems.

One of the British General Post Office's rotating arrays, illustrating the straightforward construction of a beam antenna. It is part of the Leafield radio stations' telegraph transmitter, operating around 28 megacycles or about 10 meters.





"STROMBERG-CARLSON FOR THE MAIN RADIO IN YOUR CUSTOMER'S HOME"

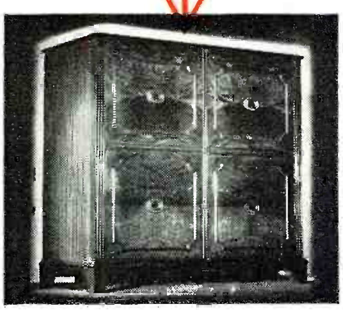
"STROMBERG-CARLSON FOR THE MAIN RADIO LINE IN YOUR SHOWROOM"

The thought that the main radio in any home should be as fine a radio as its purchaser can buy — a Stromberg-Carlson — is being carried to the radio-purchasing public by over 475,000,000 impressions in thirteen leading magazines. Turn this potent merchandising effort to your own direct service by becoming an authorized Stromberg-Carlson dealer under the very favorable Franchise Agreements now being offered. Get in touch with your local distributor or write us at once.

For Stromberg-Carlson is:

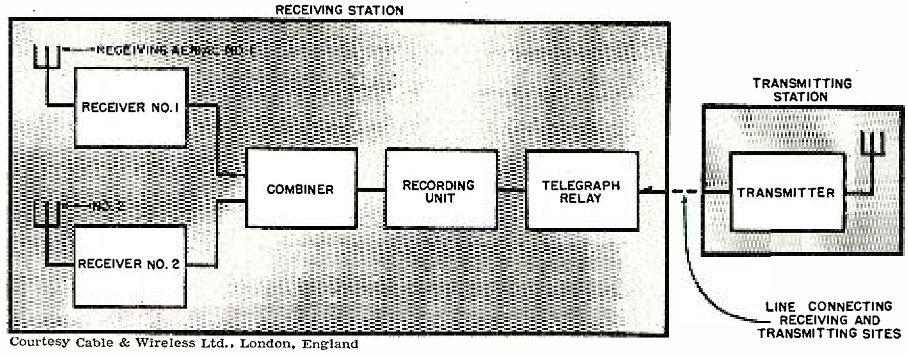
— the important radio unit — the radio unit carrying real profit opportunity — the radio unit with easy-selling public acceptance.

By becoming an Authorized Dealer now, you can organize your post-war business around the Stromberg-Carlson "main radio," a consistent profit maker — whether in an outstanding table model, console, or radio-phonograph combination.



STROMBERG-CARLSON ...ROCHESTER 3, NEW YORK

RADIOS...TELEVISION...TELEPHONES AND SOUND EQUIPMENT



Courtesy Cable & Wireless Ltd., London, England

Block diagram showing typical general arrangement of an automatic radio relay station.

Relay units will be called upon to fill the gap wherever line coverage of aural and visual signals will be impracticable, uneconomical, or unreliable.

These units will consist of strategically-located substations deriving power from public supply mains or independent Diesel electric power plants employing high-towered aerial arrays for local distribution of programs. Associated with them, satellite installations of unattended and battery-fed amplifying equipment will effect point-to-point transmission along defined routes without wasting a large part of power in indiscriminate radiation.

To minimize interference between transmitting and receiving signals, different carriers will be used and the plane of polarization of the waves emitted by the transmitting section of the aerial will be at right angles to that of the waves received by the receiving section of the aerial.

On occurrence of a breakdown in any part of such a unit, spare apparatus will be brought automatically into operation and a fault signal given to a central remote-control station.

The manifold possibilities of relaying will be recognized in time, adding a powerful tool to ultra-high-frequency utilization.

Conditioned by physical and geographical factors, u.h.f. relaying will, at relatively small expenditure, gradually be extended to span continents linking-up with a worldwide system of radio girdling the earth.

This will make possible regular transoceanic transmissions hooking up Europe with other continents by the aid of remote-controlled relay units either anchored to the ocean-bed or afloat but self-propelled to maintain a defined position.

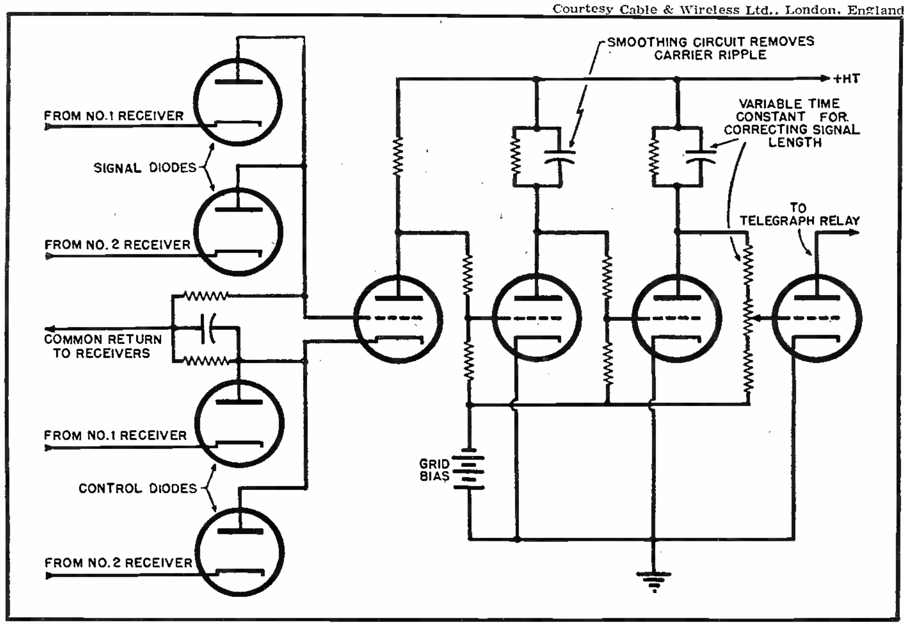
Single-network world coverage would thus be provided, effecting great economy in radio spectrum utilization.

Within the worldwide framework, monitoring stations will be set up to relay automatically field strength recordings and propagation prediction with stations forecasting reception conditions well in advance on the basis of round-the-clock observations of ionospheric variations while statistical tables of the 11-year sun-spot activity-cycle will assist in correcting any marginal errors that might occur.

Based upon the worldwide relay network and operating on the principle of different propagation conditions and time differences existing throughout the world, multichannel ultra-high-frequency communication systems will evolve for use in all cases where it is

Circuit diagram of combiner and recording unit.

Courtesy Cable & Wireless Ltd., London, England



desired to transmit signals with maximum reliability and minimum interference. These systems will enable limited point-to-point communication as well as long-distance dialing without the intervention of exchanges.

By the use of line-finder equipment, call connections will be effected automatically, permitting dozens of conversations to take place simultaneously on the same trunk lines resulting in a tremendous saving of time and labor.

By the application of television principles to phototelegraphy, the fastest method of picture transmission will become available for the sending of photographs from point to point and capital to capital with the least amount of delay.

Apart from facilitating picture transmission, the introduction of this new method on a broadcasting basis will also simplify presentation and distribution of news and photographs by linking up with visual and aural facsimile services.

Once these new services are grown up and firmly established in the public eye as reliable media, they unquestionably will provide more receiver hours than frequency modulation or television and certainly at a far lower cost-per-hour.

Newspapers will undergo a major transformation in format and contents by the establishment of the novel forms of news dissemination; world-wide daily papers—the dream as well as the nightmare of every newspaperman—published simultaneously in widely separated centers at greatly reduced cost will probably outrival one day ordinary dailies.

Television, extended to the telephone, will enable visual as well as aural contact to be maintained at will by the provision of a switchoff arrangement fitted to the apparatus.

Perhaps one of the major u.h.f. utilization offshoots destined to grow into healthy and indispensable auxiliaries in the future will be in land, sea, and air transportation. Trains, ships, and planes will be operated, steered, and controlled automatically along beam traffic lines facilitating all-weather travelling, sailing, and flying in complete safety.

Prominent among tomorrow's other uses will be medical science; u.h.f.-operated medical apparatus adding a number of new therapeutic and diagnostic tools to existing equipment.

Education will be yet another beneficiary of radio progress affording children and grownups alike opportunities for study and experience under the most convenient conditions.

Radio-frequency heating undoubtedly will infiltrate into the u.h.f. band and rank high among its users.

U.h.f.-operated systems for taxicabs, buses, automobiles, street-traffic control, police alarms, fire warnings, and a host of similar safety-of-life or public utility features, laughed at as freaks yesterday, will be commonplace tomorrow.

—30—

LETTERS
FROM OUR READERS

POSTWAR PLANNING

"I HAVE been in the Army since January 16, 1941, but in all that time, my radio hobby of civilian life since 1920 has more or less been in my thoughts. Thoughts of when I get back to postwar days. This camp is located in a remote part of the country and state, and has very little in the way of entertainment and amusement. So, with time on my hands, I think and plan what I will do in the way of my hobby after this war is over.

"Previous to my entry into the service, I was single and living at home. I had my radio room in my cellar. I spent all of my spare time there prior to induction when I met *the* girl. Then I spent 3 or 4 nights in my shack each week. I had a wonderful room with a Postal Short-wave set and a concerter hooked up with a 9-tube Philco. I also had a 15-watt p.a. system and a 5-meter transceiver which my radio 'ham' friends worked portable when visiting. (For some or various reasons I never became a 'ham.')

"When I got married, all my equipment was moved over to my wife's home, in the basement and now I am planning to build a shack, as good, if not better than the one I had. My real hobby is short-wave listening. Perhaps you may have heard of the R9LL (R9 Listeners League) with a membership of 550. I met many friends through the club and visited them in their homes in all parts of the East and some of the upper South. (My home is on Long Island, N. Y.) I have spent many pleasant hours in my radio room and to go back to not having a similar room would be like not living—that is how much radio has meant and does mean to me.

"One reads of so many postwar plans that I got to thinking that this would be the time to plan for better and more up-to-date shacks. This also leads me to write this letter. Wondered if you could run stories or articles on laying out a real shack where a fellow could have his friends and where it would be so attractive that he wouldn't mind spending many of his hours there and interest others of the household in taking part. Then here is the contest angle. Have others who are interested in radio, submit pictures or ideas on a model shack. Your company artist could draw pictures of ideas sent in and help others to develop layouts for their prize room of the house.

"I have been a subscriber to your fine RADIO NEWS mag for a good many years. In fact, since the birth of it. It has been very helpful in the past, present, and I know in the future. I save my copies for reference.

"I have applied for a course in radio through the Army but at this time, there are no openings. They write that applications should be made in a month or so, which I will do. I do not plan this as a future occupation, but only as a hobby. As a civilian I was instrumental in bringing many fellows and girls into radio through radio club R9LL.

"This idea of mine may seem simple compared to the various technical articles and stories so far submitted by your readers and writers, but I figured it was worth a try and if it will be of any use to you at this time, I will feel that at least I have tried to help out fellow radio listeners and 'hams'."

S/Sgt. Alfred G. King
Fort Robinson, Nebraska

This letter is typical of those received from many of our G.I. readers. You "hams" at home can do much to help these boys by sending in your ideas of what you consider to be an ideal postwar "ham" shack, what it should include, how it should be laid out, etc. In fact, RADIO NEWS *is always glad to purchase such articles. This applies to practically any subject of interest to the radio "ham."*

* * *

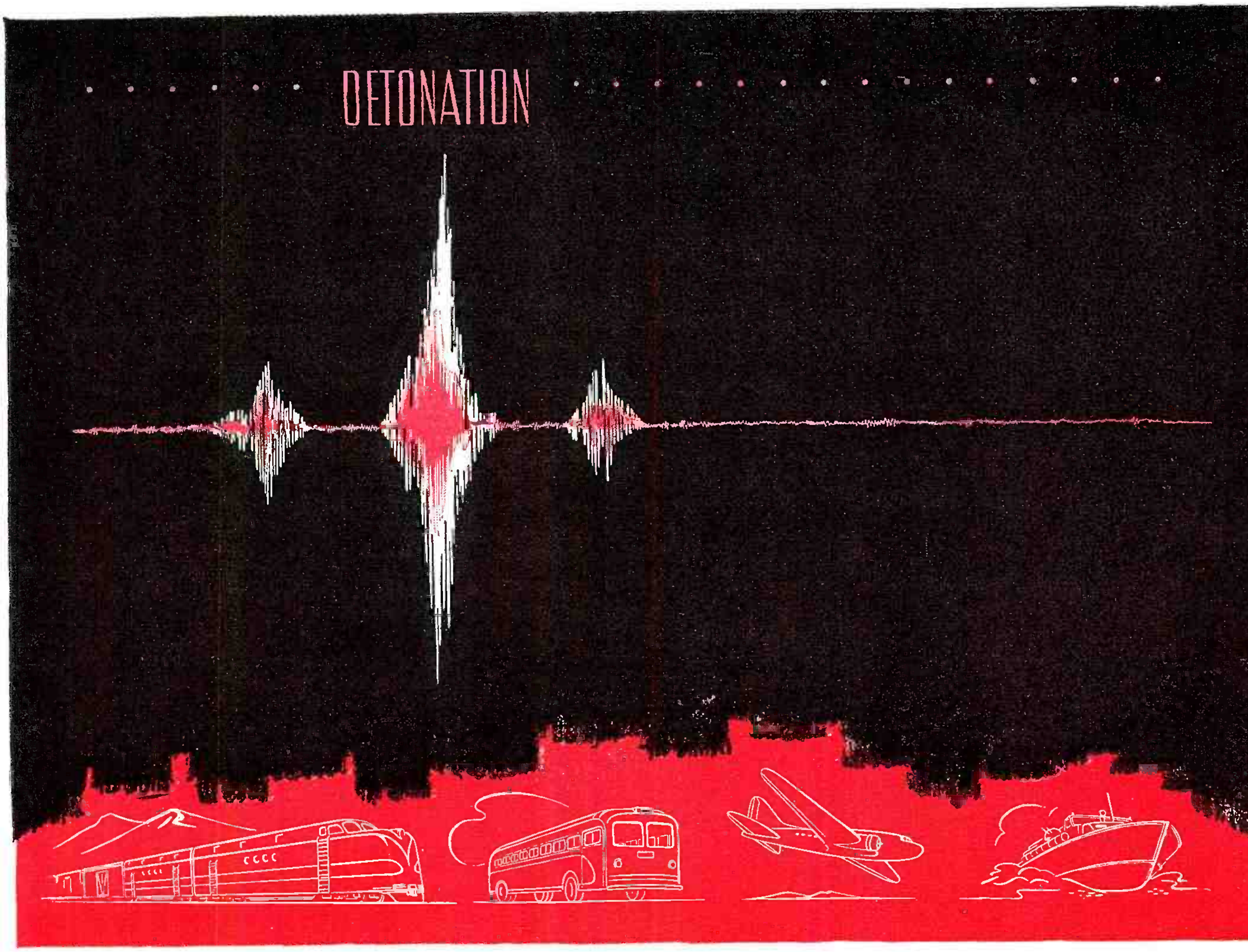
PRACTICAL SUGGESTIONS

"HAVING been a radio serviceman for the past twenty years and looking forward to a prosperous postwar radio and electrical appliance sales and service business, I'd like to suggest a few possible ideas to be used by the manufacturers of radio receivers and parts.

"First, they should make the chassis and speaker easier to remove from the cabinet. Most servicemen 'cuss' under their breath when on a service call they find a radio that takes a half hour or more to remove from the cabinet because a large glass dial with all sorts of push buttons, etc., has to be removed before the chassis can be taken out.

"The speaker usually has no plug at the chassis end so that the chassis and speaker have to be carried together or the speaker cord must be cut. Sometimes the speaker wires are passed through a hole in the chassis shelf and the wires have to be unsoldered or cut. What serviceman likes to take time to unsolder wires or have the owner of the set see him cut them? I have had customers who thought that I had ruined their radios when I was dismantling them to take them to the shop.

"Second, the *model* and *number* should be put on the *chassis* permanently and not on a piece of paper glued to the cabinet or chassis. I think some manufacturers must be ashamed of their product, as they fail to put a name or model number on



How electronics helps tell a knock from a boost...

THE MIT-Sperry Detonation Indicator is an engine instrument that discriminates between normal and abnormal combustion.

Through an electronic pickup, it *instantly detects detonation*—popularly called knocking or pinging—in most types of internal combustion engines. And it gives *immediate evaluation of detonation.*

As a result, warning is given at the time trouble *starts* . . . engine life is lengthened . . . mixture may be adjusted so that considerable fuel is saved . . . and the period between engine overhauls is extended.

No piercing of engine cylinders is required. Yet even the slightest detonation is signalled visually, and the faulty cylinder or cylinders spotted.

Use of the MIT-Sperry Detonation Indicator on airplanes results in remarkable fuel savings, longer engine life, greater safety.

The same is true of surface transportation which employs internal combustion engines.

Engine manufacturers find this instrument an invaluable aid in designing and testing. It also permits development of fuels exactly fitted to engine characteristics, thus increasing power output and lowering fuel costs. Also with the Knockometer, a special application of the Detonation Indicator, fuels with superior anti-knock characteristics can be developed and their quality production controlled.

Since 1937, Sperry engineers have been working on the perfection of a detonation indicator. This is but one of the many fields in which Sperry has pioneered in the field of electronic development.

Additional information on the MIT-Sperry Detonation Indicator is available on request.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

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FOLLOW RADIO NEWS FOR THE COMPLETE STORY OF RADAR

the set. This information would be of great help to the serviceman in looking up data or diagrams that may be badly needed to service the set properly.

"Third, it would be a great help if the i.f. transformers were marked plainly as to what frequency they should be tuned and also locate the trimming adjustment screws where everyone can't see them and think because they are not tight they might make the radio sound better if they were tightened. It is always a source of amusement when I get a radio to repair and the customer states that no one has touched it and it just stopped playing, then when I have it at the shop to find all the trimmers are so far out of adjustment that the set couldn't pick up a station even after the original trouble has been found and repaired.

"Fourth. Sometimes I think the designers in some radio manufacturing plants go off on a three day binge and then come back to design the various loop aerials and methods of connecting them to the radio. To properly align a set after servicing it, the aerial used normally should be used while aligning it on the service bench, but some of them are such a nightmare mechanically and electrically that most servicemen will leave them in the cabinet with hopeless abandon.

"Now a word to the tube manufacturers. Why do they have to make so many types of tubes? Some of them are so nearly related as to operating characteristics that they could almost be twins. Practically all of the 6-volt rectifier types could be substituted by the old familiar type 80 tube. This is only one instance; there are plenty of others. This fact has been brought home to many servicemen in these times of war scarcity.

"Now a word to the speaker manufacturers. Perhaps it is easier to make speakers that are riveted together so that it is impossible to replace the field coil or adjust the cone clearance. Perhaps this method means larger replacement business, but personally I always favor buying replacement speakers with the features mentioned.

"Possibly some may think that the above criticism means that I may be of a lazy nature, but the obvious reasons are apparent to any serviceman. The time spent trying to overcome these items means a lot in a busy day and I think that since the average serviceman is underpaid, this saving of time represents a real dollar and cents dividend to him.

"When I take a radio back to a customer and know that the set is operating as well or better than when new, I have a feeling of satisfaction and pride in my knowing how."

Thomas H. Bell
Bell Radio Service
North Attleboro, Mass.

Reader Bell has made some very good suggestions, for which we extend our thanks. What do our other readers think about improvements that could be made in postwar radios which would be of value to the serviceman who does the repair job?

* * *

REQUEST FROM ENGLAND

"MAY I take this opportunity to praise you on the excellence of your magazine, RADIO NEWS. When I am lucky enough to come across a copy over here, I read and enjoy every page. Yes, even the advertisements prove very interesting and judging from them, we will have to be very much alive to keep up with the many advancements you are making in the science of radio in your country. What a comparison your magazine makes with the sadly depleted British publications with their thin paper and fewer pages.

"Now for the main purpose of this letter. I am anxious to exchange correspondence with an American radio serviceman about my own age (I am nearly 18) and I am hoping you will be able to put me in touch with such a person who may be willing to start a pen friendship, with the object of exchanging views on servicing in both countries.

"Thanking you and hoping you will be able to assist me in this matter."

Kenneth Jennings,
Radio Service Engineer,
42 East Park Mount,
East End Park, Leeds 9,
Yorks, England

Here is an opportunity for some of you younger servicemen to exchange interesting letters with a fellow radio serviceman in England. Readers interested in corresponding with Mr. Jennings may write him direct at the above address.

* * *

MORE ON LICENSING

"JUST ran across the August, 1944 issue of RADIO NEWS (some thoughtful soul put it in a box of replacement parts as packing material) and I got quite a kick out of Sam Berger's letter about 'screwdriver mechanics.'

"He makes big talk like a 'super-dooper' radio engineer and 'sez' that servicemen should be licensed and in the same breath suggests that the manufacturers should send him a short order course in radio and complete service instructions with each set including arrows and numbers as to what 'lil ole' screw to turn to make her 'perk'. I'll bet if he had thought 'uv' it he would also suggest that the companies send a serviceman along to do the job too, Hi, hi!

"I have often wished the same thing about commercial sets (most Signal Corps equipment answers Mr. Berger's dream) but I thought it would be of greatest advantage to we 'screwdriver' boys as all the experts I've seen usually can tell what a piece does by the way it smells or something.

"'Course if some company carries out Sam's wishes, they will defeat his purpose as then when something goes wrong all the little woman has to do is dig out the instruction book, read a little and presto, it's done!—well, something is done, even if it might give the fire department a workout.

"Well you asked for our opinions, there's mine and that of a couple of other 'screwdriver mechanics' here. 73's."

S/Sgt. J. L. Mohn
c/o Postmaster, New York

"IN SPITE of the numerous comments sent to RADIO NEWS magazine regarding Mr. Berger's article denouncing 'screwdriver mechanics,' it is quite apparent that the issue is not a dead one, nor should it be. An inspection of the various opinions expressed by the readers seems to indicate the presence of two major factions: those who encourage the so-called 'screwdriver mechanics' and those self-styled 'professional technicians' who 'know it all' and resent any one else's finding out what it's all about by means of an informal education.

"I, for one, wonder just how many of those individuals whose professed aim is to protect the customer aren't really interested in self-protection, because they are very much afraid of sales or service competition. It is becoming increasingly apparent that there is a tendency for the learning abilities and ambitions of the 'old-timers' to stagnate.

"Can criticism of younger, more eager entries into the radio fields replace honest-to-pete ability and initiative. No, sir, I think not! How many of the oldtimers started out in radio as experimenters, using the simplest forms of technical equipment and rule-of-thumb theory? Right; nearly all of them. Why then, should they condemn the younger fellows who are doing the same thing in less time under more pressure? Radio is not an exclusive vocation. It can hardly be given any one classification as a field of endeavor for it involves professional men, tradesmen, business executives, amateurs, and just plain tinkerers. Why, then, try to pigeonhole it as an exclusive trade or art? There's more than enough room for everyone. Let's make ability and salesmanship the factors which identify a serviceman as good. There are far too many variables entering into the segregation of the good and bad for anyone to condemn the little fellow and his work.

"Let us, for a moment, consider two possible answers to the problem:

"Licensing: This might most easily be accomplished through the use of the Federal examining boards located in all the large cities. Licenses need not be compulsory, but rather indications of merit, and an assurance of technical ability, telling the customer-consumer that this or that radio serviceman is a qualified technician according to the rules or qualifications laid down by a competent Federal board. This would place the man without the assets of an expensive shop and equipment near the same level of customer confidence as the well-established radioman with an earned and deserved reputation. The business policies which cloud the situation can always take care of themselves because there isn't a good radio serviceman in the business who needs to worry about cutthroat prices since he knows how to advertise reliable work and guaranteed results which can and do work for themselves to build for him an indestructible reputation.

"As S/Sgt. Midi puts it in the December issue of RADIO NEWS, 'If a licensing plan is adopted, it should be an exam dealing solely with the field of radio servicing.' Business methods are chiefly of local concern and should be dealt with as such.

"Education: We must consider both customer education and serviceman education in this radio repair problem. If a radio serviceman is endorsed and accredited by some widely advertised radio school, it is natural and logical that people will come to him for radio repairs, but he must advertise the fact that he has completed a training course. On the other hand, it is true that there are a great many self-educated men whose abilities surpass those of the schooled lads. One cannot disregard these men nor force them unnecessarily into radio schools for the sake of diplomas alone. The other factor—customer appreciation of a radioman can be built upon many things; personality, technical ability, and reputation, and the customer's appreciation of the difficulties involved in any repair job. The last item is dependent upon all-important salesmanship, too.

"Let us then seriously consider the licensing or endorsement, of technical men by an impartial examining board —let any man enter, but may the best man win—30."

Bruce L. Meyer, CRT, USNR
"Somewhere in the Pacific"

"THE discussion regarding the licensing of radio repairmen is very interesting to me because it calls to mind the frequent occurence of the same sort of proposals in the field of professional photography. In fact, it would seem that such proposals are being made in nearly every field of human endeavor.

"It always appears that most of these proposals are made by persons who stand to lose by the competition of 'screwdriver mechanics,' amateurs, etc. Very infrequently do these ideas stem from persons interested in the establishment of high standards solely for the sake of the standards. From my point of view, these proposals are, essentially un-American. Furthermore, many of them would result, if adopted, in combinations in restraint of trade. Even worse, some of them would place laws on the statutes that would act in restraint of trade.

"There are persons who point to the license requirements for druggists, doctors, lawyers, and other licensed professionals, as examples and precedents for enlarging the list to include photographers, radio technicians, and a host of others. If some clear ideas are not established to fight this trend, its only conclusion will result in licensing everyone who does any sort of work whatsoever. Eventually we can expect to see 'paper boys' licensed on their ability to heave the 'daily' through a specified opening from a specified range while riding a bicycle at some designated speed.

"Vigorous attacks should be made on all attempts to introduce legislation based on the assumption that the buying public is composed of a bunch of low-grade morons who must be protected from their own foolishness. It it easy to see a vast difference between license requirements applied to professions that are directly concerned with human health and a profession that is primarily concerned with human entertainment.

"It has been suggested that a license plan will benefit the public. This conclusion will not stand up under critical examination. Usually the requirements for these plans are set up by well-established professionals of long standing. Almost without exception the importance of experience is written in as a rule requiring a certain period of apprenticeship. This period is usually made so long that many persons are immediately inclined to seek some other field. In fact, the very persons who are most discouraged by such long required training periods are the ones having the most ability, the greatest skill, and the most active minds. On the other hand, the plodding type will not be particularly discouraged by such requirements. The result can only be disadvantageous to the public.

"Furthermore, by cutting down the number of persons allowed to compete with him, the long-established professional is not required to exert the maximum effort toward keeping up with the march of progress or toward giving continuous excellent service.

"Unnecessary and restrictive legislation originates with two types of persons. One type is the person who has some personal gains in mind when the law is proposed, the other type is the person who is forever sticking his nose in other people's business and telling them how they should run it. It seems to me that the United States owes no small measure of its greatness to the fact that the above two types of persons have always been considered obnoxious. On the other hand, the 'screwdriver mechanic,' the backbone of Yankee ingenuity, is showing the regimented ingenuity of the Axis, exactly where to head in."

Thomas D. Sharples, 1st Lieut.
C.A.C.
c/o Postmaster, New York

Let's have more letters from our readers on the pro's and con's of this licensing proposal.

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Electronics at Work

(*Continued from page 55*)

their operation is dependent on controlling the flow of electrons through air and they appear to be correctly included within the field of the definition.

Why Electronics?

It appears that much of the present-day design and development work in the electronics field (military needs aside) is being done by the sales manager and the advertising man—the engineers are too busy with other things. It is doubtful if these men are, on the whole, well-grounded enough in this field to do much thinking other than of the "wishful variety." This almost inevitably leads to developments that may be physically possible, but economically unrealizable. Dress these developments in a veil of pseudo-censorship, thin with a liberal application of overgrown advertising budget, and serve to the public as a full-page spread in their favorite publications, and you have a fairly accurate case history of many of the "new" electronic developments.

It can probably be agreed that an electronic device can be designed to perform the most complicated operation dreamed of by the most highly-gifted press agent. An electronic control could be built to operate the most cantankerous boiler, under the most vicious load cycle, holding the steam temperatures, with never a waver in the steam pressure line, and having the entire performance of the boiler operator limited to pushing the start button.

Since there are already on the market automatic control systems which approach this ideal, why would the electronic system be preferred? An examination on an engineering basis discloses only three reasons why engineers, as business men, will purchase electronic control or metering devices. These three fundamental reasons are:

1. The electronic system can perform an operation *no other device can do.*
2. The electronic system can perform an operation *better* than any other system.
3. The electronic system is *cheaper* than any other system.

Electronic equipment can often perform operations impossible by any other apparatus. Such equipment, smoke recorders are an example, will find a ready sale at any price consistent with the value of the result, and will be bought not because they are electronic but because there is no other way.

Electronic equipment can often perform operations better than some other types of equipment; the new, fast, continuous temperature recorders are examples, and will be purchased because a better result is obtained at a price consistent with performance.

Electronic equipment unfortunately is not always cheaper than competing systems. When it is cheaper it will be purchased for obvious reasons.

If a piece of electronic equipment cannot be justified by any of the above, it will not be sold. Newness or novelty does not determine the design of modern boiler and turbine rooms.

To state the matter in another way, electronics can do any job—but it will not always be justified by the engineering and economic factors involved.

Electronics is usually assumed to have been born in 1885 with the discovery of the Edison effect: that electric current could flow in a vacuum. It was first applied about 1887 in the magnetic blowout on street car controllers. Another application at almost the same time was the carbon motor brush, in which conduction is suspected of being electronic in nature. These two applications are credited with having saved the infant street railway from extinction. We can say that electronics was applied almost before it was born.

The first real attempt to make use of electronics as we now think of it occurred about 1930-31, but the development failed to take hold. It is interesting to examine the reasons for that failure in an effort to use that information in estimating the stability of the present situation.

First, it is believed that the development failed because the market had not been prepared; the customers had not been educated to the idea of using a so-called "fragile" glass radio tube in the plants and apparatus.

Second, the apparatus was frequently poorly designed and poorly applied, by engineers with inadequate training in electronics and other fields. It was not the fault of electronics but that of a complete lack of understanding of the operating conditions under which the equipment was to be used. Equipment in a state little better than that of the original laboratory model was sent out and expected to operate under conditions existing in the steel mill or the boiler room—naturally it failed to operate as it did in the manufacturer's laboratory. The designer had great faith in his electronics, but too little knowledge of what it must do.

What of the Future?

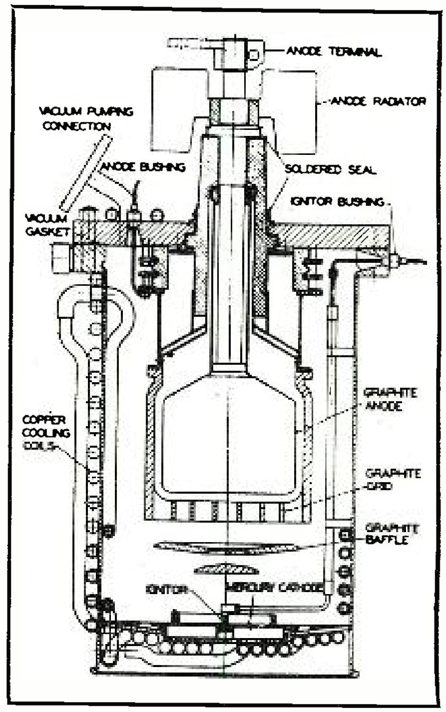
The war has apparently provided an ample testing ground to convince the skeptics that electronic equipment is not fragile or delicate. Satisfactory service in ships, tanks, and aircraft should be ample evidence that the electron tube can safely be allowed to take its place in industry. The customers have been sold—if not oversold.

The great danger to the present electronic development, and to industry in general, lies in the second reason for failure of the 1930-31 venture. It can be briefly stated as a lack of men trained to design, sell, apply, and maintain electronic equipment for industrial use. Electronic equipment unfortunately is different from other electrical equipment, and the power-trained electrical engineer is usually not equipped to handle it.

There are believed to be fewer than 1000 men in the United States and fewer than 100 men in Canada today, equipped by training and experience, able to design and apply electronic devices to industry in general. These men must be trained not only in electronic devices, but it is much more important that they also be trained and experienced in the processes, equipment, and techniques used in industry, to be able to give the purchasers adequate technical advice.

It is this shortage of capable engineers, to which the radio-trained technicians released from the Armed Forces will be able to add little, that is the real obstacle over which our forthcoming electronics boom may stumble.

Fortunately, there are certain factors in the equipment design, which, if understood by the customer and applied at the time of a purchase, may prevent a misapplication and purchase of unsatisfactory electronic equipment.



Ignitron rectifier for power rectification in transit and electrochemical installations.

An electrical engineer thinks of a resistor, an inductor or a capacitor, as a circuit constant, which can be purchased as having a certain value and which will have that same value at all times. An electron tube is not such a precision device. When new, they are considered satisfactory if they do not vary more than about plus or minus 20% of the standard rated values. During life the tube characteristics are continually changing, causing changes in circuit performance, unless the design was given a sufficient safety factor. Failure to allow for the electron tube as a circuit variable is one reason electrical engineers with power training frequently have trouble designing and applying electronic devices.

A device may work perfectly with a certain set of tubes at the factory, and later when the customer must replace some of the tubes it becomes inoperative. Another difficulty occurs in not allowing for the change of tube characteristics during the life of the tubes, and as a result the calibration of the device is found to be in error later, even though perfectly correct at installation.

It is almost always possible to design electronic devices to be independent of the characteristics of the tubes used. As a rule it calls for a higher order of engineering ability, and may raise the cost slightly. The results will be found worth the additional cost, since a well-engineered design is indicated.

A design of this nature means that a tube may change its characteristics over a very considerable range without affecting the performance. In one example, a tube operated for over five years, or about 45,000 hours. When removed the tube tested extremely low, far below the point at which it would be usable in a radio receiver, yet at no time had the recorder shown any calibration inaccuracies. When a new tube was inserted, the recorder continued to operate without change.

Performance substantially independent of tube characteristics is especially important in a control. A change in tube characteristics may cause a shift in the control point, or a tube failure may cause the control to run away, if the design is not made independent of the tube.

If the operating instructions mention periodic checking of calibration, or provide an adjustment to be checked periodically, then the instrument is probably not designed to be independent of the tubes. As a check, insert various tubes and note the effect on the calibration, and for a control, remove one of the tubes, simulating a complete tube failure and note the effect on the control operation. Then ask, is that effect desirable?

Mechanical Features

The weak spot in many electronic applications is not in the electronic circuits but in the mechanical parts used to actuate the electronic control, or in the mechanical parts used to perform the desired operation. These are the features that the electronic engineer will know least about, because they may be peculiar to one application.

In an application of electron tubes to a printing register control it took six weeks to work, and a complete redesign of parts of the machine to make the electronic register control function. The customer's application engineer failed to allow for the instantaneous, high-speed action of the control and had to reduce weights and strengthen parts before the mechanical part of the machine would stand up. During this time the electronic circuits had operated perfectly at all times.

Possible Power Applications in Power Generation

Having surveyed some of the factors which should underlie the application of electronics to any field, let us now ask—what is its future in power generation? If we remember the three basic reasons for the application of an electronic device we can find a number of present and future applications, in which electronics will definitely be a factor.

Smoke measuring and recording happens to be an excellent example of an application which can be made in almost no other way than by electronics. There are, at the present time, several photoelectric smoke recorders on the market, operating on various principles, but essentially they cast a beam of light across the stack, striking a photoelectric cell, and the output current or voltage of this cell is recorded as a function of smoke. When we try to decide what function of smoke this is, we get into trouble.

First, what is smoke? Until this question is settled by engineers, independently of the politicians, we will have no really satisfactory measuring of smoke density. Certainly the Ringelmann chart, with its reliance on purely subjective readings by the human eye, affected by the color of the smoke, the cloudiness of the sky, the position of the sun, is not an engineering measurement.

Second, many smoke-recorder engineers, designers, and smoke inspectors, seem never to have heard of Lambert's law which states that the amount of light absorbed by the smoke is an exponential function of the thickness of the smoke column. The smoke from a 20-foot stack will absorb four times the light absorbed by a column of the same smoke in a 10-foot stack, giving a reading of much more smoke when actually there are exactly the same number of particles per cubic foot.

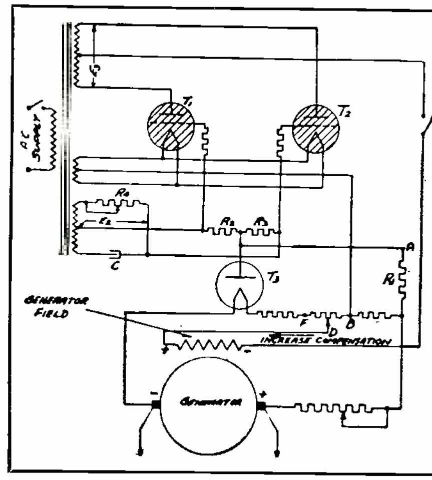
These are examples of some of the difficulties besetting the application of an electronic device in a new field. They are not the fault of electronics, but you will frequently hear electronic smoke recorders blamed for not reading correct smoke densities. What is smoke?

Another point at which electronics is entering the power field is in the measurement of temperature. For many years the intermittent, step-by-step type of temperature recorder was standard and did an excellent job. Electronics entered the picture and it was found possible to improve on even the best of the preceding types by elimination of most of the mechanical moving parts, by the elimination of the delicate galvanometer, or by removal of the step-by-step action. There are now recorders on the market retaining all the accuracy of the older models, but giving continuous movement of recording pens, without a galvanometer, and with no mechanical parts more complicated or troublesome than an electric motor. Electronics has made possible these improvements, and there are enough potential developments now available to insure a continued advance in this field after the war.

These new developments will take the line of improved versions of temperature recorders using electronic tubes as actuating elements. We can also look forward to the complete end of measurement of radiant temperatures by putting something in the furnace or pipe. The new way will involve electronic means, and we will measure temperature by looking at the hot body. We will use such devices, not because they are electronic, but because they are better.

The use of electronics in the measurement of flow is not so far advanced. Means have been proposed for this but so far they do not look too promising. This excludes the transmission and telemetering of flow readings electronically. The latter field is already well developed, there being a number of devices on the market. We can expect a continued development of electronic transmission devices, especially with the large war use of position indicators, but so far no one has proposed a practical method of eliminating the orifice in the pipe lines and of performing the flow measurement electronically and external to the pipe.

The position indicator or flow transmitter is a device well able to make maximum use of the advantages offered by electronics. Electronic devices require very small or zero input torque, they can operate at high speed, and the currents and voltages encountered are suitable for transmission over telephone wires as is frequently desirable. This is an excellent and almost always dependable application of electronics. It would seem that a thorough investigation of the possibilities of such devices should be made by the power industry, especially as to their advantages in transmitting readings to the boiler and turbine recorders and control panels, in contrast to running high-pressure piping and tubing into these panels. This will become increasingly important as operating pressures and temperatures rise.



Circuit diagram of an electronic voltage regulator.

What has been said of flow measurement applies almost equally well to pressure measurement. While we have very satisfactory recorders of dynamic pressures, as encountered in reciprocating engines, we do not as yet have a truly electronic method of measuring static pressures as encountered in steam-generating stations. There are several possible paths of approach to the problem, and it seems reasonable to expect ultimate success, with the line of development taking advantage of electronic means.

The field of automatic control offers possibly the largest opening for electronic equipment in power generation. The advantages of zero input torque, high speed, limitless output torque, and almost unbelievable precision should give electronics a great opportunity. It is here, however, that the greatest engineering skill in application will be required, if electronics is not to receive an irreparable setback at the very beginning.

The war is giving us electronic control devices in considerable variety, but their application to industrial control will not be as easy as the press agents would have us believe. The requirements of performance, safety, and dependability are very high and it will be in the application, not in the electronic circuits themselves, that the difficulties will be encountered. Watch for them there and allow the electronic engineer to worry about the tubes.

The first applications will probably be made on control problems where speed is an essential. This is an advantage of the electronic system over competing systems which will be capitalized. Another advantage is simplicity of mechanical moving parts reducing maintenance. The use of electric wires instead of oil or air tubing for transmission will be cheaper and more advantageous in certain cases. But in every case the selection of electronic control will be based on the three fundamental reasons, and not because it is electronic.

At the present time several companies can offer partial systems of automatic control, from simple on-off systems to the more complicated modulating forms of control. As the war ends we will find an increasing variety of this apparatus available, possibly involving greater use of more complicated control systems such as second and third derivative control, functions which can be easily introduced into electronic control systems.

Is There a Place for Electronics?

To one familiar with the field, it seems obvious that power generation offers a very large number of potential applications for electronics, because electronics has very definite advantages to offer over other types of equipment. The advances it has forced in the field of temperature measurement are an indication of the possible advantages to be gained by the adoption of electronic methods.

Acknowledgment

The author wishes to thank Professor J. D. Ryder for much of technical research work contained in this article. -30-

QTC

(*Continued from page* 56)

ating procedure manual which is a very neat arrangement on the basic operating procedure for police radio systems. Any of you men in police work interested in this organization, which is officially recognized by the Intl. Assn. of Chiefs of Police, write to Ero Erickson, 7135 Irving Park Road, Chicago, Illinois.

D. EGEBERG has taken out a tanker from the East Coast. L. Hvidsten, who returned from the Army last November also is shipping out of the East Coast. A. E. Davis is now 2nd aboard a cargo vessel called in recently. E. Widding and H. Anderson have taken berths aboard freighters also. Carl Amato writes from somewhere in the Aleutians where he ran into P. B. Johanssen who is also with the Alaskan Communication System. Walter Glazer was in port recently from the war zones and shipped out again aboard a Liberty. W. Poppe and C. A. Thomas are aboard tankers for a change. H. Harris is in again after a stormy voyage across the pond.

THE U. S. Coast Guard recently issued an appeal for part-time reservists in the New York area, the men are needed for general duty and are asked to serve 24 hours per week without pay.

A. C. Omberg has been appointed as chief research engineer at Bendix Radio division of Bendix Aviation Corp. Mr. Omberg was former asst. chief of the operational research branch of the U. S. Army Signal Corps.

THE Merchant Marine Council recently gave careful study to a recommendation of Capt. E. M. Webster, USCG, Chief, Communications Div., on the developments in fixed and portable lifeboat radios. Specialists of the FCC provided for the operation of these radios on both 500 and 8280 kc., thus giving both short- and long-range transmission. The present regulations require either one portable unit which can be placed in a boat or a fixed installation in a boat on each side of the ship.

Captain Webster recommended that dry cargo ships should carry a fixed installation in a boat on each side and in addition a portable outfit, making a total of three units. In the case of tank ships where the main deck is both forward and aft of a deck house, it was recommended that there be two fixed units installed on each side of the vessel and in addition that the ship carry one portable unit, making a total of five.

It was pointed out that the developments on direction finders point toward longer range equipment for postwar use which tend more and more to remove from the lifeboat the need of proceeding under its own power to a point of rescue, but instead makes it possible to locate the lifeboat and send rescue craft to its position. Such a policy would require that each boat be equipped with an efficient transmitting apparatus which could be operated by anyone without special radio knowledge..........73

"This section is designed to help the radio industry obtain trained, experienced, technical men to facilitate vital war production. Before applying for any of these positions consult your local United States Employment Service office to determine War Manpower Commission regulations concerning the changing of jobs. If you are already employed in war work at your highest skill, stick to your present job."

Spot News

(*Continued from page* 137)

address systems on submarines and hospital ships. Thus far, a half-million hours of entertainment and information have been provided by these records. The recording work is under the supervision of the Armed Forces Radio Service, directed by Colonel Thomas H. A. Lewis, AFRS Commandant.

POSTWAR RADIO PARTS were recently displayed in London under the supervision of the Radio Component Manufacturers' Association. Exhibited were miniature tubular paper condensers, sealed in molded polystyrene cases, in ranges from .001 to .1 μfd., 500 volts d.c. working for the smaller sizes, and 200 volts d.c. for the larger. Capacity tolerances were plus or minus 25%. A molded resistor, only ⅜ inch long and ⅛ inch in diameter with 1/10-watt capacity and produced in 10-ohm to 10-megohm ranges was also shown. Ceramic capacitors that were extremely small were on display too. One type used metal cylinders and external silver coatings. The smallest size shown was but ¾ inch long and 3/16 inch diameter. Capacities ranged from 10 to 100 μμfd.

Midget potentiometers were also on view. One type displayed was only 23/32 inch in diameter and ⅝" deep. Resistance ranges varied from 1,000 ohms to 3.3 megohms. They were of watertight design and capable of operating at temperatures ranging from −40° C. to 70° C. Small coupling transformers with 100 to 7,000 cycles-per-second range were also exhibited. Double wound and auto model types with bakelite and skeleton forms were on view. Unique speakers weighing but 3½ ounces were also shown.

Television

WASHINGTON IS DESTINED TO BECOME QUITE A TELEVISION CENTER. At the present writing seven stations are scheduled for operation, with at least three more to be announced soon. Among those who will have television units in the nation's capital are Allen B. DuMont, W3XWT; NBC, WNBW; Philco; Bamberger Broadcasting Service; Capitol Broadcasting Service; and the Times Herald.

A BRIGHT PICTURE OF THE FUTURE of television was forecast by Captain Jennings B. Down, USN, director of electronics for the Bureau of Ships, recently. He said:

"At the end of the war, television, long the dream of scientists and earnest experimenters, will emerge finally as a reality for the use and entertainment of our people. Television, however thrilling and satisfactory as a medium of entertainment, will spread into many fields of usefulness. . . . The developments and uses of television in the future, which will be seen now only dimly, will certainly exercise a profound influence over the life of the nation in peace, and if necessary in war. . . . It is conceivable from our present knowledge of the possibilities of television, that equipment will be developed which will alter the strategy and tactics of land, sea and air battles of the future; equipment of such significant potentialities that no military or naval command can fail to carefully weigh its offensive and defensive value."

TELEVISION INTEREST IN ENGLAND is growing daily. At a recent dinner in London, Sir Allan Powell said that the BBC is most enthusiastic about television, a contribution which will unite the nation closer than ever before. He predicted that the British Empire would be linked by coaxial cable, of simple design and construction, affording transmissions from

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Australia, India, or the British Isles. Industry was all set to provide the necessary cooperation, he said, as soon as the Government initiates the program.

THERE ARE STILL NO TELEVISION STATION ENTRIES FROM 20 states, which include: Alabama, Nevada, New Hampshire, Oregon, Rhode Island, South Carolina, South Arizona, Arkansas, Florida, Georgia, Idaho, Kansas, Kentucky, Maine, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, and Texas.

It is expected that 50% of these states will have television applicants before the year is out.

Personals . . .

Sir Ambrose Fleming, inventor of the Fleming diode, died in Simouth, England on April 19. He was 95 years old. The Franklin Institute and the IRE had honored him several years for his historic contributions . . . **Dr. Harold Goldberg,** former senior engineer of Stromberg Carlson, has joined Bendix as a research engineer . . . **N. F. Shofstall** has been appointed engineer of the GE receiver division . . . **Dr. Leroy D. Weld,** former professor of physics at Coe College has become director of research at Turner Company, Cedar Rapids, Iowa . . . **Walter A. Onorato** has been elected president of General Dry Batteries, Inc., Cleveland, succeeding the late **C. P. Diebel,** founder of the company, who died last January . . . **Rear Admiral S. C. Hooper** (U.S.N. Ret.) has received the Elliott Cresson Medal for 1945 from the Franklin Institute for his pioneering leadership in radio . . . **Don Mitchell** has been elected to the board of trustees of Sylvania Electric recently. Mr. Mitchell is vice president in charge of sales . . . **Dr. Norman A. Skow,** formerly with Bakelite Corporation, is now director of research of the Synthane Corporation . . . **Dr. Lloyd Preston Smith,** professor of physics at Cornell is now an associate research director of RCA Laboratories. He succeeds the late **B. J. Thompson** who was killed in an airplane accident during a War Department mission in the Mediterranean area . . . **E. M. Deloraine** has been elected president of the newly formed International Telecommunication Laboratories, an I. T. & T. affiliate . . . **Harold H. Buttner** and **Douglas B. Baker** are vice presidents in the new unit . . . **Gerald C. Gross,** former assistant chief engineer of the FCC has been named vice director of the International Communications Union of Berne, Switzerland. He is the first American to win this appointment, succeeding Franz Schwill, German vice director of the radio section. At present, he is on temporary duty with the Navy as a Lt. Commander.

—30—

INDEX OF Advertisers

June 1945

TYPE	A	B	C	D	E	F
1950	3¼"	3 13/16"	17/64"	2 13/16"	¼"	2½"
1960	4¼"	5"	.272"	3½"	¼"	3"
1970	5¾"	6½"	.377"	5"	⅜"	4"
1980	5¾"	6½"	.377"	5"	⅜"	5¾"

Check list . . .

✔ Low-loss glazed ceramic case for long creepage path between terminals.

✔ Corona losses eliminated on inside and outside alike.

✔ Cast-aluminum terminal ends for low contact resistance between stacked units.

✔ Close-tolerance mica units equalize loading of series-connected sections

✔ Mica sections rigidly clamped in low-loss non-magnetic clamps and heat-treated for maximum capacitance-temperature stability.

✔ Mechanical design permits units to be stacked and thereby connected in series, parallel and series-parallel. Dummy units are available to support and insulate active units.

✔ Units may be bolted together through holes in aluminum caps.

✔ Standard listings; normally available without delay; at the right prices.

● Aerovox popularized this type. Originally a *special* item made only to order and at custom-built prices, it was Aerovox that selected and standardized the sizes, voltages and capacitances so that standard Aerovox stack-mounting units could be regularly produced, listed and properly priced. The rest is history.

Especially intended for various transmitting and electronic applications, these heavy-duty micas have found wide usage in military and peaceful applications alike. Such units are especially popular in heavy-duty transmitting applications such as grid, plate blocking, coupling, tank and by-pass functions. Also in carrier-current applications.

Special yesterday, *standard* today, Aerovox stack-mounting mica capacitors have contributed greatly to available quality equipment and outstanding performance.

● **Literature on request . . .**

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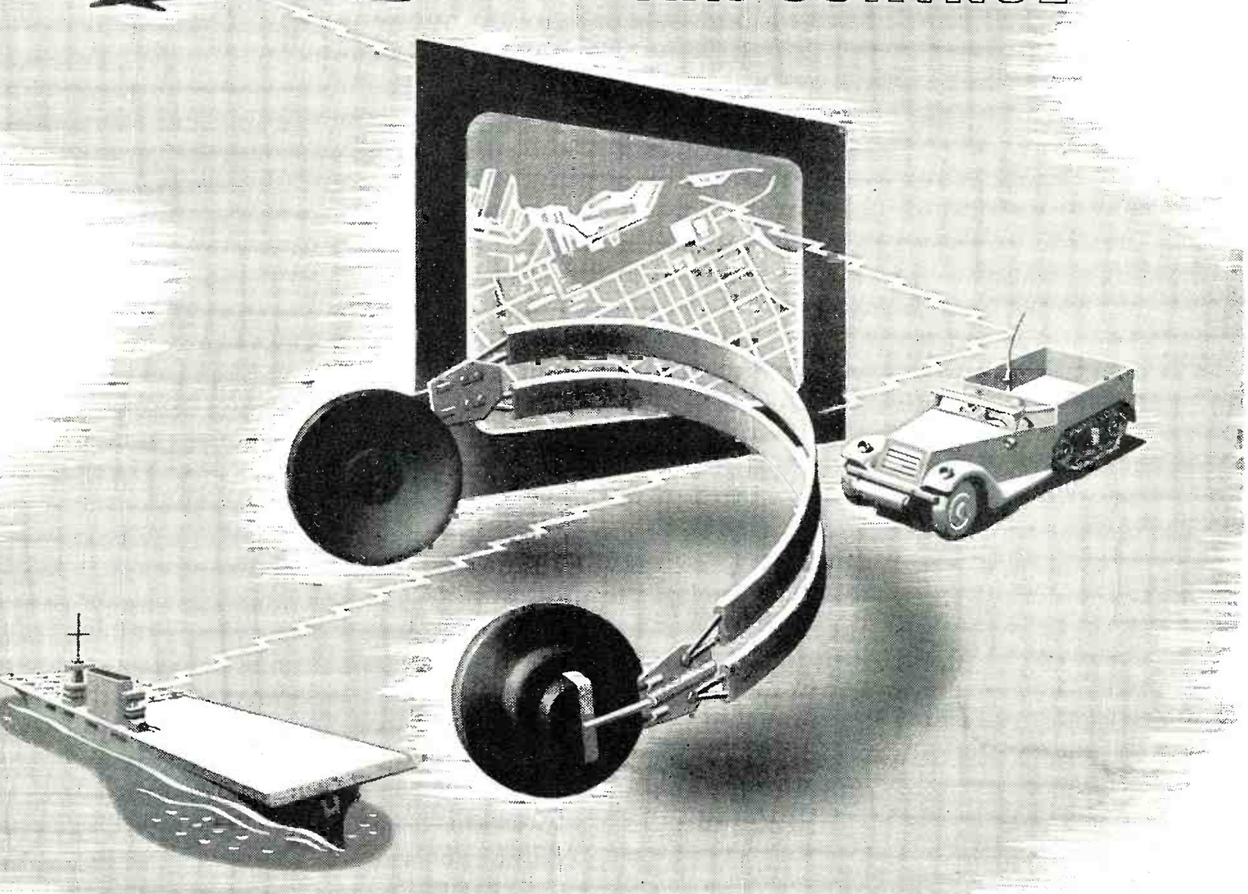
It takes more than planes to establish AIR CONTROL



Allied fighters and bombers have established one type of air control. Another type, almost equally important, has been established by Allied radio equipment and electronic devices. For, through the effective application of high-frequency impulses, skilled technicians of the Army and Navy control communication channels—detect and locate enemy planes, ships and submarines—coordinate the movements of aircraft, ships and combat vehicles—direct artillery fire. Delco Radio Division has contributed materially to this air supremacy through the development and production of varied Delco Radio products, ranging from compact mobile radio sets to highly specialized radar equipment still masked in secrecy. Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

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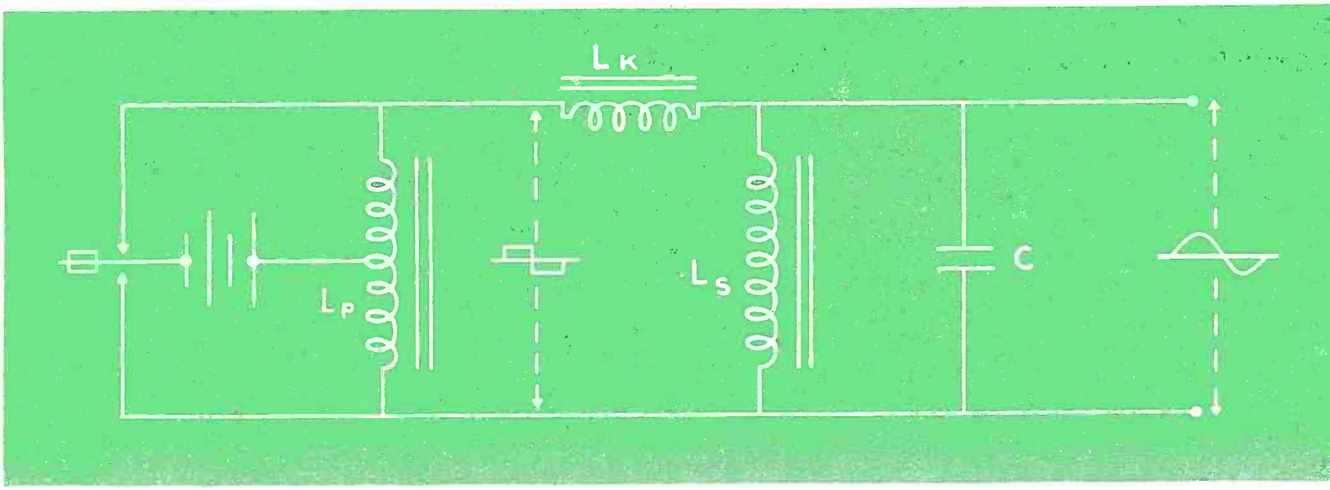

NOW, A VIBRATOR POWER SUPPLY WITH A SINE WAVE OUTPUT

● For years, it has been taken for granted that the output wave form of a Vibrator Power Supply necessarily must be a rectangular wave with its characteristic "swingback" or commutation lines. With the development of very sensitive radio equipment this, of course, caused shock excitation of the audio and RF tuned circuits. In equipment designed for sine wave, operation on square wave resulted in the wrong ratio of A and B voltages applied to the tubes.

Realizing the need for eliminating the difficulties arising from square wave operation, Electronic Laboratories research department has perfected a Vibrator Power Supply which can supply a sine wave at powers up to several hundred watts from any DC source. In addition, this output is stable and has excellent regulation characteristics with load and input voltage.

Referring to the diagram at the top of this page, L_k (leakage reactance) and the condenser, "C", form a series resonant circuit. This circuit establishes a voltage across the secondary inductance, L_s. This voltage rises as L_k is varied until it is established by the saturation of the secondary inductance, L_s. The saturation characteristic of the inductance, L_s, is such as to sustain sinousoidal voltage across the condenser, "C". This results in a smooth sine wave output voltage, substantially independent of the input voltage. An elementary form of this system is shown in figure 1. The power transformer consists of a primary winding, "P", energized from the battery through the vibrator. The secondary winding, "S", is separated from the primary by magnetic shunts, and the tank condenser, "C", is across the secondary winding.

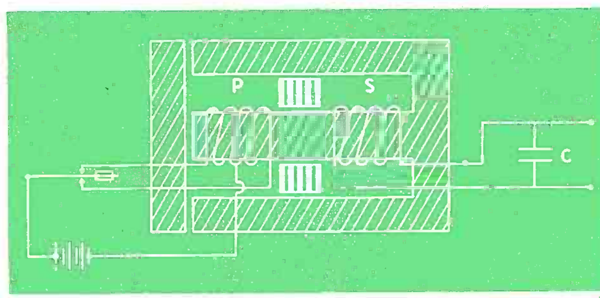

Figure 1

Since the reactive energy stored in the system is large, compared to the actual energy dissipated by the load, this system is also independent of load changes. Careful design of the primary circuit insures proper commutation for long life and reliability. Any number of voltages can be had from the system by properly tapping the tank circuit.

* * * * * *

E·L Vibrator Power Supplies have wide application in many fields: radio, electrical, electronic, marine, aviation and railroad. Their high efficiency and versatility with multiple inputs and outputs, enable them to meet many power supply needs. They may be designed to provide any wave form required for specific equipment. . . . Economy is assured because of long, efficient service with minimum maintenance. E·L Engineering Service is available to discuss your power supply problem and to design a vibrator power supply to meet specific voltage, power, size and weight requirements. *Model illustrated is a typical E·L Vibrator Power Supply with sine wave output and voltage regulation.*

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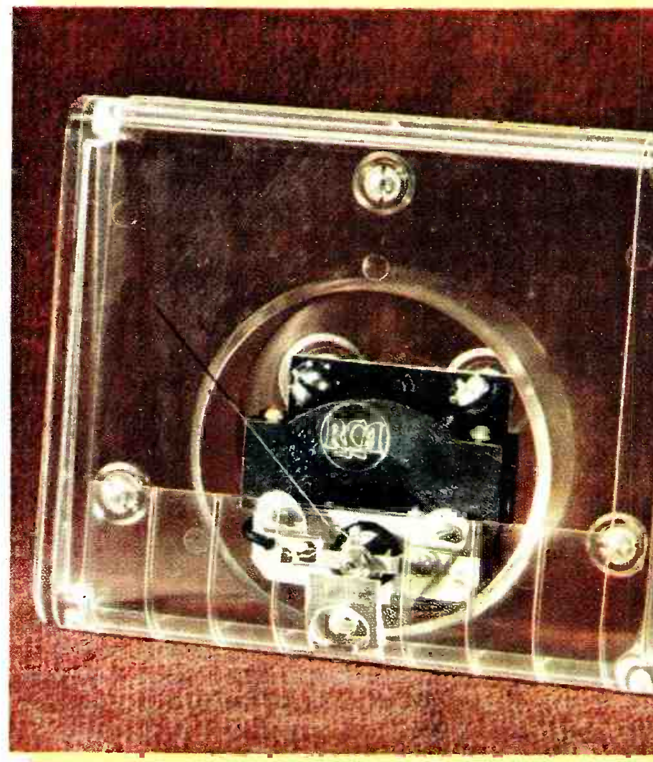

The entire meter case is molded of a clear plastic. There is no glass to loosen or break.

The New #195 VoltOhmyst

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2. Provision for alignment of f-m discriminators.

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