RADIO CRAFT

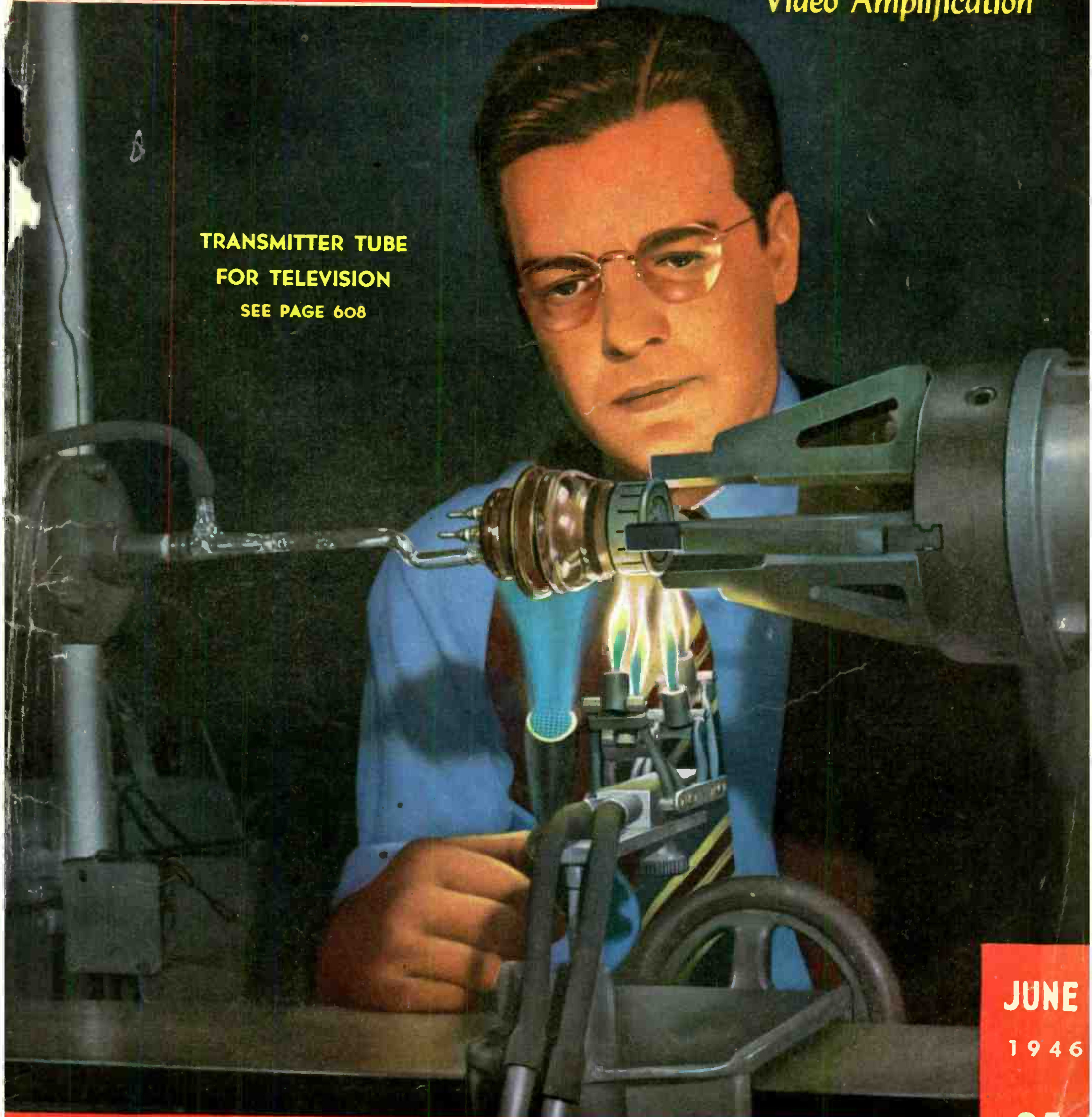
HUGO GERNSBACK, Editor

In this issue—

Television for Today

Nomograph Construction

Video Amplification



TRANSMITTER TUBE FOR TELEVISION

SEE PAGE 608

JUNE 1946

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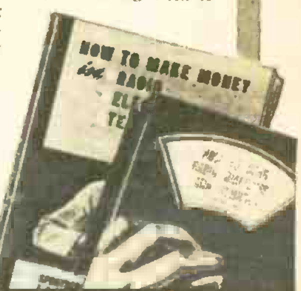

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IN THE NEXT ISSUE

The Transigenerator
Cathode Followers
Instability in Apparatus
5-Tube Superheterodyne

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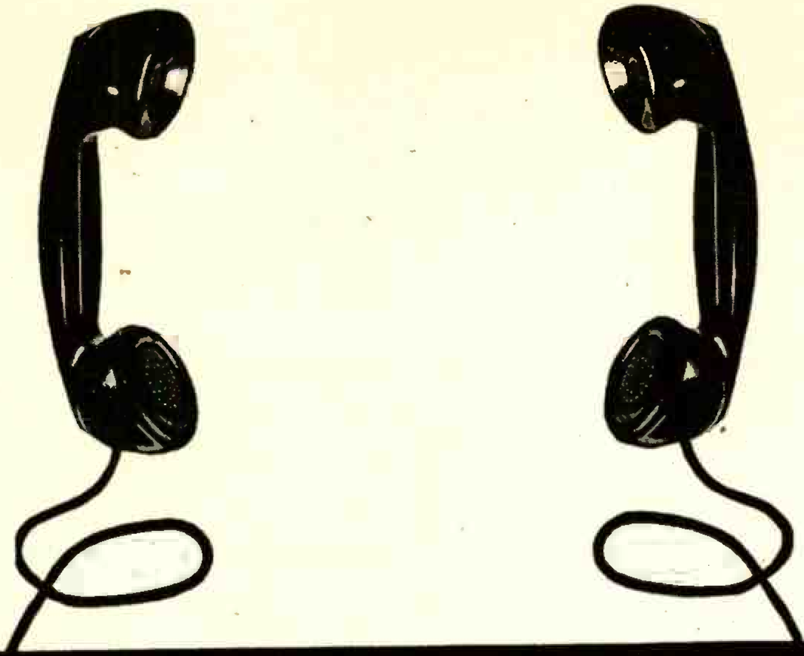
Contents June, 1946 Volume XVIII No. 9

Biographical Portrait Drawings by Constance Joan Naar

ON THE COVER

A new ultra-high-frequency triode transmitting tube is being sealed off on our cover this month. The two halves of the tube are brought together and heated gradually by rotation over the flames below. The operator aids the job of sealing off with super-hot flame from the torch in his hand.

Chromatone by Alex Schomburg from Federal Radio & Tel. photo.



ALIKE AS TWO PINS?

Yes, or alike as two telephone handsets made by the same process. Yet, pins or handsets — no two could ever be made exactly alike. Dimensions, weight, performance — all vary every time due to variables in manufacture. How can these variables be *controlled?*

Back in 1924, Bell Laboratories' mathematicians and engineers teamed up to find out, forming the first group of quality-control specialists in history. They invented the now familiar Quality Control Chart, designed inspection tables for scientific sampling. They discovered that test data mathematically charted in the light of probability theory were talking a language that could be read for the benefit of all industry.

Western Electric, manufacturing branch of the Bell System, applied the new science to its large-scale production. In war, it was used by industrial and government agencies of the United Nations in establishing and maintaining standards for military matériel. A Quality Assurance Department, a novelty back in the nineteen-twenties, has come to be indispensable to almost every important manufacturer.

Scientific quality control is one of many Bell Laboratories' ideas that have born fruit in the Bell System. The application of mathematics to production helps good management all over the industrial world — and furthers the cause of good telephone service.

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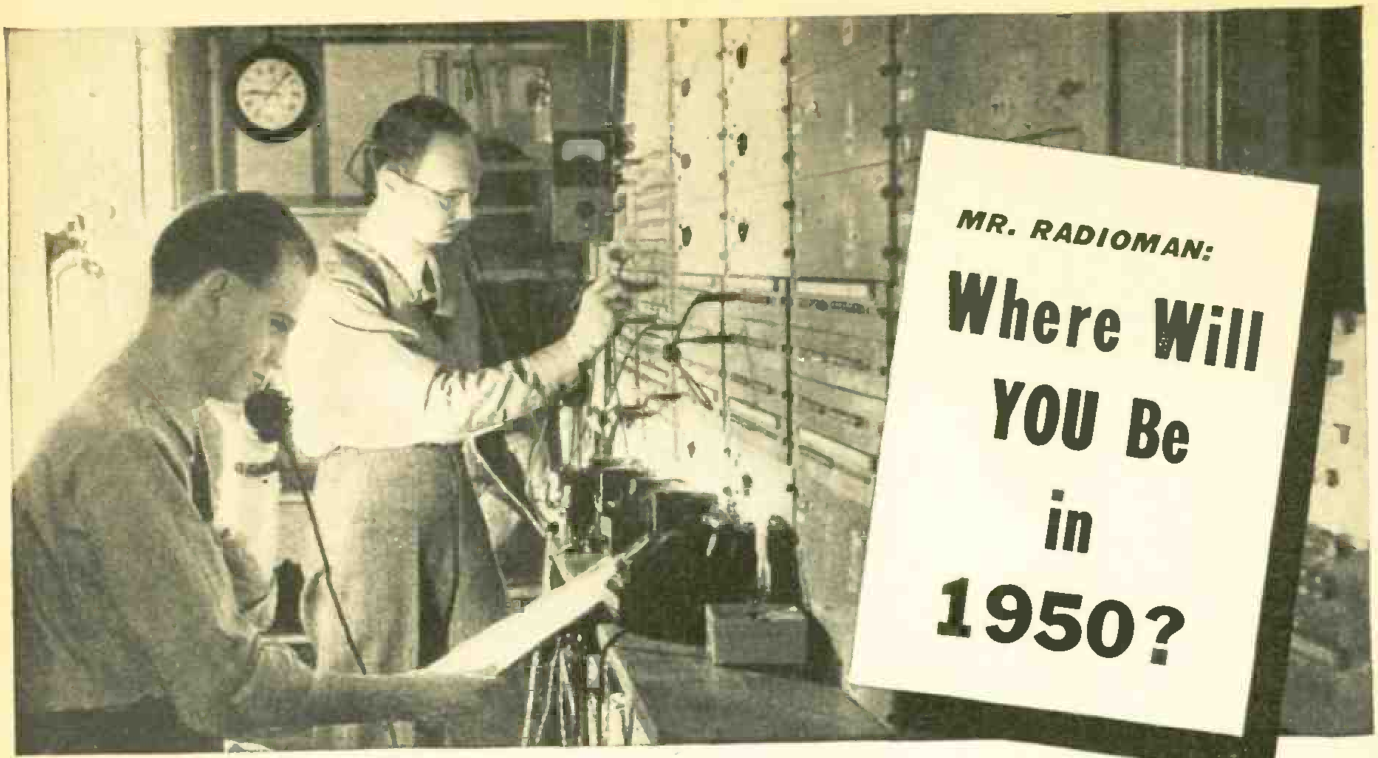

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CREI home study training in Practical Radio-Electronics Engineering can equip you to meet the requirements to *hold* your job—or advance to a *better* one. No matter what your past radio-electronics experience has been—no matter what your training—you must actually start anew to gain the confidence born of knowledge. By adding CREI training to your present radio experience you can safeguard your future and keep pace with such new developments as U.H.F. Circuits, Cavity Resonators, Pulse Generators, Wave Guides, Klystrons, Magnetrons and other tubes. Are you equipped to handle them? CREI is equipped to *help you*, by providing the know-how and ability that is required.

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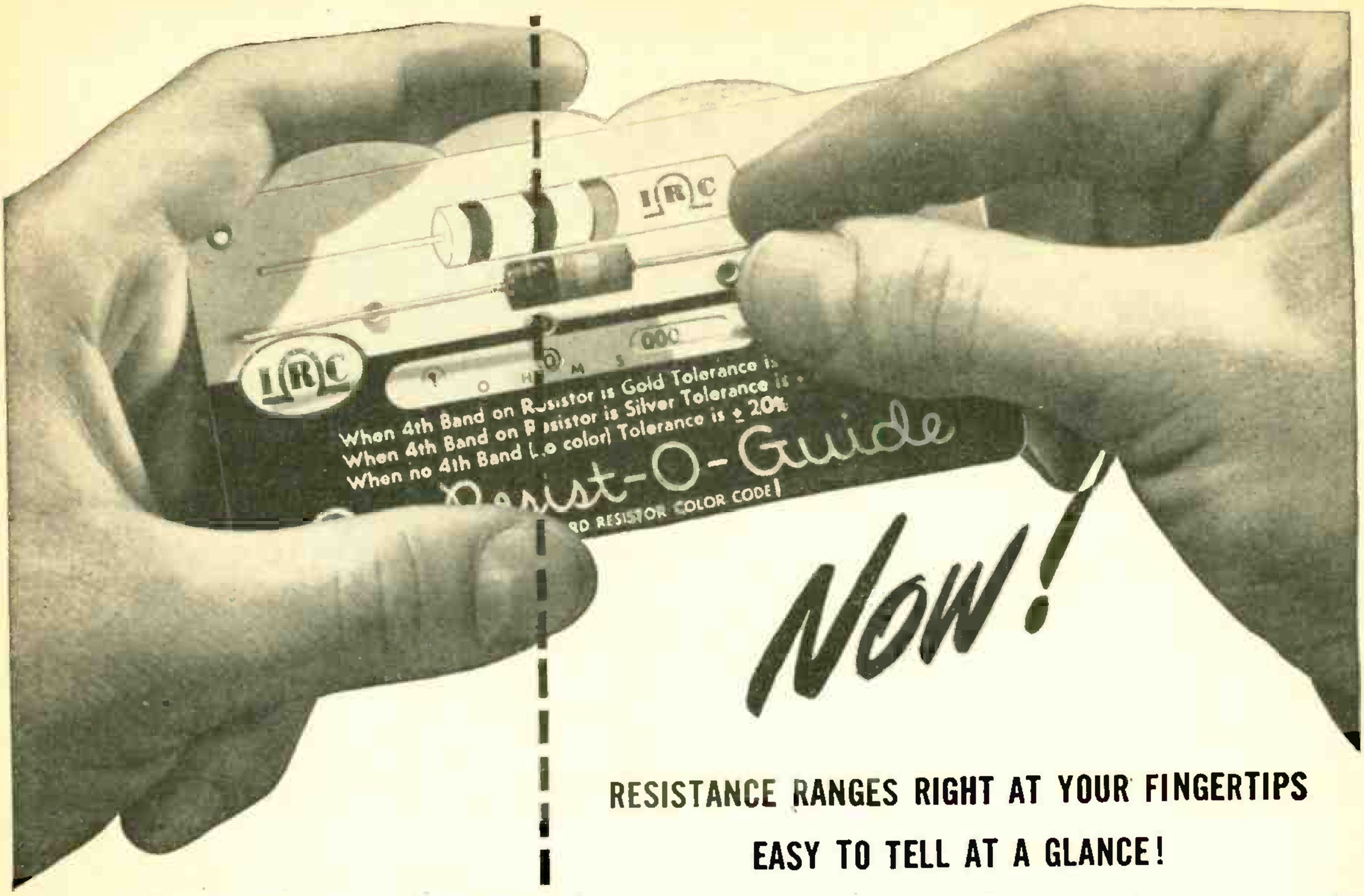

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By HUGO GERNSBACK

WHY THE TUBE SHORTAGE?

The present tube situation is one of great complexity

DURING the past few months we have received a number of communications from radio dealers and service people. The following is a good example:

Editor, RADIO-CRAFT:

"If I were running a radio magazine serving the Serviceman, I would try to find out WHY the tube situation today is worse than it was during the war and inform the serviceman and the public just what IS the truth.

"It would seem to me the customer, who supports the radio industry, should have first call on tubes, not the factory, who would only sell them more radios when they have enough and all they need is tubes to make them work.

"When so-called radio tube companies advertise batteries, pilot lamps, etc., and avoid mentioning RADIO TUBES which is their main article, I KNOW something is rotten. We don't WANT pilot lamps, batteries, what we NEED IS TUBES! TUBES!! TUBES!!!

"They were d—n glad to sell us tubes in prewar years when the factories gave them next to nothing for them, but now, there must be a black market, with greasing, etc., to get the tubes that the public needs.

"They promised great things when the war was over, or is it?? Is the army still taking most of the tubes? Is that what they feed the men? Every ad you see has something else, but no TUBES."

CHAMBERS & SON,
RADIO REPAIRS,
Upper Darby, Pa.

RADIO-CRAFT contacted a number of radio tube manufacturers, among them the largest in this country, and has gathered some information on the subject. This may serve to explain the present acute shortage and give an indication when it may be relieved.

To begin with, *officially* the war is by no means over. Very large numbers of troops are still gathered in many former war theatres from Europe to the Pacific. The Army, Navy, and auxiliary forces still maintain in use for communication purposes a great deal of radio equipment. They still consume large quantities of radio tubes, be it for new and more modern equipment or for replacement purposes.

Then, too, new trainees are still being inducted into the various services. Routinely they require large amounts of radio equipment. The Navy also still has a sizable portion of equipment afloat making it necessary to use practically all its shore radio installations. Naturally the military not only uses up millions of radio tubes, but also has priority on such matériel.

Strikes in many industries have slowed up many manufacturers — among them radio tube manufacturers. They have not as yet recovered from this slow-up, though the condition is being relieved slowly as this is written.

The complexities of modern radio tube manufacture is another reason given for the slow-down in tube production. Manufacturers have many divisions, or "units," which process different stages of production. Thus we have glass-blowing units, exhaust units, assembly units, etc. According to tube manufacturers contacted, present-day inefficiencies or shortage of certain supplies may cut output of a single unit as much as 20 percent, thus creating a bottleneck which may hold up other units which are not in themselves suffering from inefficiencies or scarcity of materials.

A rather large percentage of all labor employed in the production of radio tubes goes into the "mount." This term describes the already assembled part of the tube, comprising cathode, plate grid, etc., which is put together before the envelope is put on and the tube is ready for exhausting and sealing.

To obtain sufficient labor, during the war, it was necessary for tube manufacturers to establish so-called "feeder plants" in localities where quantities of skilled labor was available. These plants in many cases were relatively distant from the main factories, and their establishment and operation increased costs to a point that — now the war is at least unofficially over and the manufacturer has to face O.P.A. price regulations and a competitive market — consideration had to be given to closing them.

Let us now turn to the present receiving tube market, as compared to the prewar market. Prior to the shut-down of radio receiver production in 1941, the radio industry used approximately 100 million tubes for equipping their new radio receivers.

At that time the average requirement per set was 5½ tubes. The replacement market in prewar years averaged one out *(Continued on page 652)*

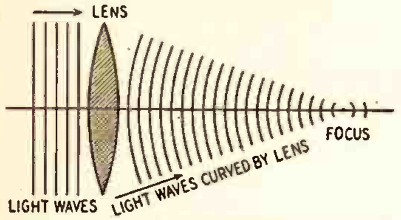
RADIO-ELECTRONICS

Items Interesting

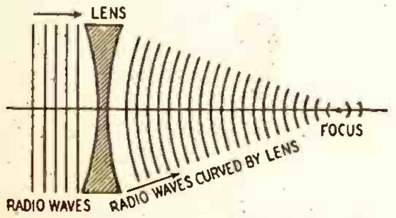
A METAL LENS which focusses radio waves as a glass lens focusses light is expected to fill an important role in microwave relay systems. Similar units, developed secretly for military use, distinguished themselves in comparison with older types of radio wave directors.

The new lens was designed and developed by Dr. Winston E. Kock and his associates of Bell Telephone Laboratories' technical staff.

It operates on a principle roughly akin to that of a simple convex magnifying glass. The action of the glass is to delay the advancing wavefront by an



Light waves slowed down by the convex glass lens and radio waves speeded up in the concave metal lens are bent in the same manner.



amount that is greatest at the center of the lens, where the glass is thickest, and least at the tapered periphery. As a result, the wavefront is reformed and headed so as to converge toward a point. This change in the velocity of a wavefront is a fundamental principle of all lenses.

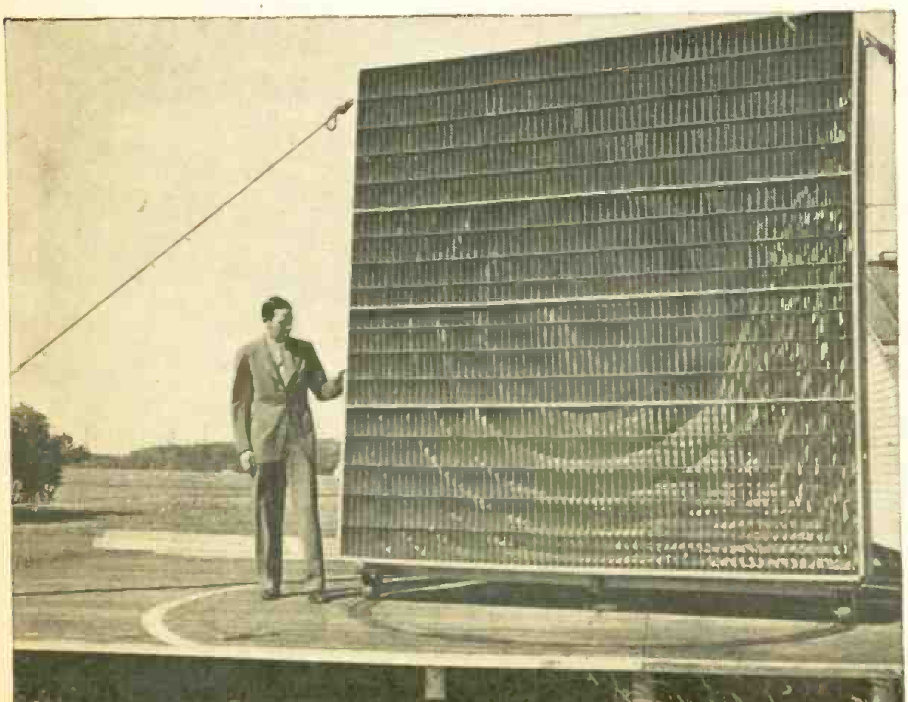
Since radio waves are of the same electromagnetic nature as light waves, it has been known theoretically for some time that radio lenses on this principle might be built. Previous to the advent of microwaves, there was an insuperable obstacle in the very much greater length of radio waves, which in the commercial broadcasting band range from an eighth to a third of a mile. For a lens to be effective, it should have a diameter of at least several times the wavelength. This would have meant a lens almost a mile wide.

It was in pondering this problem that Dr. Kock thought back to waveguides, those hollow tubes which one of his colleagues had devised some years earlier to conduct microwaves and which, in war, were to play so vital a role in supplying a physical channel for radar signals.

It was known that radio waves undergo a speeding up, or increase in wavefront velocity, when they pass along such a tube or between metal plates and that the total advance of the wavefront could be fixed by controlling the length and contour of the plates and the distance between them.

It occurred to Dr. Kock that an array of metal plates could be designed to focus radio waves just as effectively as a solid lens might focus them if due regard were given to the fact that the edges of the wavefront would be advanced rather than retarded in transit. Such a structure would also be easier to build, move and maintain than an equivalent solid lens type.

(Continued on page 651)



This large metal lens concentrates radio waves more sharply than can any other director.

CAPACITOR manufacturing methods may be revolutionized by a machine discovered in Germany and now brought to the United States for study, it was announced by the Department of Commerce last month.

This new machine, a development of the Robert Bosch concern, of Stuttgart, Germany, produces paper condensers without the conventional metal foil. The plates of the condenser are formed by coating the sides of the paper with a very thin layer of vaporized zinc. This machine may be expected to reduce the production costs of paper condensers by twenty percent.

V-2 ROCKETS, equipped with radio apparatus, will give scientists new information on our atmosphere up to a height of 100 miles, according to information released last month by the Army Ordnance Department. The rockets, taken from a captured German factory, will be equipped with apparatus to register and transmit information concerning temperature, pressure and other meteorological information, as well as reports (velocity, acceleration, altitude) on the progress of the rocket itself.

The V-2 is expected to reach a speed of 3500 miles per hour, and will land eighty-seven miles from the starting point. The flight will take seven minutes, and is expected to collect enough data in that time to keep a group of scientists busy for several weeks. The Army Ordnance Department expects to gain from it information on rocket flight which may be of great value in designing future aerial projectiles.

RADIO-CONTROLLED crewless airplanes will "watch" the atomic bomb tests over Bikini, the Navy Department stated last month. The planes, four in number, will fly at different levels into the turbulent air storms created by the blast.

They will carry devices to capture samples of the gases created by the blast and to record radio activity and other characteristics of the churning air mass.

Guide planes, bearing live crews, will fly 12 to 30 miles from the atom blast, thus being outside the danger area, the Navy Department reported.

BRITISH TELEVISION will resume war-caused interruption of almost seven years on the seventh of June at 3:00 pm, a British Broadcasting Co. notice announced last month.

Pre-war practices, including the 405-line standard will be used. Thus pre-war receivers can be put into action with no modification, the report stated.

MONTHLY REVIEW

to the Technician

MORE FM receivers were urged by the FCC, after a survey of manufacturers made last month. The eighty-four companies covered in the survey reported an expected output of 1,800,000 FM receivers for 1946. In addition, they expected to make converters and adapters numbering something less than 100,000, as well as 50,000 combination FM, television and broadcast sets.

Pointing out that applications were on hand for 834 FM stations, the FCC urged that manufacturers revise their production schedules to increase the number of FM sets.

RADIO SET PRODUCTION for 1946 will fall "far below" the FCC prediction of twenty million receivers, stated J. D. Secrest of the RMA publications bureau last month.

Calling the FCC report "a lot of wishful thinking," Secrest said the estimated volume for the first quarter of this year is only two and one-quarter million. While it is possible that production might hit two million sets a month by mid-summer, he added, the FCC figure definitely will not be reached, due largely to component shortages and an OPA bottleneck.

The Commission's estimate was nearly 50 percent higher than the peak pre-war year, 1941, when receiver output was 14 million.

"SPY RADIOS" picked up at various points in occupied Italy, were revealed last month to be ordinary radiosondes, released by American meteorological services and plainly marked as U. S. Government property.

A pint-size spy scare had been aroused before the true nature of the mysterious instruments was revealed, and at least two European powers were accused by opposing factions of undercover intervention in Italian politics.

The scare reached even to the United States, and reputable American papers pointed out solemnly that the transmitters were of the "tiny type suitable for agents inside enemy lines." The label "Notice to finder; this instrument belongs to the United States Government," according to the same source, "signified only that it is pretty certainly not Americans who are dropping the radios, as there could be no conceivable reason for the Americans or British to use that method to distribute any radio apparatus they wished to distribute in Italy."

From the description, the radios were very standard radiosonde apparatus, and apparently could not have been turned over to technical personnel for inspection, as the barometer and hygrometer, contained in each, as well as the highly special switching system, would have identified them immediately.

COMMUNITY radio broadcast towers may become the rule in the future, according to engineers of the Federal Telephone and Radio Corporation, who started construction of such a unit at Nutley, New Jersey, last month.

The Nutley tower will be experimental. It will house as many as twelve FM sending units on different channels, six color and four black-and-white television transmitters, six police radio networks serving as many different communities with signals, as well as experimental pulse - time - modulation transmitters for beamed-radio links to other cities miles away.

The tower will, its builders hope, become a center of experimental work on microwaves from which much of the services of tomorrow will spring. The waves from the 300-foot structure will run the gamut of the high frequencies from the "medium hundreds to the many thousands of megacycles."

Two strong arguments favor the community arrangement. Joint financing would make better facilities more feasible, and the tower could be put at the location giving the most effective coverage of the area served (ideal spots are not too plentiful in most communities).

TELEVISION links between Moscow and Leningrad and separate studios in the cities of Kiev and Sverdlovsk are planned for the near future, a report from Moscow announced last month. Soviet radio experts expect that by 1950 thousands of Russian sets will be receiving television in full natural colors.

Television broadcasts now are made twice a week to an area within thirty-five miles of Moscow. Daily broadcasts are expected to start this year. Clarity and reception have improved and by next year should equal the quality in the United States, the Television Center said. Only one-color broadcasts now are attempted, but equipment is being developed for colored showings.

ELECTRONIC night sight reduced the infiltration menace in the Pacific war theatre, it was revealed last month by R. H. Frye of the Electronic Laboratories, Indianapolis.

The device (known as a "snooperscope") looks like an ordinary short telescope such as may be seen in various sighting devices, with an additional disc-shaped object mounted just below it. The disc is in reality a very powerful infra-red lamp and lens, projecting a beam of invisible "black light."

The infra-red rays, reflected from objects in their path like ordinary light, operate the receiving end of the instrument. Though this looks like an ordinary telescope, it is more like a television

The portable Snooperscope and power supply. A modified form of the instrument, called a Sniperscope, attaches directly to a carbine.

tube. Only the lens at the front of the tube is a real optical device. The reflected infra-red rays are picked up by this objective lens and focussed on the image tube, causing a photo-sensitive screen to emit electrons in direct proportion to the intensity of the invisible rays.

These electrons proceed down the tube, accelerated by high-voltage electrodes, and strike an ordinary fluorescent screen at the other end, causing it to glow and thereby producing a visible image which reproduces faithfully the details of the original scene. Thus the rays pass through three stages—beams first of infra-red "light," then of electrons, and finally of visible light—before reaching the eye of the beholder.

All power for the apparatus is sup-

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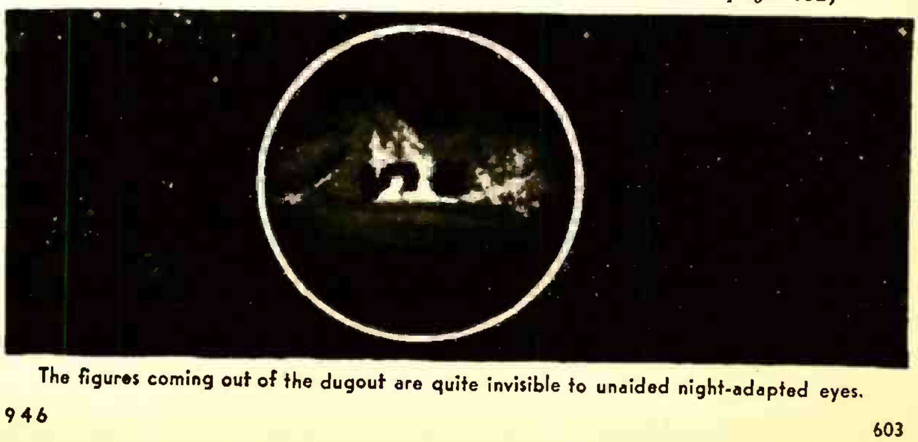


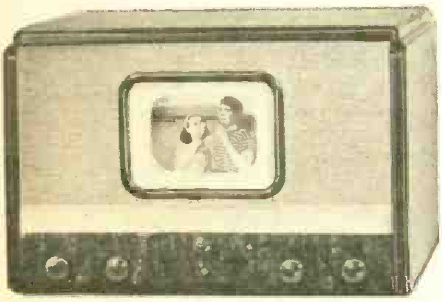
The figures coming out of the dugout are quite invisible to unaided night-adapted eyes.

By MILTON S. KIVER

TELEVISION FOR TODAY

Part I—Some Fundamental Principles

A KNOWLEDGE of fundamental radio principles is definitely essential to an understanding of television. The theory and operation of standard broadcast sound receivers is now well known. This does not imply that an automatic transition to modern television can be made, in spite of the number of similarities between the two systems. Many circuits are entirely new and different. It is the purpose of this series to help bridge the gap between the already well-known facts of radio as manifested in broadcast transmission and reception of today and the lesser-known features of tomorrow's television.



Courtesy Belmont Radio Corporation
Postwar television receiver with 7-inch tube.

Before we attempt any comparison of the two systems, let us determine briefly what components form a complete television system, from the transmitter at the broadcast station to the receiver in the home.

First, there is the scene to be televised. This scene must by some means be converted into an equivalent electrical pattern, thus rendering it suitable for transmission to our receiving antenna. In the sound transmitter, a microphone is the converter. In the television system we employ a *camera tube*. Within this tube the incident light rays from the scene are brought to focus upon a photosensitive plate. The resulting physical actions produce a charge distribution on the plate surface that is suitable for conversion into electrical currents, known as the *camera signals.*

Second, there is the problem of how these electrical currents are to be utilized. As every photographer knows, a negative is nothing more than a collection of tiny silver compounded grains which have been acted upon by light. In the television camera, much of the same situation exists. The focused light has produced a change in each of the photosensitive globules deposited on its plate. Now we must dissect the image in order to transmit it. We could, if we wished, connect a complete transmitting circuit to each element (globule) and send the entire picture at one time. This would prove far too difficult. Much simpler in practice is the method whereby an electron beam *scans* across the image in a series of 525 horizontal lines. These follow in a predesigned order and are reconstructed in identical manner at the receiver. Thus the image is broken down at the transmitter, sent in fragments and then reassembled at the receiver.

This method of transmission poses yet another problem, that of *synchronization.* As long as we are sending the image in a series of lines, some form of identification must be inserted, along with the signal, to indicate to the receiver just where one line ends and the next begins. Failure to keep both the transmitter and the receiver in step would render it impossible to reproduce an identical image at the receiver. Synchronization is accomplished by inserting a series of pulses into the television signal at the end of each horizontal line. We have one set of pulses for the end of each horizontal line and another set of pulses, known as the vertical synchronization pulses, to bring the electron scanning beam back to the top of the image after the bottom line has been traced out.

During the short intervals of time that the synchronization pulses are notifying the receiver circuits to move the beam into position for the following information, a *blanking pulse* is also active. Its purpose is to prevent the electron beam from reaching the viewing screen. Without this precaution, we would actually see a trace as the beam moved from the right-hand part of the image to the left-hand side for the start of the next line. Since no signal is being

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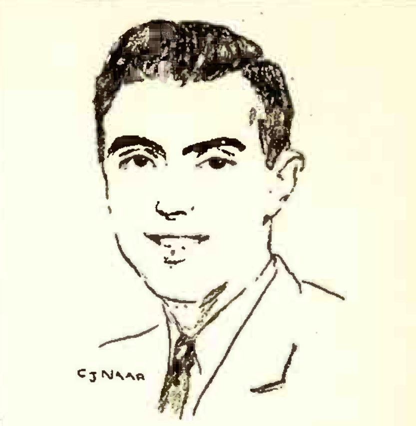


Milton S. Kiver was born in New York on November 5, 1918, just a trifle too late to make the first World War. Became interested in radio as a hobby and as a result majored in Physics and Mathematics in college. After graduation and several years of odd jobs in radio, became associate instructor in radio engineering for the Army Air Forces. From here to Illinois Institute of Technology and thence to the Navy for 27 months in the radar program. At present on the engineering staff of American Television Laboratories of Chicago.

Mr. Kiver is author of numerous articles in technical publications and of two books, "UHF Radio Simplified" and "Television Simplified."

Fig. 1—The complete video signal for one line. The high points are synchronizing pulses. All values are reversed at the grid of the cathode-ray viewing tube.

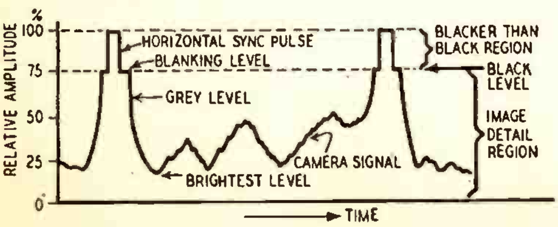
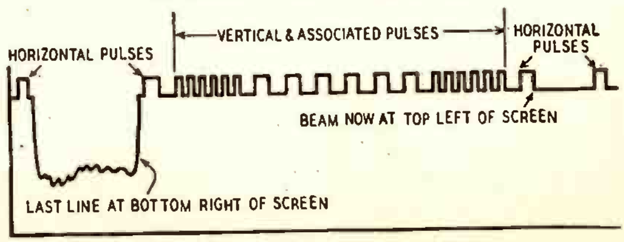


Fig. 2—The vertical pulse contains horizontal pulse components, as shown. The whole pulse is in the blacker-than-black region, and makes no trace on the screen.



By I. QUEEN

FM CARRIER STABILIZATION

Part II—Western Electric, Westinghouse, RCA Circuits

THE previous article described the need for control of the center frequency of an FM transmitter and showed that direct crystal control is not possible. Several commercial control systems were discussed. Others are described below.

A small but effective unit is responsible for carrier control in Western Electric FM transmitters. The heart of the system is a small induction motor which controls the tuning condenser in the plate circuit of the oscillator. The latter frequency is approximately 6 mc, which is multiplied by 16 (doubled four times) in succeeding stages to reach the new FM broadcast band of approximately 100 mc.

A portion of the 6 mc oscillator output is fed to frequency dividers which reduce the frequency by a factor of 1024 and therefore produce a frequency between 5377 and 6586 cycles, depending upon the assigned carrier. A crystal oscillator, operating on this same frequency, is also used.

These two frequencies are applied to the stator windings of an induction motor such that the beat frequency between them acts to turn the rotor. Thus, when the station is exactly on its correct frequency the motor is stationary, but if there is a drift in either direction, the rotor experiences a torque in the corresponding direction. The motor can take care of a change of about 50 cycles per second, equivalent to about 50 kc per second at the oscillator.

Because of its inertia, the rotor is not actuated by the relatively rapid modulation changes, but the more gradual oscillator drifts are promptly corrected.

WESTINGHOUSE CIRCUIT

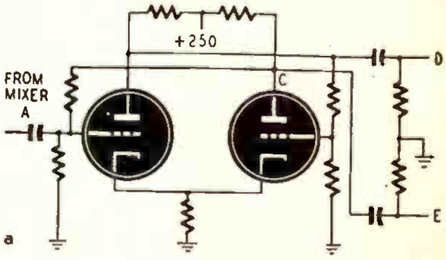
These circuits are based on methods of pulse generation and control which were developed during the war in connection with radar. As in other systems a crystal-controlled reference frequency is used as the standard with which the signal frequency is compared. The master oscillator frequency is 1/9 that of the assigned carrier. The reference crystal frequency, temperature controlled, is equal to one-half of the m.o. frequency and its second harmonic is therefore used for comparison.

The output of the reference frequency F_R is divided into two parts. One is advanced in phase by 45° and the other retarded by the same angle. Each is mixed with FM oscillator output (F_s) in a separate 6SA7 tube. (Fig. 1). As a result, the beat frequency output of each mixer tube is displaced by 90° from the other. When the signal frequency (F_s) is the greater the output at B leads A by 90° and it lags by 90° when the crystal frequency is greater. When the two are equal there is no beat frequency. (See Fig. 2.)

The output of A actuates a direct-coupled multivibrator (Fig. 3), which amplifies and flattens the peaks of the sine waves. Because the tubes are greatly overloaded, the flat portion of the square waves is reached at about the time the sine wave passes through zero. The square waves are transmitted through an integrating R-C circuit which limits the horizontal or constant portions but passes the sharp changes in voltage. As a result, voltage pulses appear across each resistance with points D and E out of phase. The pulses are drawn for two conditions: $F_s > F_R$ and for $F_s < F_R$.

A 6H6 pulse detector (Fig. 4-a), now receives the pulses and also the sine wave output of mixer B. The tube is biased just beyond the peak value of the wave. As shown in Fig. 4-b, the pulses add or subtract from the sine waves, depending upon whether the FM oscillator frequency drifts higher or lower and upon which diode plate the measurement is made. Because of the bias voltage there will be either no output at all or merely the pulse output, depending upon whether they oppose or aid. Note that the output of B appears in the same phase at F and G.

The next stage consists of four charging rectifiers designed to charge



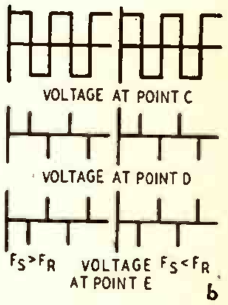


Fig. 3—The multivibrator produces pulses, to be combined with the output from Mixer B in the rectifier stage.

or discharge the condenser C according to polarity of the pulse input. These rectifiers are shown in Fig. 5-a and also at the lower right of Fig. 6, the complete schematic, including circuit parts as is shown in Figs. 1 to 5. Since current can pass through the input condensers

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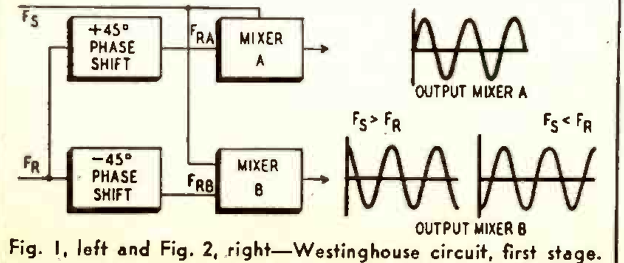
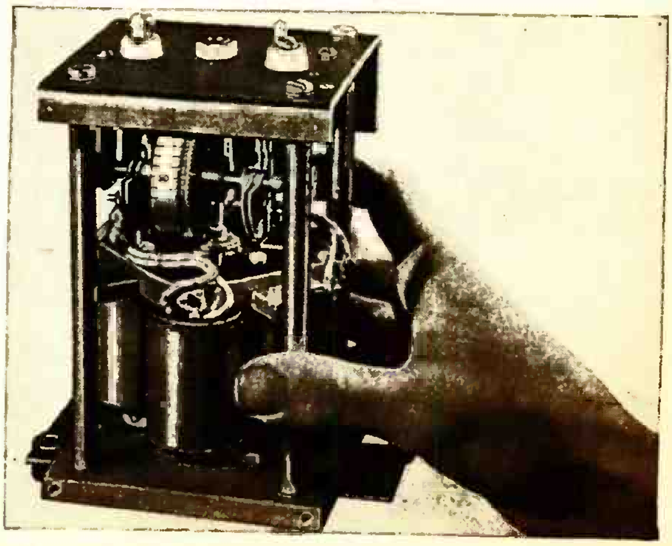


Fig. 1, left and Fig. 2, right—Westinghouse circuit, first stage.



This little motor is the heart of the Western Electric stabilizer.

in either direction because of the full-wave connection, the rise in the pulse will produce current in one direction, and the corresponding fall reverses the current. Results shown in Fig. 5-b are for a condition in which the FM oscillator is first lower than the crystal frequency and then drifts to a higher value.

Referring back to Fig. 4, it is seen that the voltage pulses at H are responsible for current at K, but that as the frequency drifts upwards this current disappears and instead current flows at L, due to voltage pulses at J (in Fig. 5).

Current through M and N can only flow in one direction, evidently upward in each. Therefore current at M must raise the potential across C. Likewise current at N lowers the condenser voltage. These are shown in Fig. 5. Since there is no bleeder resistance across C (Fig. 6) its voltage is governed only by the frequency difference between the two oscillators.

The voltage across C changes the grid voltage of a 6SL7 cathode follower in such a way that the bias voltage for the modulator control tube is varied. Changing the grid voltage (of the 6SL7) thus changes the current through the control tube (Fig. 7), and this affects the equivalent resistance of the two 6H6 modulator tubes. Each diode shown is really two sections of one tube connected in parallel. The resistance variation changes the frequency of the oscillator tubes in a direction to correct for their drift.

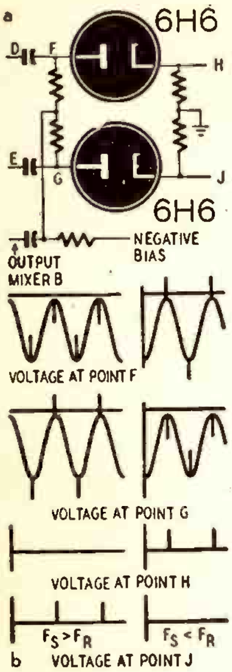
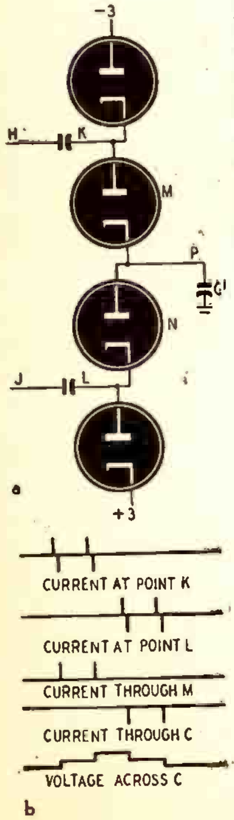


Fig. 4—The rectifier.



This system eliminates all moving or critical parts. Except for the oscillator tank it does not contain any tuned circuits. Even tube aging does not affect the operation, since they are used merely as electronic switches and do not operate on the critical portion of their characteristics. Carrier deviation is held to a maximum of ±1000 cycles, far below that permitted.

RCA "DIRECT" FM

Some of the principles previously described are used here, but under different conditions. For example, a two-phase motor controls the tuning and a reference crystal oscillator is also part of the circuit. A two-phase output is obtained from the latter by means of two balanced modulators.

The FM modulated oscillator tube is a 6V6 operating within the range 4.5-6.0 mc, which is divided by 240 in four stages. These stages use the so-called *lock-in* circuit developed by Beers, as shown in Fig. 8. A tuned circuit must be used but it results in a much better wave-form than that of a multivibrator and therefore does not require filtering. The lock-in range holds for frequencies within ±5 percent of the desired subharmonic. Tuning is accomplished by an iron slug within the coil.

The reference crystal oscillator operates within the convenient range 94-125 kc, and a divider (by 5) brings it down to the same frequency as obtained from the FM oscillator. The divided crystal frequency is now (Fig. 9), applied across two phasing circuits which causes the outputs to differ by 90°, and these together with the divided FM oscillator frequency are connected across two balanced modulators. As in the previously described system, the output will be two-phase current with a 90° difference. Whether one phase leads or lags the other is determined by whether the FM oscillator is less or greater than the correct frequency. Thus, the motor experiences a torque in the proper direction and its magnitude depends upon the correction to be made.

The induction motor can start with as high as 1000 cycles per second input. To eliminate friction and lost motion, the tuning condenser is mounted directly on the shaft. At no time is the rotor required to turn over more than ±45° to provide full frequency correction. The windings are of sufficiently high impedance to be operated directly in the plate circuits of the four 1614 type (equivalent to 6L6) motor (modulator) tubes. Therefore all frequencies down to d.c. may be transmitted.

Frequency modulation is accomplished by the *direct* system using a reactance tube. This method is simple and is well known and used by amateur FM stations. Its principle is as follows. The reactance tube is connected in parallel with the oscillator tank, with a 90° phase shift applied between its plate and grid. (Fig. 10.) As an example, a condenser may be used between plate and grid and a resistance between grid and cathode. If the magnitude of the latter may be neglected in comparison with

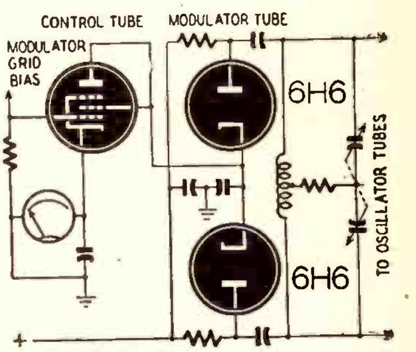


Fig. 7—Phased output to final control tube.

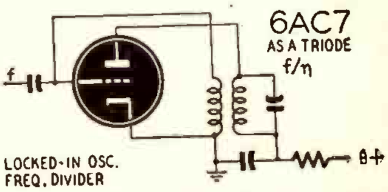


Fig. 8—Circuit of lock-in frequency divider.

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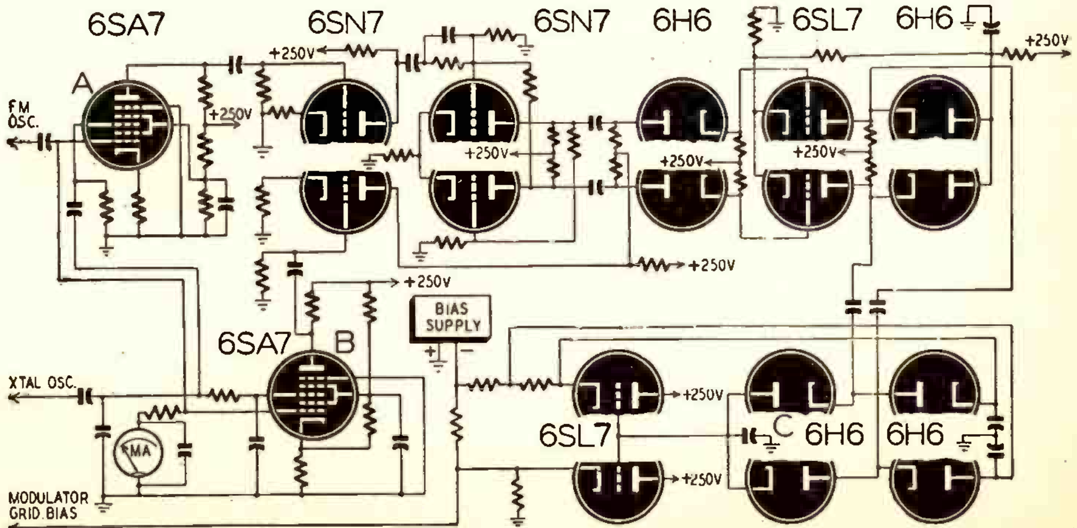

Fig. 5 (above) and Fig. 6—Condenser C in Fig 5 is the one so marked in the 6H6 output to the 6SL7 grids (bottom row of tubes, Fig. 6).

By M. CONTASSOT

THREE-CHANNEL AMPLIFIER

A 15-Watt Unit with Individual Control of Each Channel

We must never lose sight of the fact, in considering the construction of any sound apparatus, such as an amplifier of frequencies in the musical range, that it is the ear which judges the excellence of the instrument—absolutely without appeal. It is therefore indispensable to examine the conditions under which that organ functions, to adapt our sound equipment to it in the best possible manner.

The sensitivity of the ear varies as a function both of the frequency and intensity of the sound. If we consider very weak intensities, the ear hears medium register sounds much better than basses or high-frequency notes. At medium intensities, all the frequencies are heard equally well, and for very loud sounds, the basses and highs are perceived with greatest intensity.

THE CURVE OF AN AMPLIFIER

It appears from the considerations above, that the principle that leads to giving an amplifier a linear frequency curve is completely illogical. It is necessary to so design the equipment that the listener will hear the sounds reproduced under conditions which approach as close as possible those of listening directly to the sound source itself.

Let us take, for example, the case of a symphonic orchestra. If the listener is in his orchestra seat in the auditorium where the orchestra plays, he hears the music at such an intensity that his ear perceives it with the same relative sensitivity over the whole range of musical frequencies. But if he hears the same program over his radio or from records, through a loud speaker in his own living-room or bedroom, it is obvious that that intensity will not be as great—the size of a private room being considerably smaller than that of a concert hall. If he turns up the volume control to get the same sound level (which is possible) the neighbors with different musical tastes—or those who desire the sleep of the just—will not be slow in protesting energetically. He will therefore regulate the volume to a sound level rather on the weak side.

It is then that the ear registers its discontent with this "sound rationing" by refusing, as just pointed out, to hear the low and high notes with the same force as the frequencies in the middle of the audible spectrum. But, if our critical listener is clever and especially if he constructs his own amplifier, he will design it with such a response curve that it overamplifies the highs and the basses relative to the medium frequencies, *to exactly the same extent as the ear tends to weaken them.* He thus does his own ears a good turn, at the same time restoring the musical equilibrium.

THE DESIRED AIM

To establish the response curve of which we have just spoken, it is necessary to know that of the ear. That curve has been traced by the physicians and physiologists, who have established it by the average of several thousands of individual cases.

Since the amplifier is destined for the pleasure of one sole listener, it may well happen that the particular ear in question will be very different from the "average ear." Therefore it is infinitely preferable to permit the user to adapt the amplifier response to his own needs and tastes.

It is with this idea that the amplifier here described was conceived. It has three channels, one for each band of frequencies: bass, medium and high, the amplifier for each channel being controllable independently of the others.

DESIGN AND CONSTRUCTION

We shall scrupulously avoid the hackneyed description of: "the tube A, plate of which is coupled to the grid of tube B through the blocking condenser C, etc.," refusing to consider the reader so benighted that it is necessary to point out that which he can see clearly in the accompanying schematic drawing.

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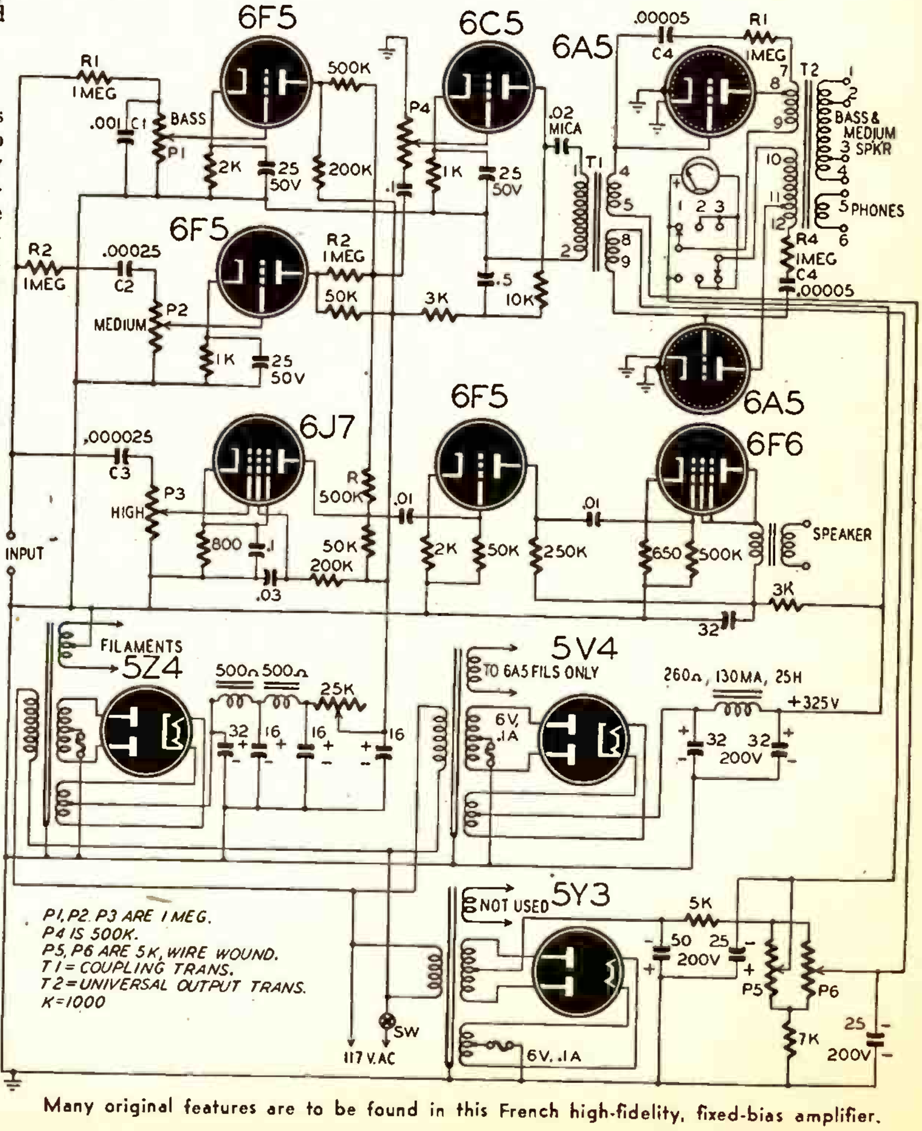

Many original features are to be found in this French high-fidelity, fixed-bias amplifier.

COVER FEATURE

HIGH-POWER U.H.F. TUBE

Triode Penetrates Far Into the High-Frequency Spectrum

COLOR television owes much to wartime radar, for the high-frequency triodes represented by the 6C22 were developed originally as radar transmitter tubes. The 6C22 itself is a modification for continuous-wave operation of an older radar tube known as the L600E. This tube was capable of delivering pulses up to a peak power of 25 kw, but was not altogether suitable for non-pulsing applications. The 6C22 was then developed by engineers of the Federal Telecommunications Laboratories for continuous duty. Working as an r.f. amplifier, it is capable of power outputs of 600 watts at frequencies up to 600 mc.

The tube is of remarkably small size for its output, as will be seen from the cover picture and the illustration on this page. Such economy of dimension is necessary for operating at the high frequencies for which it is employed. Internal construction may be seen in Photo A. The squirrel-cage structure in the left-hand portion is the grid. It consists of thirty-two .008-inch diameter wires spot-welded to and supported by a low-inductance cone, which is attached to the grid ring, seen just above the tube base. The anode is made from a solid copper cylinder. In one end is a cavity into which the grid fits; the other or water-jacket end is slotted. Spacing between the grid and anode is very close—this being another feature necessitated by the high frequency at which the tube is to work.

The filament of a high-power, ultra-high-frequency tube presents special problems. Due to transit-time effects, not all the electrons emitted by the filament or cathode when the grid is positive reach the anode. Many return to the cathode space-charge region. This causes a decrease in anode current and power output. To increase the current, the cathode must emit a greater number of electrons to compensate for those which do not reach the anode. The required emission may be several times as great as in low-frequency applications where transit-time effects do not have to be considered.

CHARACTERISTICS, 6C22		
Filament	Thoriated Tungsten	
Filament Volts		6.5
Filament Amperes		18
Amplification Factor		9
Mutual Conductance (ma/volt)		13
Maximum Anode Dissipation (Kilowatts)		2
Maximum Anode Volts		3,000
Maximum Grid Dissipation (Watts)		25
Capacitances μμf.	Cgp	6
	Cgf	7
	Cpf	0.4

The filament is therefore a thoriated tungsten wire of .025-inch diameter, coiled in a bifilar helix inside the grid assembly. It has an active emissive surface of three square centimeters. Spacing between grid and filament is held to a minimum.

Characteristics of the tube are shown in the table. Most of recent studies on it have been made at 600 mc. At this frequency, in a neutralized inverted amplifier circuit, with 1600 volts on the anode and a current of 0.65 ampere, the power output is in the order of 500 watts. A driving power of 190 watts is required.

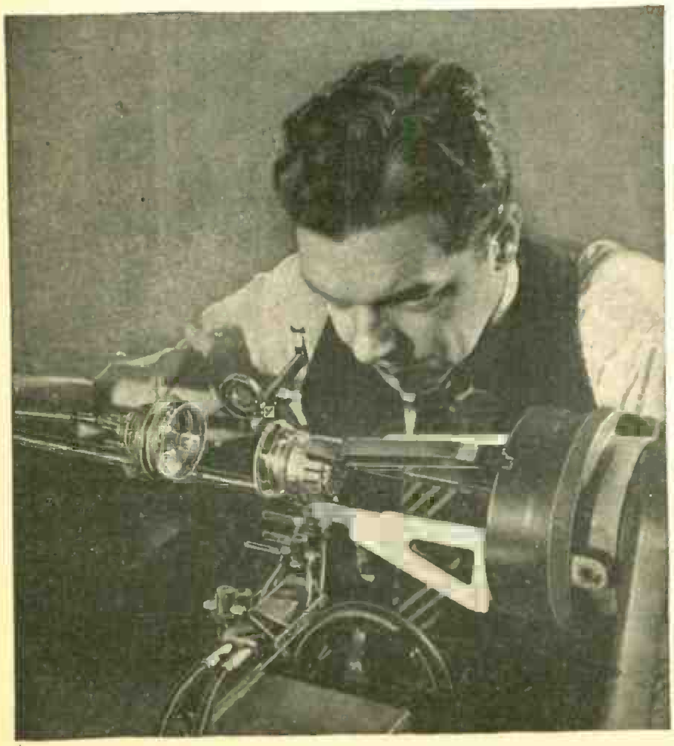

Photo A—The portion at right is the anode end. The grid is visible in the other half. Operator is aligning the tube elements before the sealing off.

THE COLOR TRANSMITTER

The high-definition color television transmitter built for the Columbia Broadcasting System by Federal Telephone and Radio Corp. operates on a frequency of 490 mc. It can be modulated uniformly with all frequencies from zero to ten megacycles, and is the most powerful transmitter of this frequency and modulation bandwidth yet installed.

Four 6C22 tubes are used in the radio-frequency section of the transmitter and three in the video-frequency modulator. The r.f. section starts with a 6V6-GT crystal-driven at 6.805 mc, and is followed by a number of conventional stages which multiply the frequency to 122.5 mc and amplify the power to 120 watts. This is followed by a 6C22 in a co-axial circuit operating as a frequency doubler, which delivers 250 watts at 245 mc. The co-axial amplifier is shown in Photo B. The anode circuit is a quarter-wave line shorted at the end farthest from the tube. Tuning is by a movable piston.

Another 6C22 doubles from 245 to the final frequency of 490 mc. The stage operates as a grounded-grid amplifier, and delivers 300 watts to a 6C22 neutralized amplifier, which also operates as a grounded-grid stage, and delivers approximately 700 watts at 490 mc. This is considerably more than is needed to drive the final to its full peak power of 1 kilowatt, but the excess power is dissipated in a damping resistor attached to the coupling line between the driver stage and the final modulated amplifier. This resistor acts to maintain constant output voltage from the driver stage in spite of the output stage's changing load as its bias is varied through the modulation cycle. This improves the linearity of the modulation characteristic and reduces somewhat the voltage required from the modulator stage.

The final, or modulated amplifier stage, also uses a 6C22 in a neutralized, grounded-grid circuit. With a drive of 350 watts it will deliver any output from zero to one kilowatt peak. The rated average output of the stage is 600 watts.

THE VIDEO AMPLIFIER

An interesting feature of the video

(Continued on page 640)

By FRED SHUNAMAN

NOMOGRAPH CONSTRUCTION

Part I—Nomograph for Current, Voltage and Resistance

A NOMOGRAM *(Greek: A new written down)* is a chart made up of a number of lines calibrated to represent quantities in the problems to be solved. A straight edge is laid across two of the lines. The answer to the problem is found where it intersects a third line. Most of the commonest radio problems can be put into nomograph form, hence this type of chart is one of the most useful to radiomen.

This principle of the nomograph is simplicity itself. Fig. 1 shows a typical one, for adding figures from 1 to 10. The outside lines which represent the numbers to be added, may be 10 inches long, divided into equal parts (inches). The totals are found on a line drawn midway between the two.

To calibrate the center line, lay a ruler across the tops and bottoms of the two outside ones. Because 0 plus 0 = 0, the base of the center line is 0. At the top, 10 plus 10 = 20, and the line is so marked. Dividing the center line equally gives us 20 divisions spaced one-half inch apart. If a ruler is now placed across the two 5's on the outside lines, the sum 10 will be read on the center one. Try 5 plus 8 or 9 plus 1.

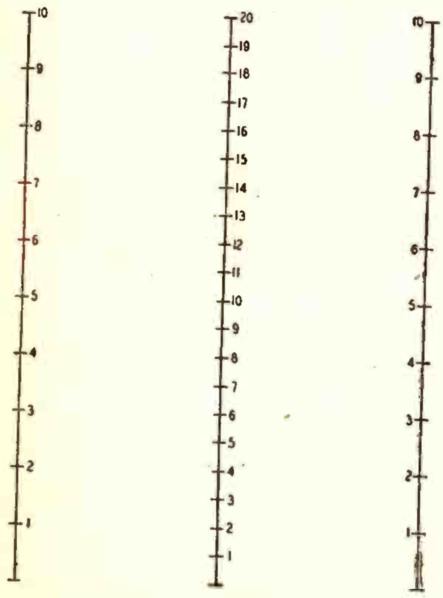

Fig. 1—The fundamental type of nomogram.

The reader will find it very helpful to actually construct such a nomogram. The important point to note is that the center line has twice as many divisions as the two outside ones. That is why their sum is found on it.

The addition nomogram may be mildly interesting. It is hardly useful—it is easier to do the additions mentally than to use the chart. The nomogram becomes valuable when applied to equations like the familiar $f = \frac{1}{6.28\sqrt{LC}}$. Such application is possible because multiplication and division can be transformed into addition and subtraction by means of *logarithms.*

Most radiomen understand logarithms. To those who do not, it is enough to say they are numbers so proportioned to ordinary numbers that the *sum* of the logarithms of any two numbers is equal to the logarithm of their *product.* For example, adding the logarithm of 5 to the logarithm of 6 gives the logarithm of 30. If we construct a chart like that of Fig. 1, using the *logarithms* of numbers from 1 to 10, we have a nomogram that can multiply.

CONSTRUCTION OF NOMOGRAMS

Nomograms for all radio uses can be constructed with the help of a small supply of logarithmic cross-section paper, which can be bought at almost any stationery or draftsman's supply house. It is well to get a few sheets of "1 cycle × 10 divisions per inch" as well as a smaller number of 2-cycle and 3-cycle sheets (also 10 divisions per inch). Some tracing paper completes the outfit. Lacking logarithmic paper, a cheap slide-rule may be pressed into service. (The slide-rule is a perfect example of a logarithmically divided scale.)

Simplest of all multiplication nomograms is the product of two whole numbers—the logarithmic equivalent of Fig. 1. A chart for the common radio equation IR = E (Ohm's Law) is set up in Fig. 2. The easiest way to construct it is to fasten a piece of tracing paper over one of the 1-cycle log sheets and trace each of its vertical border lines. You will then have two lines about 10 inches high and 7 inches apart. Draw the base-line and erect on it a vertical center line half-way between the other two. Number your two outside lines according to the scale beneath the tracing paper. Mark the two outside lines I and R, and the center line E. (I × R = E).

Next step is to calibrate the center line. The bottom number on each outside scale is 1. Therefore the center scale at the base line is 1 × 1 = 1. The top of the center line is 10 × 10, or 100. Insert a 2-cycle sheet under the tracing paper, and line the base lines up with each other. You will find the 1 and 100 in the correct positions, and can fill in the other divisions by tracing.

With this chart, the current through or voltage across any resistor between 1 to 10 ohms or 1 to 10 amperes and 1 to 100 volts can be calibrated.

A PRACTICAL CHART

Our nomogram still seems to be of little use—the range is altogether too limited, and these simple problems are easier done in the head. It is not altogether useless, though its main purpose is to show how a nomogram works, before introducing more complicated ones. Its range can be extended by multiplying or dividing either of the factors I or R by any number (most conveniently 10) and doing the same with the center scale. Or one outside scale can be multiplied by and the other divided by the same number, leaving the center scale unchanged.

One of the great advantages of the nomograph is direct reading, so such tricks are not worth while. We can make a satisfactory chart by extending the two outside scales. Let us make one with the I and R scales on 2-cycle paper,

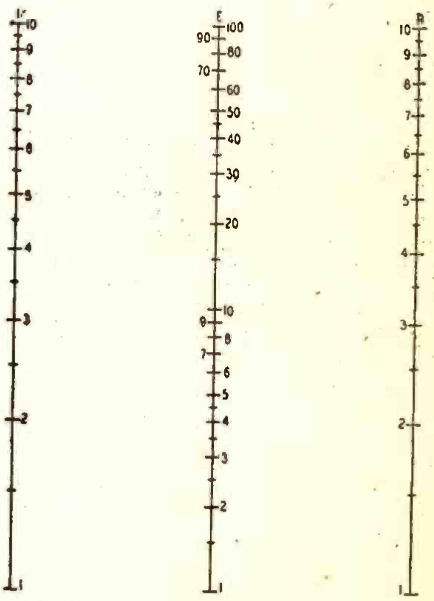

Fig. 2—Most nomograms are forms of this one.

giving them a range of 100 to 1 instead of 10 to 1. We can further increase the range by using two sets of figures for each I and R scale, giving us in effect two nomograms on the same sheet of paper.

(Continued on page 629)

By J. C. HOADLEY

BETTER BROADCAST TUNER

Companion to the Hi-Fi Amplifier Described in April

FOR persons who live within forty miles or so of a broadcasting station a TRF tuner is entirely adequate and has some advantages, particularly in large metropolitan areas where there are more than three stations. For high-fidelity reception, it is essential that our tuner not cut sidebands, or, that is, not have too high selectivity. As the standard AM broadcast stations generally operate so as to limit their band width to 10 kilocycles, it is necessary to provide a tuner with a response characteristic which has a flat top ten kilocycles wide. This can be done well with a superheterodyne, but

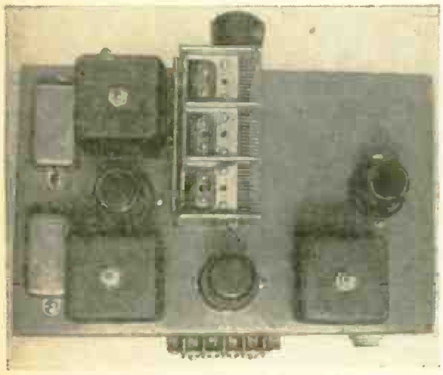

Photo A—Top view of the high-fidelity tuner.

requires special intermediate frequency transformers and a complex circuit. A simple three-tube tuned radio frequency receiver can be built with a reasonably flat 10-kilocycle band width for a small fraction of the cost of the super. The TRF tuner will have a lower noise level, as it contains less tubes. It is also much easier to align. All that is necessary is to have a screwdriver and a station. The heart of this tuner is the coils. They should be of the shielded type.

Iron-core coils have the advantage of being tunable, so that the inductance of the coil may be varied to suit the particular variable condenser that you have.

The condenser is a three-gang unit, and should have trimmer condensers mounted on it. If not, three auxiliary compression-type condensers that have a capacity of about 70 micromicrofarads should be provided. All else we need are three octal tube sockets, a few resistors and condensers and a chassis. The chassis may be bent from steel or aluminum.

The layout shown in Photos A and B worked out very well. However, it can be changed somewhat if the shape of your chassis is different. The important thing is to keep the grid leads from the tube to the condenser and coil, short, and as far away from the other grid leads as possible, or oscillation will result. These leads should also be kept close to the chassis, to keep down stray coupling. The parts in the author's model were mounted on a resistor board, which makes for a very neat arrangement.

A simple resistor board can be made of a piece of bakelite, cut in an oblong shape as in Photo C. Holes are drilled and soldering lugs are bolted to the bakelite. Resistors are soldered between the lugs. Of course, the resistors can be hung on the tube socket pins if a resistor board is not used. A terminal strip is provided on the back for connection to a power source. It is assumed that any standard amplifier will stand the additional current drain, which is very light, being in the order of 25 milliamperes. If the amplifier does not have a 6.3-volt filament supply, or if it is heavily loaded, a 1½-ampere 6.3-volt transformer may be mounted on the tuner. Note that the output is taken from a microphone connector and should be run through shielded mike cable to the amplifier.

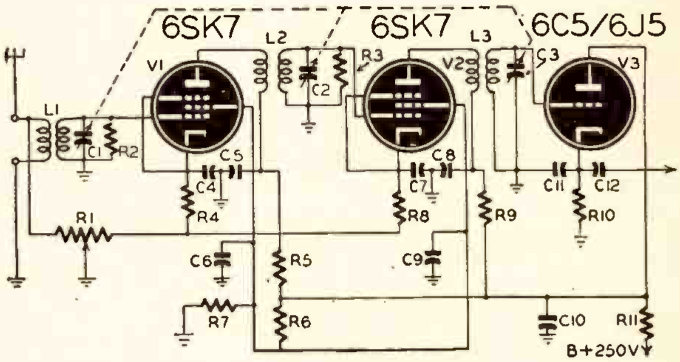

Fig. 1—The tuner is a 3-tube TRF with infinite-impedance detector.

An audio volume control was not included as it is assumed that the builder's amplifier will have one. If one is used it would be connected as in Fig. 2. The circuit diagram is shown in Fig. 1. It will be noted that resistors are connected across the coils. This is to increase the band width by reducing the Q of the coils and making their tuning broader. An r.f. gain control is provided as a sensitivity control. It has several functions. First, it allows the tuner sensitivity to be reduced when receiving a powerful local signal, which might overload the first tube's grid and cause

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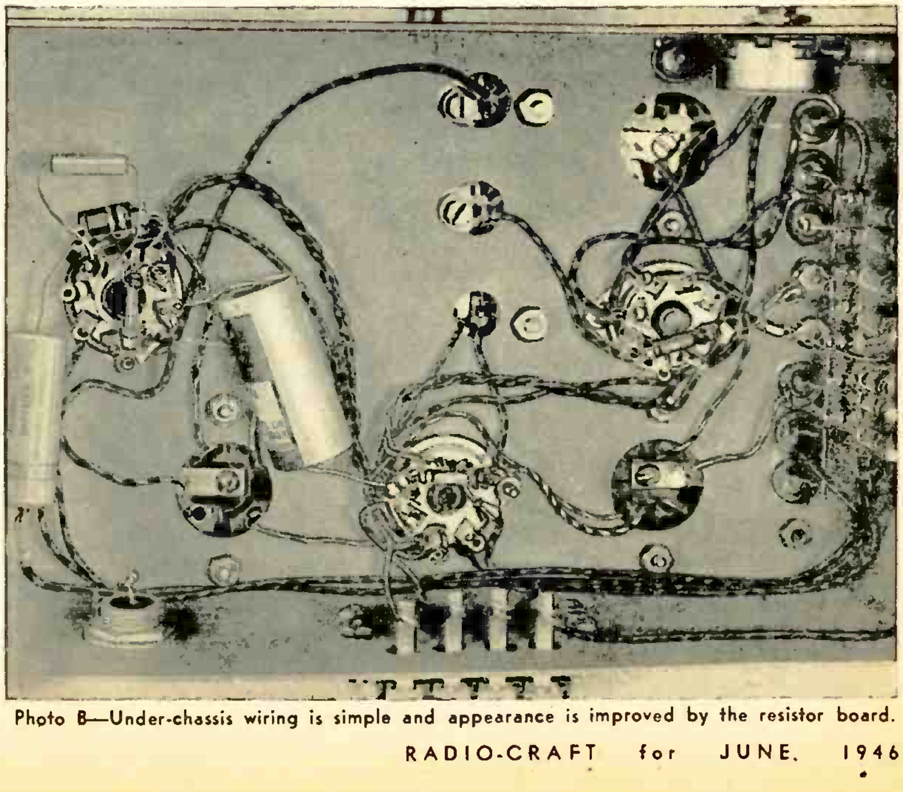

Photo B—Under-chassis wiring is simple and appearance is improved by the resistor board.

By ROBERT F. SCOTT

"PORTARIG" HAM STATION

A Versatile Transmitter-Receiver for the Amateur

WHILE a member of the armed forces, in the early days of the war, the writer was detailed to design and construct a transmitter and receiver to be operated in a "jeep" and powered by a six-volt vehicular storage battery.

The specifications for the transmitter and receiver, listed below, were very liberal and left much to the judgment and ingenuity of the builder:

Transmitter

Type of emission	A1 and A3
Output circuit	Any single wire antenna
Power input	30 watts, phone/cw
Frequency control	Optional
Primary power	6-volt vehicular battery
Size	As compact as possible

Receiver

Type	Non - radiating
Type of reception	A1 and A3
Frequency range	Same as transmitter
Frequency control	Optional
Primary power	Same as transmitter
Size	As compact as possible

The transmitter and receiver to use as many tubes of the same type as possible to simplify the replacement problem. Both to have a minimum number of controls and be practically fool-proof.

Upon seeing the specifications, the writer saw a perfect chance to develop that "dream" portable amateur station. It would even be possible to test and prove the station by operating on the 40- and 80-meter bands.

The original designs called for variable frequency oscillators, to be operated from a single control, in receiver and transmitter. This proved unreliable because of the drift of the two oscillators. In many instances they would drift in opposite directions and there was no practical method of keeping them synchronized. The next step was to resort to crystal control for both units. This method proved to be the ideal solution to the problem.

One of the principal features of this set is the ease and speed with which the frequencies may be changed. Four pre-set crystal-controlled channels are provided for the receiver and transmitter and any one of these may be selected at the turn of a switch.

Since continuous tuning is not used; the tuning elements of the receiver and transmitter are mounted on a removable tuning unit which may be replaced with one covering a different range of channels. The channels covered by each tuning unit are spaced 200 kc apart.

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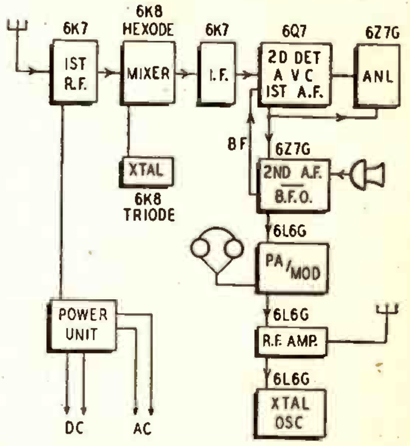


Fig. 1—Block diagram of complete apparatus.

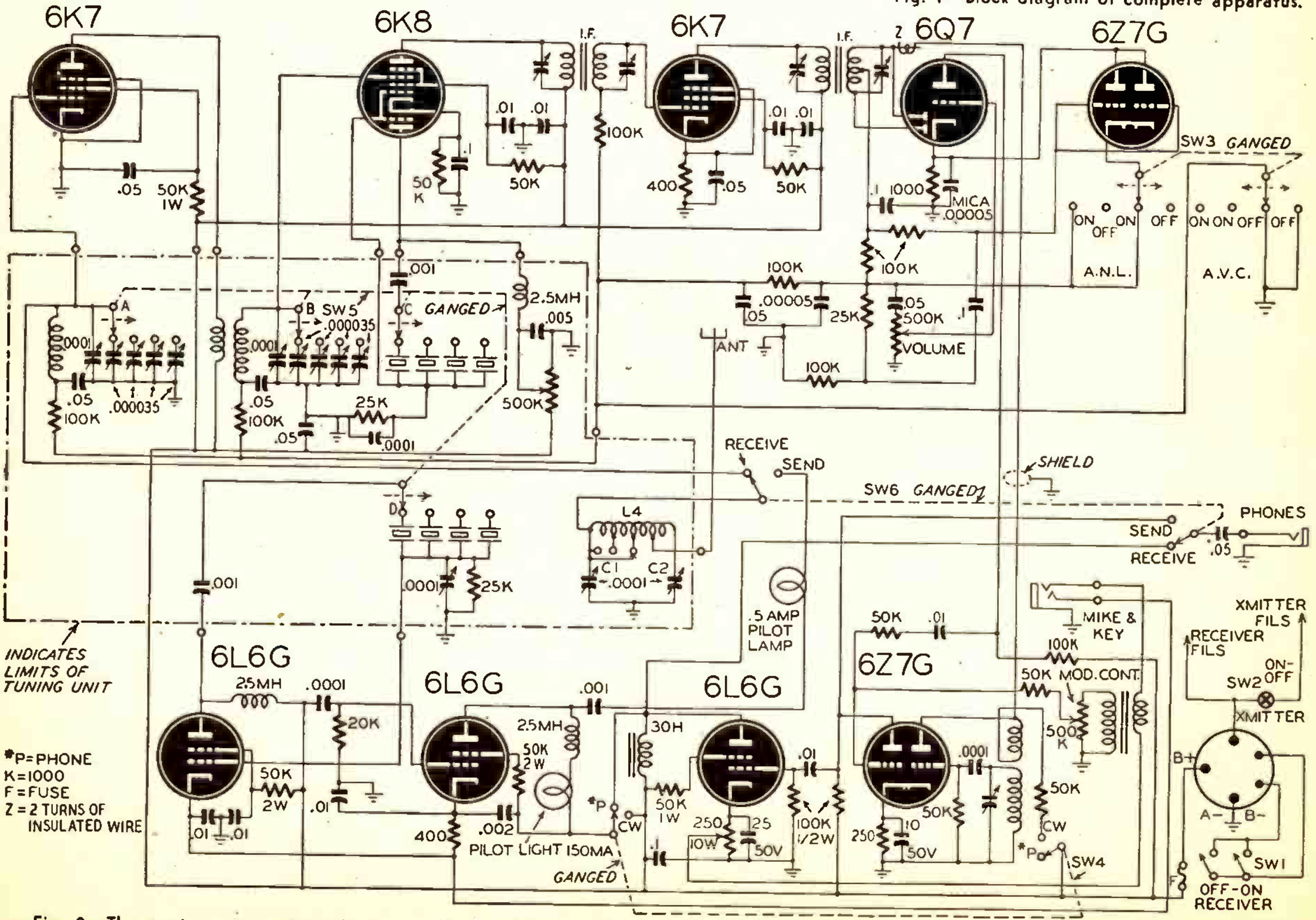


Fig. 2—The equipment consists of a transmitter and receiver adapted to work on several bands and on a.c. or 6-volt battery supply.

The average distance covered by this station is 30 miles when amplitude modulated and operated from a moving vehicle equipped with a 15-foot whip antenna. The range is more than doubled when using c. w. Under proper conditions, several hundred miles may be covered when operating from a fixed position with a quarter-wave antenna. These figures were determined when operating on frequencies between 3 and 4 mc.

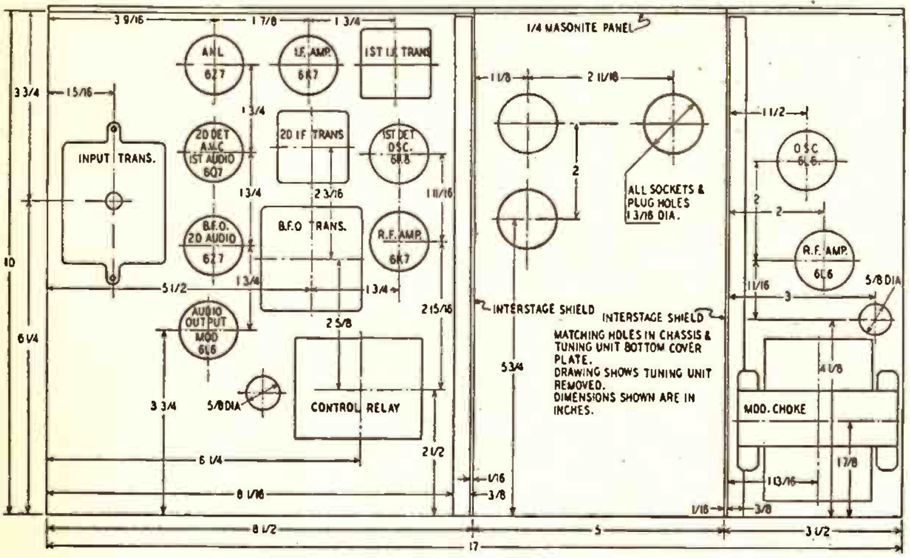
The block diagram, Fig. 1, shows the relationship between the various parts of the transmitter and receiver.

THE CIRCUITS

The receiver uses a 6K7 r.f. amplifier, 6K8 crystal oscillator-mixer, 6K7 i.f. amplifier, 6Q7 second detector, a.v.c. and first audio amplifier, 6Z7 a.n.l. (automatic noise limiter), 6Z7 b.f.o. and second audio amplifier, and a 6L6 power amplifier. (See Fig. 2.)

The transmitter r.f. section uses a 6L6 in a Pierce oscillator circuit driving a 6L6-G power amplifier. The modulator of the transmitter uses a part of the receiver audio section. One section of the 6Z7 is the speech amplifier, driven by a single-button carbon mike, and drives the 6L6 as a modulator.

With the SEND-RECEIVE switch in the receive position, the antenna is connected to the grid circuit of the r.f. amplifier. The signal is amplified and fed to the hexode section of the 6K8. At this point, the input signal is mixed with the output of the crystal oscillator in the triode section of the tube. The 456-kc i.f. thus produced is amplified by the 6K7 i.f. amplifier and applied to the diodes of the 6R7. The diode load resistor is tapped to provide a.v.c. and a.f. voltages. The a.f. voltage is amplified by the triode section of the 6Q7 and passed on to the grid of the second a.f. amplifier (one section of a 6Z7-G) by resistance coupling. The output of the 6Z7-G drives the 6L6, which has a 30-henry choke as its plate load. Headphones or speaker are connected to the 6L6 plate through a blocking condenser.



The panel layout. "Control Relay" was not used in final hookup. The ⅝-inch holes were for leads from available top-mounted components and may not be needed for different parts.

A portion of the rectified voltage of the second detector is applied to a 6N7 connected in a Dickert automatic noise limiter circuit. The switch for this circuit is combined with the a.v.c. switch to provide selective operation of either or both circuits.

When the PHONE-CW switch is in the cw position, plate voltage is applied to the b.f.o triode of the second-audio-b.f.o. tube. The output of this oscillator is loosely coupled to the diodes of the 6Q7. A second section of this switch removes the modulation choke from the plate lead of the power amplifier.

The combined power requirements of the transmitter and receiver totalled over 170 ma at 350 volts. A vibrator type power supply was selected for this service because it is compact and more easily serviced during field operation than the dynamotor or genemotor types.

To satisfy the comparatively large current requirements, two "universal" power transformers were selected. These units are equipped with two primary windings, one of which operates from a six-volt battery through a vibrator; the other operates from a 117-volt a.c. line. Each of the transformers was wired with individual vibrators in the six-volt primary winding. The high-voltage output from the transformers is rectified by separate full-wave rectifiers and fed into a common condenser-input filter circuit. The heavy current drain made it necessary to use two 6X5 rectifier tubes with plates connected in parallel in each of the high voltage circuits. When connected as in Fig. 3, the unit supplies more than 250 ma at 350 volts.

Since the 117-volt a.c. winding was available, it was decided to adapt the set so that it could be operated from line voltages if the occasion demanded. During a.c. operation, it is necessary to remove the vibrators from the circuit to prevent possibility of being damaged. Switching from a.c. to d.c. is accomplished by using two separate power cords which terminate in 12-contact sockets. A 12-contact panel-mounting male plug is mounted on the chassis of the power unit. The sockets and plug are wired so that the tube filaments are connected across the d.c. line when battery power is being used. When the set is being operated from 117-volt a.c. supplies, the a.c. socket is connected to the plug and the vibrator leads are opened so that no a.c. will circulate through the vibrators. The a.c.-socket also switches the tube filaments so that they operate from the transformer filament windings.

A five-prong tube socket is mounted

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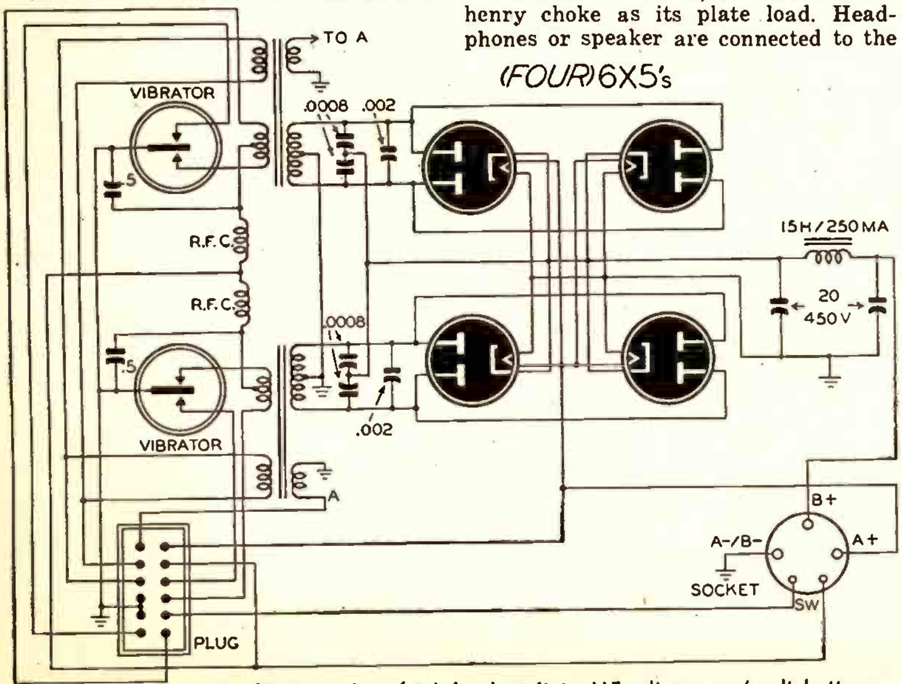

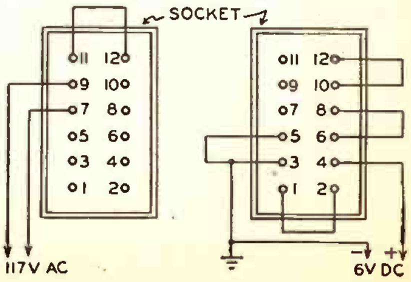

Fig. 3—Power supply. Shorting plugs (right) adapt it to 117-volt a.c. or 6-volt battery.

By JORDAN McQUAY

VIDEO AMPLIFICATION

Apparatus Which Works From 30 Cycles to 4 Megacycles

COMPLEX wave shapes encountered in radar, television, and some industrial electronic circuits have a very high order of harmonic content[1]. These signals contain a wide range of frequency components—often from 30 cycles up to 4 megacycles. Amplification of such a wide band of frequencies can only be accomplished by the circuit known as a *video amplifier*.

Chief difference between a video amplifier and an ordinary audio amplifier, is that the video amplifier (Fig. 1) provides nearly constant gain over an exceptionally wide range of frequencies *which include and far exceed the audio frequency band*. Thus, a video amplifier might be considered an extremely high fidelity audio-frequency amplifier. A comparison of the frequency response of the two amplifier types is shown in Fig. 2.

If all of the harmonic component of a complex wave does not receive the

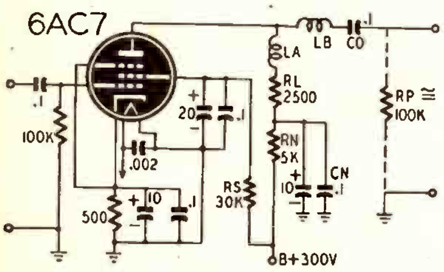

Fig. 1—A typical video amplifier circuit.

same degree of amplification, the wave shape is altered and distorted. This condition of unequal gain is known as *frequency distortion*.

If the phase delay is not constant, further distortion is introduced into the original wave shape. This is known as *phase distortion*.

[1] 1—See "Electronic Transients," *Radio-Craft*, February, 1946.

Ideal video amplifiers must be entirely free from both types of distortion. This is particularly true of phase distortion—the more serious—since it would result in reproduced pulses and wave shapes bearing little resemblance to the original.

However, through careful design and construction of video amplifiers it is possible to obtain and preserve a relatively flat gain response—so that all sine-wave components within the desired video range are transmitted without frequency distortion and without phase distortion.

This characteristic requirement of all video amplifiers is accomplished first, by sacrificing the *amount* of amplification per stage in favor of fidelity, and second, by using specially compensated resistance-coupled circuits.

CIRCUIT ELEMENTS

Because of the wide range of frequencies involved in video amplification, it is impossible to employ either transformer coupling or impedance coupling. Use of resistance-capacitive coupling, however, presents a number of circuit problems which must be overcome.

These problems can best be understood through study of an ordinary audio amplifier.

In such a conventional circuit (Fig. 3), the high frequency response is limited by various inherent circuit capacities. C_T represents the plate-to-cathode capacity of the tube, capacities due to the physical location of wires and circuit elements, and distributed capacities of the plate circuit. C_P represents the combined input and wiring capacities of the following video stage or device. Both C_T and C_P act in parallel, and shunt the load resistance R_L of the tube in the following manner.

At low frequencies, C_T and C_P have very little effect on circuit operation, because their reactance is large compared with the load resistance and the input resistance R_P of the following stage or device. But at very high frequencies their capacitive reactance becomes so small that these capacities behave very much like short circuits across the load resistor R_L and the input resistance R_P, respectively.

Thus it is necessary to modify con-

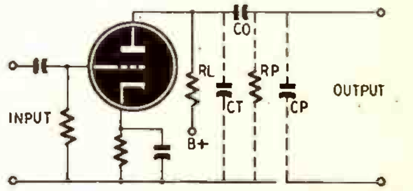

Fig. 3—Unseen components in a tube circuit.

siderably the amplifier circuit shown in Fig. 3 to adapt it for wide-band amplification.

First modification concerns a different type of vacuum tube.

The best tube for a video amplifier is one having small inter-electrode capacities *combined* with a large value of grid-to-plate transconductance (g_m). Such characteristics assist directly in limiting or neutralizing *some* of the undesirable circuit capacities mentioned previously.

Some triodes are useful as video amplifiers. Much more preferable are pentodes and tetrodes having a high value of transconductance. Of this kind is the 6AC7/1852, the 6AG7, 6SH7, and 6SJ7. Other tubes suitable for wideband operation are the types 6AB7, 6AG5, 807, 6Y6G, 6V6, 25L6, 1231, and 1232.

The recently developed orbital-beam secondary-electron multiplier can also be used as a video amplifier. It can be used over a very wide band.

The insertion of a high g_m pentode in the original triode amplifier (Fig. 3)

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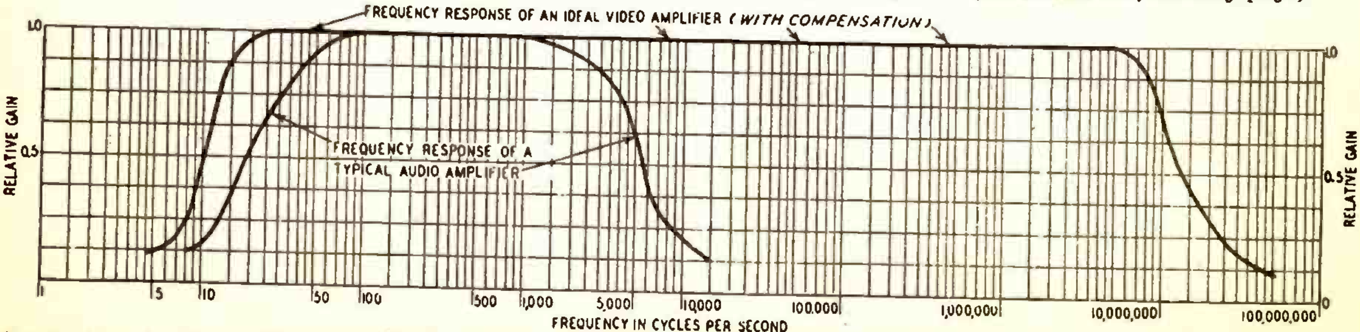

Fig. 2—A good audio amplifier may be "flat" from 30 to 8,000 cycles; a video amplifier from a few cycles to well into the megacycle range.

now results in the basic video amplifier circuit shown in Fig. 4. Although the inter-electrode tube capacities have been decreased by use of a pentode, the problem of distributed, reflected, and other circuit capacities must still be overcome. Further modification is necessary.

Such modification is known as *resonance compensation*, and chiefly concerns the extreme limits of high-frequency and low-frequency response of the amplifier.

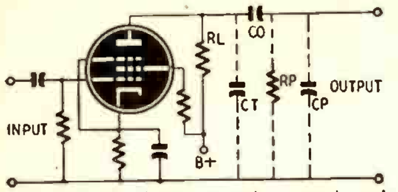

Fig. 4—Circuit of Fig. 3 with pentode tube.

Compensation methods which are effective at high frequencies produce little or no change in the low-frequency response, and *vice versa*. Therefore, the two problems can be considered separately.

HIGH-FREQUENCY COMPENSATION

Principal cause of gain decrease at the high frequencies is reduction of the plate load impedance due to the shunting effects of circuit capacities (C_T, C_P), (Fig. 4).

The upper frequency limit can be extended considerably—and the general high-frequency response greatly improved—if the effective impedance of the pentode and wiring capacity is *increased* at the higher frequencies of operation.

One method of increasing the reactance of a capacitive circuit is by creating a condition of parallel resonance. This, of course, will produce the greatest impedance at the resonant frequency of the parallel circuit. But if the Q of such a circuit is low, the resonance peak will be flattened out. If values of the resonant circuit are chosen so that the flat "peak" occurs in the region where normal gain of the amplifier begins to diminish, the mid-frequency or flat-gain response can be extended considerably into the high-frequency region.

For this purpose a small inductance L_a is inserted in series with the load resistor R_L, as shown in Fig. 5.

Value of the coil L_a is from 50 to 100 microhenrys. Value of the load resistance should be from 1000 to 4000 ohms.

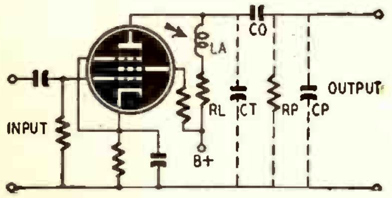

Fig. 5—High-frequency compensation circuit.

The parallel resonant frequency (L_a across the various tube and circuit capacities) is roughly the same as the upper limit of amplifier operation. This upper frequency limit rarely exceeds 3 megacycles.

This type of high-frequency compensation is known as *shunt peaking*, since the coil is connected *across* the circuit.

Another method of high-frequency compensation is known as *series peaking* (Fig. 6).

In this instance, a small inductance L_b is inserted in series with the coupling condenser C_o. At the desired upper frequency limit of operation, the inductance resonates with the input capacitance C_P of the next video stage or device.

Increased current flow through C_P in turn causes an increased voltage across this capacity, resulting in higher gain and less phase shift than possible with the preceding means of compensation.

This method has a further advantage over the shunt peaking system, since the inductance L_b isolates the effects of the output and input capacities C_T and C_P.

Gain response will be substantially

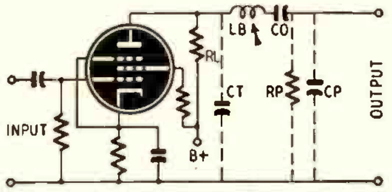

Fig. 6—Another method of h.f. compensation.

flat over the high-frequency region, comparable to mid-frequency response. And the upper limit of amplifier operation is approximately the same as the resonant frequency of the series peaking circuit.

A third method of high-frequency compensation combines the features of both shunt and series peaking. Resultant circuit (Fig. 7) gives the high-frequency extension of the shunt peaking method as well as the increased gain caused by the resonant effect of the series peaking method.

LOW-FREQUENCY COMPENSATION

The low-frequency response of an amplifier is influenced primarily by the

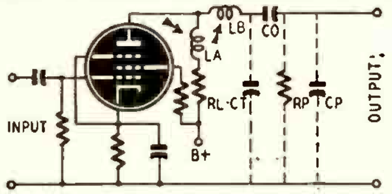

Fig 7—Both compensation methods combined.

grid-coupling condenser C_o and the effective input resistance R_P of the following stage or device. As the frequency of operation decreases, the reactance of condenser C_o increases. And at frequencies less than about 200 cycles, this reactance causes a strong attenuation of the signal wave.

To maintain constant amplitude and a minimum of phase shift at low frequencies of operation, a compensating filter—resistor R_N and condenser C_N—is inserted in series with the load resistor R_L (Fig. 8).

As the operating frequency is decreased, the reactance of C_N increases—causing the $R_N C_N$ combination to function as an *additional* load resistance. This action tends to increase the gain inversely (and at the same rate) as the coupling condenser C_o tends to reduce the gain.

The compensating filter also introduces a phase displacement in the plate circuit that compensates for the phase shift caused by the coupling circuit C_oR_L.

Low-frequency compensation may also

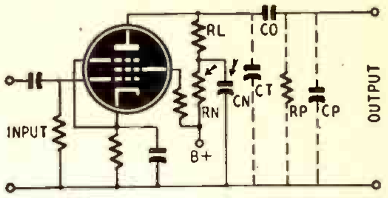

Fig. 8—Extending the low-frequency response.

be provided by a filter unit arranged in parallel with the coupling condenser C_o, as shown in Fig. 9. The resistor R_N compensates for low-frequency losses, since C_o is paralleled by the reactance of the filter condenser C_N.

Either method of low-frequency compensation may now be combined with one of the high-frequency compensation methods previously discussed, to provide a flat-gain response characteristic over a very wide range of frequencies. A typical circuit having both high- and low-frequency compensation is shown in Fig. 1, and its response curve in Fig. 2.

OTHER CONSIDERATIONS

There are other important circuit considerations in the design and construction of video amplifiers.

Parts and components must be arranged physically so that leads are as short as possible and properly spaced to minimize distributed capacitance between wires. Coupling condensers should be remote from other circuit elements, and *all* condensers should be mounted close to tube sockets, whenever possible.

For effective by-passing over the entire band of frequencies, electrolytic condensers shunted by small paper condensers are generally used. Cathode by-pass condensers must be extremely large to prevent any feed-back of cathode current at the very low frequencies of operation.

Necessary grid bias is usually obtained by utilizing the voltage drop across a resistor in series with the cathode. Variations caused by the input

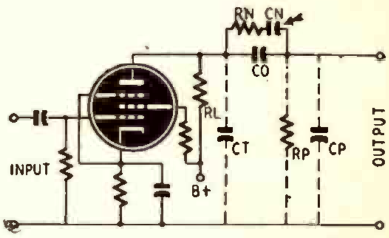

Fig. 9—Another compensation circuit for l.f.

signal are by-passed around the bias resistor by means of condensers. Time constant of the cathode resistance and capacitance should be long compared to the period of the lowest frequency to be passed. Value of the electrolytic condenser should be no less than 10 microfarads.

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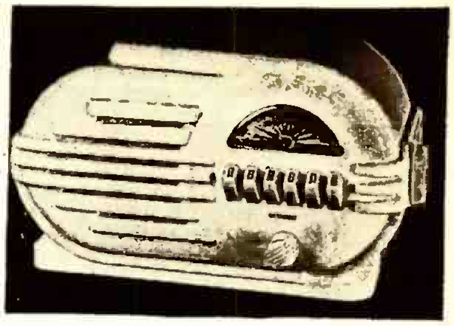
RADIO DATA SHEET 336

BELMONT RADIO

MODEL 6D111, Series A



Tuning range............530 to 1650 kc.
I.F. ....455 kc.
Power consumption............35 watts
Sensitivity (for 0.05 watt output)........10 microvolts average

Selectivity........55 kc broad at 1000 x signal at 1000 kc
Maximum power output ....1.0 watt
Undistorted power output ...0.8 watt
Voice coil impedance.........3.2 ohms

ALIGNMENT PROCEDURE

- No aligning adjustments should be attempted until all other possible causes of trouble have been thoroughly checked.
- Chassis must be removed from cabinet for proper alignment. Slight adjustments of the oscillator and antenna circuits can be made, without removing the chassis, through two holes provided on the bottom of the cabinet. The two adjustment screws can be reached with a long insulated screwdriver.
- It is important that during alignment the loop antenna be maintained at the same distance from the chassis as when the chassis is installed in the cabinet.
- Turn volume control to maximum for all adjustments.
- Connect ground post of signal generator to B– of radio through a 0.1 µf condenser.
- Connect dummy antenna value in series with generator output lead.
- Connect output meter across primary of output transformer.

Band	Signal Generator Frequency Setting	Dummy Antenna	Connection to Radio	Tuning Condenser Setting	Adjust for Maximum Output
I.F.	455 kc	0.1 µf	Grid of 12SA7	Rotor full open (plates out of mesh)	4 trimmers on input and output i.f. transformers
Broadcast	1650 kc	0.1 µf	Grid of 12SA7	Rotor full open (plates out of mesh)	Oscillator trimmer C7 on bottom of radio
	1400 kc	None	See note A	Set dial at 1400 kc	Antenna trimmer C2 on bottom of radio

Note A: Lay output lead of generator in back of loop antenna. Turn up generator output. Loop antenna will pick up energy.

REPLACING DIAL POINTER DRIVE CORD

Six inches of cord are required in the set. Use a piece slightly longer so that knots may be tied at each end.

Rotate tuning knob to extreme clockwise position. This closes tuning condenser. Knob should remain in this position until installation is completed.

Tie knot at one end of cord and place it in key washer. Wind cord one turn around shaft.

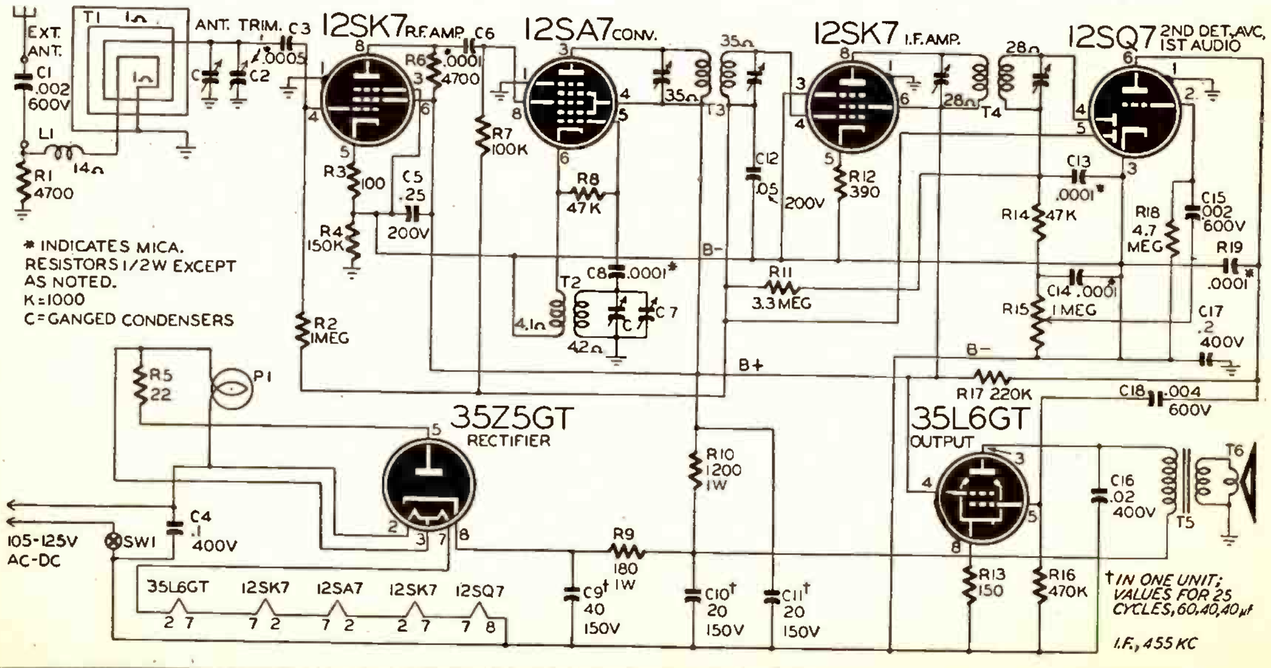
Pass cord over idler pulley.

Pass cord over pointer shaft; wind it one turn around shaft; pass it through key washer; wind it one more turn around shaft.

Hook spring over end of dial support. Tie cord to spring. IMPORTANT: Before tying knot stretch spring enough so that full contraction of spring will rotate pointer shaft at least one-half turn.

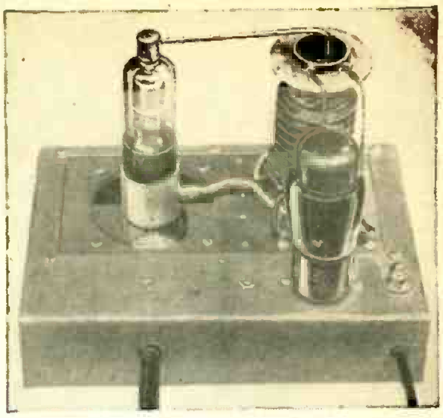
Remove dial crystal by removing Cinch buttons.

Make sure tuning knob is in extreme clockwise position. Then rotate pointer clockwise, against friction of shaft, until it is in horizontal position.



By NATHANIEL RHITA

R.F. POWER SUPPLIES



Appearance of the commercial r.f. power unit.

THE power supply has long been a headache in the design and operation of high-voltage, low-current apparatus. The necessary iron-core transformers are bulky, heavy and expensive. They are also inefficient in these circuits because the relatively high current available from them cannot be used. Television kinescopes and electron microscopes require, in general, less than one milliampere. High-voltage insulation between windings makes the transformer very expensive.

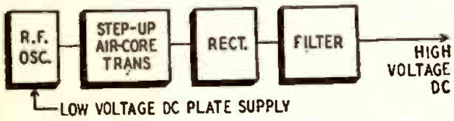


Fig. 1—Components of high-voltage r.f. pack.

A radio-frequency circuit eliminates the main disadvantage—the iron-core transformer supply. An r.f. oscillator is operated at a high radio frequency. The output is stepped up (in an air-core transformer), rectified and filtered to give the high d.c. voltage at low values of current. The results:

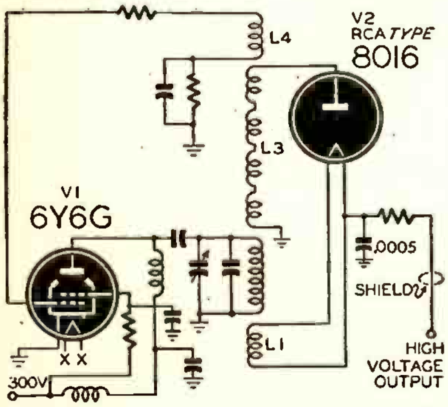


Fig. 2—The unit uses a receiving-type tube.

1. *Compactness*. The large iron-core transformer and filtering components are eliminated.

2. *Light weight*. The heavy iron core which made up most of the weight of the power supply is no longer required. Small filter condensers are sufficient.

3. *Safety*. The output current from the circuit is definitely limited even under short-circuit condition. A filter condenser of about 500 μμf can hold only a relatively small quantity of electricity. This reduces the danger of shock or injury.

4. *Economy*. Elimination of the large and expensive iron-core transformer and reduction in size of filter components permit a substantial reduction in cost.

A block diagram of the power supply is given in Fig. 1. The oscillator can be a receiving-type tube since the output power required is small. Because of the high frequency and small current, filtering is simple.

A recently announced commercial type of television power supply* is illustrated in the photograph and schematic (Fig. 2). Note the compactness and simplicity of design. A beam power 6Y6G is used as oscillator, an RCA 8016 as rectifier. The latter tube filament requires only ¼ watt, easily supplied from a fractional turn of wire on the high-voltage transformer. The unit is definitely portable and can be placed anywhere without danger of supply-line-frequency pickup by other circuits.

Figs. 3 and 4 give performance data of this supply. The voltage regulation is 15% from no load to 800 microamperes drain. The frequency characteristic is not critical, optimum being obtained at about 300 kc. This model is adapted to operate up to 14-inch direct-viewing kinescopes and similar tubes, and is available either with or without the d.c. oscillator power supply. The earlier types have an adjustable output of from 6000 to 10,000 volts.

A higher voltage model for the projection type kinescopes is also available. Due to a voltage-tripling circuit, the output is 30,000 volts.

Design considerations in this type of supply are

(a) eddy current loss
(b) voltage insulation
(c) resonance curve
(d) voltage regulation

Note the use of a pie-wound transformer secondary to guard against voltage breakdown. The coefficient of coupling between primary and secondary determines the double-humped shape of resonance curve and voltage regulation.

The advantages of a well-designed r.f. oscillator-rectifier combination make it an ideal source of supply for oscilloscopes or other cathode-ray tube applications, as voltage is usually high and current low. The suitcase-type electron microscope owes much of its portability to the use of such a power supply.

Although r.f. power supplies have not come into common use, they are by no means entirely novel. Design and operation of such a unit was described by O.H. Schade, of the Radio Corporation of America, in a paper pub-

(Continued on page 647)

* U. S. Television, New York City.

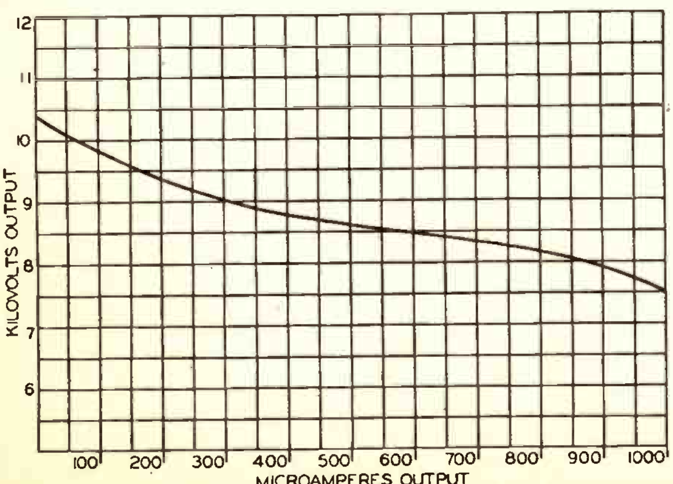


Fig. 3—Regulation curve, output voltage plotted against current.

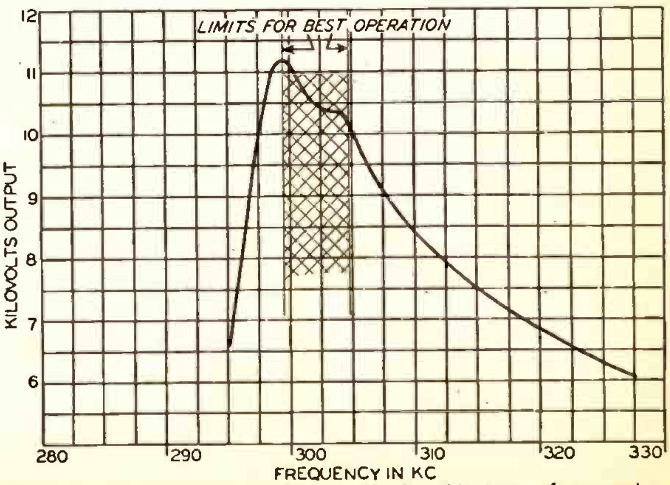


Fig. 4—Practical operating frequencies for this type of apparatus.

By ARTHUR HOWARD & MORRIS EDDY

MATHEMATICS—RADIO TOOL

Part I—Some Problems of Receiver Design and Operation

WHENEVER the word "mathematics" is uttered in radio circles, not too infrequently the novice and radio veteran are alike gripped by fear. They imagine the subject to be dull, abstract, and very difficult; something to be avoided at all costs! The appalling situation can be attributed, in no small measure, to the poor pedagogical methods in our schools.

All sciences owe a great deal to mathematics for their development. This is particularly true of radio and electronics. We deal with substances and terms which are completely insensible to the human organs and alien to our imagination. We try to understand them by meager analogies; electricity depicted, for example, as flowing water. To fully comprehend the principles and enable us to solve many practical problems in radio work, mathematics is a vital necessity. In the following, we present a number of radio problems and their solutions. They are designed to illustrate how important a tool mathematics can be to the radioman. Only simple arithmetic will be assumed on the reader's part, ordinary common sense being the most important factor in understanding the following.

THE CATHODE BIAS RESISTOR

A very frequent problem is the determination of the cathode resistance value of a vacuum tube. For example, what value resistor is required for a 6C5 triode operating as a class A amplifier, with a plate voltage of 250 volts? (Fig. 1).

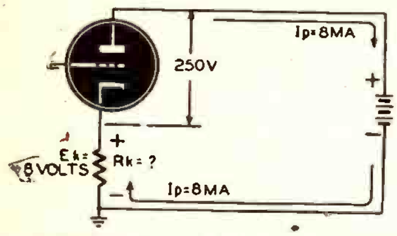


Fig. 1—Calculation of tube's cathode bias.

Turning to the tube manual, we find the grid-bias voltage to be −8 volts and the plate current, 8 milliamperes. Using Ohm's Law and some arithmetic, we solve the problem.

The formula—

$$R_k = \frac{E_k}{I_p} \times 1{,}000$$

Where R_k = resistance value of grid-bias resistor in ohms, E_k = grid-bias voltage in volts, and I_p = plate current in milliamperes.

Substituting the known values in the formula, we have—

$$R_k = \frac{E_k}{I_p} \times 1{,}000 = \frac{8}{8} \times 1{,}000$$
$$= \textit{1,000 ohms}$$

Where tetrodes or pentodes are employed, we follow the same method as above in obtaining the solution, with the added necessity of taking the screen current into account. This is shown in the new formula—

$$R_k = \frac{E_k}{I_p + I_s} \times 1{,}000$$

where I_s, the new factor, is the screen current in milliamperes.

What should the wattage rating of the resistor be? Again, mathematics will supply us with the answer.

Using the formula: $W = E_k I_p$

Where W = rating of resistor in watts, E_k = grid-bias voltage in volts, and I_p = plate current in *amperes*.

Substituting the known numbers in the formula—

$W = E_k I_p = 8 \times 0.008 = \textit{0.064 watts}$

Since there is no resistor available rated at 0.064 watts, we would use a ¼-watt resistor. Commonly, the wattage rating of a resistor is at least twice the calculated value, so a ½-watt resistor would be the smallest practical one, which would include the 100 percent safety factor.

LINE-CORD RESISTORS

The replacement of a line-cord resistor is a task the radio-serviceman is often called upon to perform. In this case, to solve the problem, his tool is not the conventional ohmmeter, but arithmetic.

Let us assume a five-tube a.c.-d.c. superhet, using a 6SA7, 6SK7, 6SQ7, 25A6, and a 25Z6, is brought in for repair. A continuity test points to an open line-cord resistor. With what value line-cord resistor should it be replaced? (Fig. 2).

From the tube manual, the serviceman finds that each tube draws 0.3 ampere. Then, he notes down the heater voltage of each tube, and adds them up. There are three 6.3-volt and two 25-volt tubes; total, 68.9 volts.

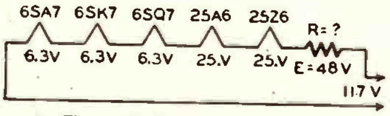


Fig. 2—The old line-cord resistor problem.

In an a.c.-d.c. circuit, the tube filaments are connected in series. Therefore, the same current, 0.3 ampere, will flow through each tube.

Since the line voltage is approximately 117 volts, our problem is to drop (117-68.9), or about 48 volts. Using Ohm's Law—

$$R = \frac{E}{I}$$

Where R = the required resistance in ohms, E = the voltage to be dropped in volts, and I = the current flowing through the tubes, in amperes.

Substituting the known values in the formula, we have—

$$R = \frac{E}{I} = \frac{48}{0.3} = \textit{160 ohms}$$

Therefore, the line-cord resistor should be 160 ohms. The wattage is found by using the formula W = EI, and *doubling* the calculated value.

VOLTAGE DIVIDER PROBLEMS

In power supplies, a voltage divider is often utilized. It is a tapped resistor connected across the output of the power source, supplying different voltages to the stages of a circuit.

To cite an example, the following voltages and currents are needed.

E_1 = 250 volts, 20 ma, E_2 = 100 volts, 15 ma, and E_3 = 50 volts, 10 ma.

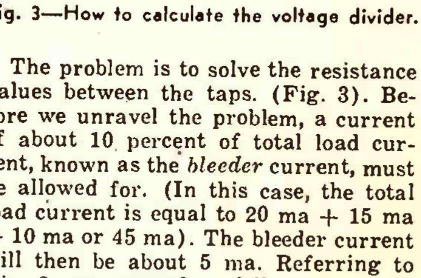


Fig. 3—How to calculate the voltage divider.

The problem is to solve the resistance values between the taps. (Fig. 3). Before we unravel the problem, a current of about 10 percent of total load current, known as the *bleeder* current, must be allowed for. (In this case, the total load current is equal to 20 ma + 15 ma + 10 ma or 45 ma). The bleeder current will then be about 5 ma. Referring to Fig. 3, we proceed as follows:

Let—I_1 = 15 ma (the current flowing through the load connected across the 100-volt tap), I_2 = 10 ma (the current flowing through the load connected across the 50-volt tap), and I_3 = 5 ma (the bleeder current).

(Continued on page 635)

By ALFRED SHORTCUT

ADAPTING A METER

Adapting the Superior Channel Analyzer to Wider Uses

WHILE many people own one of the more expensive signal tracers with a multiplicity of "eyes" or meters, others are not so fortunate. Some may not be able to afford the costlier instruments while others have bought a cheaper instrument at a time when it was available and others weren't. It was in the latter position that the writer found himself a short time ago. The instrument in question was the Superior Channel Analyzer. It was considered good for its cost but not adaptable to all service requirements. The writer set about to find out what could be done to improve it.

First the vacuum tube voltmeter was checked against a standard meter and its accuracy found suitable for service work. Linearity in a positive and negative direction was checked as the meter was to be used with a signal generator to determine FM discriminator characteristics. Linearity was passable over the first half of the scale but not good near the ends, as is to be expected in any instrument utilizing the characteristic of a tube.

The audio section also seemed acceptable. One thing that was desirable was a pair of headphones, since these made it possible to check for distortion in a stage as well as checking gain.

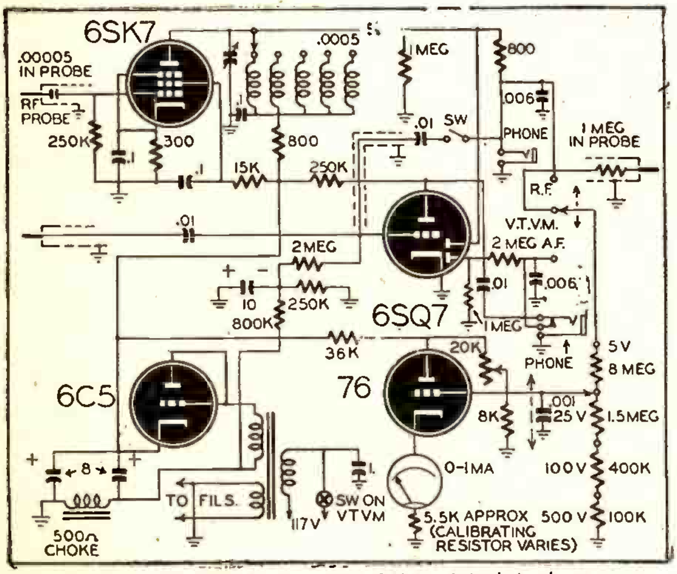


Fig. 1—Simplified schematic of the original Analyzer.

While high impedance (preferably crystal) phones are desirable, standard 2,000-ohm phones worked all right provided they were unplugged while making gain measurements. Actually the audio section of a signal tracer is seldom used to measure the gain of a stage but is much more often used to see if the stage is working or causing distortion. So whether the phones are in or out is not of too much importance.

Next we come to the r.f. section of the tracer. Here is where the instrument falls far short of the higher-priced sets. A glance at the circuit, Fig. 1, reveals a single stage of tuned-plate r.f. amplification fed into a diode detector.

This causes poor selectivity and more important, poor sensitivity. The case was taken off to get a look at the insides. By moving some condensers in the rear left hand side (facing the back) of the tracer, room could be made for an extra socket. A second tuned r.f. stage was considered but the idea was abandoned because it would be hard to wind a second set of coils to track with the original ones used. It would be harder still to mount such coils and shield them to prevent regeneration, and a two-gang condenser would be required. While thinking of coils a look was taken at the ones used in the analyzer. They were wound on wooden dowels and due to shrinkage of the dowels the wire was loose. This caused erratic tuning since vibration would move the loose turns. Coil dope was painted on the coil to hold the turns in place.

Since a tuned r.f. stage was not feasible an untuned stage was considered next. It was necessary to have good amplification up to 18 mc if the entire range of the tracer was to be used. A 6AC7 was chosen as the amplifier because of its high mutual conductance and consequent high gain. To have uniform gain from low frequencies up to 18 mc a plate resistor equal in value to the reactance of the output capacitance of the tube, plus the input capacitance and any stray capacitance, had to be chosen. In addition an inductance theoretically should be placed in series with the plate load resistor. Its reactance should be equal to one half that of the plate load resistor at the highest frequency. If the load resistor alone were used the gain at 18 mc would approximate .707 what it was at medium frequencies. So it was decided to omit the inductance, partly because coil winding is tedious but mostly because of the increased danger of regeneration and the fact that in most service work one is not interested in having an instrument absolutely flat up to 18 mc.

Fig. 1 shows the original circuit of the unit while Fig. 2 shows the modification. The circuit is self-explanatory except for some details. To prevent coupling and feedback between the 6AC7 and the 6K7 it was necessary to shield the wire from the r.f. input to the grid of the 6AC7. A large-diameter shield should be used if possible. It was also necessary to turn the low-frequency coil

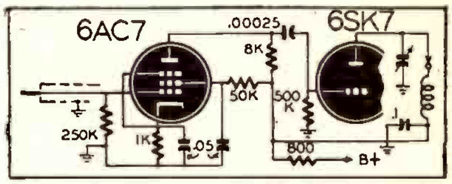


Fig. 2—A 6AC7 was added to the instrument.

90° from its original position and dress the 6AC7 plate load resistor and coupling condenser to the 6K7 away from the coil system. Other units may require even more care to prevent feedback but a little horse sense and judicious cut-and-try should cure it.

Once the extra tube had been added a longer ground wire was installed and the r.f., a.f., and v.t.v.m. cables replaced with longer shielded insulated wire. Instead of the cable end used on the original r.f. probe a phono needle test probe was used. The original probe had a built-in .0005 mf condenser so that connecting the probe to a tuned circuit would not cause serious detuning. Without this condenser touching a tuned circuit would detune it. However in most cases the gain of the tracer is high enough that touching the circuit is not necessary. Merely touching the probe to the insulation on a signal-carrying wire will pick up enough signal to operate the meter. The advantage gained by omitting the condenser is that in circuits where the cable capacity is unimportant it is possible to touch the probe directly to the circuit and trace a much weaker signal. Thus, with the use of the extra tube and the omission of the .0005 mf condenser, the tracer was connected to an antenna and a station 80 miles away received.

The revised signal tracer worked very well. Signals could be traced from antenna to voice coil, a.v.c., a.f.c., and oscillator circuits could be checked with ease, and by using the phones, noise and distortion could be isolated to the defective stage. Total cost of the modification—less than $10.00.

By JACK KING

REDUCING HUM LEVELS

Hum Level of Many Receivers Can Be Notably Reduced

RECEIVER performance can be improved greatly by reducing hum level. Work of this kind can be profitable if "sold" to the customer, but not everyone will want hum level reduced. Many are not particularly fussy about reception and will be satisfied so long as some sound comes out of the "box." Others may appreciate quality and be willing to pay for it.

Lack of hum in a battery set is very noticeable. With the volume control set at zero, and no signal input, no hum can be heard. In an a.c. or a.c.-d.c. set, a definite hum can be heard at zero volume control setting or when the radio program is interrupted, as at station-break time. This hum level—sometimes called "residual" hum—is a part of the radio design. It is usually not reduced to absolute zero but is made low enough that ordinarily it is not noticeable.

The hum heard in the service shop *may be less noticeable* than in the home or place where the radio is used. The reason primarily is that noise level in the shop may be high, preventing the serviceman from hearing the hum very efficiently. Baffling effect of a cabinet is also absent on the bench, often causing strong 60-cycle hum to be inaudible. By turning off other sets and keeping shop noise down to a low level when checking hum, better accuracy in making the listening test is possible.

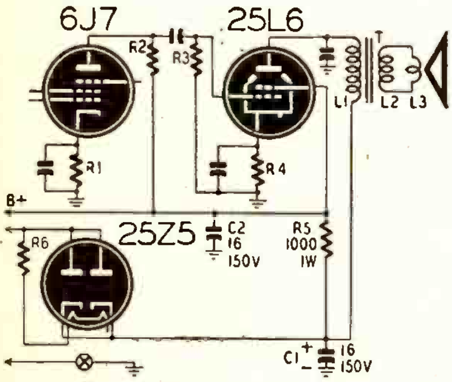


Fig. 1—Hum voltage sources in a.c.-d.c. sets.

Many of the less expensive sets have little filtering, since filter parts cost money and that increases the cost of manufacturing the radio. It might be impractical to use extensive hum reduction on many thousands of radios in manufacturing, but in specialized servicing, for superior results, it is a practical matter to see about reducing the hum to a very low level.

One common type of circuit is that shown in Fig. 1. In this circuit, a hum voltage exists across C_1, the input filter condenser. This hum voltage is applied to the series circuit consisting of L_1, the plate-to-cathode resistance of the output tube and to R_4. The value of R_4 may be about 150 ohms and, since it is shunted by a high capacity condenser, the impedance in the cathode circuit may be assumed to be very low at the fundamental and low-order harmonic hum frequencies. Small dimensions of the midget cabinet and poor loudspeaker response at 60 cycles may mean that the hum at second harmonic 120 cycles, will be most noticeable, and hum at 180 and 240 may be appreciable. Rectified alternating current from the cathode of the 25Z5 consists of two components, the d.c. and an imposed a.c., or hum voltage. Such voltage appearing in the plate circuit of the 25L6 would be heard in the speaker. We may think of this 60-cycle hum component as having two paths—one to ground through C_2, and the other through L_1, the internal resistance of the tube and the cathode resistor and its by-pass condenser. Even at 60 cycles, the reactance of the condenser is only 166 ohms, whereas that of the parallel circuit amounts to some thousands of ohms. As the hum frequency is made higher, the reactance of C_1 decreases and that of L_1 increases, further reducing the tendency for hum to flow in the plate circuit.

In the screen grid circuit, filtering is obtained through R_2 and condensers C_1 and C_2 which offer low impedance paths for hum currents.

A reduction in hum can be obtained by using a small iron core inductance in series with R_5. If the choke d.c. resistance is 200 ohms, R_5 may be reduced to 800 ohms. Usually, R_5 can be dispensed with entirely when the choke is substituted without noticing any bad effects. If the choke is a 10-henry type, its reactance at 60 cycles is 3768 ohms. The d.c. voltage drop in the choke will be low, but the impedance to hum will be much higher than that offered by the 1000-ohm resistor, reducing the hum level. At 120 cycles, the impedance would be even higher, about 7536 ohms. If a 30-henry choke is used, at 60 cycles, the impedance would be 11,304 ohms, while at 120 cycles it would be 22,608 ohms. (Using the choke in series with the entire B supply may be undesirable since the high plate current of the output tube results in near-saturation of the choke and decreased inductance.)

An ordinary carbon resistor, such as R_5, will have no appreciable reactance and may be considered a pure resistance, so that its opposition to hum harmonics is the same as that to the fundamental hum frequency.

Hum can also be reduced, of course, by increasing the values of C_1 and C_2. Usually C_2 is not very critical and a 30-µf 150-volt unit can be used, but C_1 must not be made too large in value. Using a very large condenser here will raise the peak current through the rectifier tube and possibly shorten its life. It may also give too much output voltage. Using a choke, the original operating voltages are not disturbed very much. In many cases, however, installing a 20- or even 30-µf unit in place of C_1 will work out all right. A 40-µf or higher condenser should not be used in place of C_1. If the original circuit had a very high capacity input, the use of a similar condenser in servicing, naturally, would be all right.

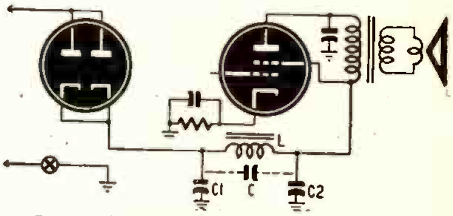


Fig. 2—Tuned-choke circuit, a rarer type.

In Fig. 2, a less widely-used type of circuit is shown. Hum output from the rectifier is a 60-cycle hum, since a half-wave rectifier is used. It may be possible to tune L. L may be a speaker field or a choke. If the inductance is 30 henrys, the reactance at 60 cycles will be about 11,304 ohms. When the reactance is known, the condenser capacitance can be found using a formula, $X_c = 1/6.28 x C$ (farads), a condenser in the neighborhood of 0.25 will be found to have the same reactance.

Using an a.c. voltmeter, and connecting it across the output filter C_2, the reduction in hum output can be noted as various values of C are shunted across L. Tuned-filter reduction is primarily at the fundamental hum frequency. Above resonance, for example at 120 cycles, the second harmonic hum output of the half-wave rectifier, the 0.25 µf condenser would have a reactance of 5300 ohms. The reactance of the .25 µf condenser, would be in shunt with the choke impedance and the net impedance would be something less than 5300 ohms. For higher harmonic frequencies, the impedance would progressively become less, since the reactance of the condenser drops off with a rise in frequency.

(Continued on page 648)

"RADIO PEN" 28 YEARS OLD

Dr Lee de Forest Original Inventor

AFTER having published Fips's lurid account of his Radio Pen, which caused him to be immediately fired, cashiered, dismissed, and forbidden to ever re-enter the premises, for his dastardly conduct in stealing inventions of others (see article RADIO PEN, April issue), RADIO-CRAFT received a letter from Dr. Lee De Forest, who writes in part as follows:

"Mr. Hugo Gernsback
"Editor, RADIO-CRAFT

"I notice that your April issue illustrates and partly describes the 'Radio Pen.' I remember distinctly that I made complete drawings and specifications of such a pen away back, either in the early 20's or possibly as far back as 1917. My recollection is that one of your magazines made quite a feature of this. At that time, the smallest available radio tube was the 'peanut,' made by Western Electric.

"If you are sufficiently interested, I suggest that you have one of your men dig back through those early files to see if that published description can be located. If so, will you not please reproduce it? You see, I am just as jealous as you are to be known as an early prophet!"

Sincerely yours,
LEE DE FOREST

Dr. De Forest's memory is very good. We located the article in the June 1918 ELECTRICAL EXPERIMENTER, an early Gernsback publication.

We reprint here a condensation of the article, and also the illustrations that went with it. It certainly makes interesting reading.

In defense of Fips; we are certain that he did not remember Dr. De Forest's original account, because no reference to it was made anywhere in his papers, through which we looked carefully after his brusque dismissal.

We did, however, find the following: He had made numerous notes on other miniature radio receivers, to wit:

POCKET LIGHTER RADIO
TIE-STICK PIN RADIO
EARRING RADIO (For ladies)
COLLAR-BUTTON RADIO
CUFF-LINK RADIO

This should give a good idea how his mind works.

Of course, it will probably turn out that neither of the suggestions mentioned are original with him. We are certain that somewhere, some patentee or an early inventor will sooner or later claim credit.

All this is as it should be. Most so-called "inventors" these days find that after they are through with their laborious work they discover that their brainchild is as old as the hills, and that somebody had preceded them possibly before they were even born.

Dr. De Forest's article from the June 1918 issue ELECTRICAL EXPERIMENTER follows:

A "FOUNTAIN PEN" RADIO RECEIVING SET

To Dr. Lee De Forest must be given the credit for developing a receiver which is only slightly larger than an ordinary fountain pen. With it, a secret service man has but to walk in the vicinity where a "spy radio station" is suspected, with the chance that he may locate the informer at his instrument.

With this "fountain pen" radio receiver it has been possible to hear stations eight to ten miles away, with little difficulty and only a small aerial. In the sectional view shown here it may be seen how it is hooked up. This sensitive receiver depends entirely upon the Audion for its efficiency, and it is only this extremely sensitive detector that has made possible a truly practical receiver of this small type.

It has been found that by using what is known as a "soft" Audion a fair degree of sensitiveness is achieved with a battery of only four volts, whereas a standard Audion requires a potential many times that amount.

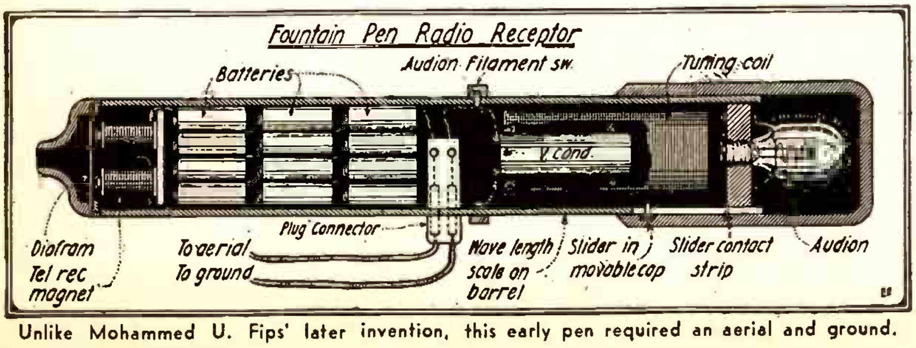
The tuning of the set is accomplished by means of a small coil, wound with No. 40 magnet wire. Taps are taken off from the coil and led to a number of points over which slides a contact mounted on the movable cap at the end of the receiver. By moving the cap one way or another the wave-length is altered to conform with the in-coming wave. The tuning coil answers satisfactorily for short wave-lengths, and

The older (and much bigger) Radio Pen had a range of 10 miles.

the Audion is connected directly to it, having an untuned secondary. The battery is placed in the middle of the receiver and at the end is placed the telephone receiver consisting of a special magnet, bobbin, diaphragm and earpiece. The antenna and ground connections are instantly made by a special double contact plug.

To operate the instrument the person using it has a metal plate attached to the heel of one shoe, to which is attached the ground wire leading to the set, the wire being passed through the trouser leg so as not to be seen. The wire to the antenna is run down through the coat sleeve and into a hollow cane which may contain a spiral aerial or a similar arrangement.

Standing against an iron fixture which connects with the ground the operator places the metal electrode on the heel in contact with the same. The cane containing the antenna is held over the shoulder or in any position not likely to cause attraction. The earpiece is placed against the ear and the other end adjusted till the signals are heard loudest.



Unlike Mohammed U. Fips' later invention, this early pen required an aerial and ground.

CORRECTION

The coil table mentioned in the article "A Portable Shop," published in the February issue, was inadvertently omitted. As a large number of readers have written to ask about the table, it is reproduced below.

No doubt many readers have already constructed the apparatus, using coils of their own design. If they have arrived at values which cover the spectrum and oscillate satisfactorily, it will not be worth while to modify them to conform with the table. Any set of coils that cover the bands is correct. In many cases the cathode tap will have to be varied from the point given, to accommodate individual differences.

Coil Table
(all coils are wound on 1½ in. forms)

I.F. coil (456 kilocycle) No. 26 enamel wire. 170 turns close wound; cathode tap 50 turns from ground.
Broadcast—No. 22 d.c.c 100 turns close wound; cathode tap 13 turns from ground.
80 Meter—No. 22 d.c.c. 29 turns close wound; tap 2 turns from ground.
40 Meter—No. 22 d.c.c. 16 turns spaced 1¼ inch; tap 1½ turn from ground.
20 Meter—No. 22 d.c.c. 7 turns spaced 1¼ inch; tap 1½ turn from ground.

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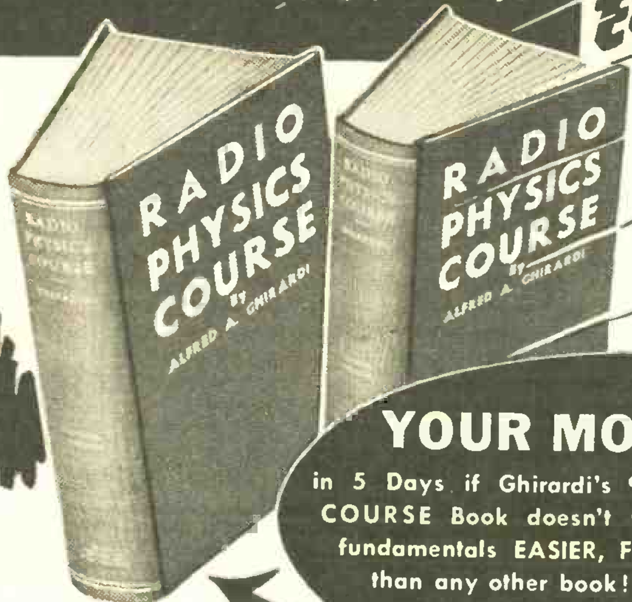

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Edited by ELMER R. FULLER

WORLD-WIDE STATION LIST

At last the effect of sun spots and the northern lights have diminished and some fair reception has been enjoyed by our observers. We sure hope that it will last a while so that some of the dx can be written into the log. The best European reception seems to be coming from the Swiss transmitters at Berne. 6.345 megacycles is very good at 8:30 pm on and 7.380 is fair at the same time. Some code interference is heard on the latter, however.

A new Mexican has been reported on 11.80 megacycles at 1 to 11 pm. The call is XERH. Brazzaville is now heard on 9.980 megacycles at 5 to 8 pm; with the news at 5:15 and 6:30 pm. On 9.745 megacycles, Leopoldville is again being heard at 1 to 9:30 pm daily. These same programs can also be heard on 9.350 megacycles, at the same hours. This is a new frequency for this transmitter.

VUD3 from Delhi, India, is now being heard on the east coast occasionally at 8:30 to 11:30 am. Reception is fair from this one. VE9AI has discontinued use of the 6.005 megacycle frequency. The German transmitter at Leipzig is being heard from 3 to 7:45 pm and from midnight on. It is a very good signal, and easily received. Identification is by the piano notes of the old folk song used by Berlin transmitters before and during the war. It is the best German heard in a long time. Programs are in the Home Service and is in all German language.

KU5Q on Guam is still good around 7 am on 9.670 megacycles. ZQI in Jamaica is heard from 4:30 to 6:30 pm on 4.700 megacycles.

Reception reports on HIT should be sent to Calle Arzobispo Nouel 24 altos, Ciudad Trujillo, Dominican Republic. Reports should be in Spanish, and *be sure to inclose international reply coupon.* The programs are heard nightly on 6.630 megacycles until sign-off at 9 pm. The station identification is made by a man who says, "El HIT Del Airo," and sign-off is followed by the National Anthem.

XEBT in Mexico City is also sending verification cards in return for good, complete reports, which should be in Spanish. They are heard very well about 8 pm on 9.625 megacycles.

All schedules Eastern Standard Time.

Freq.	Station	Location and Schedule
11.800	JZJ	TOKYO. JAPAN: 9 to 10 am.
11.810	WLWLI	CINCINNATI. OHIO: European beam. 6 to 7:45 am; 1 to 5:45 pm.
11.810	ZOJ	COLOMBO. CEYLON: 5 am to noon.
11.820	GSN	LONDON. ENGLAND: New Zealand beam. 12 to 1 am; African beam. 1 to 4 pm.
11.826	WCRC	NEW YORK CITY: European beam. 6 to 10:30 am.
11.830	WCRC	NEW YORK CITY: European beam. 10:45 am to 4:30 pm; South American beam. 5 to 11 pm.
11.830		MOSCOW. U.S.S.R.: 10 pm to 2 am; 6 to 8 am; 11 to 11:30 am; 6 to 7 pm.
11.835	CXA19	MONTEVIDEO. URUGUAY: 6 am to 10 pm.
11.840	GWQ	LONDON. ENGLAND.
11.840	VLG4	MELBOURNE. AUSTRALIA: North American beam. 12:10 to 12:45 am; 10 to 10:45 am; New Caledonia beam. 3:10 to 4 am; Southwest Pacific beam. 4:30 to 5:15 am; Asiatic beam. 5:15 to 6:45 am.
11.840	VLC7	SHEPPARTON. AUSTRALIA: Tahiti beam. 1 to 1:40 am.
11.845		PARIS. FRANCE: 8 to 9:45 pm; 10 to 10:45 pm; 11 to 11:45 pm; midnight to 3 am; noon to 5 pm; 5:30 to 7:30 pm.
11.847	WGEA	SCHENECTADY. NEW YORK: European beam. 6 am to 3:45 pm; Brazilian beam. 4 to 10:30 pm.
11.847	XMHA	SHANGHAI. CHINA: 6 to 0 am.
11.855		SINGAPORE. MALAYA: 8 to 9:30 am.
11.860	GSE	LONDON. ENGLAND: Near and Middle East beam. 11:45 pm to 5 am; 1:30 to 2 pm; African beam. 3:30 to 4 pm; European beam. 11:30 to 1:45 am; 5 to 8 am; 10:15 am to 11:30 am; 12 to 4 pm.
11.860		RANGOON. BURMA: 10 pm to 1 am; 2:15 to 3 am; 8:30 to 10 am.
11.870	WNBI	NEW YORK CITY: South American beam. 6:30 to 11 pm.
11.870	WOOW	NEW YORK CITY: European beam. 6 am to 5:45 pm.
11.880	LRR	ROSARIO. ARGENTINA: heard at 7:30 pm.
11.885		MOSCOW. U.S.S.R.: 6:45 to 8 am; 6:30 to 7:30 pm.
11.890	KWIX	SAN FRANCISCO. CALIF.: Hawaiian beam. 4 pm to midnight; 12:15 to 1:45 am.
11.893	WNBI	NEW YORK CITY: European beam. 1:15 to 4:45 pm.
11.897	JVU3	TOKYO. JAPAN: 6:45 am to 12:30 pm.
11.900	XGOY	CHUNGKING. CHINA: Allied forces in the Far East. 7 to 8 pm; Asia. Australia. New Zealand beam. 5 to 5:30 am; East Russia beam. 5:30 to 6 am; Japan beam. 6 to 6:30 am.
11.900	CXA10	MONTEVIDEO. URUGUAY: 3:30 to 9 pm.
11.930	GVX	LONDON. ENGLAND: North American beam. 5 to 7 am; 2:30 to 4 pm; 4:15 to 9 pm; Indian beam. 10:30 am to 12:15 pm.
11.950		MEXICO CITY. MEXICO: heard evenings.
11.955	GVY	LONDON. ENGLAND: European beam. 5 to 7:30 am; Near East beam. 1 to 4 pm.
11.960	HEK4	BERNE. SWITZERLAND: Tuesday and Saturday. midnight to 1:30 am.
11.970	FZI	BRAZZAVILLE. FRENCH EQUATORIAL AFRICA: 11 am to 6:45 pm; midnight to 2:30 am.
11.955	CSX	LISBON. PORTUGAL: 8 to 10 am.
12.000	CE1180	SANTIAGO. CHILE: late afternoons.
12.040	GRV	LONDON. ENGLAND: Australian beam. 12 to 4 am.
12.070	CSW	LISBON. PORTUGAL: heard 1:30 to 3 pm.
12.080	PST	RIO DE JANEIRO. BRAZIL: 6 to 7 pm.
12.080		MOSCOW. U.S.S.R.: 8 to 11 am.
12.095	GRF	LONDON. ENGLAND: Near East beam. 1 to 3:15 am; 11 am to 12:45 pm; Italian beam. 1 am to 12:45 pm.
12.110	HI3X	CIUDAD TRUJILLO. DOMINICAN REPUBLIC: noon to 2:30 pm; 6 to 10:30 pm.
12.175		MOSCOW. U.S.S.R.: 6:45 to 7:45 am; 8:30 to 10:30 am; noon to 1 pm; 7 pm to 1 am.
12.190	LSN3	BUENOS AIRES. ARGENTINA: 6.15 pm.
12.210		VIENNA. AUSTRIA: afternoons at 4:30 pm.
12.250	WXFD	ALASKA: 8 pm to midnight.
12.255	KU5Q	GUAM: 5 am; 7 pm to midnight.
12.265		MOSCOW. U.S.S.R.: 4 to 5:30 pm; 8 to 9:30 pm; 10 pm to 6 am; 7 am to 1 pm.
12.265	TFJ	REYKJAVIK. ICELAND: 8 to 9 am; 3 to 6:30 pm.
12.270		HAVANA. CUBA: evenings.
12.445	HCJB	QUITO. ECUADOR: afternoons and evenings.
13.000	HDD	QUITO. ECUADOR: 2:45 to 3:30 am.
13.050	WNRI	NEW YORK CITY: European beam. 6 am to 6 pm.
13.050	KCBR	SAN FRANCISCO. CALIF: Oriental beam. 10:15 pm to 1 am.
14.560	WNRX	NEW YORK CITY: European beam. 6 am to 3:45 pm.
15.000	WWV	WASHINGTON. D. C.: U. S. Bureau of Standards; frequency. time and musical pitch; broadcasts continuously day and night.
15.070	GWC	LONDON. ENGLAND: Far East beam. 5 to 10:15 am.
15.105		TOKYO. JAPAN: heard at 7:30 pm.
15.110	GWG	LONOON. ENGLANO: Near and Middle East beam. 6:15 to 6:45 am; 1:30 to 2 pm; African beam. 12:30 to 12:45 pm; European beam. 5 to 8 am; 10:15 am to 2 pm; 2:30 to 4 pm.
15.110	HCJB	QUITO. ECUADOR: mornings and afternoons.
15.130	KGE1	SAN FRANCISCO. CALIF.: Alaska-Oriental beam. 5 to 7:45 pm; Southwest Pacific beam. 8 pm to midnight.
15.130	WRUW	BOSTON. MASS.: European beam. 6 to 8:45 am.
15.140	GSF	LONDON. ENGLAND: Australia beam. 1:30 to 4 am; Indian beam. 11 pm to 12:45 am.
15.120	HVJ	VATICAN CITY: Wednesdays. midnight to 12:30 am.
15.150	WRCA	NEW YORK CITY: European beam. 7:30 am to 3:30 pm; Brazilian beam. 4 to 6:45 pm.
15.150	KNBX	SAN FRANCISCO. CALIF.: Oriental beam. 9 to 11:45 pm.
15.155	SBT	STOCKHOLM. SWEDEN: 6 to 7 am; 10 am to 1:15 pm; Sundays. 2:45 am to 1:15 pm.
15.160	JZK	TOKYO. JAPAN: heard at 7:30 pm.
15.170	TGWA	GUATEMALA CITY. GUATEMALA: daytime transmissions.
15.180	GSO	LONDON. ENGLAND: Near East beam. 12:15 am to 3:30 pm.
15.190	CKCX	MONTREAL. CANADA: European beam. 7 am to 3 pm.
15.195	TAQ	ANKARA. TURKEY: 4:15 to 8 am.
15.200	WLWSI	CINCINNATI. OHIO: South American beam. 5 to 7:15 pm.
15.200	VLA6	MELBOURNE. AUSTRALIA: Japanese beam. 2:30 to 3:30 am.
15.200	WOOC	NEW YORK CITY: European beam. 6 am to 3:15 pm.
15.210	KGEX	SAN FRANCISCO. CALIF.: Philippine beam. 4 pm to 1:45 am.
15.210	WBOS	BOSTON. MASS.: European beam. 6 am to 12:45 pm.
15.220	CHTA	MONTREAL. CANADA.
15.225	JTL3	TOKYO. JAPAN: 5:15 to 7:15 pm.
15.230	VLG6	MELBOURNE. AUSTRALIA: Northern Australia beam. 10 to 10:25 pm.
15.230	WLWL2	CINCINNATI. OHIO: North African beam. 6 to 7:45 am; 8 am to 12:45 pm; 1 to 5:45 pm.
15.230		MOSCOW. U.S.S.R.: 5:45 to 6:25 pm; 6:45 to 8:15 am; 3 to 3:45 pm.
15.240	KNBX	SAN FRANCISCO. CALIF.: Oriental beam. 3:45 to 8:45 pm.
15.250	WLWK	CINCINNATI. OHIO: South American beam. 5 to 7:15 pm.
15.250	WLWRI	CINCINNATI OHIO: North African beam. 7:30 am to 3 pm.
15.260	GSI	LONDON. ENGLAND: African beam. 10:30 am to 2:15 pm.
15.270	WCBX	NEW YORK CITY: European beam. 6 am to 3:45 pm.
15.270	KCBR	LOS ANGELES. CALIF.: Oriental beam. 4 to 10 pm; 10:15 pm to 1 am.
15.280	WNRE	NEW YORK CITY: European beam. 7:30 am to 4:15 pm.
15.290	WRUL	BOSTON. MASS.: North African beam. 9 am to 5 pm; Caribbean beam. 5:15 to 5:45 pm.
15.275	ZOJ	COLOMBO. CEYLON: news at 10 pm and midnight.
15.290	VUD3	DELHI. INDIA: 7 to 8 am.
15.300	GWR	LONDON. ENGLAND: South American beam. 2:30 to 4:45 pm; Central American beam. 5 to 6:15 am; 2:30 to 4:45 pm.
15.310	GSP	LONDON. ENGLAND: North American beam. 6:15 am to 6 pm; African beam. 1 to 3 am; Near and Middle East beam. 5:15 to 5:30 am.
15.315	HER6	BERNE. SWITZERLAND: Mondays. 3 to 3:30 am.
15.320		MOSCOW. U.S.S.R.: 5 to 11:30 am.
15.325	JLP2	TOKYO. JAPAN: 11:45 pm to 4 am.
15.330	WGEO	SCHENECTADY. NEW YORK: European beam. 6 am to 4:30 pm.
15.340	KNBI	SAN FRANCISCO. CALIF.: South American beam. 5 to 11:45 pm; Oriental beam. 2 to 4:45 pm.
15.340		MOSCOW. U.S.S.R.: 5:30 to 9:30 am.
15.350	WRUA	BOSTON. MASS.: European beam. 6 am to 4:15 pm.
15.350		PARIS. FRANCE: 6 to 8 am.
15.375	GRE	LONDON. ENGLAND.
15.405	PZX5	PARAMARIBO. SURINAM: 12:30 to 1 pm.
15.420	GWD	LONDON. ENGLAND: Australian beam. 1:30 to 4 am; New Zealand beam. 1:30 to 4 am.
15.435	GWE	LONDON. ENGLAND: Middle East beam. 12 to 2:15 pm; South American beam. 2:30 to 4:45 pm.
15.450	GRD	LONDON. ENGLAND: African beam. 10:30 am to 2:15 pm.
15.505	CMA5	HAVANA. CUBA: 6:45 to 7:30 pm.
15.595	FZI	BRAZZAVILLE. FRENCH EQUATORIAL AFRICA: 4:45 to 8 am.
15.620	VRR6	JAMAICA. BRITISH WEST INDIES.
15.810	LSL3	BUENOS AIRES. ARGENTINA: heard mornings.
15.875	HED4	BERNE. SWITZERLAND: 2:15 to 2:50 pm.
15.920	KU5Q	GUAM: 7 pm to midnight.
17.445	HVJ	VATICAN CITY: Wednesdays and Saturdays. 8:45 to 9:15 am.
17.527	FZI	BRAZZAVILLE. FRENCH EQUATORIAL AFRICA: midnight to 2:30 am; 4:45 to 7:45 am; 11 am to 5 pm.

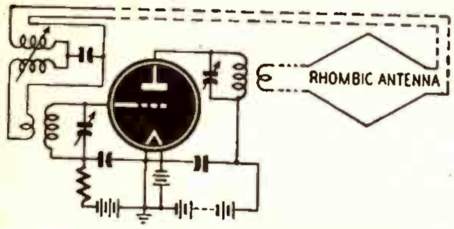
(Continued on page 660)

NEW RADIO ELECTRONIC PATENTS

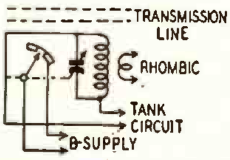
ANTENNA SYSTEM

George T. Royden, S. Orange, N. J.
Patent No. 2,393,656

A RHOMBIC ANTENNA is known as an excellent wide-band system. However, it requires a resistance termination for optimum results. This resistor must dissipate sufficient energy to prevent reflection along the antenna.



Instead of a resistor, this rhombic uses a transformer as a termination, for the purpose of transmitting some of the antenna energy back into the transmitter input. Therefore two effects are accomplished; antenna reflections are eliminated; oscillations are maintained. The transmission line between antenna output and transmitter input can be made of suitable length so that phase relations are satisfied for oscillations at the required frequency.

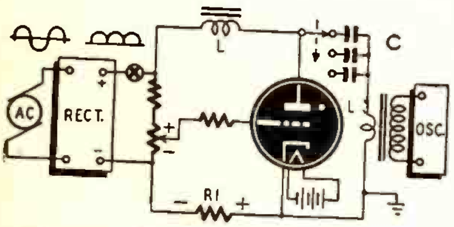


The inventor suggests the use of this system in connection with radar or radio jamming facilities. For these purposes the tuning condenser is rotated continuously through the desired band of frequencies. On the same shaft is connected a rotary arm contacting a metal band. This constitutes the B-minus return. At one position an interruption on the metal band is provided, so that during this moment (corresponding to the desired frequency) no jamming takes place. This frequency, which may be set at any desired point in the band covered by the apparatus, is used for communication transmission.

PULSE MODULATOR

John E. Gorham, Spring Lake and
Andrew W. Frevert, S. Belmar, N. J.
Patent No. 2,391,894

THIS circuit is designed to shape as well as time the pulses used to modulate an r.f. amplifier. An alternating current is rectified and applied to a thyratron control circuit. This voltage charges the condenser at a rate determined by the resistance and capacitance in the circuit. The charging current flowing through R1 puts a negative voltage on the grid which opposes the existing positive voltage, and as it dies down, two effects tend to break down the tube: (a) the rising plate voltage (b) the rising grid voltage. The variable resistor is adjusted to fire the tube at the moment of peak condenser voltage.



When the tube fires it permits the condenser to discharge through it (L prevents sudden current flow), the resulting oscillatory flow reversing the condenser voltage and quickly extinguishing the tube.

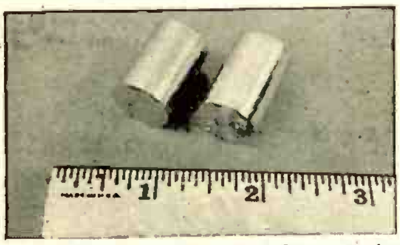
With the rectified voltage shown, the pulse rate will be twice that of the applied a.c. frequency. If pure d.c. is used this rate may be adjusted to any value by changing values of C and L (the transformer primary). The width of the pulse depends upon the size of condenser C.

New RADIO·ELECTRONIC DEVICES

SOUND PRESSURE METER

Massa Laboratories
Cleveland, Ohio

The Massa Model M 101 Sound Pressure Measurement Standard is a precision acoustic instrument developed for making absolute sound pressure measurements throughout the range.

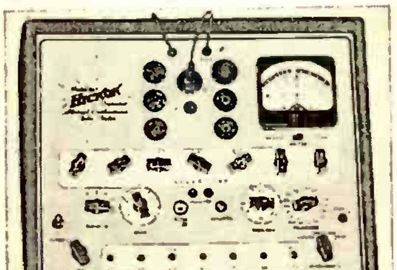


Specifications: Physical Size: ⅝-inch diameter cylinder by 15/16-inch long. Outer Housing: Metallic, chrome plated, electrically independent from both terminal connections. Electrical Connection: Two insulated pins projecting through bottom. Acoustic Impedance: Greater than 0.001 c.c. of air. Resonant Frequency: Above 45 kc, resulting in absolutely uniform pressure sensitivity throughout the audible frequency range. Free Field Response: Non-directional in all planes to 5 kc. Diffraction presented by a rigid cylinder ⅝-inch diameter at higher frequencies. Cavity Resonance: Completely eliminated in the design. Sensitivity: 23 microvolts/dyne/cm^2 sound pressure. Electrical Impedance: Equivalent to a 100 μμf condenser throughout the entire audible range.—RADIO-CRAFT

TUBE TESTER

Hickock Electrical Instrument Co.
Cleveland, Ohio.

The Model 532C (counter model) and 532P (portable) accurately test and reject all bad tubes. The tester is fitted with scales having MICROMHO ranges

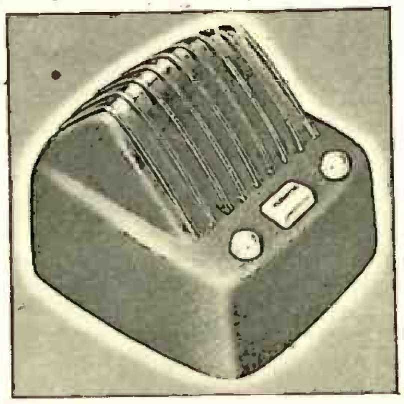


from 0-3000, 0-6000, 0-15,000 with legends indicating "Replace," "Doubtful," and "Good." This unit also provides for noise, gas, and hot and cold shorts tests. Diodes are tested separately with low voltage to prevent paralysis of the elements. Line voltage is indicated correctly on a large test meter—from 100 to 130 volts. Rectified current is used to energize plates and grids, using two rectifiers, and tests can be made of grid controlled rectifier tubes. Filament voltage is in steps to 117 volts. The tester is 17x18x8½-inches in size and operates on a power supply of 110-130 volts from 50-60 cycles. Tube complement is one type 83 and one type 5Y3-GT. Tests of all present-day tubes, including Octal, Loktal, Miniature, Ballast and Magic Eye tubes, can be made and provision has been made for future tube designs.
—RADIO-CRAFT

INTERCOMMUNICATOR

Operadio Manufacturing Co.
St. Charles, Illinois

The new Flexifone line features a 10-station master, a 20-station master, a 6-station "Supervisor" master, and remote speaker station.



Outstanding features are modern housings of durable die-cast metal; attractive gray-tan Hammerloid finish; self-clearing, gravity-assisted piano-type keyboard for station selector switches; selector keys and controls of plastic.—RADIO-CRAFT

COMMUNICATIONS RECEIVER

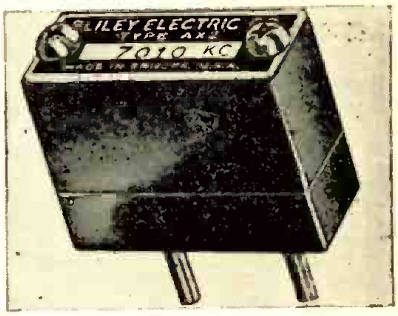
Hallicrafters Co.
Chicago, Illinois

The S-40 communications receiver features standard broadcast as well as short wave, using red markings for b.c. band. Selection of standard broadcast is thus made so simple that a child can operate it. Frequency ranges from 550 kc to 44 mc are covered in four bands. A nine-tube set, the S-40 is designed primarily for radio amateurs and short-wave listeners, but is also adapted to general use. An external "S" meter which can be connected through a special socket on the rear of the chassis is available as an accessory.—RADIO-CRAFT

AMATEUR CRYSTAL

Bliley Electric Co.
Erie, Penna.

This new crystal, Type AX2, features primary electrodes consisting of a micro-thin metal film deposited directly on the major crystal surfaces by evaporation under high vacuum. Secondary

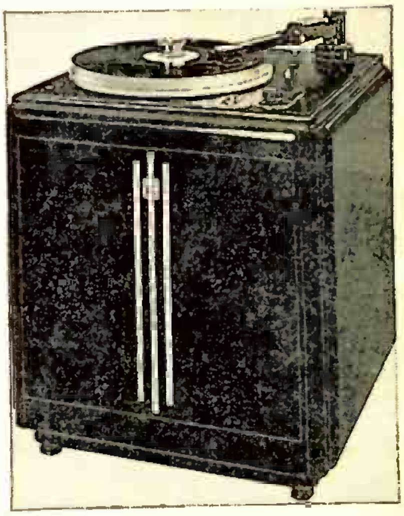


electrodes, under spring pressure, clamp the crystal and provide necessary thermal dissipation. This design results in better grid current stability over a wide temperature range, improved frequency stability under high drive conditions and substantial improvement in keying characteristics.—RADIO-CRAFT

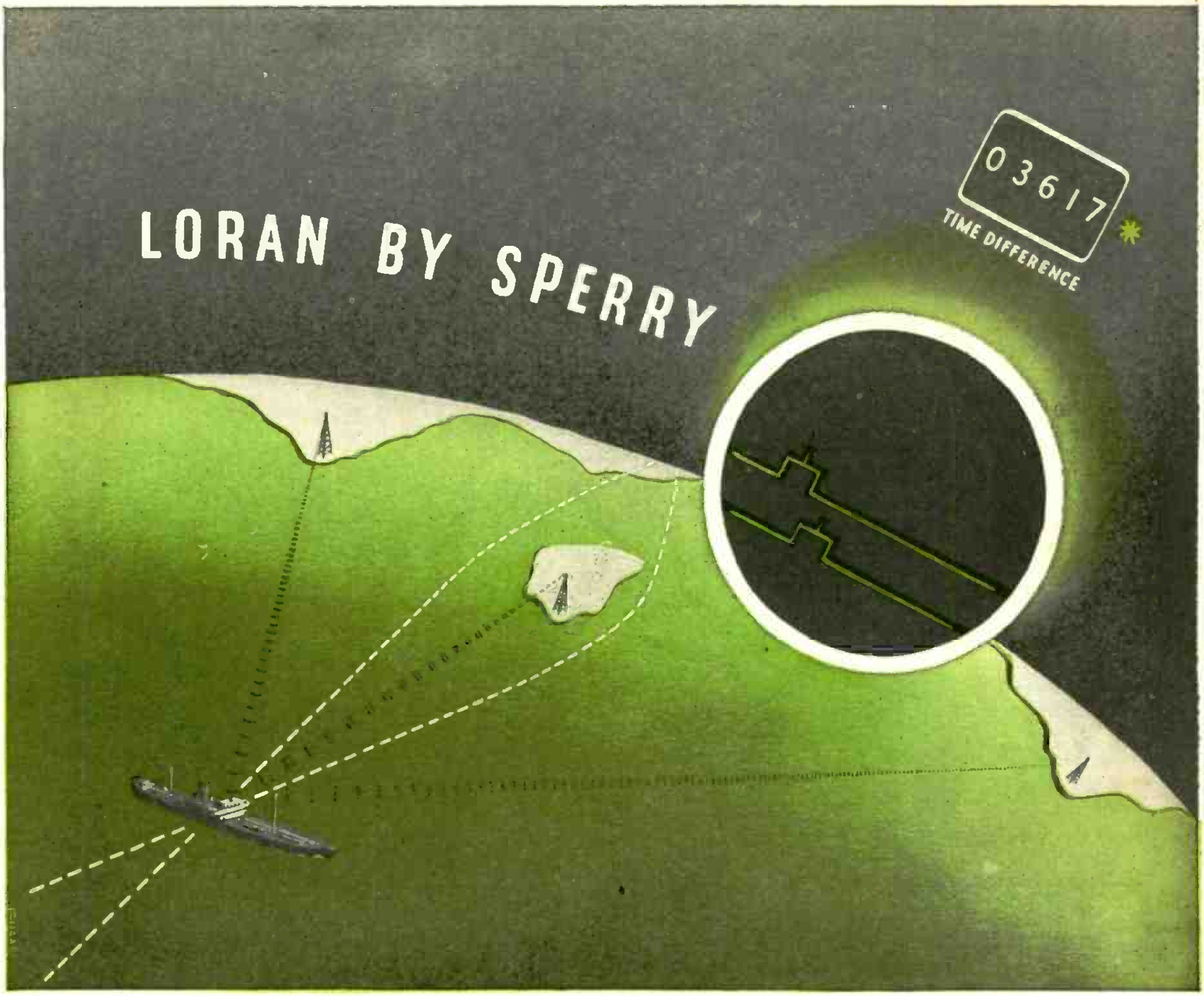
STUDIO RECORDER

Fairchild Camera and Instrument Co.
Jamaica, N. Y.

The No. 523 studio recorder is designed to meet the requirements of the commercial recording and radio industry for instantaneous or wax recordings; and the sound film industry for dubbing sound from disk to film. The table accommodates 18-inch flowed wax masters, acetate, or thicker wax masters. The synchronous motor 33.3 r.p.m. drive



guarantees absolute timing, also making the a.c. line the only interlocking device needed for dubbing sound. No. 541 magnetic cutterhead, microscope and mount in combination with the precision-built lead screw mechanism assures uniform cutting at any pitch from 80 to 160 lines.—RADIO-CRAFT



Accurate LOng RAnge Navigation...anytime...in all weather

With Sperry Loran the navigator has at hand a quick and accurate means of determining a ship's position at any time, in all kinds of weather. This system involves the reception of accurately timed radio pulses from shore-based transmitting stations, usually 200 to 400 miles apart.

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**The Time Difference Meter, giving position references* directly, *is a Sperry exclusive.*

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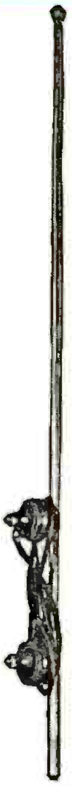

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- 66" Long
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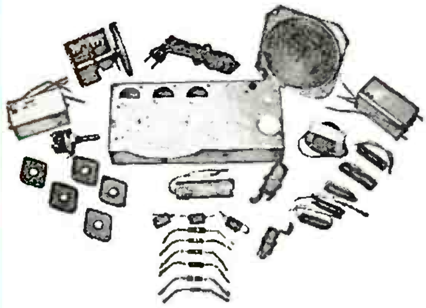

These Special Kits include: Stamped Chassis-Dynamic Speakers, Output Transformer, Volume Control and Switch, 2 Shielded I.F. Coils, Antenna and Osc. Coils, Two-gang Super Variable, 5 Octal Sockets, 20 x 20 Mfd. 150-Volt Filter, 5 Tubular Condensers, 3 Mica Condensers, 6 Resistors, 6 ft. A.C. Cord and Plug, Circuit Diagram.

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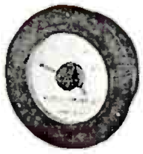

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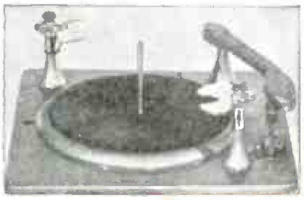

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Standard Brands, Tubular By Pass Condensers

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4 mfd. 600 Vo. T.L.A. Oil Condenser, screw base, upright aluminum can, 1½"x3¾ In. $4.50 list, replaces 8 mfd. 600 Vo. electrolytic.
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Astatic Low Pressure, curved arm, crystal pickup with Sapphire Stylus Permanent Needle, has cartridge which replaces LP6-LP21-LP23
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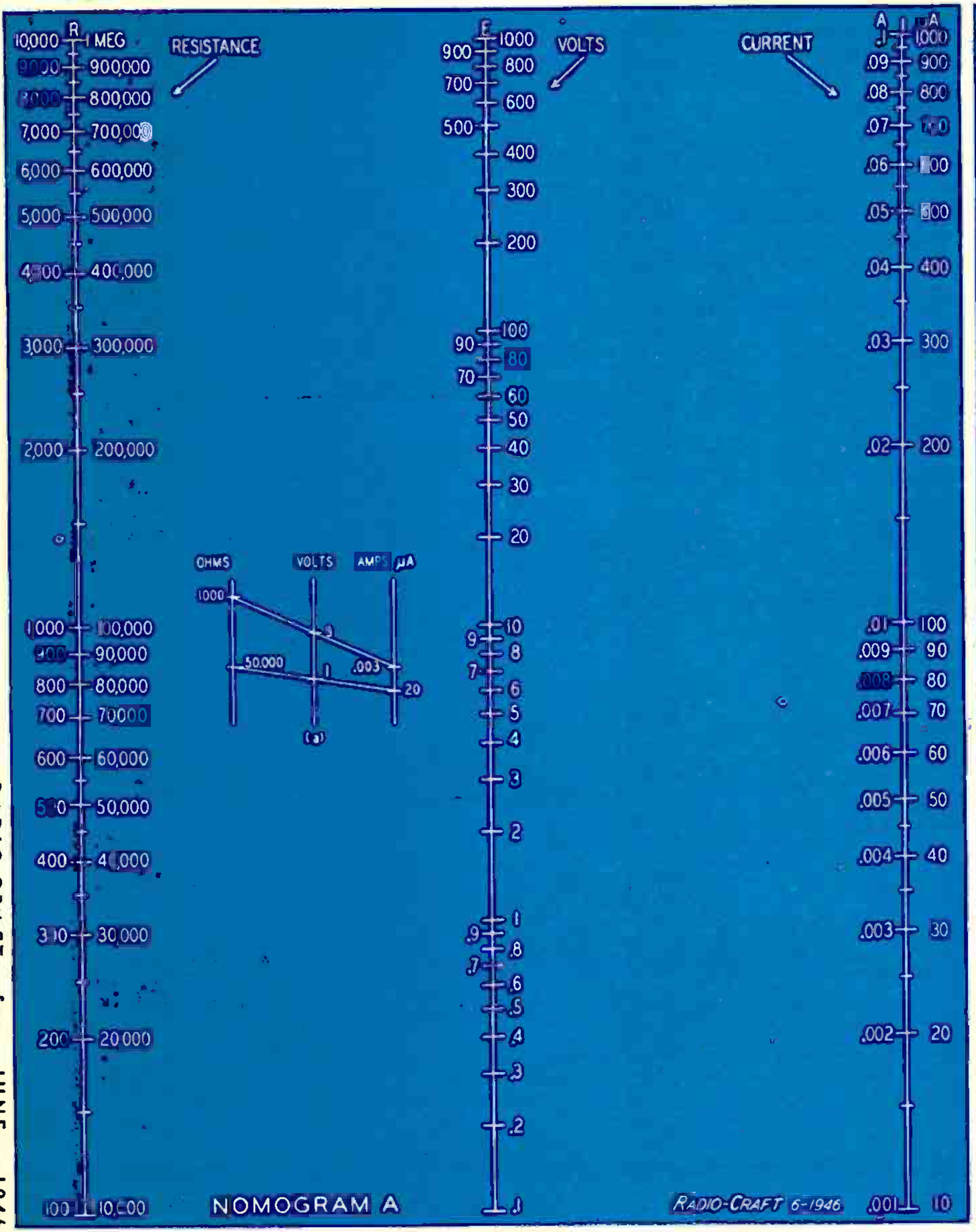
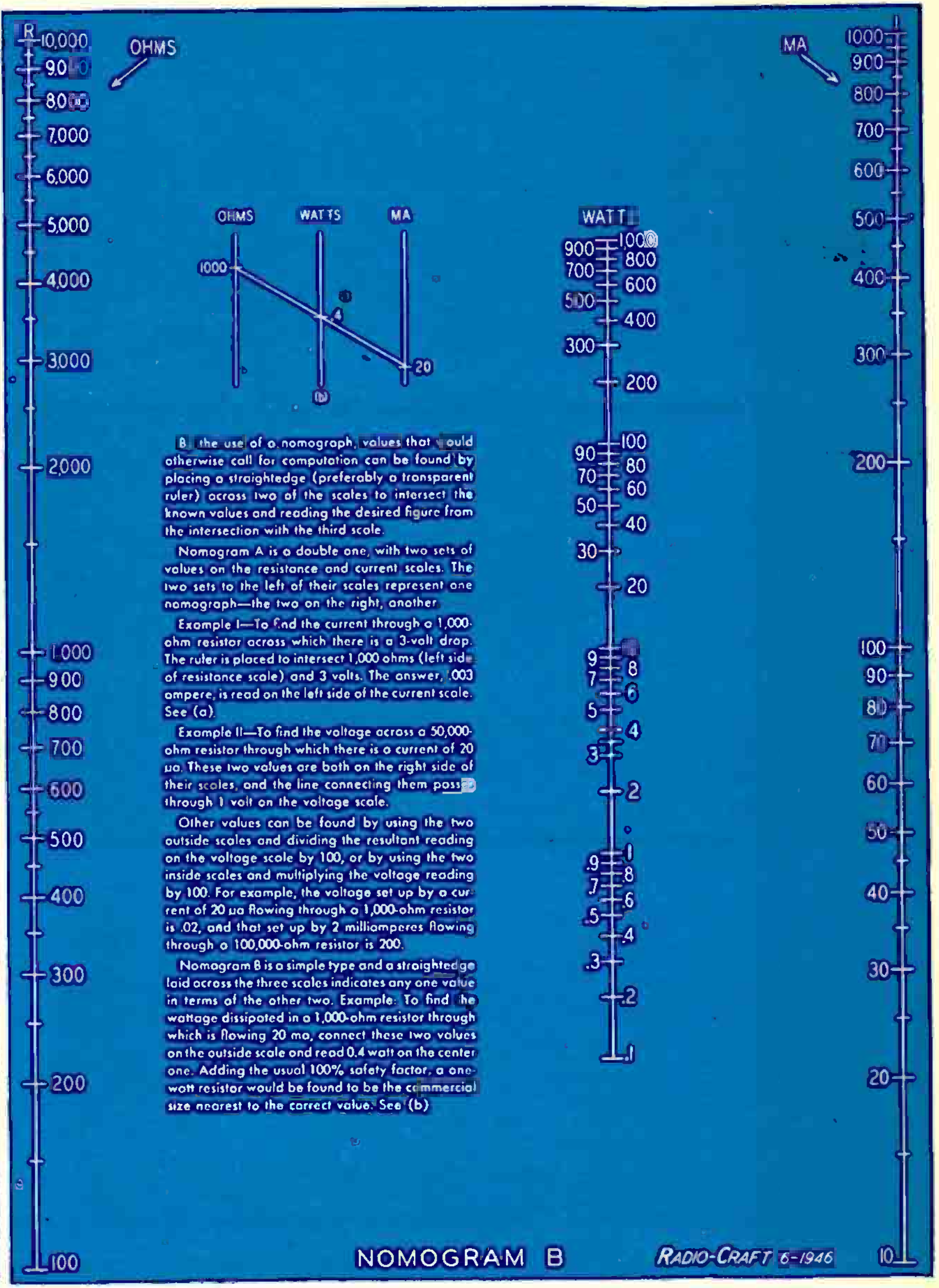
OHM'S LAW IN GRAPH FORM



WATTAGE FROM OHMS AND AMPS



B_ the use of a nomograph, values that would otherwise call for computation can be found by placing a straightedge (preferably a transparent ruler) across two of the scales to intersect the known values and reading the desired figure from the intersection with the third scale.

Nomogram A is a double one, with two sets of values on the resistance and current scales. The two sets to the left of their scales represent one nomograph—the two on the right, another.

Example I—To find the current through a 1,000-ohm resistor across which there is a 3-volt drop. The ruler is placed to intersect 1,000 ohms (left side of resistance scale) and 3 volts. The answer, .003 ampere, is read on the left side of the current scale. See (a).

Example II—To find the voltage across a 50,000-ohm resistor through which there is a current of 20 μa. These two values are both on the right side of their scales, and the line connecting them passes through 1 volt on the voltage scale.

Other values can be found by using the two outside scales and dividing the resultant reading on the voltage scale by 100, or by using the two inside scales and multiplying the voltage reading by 100. For example, the voltage set up by a current of 20 μa flowing through a 1,000-ohm resistor is .02, and that set up by 2 milliamperes flowing through a 100,000-ohm resistor is 200.

Nomogram B is a simple type and a straightedge laid across the three scales indicates any one value in terms of the other two. Example: To find the wattage dissipated in a 1,000-ohm resistor through which is flowing 20 ma, connect these two values on the outside scale and read 0.4 watt on the center one. Adding the usual 100% safety factor, a one-watt resistor would be found to be the commercial size nearest to the correct value. See (b)

NOMOGRAPH CONSTRUCTION

(Continued from page 609)

In Nomogram A, (shown on opposite page), one of the ranges (figures to the right of the scale lines) is 10 microamperes to one milliampere (1/100,000 to 1/1,000 ampere) and 10,000 ohms to 1 megohm. The other range (figures to the left of the scale lines) is from 1 milliampere to 0.1 ampere and from 100 to 10,000 ohms.

Since our outside scales range from 1 to 100, the center voltage scale might be expected to start with 1 (1 × 1) and end with 10,000 (100 × 100). But the two outside scales in this nomogram have been intentionally started with numbers which have a product of 0.1 volt. At the top we have 1 megohm × .1 ma and 10,000 ohms × 0.1 ampere = 1,000 volts in each case. How is the center

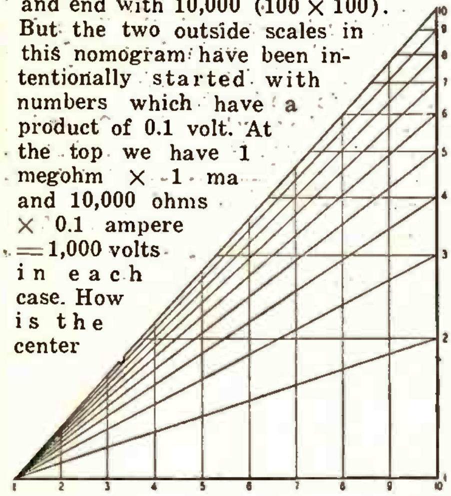


Fig. 3—With this guide (on 10- or 20-inch paper) nomograms may be drawn to any scale.

scale to be constructed? Four-cycle paper is not easily obtained—if at all—in our small size, and the center scale has four cycles.

The device in Fig. 3 solves the problem. This is drawn on 1-cycle paper (or can be drawn on any piece of paper more than 10 inches square with the help of a slide-rule scale). The base is divided into 10 equal parts from 1 to 10 (conveniently 1 inch apart). The altitude is divided logarithmically according to the 1-cycle paper (or the C-scale of a slide-rule). (Much log paper comes seven inches wide and it may be necessary to paste two sheets together, but carefully!) We can make logarithmic scales of any length with this diagonal figure.

To use the diagonal guide on the 4-cycle voltage scale, mark out the 10-volt and 100-volt points on the nomogram. One milliampere × 10,000 ohms = 10 volts. Since these figures appear on both scales, it is necessary only to connect the values together with the usual straightedge, marking the point where it crosses the center line. The two marks should coincide at the 10-volt point. Locate the 100-volt point with 10,000 ohms × .001 ampere and 1,000 ohms × 0.1 ampere, and the 1-volt point with 100,000 ohms × 10 μa and 100 ohms × .01 ampere.

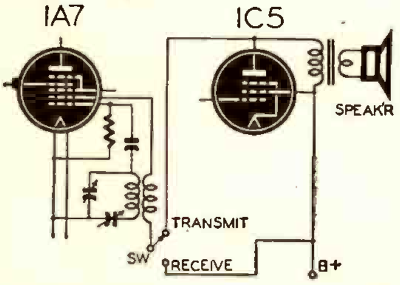
Insert the diagonal guide under the tracing paper, keep its base line directly under the base line of the nomogram,

(Continued on page 631)

RADIO · ELECTRONIC CIRCUITS

HOME BROADCASTER

A radio receiver may be used as a home broadcaster, at will, by the addition of a single switch.



As shown in the circuit, the positive lead to the oscillator tickler coil is broken and the arm of a single-pole double-throw inserted. One of the points of the switch is connected to the plate of the power output tube and the other to the B-plus line. When the switch is in the TRANSMIT position, the oscillator anode (Grid No. 2) may be modulated by speaking directly into the loudspeaker. The broadcaster may be tuned to the desired frequency by using the frequency control dial.

Normal receiver operation is had by throwing the switch to RECEIVE.

GILBERT RUST,
Evanston, Ind.

(Note—Obviously, this set will not work if the oscillator is isolated from the antenna by a tuned r.f. stage. For best results, the set should have an antenna that is closely coupled to the oscillator. A loop antenna is probably best. It would also seem that if a d.p.d.t. switch were used and the plate of the output tube cut out in TRANSMIT position, results would be better. As it is now, the two tubes are in parallel, resulting in loss of audio energy and heavy transformer primary current.—*Editor)*

R-C-L BRIDGE

Here is a very handy piece of equipment that can be constructed quite compactly yet may have the precision of a larger laboratory model. In this circuit, we find the bridge method of comparing known against unknown values and reading the ratio of the bridge.

Balance is indicated by minimum shadow on the eye of the 6AB5/6N5 indicator tube. The condition of balance is extremely sensitive due to the high degree of amplification furnished by the 12SK7 plus that of the pentode section of the 70L7.

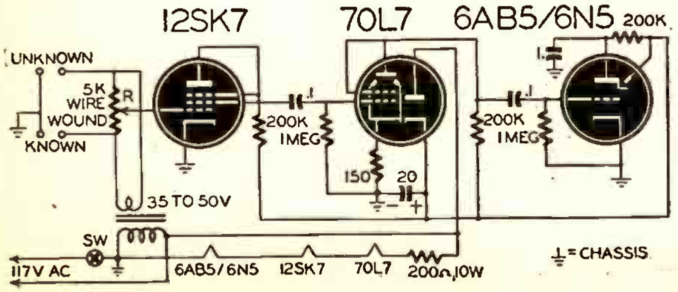
Direct current necessary for the operation of the amplifier and indicator sections of the set is furnished by the rectifier section of the 70L7 and the bridge is fed with an alternating voltage having a value from 30 to 50 volts. This voltage may be supplied by rewinding an output transformer. The 5,000-ohm wire-wound resistor in the circuit is the ratio arm of the bridge. It should have a linear taper.

RADIO-CRAFT welcomes new and original radio or electronic circuits. Hook-ups which show no advance on or advantages over previously published circuits are not interesting to us. Send in your latest hook-ups—RADIO-CRAFT will extend a one-year subscription for each one accepted. Pencil diagrams—with short descriptions of the circuit—will be acceptable, but must be clearly drawn on a good-sized sheet.

To calibrate the bridge, it is necessary to have a number of standard resistors, capacitors and inductors. These are placed across the KNOWN posts and the unknown value is connected across the UNKNOWN post. The dial of the potentiometer is calibrated from 0 to 100 and if linear will balance at 50 if known and unknown are equal. After the standards have been selected it is possible to calibrate the dial directly by placing other known values across the UNKNOWN posts and noting the position of the potentiometer R when the bridge is balanced.

Calibrating condensers should be of high quality and have a low power factor.

CAPT. DALE W. COURTER,
Hamilton Field, Calif.



VACUUM TUBE VOLTMETER

A very good vacuum tube voltmeter may be constructed from a high range d.c. ammeter.

The shunt is removed from across the terminals of a Westinghouse 15-ampere d.c. meter. The meter is inserted in the output circuit of a balanced bridge amplifier using two 6L6 tubes. V3 is the actual metering tube and V4 is used to balance out any variations in the plate current of V3 which may be caused by grid or line voltage variations.

The 6SN7-GT is used as a cathode-follower amplifier to isolate the grid of V3 from the voltage range resistors and to prevent changes in grid resistance for each range. V2 is the balancing section of the cathode follower.

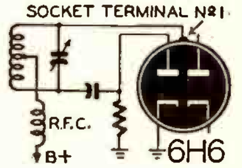
Calibration is obtained by adjusting the meter to zero with the 5,000-ohm wire-wound resistor in the cathode circuit of the 6SN7 and applying known voltages to the input.

Care in the selection of the 2-megohm resistor for the 15-volt range will result in accurate calibration over the entire range of the meter.

LEONARD W. NORRIS,
Liverpool, N. Y.

DIODE OSCILLATOR

For the sake of amusement, the writer suggested the use of the diode tube as an oscillator to a group of radio engineers. Here we are using the term "diode tube" rather loosely. The tube for this circuit is a type 6H6 metal tube, not a 6H6-G or 6H6-GT.

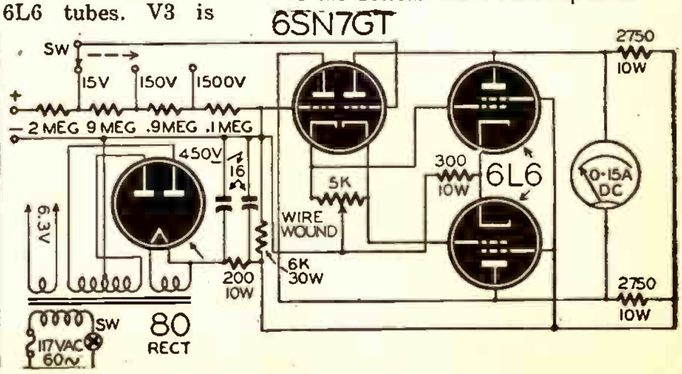


Examining the circuit, you will find that the tube is actually used as a triode. The outer metal shell of the tube is used as a plate and one of the diode plates acts as a control grid. The circuit is quite tricky and may require a little coaxing to produce oscillations.

LEO G. SANDS,
Towson, Maryland

(The circuit is interesting, but so far does not appear to have any practical angles. But has Mr. Sands tried to magnetize the shell of his tube and use it as a magnetron? Who knows—he may have a new high-frequency circuit!—*Editor)*

Tube designations were left out of the diagram below. V2 is the left-hand section of the 6SN7, V3 the bottom and V4 the top 6L6.



NOMOGRAPH CONSTRUCTION

(Continued from page 629)

and slide it left till the diagonal line representing 10 coincides with the 1-volt mark on the voltage scale. The cross lines from 2 to 9—representing tenths of a volt—can now be marked off. Move the guide up and mark the scale from 1 to 10, from 10 to 100 and from 100 to 1,000 in the same way.

This nomogram can be used for any problem where two of the quantities given on the chart are known and the third one is to be found. It has range enough to cover most radio needs, but can be extended still further by using the right side of one outside scale against the left side of the other, multiplying or dividing the middle scale by the appropriate number.

MORE DIFFICULT PROBLEMS

Most nomograms express more complex problems than the simple $IR = E$ just described. A common radio problem is: "With a given amount of current through (or voltage across) a resistor, what is a safe wattage rating?" The mathematical formula is $I^2R = W$ (watts). The difference between this and $IR = E$ is that we have a *power* of a number to contend with. I^2 cannot be handled like simple I, but is easy to deal with on a nomographic chart. Multiplication is expressed logarithmically on the chart by simple addition. Powers are expressed by multiplication. The scale for I^2 is simply $I \times 2$, or twice as long as a scale for I would be. I^4 would be four times as long.

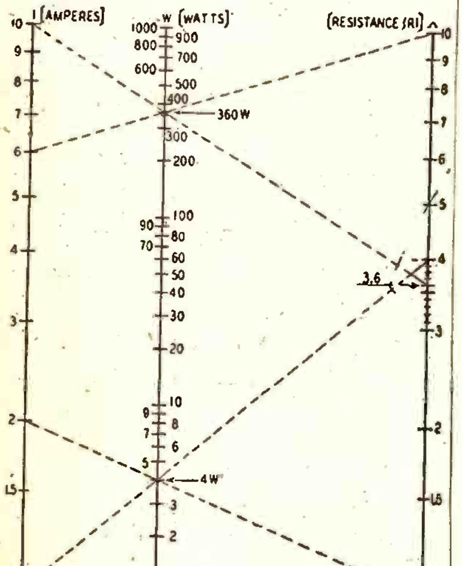


Fig. 4—Placing the "product" scale in graphs which employ roots or powers of the factors.

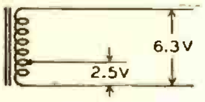
Nomograms can be constructed with scales of different lengths, but are clumsy. There is another way out of the difficulty. Let us lay out a simple nomogram on 1-cycle paper (Fig. 4), with I and R both running from 1 to 10, in amperes and ohms or any multiple or submultiple. The bottom figure for watt-

(Continued on page 633)

TRY THIS ONE

REPLACEMENT

Many times in the past we have been obliged to substitute one tube with another of different heater voltage, such as a 2A5 for a 42. To supply this tube with the required filament voltage we constructed an auto-transformer, using the iron core of a small output transformer. The first 48 turns are fed from



the 2.5 volts supplied by the filament winding of the set and the total of 122 turns furnish the 6.3 volts required by the tube. It is, of course, understood that this may also be reversed so that a 6.3-volt filament supply can be used to operate a 2.5-volt tube.

P. LIVADAS,
Alexandria, Egypt

IMPROVED VOLUME CONTROL

When a receiver using the antenna shunt plus grid-bias type of volume control circuit is tuned to a powerful station, it is often difficult to completely silence the set at the minimum setting of the volume control. This may be cured by connecting a resistor from the "B" plus end of the plate coil to the cathode of the R.F. tube. This causes additional current to flow through cathode biasing resistor thus increasing the bias on the grid.

The value of the resistor will have to be determined by experiment, but wi' probably range between 50,000 and 100,000 ohms. A two-watt resistor is recommended in this revised circuit, as considerable current flows when the volume control is in such a position as to connect its lower end to ground direct.

H. A. NICKERSON,
Dorchester, Mass.

COLOR SCHEME

In using the so-called Spintites, a serviceman usually has to dig through his tool box to select the proper size. There are invariably eight drivers to a set. The only identification one has is a small stamp on the handle denoting the size. I overcame this difficulty by dipping the handles in lacquer, using various colors. Red, yellow, and black may be used for the more popular sizes as the colors are dominant; other colors may be selected to dip the remainder. After becoming accustomed to the color scheme, much time may be saved in reaching for the proper size at a glance.

DAN W. DAMROW,
Chicago 32, Ill.

(This scheme is now in use by various manufacturers as standard practice.—*Editor)*

MIDGET CONDENSERS

In wiring many of the midget radio sets valuable space is taken by paper condensers. Since one-third to one-half the bulk of the condenser is not essential to proper functioning, space may be saved by removing the outer cover and the wax from the ends. The foil is then dipped in melted wax or paraffin so that a thin layer is deposited on the outside.

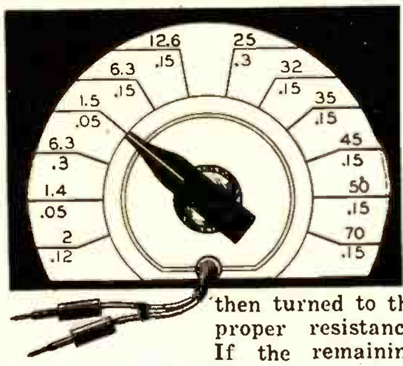
ALBERT PARKS, JR.,
Cannelton, Indiana

TUBE BURN-OUT LOCATOR

Here is a simple method of locating burned out filaments in an a.c.-d.c. receiver.

I took a 500-ohm wire-wound volume control and used an ohmmeter to mark off resistances equal to the resistance of the various types of tubes. Two flexible leads were fitted with phone tips and connected to the control.

When trying to locate a burned out filament in a series circuit, a tube is removed from its socket and the tester tips inserted in the filament holes of the socket. The dial of the locator is



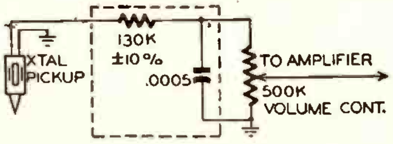
then turned to the proper resistance. If the remaining tubes heat up, the tube that you have removed is the bad one.

WRAY WYCHOFF,
Ingleside, Nebr.

(The resistance of a tube filament may be computed by dividing the operating voltage by the current. Thus a 6.3 volt, .3 ampere tube will have a resistance of 21 ohms. Resistor should be in "high" position when plugging in.—*Editor)*

PHONO SCRATCH FILTER

Here is a favorite scratch filter circuit of mine which uses no hum-collecting chokes, reduces high frequency response by only a small amount, and above all,

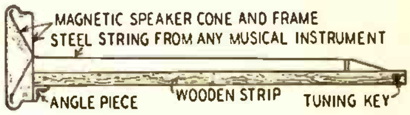


eliminates a great percentage of record surface noise.

GERALD J. WALSH,
St. Boniface, Manitoba

LOUD SPEAKING GUITAR

An old magnetic speaker can be converted into an interesting one-string guitar. The magnet and coil are removed from the speaker, leaving only the armature and stylus attached to the cone. The armature is attached firmly to a strip of wood.



The length of the wooden strip will depend upon the length of the string used. One end of the string is fastened to a tuning key and the other to the speaker armature. When the string is plucked, the cone will vibrate and act as a sounding board for the instrument. Volume depends upon cone size.

JOHN HAYNES,
Doe Run, Mo.

MULTIMETER ACCESSORY

One of our handiest gadgets is a 16-μf, 450-volt electrolytic condenser mounted in each of our multimeters, with the negative lead connected to the negative pin jack, and the positive lead to the positive pin jack, through a toggle switch. When checking voltages, a snap of the switch throws in a condenser which is known to be good, and any increase in voltage reading is clear indication of an open or partly open filter. Since the charge quickly leaks off through the meter, this eliminates the annoyance of accidentally coming in contact with a "hot" condenser, as frequently happens when a loose condenser is used to bridge across a suspected unit.

ARTHUR S. SIMON,
Armor Radio Service,
Miami, Florida

CONDENSER CALIBRATOR

With a few alterations, a signal generator may be used to calibrate condensers whose value is unknown.

Leads are brought from the ground and grid ends of the broadcast coil of the signal generator and connected to binding posts that are mounted in a convenient place on the panel.

Condensers are calibrated by tuning the generator to the low frequency end of the broadcast band. This signal is tuned in on a nearby broadcast receiver. Condensers of known value are connected across the binding posts. Tune the frequency control of the generator until the signal is again heard on the receiver. The frequency difference between the two settings of the tuning dial is noted along with the value of the condenser being used.

Condensers from .00001 to .00025 may be calibrated by this method.

AUGUSTINE MAYER,
Tiffin, Ohio

NOMOGRAPH CONSTRUCTION

(Continued from page 631)

age will be $1^2 \times$ or 1 watt, and the top figure $10^2 \times 10$, or 1,000 watts. Thus the center scale will have 31 cycles instead of 2 as in the straight multiplication charts.

But it will *not* be in the center. To locate this scale, we have to compute a few wattages, choosing them so the lines on which they lie cross at a broad angle. We can try 4 watts as a first attempt. This is 1^2 amperes $\times$ 4 ohms, or 2^2 amperes $\times$ 1 ohm. Draw both lines, as shown in the figure. Then find a similar point near the top of the scale, say, 360 watts. This is 6^2 amperes $\times$ 10 ohms, or 10^2 amperes $\times$ 3.6 ohms. Drawing these two lines to locate the 360-watt point, we find it directly above the 4-watt intersection. A vertical line can be drawn through the two points and calibrated in 3 cycles from 3-cycle paper or the diagonal guide.

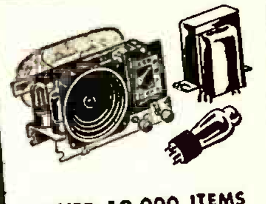
Nomogram B, shown on page 628, is suitable for calculating safe dissipation for all bleeder resistors and line cords. Note that a safety factor of 100 percent is allowed. If 20 watts is required, use a 40-watt resistor. The scales are 100 to 10,000 ohms and 10 milliamperes to 1 ampere. The watts scale would normally have six cycles, but since we are not often interested in wattages greater than 1,000 and less than 0.1 watt, only four cycles are drawn. The watts scale is located as in Fig. 4, the 1-watt and 100-watt point being particularly convenient to locate. Easiest way to make this nomogram is to draw the outside lines 20 inches long and use a piece of 3-cycle paper to calibrate the watts scale.

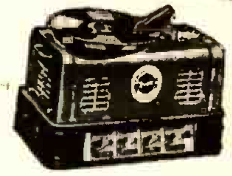
Many other radio problems are capable of easy and continuous solution with nomograms. Part II of this article will describe constructions where reciprocals, square roots and additional constant factors are included in the problem, and will give nomograms for resistance of wires R = kl/C.M. and for inductance and capacity required to tune to a given frequency $f = 1/6.28\sqrt{LC}$.

URANIUM A PROTECTOR

Deadly radiations from the uranium-made atomic bomb may be stopped short by shielding with glass containing the same mineral, Professor Alexander Silverman of the University of Pittsburgh revealed last month.

"Strange as it may seem," he said, "uranium, which is used indirectly in atomic bomb manufacture, produces a glass which is probably the best protection we have against powerful X-rays and other harmful radiations. In post-bombing rescue work, uranium or lead spun-glass garments and helmets lined with these glasses in plate form will permit safe entry into the bombed area. Oxygen respirators will be equipped with glass-insulated high-frequency precipitators to keep radioactive dust out of the lungs of the rescue squads."



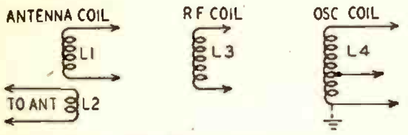


The Question Box is again undertaking to answer a limited number of questions. Queries will be answered by mail and those of general interest will be printed in the magazine. A fee of 50c will be charged for simple questions requiring no schematics. Write for estimate on such questions as may require diagrams or considerable research.

COILS FOR FM RADIO

? *I am building an FM receiver using 4.3 mc i.f. stages and covering the 40 to 50 and 88 to 108 mc bands. I want to use a tuned r.f. stage preceding the mixer. My tuning condensers have 32-μμf maximum capacity and 3.3-μμf minimum capacity. Please print coil winding data for the coils to be used in this receiver.—J.W., Tripp, S. D.*

A. The coil table below has been prepared for you. Due to stray capacitances and other factors, it will be necessary to do a little experimenting with the coils to get the exact range, pushing the coil turns together, pulling them apart or adding or subtracting one or two turns



in the same winding space.

With your intermediate frequency, there will be considerable image trouble on the higher band, and re-design of the receiver should be considered.

The tap on L4 may be varied slightly to obtain best oscillation under your conditions. All coils are wound with No. 18 enamel wire on ½-inch diameter low-loss forms.

40 to 50 mc

L1—10½ turns spaced to 1½ inch.
L2—3 turns wound ⅛ inch from ground end of L1.
L3—Same as L1.
L4—11 turns spaced to 1½ inch. Tapped 2 turns above ground.

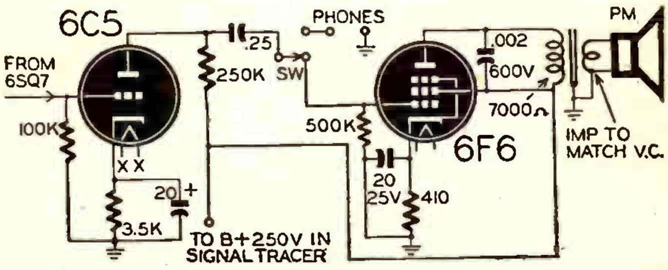
88 to 108 mc

L1—4¾ turns spaced to 1½ inch.
L2—3 turns close wound to ground end of L1.
L3—Same as L1.
L4—5½ turns spaced to 1½ inch. Tapped 2 turns above ground.

TRACER OUTPUT STAGE

? *I have a signal tracer built after one of your printed circuits. This ends with a 6SQ7 and headphones. I would like to add a speaker to this tracer. Will you please show me how to do so?—E.D., Salt Lake City, Utah.*

A. The circuit shown will adapt your tracer to loudspeaker operation, or may be used as an amplifier stage on any small radio receiver. The s.p.d.t. switch may be omitted if no phone connections are wanted. Output transformer for a 6F6 may have a 7000-ohm primary and a secondary to fit the voice coil used. Choice of tubes is, of course, very wide, and almost any triode voltage amplifier and pentode power output tube will work well in the circuit.



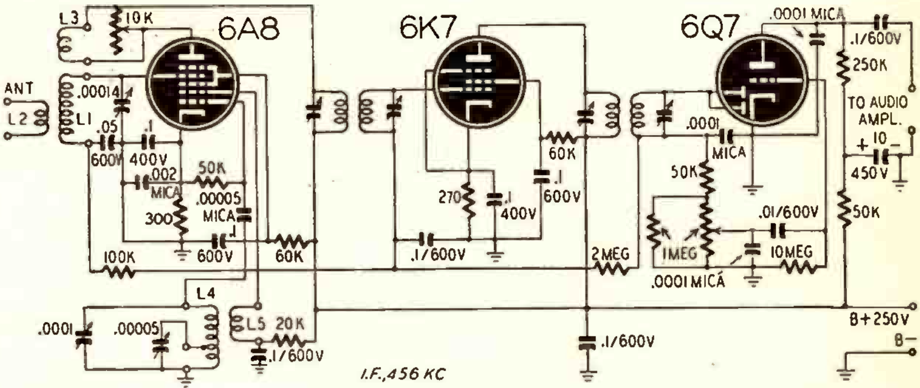
Filament connections are for the power supply of your tracer. For use as an amplifier or for other applications where a heavy enough transformer is not available, a filament transformer might be needed, or a 6C5 and 25L6 (or 25A6 or 43) may be used with a 270-ohm line cord.

SUPERHETERODYNE TUNER

? *Please print a diagram, with coil data, of a three-tube superhet tuner using a 6A8, 6K7 and a 6Q7. I would like to use plug-in coils with four or five prongs and get full coverage from 500 kc to 25 mc. I want to use 140-μμf tuning condensers with a small band-spread condenser across the oscillator coil. I have a power supply giving 250 volts.—C.V., Franklin, Tenn.*

A. This diagram is designed to meet your needs as specified. The oscillator coil uses a tapped winding so a five-prong coil must be used in this circuit. If you desire to use regeneration in the first detector stage, L3 must be included. This will require a six-prong form. If this feature is omitted, a four-prong form may be used.

A complete coil table is printed below. Coils for the longer wave-bands may be close-wound, others should be spaced as stated.



RANGE	L1 TURNS	L1 WIRE SIZE	L2 TURNS	L2 WIRE SIZE	L3 TURNS	L3 WIRE SIZE	L4 TURNS	L4 WIRE SIZE	L5 TURNS	L5 WIRE SIZE	L4 TAP TURNS FROM BOTTOM TO TAP
A – 500 TO 1000 KC 300-600 METERS	195	Nº 32 ENAM	40	Nº 32 ENAM	40	Nº 32 ENAM	127	Nº 32 ENAM	33	Nº 32 ENAM	TOP
B – 900 TO 1800 KC 160-325 METERS	110	Nº 28 ENAM	26	32	26	32	75	28	16	32	TOP
C – 1700 TO 3300 KC 90-170 METERS	60	28	13	22	15	22	56	28	14	22	40
D – 3. TO 6.4 MC 47-100 METERS	33	22	8	22	11	22	30	22	10	22	20
E – 6. TO 12. MC 26-50 METERS	18	22	4	22	8	22	16	22	8	22	7
F – 10. TO 25. MC 14-30 METERS	8.5	18	4	22	6	22	8	18	5	22	3

L3 IS JUMBLE WOUND TO 3/4" DIA. AND PLACED INSIDE NEAR BOTTOM OF L1.
L2 & L5 ARE CLOSEWOUND AND SPACED ABOUT 1/8" FROM BOTTOM OF L1 & L4.
PLUG-IN COIL FORMS 1-1/4" DIA.
L1 & L4 SPACED TO 1-1/2" ON BANDS A, B, C, D, E.
" " " " " 1" ON BAND F.

MATHEMATICS, RADIO TOOL

(*Continued from page 617*)

Working *from the bottom tap upward*—

$$R_3 = \frac{E_3}{I_3} = \frac{50}{.005} = 10{,}000 \text{ ohms}$$

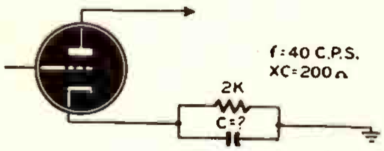
$$R_2 = \frac{E_2 - E_3}{I_3 + I_2} = \frac{100 - 50}{.005 + .010} = 3{,}333 \text{ ohms}$$

$$R_1 = \frac{E_1 - E_2}{I_3 + I_2 + I_1} = \frac{250 - 100}{.005 + .010 + .015} = 5{,}000 \text{ ohms}$$

No matter how many tapped resistors are used, we begin from the bottom and work upward as illustrated.

CATHODE CONDENSERS

In designing an amplifier, the designer has to solve many factors. For instance, what value of cathode by-pass condenser is necessary for an amplifier with an approximately flat response down to 40 c.p.s. with a cathode resistor of 2,000 ohms? The reactance of the condenser is to be one-tenth of that of the cathode resistance (Fig. 4 below):



Using the formula: $C = \frac{1}{6.28fX_c}$

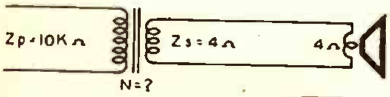
Where C = value of condenser in *farads*, f = frequency in c.p.s., and X_c = reactance of condenser (in this example, its value will be 2,000/10, or 200 ohms):

$$C = \frac{1}{6.28fX_c} = \frac{1}{6.28 \times 40 \times 200}$$

= 0.00001994 *farads* or approximately *20 microfarads*.

OUTPUT TRANSFORMER MATCHING

The primary winding of a particular output transformer has an impedance of 10,000 ohms. The technician wishes to place a speaker with a voice coil of 4 ohms across the secondary of this transformer. What ratio should exist between the number of turns on the secondary and primary windings, to provide proper matching? (Fig 5 below.)



Using the formula $N = \sqrt{\frac{Z_p}{Z_s}}$

Where N = number-of-turns ratio, Z_p = the impedance of the primary winding, and Z_s = the impedance of the secondary winding.

Then, substituting—

$$N = \sqrt{\frac{Z_p}{Z_s}} = \sqrt{\frac{10{,}000}{4}} = 50:1$$

BETTER BROADCAST TUNER

(Continued from page 610)

serious distortion. Second, it may be advanced almost to the point of oscillation to provide high sensitivity and greater selectivity so that two adjacent powerful stations may be separated.

The detector is of the so-called infinite-impedance type, which has many advantages. It has very low distortion, which makes it particularly adaptable for high fidelity reception. Its low output impedance is not affected by shunt wiring capacities, so the high audio frequencies are not attenuated.

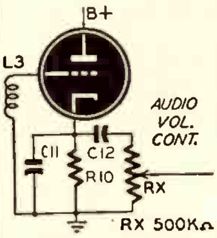


Fig. 2—How a volume control would be added to the circuit.

The output is taken from the cathode through a coupling condenser to keep the d.c. drop across the cathode resistor from biasing the first grid in the amplifier.

The wiring is straightforward, the heaters being wired first and then the grid and plate leads, care being taken to keep them short and well apart.

When the unit is finished it should be connected by means of the terminal strip shown in Photo D to 6.3 volts at 1½ amperes and 250 volts at 25 milliamperes. An amplifier should be connected to its output and turned on. The unit should have an outside antenna if it is to be used at some distance from a station. In the city you may use 20 feet of wire run under the rug, though an outside aerial will more than pay for itself by improving the signal noise ratio.

Turn the dial until a station is received. If no station is heard, then adjust the trimmers, listening to the noise level with the sensitivity control advanced full. When a station is heard, adjust the trimmers until it is at its maximum loudness. Start with the detector trimmer and work toward the one on the first r.f. stage. That done, turn the condenser all the way out to see if you can tune to a high enough frequency. If a station is heard with the condenser all the way out, turn all the adjustable slugs in the coils clockwise several turns to reduce their inductance. Then readjust trimmer for maximum volume. Turn the condenser to the low frequency end (plates engaged) and readjust slightly. If the position of the trimmers is very different at this end of the condenser, bend the end condenser plates until the trimmer adjustment holds over the whole dial.

A dial of the slide-rule or airplane type would be desirable, but a plain knob and pointer may be used with a Bristol board scale. The frequencies may be penned in with India ink.

Photo D—Terminal strip is seen in back view

The tuner when finished will prove to be well worth the work spent in its construction. The clean sound of the high frequencies and good bass will please even the most critical listener. Parts are not critical, though high-grade components will pay off in any high-fidelity tuner as in no other electronic device. A list of the required parts follows:

(Continued on page 660)

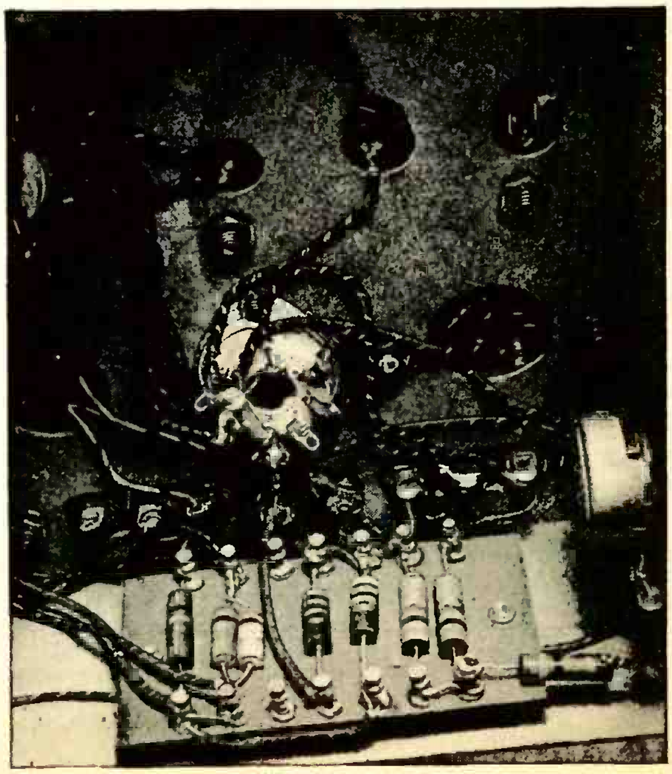


Photo C—How the resistor strip looks in a close-up. This method of attaching the resistors makes for better and more rigid wiring than letting them hang from tube prongs.

FM CARRIER STABILIZATION

(Continued from page 606)

the former reactance, current through the circuit leads the voltage by 90° and therefore the reactance tube circuit is an effective capacitance. Its value depends upon the plate current, which is dependent upon the grid voltage. In other words, the incoming audio voltage controls the size of capacitance which

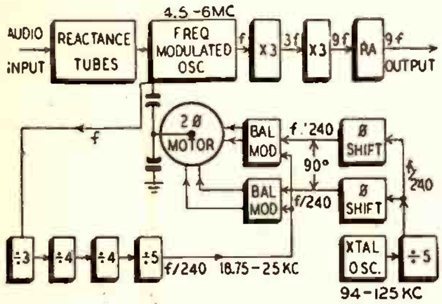


Fig. 9—Block diagram of the RCA stabilizer.

shunts the tuning tank and therefore the frequency of the oscillator.

The oscillator frequency is multiplied by 9 in two triplers. This places it in the FM band.

Convenience features the equipment. An oscilloscope is mounted on the control panel so that it can be used to observe the output of each divider to check the lock-in. The same control switch can also be used to connect the scope to either frequency multiplier (in the r.f. section) to adjust it to optimum.

Another selector switch is provided to check the motor action. A d.c. potential

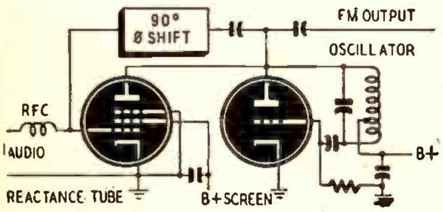


Fig. 10—Reactance-tube modulation. Control is accomplished by the plate tank condenser.

may be placed upon the modulator tubes, its value being sufficient to modulate the oscillator over a range greater than that ordinarily encountered due to ambient temperature or line voltage changes. A dial on the motor shaft may be observed to insure that the correction of frequency is as required. If for any reason the motor shaft rotates beyond the normal limits, a buzzer sounds to warn the operator.

●

Radios to the number of 100,000 will be produced in Austria, according to estimates by the government of that country.

This will do Austrian radio listeners little good, however, for the Government has decided that Austrians are too poor to afford such luxuries themselves, so almost all the 100,000 sets will be exported to get foreign exchange to buy food and essential raw materials.

TELEVISION FOR TODAY

(Continued from page 604)

transmitted during this resetting period, the trace would be completely out of place in the image. To eliminate this annoyance, the blanking pulse is employed.

The complete video signal, containing the camera signal and the blanking and synchronizing pulses is illustrated in Fig. 1. This is the form of the signal as it appears at the grid of the cathode-ray *viewing tube*. For each fluctuation of the camera voltage a different voltage is placed on the grid. This determines the number of electrons that pass into the scanning electron beam from the cathode. At the screen, the intensity of the light is a direct function of the number of electrons in the beam. When the line's end is reached, the grid is driven strongly negative, completely preventing any flow of current within the tube. Still under the influence of the blanking voltage, the receiver circuits are subjected to a synchronizing pulse, thereby setting up the beam for the following line. Once this is accomplished, the blanking voltage is removed and the camera signal once again assumes control.

At the end of a complete scanning run, when the beam has reached the bottom of the image, the *vertical* synchronizing pulse is inserted. See Fig. 2. This pulse lasts longer than the horizontal synchronizing pulse because the distance that the beam must travel—from bottom to top of the image—is much greater. It is also important that the horizontal synchronizing system is not permitted to slip out of control during this interval. Hence, the vertical pulse is broken up into a series of shorter pulses that permit control of the horizontal system at the same time. This explains why the vertical pulse is not actually one very long pulse, but rather a number of pulses closely connected, as evident in Fig. 2.

The FCC, in establishing the standards for television broadcasting, has designated the various proportions of the video signal. 75 percent of the total available amplitude of the signal is set aside for the camera variations. The remaining 25 percent is utilized for the blanking and synchronizing voltages. Since the point where the blanking voltage starts represents a point where no electrons reach the fluorescent screen, the name of *black level* has been assigned. Driving the grid more negative, as the synchronizing pulses do, certainly does not cause fewer electrons to reach the screen, since all are cut off at the blanking level. However, to name this region, the term of *blacker-than-black* has been given. (See Fig. 1.) Actually, of course, no such state can exist.

To complete the television program, the transmission of sound must be included. While several schemes exist that permit the transmission of the sound and video signals on the same set of frequencies, the most common practice today is to send each separately. The sound band, however, is placed slightly beyond the upper end of the video band, close enough to permit both to be received simultaneously at the receiver. The necessary 6 mc band is proportioned as shown in Fig. 3. It may seem curious that FM is used for the audio while the video is amplitude-modulated. However, field tests have indicated that this represents the best solution and the practice has been standardized by the FCC.

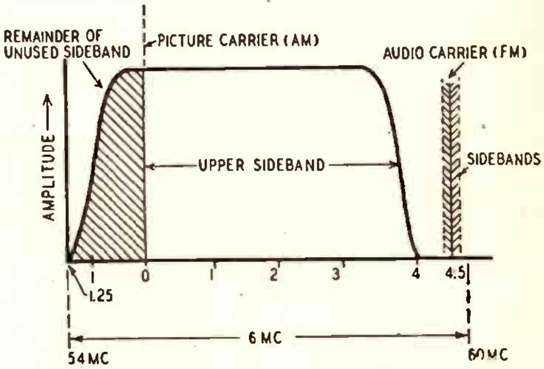


Fig. 3—Audio-video division of the television channel.

Now that we have seen the development of the video signal with its sound companion, let us investigate the arrangement of the circuits in a typical receiver, Fig. 4. A dipole antenna brings the signal down to the input stage. Whether the first stage is an r.f. amplifier or the mixer depends upon the price of the set as well as its location. In localities situated at the outer fringe of the broadcast stations' coverage area, an r.f. stage will probably mean the difference between enjoyable reception

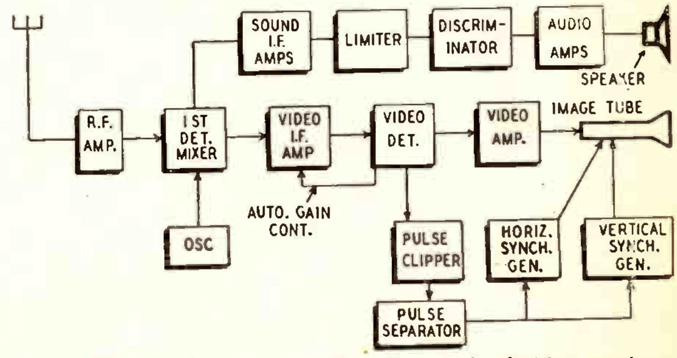


Fig. 4—Block-diagram representation of typical television receiver.

and poor or no reception at all. To be appreciated, a television broadcast must be clearly received. The eye is a critical judge and does not tolerate very much distortion. Random and background noise, to which all radio is subjected, combine with weak signals to produce an image covered with white specks. It is the function of the additional amplifier to increase the signal strength to the point where it will completely mask these noise voltages.

At the first detector, a separate oscillator produces a mixing voltage that reacts with the signal to develop the intermediate frequencies. Since the video and audio sections of the television signal have different frequencies, separate intermediate frequencies are produced. The separation occurs directly beyond the first detector, thus enabling us to deal with each signal according to its own characteristics. In addition, an early separation of both signals is necessary to eliminate any possibility of sound voltage reaching the viewing tube. Should this occur, a series of black bands appears on the screen, changing in intensity with the variations of the sounds.

Investigating the sound channel first, we find the usual lineup of stages necessary to transform an FM signal to its audio counterpart. The limiter removes all amplitude variations in the signal and thus serves as an excellent filter to guard against the trespassing of any video voltages into the loud speaker. Beyond the discriminator, the high-fidelity audio amplifiers produce enough power to drive a loud speaker. In most commercial receivers, standard broadcast reception is also included. To minimize the number of additional components needed to accomplish this, only an AM tuner is installed. A switch connects the output from this tuner directly into the audio amplifiers and the speaker. The same type of arrangement is possible on the regular FM bands. Thus, at very little extra cost, it is possible to have one cabinet house all three types of receivers.

Returning to the first detector, we find the video signal passing into a circuit much more complicated than the sound network. Aside from the additional pulse and generator stages, even the familiar i.f., detector and video amplifier stages contain many modifications. This is due to the video signal having a bandspread which extends 4 mc. A distribution of this width is needed to convey all the image information, from the very large objects in a scene that can be reproduced by relatively low frequencies to the very small details, which require a much higher frequency. Uniform response for 4 mc in a tuned i.f. amplifier can only be achieved by adequate loading; and this, as we know reduces the gain. To counteract the loss in amplification, we find that one or two i.f. amplifiers are no longer adequate; now as many as four or five

(Continued on following page)

TELEVISION FOR TODAY

(Continued from previous page)

must be included. Again we encounter the same sort of situation in the video stages, the amplifiers between the detector and the image tube. Low- and high-frequency compensation are applied to an ordinary audio amplifier to extend the range of uniform response from 15,000 cycles to 4 mc. This, in itself, alters the appearance of the conventional amplifier.

At the video detector, a second separation of signal occurs. Part of the signal continues to the grid of the viewing tube, while part of the signal is applied to a pulse clipper stage. Here the horizontal and vertical synchronizing pulses are clipped off from the signal and directed to a pulse separator network. After separation, the pulses are used to control their respective synchronizing generators. The generators form saw-tooth voltages (or currents) and by applying these voltages to deflection plates (or coils), the proper scanning action of the electron beam can be achieved. In practice, the generators operate as continuous oscillators, with the incoming synchronizing pulses triggering them off slightly before the start of their natural cycle. Thus the units are forced to keep in step with the received signal.

The video portion of the television signal is amplitude modulated and as such is subjected to all the disturbing influences of this form of modulation. For this reason automatic gain control is generally incorporated to prevent the intensity of the reproduced image from fluctuating too noticeably.

HIGH-POWER U.H.F. TUBE

(Continued from page 608)

amplifier is the coupling system, shown in Fig. 1. This is a combination of straight resistance coupling and the old d.c. amplifier circuit. The video stages

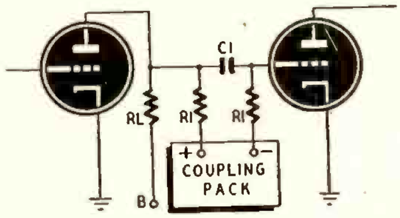


Fig. 1—The all-frequency coupling circuit.

are coupled together through an ordinary blocking condenser, the ends of which are connected through isolating resistors to the terminals of a regulated power supply, referred to as a coupling pack. This results in the higher-frequency video signals—which are most liable to attenuation by the by-passing effect of the pack's capacity to ground—being passed through the condenser. The isolating resistors (RI) are made very much larger than the first stage load resistor (RL) so the capacitance of the coupling pack does not shunt the high frequencies.

At lower frequencies, where the coupling condenser would offer considerable reactance, both terminals of the coupling pack are raised or lowered in voltage by the same amount as the plate of the first stage, transferring the signal to the second stage through a path consisting of the isolating resistors and the pack itself. The region of transfer of signal from one path to the other is gradual and smooth, and the amplifier response is uniform from high video frequencies to d.c.

Three video stages, using respectively a 6AG7, an 807, and two 807's in parallel, are followed by the first 6C22 (fourth video stage). With an input of 180 volts and a gain of 3.5, it puts out a signal of 700 volts.

The next stage—the final modulator—is a cathode follower using two 6C22's. The cathode-follower circuit is employed because it supplies a driving source of low impedance which, with the negative feedback characteristic of the circuit, tends to preserve a flat frequency response in spite of the shunt capacitance of the r.f. amplifier load.

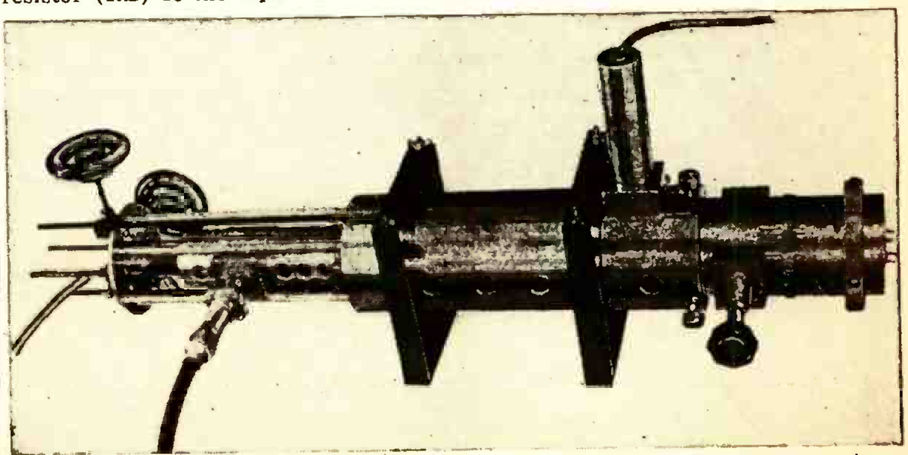


Photo B—A coaxial amplifier using the 6C22 tube, designed to operate at 490 megacycles.

A PORTABLE INTERCOM

AN intercommunication unit, portable-style, is one of the first gadgets to burst upon the postwar market. It contains a five-inch PM speaker with a voice coil matched to a carbon-ball mike, a double-throw single-pole switch, and a pair of dry cells. All component parts are housed in a tent-shaped metal cabinet with two grills cut into the face; one for the mike and one for the speaker. The switch is a slide type and is mounted between the mike and speaker openings.

The hookup is basically simple as shown in Fig. 1. The carbon-ball mike was used for greater sensitivity as it is doubtful whether a carbon-granule microphone would be sufficiently sensitive to operate the PM speaker.

An additional advantage of this unit over other communicators is that it is portable to some extent. It can be used in the open field for a distance of about 120 feet with little loss of volume, and since it does not depend on an external source for power, it can be quickly set up from apartment to roof for example, when adjusting FM or television antennas. Location of such aerials with respect to the transmitting antenna and to possible sources of "ghost" responses is important. Many schemes have been tried to get best polarization, ranging from the use of a complete radio transceiver installation between receiver and roof to simply trying the set a few days, rotating the antenna a few degrees, and trying again. This intercommunicator offers another practical solution of the problem.

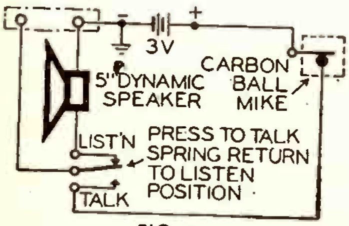
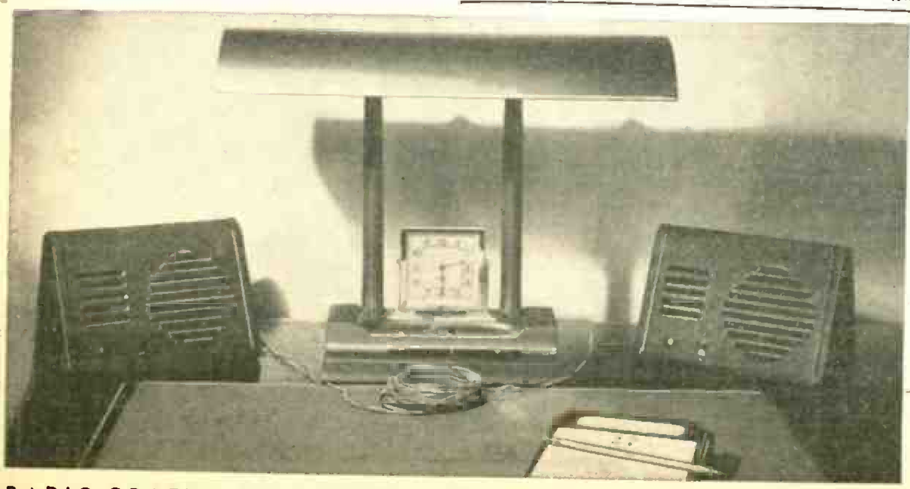


FIG. 1

When not in use, the batteries are not being drained. When one party presses the switch to the "talk" position, the batteries of the "talker's" unit operates the speaker of the "listener's" unit. The reverse occurs when the "listener" talks.



CORRECTION

The article "Dummies Save Tubes," which appeared in the March issue, page 437, contained an error in the placement of the drawings. The positions of the two drawings at the bottom of the page became reversed in the printing processes. The drawing on the left, having two 28-ohm resistors connected in series between pins 2 and 7, should have been placed over the caption: "(c) dummy for 3Q5" and the drawing with the 14-ohm resistor connected between pins 2 and 7 should have been placed on the left of the column over the caption "(b)—0.1-ampere dummy."

Our thanks to Mr. Marcus H. Moses of New York City for calling this error to our attention.

THREE-CHANNEL AMPLIFIER

(Continued from page 607)

On the other hand, we will devote more time and details to the interesting and unusual features of the amplifier.

The 1-megohm resistors R1 and R2 isolate the three inputs from each other, preventing a mutual short-circuit. The condenser C1 has as its object the short-circuiting of the high and medium notes for its particular input. Therefore the 6F5 stage at the top of the schematic is the "bass" pre-amplifier. Its gain is regulated by the volume control P1. The condenser C2 prevents basses from reaching the grid of the 6F5 directly below the "bass" input. Therefore, only mediums and highs pass. But, as we shall see, the highs will be attenuated further on. This stage constitutes therefore the "medium" pre-amplifier, controlled by P2.

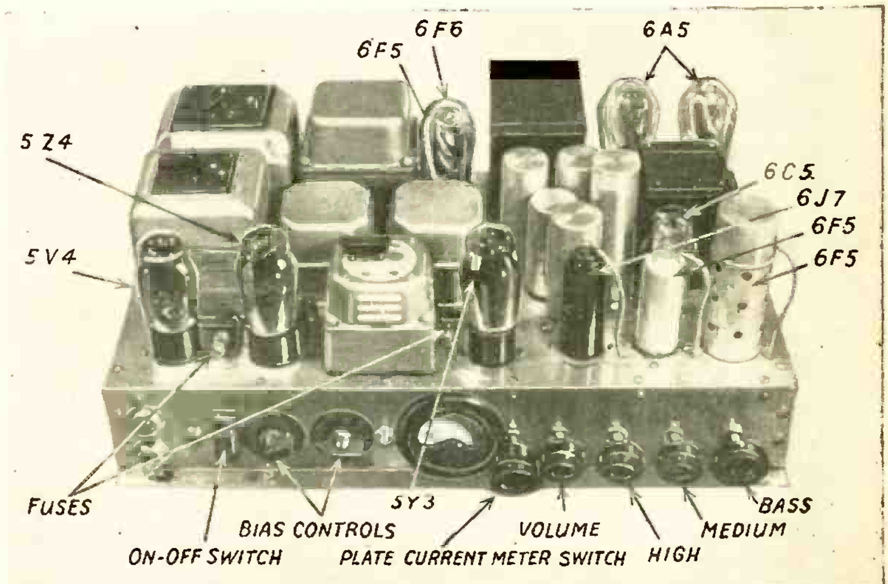
The output of these two stages is applied, through a common volume control P4, a 6C5 and a transformer, to a push-pull stage, using 6A5 triodes. Their low internal resistance permits excellent reproduction of the basses. The negative feedback circuit R4, C4 weakens the high notes, the condensers C4 being of low value (50μμf). The output transformer has two windings, the higher potential one being tapped to permit adaption to loud speakers of different impedances. This arrangement—two 6F5's, 6C5 and two 6A5's—constitute the "bass and medium" amplifier.

The low capacity condenser C3 (25 μμf) permits only the highs to pass. To enhance this effect the cathode circuit of the 6J7 is decoupled with a condenser of only 0.1 μf (across 800 ohms) which reduces the bass and medium notes through degeneration.

This stage constitutes the "high" pre-amplifier. Its gain is also independently controllable, by volume control P3. It is followed by a 6F5 and 6F6.

The output transformer feeds a little speaker, of a small diameter intended only for the reproduction of the highs. Under such conditions, this speaker has a marked directional effect. To soften this effect, signals of lower frequencies may be fed (at low level) into the "high" amplifier. This has been done through use of the resistor R.

Let us note also the milliammeter which permits rapid comparison of the plate currents of the 6A5's, or measurement of the total plate current of the two; a feature which facilitates balancing the push-pull stages and also gives a check on the condition of the amplifier.



Reprinted by special arrangement from *Toute la Radio*, Paris, France.

RADIO-ELECTRONIC QUIZ

How thoroughly have you mastered the contents of this magazine? Try the following quiz as a test:

1. How does a radio wave react when focussed by a metal lens? See page 602.
2. What is a television blanking pulse? See page 604.
3. What is a nomogram and how is it used? See page 609.
4. Can quartz crystals be used as superheterodyne oscillators? See page 611.
5. What is the band-width of a video amplifier? See page 613.
6. How do radio-frequency power supplies work? See page 616.
7. How would you design a voltage divider? See page 617.
8. What is the width of a television channel? See page 638.
9. What is a two-dimensional radio? See page 643.
10. What is the difference between a sniperscope and a snooperscope? See page 651.

TWO-DIMENSIONAL RADIOS

RECENT war-time developments in electronic circuit technique make it possible to virtually "print" a highly efficient circuit, complete with wiring, resistors and condensers, upon a ceramic plate. Batteries and tubes are soldered to the printed circuit to complete the assembly. The new development was announced in the April issue of this magazine.

The new process, developed by Centralab engineers, uses the silk screen method to apply "silver ink" to the ceramic surface. The "ink" hardens to produce a silver conductive circuit instead of the usual copper wire.

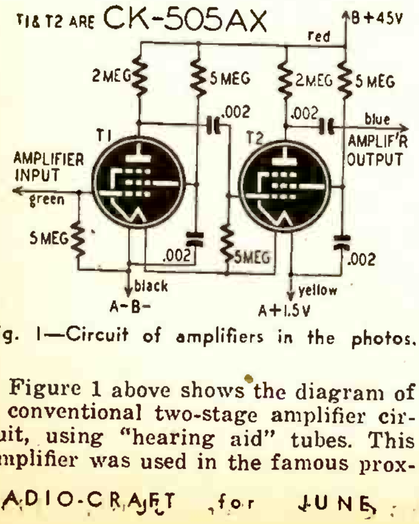


Fig. 1—Circuit of amplifiers in the photos.

Figure 1 above shows the diagram of a conventional two-stage amplifier circuit, using "hearing aid" tubes. This amplifier was used in the famous proximity fuze. In developing a technique for rugged miniature wiring circuits, for this application, the engineers came up with the "two-dimensional wiring" technique. This development makes possible unbelievable reductions in the physical size of a radio circuit. To illustrate the drastic reduction in size, Photos A and B, contrast the conventional assembly of Fig. 1 and the same circuit with the newly developed technique.

The smaller circuit is conspicuous by the apparent absence of condensers and resistors. The resistors are the small black lines which appear at the left of the tubes. They are made by screening a heavy paint, containing a large proportion of finely divided carbon onto the surface. The resistance is regulated by the length, width and chemical composition of the printed lines. Using this method, resistors ranging from 3 ohms to 200 megohms have been produced. A resinous coating is applied to the resistor to protect it from the effects of moisture, thus making it stable under all conditions.

The condensers are made from thin ceramic discs plated on each side with silver (Photo B). The capacity varies directly as the area of the plating and the thickness of the discs. It is possible to produce condensers by this method that vary in capacity from 6.5 μμf to .002 μf.

Special solder must be used for connecting power leads and tubes into circuit. A solder having at least 2 percent silver content must be used to prevent the absorption of silver ink from the surface of the plate. A low-temperature bismuth solder is used to fasten the tiny silvered capacitors to the silver leads because the heat used with normal solders would fracture the ceramic discs.

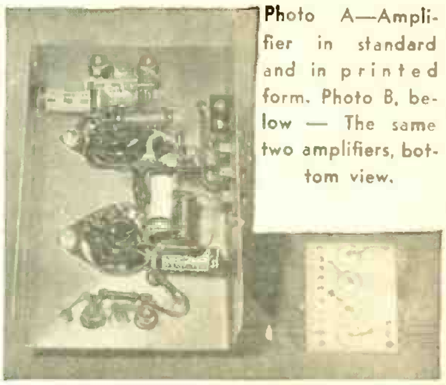


Photo A—Amplifier in standard and in printed form. Photo B, below — The same two amplifiers, bottom view.

(*Continued on page* 647)

TECHNOTES

.... LOW RESISTANCE LEADS

Save the flat copper "dial cords" from those old Atwater Kent receivers that you junk. Sections from them will make very nice low-resistance, flexible leads for plates and grids, especially for HY615's and HY75's used extensively in WERS transmitters now being converted to 144 mc ham rigs.

B. BUEHRLE, JR.,
Fergerson, Mo.

.... EMERSON FU424 AND FU427

A common complaint of these sets is low plate voltage and loss of filament voltage. The filaments of the 1.4-volt tubes are heated by the cathode current of the 117P7 (pentode section) passing through them.

An open input filter condenser will be found to be responsible for the troubles and will have to be replaced.

STANLEY RUTKOWSKI,
Erie, Penna.

.... WESTINGHOUSE M 108, M 112

When these models are subjected to humid air for a length of time, it will be noticed that the tone quality becomes very bad. This condition is caused by the voice coil coming loose from the speaker cone and may be cured by applying speaker cement freely where the voice coil and cone join.

A. K. MEMON,
Karachi, India

(Note that such troubles are more likely to occur in hot humid climates such as the writer's.—*Editor)*

.... ATWATER KENT 46

A "dead" set may be the result of the voice coil leads on the speaker cone breaking loose from the flexible leads from the output transformer. Checking and resoldering can be done without removing the cone.

B. BUEHRLE,
Fergerson, Mo.

.... SPEAKER REPAIRS

In speaker repairs where it is necessary to remove the paper cone, lacquer thinner, which may be purchased from most paint stores for about fifty cents a quart, may be used. Place the speaker face down in a tin pie plate and fill with thinner to a level that just covers the speaker rim. After soaking about twenty minutes the cone is easily removed.

Many plastic parts that have warped may be straightened by dipping in hot water and bending back to their original shape while flexible. They will retain their shape when cool.

HUBERT WATKINS,
Gulfport, Miss.

.... PHONO PICKUP HINT

I have often had trouble putting a new needle in a phono pickup head. This is especially true of heads that cannot be raised high enough to view the needle hole. Try laying a small pocket mirror under the head and the job becomes an easy one.

HOWARD SCHLIEF,
Fairfield, Pa.

Civilian Radio Jobs Wanted

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By Former Soldiers, Sailors, Marines

Radio-Craft offers its help-wanted columns free for the use of honorably discharged men in the armed services. State the type of position you seek, preferred locality, your experience, education, and other details. Confine ad to 50 words, or less. Supply name and address. Army veterans send section number or photostat of discharge paper. Navy men send photostat of discharge paper. Address RADIO-CRAFT, Classified Ad, Dept. 25, West Broadway, New York 7, N. Y. Your ad will contain a box number and replies will be forwarded to you.

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RADAR-RADIO MECH., 3 yrs. Army exp., practical instructor; married; 2 yrs. coll. M. Stark, 3118 Brighton 4th St., Brooklyn 24.

RADAR TECH.; 3½ yrs. exp., excellent electronic training, latest airborne equip., Loran. I. Gerstein, 612 Argyle Rd., Brooklyn 30.

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TECHNICIAN, Radio and electrical appliances. 6 yrs. Army exp., installing and maintaining high and low frequency equipment for Alaska Communication System. Licensed amateur, code speed 25. Can type and drive car or truck. Seeks employment with manufacturing concern offering possibilities for future. 33 yrs., married, 2 dependents. M. J. Martin, 12 No. 19 St., East Orange, N. J.

RADIO TECH.; B.S.; 1/c radio tel.; lic. Army instr.; rec. and trans. H. Mertz, 1801 Bryant Ave., Bronx 60.

H. F. Wideband Amplifier

POSTWAR video amplifier design is demonstrated in the illustrated compact high-frequency amplifier, manufactured by Sylvania Electric Products, Inc. Supplied for center frequencies between 30 and 70 mc. with any bandwidth from 2 to 10 mc., these sets are designed particularly for use as i.f. amplifiers in u.h.f. and s.h.f. receiver applications.

These units are well worth study by the serviceman and technician, for, with modifications for various applications, they are typical of what will appear in many kinds of high-frequency broadcast, television and communications apparatus.

This is the amplifier whose circuit is shown in the diagram below. It does not differ greatly in appearance from ordinary equipment.

A typical amplifier has an overall gain of 100 db with a center frequency of 60 mc and a half-power bandwidth of 9.0 mc. An external gain control is easily provided. Unless otherwise specified, a standard 500 ohm input impedance is supplied. The output stages are cathode followers designed to operate into impedances of 75 to 100 ohms with voltages ranging from 0.5 to 2.0 volts, negative or positive.

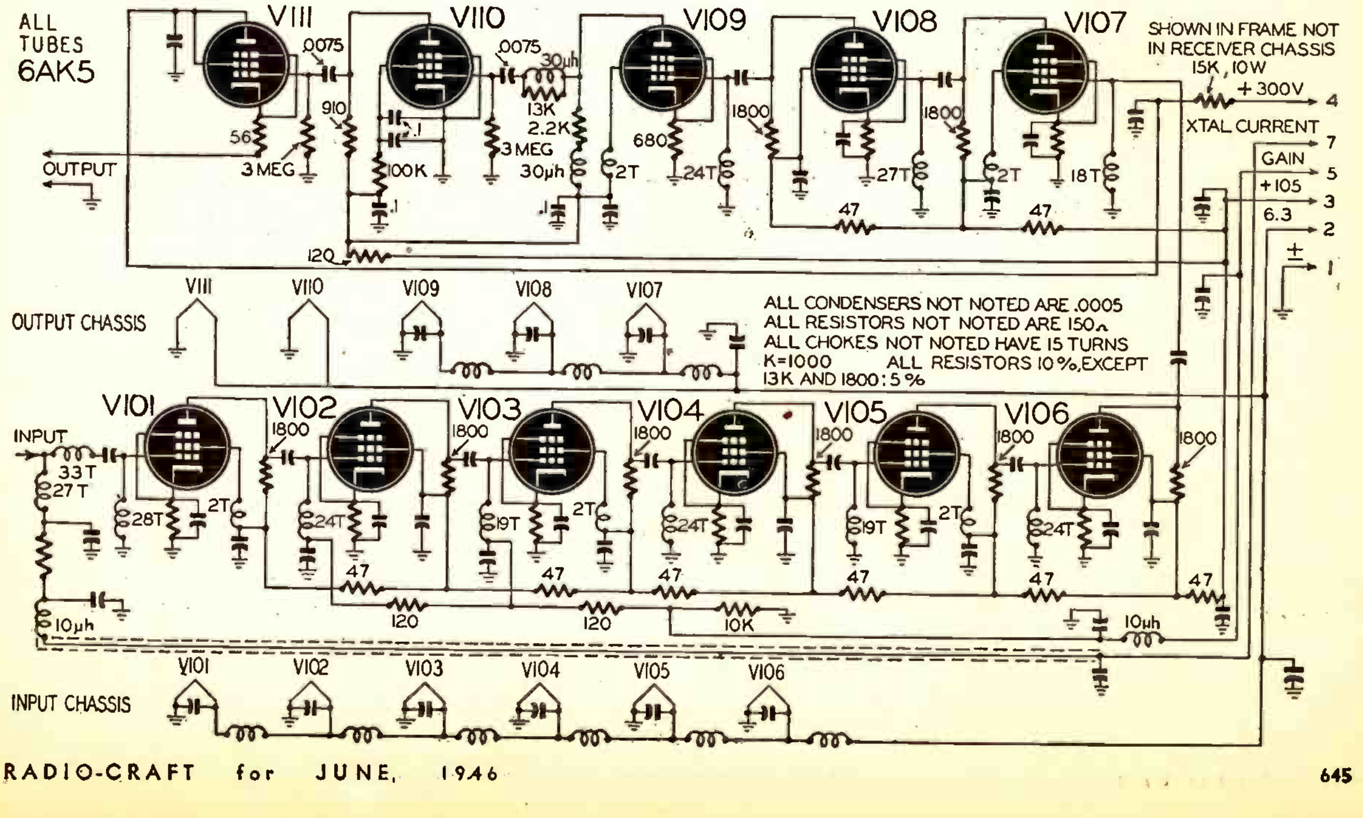
Video amplifier technique appears in the low plate resistors, high-frequency grid chokes, special chokes in the filament circuits and other features readily noticeable on the schematic. Gain per stage is low—thus eleven tubes are required for the 100-decibel gain.

The video detector may take one of several forms according to the special application of the amplifier. In broad-band circuits the frequency characteristics of the rectified video components will be such that the output at 8 mc will be reduced not more than 3 db from the output at 1 mc. These amplifiers will thus pass a square top pulse having a duration of 0.15 micro-second or greater with negligible frequency or phase distortion, making them particularly suited to television receiver applications.

Either single-ended or balanced input circuits are supplied. The balanced input circuits are designed to use with dual input systems and will distinguish between in-phase and out-of-phase signals from two channels. In one such unit this discrimination is 33 db.

The unit, as may be seen from the photograph, differs little in appearance from more conventional apparatus, the only external signs that distinguish it from an ordinary amplifier being the special small chokes.

Power supply for a typical amplifier includes + 105 volts d.c. at 90 ma, + 300 volts d.c. at 20 ma, and 6.3 volts a.c. or d.c. at 1.7 amperes. External gain control requires 0 to –12.5 volts d.c. 1.5 ma.



Available Radio-Electronic Literature

Manufacturers' bulletins, catalogs and periodicals.

A SERVICE FOR RADIO-CRAFT READERS: In order to save your time, postage and incidental work in writing a number of letters to different manufacturers to secure the various bulletins offered, proceed as follows:

On your letterhead (do not use postcards) ask us to send you the literature which you designate. *It is only necessary to give us the numbers.* We will then send your request directly to the manufacturers, who in turn will send their bulletins or other literature directly to you.

224—THE LIGHTHOUSE TUBE

Published by General Electric Company. The story of the new disk-seal electronic tube, known as the "Lighthouse Tube" and its specifications are given in publication ETR-7. This pamphlet describes the basic principles of design and operation of the tube and its advantages in the fields for which it is designed. The tube, now released from war applications, will be applied to television, FM radio and other fields in the ultra-high frequency spectrum.—*Gratis to interested parties*

225—THERMOCOUPLE DATA BOOK

Bulletin S2-6, published by Wheelco Instruments Company. A 31-page booklet of data on thermocouples and accessories. Complete with engineering drawings of all types of thermocouples. This data book may also be used as a catalog of the equipment and accessories handled by Wheelco Instruments Co.—*Gratis*

226—CANNON CONNECTORS

Sixty-four pages of material on many types of connectors, dust caps and receptacles is available in bulletin "K," published by Cannon Electric Development Co. This bulletin is illustrated and complete with dimensional drawings.—*Gratis*

227—SHALLCROSS CATALOG

An eight-page booklet describing the types of precision resistances and decade boxes available from the Shallcross Manufacturing Co. This catalog is of interest to electrical engineers, physicists, and manufacturers of electrical equipment.—*Gratis*

228—HIGH VACUUM EQUIPMENT

An interesting catalog by Distillation Products, Inc. Of interest to electronic engineers and physicists. It lists the various types of vacuum pumps and gauges necessary for high-vacuum work.—*Gratis to interested parties*

229—OHMITE CATALOG

A 16-page catalog published by Ohmite Manufacturing Company. Lists wire-wound resistors available from 1 to 200 watts with rheostats running to 500-watt capacity. Also included are volume controls, including special types, r.f. chokes and dials.—*Gratis*

230—KENYON TRANSFORMERS

A general catalog of transformers manufactured by Kenyon Transformer Co. The transformers listed are those applicable to practically all phases of radio and electronic work. This catalog includes five pages of charts and graphs of value to the engineer or serviceman—*Gratis*

231—REED FREQUENCY METERS

Bulletin 1770 contains 16 illustrated pages describing the Frahm Vibrating-Reed Frequency Meter as manufactured by James G. Biddle Co. These meters are manufactured in switchboard, portable and miniature models.—*Gratis*

232—LABORATORY OHMMETERS

Precision ohmmeters described in Bulletin 1805, published by James G. Biddle. These instruments are of interest to electrical engineers as well as telegraph and telephone maintenance men.—*Gratis*

233—PIEZO-ELECTRIC CRYSTALS

A seven-page catalog, of interest to engineers and amateur experimenters, issued by Crystal Research Laboratories, Inc. It describes the various types of crystals developed by the firm. Crystals are available for all applications, including supersonics.—*Gratis*

234—ELECTRICAL THEORY

Part 3 of a series on the theory and applications of electronics is published by Kuhlman Electric Co. This well-written booklet is illustrated with vector analysis diagrams of oscillators and other circuits.—*Gratis*

235—RECORDING DEVICES

A seven-page catalog, issued by Production Instrument Co. Includes a number of counters which have many applications in production. These counters are made to indicate the number of units or pulses produced as well as the number of revolutions or turns that have been applied to a coil-winding machine. Time totalizers and switches for actuating electric counters are also included in this well illustrated catalog. —*Gratis*

236—PLUG AND SOCKET CATALOG

An illustrated catalog of sockets and plugs applicable to radio and electronic equipment, published by A. W. Franklin Manufacturing Company. The illustrations of sockets and plugs are accompanied by working drawings and descriptive material.—*Gratis to interested parties*

TWO DIMENSIONAL RADIOS

(Continued from page 643)

In actual construction, the resistors are printed on one side of the plate and the condensers are wired to the other. Fig. 2 shows the method of connecting the portions of the circuit on opposite sides of the plate. For clarity, the parts have been drawn in symbolic form between the connecting points.

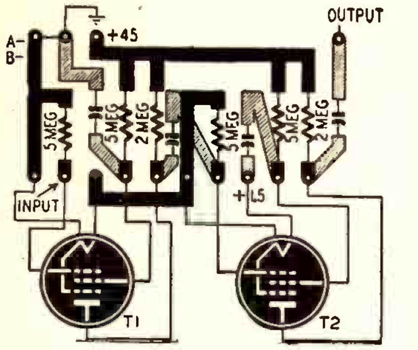


Fig. 2—"Wiring Diagram" for printed radio.

This new method of circuit design makes it possible to print *coils* for ultra-high-frequency circuits directly on the plate. Such coils have a Q of 150 to 200.

Although this technique is not applicable to the production of complete receiving or hearing aid sets, it may well be applied to unit portions of the circuits, such as resistance coupled amplifiers and simple control circuits. The small units may be replaced in a defective circuit almost as easily as a tube is changed today. The effects of this type of construction may soon be seen in smaller radios and hearing aids which will be more reliable and more easily serviced than the best sets today.

R.F. POWER SUPPLIES

(Continued from page 616)

lished in the *Proceedings of the I.R.E.* April 1943. Sylvania pointed out the possibilities of such a circuit in connection with their 28D7, a tube intended to work with a plate voltage of 28 to 32. (*Sylvania News*, Jan, 1944.) Curves showing an output voltage as high as 200 (at 1 milliampere) and currents as high as 6 milliamperes (at 100 volts) were shown; plate input in each case being 28 volts. An article on this type of power pack appeared in the August, 1944 issue of RADIO-CRAFT, with a 25A7 instead of the 28D7 which was not easily obtainable, at least at that time.

There would appear to be definite field for power supplies of this type in a number of applications where moderate current is required, whether the voltage be high or low.

●

Two types of dry cell batteries developed by the U. S. Army Signal Corps during the war, replace nearly the entire line of dry cell batteries for low temperature operation. These batteries operated reasonably well down to 40 degrees below zero.

REDUCING HUM LEVELS

(*Continued from page* 619)

The speaker field resistance in Fig. 2 might be, in many cases, 400 to 500 ohms. If a low resistance choke having a d.c. resistance of 80 or 100 ohms is put in the circuit, as shown in Fig. 3, the d.c. voltages will not be affected to any considerable extent but the hum level will be greatly reduced. The choke alone will help in reducing hum, but if an extra filter is added, C_3, which may be 16-μf, the hum will be still lower.

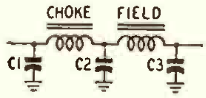


Fig. 3—A low-resistance choke will cut hum.

In a.c. sets using full wave rectifier power supplies, the hum output of the B supply may be very low since the ripple frequency is 120 cycles and the filtering can be made efficient. The hum due to an unbalanced filament circuit may then be more important. In Fig. 4, a tap is used on the filament winding and may give satisfactory results with such tubes as the 45, 47, 2A3 and 6A3. An improvement will sometimes be possible if a centertapped resistor or a potentiometer arrangement is used. In Fig. 5, the use of a potentiometer is indicated, permitting an electrical balance in the filament circuit.

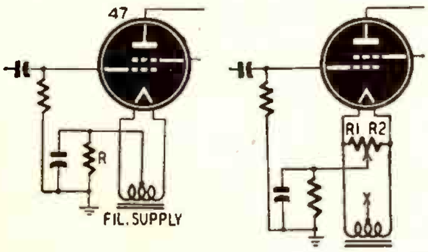


Fig. 4 (left)—Hum may arise from an off-center transformer tap in older receivers.

Fig. 5 (right)—The centering resistor was well known as a "humdinger" in its heyday.

In many sets, a push-pull output is used. A common cathode resistor is employed and no attempt is made to get a good balance in the output stage—essential for minimum hum and distortion. By using separate, adjustable resistors, as shown in Fig. 6, the balance and correct bias voltages are obtained. The maximum resistance of each bias resistor, that of R_4 or R_5, would be about twice the value of the original cathode resistor. C_6 and C_7 are not very critical in capacitance values and could be rated at 20-μf and 50 volts each. Condensers rated at 150 volts could also be used. The cathode resistances would be adjusted until equal plate currents, I_1 and I_2, flowed in the primary of T. The currents would be indicated by low resistance d.c. milliammeters placed in series with each half of the transformer.

LOW RESISTANCE CHASSIS

The importance of using a low resistance chassis can be seen by referring to Fig. 7. In some sets, one side of the filament winding is grounded to the chassis, say at point 1. The filament of the amplifier tube VT may be connected to chassis ground at point 5 and directly to the winding, C, at 7. If the chassis resistance between 3 and 4 is appreciable, a hum voltage may act in series with the grid of the amplifier tube and be greatly amplified, especially in high-

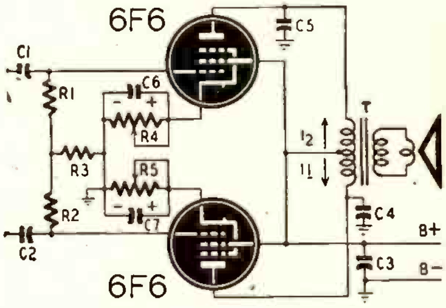


Fig. 6—Individual bias for push-pull tubes.

gain circuits. If the circuit is an r.f. type, hum modulation of the r.f. may result and then the hum will be heard due to the demodulation action of the second detector. By placing the grid return at 3, close to 4, a hum reduction may be found in some cases. Also, running a wire from 1 to 5 may prove helpful, instead of depending on the chassis as a conductor for the filament circuit hum current. Similarly, running C_1 not to point 2 but directly to point 1 is good practice. C_2 should not go to 6 but to 1. In this way, stray chassis currents can be reduced. Too many servicemen, in putting in a filter condenser, just look around for any old place to hitch the replacement unit instead of giving some thought to the matter. Note that the condensers in the primary circuit of the power transformer should be connected to a common point on the receiver chassis. If they are connected to two different points, hum may be heard.

Another important factor is an equal reading for each plate of the rectifier when testing the tube. The readings should be reasonably close together, a variation of 10% being maximum. If the plate readings are not equal, the rectifier tube should be replaced. An unbalanced rectifier may put out a 60-cycle hum plus harmonics. With the decreased ripple frequency, the filters are less effective and the hum level goes up.

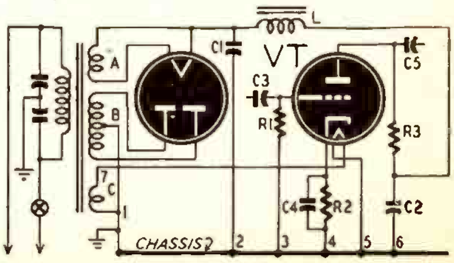


Fig. 7—Grounds to chassis may be important.

? ? WHY NOT ? ?

Have you ever asked yourself, "Why can't I have this or that gadget on a radio? Why aren't programs made to fill such and such a need?" If so, you are a charter member of the *Radio-Craft* "Why Not" club. Send us your "Why Not's" on all subjects—serious or screwball, practical or idealistic. We will pay $1.00 for every one we believe will interest the readers of *Radio-Craft*. You can get the idea from the "Why Not's" printed below. Send in as many as you like. One dollar will be paid for *each one printed.*

Why not have the manufacturers make speaker cones out of a thin plastic material that won't tear?

DAVID STRICKLAND,
Pensacola, Fla.

(Some cones already have been made in full plastics, as well as plasticized fabrics. No doubt they will come into general use soon.—*Editor)*

●

Why not imbed magnetic wire recordings in paved roads at danger spots and then equip autos with magnetic pickups so verbal warnings and directions can be given?—

E. E. YOUNGKIN,
Altoona, Pa.

●

Why not have the sound engineers of all the picture-producing companies print the picture sound tracks to the same level? Then the operator in the projection booth would not have to set the amplifier volume control whenever he changes from one reel of the picture to another.

DAVILO R. REYES,
Gamboa, Canal Zone

●

Why not give us a few articles on cabinet designs? Surely a lot could be said about reaction to heat and audio-frequency response of plywood, ordinary wood, plastics, and metal. Some radio experimenters build their own cabinets as well as what goes into them.

LUDWIG FURTH,
London, England

●

Why not install home recording equipment in television sets for the purpose of recording a television program's video signal? Then with a flick of a switch whole television programs may be recorded on phonograph records. The voltage fluctuations which affect the electron beam in a cathode-ray tube can easily be impressed on a record, and when the record is played back these voltage fluctuations are reproduced and applied to the plates of the tube. It might also be interesting to play this record of a picture on a regular sound phonograph; then we could *hear* what a picture looks like.

MORTON LUTZKY,
Brooklyn, N. Y.

[The wide frequency band required by a video signal (as high as 2½ or 3¼ mc.) cannot be recorded on any existing recording system.—*Editor*]

"PORTARIG" HAM STATION

(Continued from page 612)

on the power unit to provide a link for the power cord between the transmitter-receiver chassis and the power chassis. As it was desirable to operate the set with the power unit about six feet from the transmitter, remote power switching is available from the panel of the transmitter when d.c. supplies are used. The filament pins of the socket are used to carry the d.c. because they are larger and will offer less resistance to the flow of current. Line voltage is controlled by a switch in the line.

Determining the correct values for the transformer buffer condensers is one of the most difficult tasks encountered in constructing a vibrator-type power supply. An oscilloscope is used to determine the correct wave form of the primary voltage. The ideal wave form that may be reached in practice is shown in Fig. 4-a. Wave forms caused by too much capacity will resemble Fig. 4-b while insufficient buffer capacity will give wave forms similar to 4-c. If an oscilloscope is not available a d.c. ammeter is placed in the battery lead and condensers changed till *lowest* amperage is registered.

"Hash" chokes are placed in the positive lead to the vibrators to prevent vibrator noises from being radiated. These chokes consist of 20 turns of No. 10 enamel wire wound on a ¾-inch form.

COIL DATA FOR PORTARIG
80-METERS

L1—(r.f. grid coil) 45 turns, No. 24 enamel, close wound.

L2—(r.f. plate coil) 24 turns, No. 24 enamel, interwound with lower end of L3.

L3—(Mixer grid coil) 45 turns, No. 24 enamel spaced.

L4—(power amplifier plate coil) 54 turns No. 16 enamel, tapped at 20 and 30 turns.

Coils L1, L2 and L3 are wound on 1¼-inch forms, L4 is on 2¼-inch form.

Receiver ON-OFF switch, S1 is a heavy-duty double-pole, single-throw switch with the poles wired in parallel. When this switch is closed, d.c. voltage is applied to both vibrators and the receiver filaments. The transmitter ON-OFF switch, S2, is used to control the filament voltage to the transmitter. It is so wired that it is impossible to heat the transmitter filaments without turning on the receiver filaments and the "B" voltage.

The SEND-RECEIVE switch is a heavy-duty double-pole double-throw switch used to switch the antenna from the transmitting to receiving circuits and the phone jack from a.f. output to side-tone reception.

The volume control is a 500,000-ohm potentiometer in the grid circuit of the 6Q7.

The modulation control is a 500,000-ohm potentiometer connected across the grid winding of the input transformer to limit the audio level applied to the 6Z7 grid. This control is not brought out to the front panel since it is pre-adjusted to give full output from the modulator when speaking close to the microphone in a normal speaking voice.

Selection of the a.v.c. and a.n.l. circuits is made by the A.N.L.-A.V.C. switch, S3 which is a two-pole, four-position rotary switch. It is possible to get either type of operation, or both combined, with this switch.

The PHONE-CW switch is a double-pole, double-throw switch, S4. When in the c.w. position, the plate voltage is applied to the plate of the b.f.o. tube and the r.f. power amplifier plate lead is shunted around the modulation choke.

A 4-gang-4 position switch, S5, is the Channel Selector. Sections "A" and "B" select the proper tuning condensers for the antenna and mixer coils of the receiver. "C" and "D" select the crystals for the receiver and transmitter oscillators respectively.

Antenna tuning is accomplished by C1 and C2, which are 100-μμf double-spaced midget condensers. They are connected across the ends of the tank coil, L4, in a "pi" network. The end plate of C2 is bent so that it will short the condenser when the plates are fully meshed. With C2 shorted, the circuit becomes a conventional shunt-fed tank. By

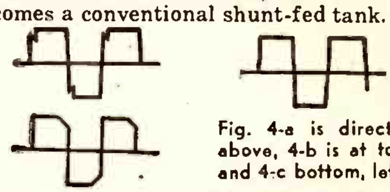


Fig. 4-a is directly above, 4-b is at top and 4-c bottom, left.

using this method of loading the transmitter output circuit any single or double wire antenna may be matched without loading coils.

The tuning unit is a desirable feature when the set is to be used on widely separated frequencies. All of the frequency-determining elements of the set are mounted on a small chassis that has three 4-prong plugs mounted on its cover plate. These plugs are located so that they will match corresponding sockets mounted on the main chassis. Metal shield plates are fastened to the sides of the tuning unit to serve as guides when inserting the tuning unit into its sockets.

The crystals for the receiver are ground for frequencies 456 kc lower than the corresponding transmitting crystal. If it is desired to operate the transmitter on 3966 kc, for example, the receiver crystal will be ground for 3966 minus 456 or 3510 kc.

No troublesome microphone batteries are used because the battery voltage is obtained from a tap on the cathode resistor of the modulator.

The tubes selected for this rig proved to be unbeatable for operating in rough terrain under all conditions. The 6L6-G proved to be the outstanding tube as an r.f. power amplifier. On occasions 70 watts power input was used for c.w. operation and 50 watts phone without a blush from the plate.

A METAL LENS
(Continued from page 602)

The necessary design theory was worked out in mathematical detail and systems of metal plates were subsequently built to duplicate the action not only of convex and concave lens but also of other optical devices, such as half and quarter wave plates and prisms.

The drawings compare an electronic lens with an optical one. Because the waves handled are an appreciable fraction of the diameter of the lens, some things can be done with them that cannot be paralleled with their glass counterparts. The concave lens elements, which consist of metal sheets, instead of becoming progressively wider toward the lens edges, as shown in the drawing, can be cut back every half-wavelength or multiple thereof, thus saving metal and making a lighter structure. The back of each metal plate thus resembles a huge saw, one side of each "tooth" following the lens curve, the other side straight and parallel with the lens axis.

ELECTRONIC "NIGHT SIGHT"
(Continued from page 603)

plied by a storage battery, which, with the vibrator power pack which supplies high voltage for the image tube, is carried on the operator's back.

A soldier with a "sniperscope" (a "snooperscope" mounted on a carbine) was said to be more effective in stopping infiltration than 12 men with regular weapons. Here is how the infra-red carbine operates, as explained by an Electronic Laboratories official:

"A fighter armed with a sniperscope hears a sound. He points his weapon into the darkness, peers into the telescope, and turns on the power supply. He moves the weapon back and forth, like an invisible searchlight, his eye pressed to the telescope, until he sights the enemy, slowly crawling forward.

"The enemy soldier is unaware that he is impaled by a beam of invisible light of a greenish hue. (In the telescope all objects appear as various shades of green regardless of their color in daylight, due to the use of high-sensitivity green phosphor on the cathode-ray tube screen.) The U. S. soldier focuses his telescope quickly, lines up a bead on the enemy with the telescope sight, and, with a press of the trigger, there is one less infiltrating enemy."

WHY THE TUBE SHORTAGE?

(Continued from page 601)

of three tubes required for set production, or nearly 35 million tubes per year.

It now appears that the radio industry is geared up to produce some 25 million radio sets per year, if and when the necessary materials become available. With FM and Television in the postwar picture, it looks as if the requirements for the original equipping of such sets will increase to approximately seven tubes per set as against the 5½ tubes per set in the prewar period.

From the calculations of these trends and other factors involved, it becomes evident that radio dealers and radio servicemen in the United States alone will probably absorb approximately 100 million tubes per year. *These requirements would be three times greater than those of the prewar period, making it necessary for the serviceman to turn away two out of three customers.*

The radio tube manufacturers feel that it is in the best interests of the industry to serve the set manufacturer first, because basically the radio receiver has made and will continue to make the tube market. Not even a radio serviceman without a single tube on his shelf would contradict the axiom: "no receivers, no tubes." Another important point: it is better at this state of our national economy to produce a number of tubes to go into a new receiver, rather than produce them to repair a worn-out antique which should be junked on account of old age. *Consumers want tubes; but new sets too.*

For these and other reasons tube manufacturers feel that new receivers should have first call on tubes; and accordingly they have allocated their production on the basis of *three tubes per new radio receiver and one tube for replacement.* Radio receiver manufacturers are and will continue to be the biggest customers for radio tubes. This is true in normal times and today too.

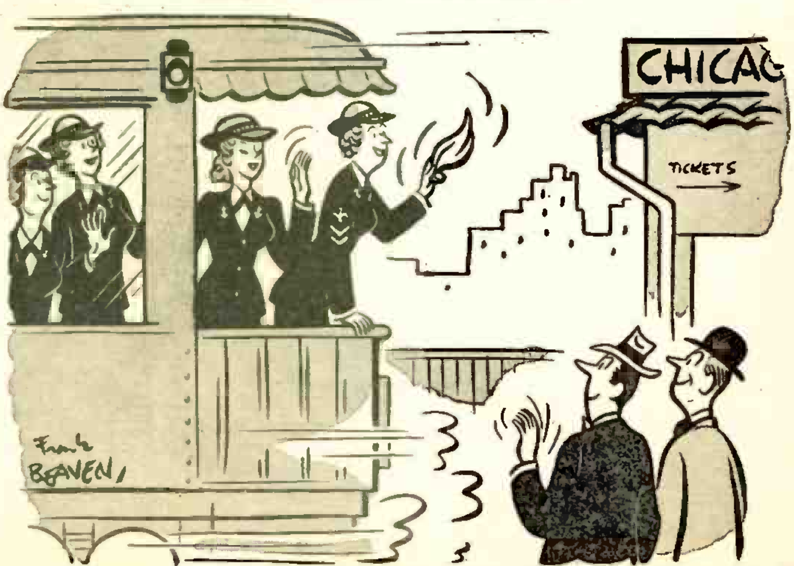
It is idle to pretend that all, or even the greater part of the approximately three million tubes a month allotted to repair and maintenance reach the serviceman, even were these quantities actually produced at present. RADIO-CRAFT is well aware that large numbers of these tubes "disappear" through intermediate commercial channels on their way from the factory to the ultimate consumer, the radio serviceman.

Throughout the whole industry, it is too well known that small radio set makers—the so-called "bed-room manufacturers" have no credit standing with the tube manufacturers, who therefore won't sell them. But the small set makers—there are hundreds of them—move heaven and earth to secure the precious tubes. They make "raids" on wholesalers, radio stores, department stores—yes they even buy tubes from the larger service establishments at fancy prices! This is a feature—albeit an unlovely one—of the present economic setup, and one that apparently can be relieved only by time and the natural play of economic forces. The radio serviceman is no worse off in this respect than retailers in other fields.

After weighing all the facts, RADIO-CRAFT estimates that the tube situation will probably continue unsettled for the rest of 1946. There may be quite a bit of improvement toward the end of the year, but the situation will not become entirely normal till sometime late in 1947. This analysis is based on the premise that there will be no unpredictable political or industrial crises or bottlenecks which would introduce totally new and upsetting factors.

Taking all the facts into consideration, the only conclusion that can be drawn is that it will be some little time before the situation will revert to a prewar normality, with sufficient tubes available to meet all demands.

RADIO TERM ILLUSTRATED



Suggested by: Quentin Piepergerdes, Kansas City, Mo.

Wave Train

HORN-IN-CONE SPEAKER

A loud speaker which is cone and horn in a single unit, has been developed by Jensen. The speaker is so constructed that the cone, which reproduces the low-frequency sounds, forms the horn of the high-frequency unit. Aptly named the Coaxial (Type H),

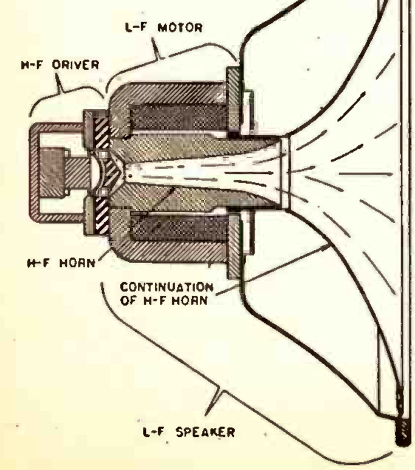
the new speaker is adapted to use in home radio receivers and phonographs, particularly for FM reception and high quality phonograph reproduction.

The Coaxial consists of two units, each reproducing a portion of the total frequency range. A compression-type high-frequency unit is attached to the back of a 15-inch direct-radiator low-frequency unit. The horn for the h-f unit is formed by a passage of expanding cross section through the core of the l-f unit, the carefully shaped diaphragm of the l-f unit forming a continuation of the h-f horn. The l-f diaphragm is driven by a conventional voice coil assembly.

The Coaxial speaker preserves the advantages of two-channel loud-speaker systems with "compression" or horn-type h-f units, while overcoming three major shortcomings of conventional two-way coaxial systems: (1) In the Coaxial, the mouth of the h-f horn is the full size of the l-f cone, thereby providing good acoustic loading in the vital cross-over frequency region. The horn mouth size is not compromised to reduce the obstacle the horn presents to radiation from the cone in the conventional horn-in-cone type.

(2) Since the cone of the l-f unit forms a smooth continuation of the h-f horn, there is no large multi-resonant cavity into which the h-f radiation can "spill over" nor into which the l-f unit can radiate. Objectionable resonances in the cross-over frequency region are therefore minimized.

The "woofer" cone forms part of the horn for the "tweeter."



(3) A special horn contour is used which gives much more uniform radiation over a broad angle than the conventional exponential type.

Electrical and mechanical cross-over networks are used which utilize the mechanical and acoustical properties of the two component channels in such a way as to yield optimum combined characteristics. Normally no control of the h-f response of the loud speaker other than that provided by the receiver tone controls, is necessary.

Additional h-f control may be provided by the use of an "L" pad. Alternatively, an "on-off" switch may be provided to cut out the h-f unit, although the resulting h-f response is not adequate for most purposes.

VIDEO AMPLIFICATION

(Continued from page 614)

Gain of a pentode video amplifier after proper compensation and where the plate resistance of the tube is large compared with the load resistance of the stage, is *the product of the load resistor* R_L *and the tube's transconductance* g_m.

Overloading of a video amplifier must be avoided. When this happens and the next stage is an amplifier, the grid of the following tube draws current and charges the coupling condenser C_0. If the charge is large enough, it may be sufficient to cut off the following stage—thus blocking the video amplifier until C_0 becomes discharged. Since the value of C_0 is dictated by the method of low-frequency compensation *and cannot be made too small in value*, the only remedy for overloading is extreme care in operation.

TYPICAL CIRCUITS

Complete circuit of a typical video amplifier is shown in Fig. 1. Upper frequency limit of this circuit is about 4 megacycles.

A pentode—type 6AC7—forms the nucleus. It is operated sufficiently above cut-off to avoid the difficulty of partial limiting in the presence of strong input signals.

The input signal is applied through any suitable coupling arrangement to the grid of the pentode. Screen voltage is supplied through resistor R_s, which acts both as a filter and a dropping resistor. Plate load of the tube consists of a relatively low value of resistance.

High-frequency compensation is provided by both a shunt peaking coil L_a and a series peaking coil L_b. Low-frequency compensation is provided by the filter network consisting of resistor R_N, and condenser C_N.

The network R_N C_N also serves as a decoupling network to prevent variations in supply voltage from influencing the performance of the pentode. However, it is usual to supply both plate and screen voltages of a video amplifier with a *constant* source of power.

All large by-pass condensers—electrolytics—are paralleled by small paper condensers for more effective by-passing action over the entire frequency band.

The amplified video output is applied to the next stage or device through coupling condenser C_0.

Another typical video amplifier circuit—of slightly different arrangement—is shown in Fig. 10.

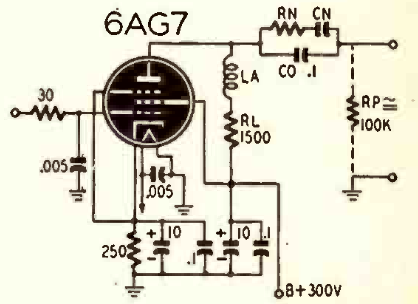


Fig. 10—Stage of a typical video amplifier.

The tube used is a type 6AG7 beam tetrode, operated in the conventional manner. Plate and screen voltages are supplied from a well-regulated source of power.

High-frequency compensation is provided by the shunt peaking coil L_a. Low-frequency compensation is provided by a filter network consisting of resistor R_N and condenser C_N, acting to increase the gain of the stage below about 200 cycles. At higher frequencies, the output of the video stage is unaffected by this network. Resistor R_N is non-inductive.

Electrolytic by-pass condensers in the cathode and screen-plate circuits are paralleled, in the usual manner, by small paper condensers.

Output of this video amplifier is coupled through condenser C_0 to the next stage or electronic device.

Video amplifiers are widely used in television, since their wide frequency range makes them responsive to all picture signals.

Video amplifiers are used in the studio for amplification, polarity changing, and impedance matching—in order to preserve the wave form of the camera signals. They are used in the transmitter for amplification and modulation, and in the television receiver for polarity changing and amplification. Preserving the wave form of synchronizing pulses and blanking pulses are other duties performed by these amplifiers.

Radar employs video amplification in its pulse-forming circuits, much as such amplifiers are used in many industrial electronic devices. A frequency bandwidth of *at least* three megacycles is necessary in order that a square or rectangular wave or pulse be amplified with negligible distortion.

Video amplifiers are also used in the final stages of a radar pulse receiver. One or more stages follow the second detector to amplify the rectified signal sufficiently to give proper deflection when applied to the plates of a cathode ray tube.

Although capable of considerable power amplification, video amplifiers are invariably operated as voltage amplifiers—since the load is normally connected to a cathode follower stage, or to the deflection plates of a cathode ray tube.

COMMUNICATIONS

LETTER FROM A NETHERLANDS AMATEUR

Dear Editor:

This is a general call from the Dutch amateur station PA0CK, this time not by radio but in writing by letter with a kindly request, more a SOS than a request.

It is well known what has happened to us since 1940 in our small country with the German Army of occupation.

Many patriots lost their lives and a great part of the Dutch people their goods. In the Dutch Interior Forces (the Dutch "Maquis") I lost four friends by a raid of the German Police at our clandestine radio station (for contact with England). For a wonder I escaped and I am glad to live and to take care of my wife. The German S.S. made inquiries in our home but we had been warned and were not there. By our return all my electrical instruments, tools, photographic apparatus, wireless materials and tubes and—last not least—all our linen had disappeared.

And now our troubles. By May we are expecting our first baby and now we have too few baby articles to receive our little stranger properly. My request to one or more radio friends is as follows: to help us with the baby articles which we need, as wool, little clothes, napkins, etc., but with the condition that I send back specific Dutch articles (possibly requested) so soon as it is possible for me to express my thanks.

Soon I hope to make contact by radio with the W . . . . stations of the U. S. A. I am thanking you in anticipation for the trouble, help and this QSO and hope to receive QSL.

C. P. A. KANTERS, PA0CK,
Dreibergenstraat, 4,
The Hague, Holland

WHERE IS ALL THAT YANKEE INGENUITY?

Dear Editor:

What I would like to see is more on how to use stuff out of the junk box. We overseas hear an awful lot about the great property of the Yanks to "make do" and improvise. Now let's see it in action! I would especially like to see articles on simple superhets and sets using one tube with multiple functions.

Some of us are still at school and haven't learned the mathematics you use in describing the technical points. I know it can't always be done, but couldn't you give us a few *simple* articles now and then? Give us the fundamentals of things like negative feedback circuits and inverters? I was only a babe when those circuits first came out.

Anyhow I still think RADIO-CRAFT is the best magazine I know.

G. RANDLER,
Natal, S. A.

RETURNED SERVICEMEN'S LETTERS

Dear Editor:

The letter you printed from one of your readers on page 364 of the February issue makes me upset every time I think of it. This is putting it mild too. It seems to me he is working on the basis that the wheel that does the squeaking is the wheel that gets the grease. I think he is using the wrong type of squawk. He fought in the war, was disabled and is to be commended. I really would like to help the guy if I could. I didn't fight in the war, was on defense as an electrician for two years, but have been in radio since the time a Crosley Triadyne was de luxe equipment.

At times I feel the same way he does about the whole thing, but we can't control present conditions in five minutes. It may seem that the larger concerns are getting more than their share of supplies and attention, but in percentage we are getting as much, maybe more. I think everything will iron out all right, but it will probably take a considerable time.

By the way, Editor, you are to be commended for printing that letter. It shows that you are made out of the right kind of stuff.

CLAUDE M. PREW
New London, N. H.

ERRORS IN SUPER-REFLEX RECEIVER

Dear Editor:

I regret to inform you that the schematic of the "Super-Reflex Radio" as published on page 403 of the March issue contains two serious errors:

The resistor R5 is connected to the primary L3. It should be connected to the grid return of the secondary of L3 instead. As shown the high voltage is in the a.v.c. circuit.

The lead from prong No. 4 of the 7E7 is shown connected to the grid return of L3. This shorts the audio signal to ground through C9. No connection should be made at this point.

I hope you can make an early issue with the necessary connections.

W. T. CONNATSER,
San Francisco, Calif.

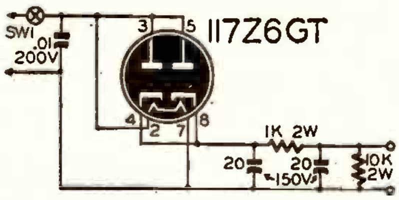
(Radio-Craft regrets the error, which is due in large part to the new and unorthodox nature of Mr. Connatser's circuit, which permits one tube to do the work of three, but leaves checkers of schematics in some doubt as to whether connections are correct or not.—*Editor)*

A.C.-D.C. "B" BATTERY

THIS small power supply is not unusual as the simple diagram goes, but it was constructed like a 45-volt "B" battery, so as not to use up too much space in the battery compartment.

A 117Z6-GT duo-diode full-wave rectifier is expensive, but space was saved. The a.c. maximum plate voltage is 117 per plate and the tube has a heater current drain of .075 milliamperes with a d.c. output current of 60 ma per plate. The rectifier plates are connected in parallel, resulting in 120 ma maximum output and halfwave rectification.

The diagram of the portable "B" rectifier is shown in the figure. A single-pole single-throw thumb switch was placed in the line cord about two feet from the plug end so the rectifier could be turned off when not in operation. This switch can be omitted if the a.c. cord is pulled from the wall receptacle after the receiver has been switched off. The panel and switch on the battery receiver must still be used because the "A" battery will still be in circuit if the power supply's switch is "off."



A small mounting strip was fastened to the bottom panel with 8-32 bolts and accessories. The a.c. line cord ends were soldered directly to this. Besides the mounting strip we placed a .01 μf paper condenser to filter out all noise from electrical appliances on the power line. One side of the a.c. cord was *not* grounded through a condenser as usual to the metal chassis; no electrical connections were soldered to this metal case because a shock could be had from it to the ground.

The wafer octal tube socket is placed upside down and spaced from the chassis with two ½-inch fiber spacers. This made more space available for other components and lessened danger of shorting to metal chassis.

A 1000-ohm 2-watt carbon resistor in conjunction with a dual 20-μf electrolytic condenser was used for filtering. This condenser must be placed as far as possible from the 117Z6-GT tube to avoid drying out the electrolytic solution. We figured, with about 117 volts output at the terminals of the cathode, the 1000-ohm carbon resistor would produce a voltage drop of 16 volts with 16 ma of current flowing through it. This current drain of 16 ma was the estimated drain of the battery receiver. This now leaves 101 volts on the output terminals of the power supply. To

(Continued on following page)

INDEX TO ADVERTISERS

A.C.-D.C. "B" BATTERY
(Continued from page 657)

insure greater stability, a 10,000-ohm 2-watt bleeder was placed in the circuit from B-plus to ground, giving a 10-ma bleeder current and dropping the output voltage to 91 volts. Also this bleeder current flows through the 1000-ohm resistor at 10 ma, producing a 1-volt drop. Voltage output is now 90, with receivers drawing 16 ma of current. Most 6-tube battery receivers draw about this much. The miniature tube variety draws around eight or nine ma. The filament supply was omitted because the cathodes of the 117Z6 will not safely pass the additional current. The battery male plugs could still be used if one plug was shorted out with a piece of wire. Tape up the remaining male plug.

The chassis was constructed from galvanized sheet metal of 3/32 material 3⅝ inches wide, 4½ inches long and 2¼ inches deep. ⅛-inch holes were drilled and placed along the bottom and sides for tube ventilation. A female socket was torn from one of the old "B" batteries and placed in the top of the chassis.

BOOK REVIEWS

TELEVISION SIMPLIFIED, by Milton S. Kiver. Published by D. Van Nostrand Co., Inc. Stiff cloth covers, 5½x8½ inches, 375 pages. Price $4.75.

Few practical books on this subject have been written for the serviceman or technician lacking knowledge of engineering mathematics, and equally lacking in patience to follow dissertations on the historical or economic aspects of the art to get a little information as to the how and why of television.

The author of this work plunges immediately into detail after a single introductory chapter which describes the general features of television receivers and transmitters, scanning, camera tubes, the need for wide transmission bands and other points necessary to present a broad general idea of the subject.

The second chapter discusses u.h.f. waves and suitable television antennas. From here the author goes into r.f. and i.f. circuits, detectors, a.g.c. circuits, video amplifiers, d.c. reinsertion, cathode-ray tubes, synchronizing and deflecting circuits.

Having covered the circuit details, the author proceeds to deal with typical television receivers and their adjustment. A long chapter (36 pages) is devoted to servicing television sets. Some space is given to special circuits, color television and the frequency modulation used for the audio transmissions associated with television programs. A glossary of television terms and a brief index complete the book.

INSIDE THE VACUUM TUBE, by John F. Rider. Published by John F. Rider, Inc. Stiff cloth covers, 5½x8½ inches, 407 pages plus preface and table of contents. Price $4.50.

For the first time in a book intended for the student or beginner, a modern approach is made to the theory and operation of electron tubes. After a brief introduction to electrons and thermionic emission, vacuum-tube action is considered on a basis of fields and charges. The result is a clearer and by no means less simple explanation of the tube and its workings than has hitherto appeared.

Though the attack is from the same point as an advanced text, the manner of presentation is kept to the beginner's level, and the material is lightened by illustrative cartoons which fully explain electronic laws and tube operation. Another interesting departure in illustration is the three-dimensional drawings, which when viewed through the red-blue spectacles provided with the book permit the reader to visualize actions which cannot be presented properly in a flat two-dimensional picture.

After describing why and how the tube functions, its characteristics as a part of electronic apparatus are considered, and a number of chapters are given to dynamic curves, transfer characteristics, voltage and power ampli-

(Continued on following page)

BOOK REVIEWS

(Continued from page 659)

fiers, and even the cathode follower. Miscellaneous tubes, including cathode-ray and photoelectric types, are described in the last chapter.

The book lacks an index, but this omission is balanced by complete sub-beading in the table of contents.

WORLD-WIDE STATION LIST

(Continued from page 622)

Freq.	Station	Location and Schedule
17.700	GVP	LONDON, ENGLAND: Netherland Indies, 6 to 6:15 am; 7 to 7:15 am; Chinese beam, 5:30 to 6 am; African beam, 6:30 to 6:45 am.
17.715	GRA	LONDON, ENGLAND.
17.730	GVQ	LONDON, ENGLAND: Near East beam, 1:30 to 10:15 am; Central and South American beam, 6 to 10:15 am; 11:45 am to 4 pm; Indian beam, 1:30 to 4 am.
17.750	WRUW	BOSTON, MASS.: Central American beam, 6:30 to 8:15 pm; European beam, 9 am to 12:45 pm.
17.760	KWID	SAN FRANCISCO, CALIF.: South American beam, 5 to 7:30 pm.
17.765		PARIS, FRANCE: 6 to 8 am.
17.770	OTC	LEOPOLDVILLE, BELGIAN CONGO: 6 to 9:30 am; 11:30 am to 12:15 pm.
17.780	WNBI	NEW YORK CITY: South American beam, 5 to 6:15 pm; European beam, 7:30 am to 1 pm.
17.780	KNBA	SAN FRANCISCO, CALIF.: South Pacific beam, 2 to 4:45 pm.
17.790	GSG	LONDON, ENGLAND: African beam, 11 am to 2:15 pm.
17.800	WLWO	CINCINNATI, OHIO: South American beam, 5 to 5:45 pm; European beam, 7:30 am to 2:30 pm.
17.800	KRHO	HONOLULU, HAWAII: Philippine beam, 4 to 11:30 am.
17.800	OIX5	LAHTI, FINLAND: 8 am to 12:30 pm.
17.810	GSV	LONDON, ENGLAND: African beam, 4 to 10:15 am; Indian beam, 4 to 10:15 am.
17.820	CKNC	MONTREAL, CANADA: European beam, 7 am to 2 pm.
17.830	WCBN	NEW YORK CITY: European beam, 6 am to 12:45 pm.
17.830	VUD10	DELHI, INDIA: 5 to 7 am.
17.845		BRUSSELS, BELGIUM: 6 to 7 am; 11 am to noon.
17.850	KCBF	LOS ANGELES, CALIF.: South American beam, 5 to 10:45 pm.
17.870	GRP	LONDON, ENGLAND: African beam, 10:30 am to 12 pm.
17.955	WLWL1	CINCINNATI, OHIO: European beam, 8 am to 12:45 pm.
18.025	GRQ	LONDON, ENGLAND.
18.080	GVO	LONDON, ENGLAND: South American beam, 6 to 10:15 am; 11:45 am to 12:45 pm.
18.135	PMC	BATAVIA, NETHERLAND INDIES: 11:30 pm to 9:30 am.
18.160	WNRA	NEW YORK CITY: European beam, 6 am to 1:30 pm.
21.470	GSH	LONDON, ENGLAND: African beam, 9:15 to 10:45 am.
21.530	GSJ	LONDON, ENGLAND: Indian beam, 4 to 8:45 am.
21.550	GST	LONDON, ENGLAND.
21.640	GRZ	LONDON, ENGLAND.
21.675	GVR	LONDON, ENGLAND: 6 to 8:30 am.
21.710	GVS	LONDON, ENGLAND.
21.750	GVT	LONDON, ENGLAND.
25.750	GSQ	LONDON, ENGLAND.
26.100	GSK	LONDON, ENGLAND: Central and South African beam, 6:15 to 8:45 am.
26.400	GSR	LONDON, ENGLAND.
26.550	GSS	LONDON, ENGLAND.

BETTER BROADCAST TUNER

(Continued from page 636)

Parts List

RESISTORS

R1—10,000 ohms potentiometer
R2, R3—100,000 ohms
R4—400 ohms
R5—10,000 ohms
R6—50,000 ohms
R7—60,000 ohms
R8—400 ohms
R9—10,000 ohms
R10—60,000 ohms
R11—5,000 ohms, 10 watts (optional if power supply is well filtered)

CONDENSERS

C1, C2, C3—gang condenser, .00036
C4, C5, C6, C7, C8, C9—.1 μf
C10—8 μf, 450 volt electrolytic
C11—.0001 μf mica
C12—.1 μf, 600 volt, tubular

MISCELLANEOUS

L1—14-7413 Meissner Iron Core shielded coils
L2—14-7558 Meissner Iron Core shielded coils
L3—14-7558 Meissner Iron Core shielded coils

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK

Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of Modern Electrics on file for interested readers.

High Frequency Currents, by *Norman Barden.*

The Rosing Telephot.

Gaumont (Talking Machine) Apparatus.

New Bellini-Tosi Apparatus, by *A. C. Marlowe.*

Wireless Interference and Perturbations, by *J. E. Taylor.*

Unique Means to Vary Wave Length.

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An Easily Constructed Variable Condenser, by *James Bitler.*

Light Portable Aerial, by *John Brady.*

Simple Electrolytic Interrupter, by *Alfred Bretonnel.*

Electromagnetic Reproducer, by *Frode Jensen.*

Sending Condenser for One-Inch Coil, by *J. McClain.*

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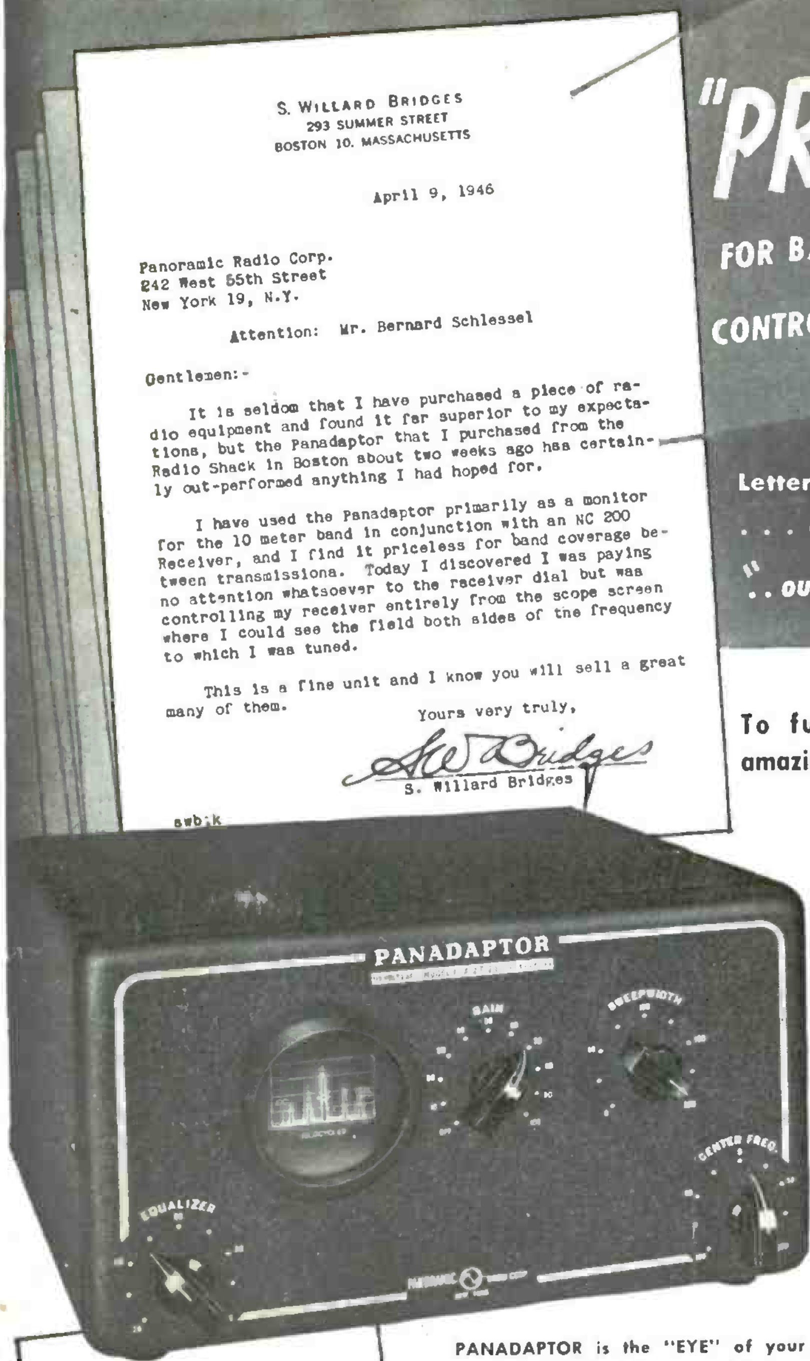
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April 9, 1946

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