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The First National Radio Weekly

663d Consecutive Issue—Thirteenth Year

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SURPRISING WAYS TO IMPROVE ANTENNAS

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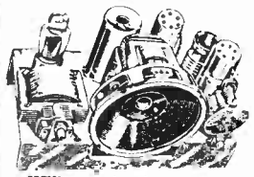

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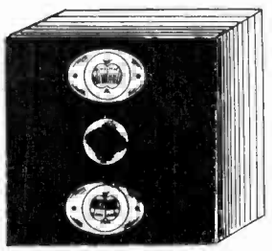

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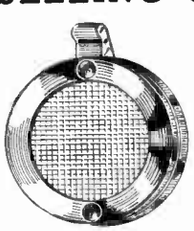

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The First National Radio Weekly
THIRTEENTH YEAR

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Here's the Way to Solder

Cleanliness Next to Godliness Here as Elsewhere

By Albert Goodfellow

THE radio experimenter has many opportunites to wield the soldering iron and so it is in his interest that he do so most efficiently and economically. It shall consequently be attempted to give a brief exposition of the correct methods to pursue.

Before any brandishing of the soldering iron takes place, the work first should be thoroughly cleaned. The quickest treatment for this purpose is by means of grinding with a wheel, scraping with some sort of scraping tool or filing with a file. Steel wool, sandpaper, emery cloth or a wire brush are also very handy for this job.

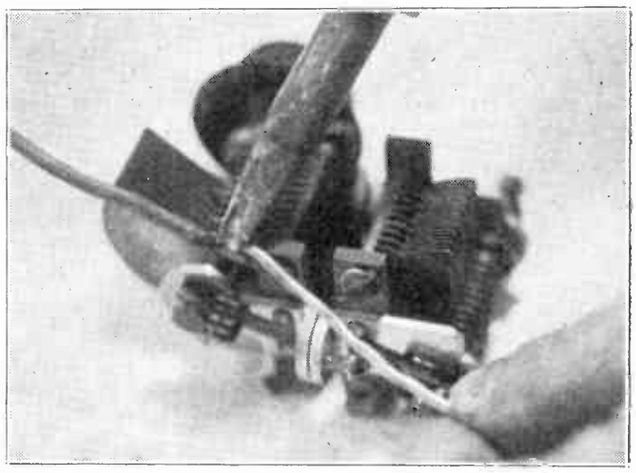
In order for solder to adhere permanently to a joint, it is essential that the connected surfaces be freed of paint, rust, grease, lacquer, or metallic oxide. The extent of the cleaning operation should be such that a space of one-half inch beyond the area to be soldered should be thus cleaned. Such precautions give a workmanlike job and affect its longevity.

Pitted Surfaces

If the joint contains pitted surfaces or is otherwise dented, it is important that the cleaning operation include the bottom of such pits. The greater the amount of time spent in cleaning operations, the less the time required to solder and the more easily is the job done, resulting in a detoured fraying of the temper. Many soldering failures occur because of the poor cleaning of the surfaces to be joined.

The next step will constitute handling the iron. Before this is appropriate, however, it would be essential that the correct size of iron be used. The size of the iron will be determined by the size of the work. For instance, one will find it impossible to solder copper tubing together when using a small iron. Small soldering jobs can be done with a heavy iron, but heavy work cannot be successfuly treated with a small iron. Another point to consider is whether the heat at the joint will be slowly or rapidly conducted away by the metal in the job. If there is ample opportunity for the heat to drift away through the body of the work, it would be necessary to use a larger iron than when the heat is not conducted away as rapidly.

When performing the all-important work of soldering, clean the proposed joint and heat the work. Then apply the solder directly to the intended joint.



It is clear that when soldering two pieces of No. 18 wire together, the heat at the joint will not be dissipated as rapidly as when the joint is formed between some heavy copper tubing and the shielding. In the latter case, it might even be necessary to use a blowtorch instead of an iron so that sufficient heat may be retained at the joint for proper soldering.

The solution of the case of the iron that does not generate enough heat is obvious. If the iron is too hot for the work, difficulties arise, also. One of the solutions for too much heat is to use a series resistor, assuming one has an electric iron. This resistor is usually variable, and is cut out of circuit when one is starting to heat the iron, so that the heating will be quickly accomplished, then the resistance arm is set to some position that experience dictates is satisfactory. Also, with the heat reduced, it will be found that the tip does not oxidize so quickly, nor readily become pitted. Another solution, omitting series resistor, is to use a long tip, say, 3 inches long, or even longer, instead of the more familiar short tip. The use of the long tip reduces the heat at the taper and lengthens the life of the tip greatly.

A Clean Iron

If any series resistor is used, be sure that it is of sufficient wattage rating for the purpose. The general run of resistors and potentiometers will not do, of course.

In the use of a soldering iron it is also important that it be cleaned, tinned and of the proper taper. An iron may have aesthetic appeal when it has a long slender taper rather than being stubby, but the slenderness detracts from the ability of the iron to supply heat at a joint. Therefore, in cleaning an iron with a file, do it so that it will not result in a slender taper. This practice will allow for a maximum application of heat to a joint to be soldered.

After the point and its cleanliness have been attended to, it is of great importance that the tip be properly tinned. This involves the application of a coat of solder to the working faces of the iron. Success in soldering requires that these working surfaces be coated with solder at all times so that there may be a rapid heat delivery. To coat these surfaces with the necessary tinning, the iron should be well heated and lightly filed on all surfaces to remove any oxide coating. Some rosin flux usually will be required. Then solder should be quickly applied to the iron so that it will adhere to the surface before another coating of oxide is formed on the iron. It is important that this tinning operation occur as soon after filing as possible, since oxide forms with-

(*Continued on next page*)

FORUM

EDITOR RADIO WORLD:

Your all-wave super as shown on pages 12 and 13 of the November 3rd issue is very interesting and should increase your circulation considerably.

May I make the following suggestions:

(1)—Provide connection for doublet aerial, as well as one shown.

(2)—Use the 55 as a full wave rectifier, instead of half wave, as this will increase your quality and power handling capacity. The loss in sensitivity is not important in view of the large amplification preceding the 55.

(3)—In the following articles, stick to the present values of biasing resistors which insure full gain. In preceding constructional articles, you started by biasing the 58's with 300 ohms and wound up with much larger values, even as high as 1,000 ohms.

(4)—Build power stage and power pack on separate chassis, for two reasons. It will reduce size of set chassis, and most builders already have one or more good amplifiers that can be used with any tuner.

(5)—When kits are sold (and they will sell like hot cakes) build the coils into a rigid unit with switching system mounted below and wired, together with padding condensers. This unit need not be longer than the average four gang 0.00035 condenser which will be mounted alongside for short connections. It will insure short and correct connections between coils, padding condensers and switch, and make construction easy even for a layman. If the i. f. is made a common frequency, such as 456 or 465, this unit should sell well to those wishing to convert present home-made jobs for broadcast only but with good i. f., to all wave.

(6)—When you finish this all-wave set, start a series of construction articles on a converter, with one or two stages of 58 r. f., a 2A7, and one 58 i. f. stage, usual 80 rectifier stage and provision for doublet as well as L type aerial. Practically everyone on the Pacific Coast that builds sets has put up a short-wave aerial, usually of the double doublet type.

The set as already published shows a great deal of thought and many clever wrinkles. The wave trap for elimination of signals the same as the r. f. is absolutely necessary. The station siren is very clever, but not necessary for those accustomed to fine tuning. (Personally, I have been twisting dials since 1910. My first receiver was bought from Electro Import Company and consisted of a single slide coil, electrolytic detector and single 75-ohm head phone.)

You are to be congratulated for recommending 2.0-mfd. bypass condensers. Most constructors have a supply of 1 and 2 mike condensers and naturally use them instead of .01 or .1 mfd. when the latter values are specified.

Your selectivity and tone controls are very well thought out and should be well received.

R. G. SMITH,
1501 Hobart Bldg., San Francisco, Calif.

* * *

What Is Good News?

Editor, RADIO WORLD:

Regarding "A Thought for the Week," in the issue of November 10th, you ask about a stated financial report wherein sales had doubled in six months: "If that isn't Grade A No. 1 news, what's your idea of good news?"

Well, my idea is that the mentioned report is only partly good. The almost 100 per cent increase in sales in six months is good.

If by net profit is meant a sum remaining from the income of the business after all necessary expenses are paid, then the report of a net profit of $412,942 is not good, far from it.

All managers, superintendents, foremen, workers and even presidents employed by a business are entitled to fair and just salaries and wages for services rendered in the process of carrying on the business. Interest on investment at a fair rate, say not over 7 per cent, insurance, both fire and accident; depreciation and taxes and what may be really necessary to apply to sinking fund are just and fair expenses and should be met. After all this has been done funds remaining, if any, I take it, are net profit.

That being the case what is net profit for? All services rendered and goods delivered have been paid for and are jointly included in the cost of doing business. Where does any charge to produce net profit come in?

No business has any right to bleed the public with charges for which no return is made in goods or services.

It would have been A No. 1 good news had the report read: "In the six months just completed our sales were nearly double the sales of the same period of last year. We have given the public the very best goods and services possible for the prices asked. Our income was sufficient to cover necessary expenses and nothing more. We have no right to anything more."

ARCHIBALD McLEAN,
608 25th St., W.,
North Vancouver, B. C.

19 Countries Send Groups to Learn How U. S. 'Does It'

During the first year of its existence, the Radio City headquarters of the National Broadcasting Company has become a mecca for radio engineers from all parts of the world. From countries in every continent, experts have flocked to the New York home of NBC to examine the world's most modern and most efficient broadcasting plant.

Nineteen countries, so far, have sent delegations, committees or lone investigators to find out how Radio City was built, how it operates on its split-second schedule, how the coast-to-coast networks are "fed" their constant diet of entertainment and information. The nations represented to date are:

Argentina, Australia, Austria, Brazil, Canada, China, Czechoslovakia, England, France, Germany, Holland, Italy, Japan, New Zealand, Poland, Russia, Siam, South Africa and Sweden.

As a result O. B. Hanson, chief engineer of NBC, has been kept busy acting as host and guide, while directing the technical operation of the world's largest broadcasting system.

According to Hanson, the things which interest foreign engineers most are the acoustical control system, developed and perfected by NBC engineers; the multiple switching system to shift programs instantaneously from one place to another, and the system of pre-setting network hook-ups to await the mere push of a button.

Present visitors at Radio City from across the ocean are members of a committeee from the British Broadcasting Corporation, including Lord Selsdan, P.C., K.B.E.; N. Ashbridge, chief engineer of the BBC; F. W. Phillips, assistant secretary of the British Post Office, and Col. A. S. Angwin, assistant chief engineer.

SOLDERING ON THE ROOF

There are occasions when a soldering job has to be done on the roof where there is no power outlet for electric iron to be plugged. It might be necessary to join the transmission line to the antenna "on location." What can one do in such a case? Well he can't use one of the old-time irons that are heated in a burner because there are no gas pipes on the roof, either. The solution to this problem can be had by an alcohol blow torch, or a can of Sterno, gotten from the local five and ten.

Six Steps to Successful Soldering

(*Continued from preceding page*)

in several seconds, depending upon the temperature of the iron.

Once this oxide formation recurs, it will not be possible to tin the iron and another cleaning will be necessary. When the iron has been correctly tinned, we are ready for the actual soldering operation.

Since the purpose of all this endeavor is to solder two metals together, the soldering operation is the most important, and the procedure in this phase of the work is of great importance. The objective in this operation is to transfer the heat of the iron to the work, and to coat its surface with some solder. This is accomplished in the following steps.

Step 1: Place the hot tinned iron on the spot (which has been previously cleaned) to be soldered.

Step 2: Raise the iron from the work slightly, using the tip as a pivot, and feed some rosin-cored solder between the iron and the work.

Step 3: Press down on the solder so that the solder will quickly melt and run into the joint.

Step 4: With a slow rotary motion, rub the face of the iron firmly over the joint. If the work is proceeding correctly, it will be noticed that the solder is running into the work properly.

Step 5: Now add some additional solder to completely cover the joint and apply sufficient heat by retaining the iron contact until a homogenous mass of solder, firmly adhering to the work, is accomplished.

Step 6: As a finishing touch, all traces of unused flux should be wiped from the joint with a rag, knife or file, and excess solder should be removed.

In this way, we have performed a correct soldering operation that will produce satisfactory results and will conserve one's temper and patience.

DON'T try to solder a joint that is not clean.

DONT'T try to solder with a warm iron. It must be HOT.

DON'T fail to tin the iron and the work.

DON'T carry flux-cored solder on the iron to the work since the flux is spoiled by heat and the molten solder readily runs off the tip. Apply the solder direct to the spot to be soldered.

DON'T fail to get the spot to be soldered good and hot, just before soldering.

DON'T melt the solder an inch or two above the work and expect it to drip into the joint and form a good job.

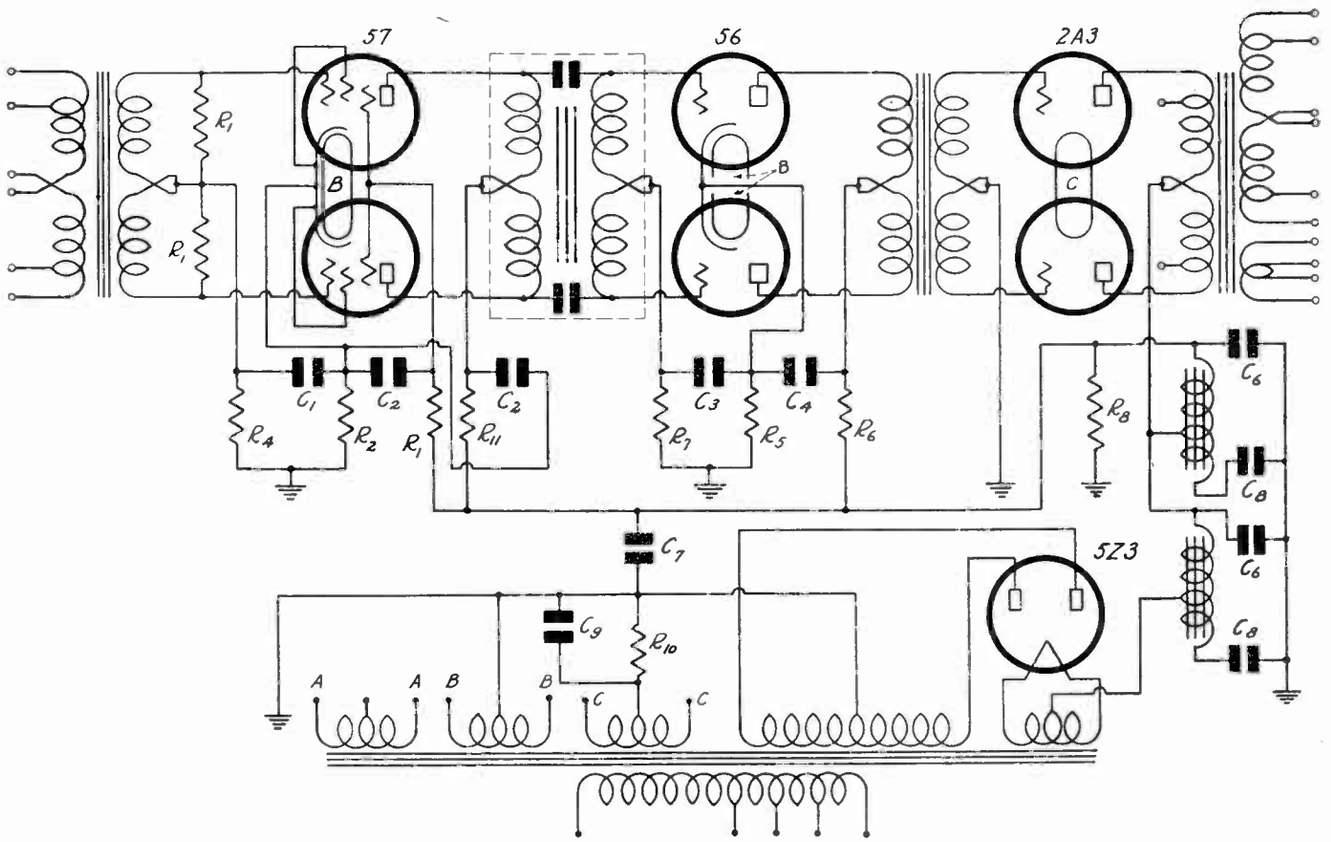
DON'T jar a joint until the solder has had sufficient time to cool.

DON'T remove the iron until the joint has attained homogeneity.

Push-Pull Raises Pointers

Bypass Condensers as Symmetry Indexes—How to Reduce Them

By C. B. Eddie



Resistor-capacity filters C1R4, C2R1, C3R7 and C4R5R6 are particularly effective against hum. C9, bypassing the 2A3's biasing resistor, should be large as practical.

IF a doctor prescribes medicine he prescribes the dose. If too much medicine is taken, the remedy may be worse than the ailment. Something of the same nature applies to the filtration of hum from a receiver or amplifier.

Assume the usual B filter. It consists of a choke and some condensers. The choke may be dismissed with the statement that for practical purposes the inductance will never be too large, although the d-c resistance of the winding may be too large to support good regulation. By good regulation is meant practically steady voltage despite large differences in current drawn.

The capacities are more or less standard. Two 8 mfd. condensers are used commonly. More capacity may be put next to the rectifier further to reduce hum, but the starting current runs high in the rectifier tube and the life of that tube may be shortened. The d-c voltage is higher, the larger the condenser next to the rectifier.

The Reservoir

At the end of the B filter the capacity may be increased considerably without reducing hum more than a little, if at all. The reason for large capacity here is not so much to reduce hum as to provide handling capacity. The charge on this condenser acts as a reservoir from which the receiver or amplifier draws sudden large doses of current, and the larger the capacity, the better the system is able to support these instantaneous demands.

But as the capacity next to the rectifier is increased more and more it may be found that the hum begins to increase. That this is true many know. What is the reason? In the case of electrolytics, perhaps the total leakage is too great. Perhaps the system comes too close to the natural hum frequency as a resonant device and some of this hum-frequency current more readily is communicated to other tubes electrostatically.

Of course the capacity should not be made larger than that which results in minimum hum.

Assuming the rectifier is properly taken care of, still there is danger of hum in the set, because just a little hum will be subjected to much amplification. For a half-wave rectifier the hum frequency would be the line frequency, normally 60 cycles. For a full-wave rectifier the frequency of greatest trouble is twice the line frequency, as the f-w rectifier is a frequency doubler. Hence, the frequency being higher by the f-w method, the filtration is easier.

Resistor-Capacity Filters

One of the soundest methods of protecting each circuit is to use resistor-capacity filters. Where these resistors are in the plate circuit the resistance has to be rather low, so as not to reduce the plate voltage too much, but the lower they are, the higher the capacity has to be. Therefore 8 mfd. and 20,000 ohms may be used for plate circuits in the power-amplifier diagram herewith, whereas for grid circuits up to 500,000 ohms may be used, and the condenser may be as low as 1 mfd.

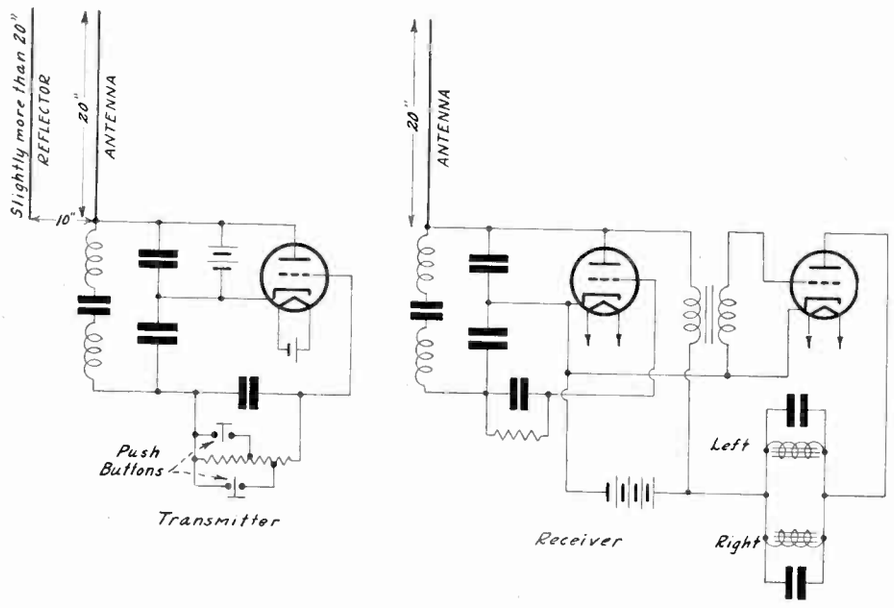
The resistor-capacity filters in the biasing circuits operate somewhat differently. They are really circuits for d-c attainments. But if the condenser is made very, very large, the effect on a-c by the resistance used for potential-determination is almost entirely offset. The rule is sound that this condenser should be as large as possible but applies almost exclusively to single-sided circuits. For push-pull there would be no signal current through these resistors (R2, R3, R10) and no condenser is across two of them, on but one is across R10, the output stage biasing resistor. Why is that?

The condenser across R10 should be omitted, also, because the stage is push-pull. The only reason for including it would be if there is a state of unbalance. Therefore, to test for whether the condenser must be in, or may be left out and therefore the circuit is in balance, send a low frequency, like 100 cycles, through the amplifier, or use the hum modulation from an oscillator feeding a receiver to which the amplifier is attached, and hear whether the volume goes up considerably when the condenser is included. Or just see whether hum is less with the condenser in. If so there is unbalance, so leave the condenser in. If not, there is sufficient approximation of true symmetry, and the power output will be somewhat greater for the omission of the condenser.

Micro-Wave Remote Control

Principle of Applying Different Modulating Tones for Starting, Stopping and Steering Toy Boat

By Roscoe Adams Latimer



The model boat remote control transmitter utilizes one acorn tube with a directional antenna in a Colpitts circuit on a wavelength of one meter.

The remote control receiver is installed in the boat and consists of two acorn tubes and a twenty-inch antenna which might be the ship's mast. Two magnets control the starboard and port motion of the rudder.

THE intriguing uses of radio has caused many laymen to forsake their usual life so that they have become "bugs," or high enthusiasts.

The enthusiasm of most radio bugs has found vent in the manifold ramifications of radio as applied to communication and in many cases their work has notably advanced the art.

Were radio confined in its application to communication solely, it would still be a most valuable blessing of nature. But radio is not only useful for communications, as we commonly use the term. It is becoming increasingly important in the development of a means of televising sight, it is steadily showing an increasing value in the field of medicine and industry, and, it seems that its applications in the field of mining are not in vain. Its utility in the nature of a "lighthouse" for maritime vessels and a beacon for those aeronautically inclined is definitely established. Is it to be wondered that the fascination of radio phenomena is so great?

In any state of mind, this is an imposing list of different ways that a God-given agency may be utilized for the purposes of man. But—we are not done. Eggs have been boiled and meals have been cooked by radio. The parasites clinging to botanical and horticultural specimens have been destroyed by radio, while leaving the host unharmed. Are the uses of radio limitless? So it would seem.

Doubtless there are many new uses for radio in the offing. Will you have a hand in their discovery?

Off to a New Field

In order that you be in the proper frame of mind for such discovery it is necessary for you to have done some work in such fields in the way of experiments. Working in the communication aspects of radio alone is not conducive to such frame of mind. Therefore, come along with us to a field where the paths are relatively untrodden, where you may blaze the way!

To experiment in the non-communication aspects of radio, one must think differently than has been customary. Yet he must not discard his radio knowledge, since it is still the essence of his endeavor.

It has been shown that there are many uses for radio, therefore, our first problem is that of choosing a purpose suitable for the beginner in a new field. The object of our choice of course should be simple and it should also be inexpensive. It should be also continually fascinating.

The satisfaction of all these conditions by the applications mentioned above is found to be limited. Consequently we must dig up another application and from our musty files, we find that 'way back in 1922 and beyond, it was a delightful indoor and outdoor sport to control moving vehicles by radio. This vehicle would either be a model boat or sonny's toy train. It might have been the kiddie car. Or, maybe, it was just a soap box on wheels. At any rate, something on wheels was made to move around most mysteriously. And do not think that this is a child's game. For, full-sized aeroplanes have been maneuvred by radio just as has been done with actual battleships. This suggests the possibility of making a livelihood in this way—growing out of a hobby of playing with so-called toys! This phase of radio has been termed "radiodynamics" by some. It shall be understood to denote the remote control of moving objects by means of radio waves. It is believed that the conditions set forth above are most satisfactorily met by a small model boat and we accordingly propose to install this equipment in such a vehicle.

Transmitter Needed

The essential elements of such a process are a transmitter whose carrier frequency is constant though capable of various modulations and a receiver in conjunction with control apparatus aboard the boat. Though this field has been neglected by most radio enthusiasts, a bit of work along these lines has been done by various persons, and the results fascinated those at demonstrations. However, these demonstrations were carried on by means of carrier frequencies that were quite low and thus required cumbersome apparatus.

The advent of the ultra-high frequencies has opened a means of simplifying this apparatus so that it is no longer necessary to lug heavy equipment around. The suggestion is made that the new 955 acorn tube be used in conjunction with a directional transmitting antenna. In this manner, possibly one or two tubes in the transmitter

Microphones Put in Three Classes According to Use

Three different degrees of sensitivity for microphones are even more necessary now than a few years ago, say officials of the Universal Microphone Co., Inglewood, Cal.

The degrees are M for medium, S for sensitive and D for damped.

M is a medium between sensitive and highly damped, and is the most practical all-purpose microphone of today. It is particularly adapted for p-a systems when loudspeakers are at a distance from the microphone, or are pointed away from the instrument.

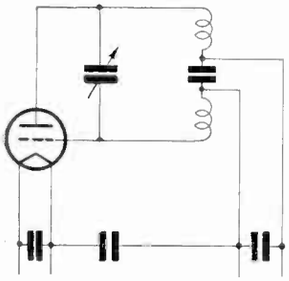
D is especially useful for the p-a systems where the loudspeakers are close to the microphone, such as sound trucks, platform speakers, interior call systems, or where p-a systems are used in halls, especially if the systems are small.

S is primarily intended for transmitting, where the music or voice cannot get back into the microphone, such as broadcast and other similar uses.

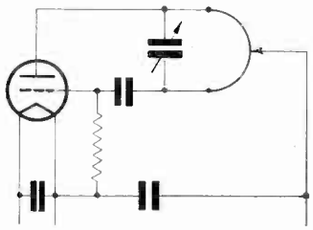
Microphones, point out Universal engineers, cannot be made to perform all functions perfectly. Microphones of certain grade and quality, even with the utmost in frequency response, cannot be made for use in a p-a system, and then changed to studio or recording use and function properly in all cases.

Hence the three classifications.

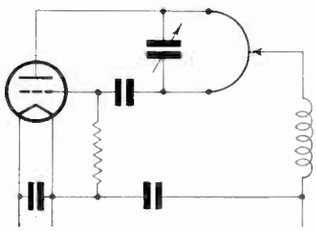
Oscillating Circuits for 1 to 10 Meters



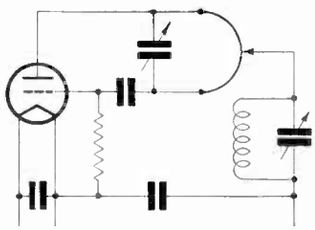
Basic oscillator circuit.



Modified for the high frequencies.



A choke is inserted to maintain oscillations.



A regenerative control is added.

and the receiver will suffice, which provides equipment of very small dimensions. This may be operated on a frequency of about one meter, which requires an antenna wire only about 20 inches long, with similarly small circuit dimensions. Such apparatus can be standard design and will differ from ordinary equipment in size only. The diagram accompanying this article shows possible arrangements for transmitter and receiver.

Tone Differences

It will be noted that the transmitter utilizes a tapped resistor in the grid circuit in order to obtain different tones to modulate the signal wave. The transmitter feeds a vertical wire one-half wavelength long, which acts as an antenna. Spaced one-quarter wave behind the antenna is another vertical wire, slightly longer in length that serves in the capacity of reflector, to concentrate the energy of the transmitter in its one useful direction.

It will further be seen from the diagram that the transmitter tones are obtainable by pressing either one of two buttons, which short different parts of the grid resistor to produce different tones. When neither button is pressed, the whole resistor serves to produce another tone. These tones will be intercepted by the receiver, which utilizes a detector and one stage of audio amplification, with a 20-inch vertical wire for antenna.

In the plate circuit of the last stage will be found two electro-magnet coils which are rigged up to control the rudder of a model boat, either to the right or to the left. These coils are shunted individually by quite large condensers which serve to make each magnet coil resonant to a different tone frequency as emitted by the transmitter. These constants are further chosen so that the combination is resonant to the tone frequency of the transmitter when neither button is pressed.

Steering Operators

In this manner if no button is pressed the transmitter will emit a tone-modulated signal that will be picked up by the antenna on the boat (which for obvious reasons can also be the mast). This note will be determined by the entire resistance in the transmitter grid circuit and will affect both electro-magnets (if properly designed) equally well so that neither will affect the rudder and a straight course will be steered. On the other hand, should either of the buttons be pressed, the corresponding note will be emitted by the transmitter, which will affect the correct magnet to a greater extent and cause the rudder to be affected as desired.

Only three effects have been described, since it has been attempted to adhere to the condition of simplicity. But the individual experimenter, as he becomes more proficient in this art, may learn to make his equipment more dextrous. It might be possible to add more controls, so that starting and stopping of the engine is possible. It might even be arranged that the speed can be made variable. At any rate, these additional duties would follow the same principles laid down in this article so that no great ingenuity will be required for elaboration of this idea.

License Required

In conclusion, the reader will be warned that the foregoing equipment may not be operated by individuals that do not possess amateur operator and station licenses issued by the Federal Communcations Commission. Since the Commission has recently ruled that amateurs may operate on any frequency above 110 megacycles, the use of this equipment on a wavelength of one meter is not illegal when in the hands of duly licensed amateur operators. Should unlicensed readers become interested in the construction of the devices mentioned in this article and desire to operate them themselves, they may prepare for obtaining licenses by referring to the article entitled "This Way to Amateur Tickets" appearing in RADIO WORLD of November 24th, 1934.

Additional Cities Cited for Amateur Examinations

In the November 24th, 1934, issue of RADIO WORLD, there appeared an article entitled "This way to amateur tickets!" In here, were indicated the various cities that have been set aside by the Federal Communications Commission for the purpose of license examinations. Information has been received since the publishing of this article wherein it is noted that the following additional cities have been indicated for similar purposes: Albuquerque, New Mexico (from the Dallas office); Billings, Montana (from the Denver office); Bismarck, N. Dak. (from the St. Paul office); Boise, Idaho (from the Portland office); Butte, Montana (from the Seattle office); Jacksonville, Fla. (from the Miami office); Little Rock, Arkansas (from the New Orleans office); Phoenix, Arizona (from the Los Angeles office); Salt Lake City, Utah (from the Denver office); Spokane, Washington (from the Seattle office).

It is further stated that examinations shall be held at these points not more than twice a year for all commercial and Class A amateur licenses.

Frequency Increases as the Emission Rises

The question in what direction the frequency changes with change in emission in a vacuum tube arises from time to time, and so a cathode-ray oscilloscope was set up, fashioned after the Western Electric Company's circuit for the W.E. 224 tube. (This bears no relationship to the receiving type 224 tubes of other manufacture.)

In the operation of this circuit, it was found that an increase in the filament of the two-electrode tube caused a decrease in the number of cycles apparent on the screen for a given frequency; and, conversely, a decrease in the filament current produced the opposite effect. This is readily proven theoretically, when it is realized that increased emission increases the frequency of the timing potential because of the lower resistance in series with the condenser for discharge; and, also, decreased emission decreases the frequency due to the greater resistance in series with the condenser for discharge.

It was also noted that to obtain the same number of cycles on the screen for any frequency required an increase in the filament current of the two electrode tube for increasing frequencies. Thus, by varyinging this filament control only, it is possible to synchronize the timing potential with the unknown wave.

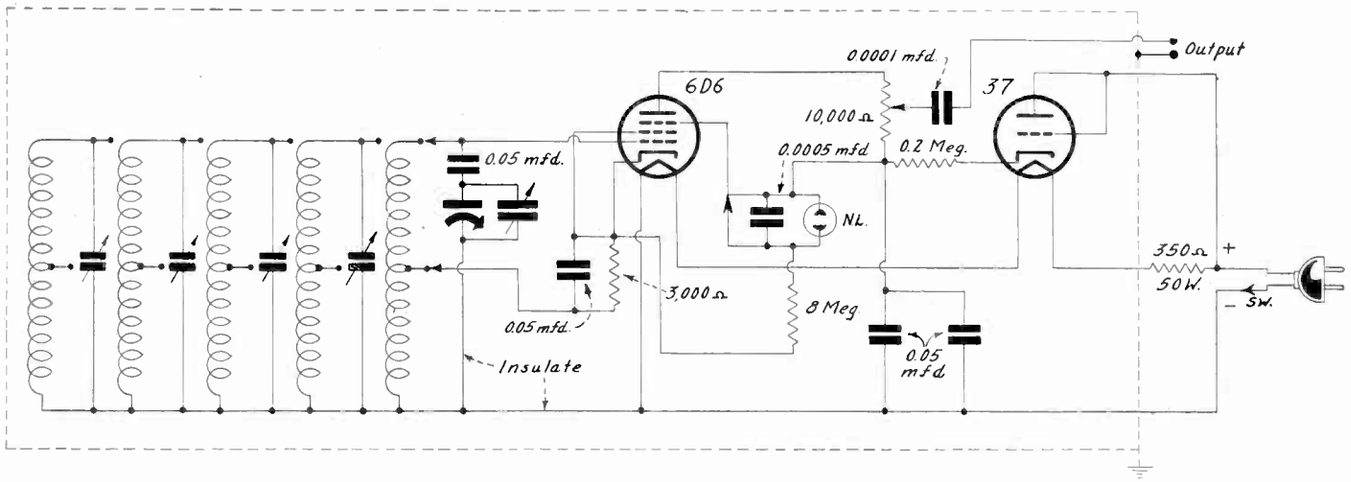
The timing axis that results from this system is not pure. The wave shape of the potential across the condenser does not constitute an exact saw-tooth. Consequently, a distorted wave shape results. In order to overcome this difficulty, there is introduced across the timing plates a wave shifting battery in series with a resistance of high value. The function of this battery and resistance is to shift the distorted portion of the timing potential off the screen so that only the undistorted portion is visible on the screen. By means of this artifice, a virtually pure timing axis results.

Due to the critical nature of the two-electrode tube filament rheostat, it was decided to attempt the substitution of the grid control of a three-electrode tube for the filament control of a two-electrode vacuum tube. However, this substitution was not advantageous since the timing axis thus obtained varied in length with changes in the grid bias. At one point, the entire axis disappeared from the screen. Thus, the three-electrode tube did not cure the ills of the two-electrode tube but introduced other ills instead. Consequently, it was decided to retain the original Western Electric Company scheme, as the most suitable one for the model that was built. The critical nature of the two-electrode tube was compensated for by using a vernier rheostat in the filament circuit.

The 339 Signal Generator

All-Wave Coverage, Modulation Optional by Switching, Humless B Supply

By Herman Bernard



A signal generator for all-wave coverage, 54 to 17,000 kc, using only fundamentals, with modulation present or absent, by switching. Though the B filter is very simple, hum is absent.

EXTREME simplicity has been applied to a signal generator for all-wave coverage. This is the Model 339. If it is true that the fewer the parts used the better, then the present system must be pretty good, because practically nothing can be eliminated.

Even the coil system is the simplest one consistent with stability. The dynatron requires only a single winding, no tap, but is not stable.

The capacity padding is both series and parallel, but this is necessary. All use is on the basis of fundamentals, reading a decimal-repeating dial.

First the parallel capacity is adjusted across the tuning condenser to serve the low-frequency band. Then as the switch is turned progressively for higher frequencies the distributed capacity of the coils becomes less, and the amount of extra capacity to be added is such as equals the reduction in distributed capacity.

The Repeating Dial

In that way the same tuning ratio is preserved, and a dial with two fundamental scales, 54 to 170 kc and 170 to 540 kc, is made to repeat itself, *i.e.*, the other ranges are 540 to 1,700 kc, 1,700 to 5,400 kc and 5,400 to 17,000 kc. The widest semi-circle of the dial face is utilized for all bands, since the two calibrations are on the outside circumference of an airplane dial using a double pointer.

On the inside "ring" are the equivalent values in wavelengths, so that answers in wavelengths are obtainable, the factors of 10 and 100 being divided into the inscribed wavelengths for the three scale-repetition ranges, whereas for frequencies the same factors are used for multiplication.

Modulated-Unmodulated Service

The rectifier and filter are exceedingly simple. The 37 is used as half-wave rectifier. Therefore the line frequency of 60 cycles has to be considered. By using a suitably high resistance and capacity, of a time constant such as to represent a frequency lower than 60 cycles, the filtration is made remarkable. There is no hum. If the series resistor is 0.2 meg. (200,000 ohms) and the capacity is 0.1 mfd., the time constant is 0.02 and the frequency is 50 cycles. Therefore, a low impedance to ground is established for frequencies of 50 cycles or higher, hence there should be no more audible hum than if the plate were returned to B minus.

LIST OF PARTS

Coils

One assembly of six tapped coils. (Inductance values given in the text.)

Condensers

One 404 mmfd. tuning condenser.
One 25 mmfd. parallel trimming condenser.
Four 0.05 mfd. fixed condensers.
One 0.0005 mfd. fixed condenser.
One 0.0001 mfd. fixed condenser.
(Four parallel capacities separately across coils are made up of twisted wire.)

Resistors

One 3,000-ohm pigtail resistor.
One 10,000-ohm potentiometer with a-c switch attached.
One 0.2-meg. pigtail resistor.
One 8.0-meg. pigtail resistor.
One line cable and slug, with 350-ohm, 50-watt resistor built in.

Other Requirements

Four insulators for tuning condenser and output post.
One strip with four insulated lugs.
One chassis and shield cabinet.
One six-hole and one five-hole socket.
One grid clip.
One knob and two bar handles.
One frequency-calibrated airplane dial (339).
One on-off switch.
One 6D6 and one 37 tube.
One output post.
One ground post.

The limiting resistor, 350 ohms, 50 watts, is built into the line cord, so that there will be less wiring in the set and also better heat dissipation.

Universal Operator

Universal operation permits use of either a-c or d-c input from the line, 90 to 125 volts. For a-c the line frequency may be of any commercial value. Since no a-c is used on the r-f oscillator plate the neon-tube modulator is necessary on a-c as well as d-c, unless one desires to operate without modulation. By switch control modulation is removable on both uses.

The neon lamp NL should be of the type that has no limiting resistor built in. The standard type, with such resistor included, permits oscillation, but of too high a frequency, one that cannot be suitably lowered, because only one lamp terminal is directly accessible.

The circuit itself, as a whole, should be insulated from a metal chassis. This requires that the condenser frame have insulating spacers at the three mounting points, and that an insulating lug-strip be used, for anchorage of the three line leads (two direct, one indirect through the limiting resistor) and besides the B plus rectifier lead (d-c) should be treated similarly.

Commercial Coils Used

The five coils are commercially made on one assembly. The inductance values are 25 millihenries, 2.1 millihenries, 250 microhenries, 21 microhenries and 2.5 microhenries. The taps are located at about one-quarter the number of turns up from ground end, except for the two highest-frequency coils, which are center-tapped.

The adjustment method is as follows:

The low-frequency band is treated first. This is 54 to 170 kc. Tenth harmonics of the generator may be used for beating with broadcasting stations, in conjunction with a receiver of the broadcast frequencies.

The dial pointer is set exactly horizontal when the tuning condenser plates are totally enmeshed. This is at about 52 kc, not

All-Wave Set Proves Wide Uses of Radio

Previously persons were told that the uses of radio were wide, and that standard broadcasting occupied only a very small percentage of the total span. Since the advent of the all-wave receiver the realization has been brought home to thousands.

They tune in police calls, amateur conversations, various telegraphic services, as well as commercial telephony, even conversations between ship passengers and friends and relatives ashore. Television, too, comes in, but only as a buzz-saw sound.

Even at the frequencies lower than the broadcast band there are surprises for many, including commercial telephony and also weather reports. Any who have had navigating experience, or do much "tripping," find the weather reports valuable. Farmers know weather affects crops and prices.

a part of the calibration. Tune in the lowest-frequency broadcasting station that yields a beat exactly on one of the bars of the generator scale. Suppose the station is 570 kc. The dial may read 57 fortunately, or may read 56 or 58, but this does not matter, so long as the result reads directly on some bar fairly close to what is desired. Then turn the generator to read approximately twice the original number. That is, 115 or thereabouts. Note where a response is heard. It will be somewhere around twice the first number. If the result is less than twice the first number read, more parallel trimming capacity is neeeded. This means an adjustment of the small capacity that is across the tuning condenser. When the second utilized response is at exactly twice the frequency read for the first response, the capacity ratio is tentatively correct for this range. Intervening responses may be ignored.

Final Tie-Down

Next adjust for coincidence of the generator scale with the station near the low-frequency end. If 570 kc is being used, adjust the series capacity until 57 is read at zero beat. If the reading is too low (56, 55, etc.), use more series capacity. If the reading is too high (58, 59, etc.), use less series capacity. The capacity meant is marked 0.05 mfd., but obviously may have to be somewhat different.

Now turn again to the second utilized point (twice the frequency) and readjust the parallel trimmer, in this instance to cause the reading of the generator to be 114 (twice 57). This slight adjustment will not disturb the low-frequency end.

For the second band, 170 to 540 kc (and subsequent bands), only extra parallel capacity is needed, and this is put across the coil. The capacity is small and may consist of twisted insulated wire used for its condenser effect, and finally treated with some adhesive.

The 170 to 540 kc band may be adjusted at the high-frequency end for second harmonic of generator beating with some broadcasting station, *e.g.*, generator dial 145 to 150 used, on the basis of stations on 1,400 to 1,500 kc.

The third coil is adjusted on the same station as for the previous band, using the fundamental of the generator.

Odd Use of Harmonic

By listening carefully to a broadcast receiver the next band can be adjusted the same way, although the fundamental of the generator may be three times the station frequency. This is possible because the receiver itself generates harmonics. If a station at 1.500 kc is used the adjustment may be made at 4.500 kc (third harmonic of the station frequency). Any station between 1.400 and 1.500 kc may be used. Multiply the station frequency by 3. The response will be weak but it will be there. Earphone listening may be necessary.

The same harmonic method possibly may be applied to the highest frequency band, but in general this band would require adjustment on the basis of a known fundamental tuned in, which may be taken from the air or from the fundamental, or low harmonic of some other generator.

There is no adjustment necessary for the low-frequency end of any band excepting the first.

Radio University

ANSWERS to Questions of General Interest to Readers. Only Selected Questions Are Answered and Only by Publication in These Columns.

Reduction of Hum

DOES THE AMOUNT of hum in a receiver depend on the amount of current drawn? If I reduce the current, would that help?—L. K.

Yes, the amount of hum does depend on the current drawn, because the inductance of the filter choke is effectively less, the greater the current passed through the choke. However, mere reduction of the current somewhat would not constitute sufficient benefit in hum-reduction, for most hum troubles. Coincident with this reduction use a resistor-capacity filter. This is very effective in the stage to which it is applied. For the case of the plate circuit of a resistance-coupled amplifier, R1 is the load resistor and R is the filter resistor. If C is 1 mfd. R may be 0.25 meg. For the grid-circuit case, leak load, the same procedure is followed, as shown in the second diagram. Sometimes hum arises from the negative-choke biasing system, and the resistor-capacity filter would be RC in the third diagram, where R has to be lower than otherwise, in the event of grid current, so might be 100,000 ohms, and C an electrolytic condenser of 8 mfd. up. Low-voltage rating type of capacity is all right here, say, 30 volts or so. For transformer-loaded plate circuits R would have to be low to hold up the plate voltage, and C would be larger. Thus, 20,000 ohms and 8 mfd. for the left-hand diagram then would apply.

* * *

Antenna Coupling in Z-B Sets

WAS MUCH interested in the zero-beat receiver that (so you say) afforded 10 kc selectivity on one tube. Will that degree of selectivity arise no matter how strongly the antenna is coupled to the single tube?—W. C. D.

It is obvious that the circuit has to oscillate all the time. Also, if the antenna coupling is made too tight, oscillation will stop, at least for a part of any band of tuning. Therefore adjust the antenna coupling so that there is oscillation near the minimum capacity of tuning. For frequencies higher than the highest in the broadcast band sometimes the circuit will not oscillate when the condenser is at minimum capacity, as that capacity is not large enough to sustain oscillation, so use a setting of 3 or 5 on the dial and adjust for that.

The coupling alteration, if needed at all, may be applied to the primary turns. Take off enough to restore oscillation at the stated capacity setting. Each coil may require such treatment. Often enough all coils will perform satisfactorily, with no adjustment of turns or other change of the antenna coupling.

* * *

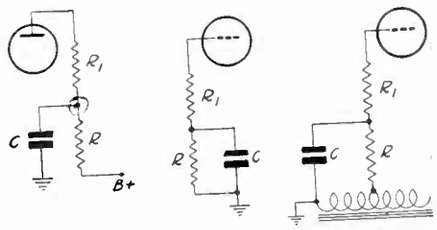
What I.C.W. Is

DOES NOT i. c. w. refer to the use of an interrupter for continuous-wave telegraphy? Then what about c. w.?—H. C.

I. c. w. is continuous-wave carrier telegraphy, with modulation impressed, as a tone for instance, the keying introducing and removing this modulation, but c. w. has nothing impressed on it save, let us say, discontinuities.

There is also a device known as an "interrupter," which is used for producing a single tone for superimposition on a continuous-wave carrier, but this, too, is i.c.w. This tone is used as an adjunct to keying, hence the system applies to telegraphy.

The c-w transmission previously referred to, that requires an oscillating receiver, is actually interrupted by a telegraph key from time to time, to impress the message, so that the receiver reproduces dots and dashes. But since there is no modulation, but only starting and stopping of the transmission, this is not technically classified as "interruption," and is not i.c.w. but c.w.



Resistor-capacity filters introduced into three circuits.

* * *

A1, A2, A3

I HEAR the amateurs talking about "A1," etc., transmissions. Does this refer to tone quality, interest of subject-matter, or what?—I. K. C.

The gradings for amateurs are as follows as to service types: A1, continuous wave telegraphy; A2, interrupted continuous wave telegraphy; A3, radiophone. A1 requires an oscillating receiver. A2 requires some tone introduced into the carrier at the transmitter, but this type of transmission isn't used much by amateurs, because usually giving too broad a result.

* * *

Standard Frequency Schedule

WHEN ARE the 5000 kc frequency standard transmissions sent out by the Bureau of Standards?—O. J. L.

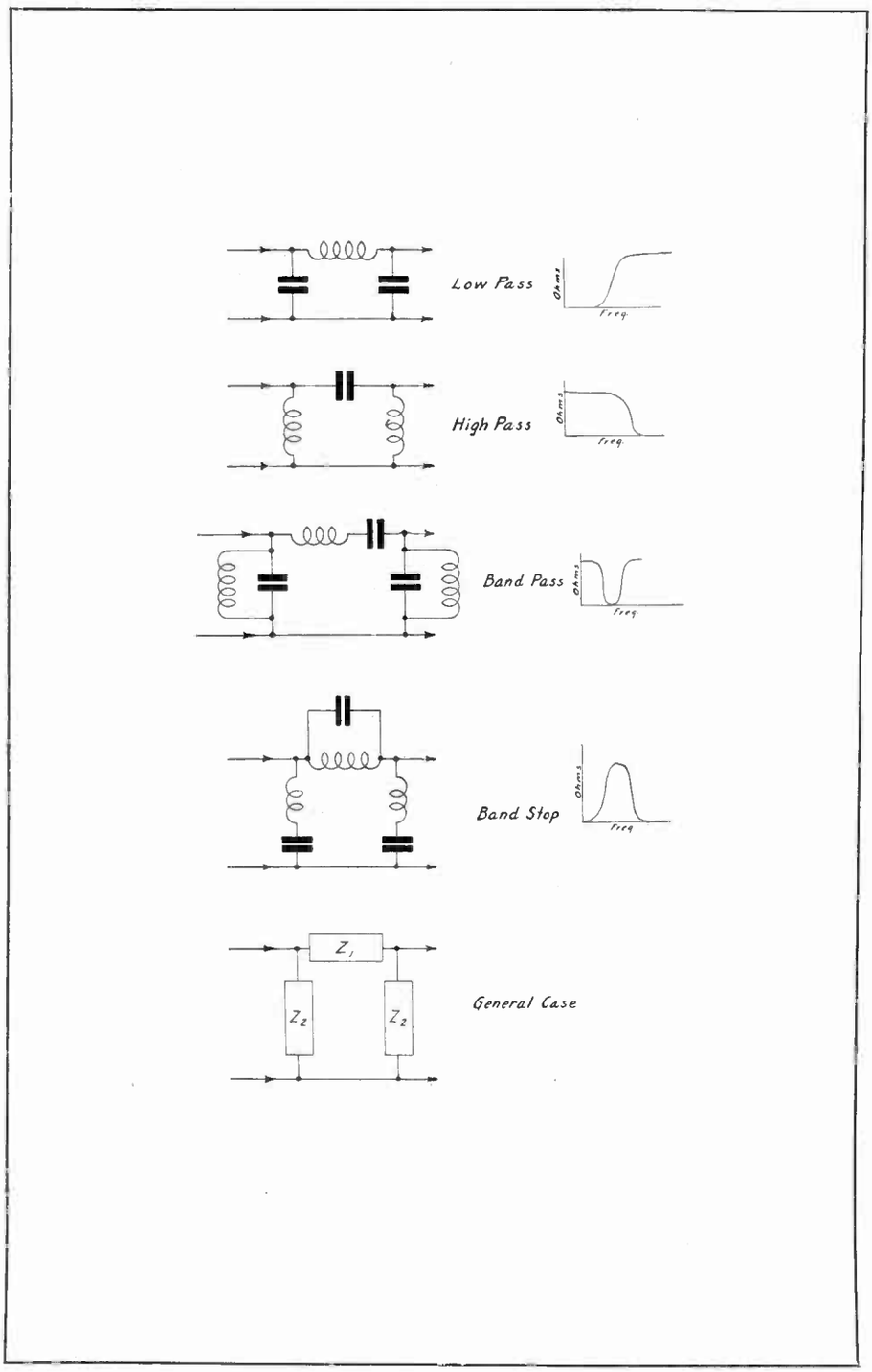
The radio station of the Bureau of Standards, WWV, Bettsville, Md., transmits its standard of frequency on 5000 kilocycles every Tuesday from 12 noon to 2 p. m. and from 10 p. m. to 12 midnight, Eastern Standard Time. These signals are accurate to one part in five million, or to one cycle.

How to use this transmission in connection with harmonics for lower and higher frequences is explained in a mimeographed Bureau circular.

Band-Pass Filters in New Sets

Cut Off Audio Highs Even for Fidelity Sets

By Roger L. Brown



Filters are circuits that either prevent or allow currents of certain frequencies to pass. The bands that are so affected depend upon the design of the filter. The circuits shown are fundamental sections and may be built in more or less number dependent upon the type of action desired.

FOR a long time selectivity of a radio receiver was a weak point in most of the products turned out until the superheterodyne circuit's general adoption. Because of the 10 kilocycle separation of broadcast stations, only 10 kc selectivity was necessary and this was satisfactorily accomplished by the superheterodyne. This permitted, as a maximum, the passage of signal frequencies on either side of the carrier on the order of 5 kc. And many receivers furnished other methods which probably reduced this maximum to 3,000 cycles. With such a receiver, a musical program lost much of its charm because of its booming tone and general lack of higher notes. Such instruments as cymbals, bells, and other tinkling devices were lost in the cacaphony and these instruments might as well have been absent from the studio presentation. Such utter neglect of the musical quality of a program caused the campaign for the high-fidelity receiver which we are now witnessing in its fruition.

The High-Fidelity Set

The high-fidelity receiver as built today allows a maximum passage of frequencies of 7½ kc on both sides of the carrier. In other words, it passes a band of frequencies 15 kc in width. This is well and good and should satisfy the most astute musician. However, when two adjacent broadcasting stations operate on frequencies that are 10 kilocycles removed from each other, quite a bit of interference would be picked up from the undesired station since our receiver will detect all frequencies above 5 kilocycles emitted from this undesired signal. It can therefore be seen that this 15 kc band must be capable of reduction to 10 kc in cases where two adjacent channels are occupied by equally strong stations. Of course, this mitigates against our efforts for high-fidelity but it is unavoidable so long as the present allocation scheme exists.

This forces upon us the need for the utilization of variable selectivity devices which have caused engineers to once again take the band-pass filter off the shelf. This is a device which can be proportioned so as to admit certain frequencies and to restrict others to an output circuit. Its design is an art in itself and can become very highly mathematical and involved. Since this is not an engineering journal, it would be out of place to furnish a discourse on the intricacies of this field, but we may indicate the generalities associated with it that may be useful in preparation for a further investigation.

Mathematical Side

The mathematically inclined define a filter as any passive four-terminal network that will have properties which, as far as steady state is concerned, can be completely defined by (a) characteristic impedances Z_{o1} and Z_{o2} at the two ends of the network, and (b) the propagation constant, consisting of an attenuation factor and an angle of phase shift. In terms of the layman, this may be interpreted as stating that a filter is a device with two input and two output posts, between which a voltage will suffer weakening and a change in phase angle due to the various impedances of the filter. Since impedances will vary with changes in frequency, the effects will vary with changes in frequency. It is thus that a filter discriminates between frequencies.

Filters may be designed so as to perform any one of four functions. They may allow only low frequencies to pass and prevent the highs to go through; they may do the reverse, allow the highs to go through and prevent the passage of the lows; they may pass only a particular band of frequencies and block all

others; or they may reverse that and block a certain band of frequencies and allow all others to pass. These types of filters have been named low-pass, high-pass, band-pass and band-stop, respectively. The diagrams indicate these circuits and their attenuation curves.

Effect of Resistance

Filters utilize condensers and inductances as component parts of their make-up since these devices have frequency characteristics of their own which can be applied to the purpose of the filter. A condenser is endowed by Nature with the ability of being a better conductor to the high frequencies than to the low frequencies. On the other hand, the inductance coil has been endowed with the property of allowing the low frequencies to pass through it more readily than the highs.

Combination of a condenser and an inductance coil in parallel or in series serves to furnish a certain frequency, called the resonant frequency, with discriminating properties. The series connection will allow the resonant frequency passage and block all others, while the parallel connection will block the resonant frequency and allow all others passage. It can be seen that combinations of these devices serves to form various abilities of prejudice for or against currents of certain frequencies. In all this activity, the factor of resistance is also a matter with which to reckon, since it will affect the width of acceptance or rejection of the band of frequencies that are incriminated.

Effect of Inductance

It is because of the inductance's preference for low frequencies and the condenser's preference for the highs that the low pass filter, as shown in the diagram, places the coil in series with the line and the condensers across it. Thus, the condensers will cause the high frequencies to be shunted around the filter circuit rather than transferring them to the output circuit while the coil will allow the low frequencies to go through itself and prevent passage of the highs at the same time. The condenser will also discriminate and prevent the lows from shunting around the circuit. Thus, the low frequencies will be transferred to the output circuit, while the high frequencies have chosen the shorter path through the condensers and will not appear in the output. In similar fashion, the high pass filter will do the reverse and furnish high frequencies in the output, having discarded the lows through the shunt coil circuit. The band filters function in the same way, except that particular bands are affected.

The High-Fidelity Case

In the case of the high-fidelity receiver, it is desired to allow a radio frequency band, fifteen kilocycles wide, an indiscriminate effect upon the radio frequency stages of the receiver while it is also desired to pass an audio band of 7,500 cycles in width through the audio stages. For the first purpose, the band pass filter is utilized and is so proportioned that it will do this. It is sometimes necessary when exact discrimination is desired that several band pass sections be used that are duplications of the one shown in the sketch, and in cascade with it.

Another tool is the insertion of resistance or the use of high resistance coils which will serve to broaden the passed band. The quantitative aspects of this matter are of extreme importance but because of their complexity for the average enthusiast, they are not treated herein. With the use of the band pass filter, we have at our detector stage a signal whose frequency varies from zero to 7,500 cycles. Sometimes, other interferences are impinged on this signal as it travels through the set. To minimize such possibility, use is made of another filter in the audio stage which is of the low pass type.

This filter will be found between the detector output and the first audio input, and usually is made variable to allow for the various conditions of interference that might arise from adjacent channel stations.

It is thus that filters have secured a new lease on life and it is hoped will have a sympathetic existence.

Action Taken By the Commission

The Federal Communications Commission granted an extension of the special temporary authority to Richard E. Byrd's Little America radio station KFZ on the frequencies of 5,740, 9,130 and 11,830 kilocycles, for an additional period of three months.

* * *

Amelia Earhart, noted aviatrix, has been granted special temporary authorization to operate radio transmitting equipment aboard her airplanes, known as NR 965 Y and NC 965 Y. The first transmitter will operate on 3,105 kc for use on itinerant trips while the other outfit is licensed for a frequency of 6,210 kc for flight over the sea to communicate with ships and coastal stations.

* * *

The Federal Communications Commission has exercised its penalizing authority by barring Ralph Ernstein, Cleveland Heights, Ohio, from examination for radio operator privileges for a period of six months because he operated an amateur radio station without a valid operator's license.

* * *

The Federal Communications Commission has adopted a new ruling whereby it is required that a reliable clock equipped with a second hand be provided in the radio room of all vessels of the United States.

Supertone Now Featuring Four Surpassing Models

Four new offerings are announced by Supertone Products Corporation, 35-RW Hooper Street, Brooklyn, N. Y. One is a short-wave booster, of the self-powered type, that adds a stage of pre-selection to improve any short-wave set, particularly eradicate images; another is an all-wave receiver of the plug-in coil variety; a third is a short-wave superheterodyne, the Superba, in a mantel cabinet; and the fourth a bandspread short-wave receiver and power pack.

These four offerings are new, in the sense that improvements have been introduced, and most modern methods adopted for the 1935 line of Supertone products. Receivers are obtainable in wired and kit forms. The offerings are in the moderate price class, and the receivers and boosterca rry performance guarantees.

Try-Mo's New Catalogue Biggest in Firm History

The finest and largest catalogue Try-Mo Radio Compan yever got out is just off the press. The object of publication at this time, which is somewhat later than catalogues usually come out, is to permit users to have a volume at Christmas time that is up to the minute. Some of the devices in the catalogue were announced by manufacturers only a few days before the catalogue came from the printer.

Although the items listed are numerous and diverse, affording a selection that meets practically every radio requirement, there is special stress on the Powertone line of receiers and amplifiers, as well as an assortment of Powertone signal generators. The catalogue is issued from the vast headquarters of the organization, Try-Mo Radio Fair, 85 Cortlandt Street, New York, N. Y.

FORUM

Antennas and Coffee

EDITOR RADIO WORLD:

In reference to an article in the November 17th issue "Captain Hall Discusses Antennas," I have been a consistent reader of your publication because it contains constructive material in regard to radio physics simplified for the layman. It seems to me that Captain Hall's theories have been a gift of nature and through some unforeseen purpose he takes a selfish stand in not giving the wonderful product which he claims to have in aerials.

I seem to understand that Captain Hall is using a National S.W. 5 receiver which I recall has been designed by some of the most distinguished engineers. But nearly all radio products, such as tubes, transformers, microphones, photo-electric cells, speakers, and other items, have come from the laboratory of pioneers like Marconi, Hazeltine, Edison, Armstrong and others.

I think it would please your readers much more by printing articles more closely related to science and practice. It is no wonder that the engineers at the broadcasting station snickered.

HARRY C. GOLD,
368 Broadway, Bayonne, N. J.

P. S. Coffee at 2:00 a.m. distorts the mind and produces day dreaming.

H.C.G.

New Short-Wave List by Government Due Soon

RADIO WORLD,
145 West 45th St.,
New York, N. Y.

Gentlemen:

The supply of the August 24, 1934, edition of the publication, "World Short Wave Radiophone Transmitters," for which you inquired in your recent communication, is exhausted, and a reprint is not considered feasible. It is therefore impossible to comply with your request and your remittance is returned herewith.

A new edition of this list will appear about January 1, 1935, and will be sold for 25 cents per copy by this office and by the District Offices of this Bureau in principal cities throughout the United States. Remittances may be in the form of check or money order, payable to the Bureau of Foreign and Domestic Commerce.

Regretting extremely my inability to supply you with a copy at this time, I am

Very truly yours,
ANDREW W. CRUSE,
Chief, Electrical Division.

TRY FOR YACHT "DIRECTOR"

Amateurs with an adventurous twist might be able to find an occasion when the yacht "Director," with call letters WKFG, will be transmitting from one of the out-of-the-way points that it is expected to visit within the next three years.

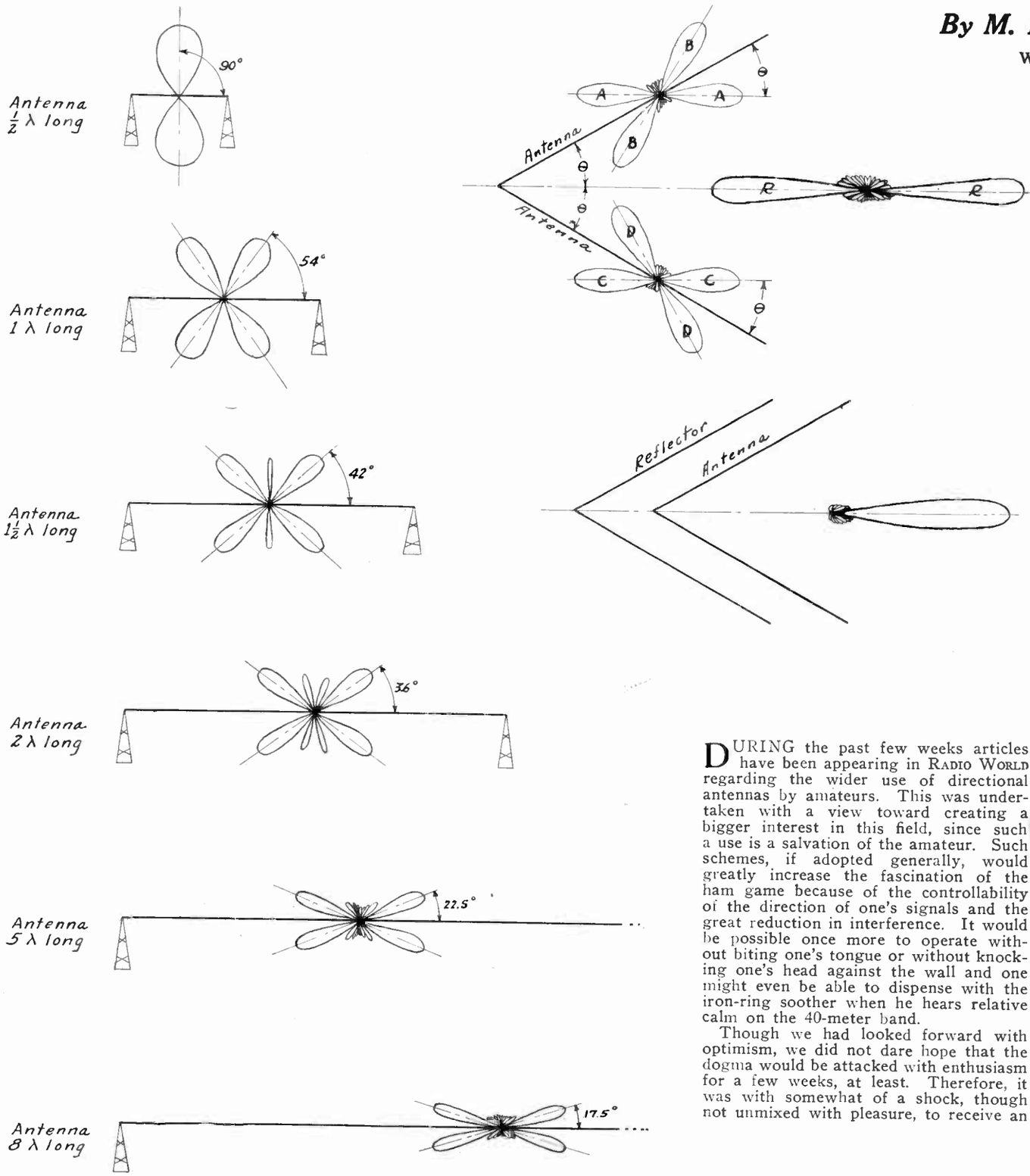
It has just been licensed to transmit on frequencies above 3000 kilocycles with a power of 300 watts. The license has been granted for third-class public service with additional authority to communicate with amateur stations.

THE "V" BEA

Spares Waves from Gettin

By M. I

W:



The manner in which radio waves will emanate from an antenna wire depends upon the length of the wire in terms of the wavelength of the signal it carries. The angle of radiation from the axis of the antenna wire becomes shallower the longer the wire. This is shown in the six illustrations at left. Combination of two single antenna wires to form a V (upper right) results in reducing the four lobes of a single wire radiation pattern to two lobes which renders the antenna system bi-directional. Lower right, two V antennas of similar dimensions but with one acting as a reflector results in a uni-directional pattern.

DURING the past few weeks articles have been appearing in RADIO WORLD regarding the wider use of directional antennas by amateurs. This was undertaken with a view toward creating a bigger interest in this field, since such a use is a salvation of the amateur. Such schemes, if adopted generally, would greatly increase the fascination of the ham game because of the controllability of the direction of one's signals and the great reduction in interference. It would be possible once more to operate without biting one's tongue or without knocking one's head against the wall and one might even be able to dispense with the iron-ring soother when he hears relative calm on the 40-meter band.

Though we had looked forward with optimism, we did not dare hope that the dogma would be attacked with enthusiasm for a few weeks, at least. Therefore, it was with somewhat of a shock, though not unmixed with pleasure, to receive an

AM ANTENNA

g "Lost" in the Ionosphere

Kunins

PS

inquiry from an amateur of wide renown who is working on a directional antenna that has not been described in these articles. Accordingly, for the sake of argument and an attempt at completeness, it shall be attempted to describe the "V" beam antenna array.

Length Affects Paterns

Various investigators have experimented with the radiation field patterns of antenna wires. The results of this work have served to show that the radiation pattern has a fixed relationship to the length of the antenna wire. As the diagrams show, when the antenna wire is one-half wavelength long, the field pattern is such that maximum energy is radiated in all directions in a plane that is perpendicular to the axis of the antenna wire. Further lengthening of this wire to one full wavelength serves to change the pattern so that maximum radiation occurs in four directions which incline at an angle of 54 degrees to the antenna axis. Further variations in the length of the antenna wire shows that this angle becomes smaller and smaller with an increase in the wire length. At eight wavelengths long, the angle has become 17½°.

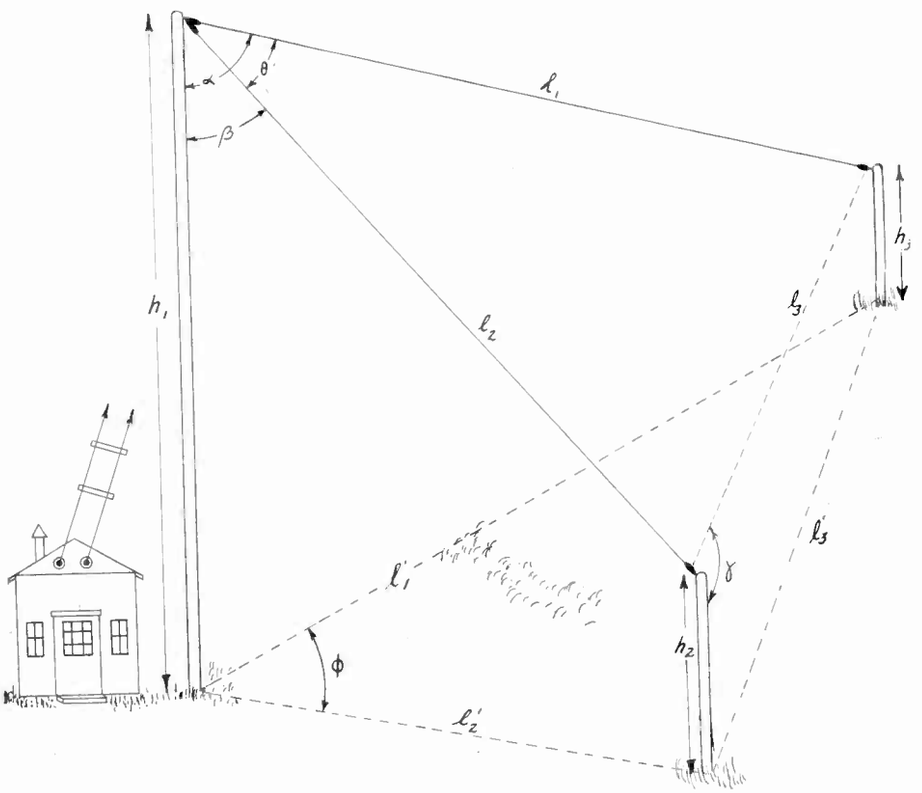
Incidentally, it might also be noted that the beam becomes more acute with increase in antenna length. We will do well to remember this point: the acuity of a directional beam is greater when the length of the antenna is greater. Of course, this is not a feature that all amateurs may utilize, because of the great amount of space necessary for such practice. However, it is something that should be appreciated in the event the opportunity to benefit from it arises.

Angle Changes

From the diagrams the manner in which radio radiations occur should be plain. It is seen that one antenna wire, of regular dimensions, has a definite directivity of its own which is directly related to its length, and that in all cases of more than one-half wavelength, there are four directions of maximum radiation. For the laudable purpose of reducing these four lobes to two, the "V" beam was originated. In this arrangement, two antennas of any desirable equal length are formed into a V as shown in the sketch.

The angle between these antennas will depend upon their length and will be twice the angle at which maximum radiation occurs for that length. As an illustration, let us take the case of two equal wires that are five wavelengths long. From the sketches, it will be noted that maximum radiation occurs at 22½° from the axis of the antenna. Therefore, the angle between two antennas that are five wavelengths long should be 45 degrees. Why is this so?

Let us again refer to the sketch showing the single V beam arrangement. The field patterns for the individual wires comprising the array are shown in light lines and contain lobes lettered A, B, C, and D. All these lobes incline at an angle of θ (to make it the general case), from the antenna wire, which, it will be noted, is also the angle between a line bisecting the angle between the antennas and the wires themselves.



To direct a beam from a V antenna array in the most desirable direction it is necessary to tilt the plane of the two wires. In constructing such an antenna system it is essential that the projection on the ground of the angle between the two wires be ascertainable so that the correct dimensions, laid out on the ground, may result. By use of trigonometric methods this angle is determined in terms of the angle between the wires.

Since the separate patterns for each antenna will exist simultaneously, they will tend to combine so that the resultant field pattern will look like the one labelled R-R.

Two-Directional Pattern

It will be seen that lobes A-A and C-C are in the same direction and will consequently add together to form R-R. Lobes B-B and D-D are in such directions as to cancel each other and disappear. The net result will therefore be R-R, a directional field pattern of only two directions. For reducing this pattern still further so that it becomes uni-directional, the old trick of reflector wires is resorted to, which is placed an odd number of one-quarter wavelengths behind the antenna and identical in length as shown in the next sketch. (It should be noted, that this treatment concerns only the horizontal plane.)

For most amateurs it is a hopeless dream to expect to have sufficient space for an eight wavelength antenna. He is accordingly limited to a wire possibly two wavelengths long at best. At 20 meters this would mean each wire would be about 130 feet in length and that the angle between them is 72 degrees. Here we run into another difficulty. A wire that is two wavelengths long radiates in all directions at an angle of 36 degrees from the antenna axis. Thus, the part of the wave that occurs vertically will shoot up a the sharp angle of 36 degrees which is not at all useful since it will suffer greatly at the Heaviside layer. This is so because the amount of attenuation that a radio wave suffers when it strikes the Heaviside layer depends directly on the angle at which it strikes the layer. The closer that this angle approaches perpendicularity to the layer the smaller is the amount of energy that is reflected back to earth. And, of course, this low limitation is not desirable. Therefore, to render this wave more useable it is necessary to arrange things so that the angle at which the beam strikes the layer is more shallow, on the order of ten degrees, perhaps.

The Tilted Beam

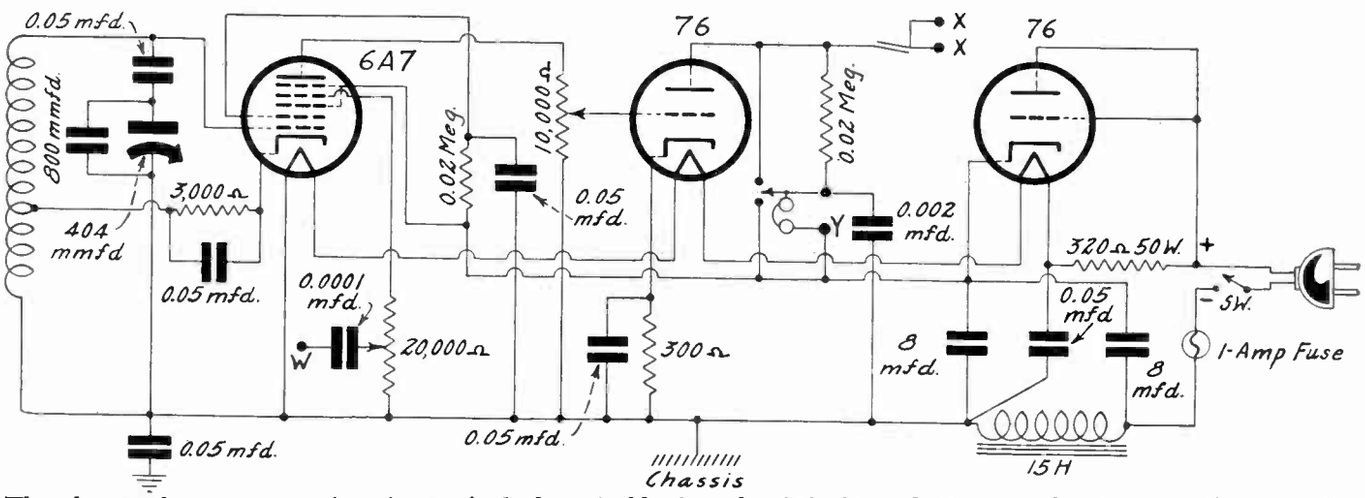
To cause a beam to strike the layer at 10 degrees when it leaves an antenna

(Continued on next page)

A Unified Meter-Monitor

Tapping Point Determines Type of Service for Hams

By Herman Bernard



The three-tube meter-monitor is particularly suitable for the 160, 80 and 40-meter bands as a direct-reading frequency meter (output from X and X) or a monitor (phones at Y). When monitoring, the transmitter is weakly coupled to W.

SINCE an amateur has an approximate knowledge of the frequency he is working, and since the amateur bands are in general harmonically related, an harmonic type generator may be used for frequency-metering and also for monitoring.

The whole subject of metering and monitoring has been somewhat lightly treated. One large manufacturer states that he does not make any such instruments because a ham can put them together so simply. But putting them together is only a small part of the problem.

The two classes of work may be defined as follows:

Frequency metering: Emitting a test frequency of known or harmonically-interpreted value for effect on the transmitter.

Frequency monitoring: Listening to or watching the effect that the frequency meter has on the transmitter.

Therefore the metering process is simply the generation and introduction of the known frequency. No modulation is necessary, as the transmitter always is oscillating when in operation.

The transmitter may be tapped for listening purpose so that the beat may be heard and resolved to zero for resonance. Then the transmitter is its own monitor.

Two in One, But Differently

The metering and monitoring functions may be united in the very same instrument, at least to some extent, whereby one listens at one point and radiates the measuring frequency from some other point. Or the two points may be in the same circuit.

The fact that one may hear the beat in the generator, although the generator is operating on a fundamental lower than any amateur-band frequency, arises from the harmonic content in the generator proper. A fundamental introduced into the generator and equal to an harmonic of the generator will beat with that harmonic present in the generator. This fact is surprising to many. Some engineers can not believe it. But the author has used the method for years.

Generators produce harmonics. As the harmonic order increases the intensity decreases. For instance, the second har-

How to Determine V from Ground

(*Continued from preceding page*)

at 36 degrees involves an artifice in the construction of the antenna. That is so to build the antenna that the wave leaves the earth at an angle of ten degrees, even though it leaves the antenna at 36 degrees. This is accomplished by tilting the beam, that is, the common point of the V arrangement is placed higher than either end so that the wires slope down at an angle that will provide this change. In this example, it is necessary for the wires to be tipped so that they form an angle of 26 degrees from horizontal.

By this means, the rays will strike that layer at 10 degrees and be rendered more useful.

Sometimes, it is also desirable to tilt an antenna sideways, in addition, to affect the radiated wave in a particular fashion. This was the case with the amateur mentioned at the beginning of this article. He lives on the Pacific coast and desires so to tilt his beam that it will perform most effectively. As the next sketch will show, he uses three poles of different lengths to support his wires. He has decided to use an antenna of a certain length with its corresponding angle Θ. But speaking practically, though he knows what this angle should be, how is he to determine this angle on the ground by the location of the two smaller poles? In other words, if he knows angle Θ, what would angle ϕ, its projection on the ground, be?

This is a problem in trigonometry. Proceeding on this basis, to solve for the equivalent of the projection of the angle ϕ on the ground, it is found that:

$$\phi = 2 \sin^{-1} \sqrt{\frac{(s - l_1^1)\ (s - l_2^1)}{l_1^1\, l_2^1}}$$

Where s is equal to one-half the sum of the three sides of the triangle formed on the ground by l_1^1, l_2^1, l_3^1. This equation states that the projected angle on the ground of the angle between the antenna wires is equal to twice the angle whose sine function is equal to the square root of the projected distances between the poles, as shown.

In the specific problem that was presented by the amateur mentioned at the beginning of this article, h_1 was 155 feet long, h_2 was 45 feet long and h_3 was 35 feet long. The angle between the wires was set at 62 degrees and the wires were 405 feet long. It is desired to ascertain the layout of the poles on the ground so that this system may be built. However, to do this, it is essential that the ground projection of the angle between the two antenna wires be known. An evaluation of the various distances according to accepted trigonometric principles indicates that:

$l_1^1 = 367$ feet
$l_2^1 = 390$ feet
$l_3^1 = 430$ feet

which subsequently gives the ground angle, ϕ, as 69 degrees.

From the forgoing statements it should be apparent to the ham who becomes interested in the V beam antenna array that he should brush up on his trigonometry in order to be able to compute the correct layout for such an arrangement. When he has this tool well shined up, it is possible for him to experiment with this antenna and note the fascinating effects of polarized waves.

To summarize the dope regarding the V antenna array, it should be said that the angle between the wires and their inclination to earth will depend upon the length of the wires.

The skin effect in the conductor provides the shielding which protects the transmission path from outside influences, the protection becoming greater, the higher the frequency.

Necessarily such a cable is quite costly and as a consequence it is only being used experimentally at present. However, when the demand by television broadcasters is sufficient, the cost may become less consequential and television will be here.

monic may have an amplitude 61 per cent of the fundamental, the third harmonic 28 per cent, the fourth a great deal less, and so on, until the value of voltage for succeeding harmonics is tiny indeed, and the difference becomes so small as to be practically unmeasurable.

Nature Lends a Hand

However, a favor of nature now comes to one's assistance. No matter how slight may be the voltage of the harmonic in the generator, if this voltage is mixed with a fundamental equal to the frequency of that harmonic, due to the detecting action the resultant voltage value is the sum of the two. Therefore if the input fundamental is of any ratable account, then so is the resultant beat, for however small the voltage of harmonic in the generator, the result of the mixture is an improvement.

It has been stated that the system works to an extent, and that extent is determined largely by the amplitude of the unknown put into the generator. With most transmitters in the frequency spans considered well applicable to the system about to be described, there is plenty of power for this purpose. the question being merely one of coupling. So the coupling of the unknown fundamental to the harmonic-generating test oscillator should be controllable, for when the fundamental frequencies to be measured are substantial harmonic orders, the coupling must be increased. However, it is possible that no response will be heard, because the coupling can not be increased sufficiently to result in an audible or visual disclosure of resonance. This would obtain when the harmonic order is severely high. At such frequency at which the present system does not produce satisfactory results, one would have to tap in at the transmitter, or use some small receiver as monitor.

Broadcast Fundamentals

The plan used was to constitute the 6A7 as a generator, electron-couple the output to a 76 amplifier tube, and supply the B power from the rectified a-c line voltage, using a 37 or 76. The circuit, with limiting resistor of 320 ohms, 50 watts, becomes "universal," and with B choke in the negative leg gets rid of line-shorting danger due to accidental striking of chassis with a "hot" wire. While the B choke is across the line the generator would hum ferociously, but that would be about the extent of the peril.

A broadcast-type tuning condenser was shunted with sufficient capacity to create a ratio of tuning corresponding to a frequency-calibrated direct-reading dial, leaving only the requirement of correct inductance, 31 microhenries. The dial scale is marked 83 to 99.9, and is read in multiples of 10 for the fundamental (830 to 999 kc). The equivalent wavelength recordings are on the scale, also, 3,600 to 3,010 meters (extreme high frequency not given corresponding odd wavelength).

The r-f output is taken through a small capacity, such as existing between lamp-cord 3 inches long, or twisted pair hook-up wire.

Precautionary Output

Two binding posts are shown in the r-f output (x and x) and so that whatever wire is used, such as lamp cord, will have both conductive ends safely held to posts, away from any danger of shorts. A few feet of such wire will couple enough to the transmitter if the rounded end is put in the transmitter, or near the feeders, or the coupling can be increased by lengthening the loop, which serves of course as antenna. or decreased by shortening the loop or moving the test oscillator farther from the transmitter. The extent of the harmonic order will have much to do with the degree of coupling required here, too. The loop is effectively just a single-wire antenna.

This is the simple case of generating a frequency, and depending on some arrangement in the transmitter for listening to the resultant beat. It is the frequency-meter practice.

Monitor Service

The monitoring method, with which the present discussion is principally concerned, consists of putting the unknown transmitter frequency into the generator at W, using electron coupling, hence the unknown fundamental of the transmitter can beat with an harmonic generated in the test oscillator.

Assume the two frequencies, the fundamental of the unknown and the harmonic of the generator, differ by 1 kc. Then a 1,000-cycle note will result, will be amplified in the succeeding tube (which is circuited for amplification of all frequencies), hence will appear in the plate circuit of this amplifier tube. Since the radio frequencies are useless now in the amplifier output, and only audio frequencies are desired, a single-pole double-throw switch is used.

At up position (referring to the diagram) at point Y, the listening post, the r-f is shorted out of the 0.02-meg. load resistor, and the inserted phones complete the d-c circuit, whereas when the switch is toggled down the 'phones are shorted out and the load resistor becomes effective. This process is advisable in any instance so that the 0.02-meg. resistor will not take more of the audio than would the 'phones.

Acuteness of Hearing

The alterations of the output circuit by switching have no detuning effect on the radio frequencies. In fact, the electron coupling of the generator itself to the amplifier is a good preservative of frequency independence despite attenuator setting, but here we have also a high resistance between source and destination, that is, the amplifier tube.

Considering the frequencies, let us find how far we can go in the use of the single scale, no switching. How far we can go in respect to harmonics themselves, as already stated, depends on coupling (under control), transmitter amplitude and, additionally, the acuteness of the operator's hearing. 'Phones are the most sensitive devices known in radio, assuming the ear is as sensitive as it should be, though some fellows can not hear beats that others can hear.

First we take a glimpse at the ratios. For the present never mind the right-hand column listing harmonic orders.

Band		*Frequency*	*Harmonic*
Meter	*Mgc Limits*	*Ratio*	*Order*
160	1.715-2.0	1.108	2nd
80	3.5-4.0	1.143	4th
40	7.0-7.3	1.043	8th
20	14.0-14.4	1.003	15th
10	28.0-30.0	1.071	30th
5	56.0-60.0	1.071	60th

Broadcast Fundamentals

Since we are to use a single fundamental range it must be large enough to encompass the highest ratio (80-meter band). The calibrated scale does exceed this ratio, being slightly in excess of 1.2.

The fundamental selected makes no difference, except as to intensity, because the scale is already calibrated and the linear differences are as found. Frequencies in the standard broadcast band were selected because direct comparison with the excellent standards that the better-grade stations afford thus becomes practical. The crystals of these stations therefore are used as standards for adjusting the circuit to the scale and, on subsequent cautious occasions, for checking the meter-monitor any time we so desire.

The scale is so prepared that the separation is much wider at the higher fundamental frequencies, and as far as practical the harmonic orders selected are those enabling the use of this widely-spread-out part of the calibration. However, the separation of bars is 5 kc even at the low-frequency part of the arc.

Lining Up

Remembering that the fundamental scale is 83 to 99.9 and that the fundamentals used actually are a ten-fold multiples. we adjust the circuit to the scale for 830 to 999 kc by series and parallel padding. The parallel capacity should be around 800 mmfd., but is not very critical, whereas the series condenser may have to be anything from 0.025 mfd. to 0.1 mfd. It is shown as 0.05 mfd. in the diagram because this value usually turns out to be about right and is used for preliminary adjustment. The series capacity, due to the large parallel padding, naturally has an important effect.

After the circuit is built, it has to be coincided with the scale.

The stations that may be used for the low-frequency end include:

830 kc: CMC, Havana; KOA, Denver; TIVL, San Jose, C. R.; WEEU, Reading, Pa.; WHDH, Boston; WRUF, Gainesville, Fla.

840 kc: CFOC, Saskatoon, Sask.; CMQ, Havana; CRCT, Toronto; VOGY, St' John's, Newfoundland; XEXX, Mexico City.

850 kc: KIEV, Glendale, Calif.; WWL, New Orleans, La.; WWPA, Clarion, Pa.

860 kc: WABC, New York; WHB, Kansas City, Mo.; XEMO, Tijuana, B. C.

870 kc: WENR, Chicago; WLS, Chicago.

High-Frequency End

For the high-frequency tie-down standard:

1,000 kc: CMBZ, Havana, KFVD, Los Angeles; WHO, Des Moines.

990 kc: WBZ, Boston; WBZA, Springfield, Mass.; XEAF, Nozales, Son.; XEK, Mexico City, D. F.

980 kc: KDKA, Pittsburgh; XEAE, Mexicala, B. C.; XEU, Vera Cruz, Ver.

Those living in the West and Middle West may use KFVD or WHO, and those living in the South may get along with CMBA, although the frequency-constancy of foreign station transmissions may not be so good as ours.

The 1,000 kc frequency may be used because when the condenser is at its own minimum capacity, the parallel trimmer is such that a note of 1,000 cycles is heard when the dial reading is 99.9, a note of 2,000 cycles when the dial reading is at 99.8, and a note of 3,000 cycles when the dial reading is at 99.7. The correctness may be judged approximately by ear on the basis of the audibility of the rising pitch disappearing at a reading of 98.5.

Low-Frequency Oscillators

If one can bring in 990 kc on a receiver and also 1,000 kc (the generator will supply the necessary "selectivity") there is a double check: the disappearing note just related, and the zero beat for 990. If one can bring in 990 and 980, if these check for zero beats, then higher frequencies will check, without special test.

(*Continued on next page*)

Telephone Company Line Made to Pass Video Band

"When are we going to have television?" That is a question often raised by the layman. He reads of the various discoveries made in this field and possibly decides that the fruits of the experiments are deliberately being withheld from the public. However, the engineer and the technical enthusiast know that there are many other limitations which prevent the debut of television. Most stubborn of these problems has been suitable telephone lines which will carry the wide band of necessary frequencies directly at the video frequencies, i.e., modulation frequencies.

Accordingly, when the telephone company engineers announce that they have devised a telephone line that will transmit signal frequency bands a thousand kilocycles in width, it does seem that television is becoming nearer to a commercial reality.

The telephone company's wire circuits as constituted at present can be made to transmit a frequency band of about 10 kc. When the circuits are well balanced, this range may be extended another 10 kc. Since a television signal requires a band width of about one thousand kilocycles for reasonably high definition, these circuits are not of much use.

Experiments by telephone company engineers have shown that a cable, consisting of a hollow pipe-like conductor about one half inch outside diameter and a concentric wire insulated from it, furnished the desirable band width that was necessary for television. By virtue of skin effects, the outer tube serves as a conductor and a shield at the same time. This is accomplished since the desired currents will concentrate on the inner surface of the tube while undesirable interference currents will cling to the outer surface.

24-Hour Clock Time Compared to Usual Case

Ordinary time indications may be represented as follows based upon a 24-hour clock:

1:00 a.m.	1:00
2:00 a.m.	2:00
3:00 a.m.	3:00
4:00 a.m.	4:00
5:00 a.m.	5:00
6:00 a.m.	6:00
7:00 a.m.	7:00
8:00 a.m.	8:00
9:00 a.m.	9:00
10:00 a.m.	10:00
11:00 a.m.	11:00
12:00 a.m.	12:00
1:00 p.m.	13:00
2:00 p.m.	14:00
3:00 p.m.	15:00
4:00 p.m.	16:00
5:00 p.m.	17:00
6:00 p.m.	18:00
7:00 p.m.	19:00
8:00 p.m.	20:00
9:00 p.m.	21:00
10:00 p.m.	22:00
11:00 p.m.	23:00
12:00 p.m.	24:00

Patent Granted on Socket With Constants Built In

The ingenuity of S. H. Evans, of Southern Pines, N. C., has been applied to the working out of a device which takes advantage of the fact that practically all radio tubes make use of standard combinations of by-pass condensers and resistors. Mr. Evans reasons that since such is the case, why not build a socket that has these devices integral with the socket assembly so that much labor may be saved in the manufacture of radio apparatus?

Without further ado, Mr. Evans set to work and evolved such a scheme and has been granted a patent to cover his work. He invented a device that consists of a tube socket assembly so constructed that the necessary cathode, screen grid, and plate by-pass condenser and resistor combinations are integral therewith, appropriately shielded.

Arcturus Dealer Portfolios

A new loose-leaf portfolio for distributors and their salesmen has just been issued by the Arcturus Radio Tube Company, Newark, N. J.

The portfolio contains actual samples of advertising materials such as consumers' price lists and radio logs, characteristic charts, book matches, tube stickers, etc., available to dealers and service men. Samples of three postcards for dealers' direct-mail campaigns, and a combination stationery unit comprising letterheads, envelopes and business cards are also included. Another section of the book is devoted to combination deals on tube checkers, oscillators, set analyzers, and Rider's Manuals.

DEAD END LOSSES

The dead end losses incurred by tapped coils seems to be a matter of small moment to modern designers though it was a bugaboo of yesteryear.

Johnstone Quits NBC for Press Direction of WOR

George W. Johnstone, known more as "Johnny" Johnstone, resigned from the Press Department of the National Broadcasting Company after a service of eleven years to become director of Press Relations for WOR, Newark, N. J.

Mr. Johnstone began his service with WEAF when that station was operated by the American Telephone & Telegraph Company at 195 Broadway in March, 1923. When the NBC was organized Mr. Johnstone became manager of the Press Department and served in that capacity until three years ago. At that time a reorganization developed a new position for Johnstone, who until his resignation, officiated as a liaison between the NBC and special radio writers throughout the country.

Instrument Helps Ham Stay Inside Band

(Continued from preceding page)

If the series capacity in circuit is 0.05 mfd., then whatever changes are needed in the series leg will not considerably change the tentative high-frequency tie-down. So adjust for the low-frequency end on the basis of altering the series capacity, if alteration is needed. If the frequency reads too high use less series capacity. If the frequency reads too low use more series capacity. Then when this end is settled readjust the parallel capacity needed at the high-frequency end by renewing the previous checking method. This change will not be serious.

The use of low-frequency test oscillators for making the high-frequency test easier consists of introducing harmonics of the instrument into the device just built. Using a broadcasting station on 1,180 kc, for instance, 98 1/3 kc could be checked accurately on this extra generator, representing the eleventh harmonic beating with the station, and the position of 98 1/3 is easily estimated with closeness.

Harmonic Orders

High harmonic orders are obtainable from peppy low-frequency oscillators, and in general harmonics much higher than what one may expect to be productive will yield excellent results.

The tuning condenser used is manufactured by General Instrument Company, and of course the system will not track some other make of condenser. The dial was calibrated on that basis. On account of the padding, the tubes used don't make any difference.

On a table previously given the harmonic orders to use were cited. Since the generator does not quite reach 1,000 kc, the end frequencies of some of the bands are not represented, but this helps to keep one inside the band. The unattained extreme frequency is only 0.1 per cent lower than the highest permissable.

For the 160-meter band 10 kc differences at the low-frequency end are read directly, while at the high end differences of 0.2 kc are read. For the 80-meter band the bars represent differences twice as great, for the 40-meter band four times as great.

Three Remaining Bands

For the three remaining bands harmonics of 15th, 30th and 60th orders are used. The fifteenth isn't so hard to work. But the thirtieth and sixtieth series require closer coupling, closer listening and despite these, introduce possibilities that some will obtain no satisfactory results in these regions without the use of a little receiver as monitor.

How to Wind Coil for the Geneceiver

The following data are for close-winding the 31-microhenry inductance for the meter-monitor, the tap being located about one-fourth the number of turns from the ground end:

Outside Form Diam.	*Turns of 32 Enam.*	*Turns of 28 Enam.*	*Turns of 22 Enam.*
¾"	39	48	70
⅞"	33	39	55
1"	29½	34¼	46
1⅛"	26	30¼	38½
1¼"	24	27½	34½
1⅜"	22¼	25	31
1½"	20¾	23	28

High-Frequency Waves Given to Marced Police

The police department of Marced, Calif., has been granted authorization to build a radio transmitter, of a portable-mobile nature, to operate on a frequency of 40100 kilocycles with 5 watts of power. A fixed station for 37100 kilocycles and 15 watts was also authorized for the jolice department.

THE AMATEUR ORACLE

Address Questions Concerning Amateur Regulations and Technique to M. K. Kunins (W2DPS), Technical Editor, Radio World, 145 West 45th Street, New York, N. Y.

Home-Made Couple

I HAVE a d-c milliammeter with a 0 to 10 m.a. scale which I should like to adapt to measuring radio-frequency voltage. Please indicate the manner in accomplishing this change?—C. N. V.

To adapt a d-c instrument to measuring radio-frequency voltage, it is necessary that a thermocouple be used in conjunction with the meter. Since thermocouples are expensive it might be economical to construct one. Obtain a piece of iron wire and a piece of constantin wire, each about two inches long, and weld them together at their midpoints so that they form a letter "X". The junction of the two wires should be as small a point as possible since the efficiency of the junction is directly affected by its size. This thermocouple should be connected to the meter by having one end of the iron wire constitute one terminal to the meter and one end of the constantin wire to constitute the other. The remaining two wires of the couple should be connected to the circuit to be measured. The thermocouple is necessary since it has the property of converting the radio-frequency voltage flowing in its input side into heat energy at the junction. This heat in the junction is transformed into direct current on the output side which feeds the meter.

* * *

Extending Current Range

I AM INTERESTED in converting a 0.1 milliameter into one capable of measuring 100 milliamperes. Please show the steps in computing the value of a shunt to be used for this purpose.—H. H.

Reference to the diagram will show that the voltage drop across the shunt is equal to the drop across the meter. From this can be written that:

$$E_s = E_m$$

however, since

$$E_s = R_s I_s \text{ and } E_m = R_m I_m$$

then $R_s I_s = R_m I_m$

by Kirchoff's law, $I_{tot} = I_s + I_m$

then $I_s = I_{tot} - I_m$

and substituting above, (third line),

$$R_s(I_{tot} - I_m) = R_m I_m$$

or $$R_s = \frac{R_m I_m}{I_{tot} - I_m}$$

at full scale deflection, $I_{tot} = 100$ and $I_m = 1$, therefore

$$R_s = \frac{R_m}{99}$$

* * *

Heterodyne Systems

PLEASE EXPLAIN the reason for two heterodyne systems as used in the equipment described in RADIO WORLD of October 20th last on page 18.—H. M.

The first heterodyne stage is used to produce the ordinary intermediate frequency on the order of 456 kilocycles—a value so chosen that a minimum number of repeat spots will result. In other words, this frequency is so chosen that when the local oscillator heterodynes the signal, a beat note results that can be received only at one point on the dial for a particular signal frequency. If this intermediate frequency is further amplified to a useful level, a certain amount of noise will be increased too. Since this noise does not occur to the same degree on the lower frequencies, it is advantageous to again heterodyne the intermediate frequency of 456 kc to say about 50 kc., where the noise will not be so noticeable. Therefore, the need for a second oscillator is apparent.

* * *

Acorn Tube

ARE THERE any special circuit requirements in connection with the use of the 955 acorn tube?—N. B.

The acorn tube is similar to regular sized tubes—on a smaller scale. Ordinary circuits may be utilized with this tube for the ultra high frequencies because of its small dimensions. A possible arrangement for this tube is shown in the sketch on this page. The coil will consist of about five to ten turns (depending on the operating frequency) with a diameter of about one-half to one inch. The condensers and resistor are standard.

* * *

Transmission Line Requirement

WHAT ARE the criteria that determine whether radiation will occur from a transmission line?—W. T. I.

Balance is the keynote. For a transmission line to be just that, it is essential that the currents in both sides be equal, and that they be exactly 180 degrees out of phase. This involves equal lengths of each side, constant spacing, with consequent correct voltage distribution.

* * *

Antenna Factors

WHAT FACTORS determine the longevity of an antenna wire?—B. K. J.

The worst enemy of antennas is the oxide coating formed on the wire surface by the weather and the deposit of soot from smoke, dust, etc. in the air on the insulators, which cause leakage. To minimize this oxide formation, and consequent increase in antenna resistance, it would be wisest to use antenna wire that is covered with enamel or other insulating cover. Of course, the enamel is probably better because of its negligible weight. This will serve to prevent the current-carrying part of the antenna wire—the outmost section—from acquiring a coating of oxide that would materially increase the radio-frequency resistance and reduce the antenna efficiency. As for the soot covering on the insulators, it is necessary that periodic inspections be made, and the soot be removed. If the soot is not removable, the insulators should be replaced. Most hams seem to forget these aging processes going on in their antenna system and do not appreciate the necessity for the inspections mentioned. If you were to measure the decrease in efficiency of an antenna after a year of use you would be surprised.

* * *

Percentage Modulation

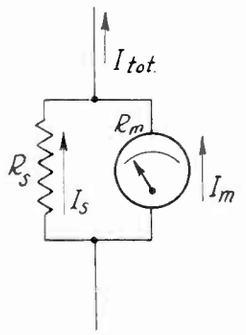
I HAVE HEARD the term percentage modulation mentioned by various hams of my acquaintance but cannot elicit a clear explanation of this term from them. Please explain the significance of this term.—L. J. H.

In telegraphy, the carrier wave is made into an intelligible signal by means of starting and stopping it to form dots and dashes. Thus, the carrier wave is either of zero or of maximum value at any instant. In telephony, on the other hand, the carrier wave is modulated by audio frequencies which may be of any value between zero and maximum amplitude, depending upon the intensity of the original sound. The degree to which the carrier wave is affected is then measured by the term "percentage of modulation." Though this is an attempt at measuring modulation quantitatively, it should be appreciated that it is only approximate since the instantaneous modulation of the carrier may be weak or strong according to whether the original audio component was weak or strong. This value varies from instant to instant so that percentage of modulation is only an average measurement of the degree to which the carrier wave is affected by the audio modulation. Since, for maximum utilization of the carrier, the modulation should affect the entire amplitude of its swing, it is wise to modulate the carrier with a signal that will swing it the whole way. When this occurs the percentage of modulation is said to be 100%. But, since the modulation amplitude varies from instant to instant, the carrier is not always modulated 100%, but may be overmodulated or undermodulated. Therefore, it is so arranged that the gain is adjusted for 100% modulation of the carrier by the strongest signal that is likely to be generated. Overmodulation is undesirable since it provokes the generation of harmonics which will distort the original signal and undermodulation is undesirable, since it is inefficient in its use of the carrier wave. It should therefore be understood that the gain of a modulator should be adjusted to swing the carrier amplitude all the way and no more based upon the strongest modulation that might develop.

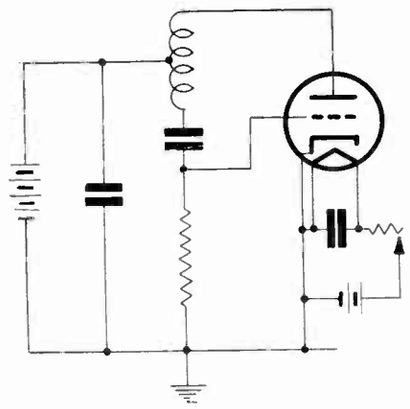
In the computation of the percentage of modulation on a single tone the following formula is used:

$$\% \text{ M} = \frac{I_m}{I} 100$$

where I is the current reading when the carrier is unmodulated and I_m is the current reading when the carrier is modulated. Voltage may be substituted for current values.



When a meter is parallelled by a shunt, the currents will divide as shown.



The 955 "acorn" tube may be used with this circuit.

Station Sparks *By Alice Remsen*

MAY AND PETER IN A NEW ONE

HERE IS A PIECE OF NEWS affording me great pleasure: May Singhi Breen and Peter de Rose have a four-a-week commercial. They started December 2nd, under the sponsorship of Humphrey's Homeopathic Medicine Company. Big Brother Bob Emery, radio philosopher and entertainer, will assist them. They will be on the air for fifteen minutes each Sunday, Monday, Wednesday and Friday morning. True veterans of the microphone, May and Peter played the ukulele and piano and have sung for more than two thousand radio performances. Since their debut in 1923 they have been away from the radio studios only once—when they were married and went on a two weeks' honeymoon. Their time is 10:30 a.m. over WEAF and network. . . . Eleven of the country's leading music critics will appear as commentators in the NBC Music Guild series over NBC-WJZ-WEAF networks during the remainder of the winter season. One of the noted musicologists will be heard with well-known concert artists in each of the Guild's four weekly broadcasts. Such well-known men as Olin Downes, critic of the New York *Times*; Leonard Liebling, critic of the New York *American*; Pierre V. R. Key, editor of the *Musical Digest;* Carl Engel, music consultant of the Library of Congress in Washington, and many others, will speak. Broadcasts are as follows: Over NBC-WJZ networks each Monday and Thursday at 1:45 p.m.; and over an NBC-WEAF hookup on Tuesdays at 1:30 p.m., and Fridays at 4 p.m.

DON CARNEY'S LONG DISTANCE

That three-hour dance series, sponsored by the National Biscuit Company, will be M-C'd by none other than our genial friend, Don Carney. What a job that's going to be for Mr. Carney—three straight hours! So if you want to dance on Saturday evenings, just tune in on WEAF and network at 10:30 p.m. and you'll get a three-hour uninterrupted dancing party made to order. . . . Paul Whiteman has another "find" in Adelaide Howell, social beauty of Atlanta, Ga., and niece of Clark Howell, editor of the Atlanta *Constitution*. She will be heard with Whiteman soon. . . . There are twelve hundred pounds of entertainment in B. A. Rolfe's "Early Bird" show. Rolfe himself weighs two hundred and seventy pounds; Eddie and Ralph heft at five hundred and ten pounds between them; Jack Parker, one of the members of The Men About Town Trio, hits a nifty two hundred and thirty; and the NBC engineer on the program, M. O. Smith, is in the two hundred-and-fifty class. Which is a lot of poundage to get up so early in the morning, for the program goes on at 7:45 a.m. They call it the "Milkman's Matinee"; over WEAF and network, Tuesday, Wednesday and Thursday mornings. . . . Gertrude Forster, Richard Maxwell, and Norman Price, were featured as the Trio Romantique over NBC networks for three years. They got tired of their name and decided to become the Peerless Trio, but they couldn't fool their listeners, as countless letters proved. The sweet singing of the Trio Romantique sounded just the same under another name. So Shakespeare was right, after all. . . . An interesting program, now being heard over WJZ and networks on Monday nights at 10 p.m., is America in Music, under the direction of John Tasker Howard, noted authority on American music. He is assisted by an orchestra under the leadership of Thomas Belviso, the Dandies male quartet and guest soloists. . . .

AND STILL THEY COME

The three-hour program seems to be gaining in favor, for along comes the Nash Motor Company with a Christmas and New Year's party, each to be three hours in length and to be studded with stars of the operatic, movie, theatrical and literary worlds. These two programs are to be presented over the WABC-Columbia nationwide network as the company's Christmas and New Year's gift to the radio listeners of the country. As a Nash owner (an old one, let it be known) I thank the company for its generosity, but I think I'd rather have a new coupe than two radio programs. What say! . . . Everett Marshall has returned to "Broadway Varieties" after a brief absence. He is commuting between the Columbia Playhouse and the Hollywood Theatre, where he is featured in the new musical production, "Calling All Stars." . . . The Laurent Wind Quartet will be heard in the Library of Congress series over CBS each Saturday at 4:30 p.m. These concerts are made possible through the provisions of the Elizabeth Sprague Coolidge Foundation. . . . Donald Novis, who is now the featured tenor of "45 Minutes in Hollywood," says in Columbia's "Quotes of the Week": "I won the Atwater-Kent National Radio Contest, netting me a neat five thousand dollars, before I ever had sung a popular song, and then nearly starved to death before learning how to sing popular compositions. This experience, I believe, entitles me to advise vocal students looking forward to radio careers on the type of songs to include in their portfolio. And my advice is this: Have on tap both popular and classical numbers. Students won't have respect for the classics if they just specialize in popular tunes, nor catch the spirit and rhythm of the popular song if they sing only classics. Those who can score in both types are most in demand." . . . I think you're right, Donald! . . .

A. B. S. CHANGES SCHEDULE

The American Broadcasting System's mystery-thriller, under the general title of "Conscience the Fury," has been changed to two complete presentations every week, instead of one story in two installments: Mondays and Fridays at 9 p.m. . . . Albert A. Cormier, who for eight years was connected with WOR, has been appointed ABS vice-president in charge of sales. A very good man, Mr. Cormier, well liked among his associates, and a go-getter for business. . . . The Harlem Amateur Nights, featured each Wednesday at midnight over the ABS-WMCA network, has caused a mild sensation on the air-waves. It's one of the fastest and probably the noisiest program in radio. . . . Erskine Gwynne, kin of the Vanderbilts, cosmopolite and shining socialite, is the latest member of New York society to make his bow as an announcer over the ABS network. Oh, yes; social registerites are invading the field from El Morocco, exclusive Park Avenue night club, but as their status is still amateur, it is not likely that their names will be stricken from the Social Register. . . . Enoch Light wins an important winter engagement after a novel audition; in the first place he waited until thirty-seven bands had already auditioned for the smart Roney-Plaza Hotel at Miami Beach, then he recruited young people to dance to his music and appeared with his men all dressed in evening wear, creating the illusion of a ballroom; it made a hit with the representatives of the Roney-Plaza and Light got the job. Rather smart of the young maestro, wasn't it? . . .

MORE ANNOUNCERS

DAN RUSSELL: Is an expert linguist, psychologist and an authority on radio and motion pictures. The Sorbonne is one of his three Alama Maters. His hobby is photography and he is a member of the Royal Photographic Society.

A THOUGHT FOR THE WEEK

CHARITY makes strange bedfellows. For instance, among those who are deeply interested in the success of the drive for the Musicians Emergency Fund are Merlin H. Aylesworth, president of the N.B.C.; William S. Paley, president of the C.B.S.; John H. Storer, president of the new American system, and Alfred McCosker, president of the Bamberger concern. Others connected with these chains are also working for the benefit of the Fund.

Two big concerts are scheduled for the Center Theatre at Rockefeller City and some important business concern will act as sponsor for an elaborate radio program. The committee has undertaken the task of raising $100,000 *for the benefit of unemployed musicians and it looks as if that sum would be placed at the disposal of the Fund treasurer and his fellow-workers.*

The world of art and music is a fine, tight little place when the needy call and there are hungry mouths and hearts to be filled.

FRANK SINGISER: Is a Young theological student, who turned to radio for adventure. Boyhood was spent in India, where his father was a missionary. Singiser was graduated from Brown University with honors at 19. His apprenticeship was served on WGY.

CHARLES B. TRAMONT, JR.: Deserted medical school to win an announcer's job over 49 other applicants at a Buffalo station. He has been married since 1925. Romance, languages and radio are his hobbies.

LYLE VAN: Gets up bright and early to romp with the Don Hall Trio; has been dubbed by Cheerio as the "perfect youth." A native of Holland, Van was educated in this country. Spent two years chasing Florida bootleggers before joining NBC.

JAMES WALLINGTON: Tried music, medicine and the ministry before he decided radio was his field. Only 25 years of age, but appears much older, and is the youngest diction award winner. Probably is best known as Eddie Cantor's foil.

DON WILSON: Came from NBC's West Coast studios to do football last year. Played four years of football at the University of Colorado. Don stands six feet, three inches, and weighs 215 pounds.

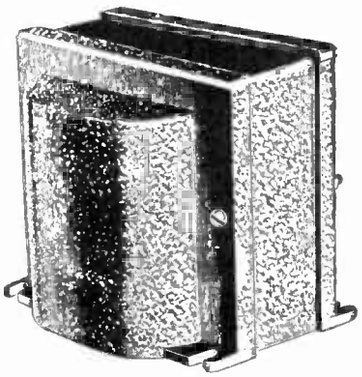
JOHN S. YOUNG: Is the only NBC staff member boasting a doctor's degree. He was first heard in 1925 over WBZ, where his work with the Boston Symphony Orchestra attracted NBC's attention. Unmarried. . . .

STUDIO NOTES

Jack Miller, Kate Smith's orchestra leader, used to be an automobile racer. . . . Connie Boswell's ambition is to own the world's largest collection of French dolls. . . . Bert Parks' first job was operating a pop-corn stand. . . . Grete Stueckgold sings six feet away from the microphone. . . . Bing Crosby yelled himself hoarse at a football game recently and couldn't sing on his broadcast; telephones were kept busy demanding why and when told the folks wouldn't believe it—but it was true, nevertheless. . . . Betty Winkler, the telephone girl of the Grand Hotel series, has stepped out of character to study Constitutional law. She's visiting classes at the University of Chicago Law School. . . . The Grummits may be a comedy sketch, but to one listener it brought tears. After a broadcast from the NBC studios in New York, at which Blanche Vincent, who plays the role of Mrs. Grummit, sang the old favorite, "My Sweetheart's the Man in the Moon," a call was received from Long Island. The voice at the other end of the phone was that of Jim Thornton, who wrote the song forty-eight years ago. In a voice choked with emotion, he told the cast that the song was sung just as his wife, Bonnie, a noted trouper of her day, had sung it forty-five years ago.

GIFTS FOR YOU

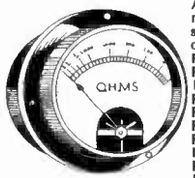
Heavy-Duty Power Transformer



WHY overwork a power transformer, run it hot, get poor results? Here is a power transformer that can be used for any set up to 18 tubes, and with good enough regulation even for Class B. It takes care of 2.5-volt tubes (up to fourteen of them), also one or two 2.5 volt output tubes, whether 2A5s, 47's, 2A3's, etc., and a 5-volt rectifier. Besides, it has a 25-volt winding at 0.6 ampere, so that if you want a second rectifier in a set you may introduce the a-c line voltage to a 25Z5 and take care of the heater from the 25-volt winding. Or, if you want to use four 6.3-volt tubes in series, from this 25-volt feed, you may do so, or even another four such tubes in series, connected in parallel with the other four. There is no other transformer on the market that affords this great versatility.

Primary = 115 volts, 60 cycles.
Secondary X = 14 amps at 2.5 volts, center-tapped.
Secondary Y = 6 amps at 2.5 volts, center-tapped.
Secondary HV = 200 ma at 400-0-400 v. a.c.
Lug terminals are at bottom. Connection code furnished with each transformer. Shipping weight 13 lbs. Sent express collect on receipt of $7.00 for 60 weeks subscription for RADIO WORLD (60 issues, one each week). Order P-1012. Remit with order and ask for NP-1012.

Wide Range of Meters



Any one of these d-c meters free with a $1.50 subscription (13 issues, one each week).
P-1020—0-6 v.
P-1021—0-50 v.
P-1022—6 v. charge tester
P-1023—0-10 amp.
P-1024—0-25 ma
P-1025—0-50 ma
P-1026—0-100 ma
P-1027—0-300 ma
P-1028—0-400 ma
P-1029—0-3-0 v.

If there is any particular meter you desire, and it is not listed, write in for a subscription proposition. In fact, if there is anything in radio that you want as a premium, we will be glad to make you an offer. Write to Premium Editor, Radio World, 145 West 45th Street, New York, N. Y.

Precision Tuning Coils

These coils may be used with condensers of from 0.00035 mfd. maximum to 0.0004 mfd. maximum. The inductances of coils are maintained equal by winding them to an identical axial length, spacing the end turns to accomplish this. The tuning is from 540 to 1,600 kc and from 1,620 to 4,800 kc. To utilize the police band, switching is necessary.

Three equal coils for t-r-f set (for use with three-gang condenser). Remit $2.00 for 16 weeks subscription (16 issues) and order P-1030 sent postpaid.

Four equal coils for t-r-f set (for use with four-gang condenser). Remit $2.50 for 20 weeks subscription and order P-1031 sent postpaid.

Two equal coils and one oscillator coil for superheterodyne at 175 kc i.f., (requires three-gang condenser). Remit $2.00 for 16 weeks subscription, order P-1032, and three coils will be sent postpaid.

Same as directly above, except for 465 kc i.f. Order P-1033.

Three equal coils and one oscillator coil for 465 kc. i.f. (for a four-gang condenser). Remit $2.50 for 20 weeks subscription and ask for P-1034. Four coils will be sent postpaid. For 175 kc order P-1034-175.

Three doubly-tuned i.f. coils, 465 kc, in aluminum shields. Remit $6.00 for one-year subscription (52 issues), and order P-1036 sent postpaid.

Same as directly above, only for 175 kc. Ask for P-1035.

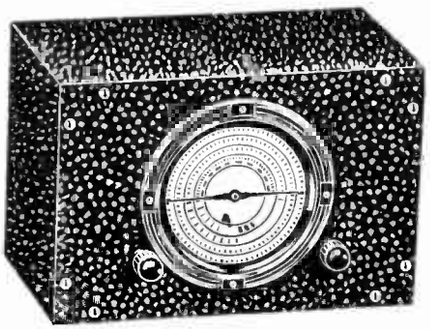
Signal Generator Parts

Tuning condenser, two coils, two precision fixed condensers, frequency-calibrated disc dial, 3-pole, four throw switch, knob, two escutcheons, for 83-100 kc, 140-500 kc, 540-1,600 kc, 1,620-4,800 kc, all on fundamentals. Wavelength calibration also is in scale for the low frequency band. These parts comprise the foundation unit for the 333-A Signal Generator. Diagram included in offer. Remit $12 for two-year subscription (104 issues) and ask for P-1037 sent postpaid.

RADIO WORLD
145 West 45th Street, New York, N. Y.

1935 MODEL SIGNAL GENERATORS
WITH DIRECT-READING AIRPLANE DIALS

MODEL 339, FUNDAMENTALS 54 kc. to 17,000 kc.



Model 339 All-Wave, Fundamental Type Signal Generator, and Model 334-A have the same external appearance, except that the 339 has three knobs. The differently-calibrated airplane dials give results in frequencies and wavelengths.

The most up-to-date Signal Generator, just released from the laboratories of Herman Bernard, is Model 339, for all-wave coverage, band-shifts by switching. All frequencies on fundamentals: 54 to 170 kc; 170 to 540 kc; 540 to 1,700 kc; 1,700 to 5,400 kc; 5,400 to 17,000 kc.

This is a three-tube device for lining up intermediate, standard broadcast and short-wave frequencies, and for station-finding, where results in frequency and wavelength (both) are read from the dial. Bernard Signal Generators are the only ones that give results in both frequency and wavelength.

Model 339 uses the new Bernard decimal repeating airplane dial, the latest dial invention for maximum legibility on all tuning ranges.

The new 6C6 tube is used as r-f oscillator in Model 339. The output is electron-coupled and equipped with attenuator. The 37 is the rectifier. Filtration eliminates ALL hum. Modulation by a 2,000-cycle note from a neon-tube relaxation oscillator is present or absent by switching. Limiting resistor is built into the cable for maximum heat dissipation.

Model 339 works on 90-125 volts a.c. or d.c. (a.c. of any line frequency). Black crinkle-finish shield cabinet is insulated from the line. Accuracy, ¾%.

Model 339, wired, adjusted, complete, with 3 tubes, ready to operate (shipping weight, 5 lbs.)..... **$16.00**
Model 339-K (complete kit, cabinet, instructions, everything except tubes)..... **$12.50**
Model 339-F (Foundation Unit, consisting of dial, five coils, instructions)..... **$4.45**

MODEL 334, HARMONIC TYPE, 100-1,600 kc.

The harmonic type Signal Generator has a direct-frequency reading fundamental range of 100-200 kc. The second, third and fourth harmonics are on the dial, as separate tiers (200-400, 400-800, 800-1600 kc.). Frequencies above 1,600 kc. can be measured by an harmonic method detailed right on the dial. Tubes used, 34 r-f oscillator, 30 amplifier, neon tube modulator. Works on 90-125 volts a.c. or d.c. (a.c. of any line frequency). On a.c. the hum is the modulation. In either use modulation is always present.

Model 334-A, complete with three tubes; wired, adjusted, ready to operate (shipping weight 5 lbs.).... **$12.00**
334-F (Foundation unit, consisting of dial, coil and instructions)..... **$3.15**

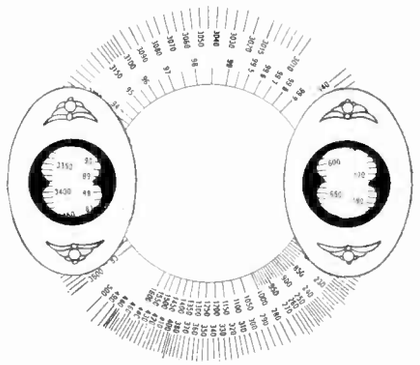
DIRECT RADIO CO., 145 West 45th St., N. Y. City, N. Y.

PARTS FOR ALL-WAVE SIGNAL GENERATOR

PARTS for a practically self-aligning all-wave signal generator are now made available for the first time. This instrument is of the "universal" type, and works on a.c., d.c. or batteries, 90-120 volts. It provides modulation on both a-c and d-c uses. On d.c. the modulation is totally removable and also adjustable. On a.c. the modulation is irremovable and not adjustable. The direct-reading frequencies covered, all on fundamentals, are: 83 to 99.9 kc.; 140 to 500 kc.; 540 to 1,600 kc; 1,400 to 5,000 kc; 5,400 to 16,000 kc.

The Foundation Unit for the all-wave Signal Generator, Model 333-AB, enables one to construct this high-class instrument, as it includes the vital and exclusive parts. The remaining parts are obtainable almost any place, or many experimenters will have these about the shop. The generator uses three tubes: a 34 r-f oscillator, a 30 amplifier, and a neon modulator.

Price, $7.00



The accuracy on the broadcast band is 1 per cent., on the 1,400 to 5,000 kc band 0.5 per cent.; in general averages 1 per cent.

The essential kit of parts for building this generator consists of:

- Precision frequency-calibrated etched metal dial (non-warping).
- Two escutcheons
- Special tuning condenser.
- Three front-panel plates.
- Five-position, three-deck switch.
- Four coils.
- One 800 mmfd. fixed condenser.
- One special neon lamp (modulator)
- One diagram, instructions.
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UNIVERSAL ALL-WAVE

THE Supertone Universal is all-wave. It is a five-tube set that works on 90-125 volts a.c. or d.c. Short waves and standard broadcasts are covered with equal efficiency. Latest tube types are used.

This New Universal 5-tube a.c. and d.c. Short-Wave and Broadcast Receiver uses the 6D6 in one stage of high-gain T.R.F., inductively coupled to a 6C6 regenerative screen-grid detector. Regeneration is controlled by a potentiometer. The set has two stages of audio, providing sufficient volume to operate the 5-inch dynamic speaker to full volume on even those hard-to-get stations. The first audio stage is a 37, the second stage is a 43 power output pentode and works on either a.c. or d.c. Chassis, completely wired, tested, with tubes and coils. 15-500 meters.... **$20.**

Cabinet only $2.50

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ADVANCED engineering embodied in the new Supertone Superba seven-tube short-wave superheterodyne creates results utterly surpassing and amazing! Certainly foreign reception is guaranteed. Why not? There are two intermediate stages, a separate 56 oscillator is used, and the modulator is the most sensitive 57. The 2A6 helps maintain maximum sensitivity—tone quality preserved by linear diode detection, and amplification highly supported by the high-mu amplifier. This is a high-gain set, sensitive all the way to 20 mgc, even in the region where other sets fall down.

The intermediate frequency is 465 kc. Automatic volume control minimizes fading.

Finest parts are used, including products of Hammarlund Mfg. Co., National Co., etc.

Combining engineering skill and economy resulting from quantity production, we are able to offer this world-beating receiver at a very low price.

It is no feat at all to tune in stations all over the world—even low-powered and otherwise hard-to-get stations—on the Supertone Superba, 15 to 200 meters.

The Superba is housed in a luxurious table model cabinet and is supplied complete in every respect. For 90-125 v. a.c., 50-60 cycles. The wired model, with seven tubes, eight plug-in coils (two for each band), cabinet, speaker, all in perfect condition, ready to play ..... **$34.**

Wired chassis, with seven tubes, eight coils, speaker (same as above, less cabinet).....$30.00

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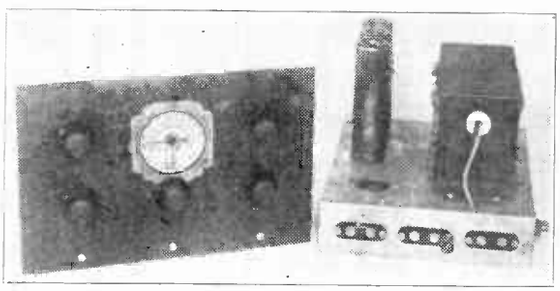

The Supertone Bandspread Receiver is a five-tube set, 15 to 200 meters, and requires a power pack. There are three 8 mfd. condensers in the pack's filter, also husky B chokes.

All Supertone products are laboratory-tested and come up to highest engineering requirements.

A large number of short-wave enthusiasts like the separate tuner and power pack. This method we have developed with bandspread tuning. The five-tube outfit covers 15 to 200 meters and provides most exceptional results.

The wired chassis, with front panel, with coils, less the five tubes. $10.00

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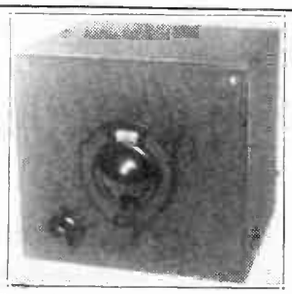

The performance of any short-wave receiver can be improved by using the Supertone Booster. No wiring changes required in the set. The booster has its own power supply for 90-125 volt a.c. or d.c. operation. Reduces image interference to a minimum.

Wired Booster, with plug-in coils for 15-200 meters, hinged-top cabinet (less tubes)..... $8.95

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The Cathode-Ray Oscilloscope

Its Development and Practical Use in Radio

By M. K. Kunins
W2DPS

Following is Part II, concluding an article begun last week, issue of December 1st.

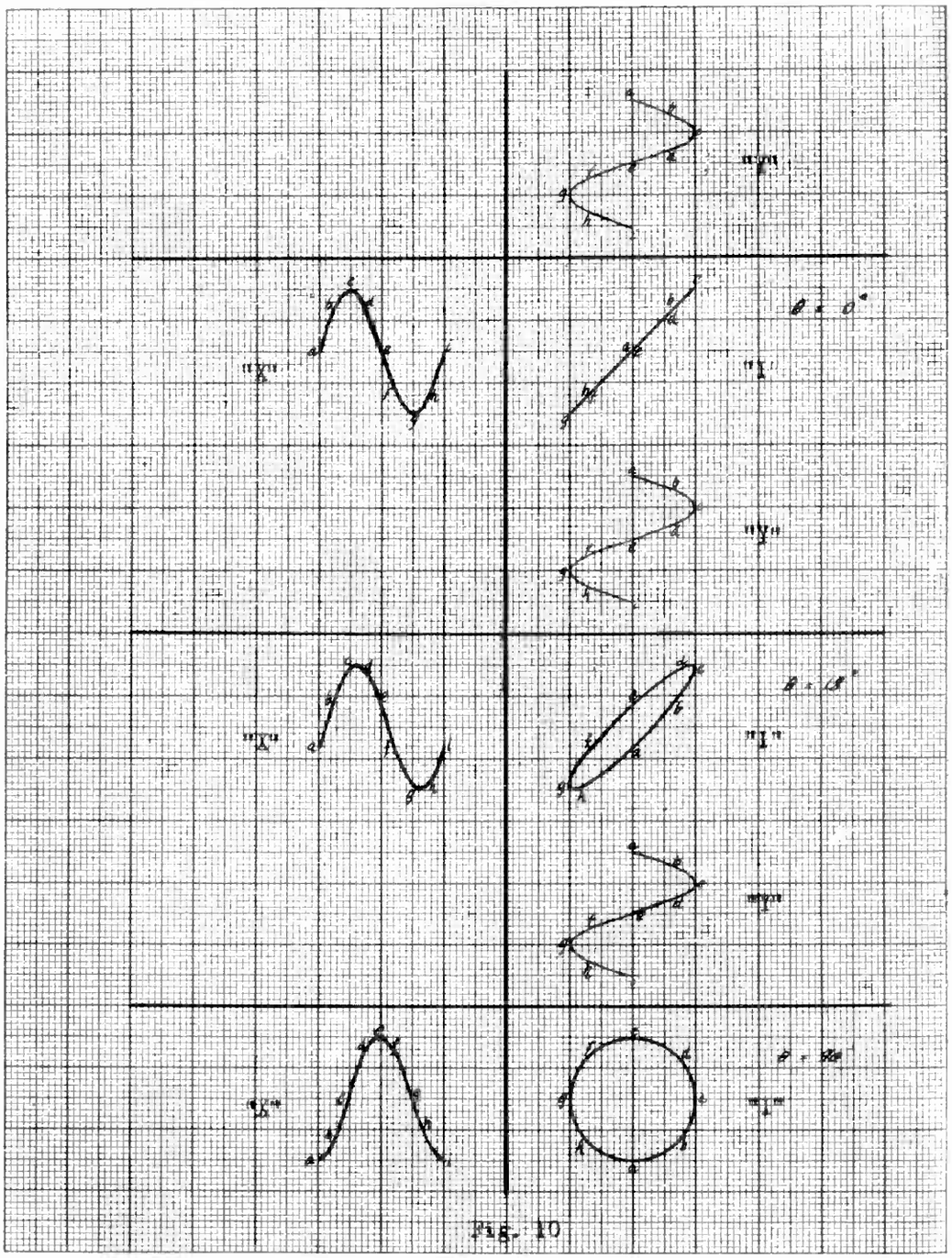


Fig. 10

ONE of the many users of the cathode-ray oscillograph is frequency comparison. Accurate determinations of this sort can be made by applying the alternating voltage from one source to one set of plates and that from the other source to the other set of plates. In accordance with the previous ideas, the resultant path traced on the screen by the spot is the curve in rectangular coordinates of the relation between the two resulting electrostatic fields at any time. If the frequencies of the two voltages bear some constant simple ratio to each other, the same pattern is traced repeatedly, producing a stationary Lissajous figure. From this pattern, the frequency ratio is readily determined. This is accomplished by drawing two straight lines tangent to the adjacent sides of the figure. The ratio of the number of points at which these lines are tangent to the peaks of the loops on the two adjacent sides is the frequency ratio of the two voltages.

Complex Ratios

Reference to Fig. 9 (last week) clarifies this procedure. As the ratios become more complex, the figure also becomes more involved as may be seen in Fig. 9d which illustrates a 4:5 ratio. If one frequency differs slightly from an exact multiple of the other, there will be a varying phase relation between the two waves. Consequently, the Lissajous figure on the screen will appear to rotate slowly in a plane perpendicular to the plane of the screen and will appear to have a front and rear. As the frequencies depart more and more from an exact ratio, the figure will appear to rotate faster and faster. Thus, it is apparent that the comparison of frequencies by means of the cathode-ray oscillograph is quite accurate since the slightest variation from an exact multiple of the frequency of one wave will cause the figure to move.

When two waves of the same frequency are applied to the deflector plates, the mutual phase angle displacement is readily determined. Thus, when the waves are in phase, the image on the screen is an inclined straight line. Waves that are out

(Continued on next page)

of phase are recognized easily due to the ellipse resulting. The size and shape of this ellipse are directly proportional to the phase angle, which is readily computed. The limit of the ellipse as its minor axis becomes comparable with its major axis is the circle which appears on the screen when the applied voltages are in quadrature (see Fig. 10). If either of the two waves is non-sinusoidal, the line, ellipse or circle produced on the screen will be composed of wavy lines. Sinusoidal waves or waves of similar instantaneous distortions will produce images that contain no wavy lines.

Wave Shapes

Another valuable possibility of this instrument is its application to the analysis of waves and their shapes. It is apparent from the preceding paragraph, that the shape of the wave applied to the plates of the oscillograph does not appear on the screen when this wave alone is applied to produce the true wave shape on the screen the plates. How is it possible, then, to produce the true wave shape on the screen?

Let us consider Fig. 11a. Suppose the wave "X" of the lower left portion of the figure to represent the wave applied to the set of plates affecting horizontal deflection on the screen; the wave "Y" of the upper right portion of the figure to represent the wave applied to the set of plates affecting vertical deflection on the screen; and the wave "I" of the lower right portion of the figure to represent the wave seen on the screen.

By projecting similar instantaneous potentials of waves "X" and "Y" to the lower right portion of the figure, the resultant instantaneous potentials will depict the shape of the wave appearing on the screen. By this graphical device, it is possible to determine the shape of the image on the screen when the wave shapes of "X" and "Y" are known. By working backwards, it is possible to determine the kind of auxiliary wave that must be applied to the set of plates not connected to the unknown wave to achieve a true representation of the unknown wave on the screen.

We will assume that it is desired to project on the screen the wave shape shown in portion "Y" of Fig. 11b. This shape represents the wave that is to be applied to the "Y" set of deflecting plates. Now what sort of wave must be applied to the other set of plates to obtain the desired result? With the aforementioned graphical device it is found that a saw-tooth-like wave must be impressed across the "X" plates to obtain an image on the screen that will accurately portray the wave shape of the potential applied to the "Y" plates.

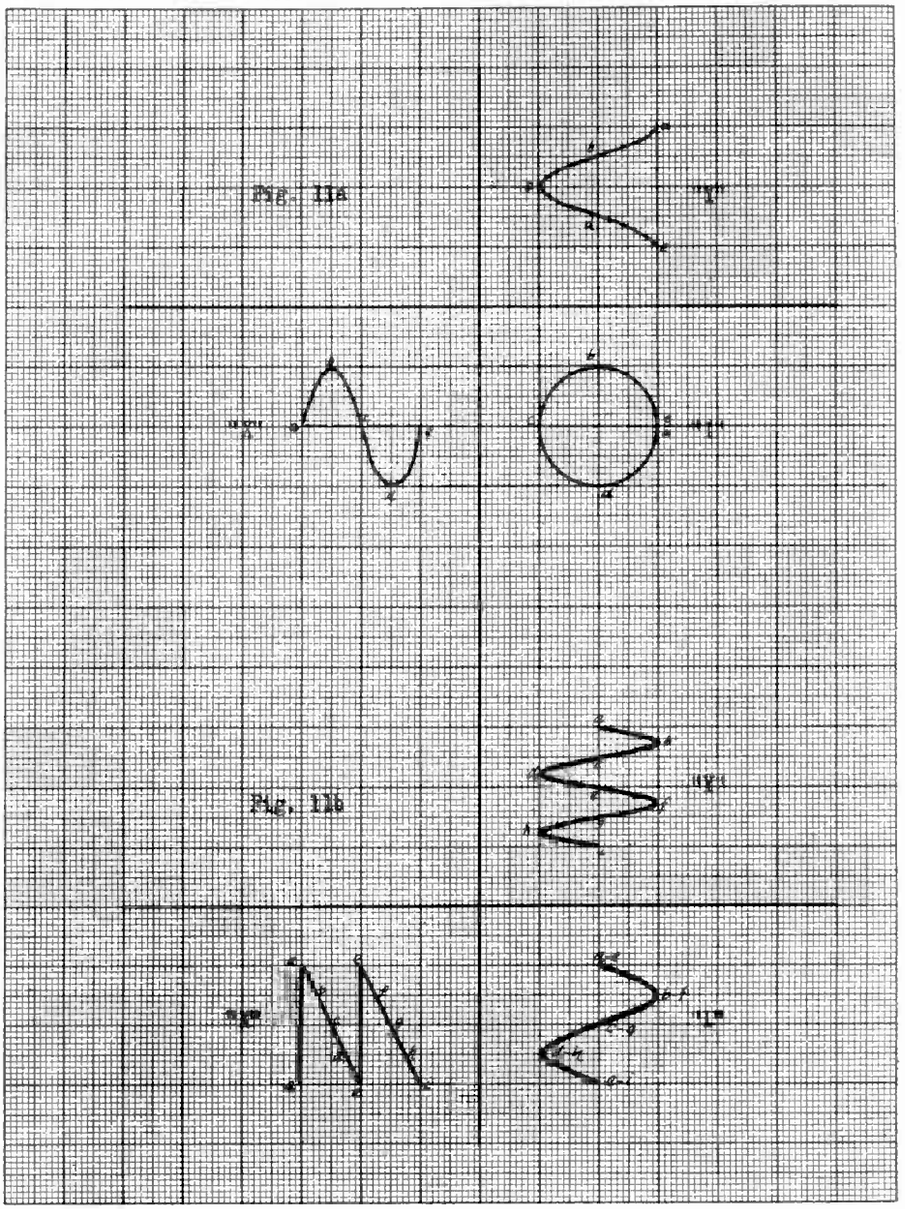
It is this matter of obtaining a saw-tooth potential that will now be considered.

Attainment of Timing Axis

A simple method of obtaining an indication on the screen of the wave shape variations in a phenomenon is to apply a potential varying with the phenomenon to one of the sets of deflecting plates. Another potential varying in a convenient known manner with respect to the other is applied to the other set of plates. The second potential produces a time axis which spreads out the linear image produced by the first potential alone into an exact reproduction of the first potential's wave shape.

If the phenomenon under observation is cyclic and the time-axis frequency is adjusted to some whole multiple of its frequency, a stationary pattern will be obtained, since the cyclic phenomenon will always have the same value for any one point in the cycle of the timing potential.

It is interesting to note the work that has been done in developing a suitable means for producing a satisfactory timing axis for the cathode-ray oscillograph. The elusiveness of the circuit which would produce an even time deflection axis caused some investigators to use some of the less familiar and more abstruse time scales. By this action they avoided the necessity of a new circuit. However, their logarithmic or sinusoidal time scales required difficult interpolation and left much to be desired in the way of simplicity.



Synchronous Resistance

One of the first systems that yielded a satisfactory linear time axis utilized a potentiometer and a battery. This system was very simple and were it not for its mechanical limitations would have proved to be a perfect time axis generator. As will be seen from Fig. 12, the potentiometer is connected across the battery and the time-deflecting plates of the oscillograph are connected between the moving contact of the potentiometer and the center point of the battery. By rotating the moving potentiometer contact, at a constant speed, a perfect saw-toothed potential is applied to the deflector plates and it is possible to view the true wave shape of the cyclic phenomena on the oscillograph screen. Since the timing frequency has to be a synchronous multiple of the unknown wave's frequency to attain a stationary pattern, the high velocity of the potentiometer's rotating arm at high frequencies limits this system to the low frequencies. Thus, this timing system is limited to about 1,000 cycles per second as its optimum frequency. However, this is a vast improvement on the limit of frequency of about 100 cycles per second for an external rotating mirror or the still slower speeds of moving photographic films.

Newer Method

Due to the frequency limitations of the synchronous resistance system, some new method of timing had to be developed. For this purpose, it was found that the charge and discharge characteristics of a condenser or inductance were possible solutions. But, because of the condenser's greater simplicity, and the fact that the inductance offered no advantages over the condenser, the inductance was not developed further. In applying the condenser for a time axis generator we can utilize the slope of either the charge or the discharge curves. Because of its greater facility, it was decided to develop an apparatus that would charge the condenser instantaneously and discharge the condenser gradually through a resistance. Because the discharge curve of a condenser is exponential, it is necessary that values of capacity, resistance, and voltage be chosen as to cause the apparatus to operate on an infinitesimal portion of this curve (see Fig. 16). Thus, a virtually straight saw-toothed potential results from a continuous charge and discharge of the condenser. By means of the auxiliary apparatus shown in Fig. 13 it is possible to alternately charge and discharge the condenser by means of a contactor. By varying the speed of the contactor, a wide frequency range can be obtained.

An alternative method is shown in Fig.

(*Continued on next page*)

Methods of securing Time Axis.

Fig. 12

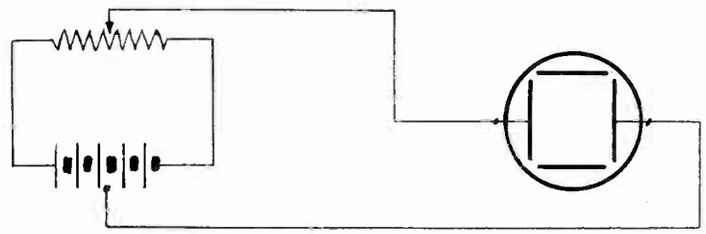


Fig. 13

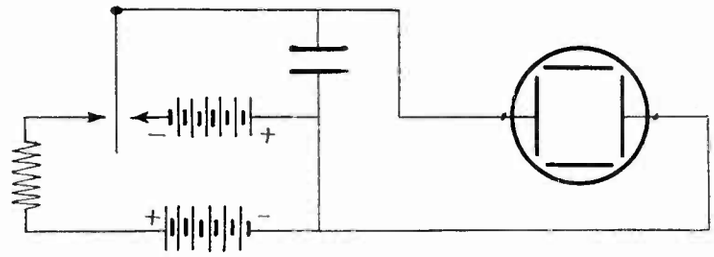


Fig. 14

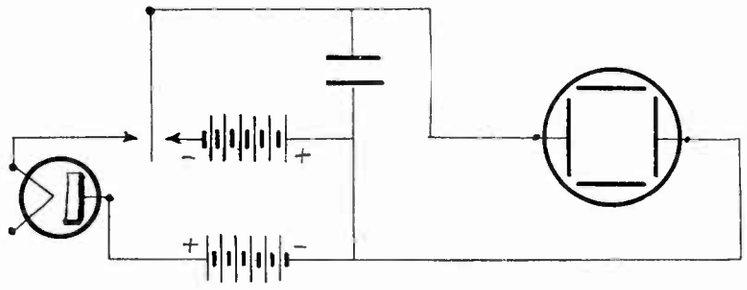
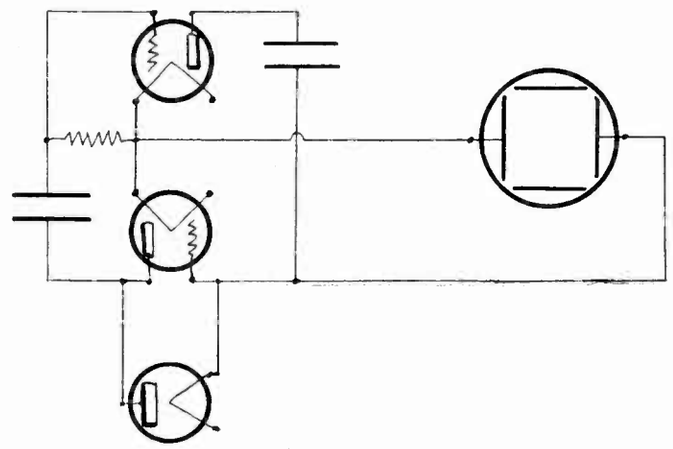


Fig. 15



14, where the inter-electrode impedance of a two-element vacuum tube is substituted for the resistance of Fig. 13. However, both these methods are handicapped by corrosion and oxidation of the contactor contact. Consequently, it would be advantageous to substitute some device that is better suited for the purpose of the contactor.

Vacuum Tube Method

The vacuum tube system illustrated in Fig. 15 effectively accomplishes this result. This is an oscillating system wherein two vacuum tubes are symmetrically coupled by means of two condensers and a resistance. This type of coupling results in an unstable condition of the circuit whereby the two condensers are alternately charged to full voltage instantaneously. Then, the charge leaks off more gradually. One of the condensers leaks through the two electrode tube and the voltage of this condenser is applied to the oscillograph for the time co-ordinate. By varying only the filament current of the two-electrode tube, the frequency of the time sweep can be changed over a wide range.

By impressing a timing potential on one set of oscillograph plates, there remains only one other set of plates for the purpose of the unknown wave. Thus, unless other means are resorted to, it is possible to view only one wave shape on the screen at any one time. Since it is very often desirable to view the wave shapes of a voltage and its current simultaneously, or the three voltages of a three-phase supply simultaneously, provisions have to be made to achieve this result.

For this problem, the use of a distributor is appropriate. Since the human eye has that fortunate defect, known as "persistence of vision," whereby an image remains on the retina for a sixteenth of a second after the disappearance of the image source, it is possible by means of this distributor to view on the oscillograph screen more than one wave shape. In this way, as many as five or more waves may be screened.

In the construction of this distributor all that is required is a motor and a combination of contacts. The final design used for this purpose in the model that was built in an arrangement with the stator contacts mounted in such a way as to allow the rotor contacts to connect them together to complete the circuit from one of the unknown potentials to the "Y" plates of the oscillograph. Two sets of rotor contacts, insulated from each other, serve to complete the two wires necessary for the circuit. With the rotor contacts rotating at a speed where the "persistence of vision" effect exists, the various unknown potentials are consecutively applied to the oscillograph plates to form an image of several simultaneous wave shapes. Four sets of stator contacts are used since that number is the most generally useful.

Some of the various possible combinations obtainable with these four contacts are:

a) Three-phase voltages and zero line.
b) Single-phase voltage and current and zero line. The remaining set of contacts may be used to brighten up either of these waves for the purpose of accentuation.
c) Two-phase voltages and currents.

To obtain the zero line on the screen one set of contacts on the stator of the distributor are shorted. By this action, when the shorted contacts are commutated, only one set of deflector plates on the oscillograph are carrying a varying potential since the other set is shorted. Thus a straight line only is seen on the screen for that instant.

Photography Becomes Practical

The net result of the foregoing procedure is a cathode-ray oscillograph with which the wave shapes of any recurring phenomena may be viewed or photographed. Also, this oscillograph makes it possible to observe the effect produced by changing experimental conditions, while they occur. For permanent record, the curves, when stabilized, may be photographed—either by direct contact prints or by means of a camera. Contact prints with bromide paper are the quickest and most convenient but the lines are not so fine and sharp as when a camera is used.

In either instance the time of exposure varies with the length of the path of the spot of light on the screen; with a longer path more time is required, each particular spot being exposed for a smaller fraction of the whole time. For contact prints, about one-fifteenth of a second is required. With a camera, equipped with a f:4.5 lens and using a fast plate, from 0.25 to 1.5 minutes are needed. The plate should be highly sensitive in the green, from 500 to 550 milli-microns.

As has been previously hinted, the main advantage of this type of oscillograph and its auxiliary time axis equipment is its flexible frequency range. With this instrument at our command, we are no longer handicapped at the higher frequencies where so many interesting and unknown phenomena occur.

WAVEMETER STILL THRIVES

The grand old man of radio that has withstood the ravages of time in its essential aspects is the wavemeter. Although it has changed its name to frequency meter and has had several operations in its day, it still is with us. In the olden days, there were many different types of resonance indicators available for the wavemeter. Among them were the milliammeter, small hot wire wattmeter, small glow lamp, thermocouple, rectifying detector, and the crystal detector. Today, we still find the milliammeter, glow lamp, thermocopule in use while the wattmeter, and crystal detector have been discarded.

1935 Model ALL-WAVE DIAMOND OF THE AIR!

8 TUBES! 5 BANDS! A. V. C.!

TABLE MODEL

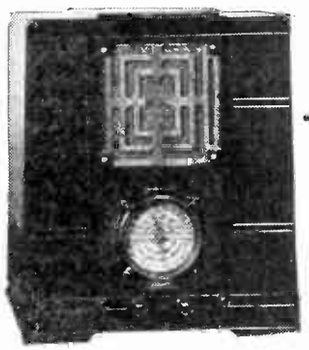


Table Model All-Wave Diamond, using the same 8-tube chassis and tubes as the console model. Wired, complete, with eight tubes. Shipping weight 28 lbs. Order Cat. 1008-T.

TO get away from the conventional and ugly cabinets in which table model receivers have been housed in the recent and remote past we have just obtained an entirely new design, 14⅛ inches wide, 10 inches wide, 9⅛ inches front to back, to house our 1008 chassis, the finest all-wave 8-tube superheterodyne receiver made. The performance is exactly the same, as between the console model and the table model.

The selection of one model or the other will depend considerably on whether you have some mantel or end table or the like on which you'd prefer to place a physically smaller cabinet (but the same-sized set), or whether you have the room for the large console, 21 inches wide, 36⅛ inches high, 12 inches front to back. We have gone to great pains to obtain two models that do not differ in performance, and that yield the maximum that radio has to offer to-day, so that space and artistic requirements can be met to the fullest, along with maximum performance.

The table model is Cat. 1008-T, shipping weight, 28 lbs., wired, in cabinet, complete with eight RCA tubes; net price (shipped from Sandusky, Ohio)— **$32.75**

The wired chassis, with speaker and tubes (no cabinet) can be purchased by any who care to use a cabinet they have. See price at right.

WHENEVER a person wants to buy a particularly fine receiver he usually feels he has to pay a particularly high price for it. Ask almost any one what kind of a set he would want and the answer would be: "An all-wave a-c set, of course." He might prefer a console model or a table model, but he would want band selection by switching. The only drawback, perhaps, is that, times not being so prosperous, he hasn't the price of such a fine instrument. But we point to something new and startling in radio merchandising—the production of a de luxe, superb all-wave set, 150 kc. to 22 mgc. (2,000 meters to 13 meters), at the inconceivably low prices of $45.57 net for the console, and $32.05 for the de luxe table model. These two cabinets are illustrated herewith, and the same superheterodyne chassis is used in both.

These prices are absolutely net, and represent complete wired receivers, equipped with RCA tubes throughout, and securely packed.

The low prices would not mean a thing unless these receivers were of first quality and excellence, unless they had great sensitivity and selectivity, so that foreign short-wave stations and domestic broadcasts could be tuned in with enjoyable volume and steadiness, and unless the tone was marvelous. These new DIAMOND OF THE AIR All-Wave Receivers, in the two models illustrated, are quality products of the highest attainment, enthusiastically indorsed by leading radio engineers, who blink with amazement when told the selling price, in view of the outstanding performance.

As a check on whether care has been taken to make this receiver outstanding, note that the low-frequency band is included. Now, an all-wave set may mean almost anything, but when you are told that the low-frequency extreme is 150 kc., and that the highest frequency tuned in is 22 mgc. (13 meters, mind you!) then you can realize that painstaking craftsmen spent long hours getting the instruments right, so that they would cover frequencies that sweep from one end to the other of program and other bands.

And there is sufficient overlapping between bands, as you turn the gentle band-selector switch, to prevent missout. And moreover, the programs come in with steadiness and clarity, for there is a highly-effective automatic volume control, to correct for fading and to prevent blasting when tuning from station to station.

Exceptional care has been taken in prevention of image interference, and the wisest experts who have given this receiver critical attention admit that the pre-selection is abundant.

Another interesting technical point: This set runs cool. The 6-volt series tubes are used—wise choice indeed—because the elements of these tubes are stronger than those of the 2-volt series, and the power consumption in the heater is considrably less. And yet there was no skimping. The primary power consumption is 80 watts.

Nor does the dial have mere arbitrary numbers on it, 0-100 for instance, as found on what we term "unfinished" sets. This receiver has the very latest illuminated airplane dial, with frequency calibration for each of the five bands, so is direct reading in frequencies, and besides has a double pointer so the benefit of wide spreadout on the scale is derived from both semi-circles. Close vernier tuning is provided.

There is a manual volume control, a tone control and provision for phonograph or earphone connection.

And the speaker? A heavy-duty 8-inch diameter-cone dynamic speaker that is a fitting climax to an expert design and assembly.

The 8-tube, high-gain, all-wave (150 kc. to 22 mgc.) Diamond of the Air wired chassis, 50-60 cycles, 110 volts; with the powerful dynamic speaker and the eight RCA tubes, may be purchased (no cabinet), Order Cat. 1008-CH. Net price, $29.25

CONSOLE MODEL

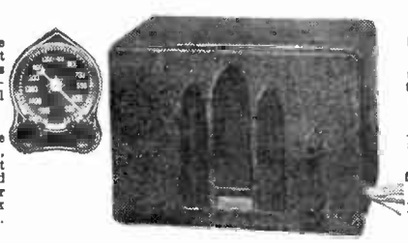
The All-Wave Diamond, 150 kc. to 22 mgc. (2,000 to 13 meters), in its distinctive modernistic console cabinet of genuine burl walnut, curly maple front, artistically carved overlays. Extra large baffle and powerful heavy-duty 8-inch dynamic speaker. Wired, equipped with following RCA tubes: one 6A7, two 6D6, one 75, one 76, two 42's, and one 80. Cat. 1008-CON. Weight, complete, 37½ lbs. For 50-60 cycles, 110 volts. Shipping weight, 51½ lbs. Net price, F.O.B. Sandusky, O.—$45.57

$45.57

6-TUBE DIAMOND AUTO SET, $23.95

OUR previous model Auto Set was so good that the model was not changed in three years. Now at last it has been improved upon, certain mechanical refinements introduced, and tubes of somewhat higher efficiency included. Some of these tubes were not manufactured until recently. Also the set now has a.v.c.

Our 1009 Auto Radio is a six-tube superheterodyne set, using one 6A7, one 41, one 75, two 78's and one 84, and tunes from 540 kc. to 1,600 kc. It is a one-unit receiver, ruggedly built for long life, and is equipped with a dynamic speaker. It has an illuminated vernier airplane type control. The manual volume control and lock are one combination. The power consumption is 4 amperes.



No B batteries required. There is a B-eliminator built in.

This is one of those fascinating auto sets that has single-hole mounting provision, and therefore is a cinch to install. There are only two connections to make: (1), to the ammeter; (2), to the aerial.

The remote tuner is, of course, supplied with the set. And the spark plug suppressors and commutator condenser are supplied, also.

The size is 8¾ inches wide, 6 inches high, 6¼ inches front to back. Shipping weight is 18 lbs.

Order Cat. 1009, wired, in cabinet, complete with six RCA tubes.

ALL OUR DIAMOND SETS EQUIPPED WITH RCA TUBES

GUARANTY RADIO GOODS CO., 145 WEST 45th STREET, NEW YORK, N. Y.