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(See Pages 12, 13, and 14)

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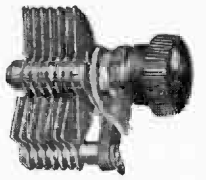

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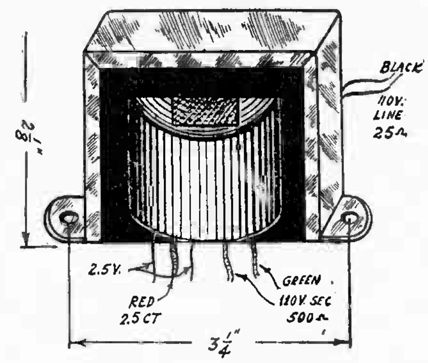

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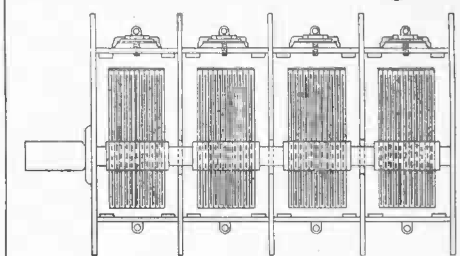

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Television in England is Nearing Commercial Stage

By Neal Fitzalan

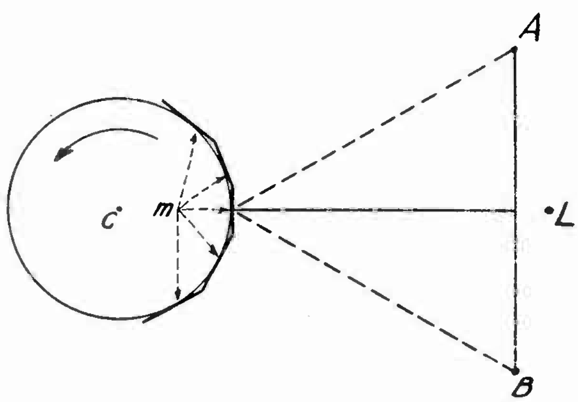


FIG. 1

A cross-section of the drum used in television equipment together with an illustration of how the light is reflected to the viewing screen. There must be one mirror for each scanning line, each producing a line from left to right.

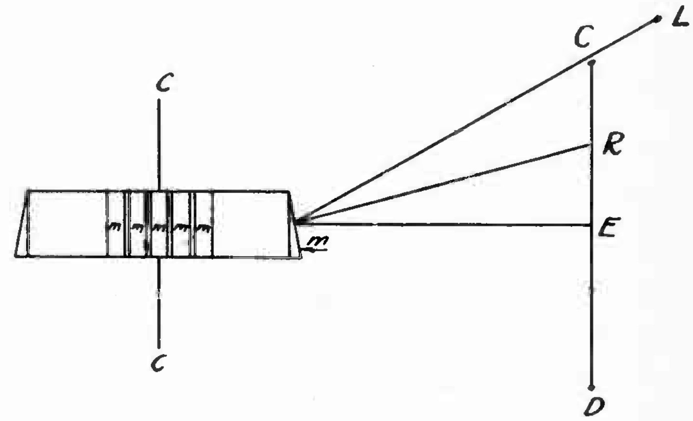


FIG. 2

Another cross-section of the mirror drum and the screen. This shows the elevation. The mirrors are set at different angles with respect to the axis of rotation in order to accomplish the desired result of vertical scanning.

ADVANCES on the television front are made all along the line. In U. S. work is being done with reflecting lenses and cathode ray tubes, in England with mirror drums, in Germany with cathode ray tubes. The latest from John L. Baird in England is news in which the mirror drum is described. This drum is used not only at the transmitter but also at the receiver, and progress has been made to the extent that the company has invited the public to participate in the results, through the medium of stores. In other words, the art is nearing the commercial stage in the opinion of the engineers who are working on the problem, and when they feel that way now, seven years after the novelty stage, we may be sure that the results are encouraging.

Just what is the mirror drum? Fig. 1 shows a section of the drum with the mirrors, m, attached. A bright source of light, L, is located somewhere in front of the mirrors in such a way that the light is reflected to a screen. In the figure the light has been placed for convenience back of the screen and above it, but it may, of course, be very close to the drum. As the drum rotates around the center, C, the mirrors intercept the light beam and reflect it, first one mirror being effective, then the next. Take the mirror directly in the path of the beam LC. When this mirror first intercepts the beam, it is reflected to B, and as the drum turns, carrying the mirror with it, the reflected beam moves over the screen toward A. At the instant the beam leaves the screen at A, the next mirror comes into play and the beam is again reflected to B. After one complete revolution of the drum, all the mirrors have passed before the light and all have caused it to travel across the screen. Usually the direction of travel is from left to right so we have to imagine that we are viewing the screen from the right side. If we were to view it from the left side it would be necessary to reverse the direction of rotation of the drum.

If all the mirrors were set in the same way, all would trace the same line across the screen. That would not do, for it would be equivalent to attempt reading a book by reading the same line over and over again, or more accurately, to attempt to read a book when all the lines had been superposed on the same line. One mirror must trace a light line in one position, the next slightly lower down, and when all the mirrors had traced their lines, the whole screen should have been covered from top to bottom.

This effect is obtained in the mirror drum by setting the mirrors at slightly different angles. How this is done is illusrtated in Fig. 2. The light beam from L just misses the upper edge, C, of the screen, or at least the line if produced would just miss. If the mirror is set so that the normal would hit the screen mid-way up the screen, at R,

FIG. 3
An instructor of the Borough Polytechnic demonstrating the latest mirror drum, the light source and the light modulator as used in the Baird laboratories in London. He is holding mirror in his left hand and the lamp and valve in his right.

(Topical Press Photo)

the light would be reflected to the center of the screen, at E. This mirror would then trace the middle line. If the mirror were set so that R would hit the middle point, the ray would be reflected past the edge D, and if it were set so that R hit A, the beam be returned to about the same point. Thus the total change in the inclination of the mirrors should be equal to the angle subtended at the mirror by half the screen. A few of the mirrors are shown on the edge of the drum.

Angles of Incidence and Reflection

The fact that the total change in the inclination of the mirrors need only be equal to half the angle subtended by the screen follows the law that the angle of incidence is equal to the angle of reflection. That is, the angle LmR is always equal to angle EmR regardless of the value of either.

This fact also enters in the horizontal scanning. For this reason the reflected beam, say mB moves across the screen at twice the rate of the incident beam mL, and this beam, or line, moves at a rate determined by the drum speed. This affects the size of the screen in relation to the speed of the drum.

An idea of the appearance of the actual drum used by the Baird company is gained from the photograph in Fig. 3, in which the man is holding the drum in his left hand. The mounting of the mirrors on the side is clearly shown, being attached to the periphery by metal angles. In his right hand he is holding the source of light employed and the Kerr cell which controls the intensity of the light according to requirements of the picture.

Synchronizing the Drum

The drum used at the receiver must run synchronously with that at the transmitter, and the transmitter must be the controlling element. Synchronizing signals are sent out as part of the transmission and these are impressed on a synchronous motor. This is clearly shown in the picture (Fig. 3), the demonstrator is holding the assembly by the field magnets, while the toothed-wheel rotor appears as a gear between the magnets. This motor does not supply all the power required to spin the drum but only enough to control the speed.

Another view of the equipment is shown in Fig. 4, where the new is compared with the old. The same gentleman is here holding the drum in his left hand and the lamp in his right. On the table in front of him are seen the old scanning disc, the visor in which the image is viewed through a magnifier, and auxiliary control devices.

There is one great advantage of the drum over the disc. The disc distributes the line of sight over a luminous area so that at any instant an extremely small portion of the total light is seen. The light is weak in the first instance. The drum, on the other hand, distributes an intense spot of light over the screen, and all the light is seen all the time, not all over the screen, of course, but only at one spot at a time. But the spot is concentrated so that the effective light over the entire surface is considerable.

The concentrated spot method of light distribution may give even more illumination on the screen than a light of the same candle power would if standing at the same distance from the screen. In that case the illumination would be inversely proportional to the distance and it would be spread out over a sphere having that radius. When it is concentrated it is spread out over the area of the screen only. Let us illustrate quantitatively. Let the radius of the sphere be R feet. The area of a sphere of this radius is $4\pi R^2$. Let the area of the screen be r^2, assuming a square screen. The illumination on the screen is greater in the ratio $4\pi R^2/r^2$ when the light is concentrated than when it is spread out all around. Suppose the distance between the lamp and the screen is 10 feet and the screen is 4 feet on the side. Then the ratio is about 78. This assumes that all the light from the lamp is concentrated in a spot and that this spot is uniformly distributed over the screen at a rapid rate, that is, so rapidly that the persistence of vision will make it appear that the light is uniformly distributed.

(Topical Press Photo)

FIG. 4
The same instructor comparing the old equipment and the new, holding the new in his hands before the old on the table. Small size, improved detail, greater illumination, and better synchronism are advantages of the new apparatus.

The Kerr Cell Valve

The Kerr cell is a device for modulating the light beam at the receiving end. It works on the principle of light polarization.

(Continued on next page)

TWO TUBE TESTERS

USING THE PREFERRED METHOD OF DYNAMIC MUTUAL CONDUCTANCE APPRAISAL

By Einar Andrews

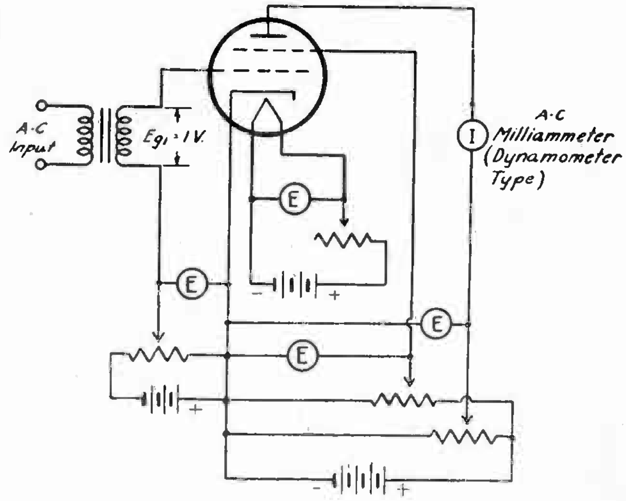


FIG. 1

This circuit is an arrangement for the measurement of the dynamic mutual conductance of an amplifier tube. One volt, or known fraction thereof, is impressed on the grid and the result a-c plate current measured with a dynamometer.

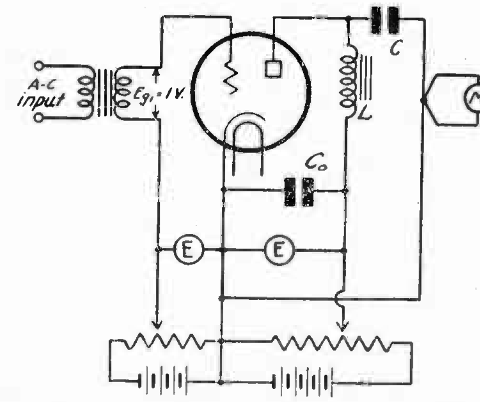


FIG. 2

If a dynamometer type of current meter is not available, the dynamic mutual conductance can be measured with an arrangement as shown here.

THE best figure of merit of an amplifier tube is its dynamic mutual conductance. This is measured with alternating voltage instead of direct, and is the ratio of the change in the effective value of the alternating component of the plate current to the effective value of the voltage impressed on the grid, very small signal voltage being understood.

This figure of merit depends on many conditions. For example, it is a function of the applied plate voltage, the applied filament voltage, and the grid bias. If there are other elements in the tubes, such as screens and suppressors, it is also a function of the voltages applied to these elements. By holding all voltages except one constant and then measuring the dynamic mutual conductance of the tube as the other varies a dynamic curve showing the performance of the tube in respect to this variable can be plotted. An especially useful curve is one that shows the variation in the dynamic mutual conductance as the grid bias is varied and all the other voltages are held constant.

Circuit for Measurement

A circuit for the measurement of the dynamic mutual conductance suggested by RCA is shown in Fig. 1. Four voltmeters are used, one for each of the four polarizing voltages, to make certain that they are those desired for the measurement. The plate current is measured with an a-c milliammeter, which must be of the dynamometer type, for the d-c must be balanced out and impedance presented by the measuring instrument should be negligible in comparison with the internal resistance of the tube. The signal is impressed on the grid in series with the bias by means of a transformer. Sixty-cycle current can be used just as well as any other. The voltage across the secondary of this transformer should be one volt, effective value, or some other suitable low value, say 0.1 volt, depending on the tube under measurement. If the input is one volt, the dynamometer milliammeter gives the dynamic mutual conductance directly in millimhos, and to get it in micromhos it is only necessary to multiply by 1,000. In case the input is 0.1 volt the readings should be multiplied by 10 to give the conductance for millimhos and 10,000 for micromhos.

To take a curve on this circuit, the readings on the milliammeter for different values of the polarizing voltage would be taken, always keeping the a-c signal at the same value.

Measuring With Thermo-couple

Many who might wish to test their tubes with this arrangement may not have a dynamometer type milliammeter, for they are not used extensively. If the circuit is arranged as in Fig. 2 the measurements can be made with a thermo-milliammeter. L would have to be a choke coil of very high inductance

(*Continued on next page*)

Why Vision Screen Follows Signal

(*Continued from preceding page*)

If light is passed through a crystal of Iceland spar in a certain direction, only half of the light gets through. The light is said to become polarized by the crystal for all the light that gets through vibrates in only one direction. Now, if another crystal of the same kind is put in the path of the ray, but placed so that it is at right angles, optically, to the first, the other half will be eliminated. That is, no light will get through two crystals when placed optically at right angles. Suppose now that a glass vessel filled with a certain transparent liquid be placed between the two crystals and a high potential is impressed across the liquid. Light will now pass through the combination, and the amount of light that gets through varies almost directly as the voltage. Therefore, if the crystals are placed at 45 degrees to start with, letting half the light get through when no voltage is impressed, the light will decrease if the voltage is decreased and it will increase if the voltage is increased. Therefore, we have a means of modulating the light beam from zero to about one-half the original amount. And the variation in the light transmitted is instantaneous. Therefore, the variation in the illumination on the screen follows the variation in the signal, which produces the voltage, without time lag and practically without distortion. The response is undoubtedly faster than that of the cathode ray, although this, too, is practically instantaneous.

and negligible d-c resistance, and C would have to be a very large condenser. The object of these is to force all the a-c through the meter and all the d-c through the choke. In order that a condenser and choke of reasonable value may be used, it may be necessary to increase the supply frequency, say to 1,000 cycles per second. This would require an audio oscillator. An 8 mfd. condenser has a reactance of 331 ohms at 60 cycles per second, which might be neglected in comparison with the internal resistance of most tubes. A coil of 100 henries has a reactance of 38,200 ohms at the same frequency, and that is large in comparison with the internal resistances of most power tubes. At any rate, it is large compared with the reactance of the condenser.

While Fig. 2 shows a triode the method is equally applicable to other types of amplifier. Likewise the arrangement shown in Fig. 1 is applicable to any type of tube.

Values Suggested

Condenser Co in Fig. 2 should also have a large value when the supply voltage has a frequency of 60 cycles, a capacity of 8 mfd. being suggested. The various potentiometers used in the two circuits should have high resistance so that they will not draw excessive current from the batteries across which they are connected. The exact value of any potentiometer resistance would depend on the current required to operate the voltmeter. If instruments with a sensitivity of 1,000 ohms per volt are used potentiometers as high as 50,000 ohms are all right, but if the meters draw about 20 milliamperes at full scale lower resistance would be preferable.

An estimate of the sensitivity of the a-c meter required will be helpful. If we know the approximate value of the mutual conductance we know the current that will flow for a given effective voltage in the grid circuit, for the current is the product of the grid voltage and the mutual conductance. Glancing through a list of characteristics of tubes ordinarily used we find that the highest value of the mutual conductance is 2,800 micromhos, which is that for the 48 power amplifier. Suppose, then, that we set the upper limit at 3,000 micromhos. If the input voltage is one volt the current will then be 3 milliamperes. Therefore the thermo-couple meter, or dynamometer, should have a range covering this current. For good sensitivity it should not read much more at full scale. This meter might read currents as low as 1/50 of the full scale deflection, say 60 microamperes. Then the lowest mutual conductance that can be read is 60 micromhos.

As a means of extending the range and at the same time increase the sensitivity for the lower values, the meter might be made more sensitive and the higher values of mutual conductance can be measured by impressing a fraction of a volt on the grid.

WORTH THINKING OVER

MAJOR EDWARD BOWES, theatrical man and radio notable, announced recently at a luncheon of the Cheese Club, a New York organization of Times Square leanings, that he did not believe free entertainments for radio audiences made much, if any difference, in the attendance of the public at regular flesh-and-blood performances in the regular theatres.

Major Bowes should know whereof he speaks, as he is responsible for the conduct of the Capitol Theatre, where Roxy was in power before he assumed the management of that house. On the other hand, if you should ask the officials of the Equity Society, you would be told that Major Bowes is all wrong.

In the meantime, many actors who have found it difficult to find positions in the casts of plays at the regular houses are finding more or less prosperity in the ranks of radio players. And there you are—but, really where are you?

Alexanderson's Directional Antenna Serves Byrd

An antenna which increases by twenty times the directional power of General Electric's short-wave transmitter, W2XAF, making this station equivalent to more than 400 kilowatts in effectiveness in one direction, is being used to broadcast the special programs to the Byrd Antarctic Expedition in Little America every other Sunday night.

This antenna, known as the Byrd antenna, is Dr. E. F. W. Alexanderson's contribution. In erecting this special antenna, engineers are bringing to the Byrd broadcasts the latest devices known to the art to promote reliability of reception. While it may be too much to hope that all programs will reach their Polar destination, the chances are very good. W2XAF was the one station reliably heard by Byrd on his last expedition to Little America.

Twelve Antennas in One

The Byrd antenna is of the horizontal checkerboard type. It is one of a dozen or more antennas which sway above General Electric's 54-acre transmitter laboratory at South Schenectady. These antennas hang from steel masts from 150 to 300 feet high, from plain wooden masts and from masts with cross bars, not unlike scaffolds in appearance.

The Byrd antenna is actually twelve antennas in one, consisting of two sections of a checkerboard, each section made up of three squares. One section is known as a reflector. Only the horizontal wires of the system function as antennas, the vertical wires being for support or power transmission to radiating wires.

The horizontal antenna was developed following years of research along lines suggested by Dr. Alexanderson, consulting engineer and radio expert of the General Electric Company. The effectiveness and carrying-power of horizontally polarized radiation were discovered by Dr. Alexanderson in 1924.

Ground Wave Absorbed

When transmitting with horizontally-polarized waves the so-called ground wave is quickly absorbed, leaving only the high angle radiation which in its carrying power appears superior to the vertically-polarized wave. With the horizontally-polarized system it is possible to shoot most of the energy into the air and, with the reflector, to direct the greater part of this energy in any desired direction instead of dissipating it in every direction over a comparatively small area.

W2XAF operates on a wavelength of 31.48 meters, 9,530 kc. The American public is afforded an opportunity of listening in to these programs to the Byrd expedition through cooperation of the National Broadcasting Company, which broadcasts them over a chain of 51 broadcast-band stations associated with the WEAF or red network. The broadcasts take place every other Sunday night from 11 to 11:30 o'clock, EST., the programs being arranged and sponsored by prominent newspapers all over the country.

Their Only Mail

Immediately at the close of the popular programs, or at 11:30 o'clock, the broadcast-wave stations are dropped but the short-wave station continues. Letters and messages from relatives and friends of the men on the expedition are read. It is the only mail they receive, now that they are cut off from all civilization, and the 75 or 100 letters read to them at the conclusion of each program by short-wave are eagerly awaited. These letters are read from the studios of WGY in Schenectady.

New Tube Tester Picks Right Meter Automatically

Precision in a wide variety of tests necessary to interpret the actual value of radio tubes formed the inspiration for an instrument designated as a Universal Characteristic Test Set, recently designed and built by National Union engineers for use in the National Union Radio Corporation laboratories.

The task of designing and assembling this piece of apparatus was accomplished by National Union engineers, W. M. Perkins, M. G. Nicholson, J. J. Drummond and H. M. Merrill.

Outstanding features of the elaborate instrument are:

1. Ability to measure, with high precision, all existing tubes.
2. Automatic protection of all current meters.
3. Automatic range changing for all voltmeters.
4. Extremely wide range.
5. Simplicity and convenience of operation.

In contrast to test sets, which in order to accommodate a variety of tubes, contain 15, 20 or an even greater number of tube sockets, this new National Union Laboratory test set has only five sockets, so arranged that any vacuum tube with a standard commercial base may be readily tested.

An interesting and valuable feature of this Universal test set is the automatic range-changing system for the various voltmeters. With meter equipment to cover adequately the entire range of filament, grid, screen and plate voltages now encountered, many multiple meters are employed. As required, automatically, the ranges of the various meters are shifted to the proper scale by a system of relays. This feature not only relieves the operator of the necessity of manually changing the range, but it also insures that the most suitable meter will, at all times, be in the circuit, thus permitting more accurate measurements. As an additional refinement, a system of relays automatically protects all current meters from overloads. Pilot lamps, interlocked with the relays, serve as indicators, showing which meter and which scale of that meter is in the circuit at any given time.

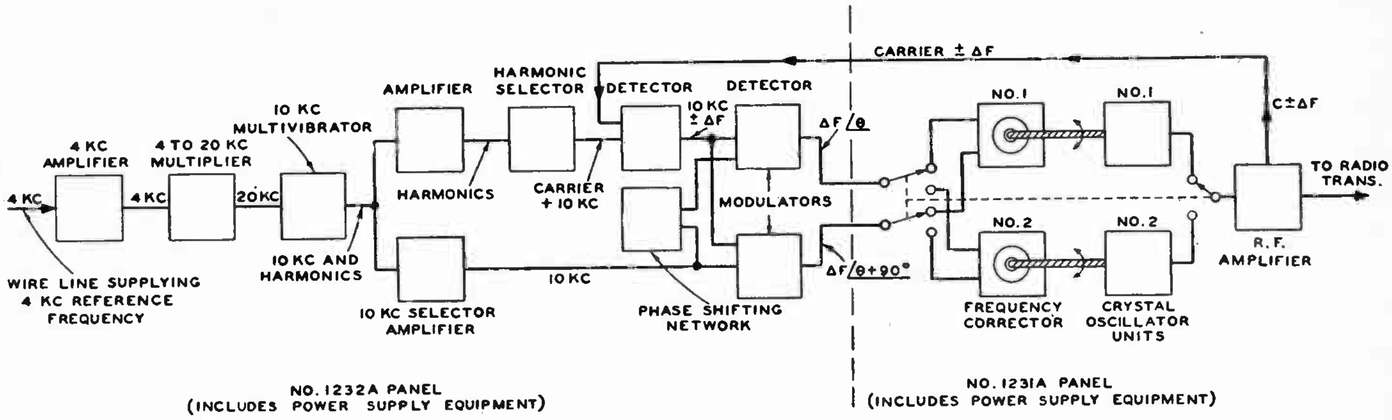
Some idea of the versatility of the test set can be gained from the following partial list of characteristics which are readily measured:

1. Filament current. Range 0—15,000 ma.
2. Grid current.
3. Screen current. Range 0—150 ma.
4. Plate current. Range 0—300 ma.
5. Emission current. Range 0—300 ma.
6. Mutual conductance, between any set of elements. Range 1—25,000 umho.
7. Amplification factor, between any set of elements. Range .1—5,000.
8. Impedance, between any element and ground. Range 100 ohms—50 megohms.

All controls and meters are arranged with a view to convenience. Particular attention was given to lighting, with the result that the illumination of all parts of the instrument is exceptionally good.

SYNCHRONIZED TRANSMISSION

New Western Electric Method Developed by Bell Laboratories Controls Carrier Frequency Within Small Fraction of a Cycle



The schematic of the Western Electric Company equipment for control of broadcast frequencies, to be used especially when stations are operating on the same frequency simultaneously.

AN interesting development by the Western Electric Company is the new equipment for common frequency broadcasting. The idea is to produce frequencies at different points that are so accurate that there will be no beat between them.

The equipment consists of two racks, one containing duplicate crystal oscillators with associated control units and a two stage radio frequency amplifier, the other containing the wire terminating equipment, the reference frequency amplifier, the multipliers for bringing the reference frequency up to a value comparable with that of the assigned frequency. Each panel, or rack, contains separate stabilized power apparatus, the power being drawn entirely from the a-c mains.

Although designed primarily for common frequency broadcasting, the equipment can be used also as the master oscillator of a radio transmitter to provide extreme carrier frequency stability to stations which are not operating on a common frequency basis.

Theory of Operation

The attached schematic when studied with the following description will provide a clear understanding of the theory of operation of the equipment.

Upon being brought into the station by wire line, the 4 kc reference frequency passes first through an amplifier. The output of the amplifier is fed into a frequency multiplier which generates the fifth harmonic (20 kc) of the fundamental frequency. This 20 kc frequency is used to control a 10 kc multivibrator. The output of the multivibrator contains the 10 kc fundamental frequency and all its harmonics up through the broadcast range. The 10 kc fundamental frequency is passed through one amplifier and the harmonics are passed through another.

The amplified harmonics then are fed into a selector which selects and further amplifies that harmonic which is 10 kc above the assigned carrier frequency of the station. The carrier frequency, generated by the crystal oscillator, which may be assumed to differ from the assigned value by some difference D is combined with the selected harmonic in a detector.

The amplified harmonic beats with the carrier frequency in this detector producing a difference frequency of 10 kc ± D. This is 10 kc ± D, together with the amplified 10 kc reference frequency from the multivibrator unit constitutes the input to a pair of balanced modulators.

Phase Shifted

The 10 kc reference frequency before being applied to one of these modulators is passed through a phase shifting network which retards its phase by 90°. The output of each modulator becomes one phase of a two-phase alternating current of the frequency D. The output of both modulators is then fed into the corrector unit which consists of a small synchronous two phase motor mechanically connected to a small variable condenser associated with the crystal oscillator circuit. The two-phase current from the modulator stage has a direction of phase rotation which depends directly upon whether the carrier frequency is above or below the assigned value. If the carrier departs from the assigned frequency, the synchronous motor will revolve in the proper direction so that the resultant change in the variable condenser will alter the frequency of the crystal oscillator and so bring it back to the assigned value.

Any deviation of the carrier frequency from the assigned value operates the frequency corrector, providing a precision of carrier frequency never before approached in broadcasting transmitters.

Quartz Crystal Oscillator

The crystal oscillator unit was especially designed for use in this equipment. The equipment contains the crystal oscillator unit and the associated corrector device in duplicate. Should one of the units fail the other may be placed immediately in service by a simple switching operation. The spare unit is kept at operating temperature continuously so that no warning up period is required before placing it in service.

The oscillator circuit, together with its associated quartz crystal control, is housed in a single unit. The quartz crystal control is enclosed in a separate chamber, within this unit. The temperature of this chamber is closely regulated by a mercury thermostat. The circuit, the crystal, and the thermostat are adjusted and calibrated as a unit at the Bell Telephone Laboratories. This insures high precision of calibration as well as permanency of adjustment.

The oscillator tubes used are uniform in construction and, therefore, need not be calibrated individually with the oscillator unit. It is possible even to replace the oscillator tube without appreciable frequency change in the oscillator. The absence of mechanical relays in the crystal heater circuit is an important factor in maintaining satisfactory service.

Advantages of the Equipment

Equipment such as that described has been found the most practical means of holding the carriers of radio transmitters in synchronism. Using the reference frequency to control the output of a local crystal oscillator rather than as the basis for generating the carrier frequency makes the station carrier independent of any interference which might be received with the reference frequency.

This arrangement also insures against the necessity of the station ceasing operation if there is a failure of the synchronizing apparatus or an interruption of the reference frequency supply. Under such conditions the crystal oscillator will continue to supply a carrier which will not drift from the assigned value by more than a few cycles per minute over a period of several hours—a variation which would not be sufficient to cause serious interference at listeners' receivers. As soon as normal conditions are reestablished, precise synchronization is restored promptly and automatically.

This Common Frequency Broadcasting Equipment makes it possible to operate a chain of widely distributed stations on a common frequency system without any special synchronizing link between the individual stations other than the circuit providing the reference frequency.

When stations in a chain are using the same program there must necessarily be the usual program line connection. Otherwise, all that is necessary to operate the station in synchronization with another station or with a chain of stations is a wire line connection to the 4,000 cycle reference frequency source.

Stations Using Equipment

Two installations of its new type of synchronizing equipment have been ordered from the Western Electric Company and are ready for shipment to WBBM, Chicago, key station of the Columbia Broadcasting System, and to KFAB, Lincoln, Nebraska. These two stations contemplate synchronizing the latter part of this month (January).

This marks the first move to be made towards synchronized broadcasting on a common frequency by any stations in the United States since the North American Radio Conference in Mexico. The move is regarded as significant inasmuch as it may signalize the widespread introduction of synchronization in the commercial broadcasting industry of the country.

Now Practical

The perfection of synchronizing equipment now makes such a development a practical possibility. The equipment to be used by WBBM and KFAB provides a precision of carrier frequency never before approached in broadcasting transmitters. It has been developed by Bell Telephone Laboratories as a result of years of experimentation which as early as 1927 produced successful tests with synchronous operation.

The system operates as follows. In the first place, the equipment includes an extremely accurate source of carrier frequency which entirely replaces the master oscillator of the station. A reference frequency is furnished by wire from the Bell Laboratories to the stations involved which serves to control the carrier frequency of each station.

Automatic Check

Whenever the local carrier frequency —the crystal oscillator—deviates from the control frequency by even a small fraction of a cycle, an automatic mechanism in the synchronizing equipment is set in operation and immediately corrects the minute difference. Consequently the carrier frequencies of the stations included in the system are at all times kept in synchronism.

As far as the synchronizing itself is concerned, no special link between the individual stations is required other than the circuit supplying the reference frequency. Although designed primarily for common frequency broadcasting, the equipment can be used also as the master oscillator of a radio transmitter to provide extreme carrier frequency stability to stations not operating on a common frequency basis.

Full Time for Both

The plan for WBBM and KFAB calls for the two stations to be synchronized on 770 kilocycles, their present assignment. Both stations now operate full time during the day but alternate during certain hours at night.

Synchronization will enable these two part time stations to utilize the air full time. The service they render to radio listeners in their area will be proportionately lengthened.

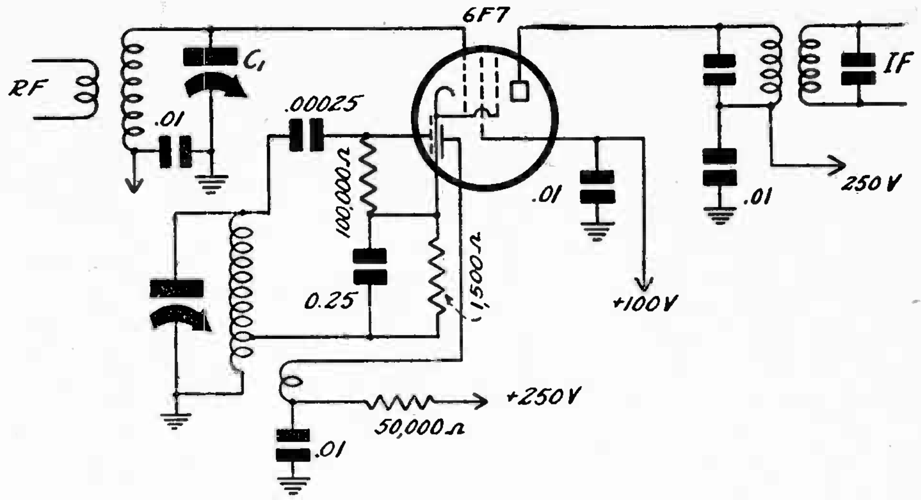
Plans to synchronize have been under consideration by WBBM and KFAB for some time and the Federal Radio Commission gave its sanction several months ago. Considerable importance is attached to this decision of the Commission as evidencing its desire to encourage wider use of synchronization in view of the possibilities it offers for relieving the congested commercial broadcasting band and broadening good service.

Synchronization of broadcast stations has been considered for a long time, and it has been tried out practically both here and in Europe. However, there has been no method until now by which the frequencies could be held constant enough. Even transmitting a signal by radio from which the other stations would get their frequencies would not work out because fading would introduce frequency changes.

C. L. McCARTHY IN NEW JOB

Charles L. McCarthy has resigned as manager of station relations and assistant to Don E. Gilman, National Broadcasting Co., San Francisco, to become assistant manager of KFI and KECA, Los Angeles.

THE 6F7 IN A MIXER



THE 6F7 is a triode pentode tube designed especially for mixers in superheterodynes. How are the elements arranged in this tube, in such a manner that we may vary the coupling between the oscillator and the pentode, or so that it is fixed, leaving no opportunity for the designer to exercise his preferences? This question is partly answered by the drawing of the tube as shown in Fig. 1. It will be noticed that the grid and the plate of the triode use the same cathode as the elements of the pentode but that they are quite independent of them. As a matter of fact, the plate is a wire placed near the cathode and the control grid for this element is a grid placed so as to control the electron stream from the cathode to the plate. The coupling between the triode and the cathode elements are therefore extremely loose and leaves to the designer much leeway.

The circuit in Fig. 1 shows a typical superheterodyne mixer from the r-f input to the i-f output. As far as the pentode circuit is concerned, it operates as a grid bias detector or amplifier, depending on the grid bias. As a mixer tube it will necessarily work as a detector regardless of the bias, it is only more or less of a detector.

The triode works as an amplifier, for every oscillator works that way. It is grid tuned in this instance, and it has a grid leak and stopping condenser. Coupling between the pentode and the oscillator is effected connecting the cathode to a tap on the tuned circuit. The nearer this tap is to ground, the looser is the coupling between the two devices, and the choice of the position of the tap is obviously opportunity for the engineer to exercise his skill and his prejudices, and he may measure the results from all coupling degrees.

A PURE-WAVE OSCILLATOR

IS PRACTICAL BY LIMITING THE AMOUNT OF POWER SUPPLIED

By J. E. Anderson

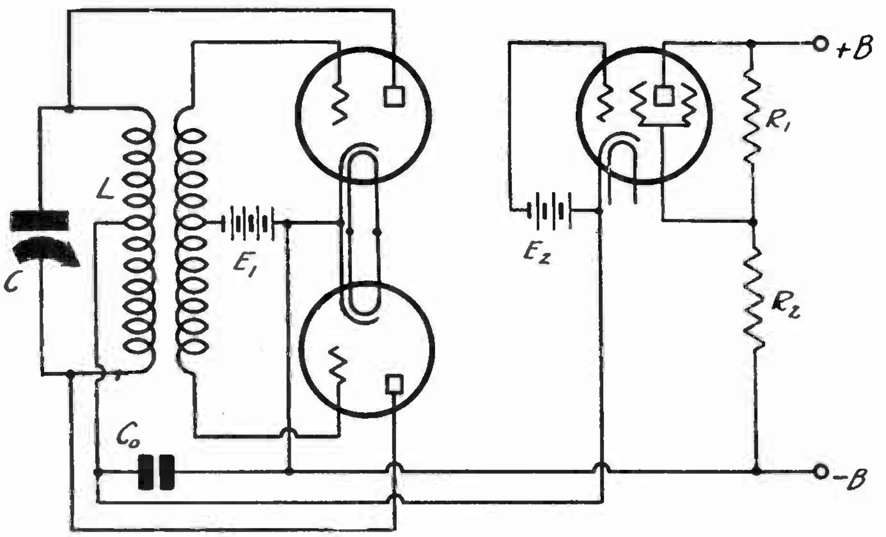


FIG. 1

A suggested push-pull oscillator in which the power supply is limited by a saturated pentode, which is a possible way of generating oscillations without harmonics.

A STATEMENT that is often made in connection with vacuum tube oscillators is that it is the curvature of the tube characteristics that limit the amplitude of oscillation. We challenge the statement. One way of expressing it is "It is precisely the curvature of the characteristic which limits the amplitude," and this statement was made after it had been pointed out that the curvature is undesirable from the point of view of harmonic production and frequency stability. Another way of saying it is "The feedback continues to build up the amplitude of the oscillation until it is checked by the curvature of the characteristic, and if this were straight the increase would go on indefinitely." The necessary conclusion is that it is impossible to have an amplifier without generating harmonics. This conclusion is inescapable if we are willing to accept the major premise.

Consider a train running on a level track. The throttle is set to deliver a definite amount of power. The train speeds up. Since there is no "curvature" on the track, that is, since the resistance is constant, we are forced to the conclusion that the train accelerates indefinitely and that after it has been running an hour or so it is going 10,000 miles per hour. Consider an automobile running on a level road. The throttle is set to deliver a definite power. The car speeds up. Since the resistance to the car is constant, we are forced to conclude that after an hour or so running the speed is so terrific that even a traffic cop would be unable to catch a glimpse of the car going by.

The Parachute Jumper

Consider a parachute jumper. He bails out at a very high altitude, say 10,000 feet, and he neglects to pull the string opening the chute. The force pulling him down is constant and so is the resistance. Consequently he gains speed at the rate of freely falling bodies. By the time he has fallen 9,000 feet he is going at the rate of 500 miles an hour.

Now, it has been demonstrated by parachute jumpers that the speed will not increase to any such value, the limit being about 200 miles. It is also common experience that the train does not gain an infinite speed, but that the limit is comparatively low. Likewise, it is also common experience that when the automobile throttle is all the way down to the floor the final speed is seldom so great that the motorcycle cop can't catch up.

It may be argued that the resistance to the train, or car, or parachute jumper does not remain constant, but that it increases as the speed increases. It is not the resistance that increases but rather the back force due to that resistance. If the resistance did increase it would not be enough to make any appreciable difference. There would be a limit to the speed even if the resistance were absolutely constant.

Then why is there a limit on the speed? Why would there be a limit to the amplitude in an oscillator, as we contend there would be, even if there were no curvature of the characteristic, that is, even if the plate and grid resistances were constant? And how are the mechanical examples cited related to the oscillator?

Law of Conservation of Energy

There is a law in physics, which means in nature, to the effect that no more energy can be obtained out of a machine than is put into it, and it is called the Law of Conservation of Energy. It is that law which has confounded all perpetual motion machine inventors. While these fellows are ignorant of the law, they are nevertheless subject to it. They are not able to avoid it, and for that reason we have no perpetual motion machine.

Many machines, and the three examples cited are included among them, are subject to a special clause in the general law, which states that energy cannot be dissipated any faster than it is supplied. In other words, there must be power balance. Examples of power balance are numerous in devices we use every day. Take the ordinary electric light, for example. There is a definite current flowing in the filament, and there is a definite resistance through which it flows at any given instant. Therefore, energy is supplied at a definite and constant rate. But the filament does not become infinitely hot after a time. The filament comes to a definite temperature and stays there, and that temperature is determined by the balance point of the power supplied and the power radiated in the form of heat and light. If anything should stop the radiation, then the temperature would go up. This happens occasionally in radio transmitters, when the radiation from the antenna is stopped. If the power supplied is not also stopped instantly, there are fireworks in the transmitting tubes.

There is similar power balance in the cases of the train, the car, and the falling aviator.

Tie-up with Electrical Case

How are the mechanical examples related to the electrical case? In the first place energy is the same wherever it appears and by what name it is called. The same holds for power, for power is only the rate of change of energy, or the rate at which energy is used or dissipated. Velocity in the mechanical case corresponds to current in the electrical. Mechanical and electrical resistance are analogous. Likewise mass and inductance occur similarly in the two cases.

The falling of an aviator is equivalent to starting a current through an inductance. At first the velocity (current) increases under the influence of the gravitational pull (electromotive force). The velocity (current) is checked by resistance and when there is power balance there is no further increase in either.

What applies to unidirectional velocity (current) applies also to alternating. In each case the amplitude increases until the power supplied balances the power dissipated.

The Electric Oscillator

In the electrical oscillator the tickler or feedback arrangement, which is supposed to cause the amplitude to increase indefinitely, acts as an escapement which supplies energy and times this supply properly. If power could be supplied without limit, then the amplitude would increase indefinitely, for each energy impulse would be a little stronger than the one immediately preceding. But when the power supply is limited the amplitude can only increase until the power supplied is equal to the power dissipated. If power balance does not occur until the amplitude is such that a great deal of distortion occurs, that is incidental. It merely brings about power balance a little sooner than otherwise would be the case.

Since there is no means known for making the characteristic curves of an amplifier straight, we have no means for testing this assertion. However, every oscillator is a device for making a partial test. We know that if the coupling between the grid and plate coils is decreased, the harmonics decrease in intensity. The reason for this is that the rate at which energy is supplied to the oscillating circuit is decreased, and consequently power balance occurs at a lower amplitude.

A mechanical analogy for this is the inclined plane. A freely falling body gains velocity at the rate of 32 feet per second every second. A ball rolling down an inclined plane does not gain speed at the same rate, even if the friction is no greater than it is when the same ball is falling freely. If the inclination of the plane is small the ball may not roll at all. Certainly a brick would not slide down the inclined plane if the slope were small. The inclination of the plane is equivalent to reduction of the feedback, or the rate at which energy is supplied.

Straightening the Characteristic

In an electric oscillator employing a thermionic amplifier, most of the energy supplied is lost in the grid and plate resistances. If the circuit could be arranged so that most of it were lost in the tuned circuit, then the oscillator would generate a pure wave. This condition can be approximated. In the first place the grid resistance can be made infinite, when no power would be lost in that circuit. (Incidentally, in many oscillators most of the energy is lost in this circuit.) If no energy is lost in the grid circuit we have the plate and the tuned circuits left. Ordinarily, a very small fraction of the power is lost in the tuned circuit. Hence, it is important to make the plate resistance straight.

One way of straightening the characteristic is to connect the oscillator in push-pull as has been done in Fig. 1. If the circuit is completely balanced the characteristic will be sensibly straight over a wide range of grid potential and the curvature for low values of plate current will be balanced out, that is, if we think of the plate current as being the difference between the plate currents of the two tubes. The curvature due to saturation, however, remains and it is effective at both peaks of the wave.

Limiting Power Supply

In order to insure a definite limit to the power supplied we may use a saturated pentode in series with the plate supply. The fact that this is a saturated device when adjusted does not insure a constant current, but it does insure an upper limit. If this limit is less than the current required by the amplifier when the swing is at the peaks, there will be a limitation to the plate current before the saturation of the tubes comes into effect. Moreover, the push-pull oscillator will draw a practically constant current and there will be little fluctuation in the demand for current from the saturated tube.

The power supplied to the oscillator will be the constant current through the saturated tube times the mean potential across the condenser Co. This power determines the amplitude at which power balance is established. This may or may not occur before there is any appreciable curvature of the plate current characteristic.

If the resistance characteristic of the tube, or tubes, were straight, and if there were no limit to the power supplied, the amplitude would increase without limit, but if there is a limit to the power supplied, there simply must be a limit to the amplitude even if the resistance characteristic were straight. Therefore, it is not hopeless to expect an oscillator that will generate a pure wave.

Fig. 2 shows the plate characteristic of a 34 type pentode for anode voltages up to 400 volts and for four different bias values. For anode voltages over 40 volts, there is virtually no change in the plate current when the bias is more than 10 volts, and for the other two bias values when the anode voltage is over 80 volts.

Of course, if the current is as low as the constant values in this case there would not be much for the operation of the push-pull oscillator, but, also, there would be little chance of saturating the tubes.

34 as a Power Limiter

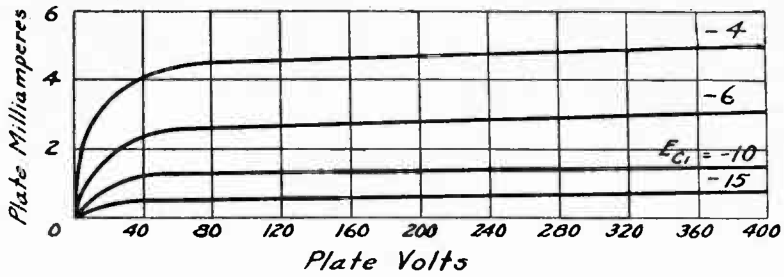


FIG. 2

The plate current and voltage characteristics of a 34 pentode for voltages on the anode up to 400 volts. This tube might be used as power-limiting device in Fig. 1.

South Bend Lathe Works Issues a New Catalogue

A new 72-page general catalogue showing the complete line of South Bend Lathes and attachments for repair shops, equipment and instrument maintenance shops, experimental laboratories and general machine shops, has just been published and is called Catalogue No. 94.

This catalogue, which is most complete, describes and prices 96 sizes and types of lathes, all of the back-geared, screw cutting type. The lathes range from small bench lathes up through the medium sizes to large swing lathes, and include gap bed lathes.

A new line added to this general catalogue is the Underneath Belt Motor Driven Lathe, incorporating many new features which provide for greater safety and convenience for the operator, and more power with a greater silence in the machine itself. Other models of drives shown include the Silent Motor Drive and the Countershaft Drive.

A full line of lathe attachments and tools for regular and special work is also shown. Any reader interested may obtain a copy of this new Catalogue No. 94 by writing to the Technical Service Dept., South Bend Lathe Works, South Bend, Indiana, and mentioning RADIO WORLD.

Leak-Condenser Triode is a Single Diode, Too

The leak-condenser detector is seldom considered as two tubes in one envelope, as the tube is usually a familiar triode. However, the grid-to-cathode circuit is a rectifier of the diode type, thus the triode is diode-biased.

A THOUGHT FOR THE WEEK

THERE'S STILL MORE TALK ABOUT THAT THIRD NETWORK. One informant, posing as an authority, insists that the NBC and the CBS will be very much upset when they learn the name of the chief backer of the new chain. When asked if this backer had more money than Edsel Ford, who was supposed to be behind the late, if not lamented, Amalgamated Broadcasting System, the same voluble source of information launched out into a dissertation on the difference between a backer who is being angled for and one who already has been landed.

Now, let's prepare to wake up some morning and read all about the third chain—but if you don't read anything definite about it for several months to come, just don't blame us. Blame the diffident backer.

Tropical Fish Interferes With Radio Reception

A radio trouble shooter for a power company encounters every imaginable kind of interference. About the only source of interference he does not meet is the well-known "leaky transformer." This man is the first on the scene in most instances, for when interference is experienced with radio the first thing the owner of the set thinks of is to call the power company, usually with the explanation that a "leaky transformer" exists somewhere in the neighborhood. In most instances, of course, the trouble lies in the set, but not in all. When the trouble is not in the set it is usually in some electric appliance which the complainant or one of his neighbors has installed. Occasionally it might be in the electrical wiring. For example, there may be arcing between an open transmission line and the branches of trees, or there may be actual leakage between the conductors of a high-voltage cable.

One of the most prolific sources of interference with radio reception, according to one power company service man, is tropical fish. No, not exactly the fish, but the device used for keeping the fish comfortable and in a tropical environment. The temperature of the water in which the fish are kept must be maintained at a constant value and for this tender purpose an electrical heater with a thermostat is used. This thermostat opens and closes the heater circuit occasionally. When it opens, the break is not clean, and as a result sparking occurs. This sets up electrical waves which are picked up by all the receivers in the neighborhood. It produces sputtering and hissing in the receivers.

One remedy for this is to throw out the thermostat and let the fish die of cold shivers. Another is to put a spark suppressor across the break points. A condenser of 0.1 to 1 mfd. will do, or a condenser with a resistance of about 100 ohms in series with it.

LINE BLOCKED IN A UNIVERSAL TYI

INVENTION PERMITS INSERTION OF AN ATT SELECTIVITY GREATLY INCREASED, ZERO B TOR USED ON D. C. AND BATTERY POWER, V —NO FREQUENCY SHIFT IF

By Herm

THE handiest test oscillator is the universal type, since it works anywhere, requires no batteries on line a.c. or d.c., but if the lining up has to be done on a battery-operated set, in a location where there is no line electricity, then B batteries of 90 volts as found on the premises can be pressed into temporary service. Hence there is really nothing to renew except the tubes. However, when the test oscillator is connected to the a-c line or even the d-c line the oscillation voltages will feed through. This is particularly objectionable on the a-c line, because then the receiver is almost certainly a-c operated and the common feed is complete.

Since modulation is needed on d.c. or batteries, the usual method is to use a grid leak of high value. This produces grid blocking, an unstable audio tone. There may be fluctuations in the output as read on an output meter, due to the variations in amplitude of this low-frequency modulation, rendering the qualitative measurement of the receiver difficult.

Testing of A-V-C Sets

Another factor is that when oscillation voltage feeds through the line there is no possibility of using an output attenuator (volume control), since no matter where the control is set, the oscillations through the line are independent of it, as they take a different course. So lining up receivers that have automatic volume control becomes difficult if not impossible. The reason is that a.v.c. tends to make all fairly strong signals of a level output volume, no matter what they are originally, and only by attenuation would it be possible to reduce the test oscillator output so that what is fed to the a.v. a-v-c set is below the threshold of the control voltage in the receiver's diode detector or other a.v.c. device.

Since the test oscillator is connected directly to the line an investigation was directed toward eliminating the stray radiation and confining it exclusively to the output wire. This is a shielded wire, with sheath grounded. The investigation was carried on, though not uninterruptedly, for nearly two years, with practically every method unsuccessful. It was possible to reduce the quantity of stray coupling by reducing the amplitude of the oscillation originally, but this was no solution. Not only did it beg the question but the percentage of feedback transmission through the line was scarcely reduced.

Localized in Plate Circuit

The trouble finally was traced to the plate circuit, and when a suitable filter was inserted the feeding-through was reduced very sharply and then an attenuator showed that it could really control the output considerably. The filter consisted of a series resistance in the plate return, 20,000 ohms having been used, but higher values being practical, to the point where the effective plate voltage is reduced to near the value that stops oscillation altogether, when the oscillator may not be "self-starting." From the high r-f side of this resistor to effective ground (negative filament of the 30 oscillator) a condenser of 0.05 mfd. capacity or higher should be put. This may be 1.0 mfd. for a bit more effective filtration, although under no circumstances should the condenser be electrolytic. A paper condenser is suitable.

The blocking is considerably augmented by the introduction of a series resistor in the plate leg, unbypassed this time, and shown as 0.005 meg. (5,000 ohms). This is placed between plate and the coil and serves the dual purpose of aiding line-blocking and of serving as a protected feed for the output.

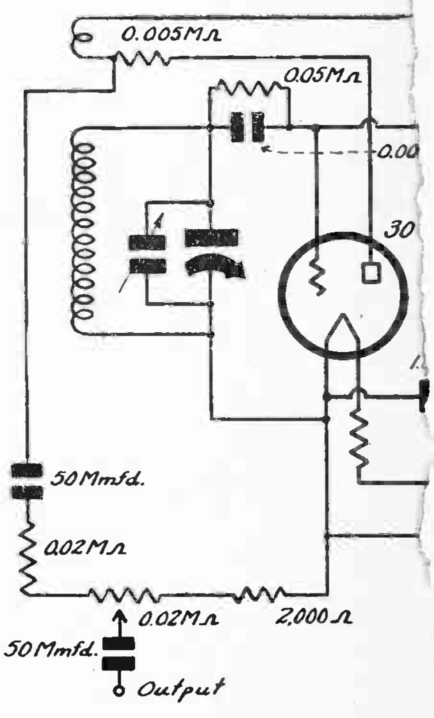
The stray coupling may be considered in two aspects. One has to do with feeding through the line. The other has to do with radiation "through the ether," so to speak.

Shielded Cable's Effect

As for feeding through the line, it might be assumed that such trouble would not be met, because the line has an impedance of 1 ohm at 60 cycles. At the lowest frequency that the test oscillator covers one might expect that a mere ohm would constitute a short circuit, not to mention the highest frequency, although this is not so. A small fraction of an ohm will constitute an appreciable resistance, as proved by the fact that current of the oscillating frequency (135 kc) will flow through it, and likewise current of the frequency represented by the other extreme of tuning, i.e., 380 kc. Local oscillation voltage must be considered from a different angle than mere carrier voltage derived from an aerial that picks up what are of course oscillations of a transmitter, but a transmitter that is some distance away.

The type of radiation that gets out through the oscillator box, whether of the shield type or not, needs consideration, too, and it is found that this radiation stops completely when the shielded cable used as output lead has sheath grounded, either at the far end, or, preferably, at both ends.

There is no trouble even from feeding through the line, and none from ether radiation, on intermediate frequencies even in the unblocked model. The test oscillator covers 135 to 380 kc, with those frequencies imprinted on the dial scale, and with popular intermediate frequencies also imprinted, i.e., 175, 400, 450 and 465 kc. The broadcast band is taken care of by imprinted fourth harmonics, 540 to 1,520 kc.



A new development by Herman Be line blocked. This is the first time series resistor in the positive fi

As stated, the intermediate frequencies are handled all right, but lining up at the radio frequencies causes the trouble, as the receiver is far more sensitive at that level, so the line-feeding becomes a menace as does the ether radiation. However, both are squelched in the model under discussion.

Tickler Proportions

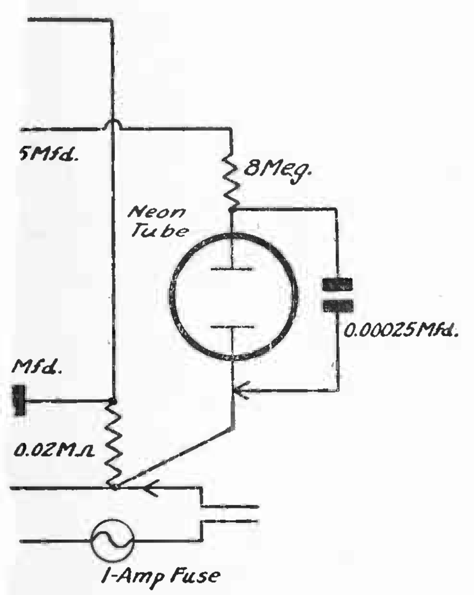
It can be seen that the 30 tube is used as radio-frequency oscillator, tuned-grid type, and the tickler may be larger than usual and closely-coupled, but should not be of the same inductance as the secondary. It may be of greater or less inductance, but not so great as to stop oscillation at the higher radio frequencies of tuning, due to the tickler then acting as a choke.

Also it is clear that when a.c. is used it is directly on the plate, reduced in quantity by the series resistors, but there nevertheless. So at resonance, for a-c use, there is always modulation. Perhaps the point needs stressing, in the light of what is to follow. For a-c service there is never any absence

FOR FIRST TIME
'E TEST OSCILLATOR

:NUATOR, ALSO LINING UP OF A-V-C SETS— :ATS ALWAYS OBTAINABLE—NEON MODULA- 'ITH MODULATED - UNMODULATED SERVICE POWER SUPPLY IS CHANGED.

n Bernard



:nard, a universal type oscillator with such a feat has been reported. The ament leg is 1,750 ohms, 10 watts.

of modulation and never any possibility of removing modulation.

Separate Audio Oscillator

Now, the grid leak is of low resistance, 50,000 ohms, and therefore it will not produce audio oscillation on d-c or batteries. So some means must be provided to generate audio frequencies. This is done through the use of a small neon lamp, which may be of the type that fits in a candelabra base. The lamp should be of the type that has no series resistor built in, as the resistor, though small compared to the load resistor, would interfere somewhat with production of audio oscillations, rendering the lamp itself inaccessible directly to the 0.00025 mfd. condenser that makes oscillation possible. The series or limiting resistor is 8 meg.

Now we have, for d-c and battery use, a radio-frequency oscillator of the familiar type, plus a separate modulator tube, and since the audio component is derived elsewhere than from the r-f oscillator, we may introduce a switch and remove or introduce modulation, as we prefer. The best way is to cut the lamp's condenser in or out, as the lamp may oscillate even if one terminal is free, so long as the condenser is there. For servicing broadcast sets, at intermediate and broadcast levels, including t-r-f sets at their single band level, we always use modulation, especially as we can hear the result in the speaker.

Modulation Removed

However, there are some uses for which the carrier alone is more suitable, as when operating on higher order harmonics than intended originally, that is, for frequencies above the highest of the broadcast band. There is practically no limit to the harmonic orders, as oscillations have been heard on the 100th harmonics, beating with shortwave carriers. Also, an audio beat oscillator of the uncalibrated type arises from this beating, with the absence of modulation. The extra advantages of having modulated-unmodulated service may not be important or extensive, yet it is just as well to have these advantages so long as they require nothing more than the introduction of a switch.

The neon tube audio oscillator is in some respects a mysterious device as yet, in the sense that its various aspects have not been fully explored, or, if explored, remain unreported. Certain it is that the audio tone is easily produced, if the limiting resistor is high enough, the condenser across the lamp not too high, and the supply voltage is sufficiently high and not too high.

Change of Pitch

The amplitude of the oscillation voltage is generally taken as the difference between the striking and the extinguishing voltages of the lamp. This is no doubt true for a given set of constants. But if the condenser across the lamp is variable, while the frequency of audio oscillation changes throughout the range of audibility, and beyond, so does the amplitude change, for as the capacity across the lamp is increased the more oscillation voltage passes through the condenser, until when the capacity is high enough the lamp goes out. Therefore the oscillation voltage is to be taken as part of the supply voltage. Thus, since the higher the capacity the lower the frequency, and the higher the capacity the greater the bypassing, the lower the frequency the lower the intensity of the oscillation. This is the audio oscillation only. The low-frequency audio end is limited in this sense, though it easily reaches below the lowest audible pitch in external examples.

Since capacity will change the frequency, as stated, and since the neon lamp must be coupled to a regular radio tube that is used as r-f oscillator, the r-f oscillator's tuning condenser is bound to have some effect on the frequency of the modulation tone. In general, the tuning condenser is effectively in parallel with the neon tube, to a greatly reduced capacity extent however, due to the very high value of series limiting resistor, 8 meg. The resistor purposely was put between grid of the r-f oscillator and one side of the neon lamp so that the condenser across the lamp, as far as practical, would be removed from the tuning condenser.

Nevertheless, as stated, there is a change in the pitch of the audio tone used as modulation, depending on the radio frequency generated. At lower frequencies, for example, the intensity seems to be lower, while at higher frequencies the tone is undeniably higher in frequency and may be higher in intensity, likewise. The bare test of using a single channel in a receiver for reception, and putting the modulated r-f oscillation into the set through the shielded cable, and then tuning the oscillator, is by no means a conclusive test as to the audio intensity, though there is a change, since the audio is now part of the r-f intensity, and the higher the frequency of the oscillator, the lower harmonic order used for establishing the radio frequency to which the receiver responds. The increased intensity at higher r-f oscillator frequencies is due to the lower order of harmonics beating with the station.

A Real Improvement

The change in the frequency of audio modulation therefore should be regarded as inevitable, and no importance need be attached to it, as any audio frequency that does the trick is suitable. But this change in tone should not be considered as an aspect of instability of the radio-frequency oscillator, which is most stable, no more than a studio pianist running through the scale affects in any way the frequency stability of your oscillator that may be beating with the carrier of the station emitting his program.

The inclusion of the neon tube oscillator is not just a stunt of some kind, or a novelty without any real value, but actually improves the performance mightily for the following reasons:

First: The necessity for a high value of grid leak is avoided, and therefore the oscillator gives just as sharply selective response at the high frequencies of r-f tuning as at the low frequencies.

Second: The modulation is constant for any setting of the tuning condenser, that is, for any radio frequency generated, or harmonic of such radio frequency, whereas a

(Continued on next page)

(Continued from preceding page)

high grid leak produces a tone that is constantly wobbling as to both frequency and amplitude and makes it impossible to get an accurate reading from an output meter.

No Over-Modulation

All systems of using a single tube as combination audio-oscillator and radio-frequency oscillator, which condition obtains when grid blocking is used, produce over-modulation the moment the modulation is sufficient to give satisfactory aural response. Thus there is a change of radio-frequency generation due to the audio-frequency introduction, and a frequency-calibrated scale that holds for a-c use, for instance, will not hold closely for d-c or battery use. It is far preferable of course to have a system that, when change is made from one form of power to another, yields the same frequency. This is possible only when modulation does not produce distortion. So it is clear that more than 100 per cent. modulation, as produced by the grid-blocking method, is a form of distortion, and as such, changes the carrier frequency.

And there is another consideration. With the grid-blocking type of modulation omitted it is practical to obtain zero beats at any and all settings. Previously it was stated that the necessarily high leak value to produce blocking reduces the selectivity at the high-frequency end of the tuning, say, in the present example, from 200 to 380 kc, and harmonics of that range. The equivalent parallel resistance of this series leak is so low that a highly-damped generator results, and it becomes impossible to produce zero beats. But with the almost perfect type separate audio oscillator, such as the neon tube, there are zero beats at all settings, on d.c. or batteries, and of course zero beats on a.c. as well, when the neon tube's effect as a modulator is masked by the greater intensity of the hum modulation.

What Zero Beats Are

Zero beats consist of beats with carriers where the test oscillator's frequency is so close to that of the carrier that no audible note results, save possibly that of the modulation present in the test oscillator, and even this is practically wiped out. Naturally the beats scarcely ever are encountered in lining up of intermediate channels of the commercial frequency range, but on the broadcast band these beats abound, and are very valuable for nice testing of the oscillator for accuracy, as just the point represented by the station's frequency may be referred to the oscillator harmonic being used. Thus the fourth harmonics of the test oscillator beat throughout the broadcast band, being read on the broadcast tier of the dial directly, and without giving any thought to what harmonic order is represented. All one need know is the frequency of the transmitting station. Suppose it is 860 kc. Then at 860 on the dial scale the beat is reduced to zero and the percentage of reading accuracy in the test oscillator is gauged. Suppose, again, the station is transmitting on 860 kc and the test oscillator reads 880 kc on the broadcast part of the scale. This is a difference of 20 kc out of 860 or one part in 43. The accuracy is 100/43 or about 2.33 per cent. This would not do at all, and is cited merely as an example. The reading accuracy of the test oscillator should be better than 1 per cent.

Frequency Stability

An entirely separate consideration, though often confused with the reading accuracy which has to do with physical limitations, is the electrical accuracy or frequency stability. The test oscillator diagramed had a stability of one part in 100,000, which means that the frequency generated does not wobble or shift more than one cycle in 100,000 cycles. This is very valuable for zero beating, and also in general is a great asset in the direction of higher-grade test oscillator performance. The frequency generated will not be one thing one day and something else the next.

The scale should be metal, as all the celluloid and such compound scale discs, in fact, all flexible ones used, may warp, even at one end of the scale and not at the other, thus rendering the scale of uncertain value, in fact, of little value in the affected region. While it is true that warpage may not be present, the point is made that there is always danger of it, and metal is far preferable, though it requires an etched scale.

Some Tests

Some tests may be stated in conclusion. The first test is of the reading accuracy, already discussed. Another test is of the change in frequency due to shifting from one power source to another. Suppose the test oscillator is operated on a.c. and a zero beat is established with a station. Now the test oscillator is to be operated on d.c. and is switched over externally. If zero beating on d.c. could not be produced the present test could not be made, but the zero beat is infallible, as already assured, and therefore when the switchover is made, the same zero beat is present, which completely confirms the assertion that there is no change in frequency when the power source is changed.

Compare this with the case of grid blocking, where the leak is necessarily high. Suppose a low value of leak is connected in parallel with the other to omit the modulation. Now there would be zero-beat possibility, in fact, virtual assurance of it. But note the generated radio frequency for a given setting with modulation and the identical setting without modulation. There has been a serious shift, usually around 5 per cent., which is intolerable.

With the line blocked we may use an attenuator, and we may test the attenuator by turning the knob while watching an output meter that is connected to the set, or while listening to the result through the set's speaker. A program will be on the air. The test oscillator's attenuator may be turned until no oscillation is heard at all, though at first there was a beat or modulation heard mixed with the program. Now the program alone is heard, proving there is no stray radiation or pickup, no feeding through the line, and that the attenuator works perfectly.

A word of caution: some neon tubes, particularly those of the candelbra type without built-in resistor, light on d.c. only when connected one way. If no audio oscillation results, or no light, reverse the connections to the lamp, as only d.c. is fed to it when the lamp is of service. And moreover the lamp will light only faintly under any and all conditions of production of audio oscillation, hence can't be used as pilot lamp.

ALL-WAVE O

WITH DATA O FULL DIREC CALIBRATIONS,

By Edward

The author with one of his all-wave oscillators.

WITH the increasing popularity of broadcast-short-wave receivers, it becomes advisable to possess a test oscillator that generates all desired frequencies fundamentally. For intermediate and broadcast frequencies an harmonic type oscillator is very satisfactory, but when one desires to know frequency values on short waves, the harmonics become too numerous, and confusion results.

The circuit is shown in Fig. 1 for a plain oscillator, without modulation, but if modulation is desired, using only the single tube, the grid blocking method may be used. This requires that the leak value be increased until a tone is heard at all points on the dial. Check up to be sure the tone does not disappear; increase the leak value if it does.

This is the easiest way to do the job with a single tube, but none of the single-tube methods is quite as satisfactory for modulation as the separate-tube circuit, unless a-c is on the plate.

Transformer in Oscillation

The battery oscillator of course is useful anywhere, the a-c model only where there is line a-c of the frequency intended, say, 60 cycles. For those who do not require

Winding Data for Oscillator Solenoids

Inductance in Microhenries	*Number of Close Turns on 1" Diameter*
90.0	60 turns No. 32 enamel
14.4	21 turns No. 28 enamel
2.3	8.9 turns No. 18 enamel
0.37	3.0 turns No. 16 enamel

The coils are 1/16 inches apart in all instances, honeycombs and solenoids.

SCILLATORS

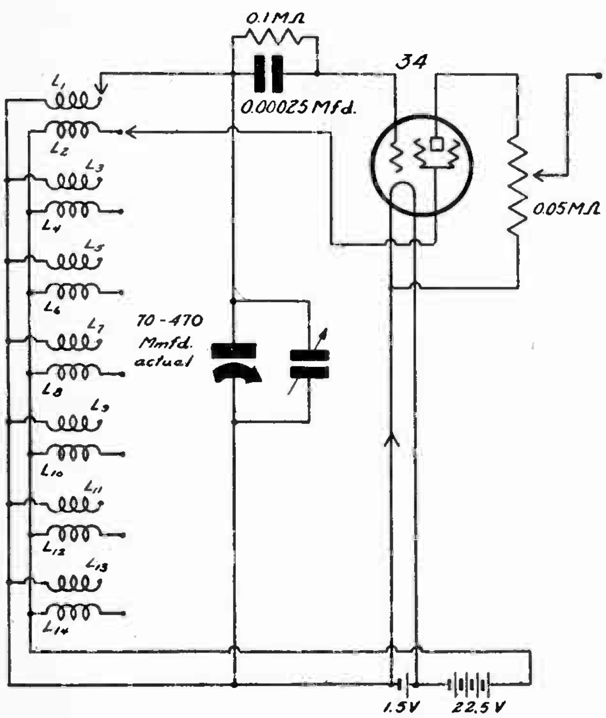
N COILS AND TIONS FOR ;0 TO 22,000 kc.

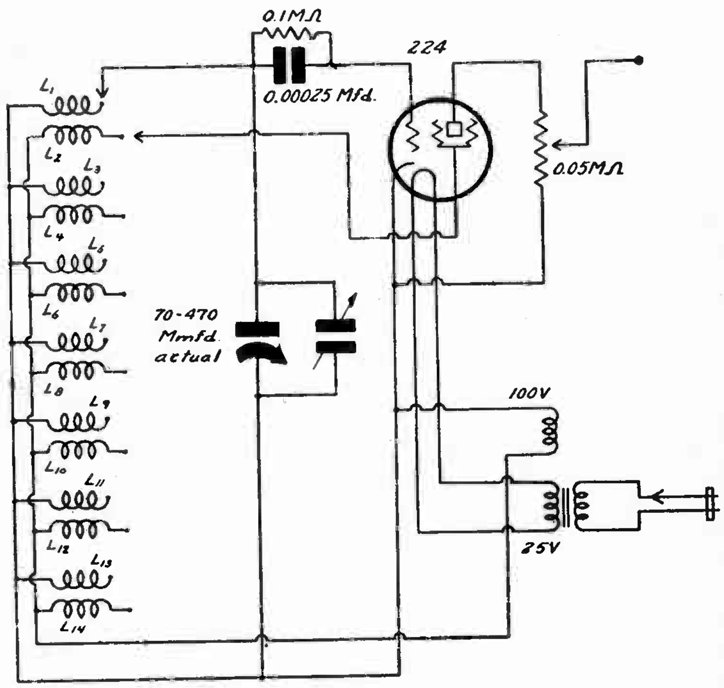
M. Shiepe

cause the condenser alone is 406 **mmfd.** The capacity ratio is 6.71 and the frequency ratio nearly 2.6, but for overlap purposes the ratio of frequency was taken as 2.5. This overlap exists though not noted in the following table. The 2.5 frequency ratio is equivalent to a capacity ratio of 6.25, of particular importance because once the inductance value is found for the lowest frequency, the condenser being the same for the rest of the bands, the succeeding inductances are smaller by the amount of the capacity ratio. Hence, for the lowest band, 50 to 125 kc, the inductance is 22,000 microhenries, and for the next band it is 22,000/6.25 or 3,521 microhenries.

Honeycomb Used

The three largest coils had better be honeycombs, of which the largest is a little





service from the oscillator except where there is a-c. the diagram for such a circuit is shown in Fig. 2. It must be understood that modulation always is present in the a-c model, also always in the battery model if grid blocking is used, although a battery model with separate audio oscillator will permit modulated-unmodulated service. The audio oscillation could be fed into the normal plate of the 34 tube of the battery model through a 100,000-ohm resistor connected to grid of the modulator, or to arm of a potentiometer, if there is to be attenuation of a-f., total potentiometer resistance across the grid circuit.

Any small audio transformer may be used for audio modulation, sometimes clearer results obtaining if the intended primary is used instead as secondary. It is nearly always advisable to put a small condenser across the winding used in the grid circuit, say, around 0.002 mfd. While this lowers the frequency a bit, it gives the note more definite character and also prevents the tuning condenser of the r-f oscillator from changing even slightly the pitch of the audio note as the r-f condenser is rotated through its total angular displacement.

The question of frequency-range selection must arise as an early consideration. Since there is to be switching anyway, it is just as well to include seven coils and cover from 50 kc to around 22,000 kc, or, in meters, from around 6,000 to around 14 meters.

Large Tickler

Two windings will be necessary for each coil, but differential between secondary and primary need not be struck, since a large tickler, equal to the tuned winding, has a tendency to reduce the oscillator at the higher frequencies of any band, therefore the windings may be taken as equal. The oscillator itself tends to generate stronger oscillation at the higher frequencies, so any method, even a mild one such as the larger tickler, works in the general direction of leveling the amplitude.

The tuning capacity ought to be reduced for fine distinctions at high frequencies, but this is not done, because very close frequency readings for the very high frequencies are not necessary for servicing, though advisable for sets, especially those to be tuned by persons not experienced in radio. Using the same capacity ratio throughout simplifies matters.

That capacity ratio is a little smaller than normal for an equivalent maximum-capacity condenser, the reason being the introduction of a high minimum, so that there will be no doubt that the correct value is obtainable. Moreover, the high minimum acts as a sort of check of wobbulation, because there is more capacity in circuit, and at the still higher capacity settings, of the tuning condenser, say, from the middle of the dial up (in capacity), the frequency stability is very good, characteristic of all grid-leak-condenser type oscillators with constants appropriately selected.

Overlap Provided

Here the total minimum is 70 mmfd., meaning that when the condenser is at zero on the dial, that is the total capacity in circuit. It includes the condenser's own minimum, the value of the trimmer, Ct, the capacity of the wiring, socket, tube, etc. Ct should be a small air-dielectric condenser, commercial rating 50 mmfd. or a bit more, as the extra amount will be contributed by the other capacity factors mentioned.

The maximum capacity is 470 mmfd., because

less than 1,000 turns of No. 36 single silk wire on a ⅜-inch diameter, and as such coils are obtainable cheaply in the market, the three honeycombs may be adjusted to proper values by removing turns. Then the ticklers are made approximately the same as the secondaries, with the single proviso that if oscillation is absent at the highest frequencies of any band, a few more turns taken *off* the tickler will cure the trouble. The turns should be removed in this special instance, not added, though addition is the usual practice for inducing oscillation where the tickler originally is small.

The following table gives the relationship of inductance and frequency range to the capacity specified:

Coils	*Microhenries*	*Kilocycles*
L1, L2	22,000	50-125
L3, L4	3,521	125-312.5
L5, L6	563	312.5-781.25
L7, L8	90	781.25-1,758.1
L9, L10	14.4	1,758.8-4,937
L11, L12	2.3	4,937-9,893
L13, L14	0.37	9,893-22,259

The odd frequency terminations are to be disregarded in actual practice.

In the three low-frequency bands honeycombs are used, while the four other inductance values are obtained from solenoid windings.

Inductance Test

The Trade Editor of RADIO WORLD can give information about the honeycomb coils.

The 50 kc setting is practically the extreme, and the test for the right inductance is made as follows:

Two honeycomb coils are made into a

(*Continued on next page*)

(*Continued from preceding page*)
transformer with windings as received. The actual number of turns may be 927, and as it will be a bit too much, an oscillator as built is coupled to a broadcast set's antenna input, slightly as by a few turns put around the antenna wire near the set, other end of wire to output of oscillator. A station is tuned in that has a frequency that is a multiple of 50 kc and another station 50 kc removed must be receivable by tuning the set to the other dial position. The frequency is 50 kc when zero beat with a station on a frequency multiple of 50 is repeated when the receiver dial is turned to the other station 50 kc removed in either direction, test oscillator unmolested.

Harmonic Identification

The harmonics have to be identified for calibration, but that will come later. The coil that registers 50 kc near the extreme end of the oscillator dial, practically full capacity used, is the right one. Then the oscillator is turned to minimum capacity and the trimmer is adjusted so that a beat is struck with the receiver tuned to your set, since what we desire is some multiple of 125, 750 kc. The receiver will not tune to 525 kc, but will tune to 775 kc, but there is no station on 775 kc, so we shall not be confused by an harmonic if we select 750 kc, or very close to it, then turn the receiver to 1,250 kc for check-up, as a beat should result when the oscillator is left at 125 (tenth harmonic). This beat, in fact, will be heard in the set at 1,500 kc, 1,250 kc, 1,000 kc and 750 kc. This is simply a check-up, remember, the receiver being tuned when the oscillator is unmolested at 125 kc.

Solenoids Next

As the fundamental frequencies become higher the selection becomes easier, at least for a while, especially if one takes the pains to build one oscillator for the low-frequency determination (first coil) and then builds another so that turns from next coils may be removed until the point where the highest frequency of the first oscillator is struck at minimum capacity and the lowest frequency of the other at almost maximum capacity.

In this way we progress to the solenoids, and these may be wound according to the suggestion given elsewhere.

Always the succeeding inductance may be selected on the basis of putting the next higher inductance (lower-frequency coil) in one oscillator while the smaller coil is in the other, except of course that for solenoids, where one is to calibrate the oscillator himself, the turns values may be followed as tabulated, which are for inductances that are themselves not shielded, though the total oscillator may be in a metal compartment. It has been found that such an enclosure of the total oscillator has the effect of increasing the capacity a bit, which may be compensated by using slightly less trimmer capacity. But the inductance should not change enough to require such check-up of inductance for solenoids as for the honeycombs.

Calibration Begun

Once the ranges are checked, and the presence of oscillation thus verified, or if there is no oscillation it is established either by reversing connections to tickler or to grid coil, the next step is calibration.

We started with 50 kc. If it is possible to pick up traffic on the 600-meter channel on the broadcast receiver, which is unlikely, as the frequency is 500 kc, then the beat established may be used for 50 kc, since it has been already verified as to dial position, and only the test oscillator need be variably tuned, the receiver remaining fixed at 500 kc.

So the frequencies will be those fundamentals of the oscillator that beat with 500 kc. By dividing 500 by 10, 9, 8, 7, 6, 5, and 4 for this range, we obtain the frequencies. These are 50, 55.55, 62.5, 71.43, 83.33, 100 and 125 kc. We established the tenth harmonic of 50 kc and so we know that lower order harmonics of higher oscillator fundamentals will establish the succeeding frequencies. If we like we need not plot, but should keep a record of the odd frequencies and use 50, 62.5, 100 and 125 kc. We have also reverified the extreme frequency of 125 kc.

Since we now have our bearings we may turn the receiver to some other low frequency, say, 600 kc.

Other Points

Now we can tell where that came in, by referring to the recorded point for 62.5, for 60 kc is just a bit removed, in the direction of more condenser capacity. Hence we have the tenth harmonic of 60 and require the harmonics of other fundamentals that will beat with 60. They are 60/9, 60/8, etc., up to 600/12 and the fundamentals of the test oscillator thus obtained, by leaving the receiver at 600 kc and tuning the oscillator to frequencies from 60 kc up are 60, 66.67, 75, 85.71, 100 and 120 kc.

Having now sufficient frequencies to plot a tentative curve, we get as large a sheet of plotting paper as practical or desired, and mark frequencies as one variable and dial settings as the other, one on the horizontal the other on the upright plane, and with 50, 60, 62.5, 75, 100, 120 and 125 kc as frequencies, record the points. The result will be close enough for us to identify stations on their tenth harmonics as far as we can, that is, tuning the receiver from 500 kc (if it goes that low) to 1,250 kc. In that way we obtain an all-sufficient number of points, reshape the penciled curve according to all the points registered, and draw in the curve in ink. Cellophane envelopes are obtainable in stationery stores for containing the curves so they will not become soiled.

The next band is somewhat easier because harmonics are fewer. Take 125 kc as the lower limit. Select a station at or near 600 kc or a bit higher in frequency on the receiver. There should be a beat near the maximum capacity of the condenser. It is the fourth harmonic of 125 kc beating with 600 kc, or the fifth harmonic of 126 kc beating with 630 kc.

Curve Shape Known

We may then leave the test oscillator at 125, let us say, and get the other points by tuning the oscillator to higher frequencies which are 600/4, 600/3 and 600/2, or 125, 200 and 300 kc. From even this much a tentative curve may be drawn and other low-frequency stations used, generally the lower the frequency used in the receiver the better.

Already the general shape of the tuning curve has been determined, and for the next band, stations in the broadcast realm beat with fundamentals of some of the oscillator frequencies, enough for a curve from, say 540 to 780 kc, while for the lower frequencies of the test oscillator for this range, second harmonics of the oscillator may be compared to broadcast fundamentals, i.e., 312.5 from the oscillator beats its second harmonic at a 5,000-cycle note with 630 and 620 kc in the broadcast band, and 390 kc in the oscillator beats its second harmonic with 780 kc in the broadcast band. Such stations in the broadcast band as are receivable and identifiable may be used.

From 780 to 1,500 kc the fundamentals of the test oscillator may be checked for the next band, which, however, goes above 1,750 kc, so now we no longer have test oscillator frequencies equal to or lower than broadcast frequencies, but instead always the test oscillator's fundamentals are higher, and the question arises, can we work the harmonic system backwards?

Working It Backwards

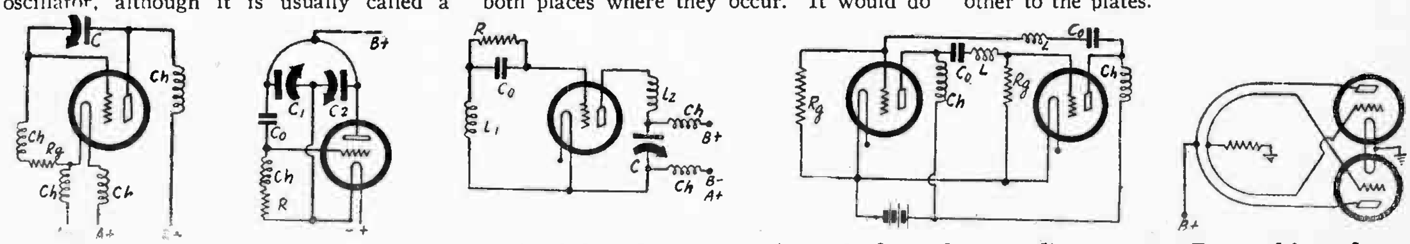
That is, while we were able to hear harmonics of the test oscillator beat with broadcast station fundamentals, can we beat fundamentals of the test oscillator with the higher frequencies than those to which the receiver tunes? If so, where are these frequencies and how do they come through?

This can be done, provided earphones are

(*Continued on next page*)

Five Short-Wave Oscillators

There are five short-wave circuits reproduced on this page, all having especially been designed for ultra-high frequencies. The first on the left is the well-known and dependable ultraudion. The tuned circuit consists of the capacity C, the grid to plate capacity, and the leads connecting the variable condenser to the grid and the plate. To get short waves the variable condenser should be made as small as possible and the leads to it also as short as possible. The second circuit is a tuned grid, tuned plate oscillator, although it is usually called a balanced Colpitts. It becomes a Colpitts if a high inductance choke is put in series with the B supply. The coil consists of a single loop of wire as small as practicable. The third circuit is a modification of the Hartley although it is much more complex than the ordinary Hartley. The coils L1 and L2 should be as small as possible, for example, only straight wires, and the condenser C should also be small. The fourth circuit is supposed to be capable of generating extremely short waves if L and C are small in both places where they occur. It would do so if the addition of the extra tube did not introduce two additional capacities, not shown in the circuit, and if these capacities were not effective in lowering the frequency. Nevertheless, it is one of the circuits used for generating short waves. The last circuit is a push-pull oscillator which is exceptionally easy to build but there is no ready means of varying the frequency generated. The inductance consists of two loops, or half loops, of wire placed side by side. One is connected to the grids, the other to the plates.



Five oscillating circuits especially devised for the generation of ultra-short radio waves. By making the inductance and capacity in any of these circuits as small as possible, it is possible to reach as short waves as five meters, or less

Combination Brute Force and Tuned Filters

By Morris N. Beitman
Engineer, Supreme Sound Systems

FIG. 1
Two sections of a brute-force filter ordinarily used for filtering out the 120-cycle ripple in a full-wave plate supply.

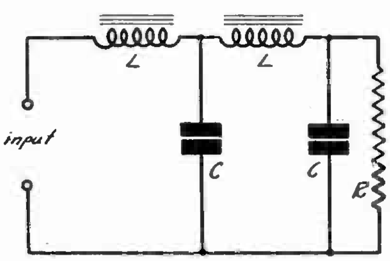


FIG. 2 (extreme right)
A combination filter consisting on one brute-force section and one tuned section. This improves filtering at less expense.

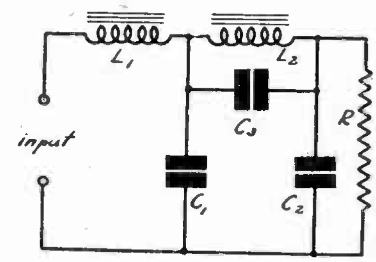
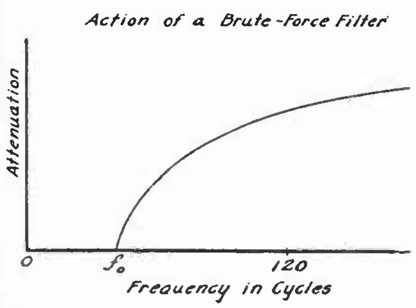


FIG. 3
The attenuation characteristic of a brute force filter. The filtering is proportional to the height of the curve at the frequency of the ripple.



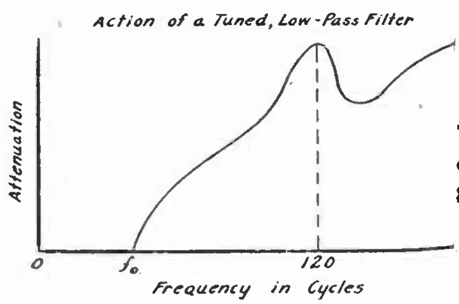


FIG. 4
The attenuation characteristic of the combination filter in Fig. 2 showing greatly increased attenuation at the ripple frequency.

THE usual two stage choke-condenser combination filter (Fig. 1) is of the type known as the brute-force, or low-pass untuned filter. Its impedance increases with the increase of frequency and is so designed that its attenuation at 120 cycles is sufficient to reduce the A.C. ripple to a tolerable figure. With the advent of power amplifiers the current drain has greatly increased, or what corresponds to the very same thing, the load resistance R has decreased. The filtering action of one section of choke-condenser filter in a full-wave 60 cycle power supply is expressed by the formula:

$$\text{Voltage fluctuation} = \frac{1}{1 + \dfrac{753.6\ L\ (1+753.6\ CR)}{R}}$$

It is evident from the above relation that the filtering action decreases almost directly with the decrease of the load resistance. In such cases it becomes necessary to increase the total capacity and construct chokes to carry the additional current. This procedure, however, would drastically increase the cost of the filter; for although condensers of twice the previous capacity may be obtained for a little less than twice the cost, the cost of making a choke coil of the same D.C. resistance, inductance, but twice the current carrying ability is almost prohibitive.

In a full-wave filter from the practical point of view the entire ripple may be considered of 120 cycle nature. A tuned filter (band pass) may be constructed to filter this hum at a much lower cost. A filter of the tuned type offers its peak attenuation to a given frequency (120 cycles in this case) and loses its filtering action as the frequency increases or decreases from this given frequency. But since all other frequencies are negligent in comparison with the main ripple frequency such an arrangement is entirely satisfactory.

Another objection often raised in regards to the tuned filter is that it must be designed for a particular load resistance and since the load resistance of a radio set or power amplifier varies somewhat it fails to accomplish its objective. The variation in a modern set, using class "A" power output, is trivial in comparison to the total current drain. For example in an eight-tube superheterodyne with 2A5 output tubes and AVC, the greatest percentage variation of the load resistance is approximately 10%, and this occurs only with no signal input or when tuning between stations.

To overcome these objections of non-filtering of side frequencies and harmonics and variation of the load resistance, and at the same time to reduce the cost of the filter a combination tuned and brute-force filter is used. One such combination is to have one section of the brute-force type and the other tuned. This method is illustrated in Fig. 2. It makes but little difference which filter is placed next to the rectifier. The design of these filters will be next considered.

A brute force filter has a continuously rising curve of impedance as the frequency increases. To obtain good filtering with this type filter it is desirable to choose f_o, the frequency at which attenuation begins, as low as possible without making the choke

(Continued on next page)

Calibration of Short Waves

(Continued from preceding page)

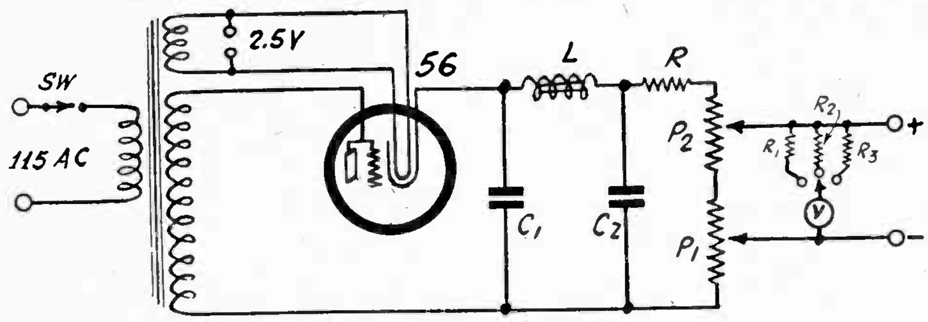
used in the set. If the receiver has a strictly linear detector the intensities are exasperatingly low or the harmonics absent, but otherwise there is sufficient harmonic content in the detector output to yield a recognizable beat between the fundamental frequency of the test oscillator and an harmonic of the station frequency in the set. A station is being received in the set, of course.

Let us take an example. We desire some information about the region between 1,750 and 1,500 kc. If we tune the receiver to 750 kc we can verify the 1,500 kc position already obtained, because the second harmonic of 750 kc is in the receiver, too, though weakly, and the frequency of that harmonic is 1,500 kc. At 760 kc in the receiver we can account for 1,520 kc, at 770 for 1,540 kc, and so on until 870 kc, which yields a second harmonic of 1,740 kc, and the same system is followed until the last coil is calibrated. For satisfactory results, however, it is imperative that the receiver be of the tuner-radio-frequency type, as superheterodynes are too replete with harmonics and offer other complications. Even experts are baffled when trying to use a super for this purpose, and the author himself has had his troubles.

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6 without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.



The 56 used as a rectifier of the line voltage.

The 56 as Line A-C Rectifier

I THOUGHT THAT the recommendation for use of the 56 as a diode was that the plate should be tied to cathode, but in a converter diagram you printed last week you show the grid tied to the plate to form the anode and leave the cathode as you find it. Which is correct?—O. L.

The 56 when used as a diode detector in a receiver preferably should have the plate tied to the cathode, and this is the tube manufacturers' recommendation, also. But when the 56 is used as a rectifier of the line voltage, even for the small current drain intended, it is preferable by far to interconnect plate and grid, so that the grid is not used alone as anode, as it has not much area, and the demands on it are considerably greater than the other practice would justify. Thus the diagram given on this page would be followed for rectifying the line voltage. The d-c voltage measurements may be taken as shown. L may be a choke of 15 henries, C1 and C2 may be 4 mfd., R is a limiting resistor, and the sum of P1 and P2 should be 20,000 ohms. R would be included only if the resultant voltage, of around 120 volts d-c output, exceeds the meter range. The value of R would depend on what reduction of voltage is necessary.

Short-Wave Antenna Tuning

MAY A SINGLE WINDING be used for antenna purposes in a receiver intended to cover several bands of short waves, and if so what would be the diagram for a three-tube set, where the detector is of course regenerative and there are two stages of transformer-coupled audio amplification, battery-operated?—J. Q. W.

A single winding may be used, but, like most other methods that seek utter convenience, it is not the best. Each primary should be selected for the band to be worked. Also, it is preferable to have the series condenser changed, band for band, or use a variable condenser of 50 mmfd. in this position, and adjust it as required. Often stations that don't come in well or at all are brought up to satisfactory volume by the antenna condenser adjustment. Another factor is that the antenna capacity is made small in its effect on the tuned circuit, as 6 to 50 mmfd. are in series with, say, 200 mmfd. antenna capacity. The switching arrangement shown may be used, or plug-in coils. The series antenna condenser, if variable, eliminates dead spots, "tuning out the dead spots" as required, and moreover enables secondary adjustment of regeneration, as the less capacity used in this position, the lower the losses in the tuned circuit and the readier the regeneration. After all, there will be regeneration only when the feedback voltage is greater than the equivalent voltage condition represented by circuit losses. That is what is also expressed as negative, resistance required before oscillation obtains. The leak should be as high as practical, but if 5 meg. produces a tone, it should be reduced until the tone disappears. Only at the higher frequencies would the tone be heard, so listen for it.

* * *

Resistance's Effect on Frequency

I WAS VERY MUCH interested in your reply to a question about straight-frequency-line condensers, published in Radio University last week, especially as I have been doing some experimental work along

TWO TYPES OF FILTERS

(*Continued from preceding page*)

and condenser of size beyond economic consideration.

The size of C and L is determined from the equations:

$$C_1 = \frac{.318}{f_o R} \text{ farads}$$

$$L_1 = \frac{.318 R}{f_o} \text{ henries}$$

Where f_o may be considered as high as 50 cycles with good results. From these formulas the values for L_1 and C_o may be computed. (Fig. 2).

Somewhat different formulas have been computed to be used on a tuned type filter.

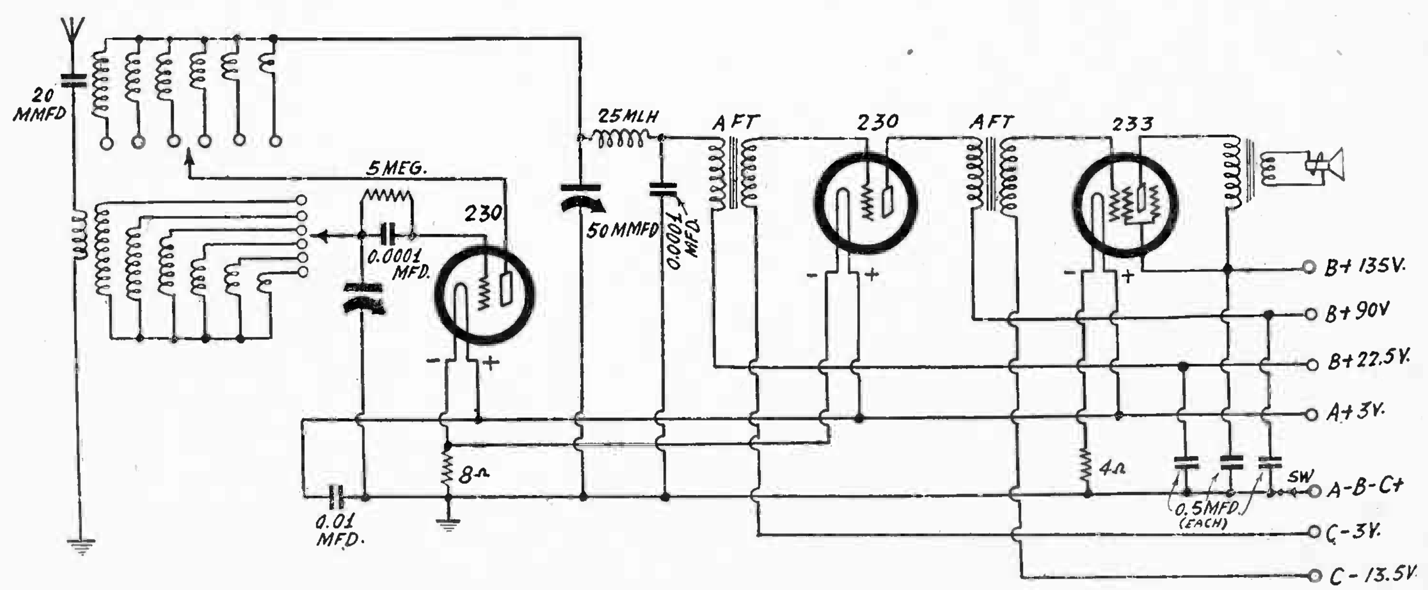
$$C_s = \frac{.000655 f_o}{R \sqrt{14400 - f_o^2}}$$

$$C_2 = \frac{.000655 \sqrt{14400 - f_o^2}}{R f_o}$$

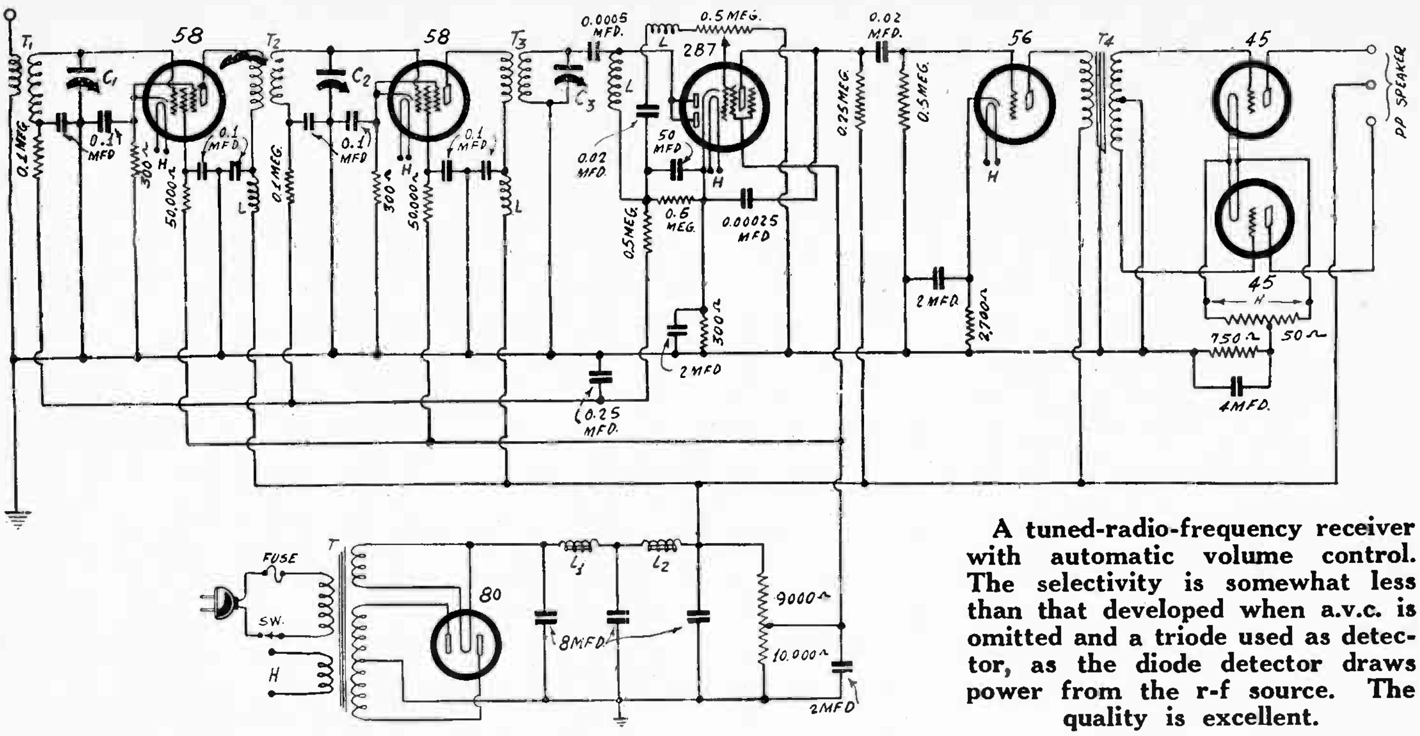
$$L^2 = \frac{.000655 R \sqrt{14400 - f_o^2}}{f_o}$$

The values for different parts of Fig. 2, may be found from the above. Here again f_o should be chosen as small as possible. In the combination filter, f_o should be taken the same in all formulas.

To summarize, a combination of brute-force and tuned filters is used to reduce the size of the parts and thereby effect an economy, while functioning satisfactorily in reducing side frequencies and overcoming variations in the load resistance, not possible with a tuned filter alone.



A three-tube battery-operated receiver. This represents a compromise in the aerial circuit. Better results will be obtained if the antenna series condenser is made variable, and a separate primary is used for each band.



A tuned-radio-frequency receiver with automatic volume control. The selectivity is somewhat less than that developed when a.v.c. is omitted and a triode used as detector, as the diode detector draws power from the r-f source. The quality is excellent.

this line, just as a hobby. I have come to the conclusion that a straight-frequency-line condenser is not practical for all circuits, but had better be adapted to a single circuit, as there are other factors than capacity and even inductance that concern frequency. So far we have looked to inductance and capacity, and all formulas consider them, but I know experimentally that the formulas are correct only for negligible resistance. When the resistance becomes large, including the resistance of a grid leak, by the way, the tuning is changed. Also grid current conditions affect frequency, as you have pointed out in another connection. But this, again, is merely a resistance condition. For straight work in t-r-f systems perhaps the condenser would be generally useful if made strictly to a straight-frequency-line requirement, but the moment regeneration, oscillation, grid leaks, plate resistors and the like figure in the equation, one must pay deep regard to the effect of resistance on frequency, to my mind a sadly neglected subject. Has not your experience confirmed my findings?—L. S. Q.

Yes, our experience conforms with yours. But we do not deem the problem insoluble, neither do you, for you suggest indirectly what may be done. The t-r-f sections will track well, as there are no resistances of an extraordinary nature or high value, nor is there grid current (assuming proper circuit design), nor oscillation nor regeneration. In any oscillator circuit, or regenerative detector, it matters not which, exactly the conditions that you describe do exist, the curve is S-shaped (tuning characteristic) and for straight-frequency line tuning the plates of the oscillator or regeneration regenerative detector section would have to be cut especially, to take the kinks out of the curve. This would be done on the basis of following the tuning curve as already established in t-r-f, even for sets of the t-r-f types with regenerative detectors. Obviously the subject requires much study and more experimental work should be done. Recently the subject of the effect of resistance on frequency has come up for discussion in learned periodicals. The general effect is to reduce the frequency, hence the equivalent of increase of capacity. This is confirmed by the reduction of frequency tuning ratio, resistor included, compared to resistor excluded. Thank you for inviting a few words on this interesting subject.

* * *

A.V.C. in T-R-F Receiver

PLEASE DISCUSS the practicality and effect of automatic volume control in a tuned-radio-frequency receiver. How is the last coil coupled to the detector? Will not 45 push-pull, driven by a 56 or some similar tube, give excellent quality?—K. R. S.

It should be recognized that the tuned-radio-frequency receiver does not come up to the selectivity of the superheterodyne, and therefore if extraordinary selectivity is not required, the t-r-f receiver will be completely satisfactory. The quality is excellent, especially on the basis you outline, with a diode detector of course, a 56 driver and the 45 push-pull output. The receiver that you have in mind would be like the one shown in the diagram, and the coupling between last coil and detector would be through a choke and stopping condenser. If the choke is of very high inductance no account need be paid to its effect on the secondary of the transformer with which it is associated. This choke, L, should be of 20 millihenries or greater inductance. The method of introducing automatic volume control is standard.

* * *

Push-Pull Circuit

WILL YOU PLEASE SHOW a push-pull radio-frequency amplifier circuit, using the 30 tubes, and a 30 type detector, for battery operation?—I. L. S.

The capacity of the tuning condenser in the diagram herewith suggests broadcast frequencies. The push-pull input is tuned with two sections of a three-gang condenser, while the input to the detector represents the other gang in service. Note that no tap is needed on the input coil to the first two tubes, but that the output coil, primary of interstage transformer, is tapped at center. The input may be taken from another primary, untapped, inductively related to L.

* * *

Glow Discharge Oscillator

SUPPOSE a glow discharge oscillator is constructed with a neon tube, how high frequencies can be obtained and on what does the frequency of oscillation depend? What conditions are necessary to insure oscillation?—W. N. B.

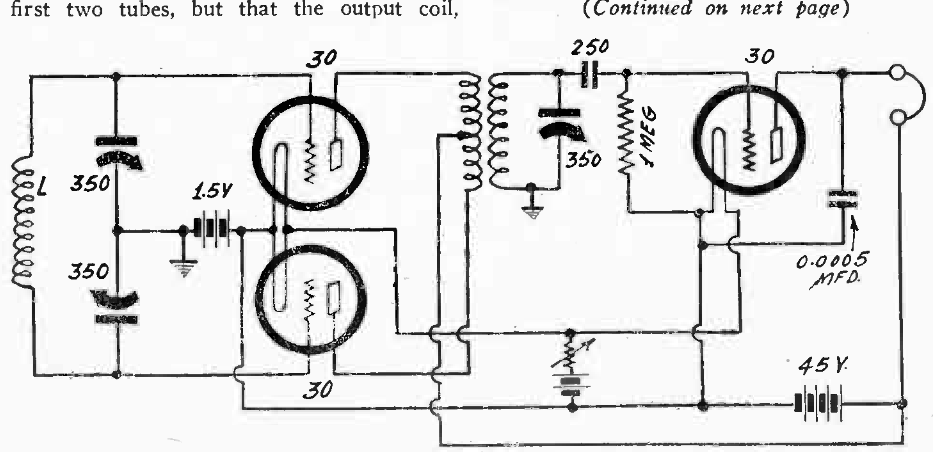
To a first approximation, the frequency is determined by 1/RC, where R is the resistance through which the condenser C is charged. However, the frequency also depends on the voltage in series with this resistance, the voltage at which the neon tube begins to glow, the voltage at which it ceases to glow and on the resistance of the neon tube while it is discharging. The complete expression for the frequency is very complex and is not accurately known, mainly because the resistance of the discharge tube during discharge is not known. The maximum frequency obtainable depends on the value of the charging resistance, the voltages, and on the value of the capacity. Frequencies as high as 100,000 cycles per second have been obtained.

* * *

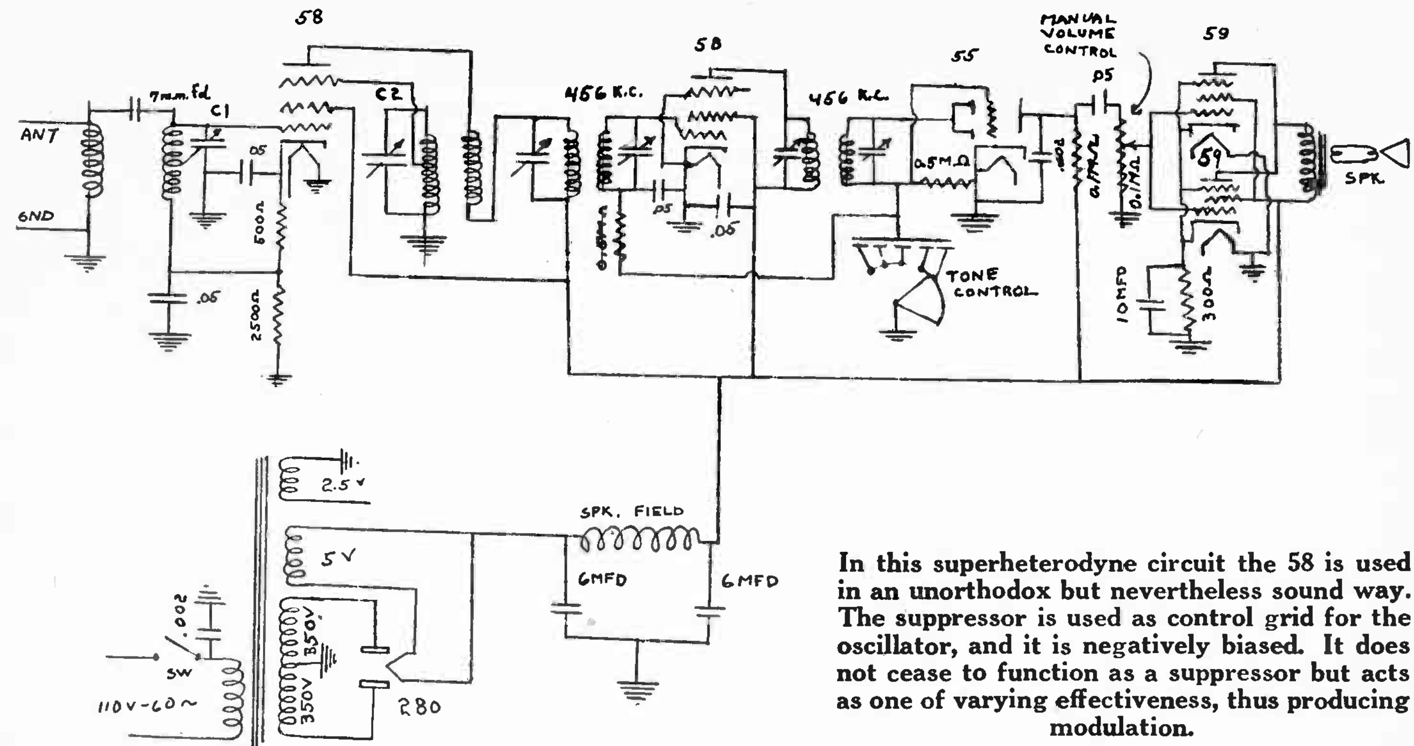
Push-pull Condenser Microphone

IS IT POSSIBLE to hook up a condenser microphone so that half the voltage generated is impressed on one tube of a push-pull amplifier and the other half on

(*Continued on next page*)



A push-pull radio-frequency amplifier feeding a detector for earphone service.



In this superheterodyne circuit the 58 is used in an unorthodox but nevertheless sound way. The suppressor is used as control grid for the oscillator, and it is negatively biased. It does not cease to function as a suppressor but acts as one of varying effectiveness, thus producing modulation.

(*Continued from preceding page*)
the other tube and have the phases right?—T. L. D.

Sure, if the resistance used as load on the microphone is divided into two equal parts and the middle point is connected to the cathodes of the tube, the conditions are right. It is only necessary to arrange the condenser polarizing battery so that it will not ground either grid to the signal. That is simple if a separate battery is used for the microphone.

* * *

Potential and Voltage

SOMETIMES the voltage on a grid or plate or screen is called a potential and sometimes a voltage. Do the two terms mean the same thing, and if so, why is it necessary to have two? If they are not the same thing, what is the difference?—P. A. S.

The difference between potential and voltage is the same as the difference between money and dollars. It is not necessary to measure money in terms of dollars, for it can just as well be measured in pounds, crowns, francs, pesetas, and so on. Likewise it is not necessary to measure potential in terms of volts. It can be measured in terms of electrostatic units and many others. The electric potential at a point is the work done in carrying unit charge of electricity from an infinite distance up to that point against the electrical forces. If the unit charge is the farad, the unit of potential is the volt, and then we can call it voltage. If the potential is measured in electrostatic units, it is not voltage. It is a misnomer to call it that, althought it is often done.

* * *

Resistance of Dry Cell Battery

WHAT is the resistance of a dry cell battery? How can it be measured? Is it of the order of one volt, or is it higher?—F. R. T.

The resistance of a dry cell battery depends on the condition of that battery. When it is fresh, the resistance is low; when it is nearly exhausted, it is very high. The value of the resistance at any time can be estimated by connecting an ammeter across the battery. When it is fresh, the short circuit current is about 30 amperes. For a single cell having a voltage 1.5 volts, this would make the resistance 0.05 ohm. But the resistance of the battery is less than this because there is some resistance in the meter. In fact, most of this resistance may be in the meter. When the battery has been used for a while, very little current flows when the ammeter is connected, showing a very high resistance. The electromotive force of the battery does not change appreciably with age of the battery, as can be determined by measuring the voltage with a non-current drawing voltmeter.

* * *

Suppressor as Control Grid

IN MOST INSTANCES the 58 tube is used in the orthodox manner, but it has so many possibilities that it seems to me that it could be utilized to better advantage by disposing the grids in a different manner. For example, would it not be possible to use the suppressor grid as the control grid of the oscillator in a superheterodyne, using the plate both for anode of the oscillator and the mixer? This could be done by connecting the tickler in series with the lead to the intermediate frequency tuned circuit. If you have a diagram showing this use of the suppressor in a superheterodyne, will you kindly publish it?—W.L.J.

The six-tube superheterodyne printed at the top of this page has the arrangement of the elements in the 58 just as you suggest. The circuit is a commercial receiver and no doubt it has been tested out thoroughly. The suppressor grid return, the low side of the tuning condenser, is grounded. Hence there is a negative bias on the grid, which is desirable since there is no grid leak and stopping condenser. It will also be noticed that the suppressor is connected to a tap on the coil. The arrangement represents both a novelty and a utility and shows how resourceful engineers may solve many problems with latest tubes.

Station Sparks

By Alice Remsen

NEW CBS ACTIVITIES

The Columbia Broadcasting Company has increased the number of its network programs originating on the Coast. Five major programs, including two premieres were heard in a single night recently. This at least gives the overworked New York studios a little rest.

Emery Deutsch, who was a familiar musical figure to CBS listeners for many moons, has returned as staff conductor under the Columbia banner. Mr. Deutsch had an extended leave of absence, during which time he conducted the Paramount Theatre orchestra and also toured for the Paramount Corporation.

LITTLE JACK LITTLE ADDED

The orchestra now heard with the Happy Wonder Bakers program is that of our diminutive friend, Little Jack Little. He broadcasts for the bread company on Tuesday evenings at 8:30 p. m. The Happy Wonder Bakers and Vivien Ruth will be heard on Monday, Wednesday and Friday just the same. . . . Ted Fiorito has recently appeared in two movies, "Sweetheart of Sigma Chi," with Mary Carlisle, and "Hot Air," with Dick Powell. . . . Jacques Fray, of the piano team of Fray and Bragiotti, used to be a music critic for two Paris newspapers. . . . Evan Evans, the Welsh singer, was once a cotton broker. . . . Fred Waring possesses a very valuable set of phonograph records. They cover his microphone performances electrically transcribed, every one of them, taken right off the air. . . . Dick Powell's engagement as singing master of ceremonies on the Old Gold programs with Ted Fiorito's orchestra has been extended by popular request. . . .

MOM AND HER BOY

Georgie Jessel will be telephoning his mother without benefit of microphone while he spends his vacation away from the radio studios, basking under Florida's warm sun. The Jessel half-hour, with Vera Van and Freddie Rich's orchestra, will return to the Columbia air-waves at a new time—Saturdays at 7:30 p.m., EST, beginning March 10th. . . . Plans for Bing Crosby to come East and broadcast his Monday night programs from New York have been shelved for awhile, because it appears that Hollywood can't do without him. The movie moguls have him working on another picture. Meanwhile, he'll continue his melodious Mondays with Gus Arnheim's orchestra and the Mills Brothers from KHJ, Los Angeles. . . . Waldo Mayo, conductor of "The Voice of Romance" over CBS, worked one season as accompanist for Enrico Caruso, and another as Tettrazini's accompanist. . . . Harry C. Butcher, manager of WJSV, Washington, acquired two titles last week. Governor Ruby Laffoon of Kentucky, made him a Kentucky Colonel, and Elder Solomon Lightfoot Michaux made him an honorary deacon in the Church of God. Elder Michaux was all for making Harry a regular deacon until he found he smoked. This, of course, was not quite in keeping with the rules of the Elder's church. He solved the problem by modifying the title to "honorary." . . . Frederick William Wile, the political analyst of the air, was a recent guest at the White House. . . .

SURPRISE FOR ANDRE BARUCH

Announcer Andre Baruch, with, perhaps, some idea of spending several months on a desert island, hurried into a bookshop the other day and asked for a copy of "Anthony Adverse." "We haven't any of Anthony's verse right now," said the young lady behind the counter, "but I can give you the newest book of poetry, 'Poet's Gold,' by David Ross." Andre was a little astonished, but he thought it was nice of the young lady to be interested in his fellow-announcer's work. Hoping to keep the flame of interest burning brightly, he asked: "Who is this David Ross?" "Oh, him," replied the young lady. "He was one of the best liked poets of the early part of the century, but he got killed in the war." . . . Englishmen will get a great kick out of the broadcast of the Oxford-Cambridge boat race, on March 17th, from 9:00 to 9:30 a.m., EST., over WABC. It will be the 86th meeting of the two historic universities on the River Thames. . . . Don Voorhees and his band swung into a fast number at a rehearsal recently of the Fire Chief program in the big auditorium studio in Radio City. After a few measures the small group of listeners in the studio heard a piano join in the music, playing a fancy obbligato, full of runs and arpeggios, and a moment later the face of Ed Wynn peered over the music rack. Wynn is an accomplished pianist and often kills time during a music rehearsal by helping out the band. . . . Orphan Annie celebrated her one thousandth performance on the air on February 20th. She has been on the air six nights a week since December 8th, 1930. . . . WNEW, the new station located at Newark, N. J., but broadcasting from Madison Avenue, New York, is giving a good account of itself with local broadcasts. . . . NBC's Radio City studios are very popular among the New York sightseers. Nearly five thousand persons made the tour during one recent week-end. . . .

"THREE ON A MIKE" LIKED

Southern Melodies, presented by three Democratic women who know their Dixie, make a program worth listening to. "Three on a Mike" is one of the most popular features presented each week by WSM, Nashville, Tennessee. Velma Dean croons the songs, while Marjorie Cooney plays piano and Betty Waggoner the guitar. . . . WHOM, New York, has had a change of management. Clement Giglio, eminent Italian impresario, has taken over a financial interest and the executive management of this bright little station. . . . The De Marco Girls and Frank Sherry, tenor, have returned to the WOR microphones on Thursday evenings at 9:30, after an engagement with Rudy Vallee. . . . Al and Lee Reiser, WOR and NBC, piano duo, are appearing nightly in Dorothy Parker's new show, "After Such Pleasures." Their appearances on the stage do not interfere with their broadcasts. Al and Lee are also heard in "The Enchanting Hour" over WOR, their own program on Saturday evenings, WOR; "Down Lovers' Lane" on WEAF, and "Castles in the Air," WEAF, Tuesdays at 11:00 a.m. . . . The purveyor of everlasting youth to Hollywood's glamorous beauties of the screen, is now giving advice to Station WMCA's audience daily at 1:30 p.m. EST. . . . Francis Marion, contralto, of "Music in the Air" has joined the vocal staff of WMCA. . . . Beniamino Riccio, famous baritone, has rejoined the staff of WMCA, after a flying concert tour of Pan America, including Panama, Cristobal, La Guaira, Trinidad, Kingston and Port au Prince. . . . Ray Heatherton, who is heard on several NBC programs, including his own programs, Mondays, 3:15 p.m. and Fridays, 3:15 p.m., Tuesdays, on Castles in the Air, 11:00 a.m. and Wednesdays, The Ipana Troubadors, at 9:00 p.m. (all programs on WEAF and network), loves his work and is continually studying. He is only twenty-four years old and bears a striking resemblance to Buddy Rogers, except in coloring, Ray being much lighter complexioned than Buddy. Ray was a choir boy at St. Paul's famous cathedral not so long ago, which probably is one reason he is so quiet and serious-minded. . . . It has been decided that Don Bestor is to remain for another twenty-six weeks on that broadcast with Ethel Shutta and Walter O'Keefe. . . . Very glad indeed to hear that Henry Theis is back at WLW, Cincinnati, with that swell band of his, and on a fine sponsored program, too. Good luck, Henry, you deserve it. . . . Now Powell Crosley, Jr., has acquired the presidency and controlling interest of the Cincinnati Reds, radio listeners of the Nation's Station may look forward to hearing many of their favorite ball-players on the air this coming season.

TIME SIGNAL FROM WOR

WOR, Newark, N. J., with studios in New York City, sends an audio note every hour on the hour, as a time signal.

No matter what the program is or who is broadcasting, the note above is sent. If no program is on at the second a time announcement is given.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor,* RADIO WORLD, *145 West 45th Street, New York, N. Y.

Oakley Cohen, 6550 So. Justine, Chicago, Ill.
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A. L. Reed, 521 N. 76th St., Seattle, Wash.
G. W. Phillips, 8154 So. Green St., Chicago, Ill.
C. F. Vizzetti, P. O. Box 493, Deming, New Mex.
John D. Danilouis, 491 N. Oakland Ave., Sharon, Penna.
M. L. McTeer, 1048 Central Ave., Charleston, West Va.
R. B. Stevenson, 209 Kreshe Bldg., Flint, Mich.
Edward Kohanek, Big Spring, Tex.
J. G. Tucker, General Delivery, Dubuque, Iowa.
George J. Wisthoff, 1109 E. Second St., Michigan City, Ind.
M. R. Hanson, 427 S. Neosho St., Council Grove, Kans.
J. R. Grant, 237 Plymouth Place, Merchantville, N. J.
E. H. Olson, 10156 Yale Ave., Chicago, Ill.
Albert U. Jaeggi, P. O. Box 44, Signac, N. J.
Edw. E. Yount, Saratoga Radio Repair, 2715 Saratoga St., Omaha, Neb.
J. A. Ladue, 226 W. Broadway, Apt. 104, Long Beach, L. I., N. Y.
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John J. McCarthy, 208 Laurelton St., Springfield, Mass.
Donald Henderson, 1208 Princeton Ave., Bluefield, West Va.
Fred Moore, 7659 Wilcox St., Forest Park, Ill.
E. H. Langley, P. O. Box 344, Menlo Park, Calif.
F. K. LaVallee, 2952 Alter Rd., Detroit, Mich.
Paul J. Bearer, 410 Fairmont Ave., Trafford, Penna.
E. E. H. Taylor, 9 Lincoln Avenue, Toronto 9, Ont., Canada.
John H. Averiel, 9 Sumner Park, Dorchester, Mass.
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Charles S. Grace, Robinson, Ill.
E. Millward, 42 Shannon St., Toronto 3, Ont., Canada.
E. Williams, 98 Morningside Ave., New York City.
Maxwell M. Snavely, 821 Goshen Ave., Elkhart, Ind.
R. Williams, 319 Third Avenue, Verdun, P. Q., Canada.
B. A. Snodgrass, R.F.D. No. 2, Box 39C, Charleston, West Va.
Albert S. Roberts, Jr., The Phillips Exeter Academy, Exeter, N. H.
Milward W. Cairns, Walton, N. Y.
Douglas Perry, 106 W. Nash St., Louisburg, N. C.
Walter Shotts, 823 - 6th Ave., N.E., Minot, N. Dak.
M. E. Griswold, 75 Olive St., Springfield, Vt.
John G. Eilenberg, 354½ Grant St., Phillipsburg, N. J.
Clarence E. Weaver, 483 Bayard Street, So. Williamsport, Pa.
I. J. Diehl, 7515 Arthur St., Oakland, Calif.
Ralph E. Staley, R.F.D. No. 3, Box 260, Springfield, Ill.
The Bart Company, Knoxville, Tenn.
John F. Fox, 32 McDonough St., Providence, R. I.
E. G. Quinn, Victory Sta., Gastonia, N. C.
Jack Fujiwara, Box 80, Kukuikaele, Hawaii.
Jack Manson, 449 Orleans St., Beaumont, Tex.
J. Menichino, 1006 N. Liberty St., Mahoning, Pa.
South Bend Lathe Works, South Bend, Ind.
R. L. Woolridge, P.O. Box 178, Camino, El Dorado Co., Calif.
Basil G. Stewart, Chesapeake, Ohio.

Tradiograms

By J. MURRAY BARRON

A handy hardware kit for radio experimenters and service men is being produced by Edward M. Shiepe, 135 Liberty Street, New York City. More than 500 pieces, metallic and insulated, are contained in identified compartments of the box. Screws, nuts, bolts, washers, etc., selected by screw-machine engineers, constitute the assortment.

* * *

Emerson Radio and Phonograph Corp. is now located at its new headquarters, 111 Eighth Avenue, New York City. Jobbers and dealers are invited to visit the new show rooms and factory.

* * *

The Philco Radio & Television Corp. has main offices at 254 Fourth Avenue, New York City. Service parts and shipping departments are at 37 Great Jones Street, East of Lafayette Street. In **Newark, N. J.**, sales, parts and service are conducted or sold at 393 Central Avenue.

* * *

A recent meeting of the International Short Wave Club, New York City Chapter, was held at Stuyvesant High School, New York City. The meetings are held every other week and an open house is held. Anyone interested in short waves is invited. For the balance of the season an excellent array of talented speakers is booked.

* * *

Each month one sees the popularity of short-wave reception growing. Those, a few months ago, who thought there wasn't anything to it have become ardent followers of the high frequencies. The end is not anywhere near.

* * *

The past week saw some exceptional wired chassis bargains in Cortlandt Street. One model seven-tube t-r-f wired chassis, with line voltage regulator, was offered for $8.75. A five-tube model was priced at $7.75. Both of course were without tubes, cabinet or speaker, but were tested and ready to operate.

* * *

Another successful meeting of the New York Short-Wave Club was held at the Y. M. C. A. on Sixty-third Street, New York City. Larger quarters have been obtained, due to increased attendance. Those who are interested in the short-wave field are invited to attend. As there are always guests speakers with interesting subjects and information that should appeal to all.

* * *

The duplex windows of the 85 Cortlandt Street store of the Try-Mo Radio Co., Inc., have been redecorated with an unusual display of short-wave parts and receivers. For the experimenter who wants to build his own there is an assortment of parts, with one of the largest variety of short-wave coils to be found anywhere in the country, and for the fellow who wants a wired chassis there is a complete line from a one-tube outfit to the Hammarlund Comet, also a wide choice of battery, a-c, a-c and d-c, and d-c models.

* * *

The serviceman and the experimenter who take care of the radio wants of the neighborhood will find a market for a good short-wave converter. Most homes have a radio set. A short-wave converter that will turn the broadcast set into an all-wave one, and should perform very satisfactorily. In New York City there are offered several very excellent short-wave converters which have records of tuning in European countries.

Radio stores and servicemen living a considerable distance from the larger centers and with a large outlying district within their trading center can pick up business in a number of items. Today we find numbers of speakers put away in the closet or other places because they will not work, and the owner knows of no place to get such repair work done. It is now possible to get replacement parts, such as voice coils, cones, transformers, filters and etc., thereby covering a field in your community that has hardly been touched.

* * *

Whereas last year one had the choice of a small number of short-wave and all-wave receivers through the retail store and in most cases bought from a mail order house or direct from manufacturer, we find today all well-located stores are handling a number of short-wave and all-wave receivers put out by large manufacturers. These are the sets that the family uses. Of course there is the man who wants the special, or custom-built receiver, and the market in this direction is large, too.

* * *

While the plug-in coil short-wave receiver is considered the most efficient, everything considered, we find that more and more the idea of a switch is gaining favor, in fact there are no less than a half a dozen organizations now experimenting and testing various types of coil switches. Possibly by the year 1935 most of the better-known sets will be so equipped.

* * *

From a visit to the various laboratories of the radio trade in the East, one can see that short-wave business is increasing. This does not mean just for police signals. There is a known market for a set that will bring in the foreign stations as well as broadcasts.

Roosevelt Asks Board for All Communication

Washington.

President Roosevelt in a special message to Congress requested the creation of a Communications Commission, in line with the recommendations of his special inter-departmental committee. Bills were drawn to that effect.

The powers now exercised by the Federal Radio Commission would be turned over to the Communications Commission, which would also take over the supervision and regulation of telephone, telegraph and cable, work now done by the Interstate Commerce Commission. The Power Commission would govern power companies, the I.C.C. transportation, and the new body communication.

Corporate Activities

CORPORATION REPORT

Hygrade Sylvania Corporation—Net income for the year 1933, after deduction of taxes and other charges, $655,072, which equals $2.67 a share on 192,684 no par common shares, after $6.50 preferred dividend requirements, as compared with $851,527, or $3.66 a share, in 1932.

PATENT LITIGATION

A patent-infringement suit was filed in the Federal court at Wilmington, Del., on February 13, 1934, by Helen May Fessenden, of Chestnut Hill, Mass., widow of Reginald A. Fessenden, electrical engineer, against the Radio Corporation of America. It is asserted that the corporation has infringed two patents granted to Professor Fessenden in 1927, one for wireless directive signaling and the other for wireless transmission and reception.

The Radio Corporation of America has brought suits against two of the companies associated with the International Telephone and Telegraph Company, namely, the Mackay Radio and Telegraph Company, Inc., and the Federal Telegraph Company, of Newark, N. J., claiming infringement of six patents relating to radio inventions used in marine, transoceanic and domestic radio communication, of six United States patents relating to radio tubes.

Judge Thomas in the United States District Court, District of Connecticut, in suits brought by the Radio Corporation of America and others against Majestic Distributors, Inc., a subsidiary of the Grigsby-Grunow Company, held the defendant infringed ten of eleven patents relating to radio tubes. These included patents owned by the Radio Corporation of America, and others under which it is licensed with the right to grant licenses to others. The court held one patent not infringed.

BANKRUPTCY PROCEEDINGS

Harry Hershfield, of 340 W. 57th St., New York, N. Y., a radio commentator and a cartoonist.—Liabilities, $16,289; no assets.

Square Radio Corporation, retail radio, of 4910 Thirteenth Ave. and 486 New Lots Ave., Brooklyn, N. Y. Claims by Bruno-New York, Inc., $500; Bushwick-McPhilben Corp., $500, and Emerson Radio and Phonograph Corp., $500. James I. Virdone, 186 Joralemon St., Brooklyn, N. Y., appointed receiver.

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3-gang .00015 condenser, brass plates, with trimmers on 2 sections .... 99c.
0.001 fixed condenser............ 2c.
Chassis for 6 or 8 tube circuit.... 75c.
5-wire cable and UY plug attached .... 30c.
Yaxley 20-ohm potentiometer.... 12c.
30-ohm rheostat with switch...... 30c.
7,700-ohm voltage divider, tapped 4 places .... 25c.
Fixed filament resistor (2-ohm, 6.5-ohm, 30-ohm) .... 7c.
Cartridge grid leak, 5,000, 75,000, 250,000, 2,000,000 ohms.......... 5c.
Speaker or phono jack.......... 5c.
2-ampere fuse .... 3c.
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A battery charge tester,
0-6 volts
0-50 volts
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0-50 Milliamperes
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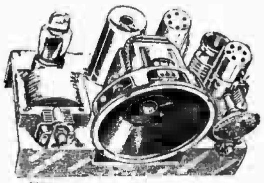

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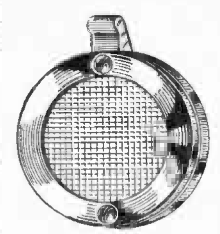

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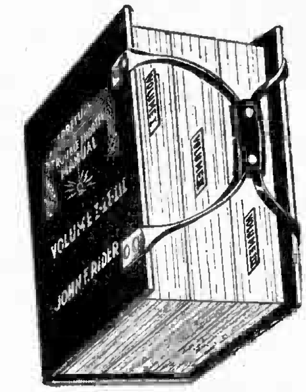

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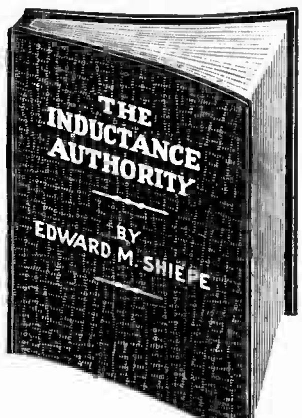

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Atwater Kent 80, 82, 84, 55B, 627, 87, 90, 92, Early models 83, 85	8¾"	1.80
Baldwin Head Supplied	9"	2.61
Bosch 5 and 5A	6"	2.11
Bosch 48-58	9¾"	2.11
Bosch	7"	1.70
Brunswick 10	8"	1.80
Brunswick D	8"	2.21
Brunswick 11 12, 15, 16, 18, 33	12"	2.21
Brunswick E	8"	1.90
Colonial 33-LL, 18	12¾"	3.50
Colonial 34, 35	12¾"	2.61
Colonial 36	10"	2.30
Crosley M45	9"	1.90
Crosley 408	9"	2.90
Earl Inductor Dynamic	10"	1.01
Earl	10"	2.51
Edison R4-5-7-8	11¾"	2.11
Eveready	10"	2.21
Eveready	12¾"	2.30
Freed-Eiseman NR 80-95	10"	2.51
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Fada Shallow	8¾"	3.00
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General Electric 31, 51, 71, 120, 822	10¾"	2.00
Hammarlund Hi-Q 31-50	10¾"	2.00
Jensen	8"	1.44
Jensen D4, D5	9¾"	2.11
Jensen D7, D9	11¾"	2.11
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Magnavox 144	7½"	1.80
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Oxford 7, 72, 70, 82, 83, 85, 86, 92, 93, 96, 97, 98, 99, 100, 101, 104, 108, 109, 116, 111, 112, 113, 114, 115, 116, 117, 124, 128, 129, 139, 148	12¾"	2.21
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RCA 106, 46, 80	10¾"	1.60
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Victor RE 32-45-57-75-52	9"	.96
Westinghouse WR10-WR15	10½"	2.11
Wright DeCoster 155	6"	1.55
Wright DeCoster	8"	2.00
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Zenith 87	9"	2.10

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Apex Lgt 95, MD 549	11500	2.56
Atwater Kent 53, 55, 65	650	3.44
Atwater Kent 53, 55, 65	1000	3.92
Atwater Kent 53, 55, 65	1700	4.00
Colonial 33 A.C.	6000	3.92
Colonial 33 D.C.	550	2.64
Crosley M45	1500	3.04
Crosley M45	2500	3.04
Crosley 8½"	2500	3.04
Crosley 8½"	7500	3.92
Crosley Isodyne	2500	3.20
Crosley Isodyne	7500	3.52
Crosley Model 58	10000	3.92
Edison	4500	3.95
Fada	10000	4.40
Gloritone 8" tapped	1800	3.12
Jensen D4, D5	2250	2.88
Jensen D7, D8	1500	3.20
Jensen D9, D15	550	2.56
Jensen D9, D15	1000	2.40
Jensen D9, D15	1650	2.80
Jensen D9, D15	1800	2.80
Jensen D9, D15	2500	3.20
Jensen D12	2300	2.40
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Majestic G5	1000	2.64
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