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RADIO WORLD

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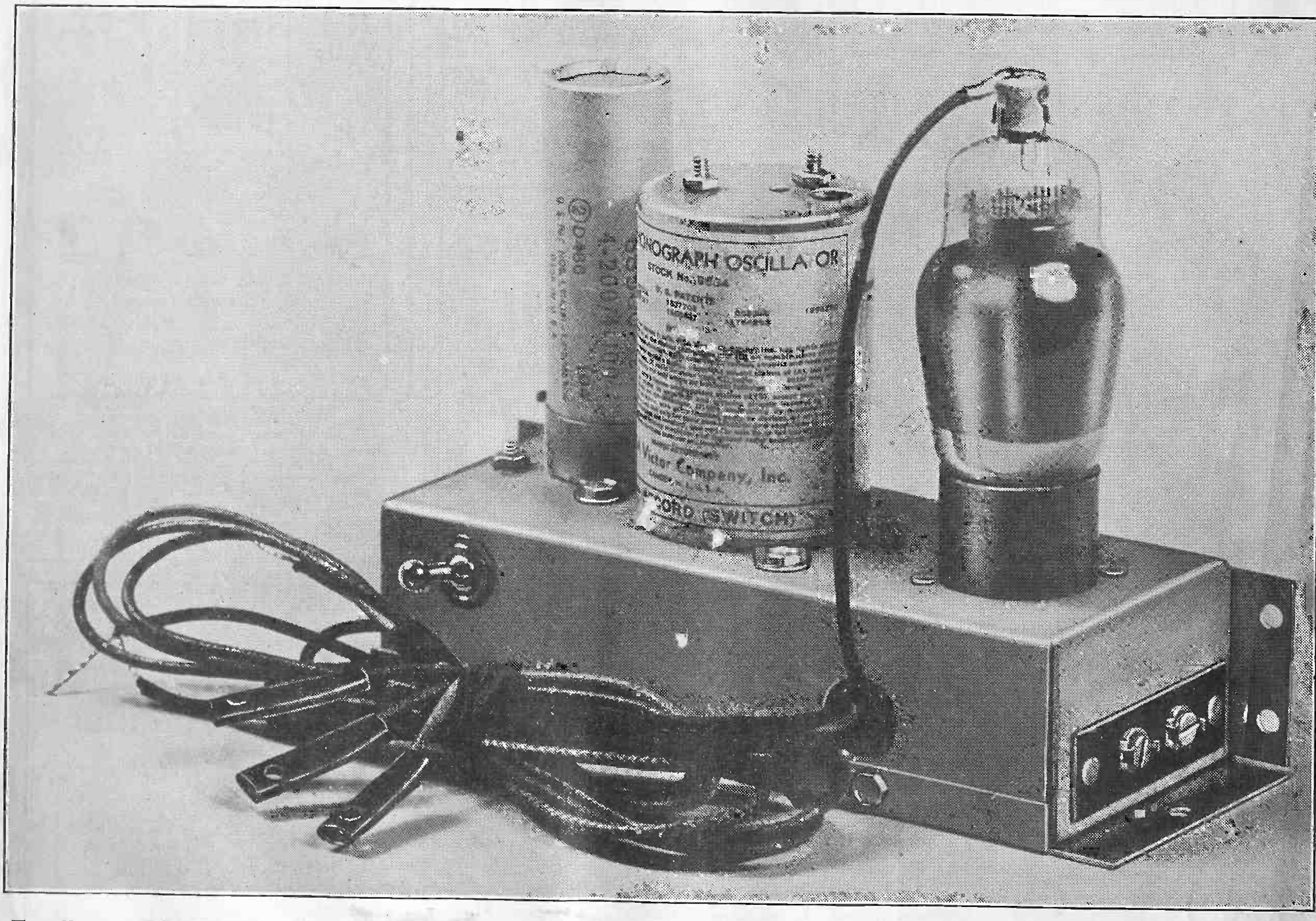
The First National Radio Weekly—

676th Consecutive Issue—13th Year

- **Calibrating An Audio Generator**
- **Modulation Methods**
- **Capacity Measurements**

COMPACT PHONOGRAPH OSCILLATOR



Excellent results, especially in vol[illegible] are attained by using an oscillator modulated by a phonograph pickup to reproduce records through a set, at full amplification. See page 19.

LOCAL OSCILLATOR TROUBLE SHOOTING

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THIRTEENTH YEAR

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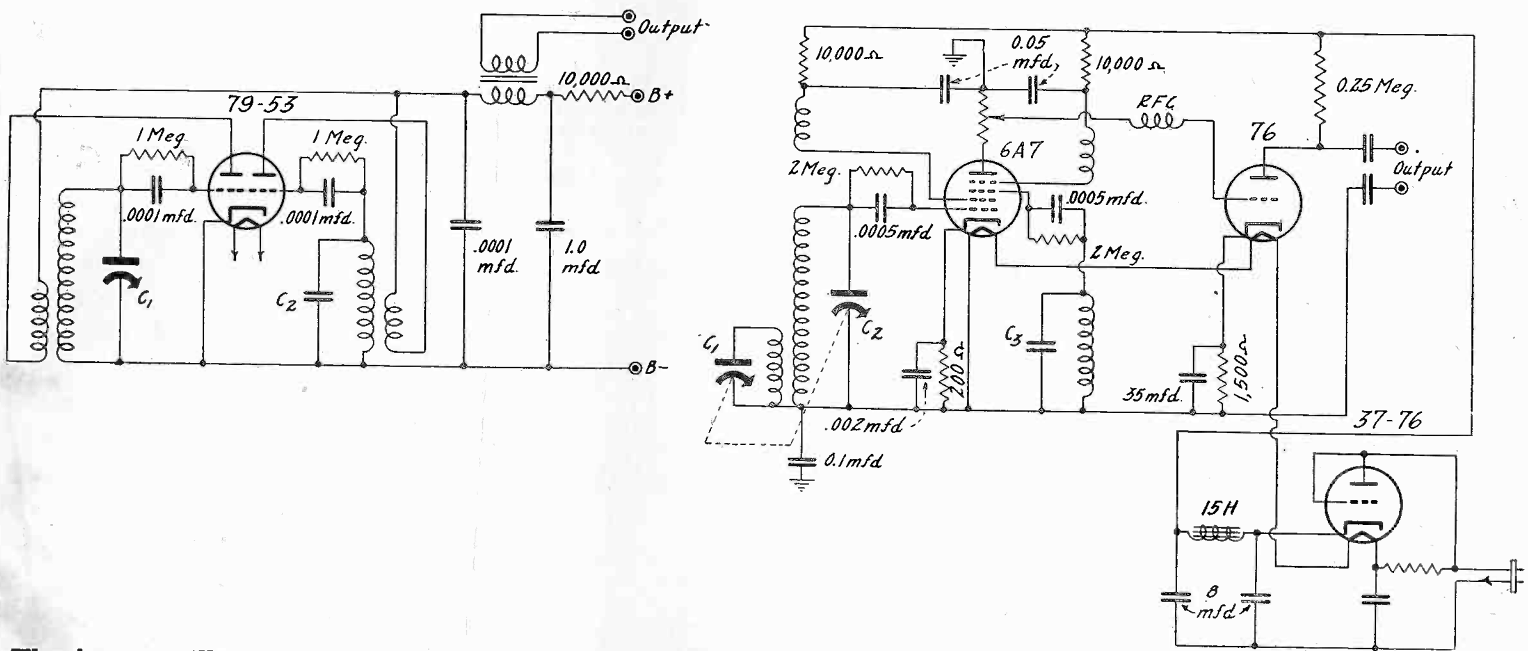
Audio Oscillator Calibration

Low Radio Frequency Generator and Broadcast Stations Used

By Herman Bernard



The beat oscillator at left represents the principle. Sufficient coupling between the two radio frequencies is inherent due to the geometry of the tube. There is no attenuator. At right is a beat frequency oscillator with second and higher harmonic trap. There are an amplifier stage and a rectifier.

THE fact that any one possessing an audio oscillator gets many requests from prospective borrowers of the device indicates that there is need for such an instrument but the price is more than a casual user would want to pay. However, he himself can build two oscillators in one, mix the frequencies and take out the audio resultants. Thus he would have a beat frequency oscillator for the audio range, indeed for a much wider range, but would want to restrict the frequencies to avoid crowding the dial. So perhaps 10,000 cycles would be one extreme and theoretically zero would be the other, although practically, in terms of calibration, the low limit would be 60 cycles.

It is easy enough to build the instrument, but the important consideration that stumps many is the calibration. Yet this calibration may be carried on with the aid of a signal generator that produces low radio frequencies, using beats with local broadcasting stations. It is assumed that such a low radio frequency oscillator is possessed by all, since it is basic for implementation of the up-to-date radio worker and experimenter.

Creating the Table

Assuming that a beat frequency audio oscillator is built, and that the object is to calibrate it, without the aid of any other standards than the broadcasting stations, and with a receiver and a signal generator as instruments, the process is as follows:

First, write down the local station frequencies.

Second, divide these frequencies by 1, 2, 3, 4, etc. Divisors up to and including 10 may be sufficient, while up to and including 20 enables the use of higher frequency broadcasting stations (say, above 1,000 kc) for beats with the low radio frequency signal generator.

Third, tabulate the results, writing down the previous divisor, which now is used as a multiplier of low frequencies and known as an harmonic order that produces the station frequency. Such a table is shown herewith for Metropolitan New York stations that come in particularly well at a given location, the fundamental of the stations being included for convenience of reference (first harmonic).

Comparison with Other Stations

Set the receiver going, also and tune in the lowest frequency station on the list. This is 570 kc in the author's instance. The low radio frequency signal generator, if set at 190, will beat its third harmonic with the station fundamental. Adjust the signal generator for zero beat with practically no antenna input, except from generator. Do this as carefully and accurately as possible. There is a rising pitch on each side of zero beat, heard in the speaker.

Since there is a program in progress if the station is on the air, a good way to check for zero beat is to get between the audible squeals so that though the signal generator is beating an harmonic with the station carrier, no aural intimation exists of the operation of the signal generator.

Leave the low radio frequency signal generator going (without any modulation on it) and multiply its fundamental by the next ascending or descending integers. Thus 190×4=760, 190×5=950, 1140 and 1330 kc. Consulting the list of station frequencies, we find there is a station on 760 kc, and tune that in (signal generator unmolested) to zero beat, but there are no stations listed at 950, 1140 and 1330 kc, hence no zero beats would result except at 570 and 760 kc. But there is a station at 940 kc, resulting in a 10 kc beat with 950, also a station on 1180, 40 kc beat with 1140, and no tabulated station near enough in frequency for use with 1330 kc.

It is plain therefore that the sound emitted by the speaker when beats are established as in the two instances cited would be 10,000 cycles and 40,000 cycles. However, though the 10,000 cycle note could be heard weakly if it alone were present, the 40,000 cycle frequency is a radio frequency rather than an audio one, and we desire to terminate our span at around 10,000 cycles anyway. (The audio tones will be referred to in terms of cycles).

Interference Removed

However, the beat is mixed with a program, and unless rather low in frequency and pronounced in volume, may not be distinguished for purposes of aural comparison. Therefore, with receiver dial calibrated so that the tuning positions for the test stations are known, remove the antenna as already intimated, so that no program is heard as the receiver dial is turned from one end to the other. When the signal generator is coupled to the receiver the beats will be heard nevertheless. And the beats will not be interfered with by program modulation.

So far we have obtained aurally one useful frequency, 10,000 cycles, so let us return to that, and hear the note. Now it comes in. If one is on in years he may not hear the note, as ears lose their high audio frequency keenness with time, but a younger chap would be glad to help out, to spot the frequency generated by the audio beat oscillator that corresponds to 10,000 cycles.

The two radio frequency oscillators that beat to produce the tones of the audio oscillator may be arranged so that the highest audio frequency (10,000 cycles) results when the variable condenser rotor plates are totally meshed, or when they are totally disengaged, and the condenser that tunes the other oscillator circuit is set so as to cause the resultant 10,000 cycles.

Harmonic Trouble

The actual radio frequencies used do not matter so much, although many persons prefer to use low radio frequencies. Harmonics of a particular radio frequency may beat with fundamentals of other frequencies, or beat with harmonics of other radio frequencies producing unwelcome tones. For instance, if 22 kc beat with 27 kc the expected value would be 5,000 cycles, but 44 would beat also with 54 kc, yielding 10,000 cycles. These two could be readily distinguished by ear if separate, but they are together. If 22 and 24 kc were used, the result, 2,000 cycles, would be expected, but 44 and 48 would beat, yielding 4 kc, also 66 and 48, yielding 18,000 cycles, and 132 and 144, yielding 12,000 cycles.

One way of solving this difficulty is to use a push-pull circuit for each oscillator, to balance out the even harmonics, particularly the second, and track the variable oscillator with a circuit tuned to the third harmonic, which will also act as a shunt to the higher harmonics of the radio frequency oscillators. Harmonics of the audio tones will be present anyway, but are recognizable because of the much greater intensity of the desired fundamentals.

Another and simpler way of treating the radio frequency oscillators is to track the second harmonic of the variable, using a two gang condenser. This will take care of the higher harmonics, too. The tracking need not be perfect. The harmonic frequency circuit may be tuned to a bit lower than the second harmonics of the variable frequency oscillator's fundamentals, never higher.

EXAMPLES OF AUDIO AND HIGHER FREQUENCIES OBTAINABLE BY THE STATION-LOCAL GENERATOR METHOD

H F1	*F1 (n)*	*(F2)*	*Fx (Cycles)*
3x190	570	570	0
4x190	760	760	0
5x190	950	940	10.000
6x190	1140	1180	40.000
7x190	1330	—	—
2x285	570	570	0
3x285	855	860	5.000
4x285	1150	1180	30.000
5x285	1425	1450	25.000
4x142.5	570	570	0
5x142.5	712.5	710	2.500
6x142.5	815	810	5.000
7x142.5	997.5	940	57.500
8x142.5	1170	1180	10.000
9x142.5	1282.5	1250	32.500
10x142.5	1425	1450	25.000

Selecting Radio Frequencies

In assigning values of radio frequencies, follow the practice of using zero beat as one extreme. In any event the variable has to tune over a band of 10 kc. This is one reason for selecting low radio frequencies, since condensers of moderate capacity may be used, not too much frequency coverage will arise, that is, there will be no overcrowding, and the stability may be better.

The fixed frequency may be either higher or lower than the variable radio frequencies, excepting the one condition common to both when the two are equal. If the fixed frequency is higher, the zero beat setting is made on the fixed condenser with the variable at minimum. If the fixed frequency is lower the variable is at maximum capacity for zero beat. Either method works well. In general, with the fixed condenser set for lower frequency the low sound frequencies are spread out, whereas if the fixed condenser creates a higher frequency, the high sound frequencies are spread out. If the variable is straight frequency line, however, there is no difference in the shape of the curve either way, except as due to dips at the low capacity settings of commercial condensers in the straight frequency line category.

The actual selection of frequencies for audible comparison may be made on the basis already outlined, and it is obvious that the higher audio tones recur more frequently, hence search must be made for low tones.

Close Quotients

These would result where the station frequencies, when divided by 2, 3, 4, etc., yield quotients very close to one another. An inspection of the table for such close instances will provide the answer. Looking down the harmonic column we find that the fifteenth harmonic of 50.666 beats with 760 kc. The recurring 6 should be carried to a fourth place for still closer accuracy, and this would apply elsewhere to recurring sixes, threes and fives, etc., and indeed any number that has other than zero in the third place, because the originally small differences may become important.

Since the fifteenth harmonic of 50.6666 equals 760, and the sixteenth harmonic is 810.6656, and as there is a station at 810 kc, by turning the receiver dial until 810 kc is tuned in, the resultant audio tone is 810.6656 minus 810 or 665.6 cycles. Going the other way the fourteenth harmonic of 50.6666 is 709.3324, and there is a station at 710 kc, so a note of 665.6 cycles is heard again, confirming the previous example, it so happens.

Sufficient frequencies from these lows up can be obtained, as working out selected examples will prove, especially if one realizes that the larger the difference in low frequency fundamentals the higher the resultant audio frequency will be. Below 500 cycles, etc., scarcely can be obtained by this method. But the curve can be extrapolated and checked against the line frequency of 60 cycles, using the twelfth harmonic for 720 cycles, just above the 656.6 cycle point, the eleventh for 660 cycles, just below 656.6, the tenth for 600 cycles, ninth for 540 cycles, etc., to 60 cycles, as the beat phenomenon will be plainly audible.

SUBHARMONICS OF PRINCIPAL NEW YORK CITY STATIONS

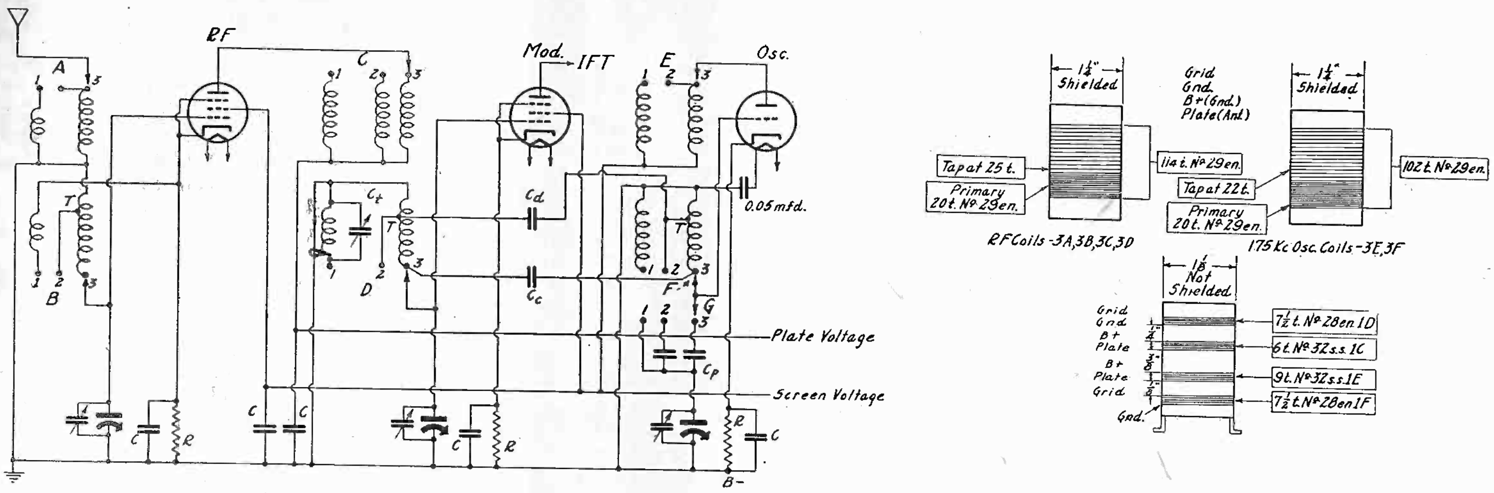
H										
1	570	660	710	760	810	860	940	1180	1250	1450
2	285	330	355	380	405	430	470	590	625	725
3	190	220	236.666	255	270	286.666	313.333	393.333	416.666	483.333
4	142.500	165	177.500	190	202.500	215	235	295	312.500	362.500
5	114	132	142	152	162	172	188	236	250	290
6	95	110	118.333	126.666	135	143.333	156.666	196.666	208.333	241.666
7	81.428	94.286	101.428	108.571	115.714	122.857	134.286	168.555	178.555	207.143
8	71.250	82.500	88.750	95	101.250	107.500	117.500	147.5	156.250	181.25
9	63.333	73.333	78.888	84.444	90	95.555	104.444	131.111	138.888	161.111
10	57	66	71	76	81	86	94	118	125	145
11	51.818	60	64.545	69.091	73.636	78.182	85.454	107.273	113.636	131.888
12	47.500	55	59.166	63.333	67.5	71.666	78.333	98.333	104.166	120.833
13	43.846	50.761	54.615	58.462	62.308	66.154	72.308	90.769	96.154	111.539
14	40.714	47.143	50.714	54.285	57.857	61.428	67.143	84.277	89.277	103.571
15	38	44	47.333	50.666	54	57.333	62.666	78.666	83.333	96.666
16	35.625	41.250	44.375	47.5	50.625	53.750	58.750	73.750	78.125	90.625
17	33.529	38.823	41.765	44.706	47.647	50.588	55.294	69.412	73.529	85.294
18	31.666	36.666	39.444	42.222	45	47.777	52.222	65.555	69.444	80.555
19	30	34.737	37.368	40	42.631	45.263	49.474	62.105	65.789	76.315
20	28.5	33	29.588	38	40.5	43	47	59	62.5	72.5

H represents the harmonic orders of frequencies to the right that produce zero beat with fundamentals on the top numerical line.

"All-Waving" Old Sets

of Separate and Electron Mixer Types

By Leonard C. Wood



Use of tapped coils for the police band. This is sometimes a necessary expedient because of space limitations. New coils for this dual purpose must be used or old ones revamped. The police band may be skipped, if desired, and 540 to 1620 kc, 4.8 to 14.4 mgc. coverage enjoyed. The switch is of the seven hole, three throw type. The coil construction diagram shows upper left for r. f., broadcast and police bands, upper right oscillator for same (175 kc), while mixer coil for high frequencies is below. With windings in same direction, polarities are as marked. The high frequency r. f. coil is like the upper part of the mixer coil.

IN changing over standard broadcast receivers for all-wave service (540 kc to 20 mgc, approximately), two general types of circuits are encountered, one having separate oscillator tube and modulator tubes and the other a combination oscillator and modulator. Previously the combination tube was the 58, worked with an oscillator coil in the same shield can as housed the first intermediate transformer. While this circuit was sensitive it was not stable in the oscillator, and besides the 58 tube was used as modulator and oscillator before the pentagrid converter tube was marketed, and the pentragrid type is superior to the 58. Therefore it would be advisable to put in a new socket of the small seven-prong type and use the 2A7 or 6A7 (depending on heater voltage supply) instead of the 58 or 78.

The other type of tube consisting of two tubes in one envelope, such as the 6F7 and the like, is to be treated as if separate tubes, as external coupling must be provided, whereas with the pentragrid converter tube there is coupling present electronically. For the highest frequency band it is usually advisable to augment this electron coupling, which is independent of frequency and therefore sometimes not strong enough for this band, where the keenness of the circuit naturally declines because the circuit losses begin to pile up enormously. Hence inductive coupling between modulator and oscillator may be used additionally.

Improvising Small Condensers

The first diagram illustrates a circuit converted to all-wave coverage, where the oscillator and modulator tubes are separate, with the present coils taken out entirely, that is, the broadcast band inductances, so that a tapped coil may be used as for its full secondary for the broadcast band and for about one-ninth that inductance for the police band, which includes two amateur bands and other transmissions.

Therefore the first diagram may be used for the tuner section of a superheterodyne, with a three-gang condenser, for building a circuit anew, as well as for making over an existing circuit, using the tapped coil method for the purposes outlined. As no inherent coupling is present between modulator and oscillator for the broadcast band, a small condenser, C_c, may be inserted, about 1 mmfd., which may consist simply of two pieces of insulated wire, each 2 inches long, and made into twisted pair, the bared wire at adjacent ends being used for connections and the wire terminals at the other ends left free. Each wire then serves as the plate of a tiny condenser.

For the police band the same system prevails. The wire pieces, 1 inch long, are connected at their respective extremes to the tabs on the switch, being twisted and left in position. (C_d). This second band coupling is trivial for the broadcast band where it has practically no effect, and the other improvised condenser functions (C_c).

Expedient Sometimes Necessary

For the switching arrangement, using tapped coils, the same antenna, interstage and oscillator primaries are used for the two bands, only the utilized inductance of the secondaries being changed. The tapped coil system is not as effective as the separate coil system, but it does work, and is sometimes a necessary expedient for total coverage of the bands desired, because in making over an existing receiver there may not be room for the extra coils required.

When one gets to the highest frequency band, separate coils are used, and therefore the d-c terminals of the windings may go to different destinations. One instance where it is advisable to make a different return is in the grid circuit of the first tube, as this may be returned directly to cathode, for zero bias, with consequent heightening of sensitivity. If it is not deemed advisable to run the tube with no bias, since the tube life will be shortened, it is practical to use two series resistors instead of R. No value is ascribed for R, but if R is 300 ohms, it may be replaced by two resistors the sum of whose resistances equals 300 ohms, e.g., 100 and 200 ohms, with the 100 ohms terminating at ground, with a separate bypass condenser across it, and the grid return for the highest frequency band returned to the junction of the two resistors.

Case of Different Tubes

C are bypass condensers already in the set, R are resistors also present, and left as found, except as already explained, while C_c is the broadcast band coupling condenser and C_d is the police band coupling condenser. The d-c voltages are not disturbed, and the high frequency coils are designed to be effective on moderate B voltages, say, around 200 volts on plates, whereas they do not spill over on 250 volts more commonly found.

Of course different types of tubes are found in receivers that are to be made over, but the generalized condition is described sufficiently in the diagrams. For instance, if the r-f tubes have no suppressor, ignore the suppressor leads in the diagram. If the r-f tubes have no screens the receiver is probably too old to be worth remaking, while if the oscillator tube has more elements than shown, leave the other elements connected as they are in the receiver. Only the grid and plate need be considered.

In making over the receiver it is important to bear in mind the fact that the "high" sides of the coils, meaning those to which high radio frequency potentials are applied, as contrasted with the r-f grounded ends (B plus and B minus, or cathode) must be switched. To use the tapped coil system the secondary must be switched in each instance as to proper part or whole of the winding. For the broadcast band the point is one extreme, for the police band it is a tap, and because only a seven-deck switch is to be used, the unused portion of the secondary can not be shorted out, and the grid obviously can not permanently be connected to the full secondary.

The precaution most important in connection with the switch installation is to remove the common joint of stator of the condenser and grid of tube from the broadcast coil secondary. That is, disconnect the high side of the broadcast coil if such a coil is to be retained in the set instead of being replaced with a tapped coil. The reason is because grid is to be connected permanently only to the stator and to the proper index or moving part of the switch. This index is one of the extreme tabs on the switch deck.

The Different Positions

With condenser stator and grid of the tube constituting one lead, joined as the index tab, the other tabs on the same switch deck represent connection points for the coils. In the example of the grid windings of the r-f and modulator tubes the tabs go respectively to one extreme and to tap of secondary, while for the last band one extreme of the new coil is picked up. Also for the primaries, new ones are selected by the switch for the last band.

It is necessary to have high impedance primaries to get high frequency results from sets thus to be made over, and this end is aided by leaving the coils for this band unshielded. Moreover, one coil form is used for the four windings of the modulator and oscillator coils. Thus also does inductive coupling exist between modulator and oscillator to help bring up the response on this band.

The data for the use of the tapped coils are found in a diagram, with the separate high frequency coils on one form also explained as to connections, number of turns, spaces between windings, diameter of tubing and identity of windings. The switch decks are lettered A, B, C, D, E, F and G. The bands are numbered 3, 2 and 1, where 3 is the broadcast band, 2 is the police band and 1 is the high frequency band. This number sequence is followed because index plates better follow that rotation.

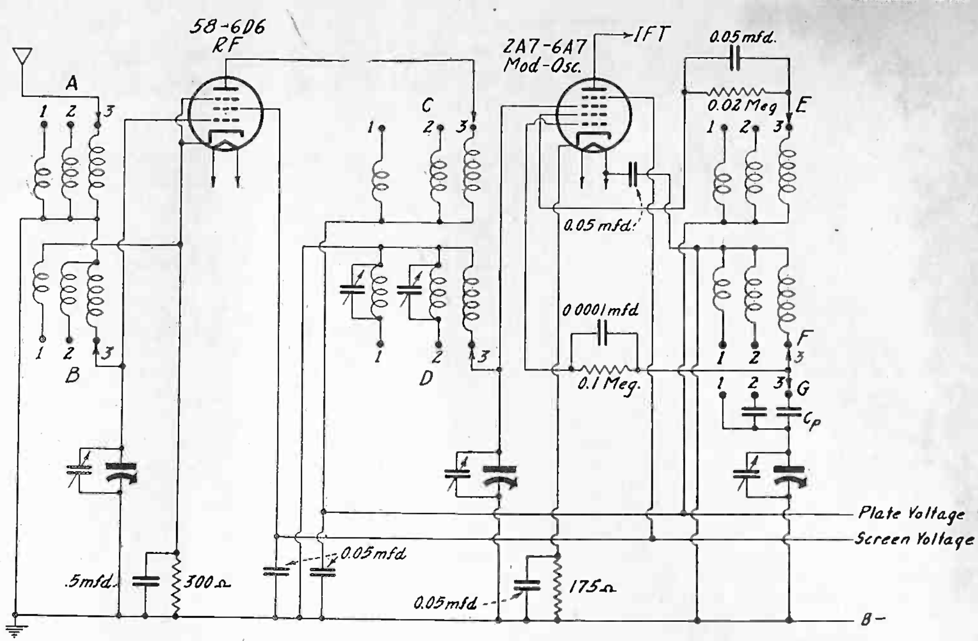
Soldering Salt

The usual type of switch construction is to have one set of decks on one side of the shaft and another on the other side, so a six-circuit switch would take up no more room than an old style three-circuit one, and in this instance an extra deck is added, for switching the padding condenser.

The r-f and oscillator coils are wound on 1⅛ inch diameter and the forms have a height not exceeding 2¼ inches, so that there is room to mount them upright on the chassis bottom. This may be done by soldering the coil brackets to the chassis. Ordinarily this may not be so secure a connection, unless soldering salt is used for flux, these being exceptionally effective in removing emulsions, and also being non-acid and thus splendid for radio work. Any one interested in such salt, may obtain information by addressing Trade Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y.

The oscillator coils for two bands must be selected for the intermediate frequency of the receiver. It is not deemed advisable to try to make over tuned radio frequency sets. For intermediate frequencies around 175 kc, including 172.5, 177.5 kc and the like, one type of coil is used, having a secondary inductance of 190 microhenries, tapped at 23.3 microhenries. This coil requires a minimum circuit capacity of 40 mmfd. for tying down are 1450 kc on the broadcast band, and 40 mmfd. is just right for the tap on this oscillator coil. In this instance the oscillator circuit minimum is of less capacity than is the r-f section, which has 44 mmfd.

A padding condenser is needed, and it will be serviceable only for one band. This is C_P at G3 position. The padding capacity has been computed as 650 mmfd. to reduce the circuit capacity to 260 mmfd. Since this padding condenser always is adjustable it should be of a value that includes 650 mmfd. in the range. Sometimes higher capacity is needed, due to circuit conditions, and therefore it is advisable to have a condenser enabling this leeway, or, if the adjustable capacity at maximum falls short of the requirement, a parallel fixed condenser may be put across the adjustable capacity so that one may strike just the right setting for maximum response in the broadcast band at 600 kc.



Separate coils used in each stage, the preferable practice, providing there is room. Data on the coils for this outfit will be published in an early issue.

Adjusting Padders

For the police band no oscillator capacity adjustment is made on the parallel trimmer, but a series condenser of around 0.004 mmfd. may be used. Actually it is practical to omit the series padding condenser Cp2 for the police band where the i.f. is around 175 kc. as is apparent from the large capacity of the series condenser compared with the capacity of the tuning condenser, which will be around 400 mmfd, or a 10 to 1 ratio.

If the intermediate frequency is at or near 465 kc. including 456 kc. the oscillator coil for the broadcast band, and the tap location for the police band, are different than in the previous instance, and the series padding capacity for broadcasts may have to be 480 mmfd. It is usual to find 350-450 mmfd. condensers commercially, but these can not be held to close tolerances in production and may fall short of the necessary capacity, whereupon a small fixed condenser is put across the variable.

For the police band the padding condenser is computed at 0.00265 mfd., so a 0.002 mfd. fixed condenser with a variable across it like the one suggested for the broadcast band, at 175 kc. may be used for adjustment.

Coil System Tried Out

The coil system has been worked out experimentally for the broadcast band, and for the high frequency band, while the tap positions for the police band have been computed, including introduction of correction factors shown necessary by experiments with the broadcast coils. The full broadcast coils fell short of the theoretical inductance because of the effect of the shield, which both increases the capacity and reduces the inductance, but evidently the inductance effect was greater. The oscillator coils were verified experimentally.

The r-f and oscillator coils for the broadcast and highest frequency band were checked for inductance as wound, the directions for winding being those found under the first illustration.

The capacity at minimum in the oscillator circuit always must be different from the minimum at the r-f level. This is due to the necessity of the capacity curves crossing for good tracking and applies particularly to the broadcast band. In the case of specifications for the 175 kc oscillator coil, the capacity is less than at the r-f level. The two values are 40 and 44 mmfd., respectively. For the 465 kc coil the oscillator capacity is greater the values being 50 and 44 mmfd. The r-f coils are the same for both instances.

For the highest frequency band with the total separate coil system, second illustration, there is a trimming condenser across the modulator secondary, but due to the close coupling between modulator and oscillator, needed for peppy results, this extra trimmer is sufficient, and may be set near the high frequency end of this band (not at extreme high frequency however) to provide maximum response. No tracking adjustments should be made at the extremes of any bands.

Frequencies Covered

The frequency coverage with the foregoing system, applied to the usual run of broadcast band tuning condensers, will be approximately as follows:

Band 3 (broadcast): 540 to 1620 kc. 555.2 to 185.1 meters.

Band 2 (police, amateur, etc): 1600 to 4800 kc. 187.4 to 62.46 meters.

Band 3 (high frequencies): 4,800 to 14,400 kc. 62.46 to 20.82 meters.

The second diagram refers particularly to the conversion of a set that has a pentagrid converter tube. This is the example of the coupling being cumulative, that is, inductive coupling added to the electronic coupling. The positive on the feedback grid (No. 2) should be less than the plate voltage, and is made so by the dropping resistor of 20,000 ohms, bypassed by a large condenser. A precaution to take is to measure the voltage between the feedback grid and cathode, and compare it with the voltage between screen and cathode. The voltage from screen to cathode should not be more than the other, and if it is, reduce the value of the limiting resistor to 10,000 ohms, or other quantity, until the condition laid down is fulfilled. It is advisable for purposes of aiding stability to have such a limiting resistor in circuit, also to have the leak so somewhat larger than usual. The value shown is 0.1 meg. The grid return is to grounded B minus, instead of to cathode, as oscillation is supported

(Continued on next page)

A Photoelectric Alarm

An Inexpensive Expedient for the Silent Watchman

By A. T. Ammold

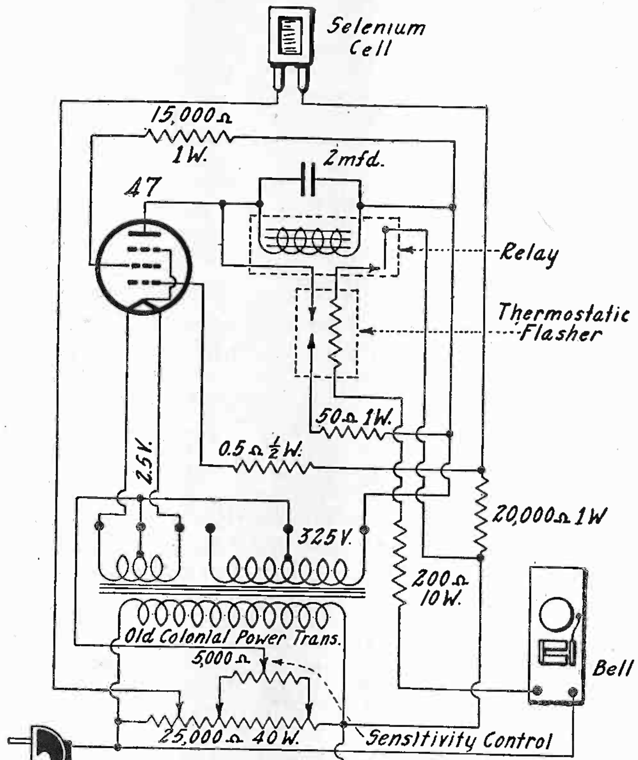
THOUGH television is an important application of photoelectric principles, there are other directions into which these phenomena may be applied. One such application might be the control of processes by changes in light and it is proposed to describe herein one such problem as was designed to indicate the presence of an automobile at the door of a public garage at night.

The apparatus was taken from stray parts almost all of which might be found in any fan's pile. The designer of the equipment first sought out a power transformer from an old receiver. The sketch shows that this transformer contained a 110 volt primary with 2.5 volt and center tapped 650 volt secondaries. This transformer serves to furnish the necessary potentials for the selenium cell and the amplifying tube.

Further control of this voltage is provided by means of a 40 watt, 25,000 ohm resistor that is shunted across the 110 volt line. A sensitivity control is provided by a 5,000 ohm potentiometer shunted across a portion of this bleeder resistor so that the apparatus may be made to function in a more or less sensitive manner. Another resistor of 1 watt rating and of 20,000 ohm resistance is connected in series with the other side of the cell to the line and our primary circuit is supplied with power. A one watt, 15,000 ohm resistor and a ½ watt, 0.5 ohm resistor then serve to bias the respective grids. The control part of the circuit is then connected, consisting of the relay and its associated condenser, the thermostatic flasher button, the bell and the limiting 200 ohm, 1 watt resistor. This completes the wiring installation and the apparatus is ready for trial.

The equipment is then to be mounted so that it may be in a position to catch the headlight beam of a waiting automobile that desires entrance into a garage. When suitably mounted, the apparatus will be affected by the light from the automobile headlights striking the selenium cell which causes the grid bias upon the 47 to change thus affecting the plate current that flows through the relay coil. This effect will manifest itself as an increase in plate current which will cause the relay to close its contacts. No sooner does the relay close its contact than the bell circuit is completed and the bell starts ringing.

But this bell current also passes through the heater coil of the thermostatic flasher button which causes the bimetallic strip incorporated in its construction to close the button contact causing the main relay to open. The opening of the main relay causes the thermostatic heater coil current to stop so that the button contact after a while becomes open again. The opening of the button contact removes the shorting influence of the thermostatic flasher across the relay coil so that the relay coil once more becomes energized to again ring the bell that stopped ringing when the relay became unenergized by the shorting effect of the flasher button. This intermittent action of the thermostatic button in conjunction with the relay causes the bell to ring intermittently at a frequency that is determined by the characteristics of the flasher and the size of the current flowing through its heater element. The characteristics of the bell will also affect the operation to a limited extent. It will be seen upon reflection that the bell remains ringing during the period that the relay closes and the flasher heater coil heats up sufficiently to close its contacts. The length of time that the bell will not ring will occur during the period that the flasher button cools off sufficiently to open its contact. This intermittent operation of the bell will continue so long as the headlights of the automobile remain upon the selenium cell. When the light is removed the resistance of the cell again resumes its high value so that the grid bias reduces the plate current through the 47 sufficiently to de-energize the relay and stop the sequence of operations enumerated.



An alarm bell is caused to automatically ring in intermittent fashion upon the flashing of a beam of light upon the face of the selenium cell.

LIST OF PARTS

Coils

One power transformer.

Condensers

One 2 mfd. condenser.

Resistors

One 40 watt, 25,000 ohm resistor.
One 1 watt, 20,000 ohm resistor.
One 1 watt, 15,000 ohm resistor.
One 10 watt, 200 ohm resistor.
One 1 watt, 50 ohm resistor.
One ½ watt, 0.5 ohm resistor.
One 5,000 ohm potentiometer.

Other Requirements

One 200 ohm relay.
One 29c thermostatic flasher.
One bell.
One 47 radio tube.
One selenium cell. (with optional lens).
Box and hardware.

(*Continued from preceding page*)
a little better this way for the highest frequency band, due no doubt to the lessened grid current.

Values of resistors and condensers are given on the second diagram. The bypass condenser for the first stage biasing resistor should be much larger than usually found, for fullest pep, and therefore 0.5 mfd. is suggested. Minimum is 0.1 mfd.

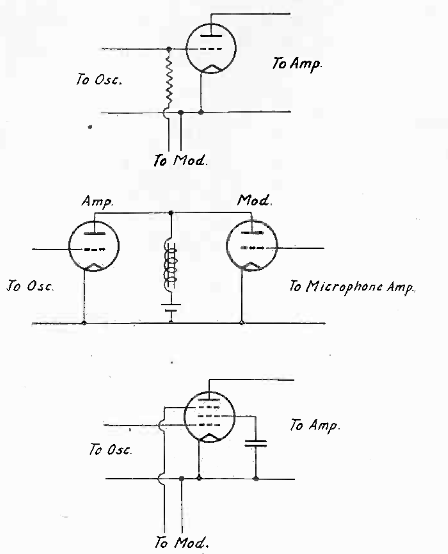
Both circuits show oscillator heater grounded through a condenser. If a circuit using series heaters of the 6.3 volt type is used, this condenser should be placed where shown and in addition another condenser of 0.05 mfd. put between one side of the power line and the set side of the limiting resistor that is in the other power lead. The reason is that electrons of the receiver frequencies flow in the heater lead otherwise. This has been verified experimentally.

[*A great deal of interest has been awakened by the campaign begun in last week's issue, dated March 2, concerning the conversion of standard broadcast receivers to all-wave use. The present article by Mr. Wood answers questions that rained at him because the previous article struck such a popular appeal. Mr. Wood has consented to continue this series and will have an article on an interesting phase of this modernization work each week for the next several weeks, at least. An opportunity is offered to service men, stores, manufacturers and others to modernize their and others' standard broadcast receivers to cope with the ever-growing all-wave demand. Technical questions, even concerning sets that readers have and which they desire to make over, may be addressed to Mr. Wood. Enclose a stamped, addressed envelope. Direct mail to Mr. Leonard C. Wood, care* RADIO WORLD, *145 West 45th Street, New York, N. Y.*—EDITOR.]

Three Modulation Methods

Control Grid, Suppressor and Plate Coupling

By Edward L. Woolsey



Modulation of a high frequency alternating current by a low frequency alternating current may be accomplished by means of connecting the low frequency apparatus to any of the elements of a radio tube.

RADIO phenomena exist because of the ability of electric currents of high frequency to radiate from their conductors in the form of electric and magnetic fields. This ability is pronounced for frequencies above about 10 kilocycles. The higher the frequency, the greater will be this radiation distance and it is because of that fact that the high frequencies can travel greater distances with less power. Reduction of traverse occurs at micro waves. The very long transmission lines around the country that distribute electric power at 25 and 60 cycles do not radiate their energy any appreciable distance because of the low frequencies. Therefore, to use alternating electric current for radio purposes—that is, to communicate between great distances—it is necessary to make use of high frequencies.

But, these high frequencies will not produce an intelligible signal at the receiver unless carrying the lower frequencies associated with sounds. These frequencies occur between 30 and 10,000 cycles. The process of supplying the high radio frequency with the low sound frequency is called modulation.

There are many methods for achieving modulation of the high radio frequencies with low sound frequencies.

Heising Modulation

Modulation of radio frequencies may be accomplished by impressing the audio tones on any of the elements of the radio frequency tubes. One of the first methods of this process was to impress these tones upon the plate of the high frequency stages. This was named Heising modulation after the name of the man who originated the circuit. Referring to the middle diagram, it will be noted that the audio portion of the circuit is impressed across the plate circuit of the high frequency stage by means of a common plate supply in series with which there is inserted a high inductance choke. This choke tends to maintain constancy of plate current drawn from the B supply due to that characteristic of inductances. Thus, if the modulator stage plate current varies due to impressed voice or other sound frequencies, the oscillator stage will have to vary accordingly to maintain the total plate current constant. In other words, assuming that steady conditions involve a plate current of 100 milliamperes, if the modulator is so affected by sound frequencies upon its grid as to draw 80 milliamperes, it will be possible for the oscillator tube to draw only 20 milliamperes to maintain a constant total plate current of 100 milliamperes. Similarly if the modulator plate current becomes only 10 milliamperes for the same reason as before the oscillator plate current will become 90 milliamperes. Thus, is the high radio frequencies of the plate modulation scheme of Heising affected by the low audio frequencies of the modulator to become a carrier upon which there appear audio modulations.

Another method of modulation is impressing the audio frequencies upon the control grid of a three element tube. Because of the amplification factor that a tube possesses, a small variation of modulation in the grid circuit produces a comparatively large variation in the plate circuit. Thus this method of modulation has the advantage over the Heising scheme in that a much smaller modulator tube may be used to affect a given oscillator tube. The first diagram indicates the manner in which the modulator voltage is impressed across the grid of the tube to affect the plate current. In utilizing this method, however, it is imperative that suitable precautions be taken to prevent undue distortion because of improper biases, incorrect coupling methods and wrong tube combinations. A high impedance should exist in the grid circuit.

Suppressor Grid

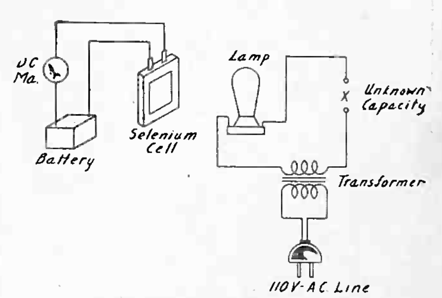
With the advent of the pentode tube, additional elements hinted the possibility of a new method of modulation and sure enough there was introduced the process of modulating by means of the suppressor grid in such a tube. This method is pictured in the last sketch where it will be noted that the audio modulation is impressed upon the radio frequency carrier by means of its connection across the suppressor grid-filament circuit. Thus, the modulated stage's control grid is left free to receive the oscillator's output and at the same time receive the audio modulations in the same stage. This also effects an economy in apparatus and achieves the same advantage obtainable from the control grid method of modulation, except that it takes more amplitude fully to modulate the suppressor. The system's value is perceived when it is seen that the amateurs are more or less abandoning grid modulation and becoming suppressor grid modulation converts.

An Unusual Type Of Capacity Meter

For those that are experimentally inclined it will be quite interesting to connect together the apparatus shown in the sketch to achieve an intriguing demonstration of various principles in the measurement of an unknown capacity, with a new angle to it. Many have been the schemes for the measurement of small capacities but here is a method that specializes in the measurement of large capacities. The apparatus involved includes an ordinary incandescent lamp, a transformer whose inductance is known, a selenium cell, a d-c milliammeter and a battery. In mounting this equipment, it is essential that the cell and the lamp be fixed at specific positions and not moved therefrom once the apparatus is calibrated.

We have to use the same type of lamp when replacing. The equipment can be calibrated so that the milliammeter will read directly in terms of the unknown condenser that is connected across the terminals, marked "X." Known capacities are used as standards for calibration.

The theory of operation of this gadget may be outlined as follows: When an unknown condenser is connected in series with the transformer, a series resonant circuit is set up which will allow maximum current to flow through the circuit only at its resonant frequency. Since the frequency of the power line is constant, the impedance of the circuit will vary with different sizes of condensers



An unknown capacity may be measured by photo-electric means as shown in the indicated circuit.

in the circuit. This will afford different intensities of illumination to the lamp which will be measured by the cell circuit to give a direct reading of the illumination of the lamp, the impedance of the lamp circuit, from which is derived the capacity of the condenser in terms of meter current.

If various known condensers are connected across the unknown terminals initially it is not necessary to know the inductance of the transformer to compute the capacity of the condenser. By connecting various sizes of these condensers across the terminals and noting the respective readings on the milliammeter, it is possible to achieve a direct calibration of the meter dial in terms of capacity.

MONEY-MAKING PHO

Sandwashing, Weighing, Burglar-

Some Parlo

By Sa

[Numerous requests have been received for continuation of photoelectric experiments. It is believed that the experiments shown below are of even greater appeal than those previously detailed by the author.—EDITOR.]

EXPERIMENT 16

The Construction of a Light-sensitive Turbidity Alarm

In the operation of sand filters it is necessary periodically to wash the filter beds. This is done by reversing the flow of water through the filter, passing the wash water through a glass until the water is running clear, indicating the washing is complete. This requires a man to watch the flow of dirty water constantly, and to be sure that the washing process is stopped at the proper time.

An AM cell can do the watching and sound an alarm when the water is clear, by the arrangement, as shown in Fig. 23. A light is mounted on one side of the sight glass and the cell on the other side. The cell is connected to the sensitive relay which in turn controls an alarm circuit using the front contact of the relay.

The operation is fairly evident. When the back washing is started and turbid water is flowing, the cell is switched on. The dirty water prevents light from the lamp reaching the cell and the relay remains open. When the water runs clear the light will reach the cell and the relay will close to sound the alarm. This prevents a waste of water, for the water used for back washing a filter must be run to the sewer.

EXPERIMENT 17

A Photo-electrically Operated Weighing Alarm

In handling some commodities, such as coal, it is customary to load a given weight of material on the truck or wagon. This operation is greatly facilitated when some means is provided to indicate to the loader when the desired weight is reached, without having to depend upon the constant watchfulness of a weighmaster.

This can be accomplished by arranging the scale so the beam of the scale will expose an AM cell to a beam of light when the proper weight will be reached. The simplest method of accomplishing this is shown in Fig. 24, where a box containing a light is arranged on one side of the beam of the scale, and a second box containing the cell is mounted on the other side. Holes are cut in these boxes so that when the scale beam is down it will lie directly in the path of the beam of light issuing from the light box and prevent the light from entering the box containing the cell.

The cell is connected to a battery and relay, with the front contacts of the relay connected to a bell or light circuit as shown in Fig. 24.

As long as the scale beam remains down, the bell will not ring but when sufficient weight is put on the scale to cause the beam to rise the light will be permitted to fall on the cell and the alarm will sound or the indicator light will be switched on by the closing of the relay.

This system does not affect the accuracy of the scales in the least, because the light beam obviously adds neither friction or weight to the beam of the scale.

EXPERIMENT 18

Lighting Stores from Police Inspection with an "R" Cell and Relay

Everyone has noticed rows of stores darkened for the night wherein thieves may work with perfect security. True, one will find the policemen on the beat trying the doors, but this is no indication of conditions within the store. How much better it would be if the patrolman could illuminate the whole interior of the store with no more effect than to switch on his flashlight. This becomes possible by employing the AM light sensitive cells in another of their many roles.

The apparatus for the purpose is shown diagramatically in Fig. 25, which also shows the circuit employed. It will be noted that in addition to the usual cell, battery, switch and relay, a second relay and transformer are used to handle the additional current in the lighting circuit of the store. This second relay must be capable of handling the current required to light the store lights without burning the contacts on the relay.

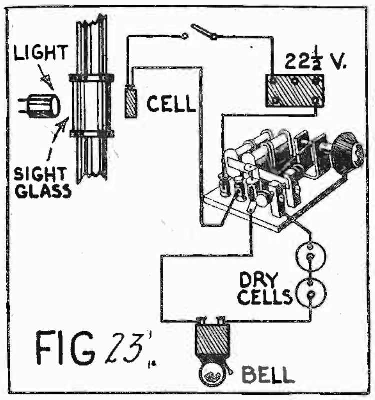
The cell is mounted in an inconspicuous place in the show window of the store with the rest of the appaartus in a cabinet within the store in a place conveniently near the store switches. The battery, switch and sensitive relay are connected in the usual manner. The contacts of the sensitive relay are connected to a transformer secondary and the windings of the heavy duty relay. The contacts of t large relay are connected into the ligh ing mains to the store switches as show A switch is provided to short out t contacts of the large relay during the ev ning hours the store is open for busines

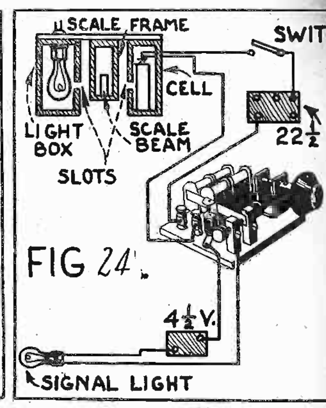
The battery voltage and sensitive rel are adjusted till a flashlight beam w operate the relay. When the small rel functions it will close the circuit to t large relay and operate the light circu

To put the apparatus in operation aft the store is closed at night it is necessar only to close the switch on the batte and the cell and open the switch acro the contacts of the large relay. T switches to the store lights are left clos or only such lights as is desired to opera at night.

When the patrolman passes the store has but to turn his flashlight on the c and the store lights are switched o giving him a good view of the sto Should the apparatus fail to operate, is a good sign some one has tampere with the circuits, and further investigati should be made, that intruders may

Fig. 23 displays the turbidity alarm. Fig. 24 concerns the connection of parts to use for weighing alarms. The lights in a store are switched on when a flashlight shines on the cell in the arrangement of Fig. 25. An electric light can paradoxically be lit by means of a match in Fig. 26.





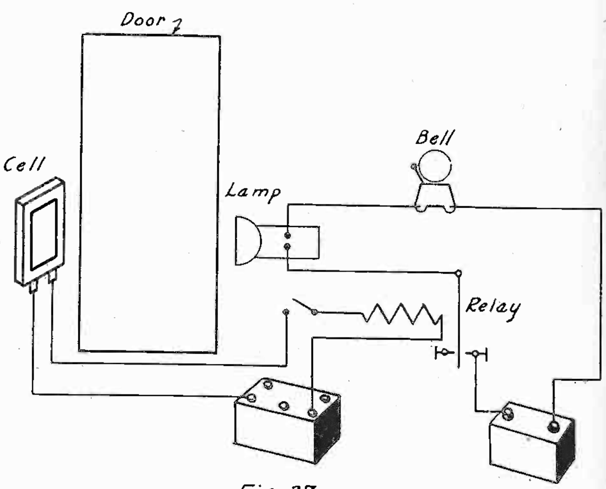
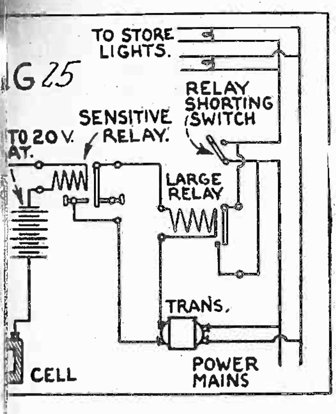
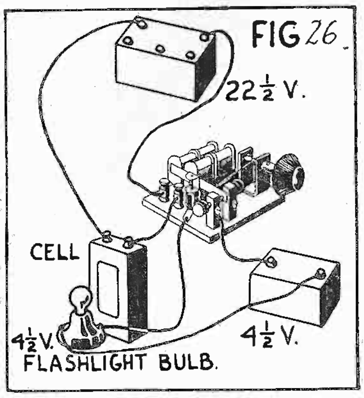


Fig. 27

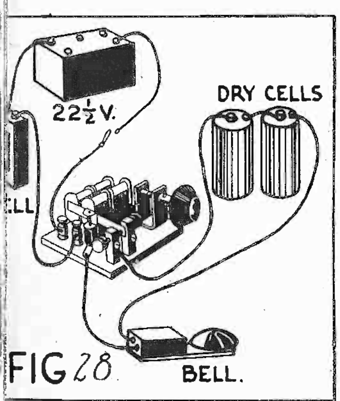
OCELL APPLICATIONS
oofing and Fire Alarm Methods—
Tricks, Too

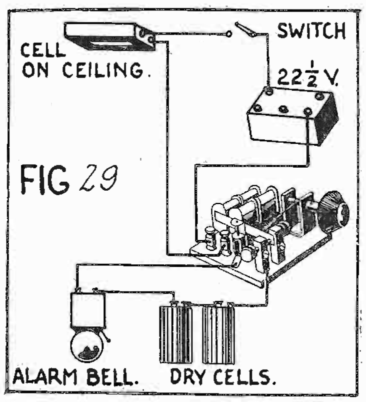
Wein





An alarm system that indicates the intrusion of strangers is concocted by the circuit of Fig. 27. Fig. 28 will cause the operation of an alarm bell in a garage to denote the presence of an automobile desirous of entrance. Fig. 29 will wake up the early riser that wants to get up with the sun.





esponsible for the failure of the apparatus to function.

It is by such cooperation with the local police, that crime may be kept in check.

EXPERIMENT 19
Lighting an Electric Light with a Match

This simple experiment is readily arranged and is quite mystifying to the spectator. The apparatus is set up as shown in Fig. 26. A small flash-light bulb is mounted in front of the cell. The batteries and relay are placed out of sight, while the leads to the cell and lamp should be made as inconspicuous as possible.

After connecting the apparatus, the relay is adjusted in the manner previously described. That is, with the cell and the lamp in a dim light, wrap some opaque material around the lamp so that no light from the bulb will reach the cell. Strike a match and bring it close to the electric bulb. The light falling on the cell will close the relay thus switching on the electric bulb and the light from the bulb striking the cell will keep the relay closed. To switch off the bulb simply insert a card or other opaque object between the bulb and the cell and the light will go out. A more striking way to switch off the light is to put several fingers around the bulb and pretend to squeeze the light out. It can be relit by bringing another light close to the cell.

There should be no difficulty in performing this experiment.

EXPERIMENT 20
Starting an Electric Motor with a Match

This is a rather interesting experiment in which an electric motor is started by striking a match and stopped with a wave of the hand. It is a modification of a previous experiment and is rather startling.

The cell is arranged with a flashlight bulb above it as shown in the illustration. The rest of the wiring is rather easily done, the motor used should be one of the small battery motors which may be belted to other toys. When the apparatus is assembled the adjustments may be made in the usual manner.

The cell is covered and the adjusting screw on the relay is turned to the left till the motor starts and the bulb lights up, then turned back till the light goes out and the motor stops. The outfit is then ready to test.

Strike a match and hold it over the cell and the relay will close and start the motor, the light coming on at the same time will serve to keep the motor running. Simply waving the hand between the bulb and cell will cause the relay to drop back and stop the motor. The trick can be repeated as often as desired.

EXPERIMENT 21
The Oscillating Light

This amusing experiment is a slight modification of the previous one. Place both light sources coming from the "on" and "off" before the cell. What actually happens is this. Normally the armature of the relay closes the circuit through the "off" position, thus putting the light in the other circuit in the "on" position. Both these light sources falling alternately on the cell, and in this fashion oscillating the armature to and fro and operating both lights on and off. The frequency of the light depends directly on how close the two lights sources are with respect to the cell. In other words, the frequency of the oscillating lights may be varied at will merely by increasing or decreasing the distance between the lights and the cell. Further, the "on" or the "off" period can be increased merely by increasing or decreasing one of these two lights falling on the cell.

EXPERIMENT 22
Alarm System to Warn of Visitors or Intruders

In the previous experiments the change from dark to light on the cell has been the controlling factor. In this case use is made of the fact that interrupting a light beam can be used for alarm purposes as well. The setup of the apparatus is a little more complicated but should present no difficulties if the illustration is carefully studied.

A source of light is required for this experiment and the case of a focusing type flashlight serves very nicely. Instead of using the regular batteries in the flashlight which would soon be worn out two wires are connected to the flashlight, one to the case and the other to the center contact directly in back of the bulb in the light. These two wires are connected to the standard dry cells and relay as shown in Fig. 27. The flashlight case is mounted on one side of a doorway or other passage to be protected while the Cell is mounted on the other side about 4 feet from the floor. The light should be focused so it is concentrated on the cell.

The cell, batteries and relay are connected as shown. It will be seen both contacts of the relay are used, one for the light and the other for the alarm signal, a bell or buzzer.

When the apparatus is all set up it is to be adjusted in the following manner. Press the pushbutton which will keep the light on continually. Turn the adjusting screw on the relay to the right until the bell rings, now turn it back slowly until the bell just stops ringing. Remove the finger from the button and the light should stay lit.

The circuit is now balanced, the light falling on the cell is just sufficient to cause the cell to pass enough current to keep the relay armature pulled up against

(Continued on next page)

New WOR Antenna

Installation for 50 kw Concentrates Energy

TWO steel towers and a suspended cable emitting a pattern of radio waves that will concentrate on New York, Philadelphia and other cities, uncannily diminish over the Pocono Mountains and other thinly settled areas and re-occur beyond, are among the features of WOR's new broadcasting station at Carteret, N. J., scheduled to go on the air with regular programs the latter part of February.

This directional antenna system, first of its kind to be used by a commercial radio station, has been specially designed by Bell Telephone Laboratories to operate with the 50-kilowatt Western Electric transmitting equipment and to focus its power where the greatest number of listeners reside.

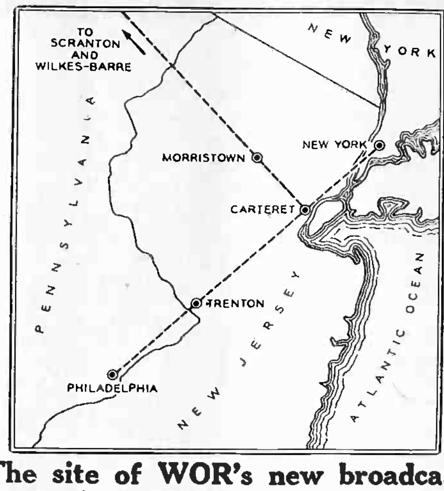
The importance of obtaining this focus of power lies in the fact that more electrical noises are produced in congested areas than in thinly populated sections. Electric trains, power lines, elevators, electrical appliances, all contribute to the "noise level" picked up by radio sets.

Must Greatly Exceed Noise Level

For consistent reception the signal of a broadcasting station must be far above the noise levels. Consequently stronger signals are necessary in cities than in the suburbs or in the country.

In WOR's antenna system, the cable is suspended midway between the two towers, each 385 feet high and 790 feet apart. The three antennas are arrayed in a straight line and are spaced in accordance with wave length factors. Carteret itself is located on a line between New York and Philadelphia and the antennas run at right angles or broadside to this geographical line. Their broadside discharge of radiation is much more powerful than the lengthwise discharge. In fact, to secure on all sides a radiation equal to that which is trained on New York and Philadelphia would require 120 kilowatts in the antenna.

In contrast, a uniform radiation of 6 kilowatts would be equivalent to the signal strength which is radiated along the line of the antennas to the New Jersey communities near at hand. Beyond these communities where the intensity begins to fade out lie on one hand the Atlantic Ocean and on the other the Pocono Mountains.



The site of WOR's new broadcast transmitter at Carteret, N. J., is on a straight line running through Philadelphia, Trenton, and New York. The maximum strength of signal is radiated along this line. At right angles to it, direct radiation covers the populous suburban area out to Morristown, while the sky wave reaches Scranton and Wilkes-Barre during the night time.

Antenna Spacing

Drawn on a map, the field of radiation takes the form of an hour glass, with Carteret and its surrounding communities falling within the neck of the glass, and with the bulbs enclosing the New York and Philadelphia areas.

The effect is obtained by the spacing of the antennas. This is calculated so that the waves they emit broadside are in step, the crests and troughs matching precisely and re-inforcing each other. The waves emitted lengthwise by two of the antennas, however, are out of step. They not only tend to neutralize each other in that direction but, as though squeezing in from the ends, react to re-inforce further the power emitted broadside.

Up to this point only the ground waves or those emitted horizontally have been taken into consideration. The design of the antenna also takes account of the effect of the sky waves, those emitted upward.

At night these waves are reflected back to earth from a layer of ionized atmosphere at an approximate height of 60 miles. Where returning sky waves mingle with ground waves, interference occurs unless one predominates with an intensity at least four times as great as the other.

The arrangement of the antenna actually aims the sky waves at certain strategic angles. For more than 50 miles around the station, ground waves will over-ride them. For example, the territory from Carteret to Morristown will receive ground waves. Beyond, sky waves will increase in relative strength so that at Wilkes-Barre and Scranton they will clearly predominate. Similarly, Philadelphia will lie within the pure ground wave area while Baltimore and Washington beyond will receive clearly predominant sky waves.

Greater Service Area

The new broadcasting equipment will extend WOR's service over a much greater area than does its present 5 kilowatt equipment. Calculations indicate that at points as far distant as Miami, Florida, the station's apparent power will be 24 times greater than at present.

The broadcasting apparatus is connected with the antenna system by a concentric transmission line consisting of one copper tube within another, the outer being 2⅝ inches in diameter and the inner 11/16

(*Continued from preceding page*)

the contact connected to post 4 which keeps the light on. Now should any solid object be placed between the light and the cell this current will be reduced and the relay armature drops away which cuts off the light and starts the bell ringing. The light going off completely will keep the bell ringing until the apparatus is reset by pushing the button to switch on the light again.

The width of passage this apparatus will protect depends entirely upon the intensity of the light beam. The average width is 5 feet with dim light in the room. The presence of much light from other sources on the cell will interfere with its proper operation. It may be necessary to use a shield around the cell which may be made of a deep box large enough to hold the cell which is placed well back in the box with the sensitive side towards the opening of the box. The light beam may the reach the cell easily but other light not in a direct line with the box opening will not affect the cell.

EXPERIMENT 23
Alarm Systems for Gasoline Stations

Gasoline stations as a rule are locked up after a certain hour but have a watchman in attendance. During the cold weather the doors are closed and a late comer must stop his car outside and blow the horn to call the night attendant.

This becomes unnecessary when the AM cell and relay is used to operate a bell from the automobile headlight.

The cell is mounted inside the garage door which has a hole cut in it about the level of an automobile headlight. The cell is connected to the unit in the usual manner, with a switch provided to open the circuit during the day-time. The relay contacts control a bell in the output circuit.

When the garage doors are closed the cell circuit is closed. When a car pulls up to the front of the garage, the headlights fall on the cell and actuate the relay which in turn sounds the bell to warn the attendant a car is outside. This operation is not quite so annoying to the neighbors as the horn blowing system.

EXPERIMENT 24
A Sunrise Alarm

From the foregoing experiments it should be easy for one to assemble and operate an alarm bell that will be operated by the sun rising in the morning. (Fig. 28).

The cell should be mounted near the window, preferably one facing the east but the alarm will operate satisfactorily with the cell near any window. The relay unit may be located at any convenient point while the bell is mounted near the bed. A switch may be included in the circuit to cut the alarm off during the day.

The apparatus is now ready for use. Close the switch upon retiring and the bell will ring when daylight comes and will keep ringing till the switch is opened.

EXPERIMENT 25
How to Make a Photo-electric Fire Alarm

Most fire alarm systems depend upon a rise in temperature to operate the alarm device. By using the AM cell and associated apparatus, a fire alarm is readily arranged that operates from the light given off by the flames.

The cell is mounted on the wall or ceiling of the room to be protected and is connected to the unit in the usual manner, (Fig. 29). A switch should be provided to open the circuit when the alarm is not used. The contacts of the relay are connected to a bell and battery as in the usual alarm system.

usual alarm system. Of course, it is advisable to shield the cell from being affected by the lighting system in the room otherwise false alarms will continually occur.

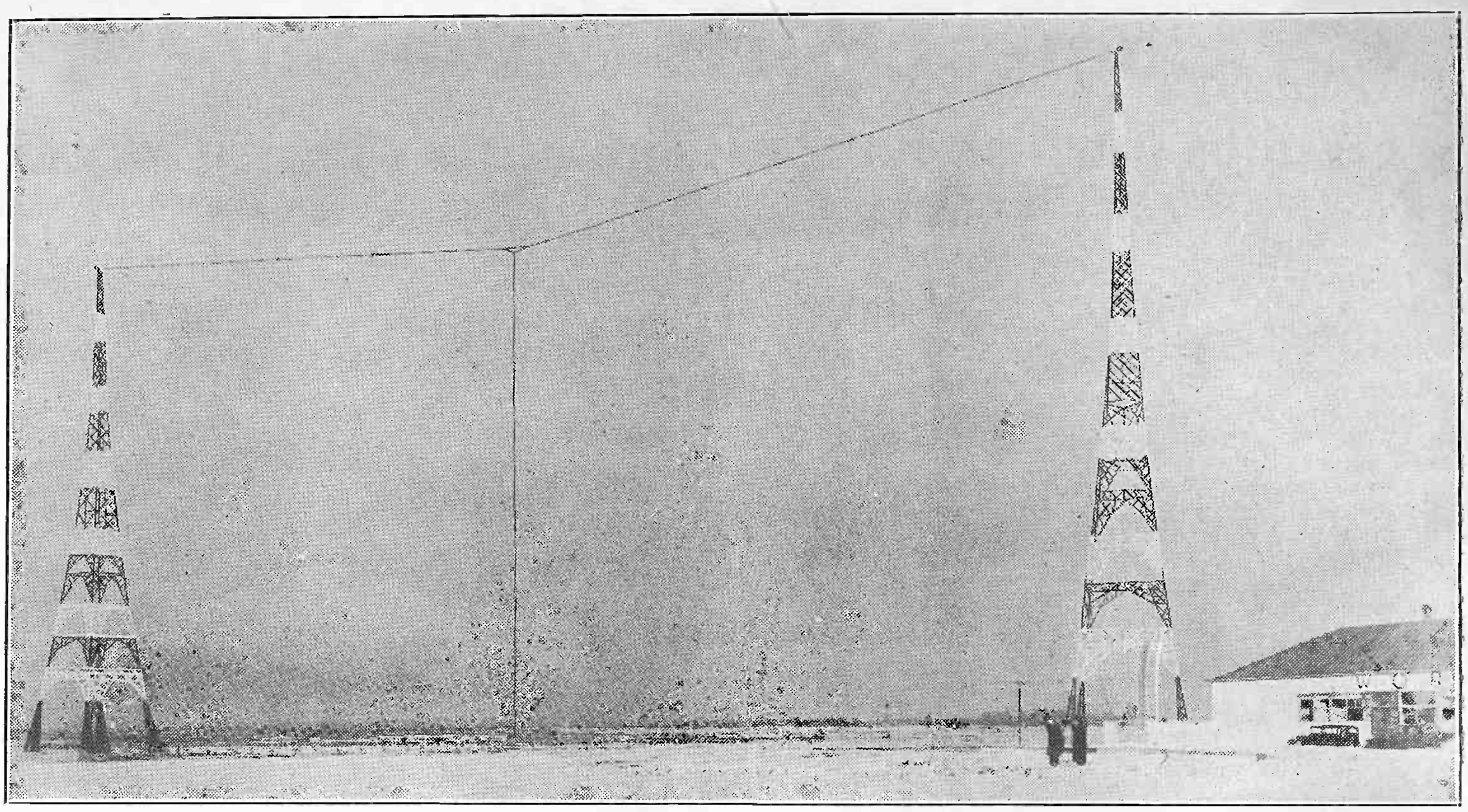


Illustration from Western Electric Co.

General view of the antenna system showing the two steel towers each 385 feet high and the WOR transmitter house off to one side. The photograph has been retouched to bring out the catenary and the central cable antenna supported by it.

inches in diameter. This line runs 600 feet from the transmitter building to a point mid-way between the two towers, being laid 5 feet underground. Not a single wire leaves the transmission house above ground.

Through a special network the transmission line divides at this point in three branch lines of similar construction. One is coupled to the central cable antenna. The other two extend 390 feet in opposite directions to each of the end towers. This length is above ground and is covered with heat-insulating material to eliminate sharp differences in temperature between the inner and outer tubes which would create uneven expansion and contraction.

The entire transmission line is filled with nitrogen under ten pounds of pressure and sealed. Moisture is thus entirely eliminated.

The transmitter is located on a swampy site. At hightide, a large area is actually under salt water. The transmitter is grounded in this swampy soil by an extensive system of underground conductors. There are 40 miles of No. 8 drawn copper wire under ground, part running at right angles to the line of antennas, and another radiating out beneath the end towers. Half of this system is below water level a greater part of the time.

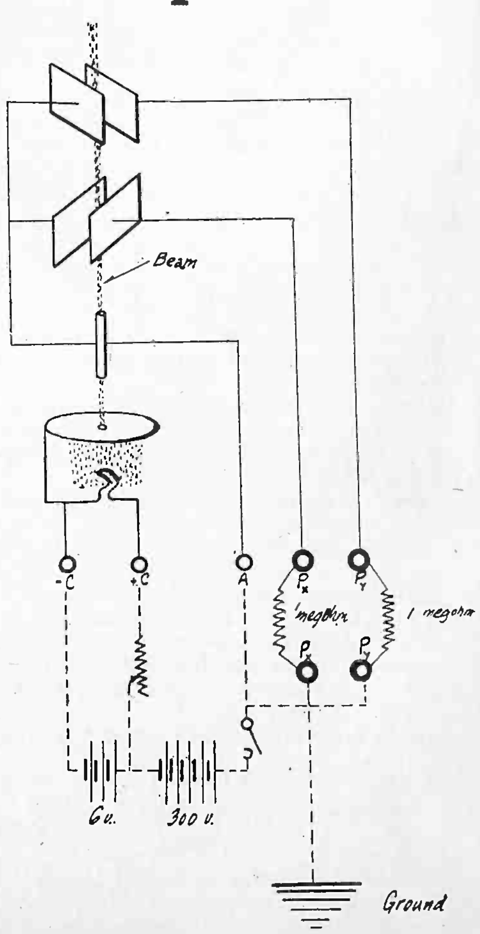
The main ground bus, 1/16 inch thick by 6 inches wide, runs between the two towers and extends beyond them at either end. All lateral and radial ground wires are welded to the main bus and the north ends of the copper wires all terminate in the Rahway River. A length of ¾ inch stranded cable of bare copper is laid along the bottom of a creek which runs through the site and ends in the Rahway River also. All of the radial ground wires which cross this cable are welded to it.

Altogether 14,000 welds were made in the building, equipment and antenna system. The building itself constitutes virtually a metal sheath enclosing the transmitting equipment in a shield. Save for the office it has no windows. The metal sheathing of the walls, the copper roof, even the re-inforcing rods in the foundation, are welded to form a single continuous ground. The structural steel contains projections which protrude from the partitions so that they also can be welded in as part of the single unit.

Within the transmitter house a novel arrangement of panels and power equipment has made it possible to eliminate all overhead conduit and all overhead high voltage busses. Motor generators and transformers are arranged in the basement directly beneath the transmitter so that all leads come up through the floor directly into the respective panels where they terminate.

The Cathode Ray Tube Fundamental Operation

A sketch shows the elements of a cathode ray tube together with the manner in which they are interconnected. It will be seen that first there is the electron emitting cathode, not dissimilar from the ordinary vacuum tube's cathode. In one type of cathode ray tube this cathode is energized from a 6-volt battery in series with a conventional filament resistance. Connected to this cathode is a disc that is solid with the exception of a pinhole in the center. This electrode serves to force the electrons into the form of a beam rather than a cloud. Being connected to the negative side of the cathode it also serves to concentrate the electrons more closely. This beam of electrons then passes through a tubular anode to which a high positive voltage is connected which serves to attract the electrons from the cathode and supply them with a high velocity, causing them to pass through the anode towards the two sets of deflector plates which are mutually at right angles to accomplish movement of the beam in any direction in one plane that is normal to the electron path. High resistances are connected between deflector plates to prevent the accumulation of static charges upon them and thus affect the electron beam in an unwanted fashion. The beam then continues on to the fluorescent screen where the visible spot appears representative of the position of the beam.

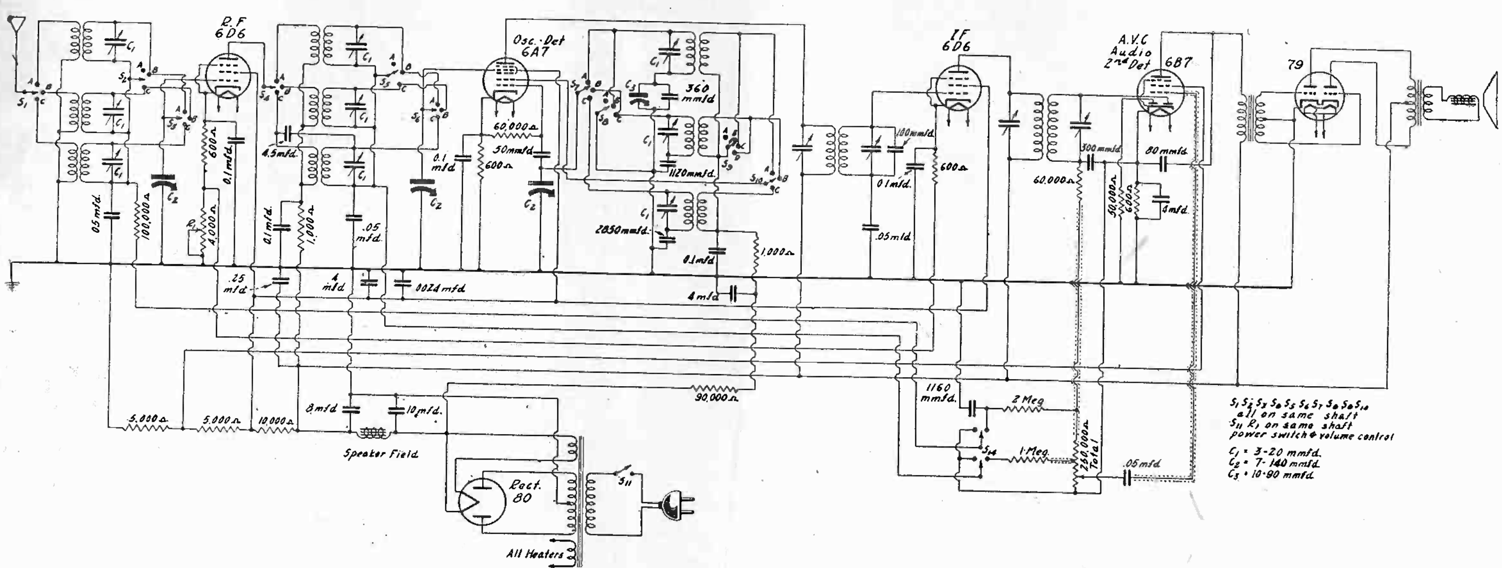


The fundamental elements of a cathode ray tube and their interconnection.

A Compact All Wave Super

Six Tubes Furnish Fancy Trimmings of Larger Sets

By Harry Murman



A six-tube superheterodyne receiver for all wave operation that includes a stage of preselection, automatic volume control and class B audio amplification.

THE all wave range of the radio spectrum, as it is commonly understood these days, represents quite a field for exploration to those that would not leave the hearthstone. By the simple expedient of a careful twist of the dial, it is possible to kidnap the atmosphere of many far off lands. Such performance is not at all remarkable nowadays, but it is of some moment to point to such a set that at the same time is economical of the amount of power it eats up from the powerline.

We present a six tube set that has all the trimmings. It tunes in all the frequencies between 540 kc. to 30,000 kc., has automatic volume control, a stage of pre-selection, Class B audio amplification and the superlative qualities of the superheterodyne circuit.

The controls of this receiver have been concentrated into the one tuning control, the one wave band switch, the switch that chooses between automatic volume control and manual volume control, and the combined volume control and power switch. No plug-in coils are necessary which relieves the operator of quite a bit of the nuisance that is involved with such apparatus. It is possible by the use of a suitable vernier dial to operate the tuning control quite accurately, which is very necessary in the hunt for distant stations.

Good selectivity is afforded by this receiver since the tuning control operates three circuits simultaneously. The radio frequency stage, the first detector stage and the oscillator stage. This allows for a high signal to noise ratio that is so valuable on those weak signals. It should thus be fairly easy to separate all stations in most locations.

When a signal strikes the antenna of this set, it is conducted down the feeder to one of three antenna coupling transformers depending upon the position of the wave band switch. Here the signal is tuned in by means of one of the sections of a three gang variable condenser from where it is impressed across the grid circuit of the radio frequency tube—this stage of preselection serves primarily to reduce image frequency interference to a negligible value. The output of this stage is then fed to the detector tube by means of a suitable transformer consisting of three units for three different bands that are chosen by means of a suitable switch on the same shaft as the one in the r-f stage. Here, the second unit of the three gang condenser is applied to the detector transformer.

As is the case in most superheterodynes of today, the first detector stage also functions as a mixer stage which causes the incoming r-f carrier to mix with a locally generated oscillation. This locally generated oscillation is controlled by the third set of coils and the third unit of the three gang condenser.

The oscillator plate circuit, being tuned by the third section of the ganged condensers, maintains a constant frequency difference from the transmitted signal

(Continued on next page)

LIST OF PARTS

Coils

Two sets of coils (R. F. and 1st detector) (three primaries and three secondaries each).

Secondaries: 540-3000 kc.; 160 turns No. 30 enam. 1½" dia.
3000-12000 kc.; 21 turns No. 24 enam. 1½" dia.
12000-30000 kc.; 5 turns No. 16 enam. 1½" dia.

Primaries: 540-3000 kc.; 40 turns No. 30 enam.
3000-12000 kc.; 6 turns No. 24 enam.
12000-30000 kc.; 2 turns No. 16 enam.

One set of coils (oscillator) (three primaries and three secondaries each).

Secondaries: 1005-3465 kc.; 72 turns No. 30 enam. 1½" dia.
3465-12465 kc.; 17 turns No. 24 enam. 1½" dia.
12465-30465 kc., 5 turns No. 16 enam. 1½" dia.

Primaries: 1005-3465 kc.; 16 turns No. 30 enam.
3465-12465 kc.; 5 turns No. 24 enam.
12465-30465 kc.; 2 turns No. 16 enam.

(Primaries wound on top of secondary, ground end.)

(Note: These values will vary with different tuning condensers, with different wiring arrangements, etc., and so represent only approximate values.)

Two 465 kc. intermediate frequency transformers.
One set of input and output transformers for Class B operation of 79.
One power transformer.

Condensers

One three gang 140 mmfd. condenser.
Nine 20 mmfd. trimming condensers.
One 80 mmfd. trimming condenser.
One 90 mmfd. trimming condenser.
One 100 mmfd. trimming condenser.
One 300 mmfd. fixed condenser.
One 360 mmfd. fixed condenser.
One 1120 mmfd. fixed condenser.
One 1160 mmfd. fixed condenser.
One 2400 mmfd. fixed condenser.
One 2850 mmfd. fixed condenser.
Four 0.05 mfd. fixed condensers.
Five 0.1 mfd. fixed condensers.
One 0.25 mfd. fixed condenser.
Three 4 mfd. fixed condensers.
One 4.5 mfd. fixed condenser.
One 8 mfd. fixed condenser.
One 10 mfd. fixed condenser.

Resistors

One 2 megohm resistor.
One 1 megohm resistor.
One 100,000 ohm resistor.
One 90,000 ohm resistor.
Two 60,000 ohm resistors.
One 50,000 ohm resistor.
One 10,000 ohm resistor.
Two 5,000 ohm resistors.
Two 1,000 ohm resistors.
Four 600 ohm resistors.
One 4,000 ohm potentiometer (combination volume control-line switch).
One 250,000 ohm tapped potentiometer.

Other Requirements

One ten deck four pole rotary switch.
One two deck two pole rotary switch.
Two 6D6s, one 6A7, one 6B7, one 79, one 80.
One loudspeaker.
Necessary wire, hardware, etc.

The Effectiveness of a Coil

Is Expressed in its "Q", a Ratio of Resistance to Inductance

By E. A. Banjin

ONE of the factors in radio that is not one of its least blessings is that of being able to tune from one station to another without hearing more than one station at once. This process of tuning is really the backbone of radio, since otherwise we would be restricted to receiving only one station ever, and we most certainly would not be much interested. Radio would not serve its present useful purpose.

This process of tuning is technically known as resonating and the manner in which it is achieved seems graciously provided. All radio technicians know that the combination of a capacitance and an inductance either in series or parallel provides us with the tuned circuit. When a pure capacitance and a pure inductance only are connected in series (that is, there is no resistance in the circuit), there will be a particular frequency at which maximum current will flow through the circuit. With no resistance in the circuit, this current will have an infinitely large value. But, of course, such a condition of resistanceless capacity or inductance does not exist in actual practice and so this consideration of infinite current is merely theoretical.

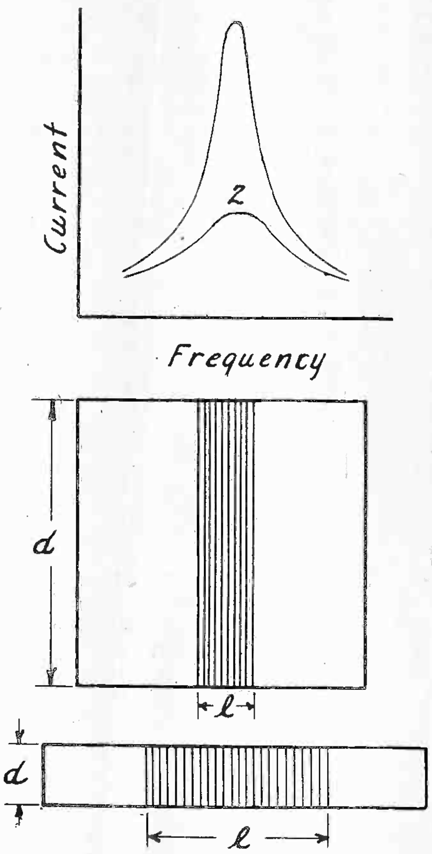
No Perfection in Practice

Yet practically speaking, the current becomes a maximum at the resonant frequency. When the inductance and capacity are connected in parallel, the situation is the reverse, the resonant frequency will induce a minimum of current in the external circuit. Thus, when an alternating current consisting of many frequencies is introduced into such a circuit of either the parallel or series combination, there will be a discrimination for the resonant frequency with regard to the others. The series circuit will accept the resonant frequency while the parallel circuit will retard the resonant frequency. Combinations of these series and parallel resonant circuits are to be found in all branches of radio practice, and, as has been said, forms the framework upon which the science of radio depends.

However, in practice, we do not meet the perfect condition of a resistanceless inductance or capacitance. All these units have a certain amount of resistance which tend to detract from this ability to choose, known technically as selectivity. The selectivity of such a resonant circuit therefore suffers and does not approach the maximum conditions obtainable with resistanceless circuits. But, we can design our parts practically to insure a minimum of resistance with its accompanying maximum of efficiency, insofar as selectivity is concerned. In a consideration of this matter, we shall restrict our attention to inductances. This is so since the resistance of a capacitance is represented by its leakage which should be a negligible item in a condenser.

Curve Differences Explained

If the value of the current flowing through a series circuit of inductance and capacity is plotted on a chart against variation in frequency, the result will appear possibly as in Curve 1. If a resistance is inserted in series with this circuit, tantamount to replacing the coil with one of higher resistance though of the same inductance, or of replacing the condenser with one of higher leakage yet of the same capacity, a curve similar to that represented by 2 will be the result. A study of these curves will reveal that Curve 1 represents a condition of greater selectivity than does Curve 2, since the value of the desired frequency is so much greater than that of any other frequency in Curve 1 than is true for Curve 2. The circuit of Curve 1 is therefore said to be more selective than that of Curve 2.



The selectivity curve obtained from a resonant circuit depends in great measure upon the physical dimensions of the coil.

To specify the degree of selectivity of such a circuit, it is customary to compute the width of the frequency band within which the current exceeds a certain percentage of the maximum at resonance. This percentage may be assumed arbitrarily, it being only necessary that the same percentage be used for each curve under consideration. The most convenient limiting points occurs where the current ranges from 70% of maximum to 70% on the other side of maximum.

A mathematical analysis of this condition reveals that the sharpness of resonance in such a circuit is dependent upon the ratio of R/L. Application of this principle to the design of coils for inductances has introduced the letter Q which is representative of the coil's merits for such purposes. Q is mathematically equal to the quantity $\omega L/R$. The Q of a coil may therefore be defined as the ratio of the reactance of the coil to its resistance and since the percentage of frequency discrimination of a resonant circuit is inversely proportional to the value of Q, this measure of a coil's discriminatory characteristics is of quite some importance.

Larger Q, Better Selectivity

A little consideration of this function reveals that the larger Q is, the better will be the selectivity characteristics. From its definition, since resistance is in the denominator, it can be seen that for a large Q, a coil should have a low resistance which will make the ratio of the two quantities of reactance and resistance as large as possible. It is therefore of interest to consider a coil of a given inductance and investigate the various ways of achieving this size of a coil. The following table reveals the result of such an investigation.

100 MICROHENRY INDUCTANCE

Number of Turns	*Size of Wire*	*Size of Diameter*	*Coil (in) length*	*Coil Resistance*
70	30	1	0.775	1.925
35	30	2	0.39	1.925
25	30	3	0.276	2.07
100	24	1	2.13	0.685
43	24	2	0.915	0.59
29	24	3	0.616	0.595
180	18	1	7.5	0.307
58	18	2	2.42	0.1975
36	18	3	1.5	0.184
330	14	1	22.0	0.222
80	14	2	5.0625	0.108
45	14	3	3.0	0.091

(Compiled from Shiepe's "Inductance Authority.")

It will here be seen that we are considering the various ways that a coil can be constructed so that in each instance its inductance is 100 microhenries. The inductance of a coil is determined by the number of its turns, the diameter of its form, the length of its winding and other factors that need not be considered in this discussion. Since we have three independent variables here, there may be any number of combinations of these parameters to yield the given inductance. And, since the size of the coil is dependent upon the size of the wire, this latter figure may be utilized to concentrate the two variables (inferable from the wire size) involved

(Continued on next page)

Compact All-Wave Super

(Continued from preceding page)

throughout the entire frequency range. Thus, a difference or beat frequency is developed when any signal is received which is the same at each position of exact resonance. Thus the functions of the first detector and oscillator are performed by a single tube.

At this point, it should be noted that the three tuning ranges are obtained through a coil-selector system in conjunction with the ganged condensers. Three sets of coils, each consisting of three pairs of primary and secondary coils, are employed and with each shift of the range switch, a different and complete coil set is substituted.

(*Continued from preceding page*)

in coil size. We shall therefore consider the effect of varying the size of the wire upon the resistance of a coil of constant inductance. Reference to the table shows that we have considered four different wire sizes: No. 30 enam., No. 24 enam., No. 18 enam. and No. 14 enam. Three different coil diameters are presupposed: 1 inch, 2 inches and 3 inches.

Aid for Home Constructor

The table shows that an inductance of 100 microhenries may be achieved from 330 turns of No. 14 enam. on a 1 inch coil form that would be 22 inches long and may also be obtained from 25 turns of No. 30 enam. on a 3 inch coil form which would be a little more than ¼ inch long. This surely is a wide choice of sizes that can be utilized and when one considers the Q angle of the problem he realizes that there can be little doubt that the 330 turn 22 inch coil is far superior to the 25 turn coil that requires only ¼ inch of length. This is so since the former coil's resistance is 0.222 ohms while the latter's resistance is 1.925 ohms. Further investigation of the table shows that of the possibilities considered there, a coil of 45 turns of No. 14 enam. wire on a 3 inch form will be 3 inches long and have a resistance of only 0.091 ohms! That surely is a far cry from the 2.07 ohm resistance of one of the other possibilities.

The home constructor will therefore appreciate that when he builds his radio equipment, he has a wide choice of physical dimensions to achieve a given inductance but there is an optimum point where the coil resistance is lowest with its Q at the highest. Under such conditions the cause of selectivity is materially aided.

Shure Announces New Type Crystal Microphone

A series of new diaphragm-type crystal microphones is announced by Shure Brothers Company, microphone manufacturers, 215 W. Huron Street, Chicago. The instruments are intended for general-purpose use and have a much higher output level than non-diaphragm type crystal microphones.

The crystal element is of the "bi-morph" type, and is "cantilever" actuated. This principle affords a "matched-impedance" mechanical circuit. A low gain single-stage of amplification is generally sufficient to equal the output of a two-button carbon microphone. No coupling transformers are necessary, and the microphones operate entirely without polarizing voltage or exciting current.

Model 70H is a general-purpose unit for direct mounting on microphone stands or installation in rings with suspension springs.

Model 71A is specially designed for "close talking" applications. The crystal unit is the same as that employed in the 70H, but acoustic damping minimizes all sounds except the speaker's voice. Model 71AS has "push-to-talk" switch on handle and seven feet of cable.

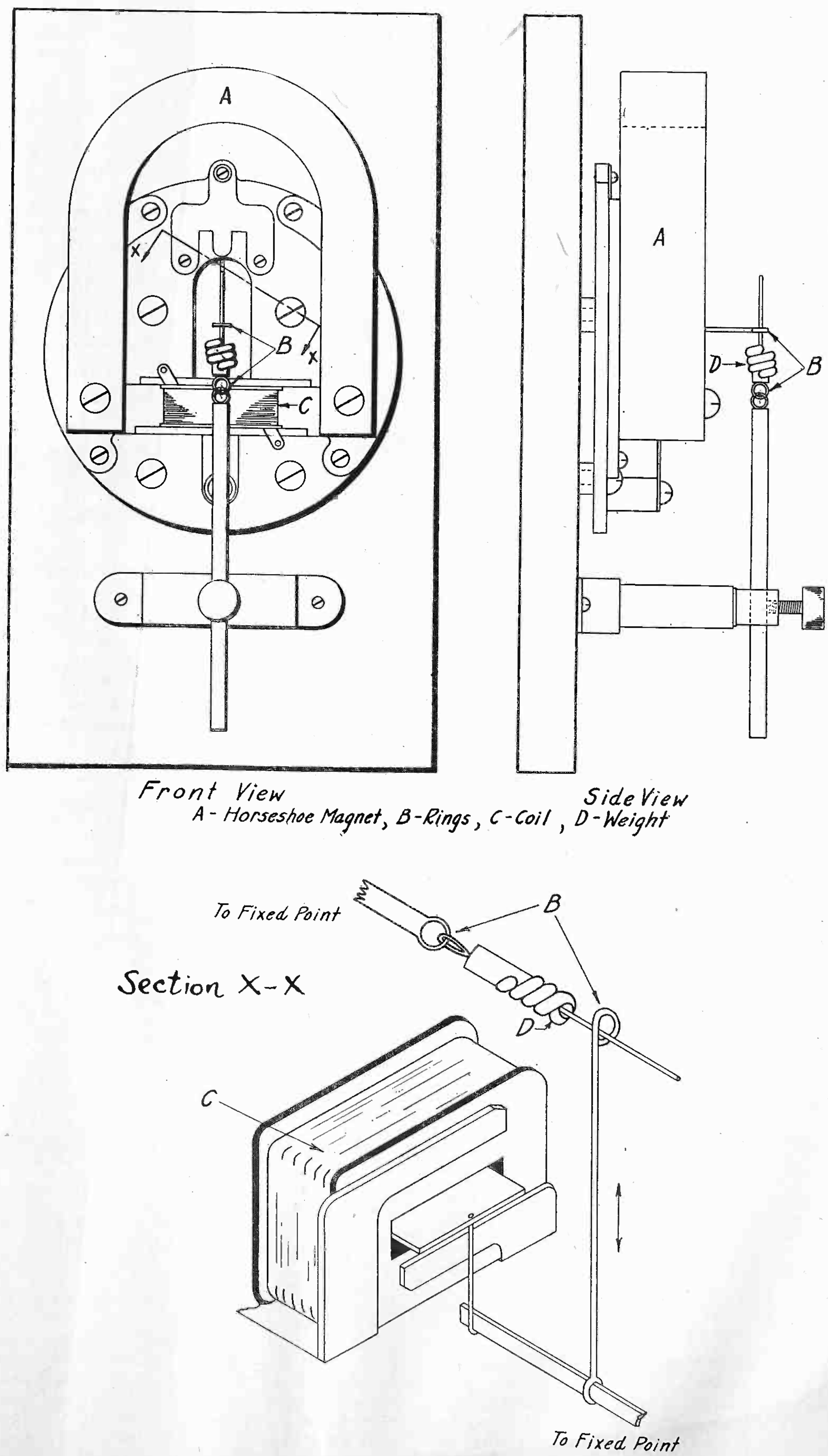
High Resistance Brush

A recent automotive radio development now being manufactured by The Ohio Carbon Company, 12508 Berea Road, Lakewood, Ohio, is a carbon brush containing high-resistance material and designed for use on radio-equipped Ford V-8 cars. It is customary when installing radio-sets on cars to introduce resistance between the distributor and the coil. This was not previously possible in the case of the Ford V-8 car because of the combined distributor-coil unit. The new brush, however, fulfills the same function. The manufacturers state this brush sacrifices no long-wear or other qualities.

An Ultrasen

Switch Operates fro Currents of

By Horace



A new type of relay that is very sensitive to very small currents.

sitive Relay

n Audio Frequency Radio Set

eeley

A NEW type of relay has a sensitivity that is an improvement upon those called sensitive at present. This new relay attacks the problem of sensitivity from an angle that has not heretofore been generally considered for relay application. It is operable from the comparatively small currents that emanate from an ordinary detector tube used in radio. It can thus be applied to remote control apparatus where compactness is desirable. Such an application might be on a small model boat that is controlled by radio and by the use of one detector tube and the relay can be made to operate as desired.

The relay involved in this discussion is pictured in the diagram. The two top sketches reveal the appearance from the front and the side of a model that has been built and operated. The lower sketch is illustrative of the principle involved in the operation. Similar parts are labelled similarly in all sketches and thus serves as a means of comparison.

The top sketches show that the relay consists of a permanent horseshoe magnet between the poles of which there is mounted a small coil that is similar to those used in headphone magnets and speaker units. The armature within this coil is attached to a cantilever bar between whose fulcrum and free end there is attached a rod at the free end of which there is a ring, B. Loosely fitting within this ring is a rod at the other end of which there is a similar ring which fits into a third such ring. This last ring is part of a fixed rod which connects to the external electrical terminal. It will be further noted that this middle rod carries a lump of solder for the purpose of giving it greater mass and greater inertia.

The lower sketch reveals the principle of operation. It is that part of the completed assembly that is seen as one looks at the front view along the line X—X in the direction of the indicated arrows. In this lower sketch will be seen the coil C with its armature to which is attached the rod and ring assembly. When this coil is fed an audio frequency voltage, its armature will start swinging at that audio rate. This comparatively rapid vibration of the armature will be communicated to the first ring through the cantilever arrangement. This will cause the ring to vibrate in similar fashion.

Vibration Transmitted

This vibration will then be transmitted to the rod bearing the weight D. But, because of the relatively great weight of this rod, it will not be able to follow the rapid vibrations and so will remain suspended within the ring without touching it. This mid-air action will also occur at the other end of the weighted rod so that electrical contact from the cantilever bar to the other terminal will be broken.

It is thus obvious that when an audio tone is fed this relay, the control circuit will be open while when no signal is impressed upon the relay coil the contact will be closed. Of course, such a relay will control only small currents and if it is desired to affect larger currents it will be necessary to provide this circuit with a power type of relay that operates from the contacts of the relay described herein.

Station Sparks

By Alice Remsen

VIVIENNE WITH FRANK MUNN

The Bayer's Aspirin Musical Revue has a new feminine soloist, Miss Vivienne Segal, popular musical comedy star. Frank Munn, however, is still the male soloist, and Gus Haenschen's Orchestra continues to supply the musical background, with special features, such as violin solos by Bertrand Hirsch, piano duets and guitar specialties, which proved popular on the earlier broadcasts. An NBC-WEAF network carries this fine program, each Sunday at 9:30 p.m. . . . Dr. Joseph Jastrow, internationally famous psychologist and author, may now be heard in a new series of twice-weekly discussions of personal problems. His broadcasts are presented under the general title of "The Herald of Sanity." Dr. Jastrow not only discusses problems of mental health, balanced life and sane living, but he also answers questions sent in by listeners. He is a professor emeritus of the University of Wisconsin, a past president of the American Psychological Association and a lecturer at the New School for Social Research in New York. His talks are heard each Wednesday and Friday at 3:45 p.m. over an NBC-WEAF network. . . . Phil Duey, NBC baritone, who made his radio debut nine years ago at NBC's old studios, 195 Broadway, has signed a new management contract with NBC Artists Service. . . . Phil Cook has a new and novel radio series called "The Note Book," daily except Sunday, at 8:00 a.m. over an NBC-WEAF network. As usual, the versatile Phil plays all the characters. . . .

CANDID CAMERAGRAPH

Leo Reisman . . . taskmaster of dance band conductors . . . short, swart, solid . . . oblivious to studio audience as he bawls out orders before broadcast time . . . "get in there, saxophone; push it," he barks . . . bends head and body agitatedly . . . stops abruptly to ask for quiet in the wings . . . taps long baton again . . . "once again," he says . . . "Quickly, please, quick-lee" . . . holds baton between thumb and forefinger of right hand . . . waves it loosely, rapidly . . . signals by baton, body, head and whispers . . . shows lower teeth as he stabs air with baton . . . puts left forefinger to lips to indicate pianissimo . . . stands with one foot on podium, the other on podium step . . . beams over rhumba selections . . . black, curly hair falls over his silver rimmed glasses during the more violent body movements . . .

Sally Singer, blues singer on same program, offers contrasting study . . . sings effortlessly . . . body swaying rarely discernable . . . walks to and from microphone cooly . . . with assurance . . . invariably wears turban hat tilted sharply . . . poise plus . . .

Johnny, call boy, stands on platform to reach microphone . . . makes his first "call" . . . step down, advances a pace . . . makes his second "call" . . . takes another step forward to make his third "call" . . . appears to enjoy it . . . watches drummer in off moments and seems fascinated . . . broadcast over, bandsmen and performers quickly disperse . . . except Leo . . . who whips out handkerchief from back pocket to mop his hair, his forehead, his collar . . . a hard night for the disciplinarian of dance orchestras . . .

ANNE RHYMES HER WAY

The Minneapolis Symphony Orchestra, directed by Eugene Ormandy, and Anne Campbell, nationally known "Poet of the Home," has inaugurated a weekly series of programs presenting classical music and Miss Campbell's popular poetry over a coast-to-coast WABC-Columbia network Saturdays, from 10:00 to 10:30 p.m., EST.

Miss Campbell is widely known for her poems about everyday life and will feature on the broadcasts selections from her three published volumes of verse and from her daily poems which have been syndicated by newspapers over a large area for the past thirteen years. . . .

Born on a Michigan farm, Anne Campbell attended a rural school and began writing verse as soon as she could hold a pencil. The family subsequently moved to Detroit and after finishing her education, the young poetess joined the staff of a farm magazine, where many of her rural poems were published. A short time later she married a Detroit newspaperman and forsook her professional career for that of homemaking. She continued to write, however, and a few years later her work attracted the attention of a Detroit editor, who asked her to write a poem a day for his paper. . . .

Conductor Ormandy's varied experience, running the gamut of musical presentation—from the pit of a motion picture theatre to the podium of the New York Philharmonic and the Philadelphia Symphony Orchestras—has particularly fitted him to give the public what it knows and loves. . . .

Hailed as a child prodigy in his native Budapest, Ormandy gave his first violin recital at the age of seven, and was a professor of music when only seventeen. He is still in his thirties. Coming to America in 1921, he began playing in the pit orchestra at the New York Capitol Theatre, soon became concert-master, and later conductor of the same organization. Still later he became a musical director of the Columbia Broadcasting System before taking up the baton with the Minneapolis Symphony. . . .

Sponsored by General Household Utilities Company. . . .

"DR." ROCKWELL AND OTHERS

Brad Browne and Al Llewelyn, song and patter team, who entered radio in the days before crooners, have returned to the WABC-Columbia network and are broadcasting every Tuesday and Thursday at 9:45 a.m., sponsored by the makers of Fels Naptha Soap. . . . And here is the irrepressible "Dr." George Rockwell, veteran comedian of musical comedy and vaudeville—and what is Doc doing? Well, he has transferred his talents from the stage to the WABC-Columbia network; but not as an actor—oh, no! He is now an author, which is no new role for him; he is writing the new series of light comedy programs entitled "Coffee and Doughnuts," which is a daily feature of the CBS chain, each morning except Sundays from 9:00 to 9:15 a.m., EST.

Radio University

Socket Connections

WILL YOU KINDLY show bottom view of the connections to the socket for the 6C6 and the 57, also diagram of the relative position of elements?—C.L.

The diagrams requested are printed herewith and may be used as guidance also for the negative resistance circuits discussed on pages 6 and 7.

* * *

Clock Can't Be Bought

PLEASE ADVISE WHETHER the clock mentioned in the article on a radio-phonograph combination that appeared in RADIO WORLD recently can be purchased?—R. F. B.

The clock described in this article is not available on the market but is constructed by the builder of this equipment himself according to the instructions outlined.

* * *

Bypass Condenser Values

PLEASE ADVISE WHETHER the diagram appearing in RADIO WORLD for November 4, 1933, page 5 is correct?—M. J. O.

The diagram is correct as far as the wiring is concerned. However, the value of the by-pass condensers should be 0.1 mfd. in all the cases where it is designated as 0.01 mfd. It might be added for the sake of completeness that the radio frequency choke coils are 60 millihenry chokes, that the volume control should be a potentiometer of 50,000 ohms and that the voltage divider should have a total of 30,000 ohms with five adjustable points.

* * *

Short Wave Input

IS IT practical to use an untuned stage in a short wave set and may the antenna input be to a choke?—C. F. G.

Yes, this is practical. The intensity variations due to swinging antenna are thus avoided. A 50-turn honeycomb coil is satisfactory. A high impedance input provides more pep, but a selector stage should precede the tuned modulator, if the set is a superheterodyne.

TRADE REFERENCE SERVICE

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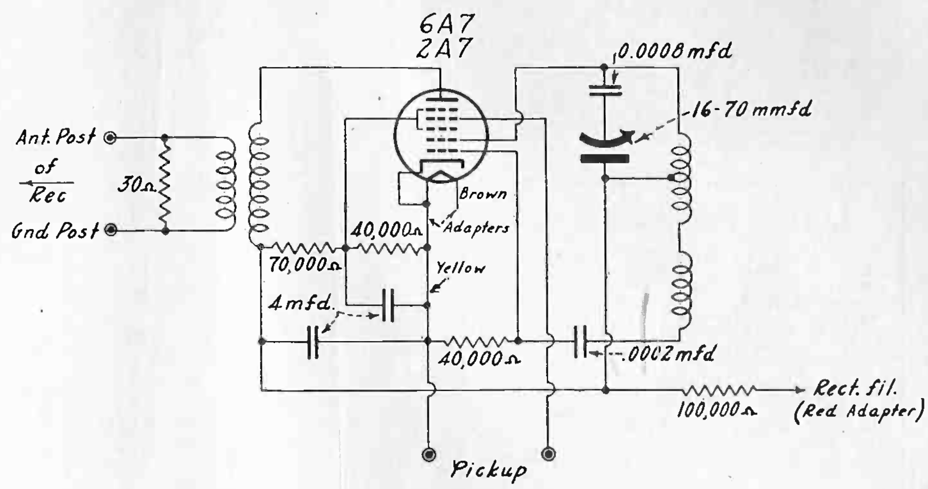
The RCA Phonograph Oscillator

Input is Made to Set's Antenna Winding

By J. B. Huller

THE growing interest being displayed in recorded music has revived a dormant industry and has increased the possible sales for the radio service man. This is so since the radio set is an excellent means for reproducing such recorded selections which incurs the need for adapting the radio equipment for this purpose. A phonograph record that is reproduced over the radio set's amplifier and speaker displays a remarkable tonal quality not hitherto enjoyed from the old style of acoustic phonographs. And so the radio equipment offers a distinct advantage and thus entails a wide market.

Hitherto, a phonograph turntable and pickup were coupled to the radio set by means of plugging into the detector stage where the lateral vibrations of the phonograph pickup needle were converted into a electrical counterpart of the original sound energy. Those radio sets that were equipped with suitable jacks were thus easily adapted to this purpose. But, there are many sets that do not come equipped with this jack and to install such equipment into one not so constructed was more or less of a difficult job, since it involved taking the set apart to a certain extent.



The circuit diagram of the phonograph oscillator.

Method of Operation

In the February 2, 1935, issue of Radio World was indicated a means whereby this objective could be attained without ripping the set apart and it is now recorded that such an apparatus is commercially available. For the service engineer, the new phonograph oscillator does two things. It makes additional profits for him through the sale of additional equipment and solves one of his toughest problems in phonograph modernization work.

The output from the pickup soil modulates the oscillator which is coupled to the antenna of the receiver. This modulated signal is tuned in on the receiver just like any broadcasting station. The installation of this phonograph oscillator requires only a few minutes. No struggle is involved to get the grid bias right and no circuit changes are necessary. For the receiver owner, the phonograph oscillator provides a miniature broadcasting station right in the home. Its fidelity of record reproduction is limited only by the quality of the receiver to which it is attached. It enables the owner to hear his favorite artists whenever he wants them and as often.

The RCA-RK-24 phonograph oscillator is a small broadcast band oscillator unit designed for use with any electric phonograph pickup, it may be attached to radio sets of all kinds and types. It may be used for attaching any type of magnetic pickup to any type of receiver with slight modifications (usually the inclusion of an input transformer).

Fool-Proof Construction

The primary purpose of the RK-24 phonograph oscillator is to insure proper phonograph reproduction within the limits of the receiver in all cases, avoiding the necessity of any circuit changes. No longer is the service engineer worried with the problems involved in overcoming avoidance of hum, distortion in the audio system and other factors that invariably occur.

ELECTRICAL SPECIFICATIONS

Type of Oscillator Circuit	Modified Hartley
Type of Modulation	Pentode Control Grid
Type of Radiotrons	2A7 or 6A7
Heater Current	0.3 or 1.0 (Depending on Tube Used)
Heater Voltage	2.5 or 6.3 Volts (Depending on Tube Used)
Plate Voltage	150 Volts to 400 Volts
Plate Current	2.0 M. A. at 250 Volts
Input Pickup Impedance	2450 Ohms at 100 Cycles
Output Impedance	30 Ohms
Tuning Frequency Range	1400 kc. to 1700 kc.

PHYSICAL SPECIFICATIONS

Height	5½ Inches
Width	7 Inches
Depth	2½ Inches
Weight	1 Pound
Weight Packed for Shipment	2 Pounds

The unit is of simple design and foolproof construction, and may be attached to practically any set by one unskilled in the art of radio service. Suitable leads with special contacts are provided for obtaining filament and plate power for the oscillator unit, so that internal wiring to the chassis is not necessary.

Of unusual interest is its ability, through the use of the 6A7 or 2A7 tubes, to be used with receivers having either 2.5-volt heater type tubes or 6.3-volt heater type tubes. *For this reason it is sold without tube.* This adaptability makes it possible to operate the RK-24 oscillator with practically all radio sets of the a-c type manufactured during the last five years.

The RK-24 is actually a miniature transmitting station, modulated with the output of the phonograph pickup. As the frequency range of the pickup is usually equal to or better than the transmission range of the ordinary broadcasting station and there is no intervening factor such as fading and distortion due to transmission, the phonograph quality will, in practically all cases, be that obtained with the very best possible local broadcasting stations to which the receiver may be tuned.

For this reason, one will know in advance that the phonograph reproduction quality will be limited only by the capabilities of the receiver to which it is attached.

The simplicity of connections is such that it usually takes about five minutes to install.

A Transferable Unit

The RK-24 may be removed from one receiver to another very quickly and easily. Optimum results will be obtained in all cases. Avoidance of any switching requirements in the radio chassis proper, as well as any circuit changes, such as changing of detector tube bias to operate them as audio amplifiers and lack of sufficient audio gain, are all eliminated through the use of the oscillator.

We believe this oscillator fills a long-felt need often expressed by service men modernizing old phonographs, or service men attaching electric phonographs to ordinary radio sets. It also opens up a new field due to the simplicity of its connections, and the assured results obtained.

* * *

Coil Information on Similar Circuit

Please Indicate the coil and condenser constants of the phonograph oscillator circuit published in Radio World for February 2, 1935—J.L.F.

All three coils may be wound upon one coil form 1¼" in diameter and 5" long. The separation between coils should be between ½" to ¾".

Primary coil: 50 turns No. 28 enamelled wire.

Secondary coil: 135 turns No. 28 enamelled wire.

Tickler coil: 55 turns No. 28 enamelled wire.

Secondary condenser: 70 micromicrofarads.

Tickler condenser: 120 micromicrofarads.

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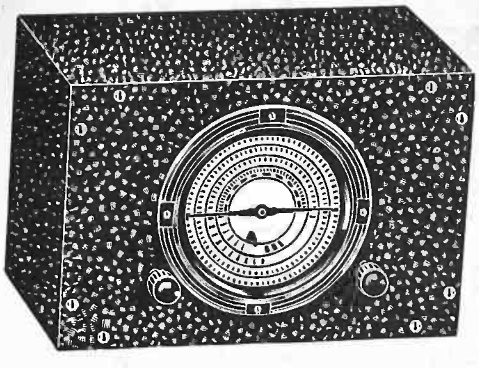

MODEL 339 ONLY $16.00

THE new 339 Signal Generator, designed by Herman Bernard, operates on fundamentals from 54 to 17,000 kc, 5500 to 18 meters, on a.c. or d.c., with modulation option in either use, and sells at approximately half the price of equivalent instruments. Bands are shifted by a front panel rotary switch.

One of the outstanding features of the 339 is the vernier airplane dial. This has direct-reading scale both in frequencies and wavelengths and is of the decimal-repeating type, a new invention of Mr. Bernard. Thus the top scale, in frequencies, is 54 to 170 kc. The lower scale in frequencies is 170 to 540 kc. The other bands are read as 10 or 100 times these frequencies.

Answers in Wavelengths, Too

As wavelengths are calibrated on the dial, too, division by the same factors, applied to the wavelength scales that adjoin the frequency scales, gives the answer in wavelengths. Bernard signal generators are the only ones that yield determinations both in frequencies and wavelengths.

The dial is 3.5 inches in diameter and has a double pointer enabling close readings. The decimal repeating dial itself enables close readings because the circumference of scales is not diminished for succeeding bands. The 54 to 170 kc scale has gradations in spaces of only 1 kc. Thus for the broadcast band, 540 to 1700 kc, 10 kc separation prevails. The 170 to 540 kc scale has gradations in 1 kc from 170 to 200 kc, and bars separated by 5 kc for 200 to 540 kc.

Coincidence of generated frequency and scale reading is very close. Never is the accuracy less than 1 per cent., and for most settings there is no observable difference between the true frequency and the read frequency. This high order of accuracy obtains in no other instrument, selling at less than three times the cost of the 339.

Why 339 is Best Choice

Many, no doubt, have been somewhat confused by the numerous types of signal generators, but will note that the best of them cover wide ranges on fundamentals, have an attenuator, and permit of presence or absence of modulation. Also they have a vernier dial and are direct-reading in frequencies, accurate to at least 3 per cent. The 339 has all these advantages, besides affording wavelength determinations as well, and operation on 90-125 volts a.c. (any commercial frequency) or d.c. And the accuracy is three times as great. Moreover, the 339 is well built, for lifetime use, and covers all waves fundamentally, besides permitting measurements of frequencies up to 100 mgc (down to 3 meters) by resort to a slight calculation method, applying a simplified harmonic system to the 5,400 to 17,000 kc fundamental band.

The 239 has a 37 rectifier tube, so that d.c. is used on the plate. Modulation is provided by a neon tube relaxation oscillator at a frequency of about 1,000 cycles. Limiting resistor for the tube heaters is built into the a-c cable assembly for maximum heat dissipation.

Lowest Prices for Precision Products

By insulation of the oscillator and rectifier systems from the shield cabinet, danger of line shorting is removed and grounding the cabinet becomes practical. Output and ground posts are provided.

Model 339, wired, calibrated, adjusted, complete with three tubes, ready to operate; instructions (shipping weight, 5 lbs.) $16.00

Model 339-K, complete kit, cabinet, instructions, everything except tubes (shipping weight, 5 lbs.) 12.50

Model 339-FC, Founadtion Unit, consisting of dial, tuning condenser, five coils, instructions (shipping weight, 2 lbs.) 5.45

Model 339-LK, a-c line cord with limiting resistor built in (sent postpaid at this price in U. S., Canada, Mexico) .... .65

USES FOR THE 339

The primary purpose of the 339 is to enable lining up radio receivers at intermediate-frequency and station-carrier-frequency levels. The generator emits the desired radio frequency, accompanied or unaccompanied by a superimposed sound, as desired (switch controlled). The sound is generally useful when the indicator consists of speaker or earphones.

Also, the 339 serves as a frequency and wavelength meter for all stations, 54 kc to 17,000 kc, when the 339 is used in conjunction with a receiver. Not only is the 339 a station finder, but also a device for measuring the frequency and wavelength of the station. Hence listeners may use the 339 to advantage with their all-wave sets, without any molestation whatever of the receiver or its wiring.

The 339 has three knobs, instead of two shown.

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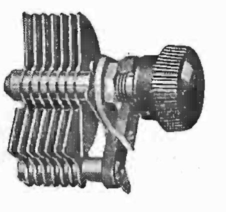

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