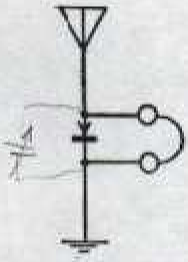
101 Receiving Circuits



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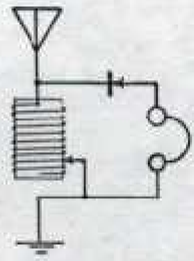

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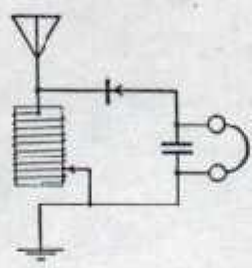

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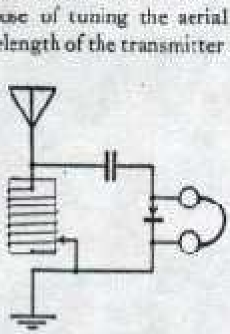
1. This is the simplest of radio receiving circuits. A crystal detector is placed between the antenna and ground, and the telephones are shunted around it. Signals on wavelengths nearest that of the natural period of the antenna will be received strongest, altho none will be heard with intensity as great as where a tuner is employed, on account of the aerial circuit being highly damped by the presence of the detector.

2. In this circuit we have a variable inductance inserted between the antenna and ground for the purpose of tuning the aerial wire system to the wavelength of the transmitter from which reception is desired. The telephone and detector are placed in series across the inductance for the purpose of rectifying and converting into sound the wave trains traveling thru it. This is a marked improvement over circuit No. 1, for the high resistance detector is removed from the antenna circuit, and the tuning coil permits adjustments to various wavelengths without undue interference from others. This circuit is employed in most of the lower priced receiving outfits now marketed for the reception of broadcasted radio concerts.



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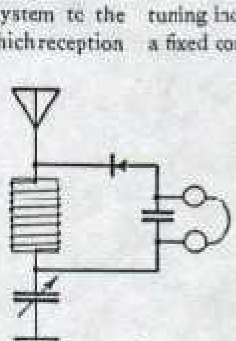

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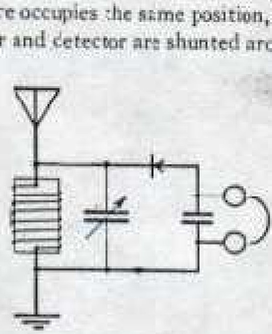

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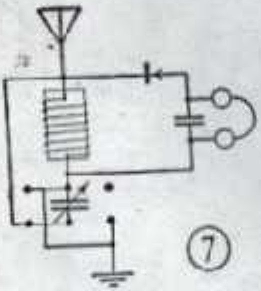
3. Here we have a system very similar to the previous one, except that a fixed condenser is shunted across the telephones. This has a capacity of about 0.001 mfds. and is usually referred to as a stopping condenser or a phone condenser. Its purpose is to store up energy while the current is flowing thru the detector and discharge it thru the telephones during the opposite alternation.

4. This shows another means of connecting the same instruments employed in circuit 3. The tuning inductance occupies the same position, and a fixed condenser and detector are shunted around it, but the telephones are connected across the crystal detector rather than across the condenser. With some crystals better signals are obtained with the telephones in this position while with others the opposite is true.

5. In this circuit tuning is accomplished by means of a variable condenser placed in series with the ground. For a limited range of wavelengths the inductance can be fixed, and may either take the form of a simply wound solenoid or a honey-



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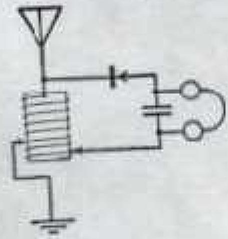

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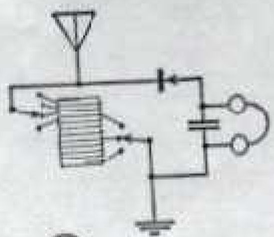

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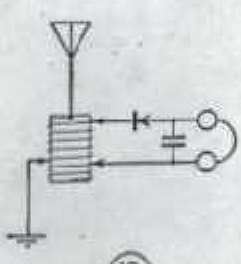
comb coil. With the condenser in series, no wavelength can be obtained as great as if the condenser were omitted, and the lower the capacity used, the shorter will be the wave to which the set is tuned.

6. Again we have variations in wavelength of the receiver made possible by the use of a variable condenser. The inductance of fixed value is connected between the antenna and ground with the variable capacity across it. With this arrangement only wavelengths greater than that which would obtain if the condenser were removed, can be tuned in. It is not as selective as circuit 5, and with the majority of antennas it is found that two wavelengths are almost always covered by systems of this kind.

7. Since by the use of circuit 5 we get variations of wavelengths below that resulting from the effect of the antenna, inductance and ground alone, and wavelengths above that by employing circuit 6, many experimenters use a switch for changing the variable condenser from one position to the other in order to cover the whole wavelength range with but one set of instruments. Here we have a simple method for accomplishing this. The variable condenser is connected across the two blades of a D.P.D.T. switch, the antenna on one pole, ground on two diagonally opposite poles, while the fourth one is left dead. By throwing the switch to the left the condenser is placed in parallel with the inductance, and when in the opposite direction the capacity is inserted in the ground lead.

8. This is a simple circuit for a two slide tuning coil. While all of the hook-ups previously shown have but one tuned circuit, this one has two, which are conductively coupled to each other. The antenna circuit is tuned by the slider connected to the ground, while the secondary or closed circuit is adjusted by the other slider. Tuning of a little more selective variety is the advantage of this type of receiver over the single slide outfits.

9. Again we have a single circuit tuner but in this case the use of taps rather than sliders on the inductance is illustrated. In order to get any number of turns, from the first to the last, it is necessary to use two switches. At one end the coil is tapped for one switch at every turn until a number equal to the square root of the total number of turns on the coil, is taken off. The points of the second switch are connected to taps which are separated by a number of turns equal to the number of taps on the first switch. The advantage of this system of tapping the coil is that it gives the minimum number of switch points that may be used to give one turn variations of inductance throughout the length of the coil.



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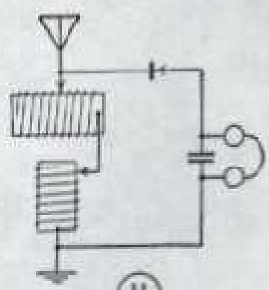

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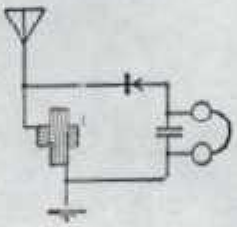

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Switches have gradually replaced sliders on variable inductances because they permit the instrument to be conveniently mounted on a panel, prevent the wearing of the wire and the short circuiting of turns due to metallic particles getting between them, make adjustments easier, reduce the capacity effect of the operator's hand by keeping it farther from the coil, and make contacts which are less affected by dust.

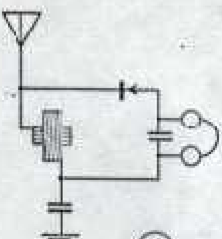
10. This circuit shows the connections of a receiving outfit employing a three slide tuner. This may be considered a two circuit tuner, conductively, but variably coupled. The primary or antenna circuit is tuned by changing the position of the ground slider, the secondary is tuned by varying the distance between the other two sliders, and the coupling may be altered by moving the secondary sliders together, to or from the antenna end of the inductance. It is evident that when the number of turns separating the secondary sliders is comparatively small, a greater range of coupling may be obtained. This circuit gives the greatest selectivity of all single winding tuners.

11. This diagram illustrates a means of increasing the wavelength of a single circuit receiver by the addition of a second inductance or loading coil. The two coils are placed in series and treated as but a single winding. For relatively long waves, when the last turn of the first inductance has been reached, the slider on the loading coil is moved

of the system, as the whole winding is in the circuit at all times. Opposed to these advantages, however, are the facts that all variometers have a limited range of inductance variation and since the resistance in the circuit always remains the same the efficiency is low when comparatively small values of inductance are used.

13. Because the minimum inductance obtainable in a variometer is comparatively large, it often happens that when this instrument is used as a tuner the wavelength at the lowest adjustment is longer than that of the desired signals. To overcome this difficulty and permit shorter waves to be reached, a condenser is placed in series with the ground lead. This may be of the variable type but if only a relatively narrow band of waves is to be covered, a fixed condenser will serve the purpose since the variometer is capable of fine adjustments to the incoming signals.

14. This circuit employs a variable condenser in shunt with a variometer for tuning the receiver. An arrangement of this sort is intended for wavelengths greater than those obtainable by the use



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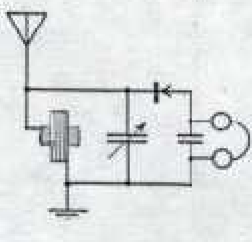

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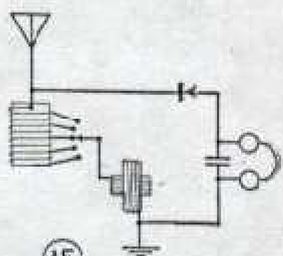

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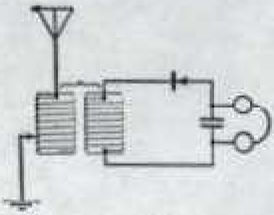
from its position of minimum inductance toward the opposite end until the desired wavelength is obtained. It is well to mount the two coils at right angles and several inches apart so that when the loading coil is not required, losses which would otherwise be high on wavelengths near its natural period will not be so greatly felt.

12. In this circuit another means of tuning is shown where a variable inductance of the variometer type is used for changing the wavelength of the system. The inductance of the circuit is altered by varying the mutual inductance between two coils connected in series and mounted in such a way that the self inductance of one may be made to assist or oppose that of the other. This gives gradual variations of wavelength and therefore has the advantage of permitting close adjustment to sharp waves. Another point of superiority over the types of inductance previously considered is that there are no dead ends to reduce the efficiency

of the variable inductance alone. As in circuit 13, and fix capacity will suffice if a comparatively small range of wavelengths is to be covered, but otherwise a variable condenser should be used. Since the variometer provides for gradual changes in the wavelength of the outfit, the capacity may consist of a condenser which is varied in steps by means of a fan switch passing over contacts connected to the plates.

15. In this circuit we again make use of the quality of the variometer which permits minute variations of inductance. Here we have the variometer connected in series with a tapped loading coil. One set of switch points is all that is necessary, and the taps are separated by a value of inductance equal to the range of the variometer. In this way any degree of inductance may be obtained, from that of the minimum of the variometer to the total of the tapped coil plus the maximum of the variometer.



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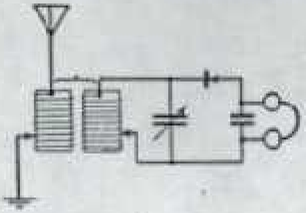

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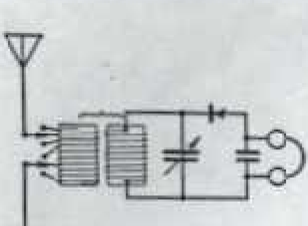
16. This is a simple loose coupler circuit showing a variable primary or antenna inductance inductively coupled to a secondary or closed circuit inductance of fixed value. A detector, fixed condenser and telephones complete the receiving system. Such a receiver is commonly referred to as having an aperiodic or untuned secondary, since it has but one possible value of inductance and no tuning condenser. The tuning is done by varying the primary inductance and the untuned secondary responds to all wavelengths to which the primary may be tuned. Altho the closed circuit has a high damping factor due to the absence of a condenser across the inductance terminals, it responds to different wavelengths with varying degrees of efficiency. The more nearly the wavelength of a desired transmitter approaches the natural period of the secondary of the loose coupler, the greater will be the transfer of energy from the antenna system to the detector circuit. By changing the inductive relation between the primary and secondary coils sharp tuning is secured. This feature is the greatest advantage of the two circuit tuner over the single coil type.

17. In this diagram we have a loosely coupled receiving tuner with two tuned or periodic circuits. The wavelength of the antenna circuit is varied by changing the value of the variable primary inductance and the secondary may be placed in resonance with it by a selection of the proper values of the closed circuit inductance and variable tuning condenser. In cases like this where both circuits may be tuned to the frequency of an incoming signal, maximum transfer of energy between the circuits occurs and the loudest response in the telephones results. By altering the coupling between the two coils varying degrees of selectivity in tuning may be obtained.

Before the vacuum tube came into use this circuit was considered the best that could be used. In fact, at present it is surpassed by no other crystal detector circuit and is the fundamental wiring diagram of the best equipment used at sea.



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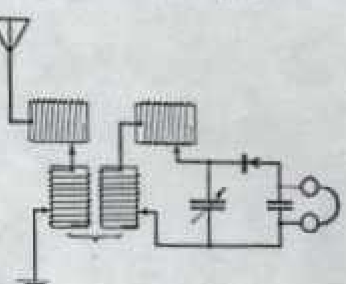

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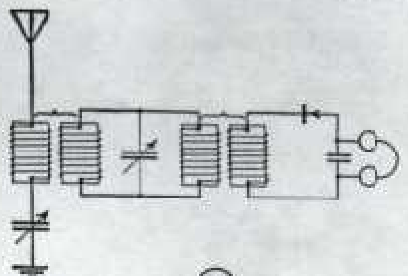
18. This circuit depicts the usual crystal detector, telephones and stopping condenser, connected to a loosely coupled two circuit tuner whose secondary inductance is of fixed value while the primary is varied by means of units and tens switches. A tuner of this type is usually built so that the coupling between the coils is varied by rotating the secondary inside the primary tube, and is commonly referred to as a vario coupler. It is a simple matter to vary the inductance of the antenna coil by either a slider or switches, but since the closed circuit winding is arranged to be rotated, mechanical difficulties make variations in the inductance of the secondary practically out of the question. For that reason all of the tuning in the secondary circuit is accomplished by means of the variable condenser shunted across the winding.

19. In this figure a system for increasing the wavelength of a receiving outfit is shown. A

second inductance or loading coil is connected in series with the primary of the receiving transformer to increase the inductance and therefore the wave-length of the antenna circuit. Where a tuned secondary is desired it is essential that a second loading inductance be placed in the closed oscillatory circuit. It should be noted that it is so placed that the secondary condenser is wired across the secondary inductance and loading coil rather than across the secondary alone. As in the case of circuit 11 the loading coils should be placed at right angles to the loose coupler windings so that they will least affect the tuning when they are not in use.



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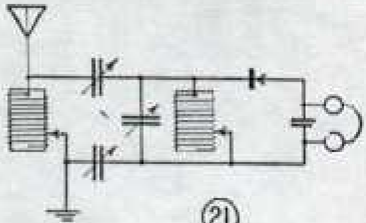

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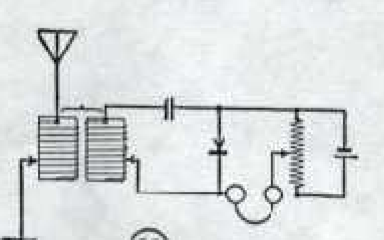
20. The circuit here shown is that of an extremely selective loosely coupled receiving tuner having three circuits. The antenna circuit includes a variable condenser and an inductance which is inductively coupled to a coil of an intermediate circuit. The intermediate circuit is tuned to resonance with the antenna circuit by means of a variable capacity, and has a second inductance which is variably coupled to the detector circuit. In this case the detector circuit is aperiodic

Altho seldom used by experimenters, this three circuit tuner has found considerably favor in commercial radio service. For about ten years some of the largest steamships afloat have employed this circuit in the form of the well known Marconi Multiple tuner and some operaters favor it.

21. Here we have a two circuit tuner employing electro-static coupling between the tuned circuits. The open circuit is tuned by means of a variable inductance while variations in the wavelength of the closed circuit are accomplished by the variable secondary inductance and the variable condenser. Coupling between the circuits is varied by changing the capacities of the two variable condensers connected between the ends of the two inductances. In a commercial form the shafts of the two are mechanically coupled so that both may be varied by a single knob. This circuit is used in some of the U. S. Navy outfits, both in this way and combined with electro-magnetic coupling.



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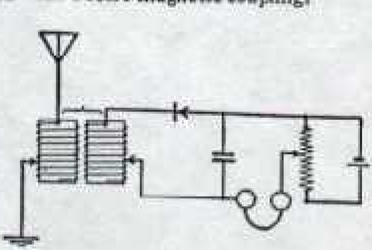

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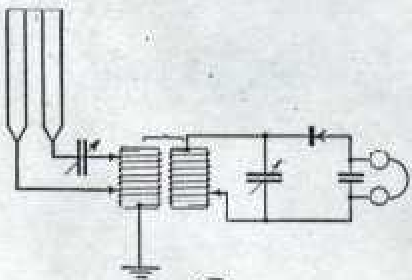
22. This circuit employs a simple loosely coupled tuner but varies from the arrangements previously considered in that a local battery is used. With some detectors, such as carborundum, signal strength is greatly improved by employing a direct current potential of the correct polarity in series with the crystal and the telephones. This is due to the fact that the crystal detector works by virtue of its unilateral conductivity which is more pronounced at certain voltages than at others. To obtain the correct potential a potentiometer of at least 500 ohms is shunted across the battery in the manner shown, and variations of the voltage applied to the detector and telephones are permitted

23. Another potentiometer diagram is here shown. The principle upon which this circuit functions is practically identical to that employed in circuit 22. It differs in that the stopping condenser is shunted across the telephones and potentiometer, and the secondary inductance is included in the local battery circuit. While found in some high class commercial equipment this circuit in most cases is less desirable on account of the click caused in the telephones by making and breaking the battery circuit when the inductance is varied.

A potentiometer circuit of the kind shown in diagram 22 or 23 is essential where electrolytic detectors are used



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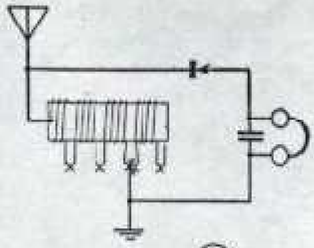

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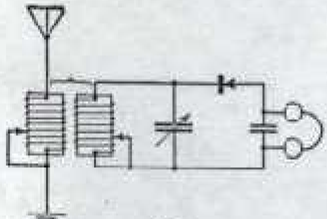
24. A type of antenna not previously referred to is illustrated in this circuit. It is termed a loop antenna but must not be confused with the coil type or directional loops, for it is as efficient as the ordinary aerial and is no more directional. Such an antenna with its attendant tuning arrangement was championed by De Forest in the early days of wireless development and found considerable favor among experimenters at that time.

25. The principle of the dead-end inductance switch is illustrated in this figure. A single circuit receiver is shown only for the sake of simplicity, the dead-end system being applicable to inductances of any circuit, regardless of its complexity. The idea of the device is to remove the unused portions of the inductance from the active part of the circuit so as to minimize absorption and resultant losses. This is quite important where tuners of long wavelength ranges are used, for in these instruments the natural period of the whole winding is very often equal to the wavelength of a signal tuned in on a fractional part of the inductance. Such a condition increases the resistance of the winding enormously, and if efficient reception is to be conducted it is imperative to use a dead-end device for breaking up the inductance into sections to keep the natural period away from the useful wavelengths.



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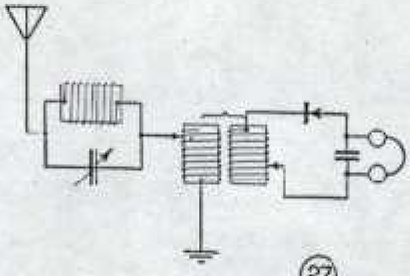

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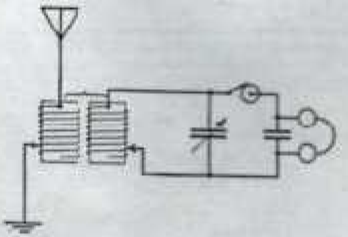
26. Here the end of the inductance, which is usually free, is connected to the variable contact so that the unused portion of the coil is always shorted. To the man who has given little attention to radio frequency circuits but who is familiar with alternating current theory, it would appear that this method would seriously impair the efficiency of the outfit, but as a matter of fact it is used in some of the most popular regenerative tuners. However, there is no doubt but that there are losses due to an arrangement of this kind for the inductance of the coil is reduced while the resistance per turn remains the same. The object of shorting is to prevent the unused inductance from forming an oscillatory circuit whose natural period might be near the wavelength of a desired signal and thereby absorb a considerable amount of energy.

27. This circuit gives a method of reducing interference from signals on a wave differing in length from that of a desired station. This is accomplished by placing an inductance shunted by a condenser in the antenna circuit and tuning them to the frequency of the interfering signal. This simple tuned impedence or radio frequency trap oscillates at the period of the undesired transmitter so that the current flowing in each half is practically equal and opposite in linear direction. Theoretically this neutralizes the current at this wavelength at the point where the receiving tuner is connected, thereby preventing those impulses from travelling thru the primary of the transformer to the ground. The system is quite effective where the interference is caused by an undamped wave transmitter, but does not eliminate as great a portion of damped wave signals.



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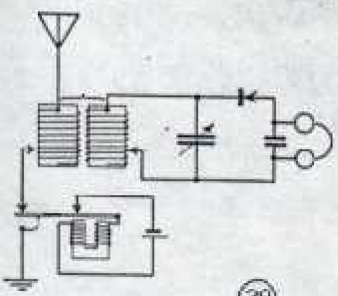

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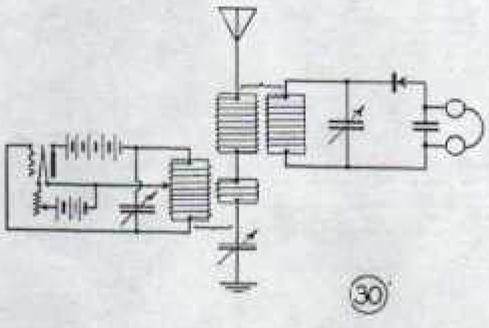
28. In this diagram we have the connection of a receiving outfit designed for the reception of sustained or undamped waves such as are emitted from arc transmitters, high frequency alternators, and oscillating vacuum tubes. Since undamped waves have no period of oscillation within the range of the human ear, it is necessary to employ in the receiver a device for breaking them up into audible groups. In this circuit an old, simple, and reliable method is given. The tuner does not differ from those previously described, but in place of the usual detector an instrument known as the Poulsen tikker is connected. This is merely a revolving disc upon which a spring wire or brush is brought to bear. As the disc rotates the light contact interrupts the circuit owing to the irregular surface over which it travels. The make and break does not occur regularly so the note produced in the telephones is not of a musical character. The received energy is accumulated in the secondary or closed circuit of the tuner while the tikker contact is open, and discharged thru the telephones when the circuit is closed. In this way the continuous wave is broken up at a rate which is within the limits of the ear and the received signal is thus made audible.

29 Another system for the reception of undamped waves is illustrated here. A loosely coupled receiving tuner with a crystal detector and telephones comprise the receiver proper, but in series with the ground lead is a make and break device This serves to interrupt the incoming energy at an audible rate so that groups of oscillations rather than continuous oscillations take place in the circuits It is these groups which are actually heard and their frequency determines the tone produced in the telephones by the incoming signal.

The interrupting mechanism is called a chopper and may either consist of a separate set of contacts on a buzzer or a revolving make and break of the commutator type. Its position in the circuit must not necessarily be in the ground lead, but may occupy almost any place in the open, or even the closed oscillatory circuit



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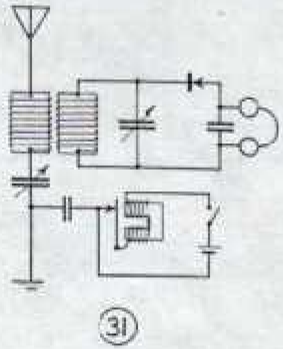

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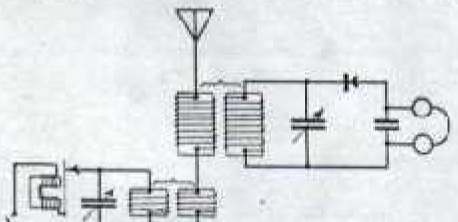
30. A more elaborate means of breaking up continuous waves so as to produce audible signals is given in this circuit. The usual type of crystal receiver is used, but a local generator of high frequency oscillations is inductively coupled to the primary circuit. This oscillator is tuned to a wavelength differing from that of a desired signal by some frequency within range of the ear. That is, if the incoming signal is being transmitted on a wavelength of 10,000 meters or 30,000 cycles, the local generator should be adjusted to radiate energy at a frequency of 29,000 or 31,000 cycles. This would produce a note in the telephones equal to the difference between the two or 1,000 cycles per second. This is called beat or heterodyne reception. With this system an even tone is produced and its frequency can be regulated to suit the operator. Due to the inherent characteristics of the detector, the efficiency of the receiver on weak signals is considerably increased by super-imposing local oscillations upon the incoming signals, for the value of the current flowing thru the circuit is built up to a point where slight variations in the signal energy result in greater variations in the telephone current, than would normally be the case.

In this circuit a vacuum tube oscillator is shown, but an arc or other form of high frequency generator will answer the same purpose.

31. A buzzer test circuit is here shown connected to a crystal detector receiving outfit. Its purpose is to assist the operator in determining the most sensitive adjustment of the detector. Various buzzer hook-ups are possible, but the one here given combines simplicity with effectiveness. A battery and a device for opening and closing the circuit are wired in series with the buzzer, while the contact of the instrument is led thru a fixed condenser to the ground. In operation the buzzer is started by closing the circuit and the point of the detector is moved about the surface of the crystal until a spot is found where the buzzer is heard with maximum strength in the telephones.



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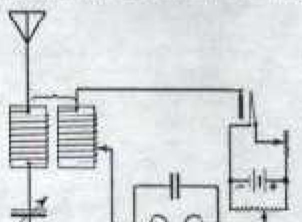

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32. It frequently becomes desirable to have a buzzer circuit which will radiate most of its energy on a definite wavelength. Such a hook-up is shown in diagram 32. A tuned oscillating circuit, consisting of a condenser shunted by an inductance, is placed in series with a battery, buzzer and switch. When the switch is closed the buzzer contacts periodically open and close the circuit, setting up oscillations in the tuned circuit at an audio frequency equal to the tone of the buzzer, and on a wavelength determined by the capacity and inductance of the high frequency circuit. The inductance is electromagnetically coupled to the receiving circuit which must be tuned to the wavelength of the buzzer system before any response in the telephones can be expected. The advantage of this circuit over the preceding one is that actual radio frequency energy is supplied for testing the receiver. The best point on the crystal can be more reliably located and any defect in the tuning system will be checked up as well.

33. The Fleming valve detector from which the audion wave developed is shown connected to a loosely coupled tuner in this diagram. The action of the detector is based upon the theory that in a vacuum negative charges will flow from a heated to a cold electrode and not in the reverse direction. The current flow is opposite in direction to the electronic stream. The cold electrode is termed the anode or plate, while the heated member is called the filament. To produce the required temperature, a battery is connected to the cathode, or filament, thru a variable resistance. Telephones shunted by a condenser are wired in series with a tuning inductance between the filament and plate to form the external circuit of the valve. Connection to the filament is made thru a potentiometer which may be regulated to place the proper charge on the plate.

In operation the potentiometer is adjusted to a point where a feeble current will continually flow thru the circuit. When a signal is tuned in, a radio frequency alternating current is induced in the closed circuit, tending to reverse the plate potential at a rapid rate. The alternation which assists the local potential increases the current flowing thru the telephones while the opposite alternation decreases it slightly. In this way a pulsating direct current rather than an alternating current is applied to the telephones. Owing to the fact that the effect of the positive side of the received current is greater than the negative, each group of oscillations, instead of single oscillations affects the telephone diaphragms, thereby producing audible sounds.

The Fleming valve is no more sensitive than the crystal detector but is considerably more reliable.