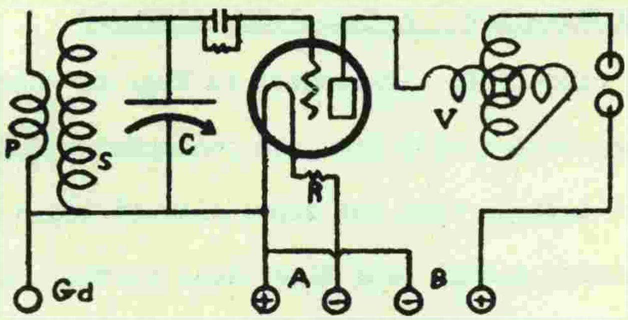

LESSON

34 R

REGENERATION
APPLICATION AND CONTROL

RADIO-TELEVISION TRAINING SCHOOL
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RADIO-TELEVISION TRAINING SCHOOL, INC.

5100 SOUTH VERMONT AVENUE • LOS ANGELES 37, CALIFORNIA, U. S. A.

REGENERATION - ITS APPLICATION AND METHOD OF CONTROL

Regeneration is a system of amplification in which increased output is secured by feeding some of the amplified signal back into the grid for further amplification. With proper control, regeneration can be used in many practical applications.

REGENERATION - A FEED-BACK PRINCIPLE

A simple receiving circuit is illustrated in Fig. 1. Here the function of the detector tube in conjunction with its grid condenser and leak, is to reduce the radio frequency oscillations from the input circuit to an audio frequency and to convert them into unidirectional (one direction) current pulsations in the output circuit. It happens, though, that all of the current is not rectified and that the detector output is thus made up of two components - a radio frequency current and the rectified or audio frequency current. This is illustrated in Fig. 2. The audio current flows through the telephone receivers and produces the audible sounds, while the radio frequency current is ordinarily allowed to go to waste.

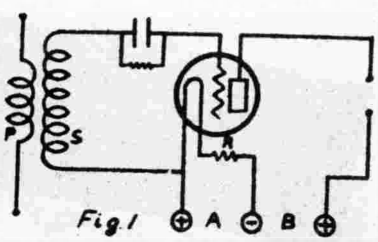


Fig. 1

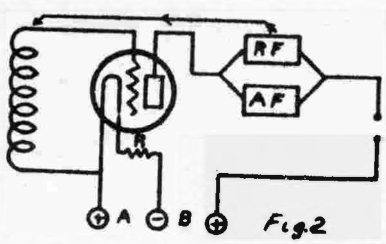


Fig. 2

In a regenerative system, however, these two components are separated, and the radio frequency energy is put to practical use by feeding it back into the grid circuit in some manner as is illustrated by the curved arrow in Fig. 2. Here it greatly reinforces the incoming grid current oscillations and thereby causes greater variations in the plate current flow. The result is that the detector output is greatly increased without having to increase the initial amount of input energy. Greater operating efficiency is thus secured, and louder sounds are produced in the headphones or loud speaker.

Since regeneration makes it possible to build up very weak signals to an audible point, radio circuits employing this principle are excellent long distance receivers. Many of the short wave receivers in present use employ some form of regeneration.

METHODS OF REGENERATION

To convert a vacuum tube circuit into a regenerative system, it is necessary only to provide some means of returning some of the energy from the plate circuit to the input or grid circuit of the tube. This can be done in several ways, and it is the method of control that distinguishes one type of regenerative circuit from another. In any case, however, very fine adjustments must be provided so that regeneration will not be overdone and cause distorted signals with an unnatural tone.

Probably the most common method of regeneration is the use of a feed-back or tickler coil connected in the plate circuit and inductively coupled to the secondary of the antenna tuner. In another system the féed-back is controlled by means of a variable condenser, while a third is the tuned plate circuit. Each of these methods, as well as a number of others, possesses certain advantages or disadvantages as will be proven in the following sections.

From the preceding discussion it is evident that a regenerative detector always involves three individual circuits - the primary or antenna-ground loading circuit "P", the secondary or grid-filament input circuit, and the regenerative or plate-feed back circuit. The number of coils used, of course, will differ with different circuit arrangements, depending upon the feed-back method employed.

A SIMPLE INDUCTIVELY COUPLED REGENERATOR

A simple yet very efficient form of inductively coupled regenerative receiver is illustrated in Fig. 3. This employs the old familiar vario-coupler with a tapped primary and rotating secondary, and a variable condenser. The tuning circuit is connected directly across the primary L-1 of the coupler, while the secondary or rotor is connected in series with the plate circuit. The plate current thus sets up around the secondary a magnetic field that reinforces the field of the grid circuit, with the result that the grid current is strengthened and louder signals are produced. The amount of regeneration is controlled by adjusting the position of the rotor. But the rotor should never be turned beyond the point at which the set begins to squeal or howl.

In operating the set, the first step is to adjust the primary L-1 until the sounds are heard in the head-phones, and then tune the circuit into resonance by means of the condenser C-2. Finally regeneration is cut in by adjusting the rotor L-2 of the coupler. The circuit gives very good results, and if good quality apparatus is used it is capable of fairly sharp tuning.

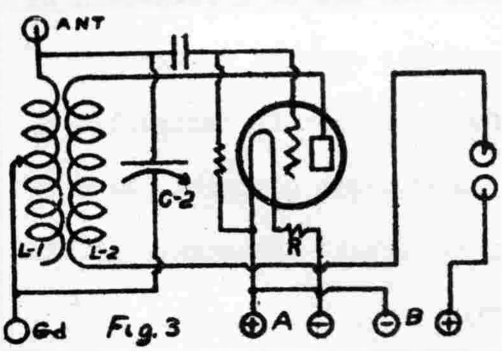


Fig. 3

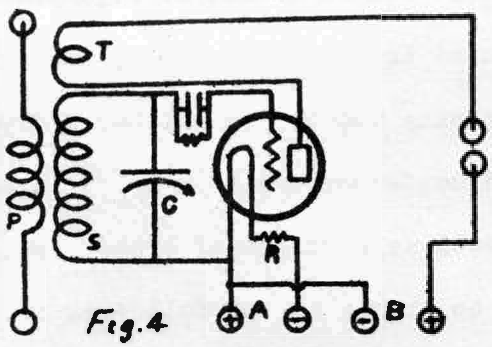


Fig. 4

THE 3-CIRCUIT TUNER

The most common form of regenerative detector circuit in use today is that employing a tickler feed-back coil. In this system a tuning unit is used that is composed of three individual coils, and it is commonly referred to as a 3-circuit tuner.

The general circuit arrangement is illustrated in Fig. 4. The tuner consists of an aperiodic (untuned) primary of 10 turns "P", and a secondary of 55 turns "S", shunted by a .0005 Mfd. (23-plate) variable condenser "C". The advantage of using an aperiodic primary is that it gradually diminishes radiation in case excessive regeneration is cut in. This will be explained in greater detail later on. As usual, one side of the secondary is connected in series with a grid condenser and grid leak to the grid of the detector tube, and the other side is connected to the positive side of the filament.

The feed-back or tickler coil "T" consists of 34 turns of wire wound on the rotor and is coupled to the grid end of the secondary. It is connected in series with the plate circuit as is illustrated. The action of the entire circuit is as follows:

When a station is tuned in, the tickler coil is first set for minimum regeneration, that is, its axis is at right angles to that of the secondary. The station is located by adjusting the tuning condenser; and when the signals are heard clearly, the tickler is slowly turned until the sounds are heard with maximum intensity. This increase in signal strength is caused by the radio frequency component of the plate current setting up around the rotor a magnetic field that reinforces the field of the secondary. The grid oscillations are thus greatly strengthened, and greater variations in the plate current are produced.

One disadvantage of this circuit and coil arrangement is that every time the rotor coil is changed in position the secondary circuit is detuned somewhat, and the tuning condenser must be readjusted to restore resonance. This is because the coupling or mutual inductance of the two coils is varied. This accounts for its not being possible to log stations with this circuit, that is, to accurately mark the dial settings for the correct tuning adjustment of a certain station.

A REGENERATOR CAN BE A MINIATURE TRANSMITTER

When the tickler of a regenerative circuit is tuned beyond the point at which a click is heard and the set begins to whistle and howl, so much energy is fed back from the plate to the grid circuit that the tube is thrown into oscillation. In this condition the tube actually becomes a generator of radio frequency oscillations that are sent out or radiated from the receiving antenna. These emitted waves will affect all other nearby receiving sets.

For instance, if the regenerative detector oscillates and sends out waves at a frequency slightly different from the frequency of the carrier waves of a broadcasting station, these two sets of waves will be superimposed upon each other and produce in all nearby receiving sets a shrill squeal or whistle varying in tone and pitch, depending upon the difference between the two frequencies. A slight movement of the tickler will change the frequency of the radiated waves and vary the pitch of the whistle. Such interference is extremely objectionable.

The operator of a regenerative set should guard against rotating the tickler coil beyond the point at which a click is produced; for if there were a signal to be picked up, he would have received it with his particular tuning adjustment just before the tube began to oscillate and whistle. Frequently such sets are referred to as "bloopers," and they are not the best type of set to use in a congested city district, especially when they are in the hands of inexperienced or careless operators.

THE TUNED PLATE REGENERATIVE SYSTEM

Another very effective method of setting up regeneration in a tube detector circuit is the tuned plate system, in which the plate circuit is brought into resonance with the detector circuit by means of a variable inductance such as a variometer.

In this tuned plate method of regeneration use is made of the capacity effect existing between the internal elements of the vacuum tube. If the construction of a tube is considered, it will be seen that the grid and plate consist of two metallic surfaces separated by an insulator - in other words, they form a small condenser through which it is possible to transfer energy from the plate to the grid when the proper electrical conditions exist.

When the grid and plate circuit are thus tuned to the same frequency, the stronger plate current oscillations will occur in exact synchronism (in step with) the feebler grid oscillations. The result is that energy is fed from the plate to the grid through the condenser action existing between the two. Consequently the voltage variations impressed on the grid are greatly reinforced, and the output of the tube is increased many times.

An interesting circuit employing tuned plate regeneration is illustrated in Fig. 5. The tuner here consists of two coils wound on a 3-inch tube. The primary consists of 8 to 10 turns, and separated from the primary by about one-half inch is the secondary which consists of 68 turns and is shunted by a .00035 Mfd. (17 plate) variable condenser. A variometer is connected into the plate circuit in series with the ear-phone receivers and B-battery. The remainder of the circuit is of standard construction.

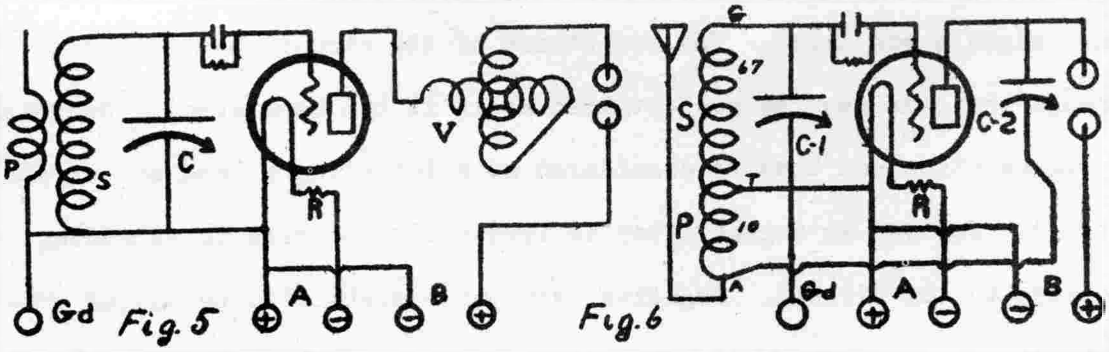


Fig. 5 Fig. 6

In tuning the receiver, the variometer is first set in the zero position. The station is then located by adjusting the variable condenser; and when the desired signals are heard clearly, the variometer is slowly turned until the signals are heard with maximum intensity.

However, the variometer should never be turned beyond the point at which the set begins to whistle, for then too much regeneration is cut in and the tube is thrown into oscillation.

REGENERATION AS NEGATIVE RESISTANCE

Frequently regeneration is referred to as negative resistance. When a receiving circuit is tuned into resonance with an incoming wave train, the inductance and capacity of the circuit are so balanced that they neutralize each other. The only opposition that the current oscillations then experience, is the resistance of the various parts and of the connecting wires.

It is evident that when this resistance has been decreased to its lowest practical value, the current flow will be maximum, and the received signals will come through with greatest strength. Since this resistance cannot be eliminated entirely, there is a limit beyond which signal strength cannot be increased.

Through the action of regeneration the oscillations in the grid circuit are greatly intensified, with the result that greater plate current variations are produced and louder signals are heard. The resistance of the circuit has not been affected, although the same results are obtained as if it had been greatly decreased. The effect of regeneration can thus be considered as eliminating a good bit of the circuit resistance. Cutting in regeneration is frequently referred to as adding negative resistance to the circuit. Negative resistance might also be called subtractive resistance.

A CAPACITY FEED-BACK CIRCUIT

The circuit described here is an excellent illustration of capacity feed-back, that is, of cutting in and controlling regeneration by means of a variable condenser.

It is a very efficient circuit, is stable in operation, easy to tune, and best of all is not one that will readily disturb nearby sets with annoying squeals.

The circuit arrangement is illustrated in Fig. 6. The antenna and tuning inductance is a single coil of the auto-transformer type. It is wound with No. 22 D.S.C. wire on a 3-inch tube and consists of 78 turns with a tap taken off at the tenth turn. The first 10 turns then constitute the primary or antenna inductance "P" and the next 68 turns the secondary "S". The latter is shunted by a .00035 Mfd. (17-plate) condenser C-1. The outer end of the secondary "G" is connected in series with a grid condenser to the positive side of the filament. The antenna is connected to the beginning of the coil at "A".

The plate or output circuit of the tube divides, one part leading through the ear-phone receivers to the positive terminal of the B-battery, while the other branch leads through a variable condenser C-2 to the antenna terminal "A". It is through this latter branch that the radio frequency component of the detector output is fed back into the grid circuit and regeneration is effected. The amount of regeneration is controlled by adjusting the condenser C-2. The remainder of the circuit is self-explanatory.

In tuning the set, the condenser C-2 is set at about 25, that is, the rotor plates are about three-fourths withdrawn from the stator. The station is then located by means of the tuning condenser C-1. Lastly the condenser C-2 is adjusted until the signals come in with good strength. Care should be taken, however, in not cutting in too much regeneration and causing the set to oscillate. In case a hissing sound is heard in the ear-phones, the filament rheostat should be turned down somewhat.

RESISTANCE CONTROLLED REGENERATOR

Another method of controlling the feed-back effect in a regenerative detector, is by means of a variable high resistance shunted across the tickler or feed-back coil.

This scheme has become quite prominent on account of its simplicity and the ease and smoothness with which regeneration can be varied. It permits the use of a fixed tickler coil, and the tuning or wave length adjustment of the secondary circuit is not affected by variations in the feed-back circuit. Another advantage it offers over the 3-circuit tuner is that it does not involve the use of a moveable or rotating inductance with its possibilities of broken wires or poor sliding contacts.

An effective circuit in which regeneration is controlled by this resistance method is illustrated in Fig. 7.

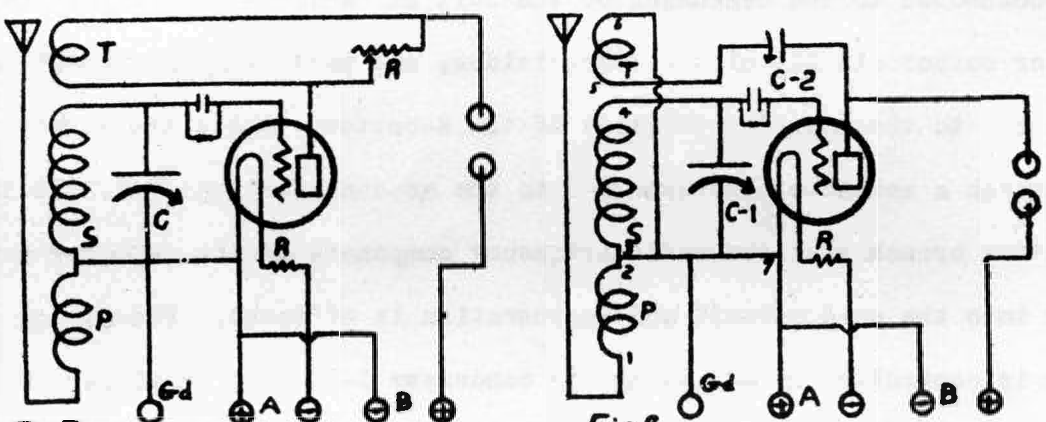


Fig.7 Fig.8

The tuner consists of three coils wound with No. 22 or 24 wire on a 3-inch tube. The primary consists of 8 turns. The secondary is separated from the primary by one-fourth inch and consists of 69 turns. It is shunted by a .00035 Mfd. (17-plate) variable condenser. The tickler consists of 20 turns and is separated from the secondaryby one-eighth inch. All three coils are wound in the same direction. The tuner is connected into the circuit as illustrated in the figure. "R" is the regeneration control unit connected directly across the tickler, and consists of a 50,000-ohm variable resistance. The remainder of the circuit is of standard construction.

To put the set into operation, the resistor "R" is first set with about one-fourth of the resistance cut in. The station is then located by adjusting the tuning condenser "C". Lastly, regeneration is cut in until the signals are heard with maximum loudness. However, the set should never be allowed to howl or squeal. If a hissing sound is heard in the ear-phones, the filament rheostat should be turned down slightly. In general, the set will be found to be very stable in operation, easy to tune, and capable of pulling in good distant stations.

A GOOD CAPACITY FEED-BACK CIRCUIT

Another highly efficient regenerative circuit is illustrated in Fig. 8. It is modeled after the Weagant "X" circuit, and in it regeneration is controlled or varied by means of a variable condenser. The tuner is of the 3-circuit type employing a fixed tickler. The primary "P" consists of 8 turns, and the secondary "S" of 68 turns and is shunted by a .00035 Mfd. (17-plate) variable condenser C-1. The two coils are separated one-fourth inch. The tickler "T" is separated from the secondary by one-eighth inch and consists of 20 turns. All three coils are wound in the same direction with No. 22 D.S.C. wire on a 3-inch tube. The condenser C-2 has a capacity of .00025 Mfd. (13 plates).

The circuit arrangement is quite simple. The antenna is connected to No. 1 the beginning of the primary. The end of the primary No. 2 is joined to No. 3 the beginning of the secondary; and this common connection is then joined to the positive side of the filament No. 7, to the stator of the condenser C-1 and to the ground terminal binding post "Gd". The end of the secondary No. 4 is connected to the rotor of the condenser and through a grid leak and condenser to the grid of the tube. The plate circuit divides, one part carrying the audio frequency output to the ear-phones, while the other part carries the radio frequency component through the condenser C-2 to the tickler coil "T". The stator of the condenser C-2 is connected to the plate and the rotor to No. 5 the beginning of the tickler.

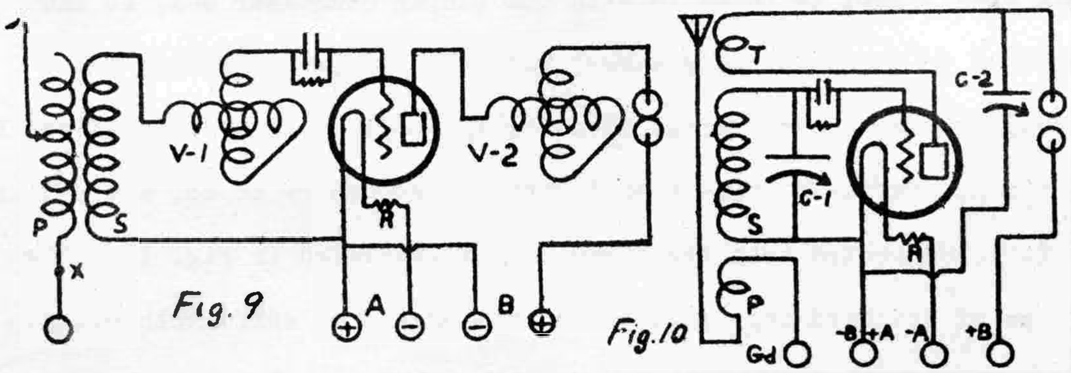
The circuit is very stable and easy to operate. In tuning, the condenser C-2 is first set with the rotor plates about three-fourths out of mesh. The station is then located by means of the condenser C-1. Lastly regeneration is cut in by adjusting condenser C-2, but this should never be carried beyond the point at which the set begins to howl or squeal. If a hissing sound is heard in the ear-phones, the rheostat should be turned down. The circuit is an excellent one for good distanCe reception.

THE TWO VARIOMETER SET

The circuit illustrated in Fig. 9 is probably the oldest and most familiar type of regenerative circuit known to those who have grown up with radio. As illustrated, the cirCuit employs two variometers and a variocoupler. One variometer V-1 serves to tune the grid circuit, while the other V-2 tunes the plate circuit. It can be further improved if desired by connecting a .001 Mfd. (43-plate) variable condenser in series with the ground lead at point "X". However, this introduces another control and thus makes the tuning more complex. In general, the set is a very efficient one and capable of good long distance reception, but is rather difficult to tune to get best results.

In selecting the parts it is important to observe that the two variometers have enough turns of wire so as to cover the desired wave length range. The set should be assembled with the coupler in the center and variometer on each side, as this arrangement prevents any feed-back action between the two. To tune the set, the plate variometer is first set at zero, minimum regeneration. A station is then located by adjusting the primary of the Coupler and the grid variometer. Next, the secondary of the coupler is adjusted so as to sharpen the tuning. Finally the plate circuit is tuned by means of the variometer V-2. This cuts in the regeneration and increases the signal strength. It may be necessary in the meantime to slightly change the settings of "S" and V-1 in order to obtain best results. Regeneration, however, should not be increased too much, or the quality of the signals will be spoiled due to distortion. Another advisable point to bear in mind is that filament operation can be economized somewhat by reducing the brilliancy of the tube and increasing the regeneration. In this way there is less drain on the A-battery.

The set functions best with the larger tubes, for the smaller tubes especially those of the 199-type have a very low internal capacity. Since the tuned plate system of regeneration depends upon this internal capacity for the feed-back energy, difficulty is experienced with these smaller tubes; the same applies to the circuit discussed previously.



ANOTHER TYPE OF CAPACITY FEED-BACK REGENERATOR

The advantages of a 3-circuit tuner employing a fixed tickler coil have already been made clear. The circuit illustrated in Fig. 10 is another efficient way of using such a tuner. Regeneration is again effected by means of a variable condenser, this time, however, connected directly from the plate to the positive side of the filament of the tube. Its action will at once be understood if we recall the small fixed condenser that has always been used as a bypass across the primary of the first audio transformer and the B-battery. Its function was to provide a special path for the radio frequency component of the plate current, so that the audio current could go freely on its journey to the transformer, but the radio frequency current could at once get back to the positive side of the filament.

In the present circuit the fixed condenser is replaced by a variable condenser (C-2 in the figure) having a capacity of .00025 Mfd. or 13 plates. This condenser thus acts as a throttle and affords a convenient and easy means of regulating the amount of radio frequency energy that is fed back into the grid circuit. Variations in the setting of this throttle condenser do not affect the tuning of the grid circuit, which is an important factor when distant stations are being looked for, for when once a weak signal is tuned in with the tuning condenser C-1, it can easily be increased to the point of greatest volume by simply adjusting C-2.

The 3-circuit tuner is constructed identically the same as that described in a previous paragraph, having a primary of 8 turns, a secondary of 68, and a tickler of 18 turns. It is connected into the circuit as illustrated in Fig. 10. The entire circuit is of standard construction and the sketch is self-explanatory. Should it happen when the set is put into operation that no volume can be secured, the leads to the tickler coil should be reversed.

It is quite an easy matter to change over a set that has installed in it a 3-circuit tuner employing a rotating tickler to the one described here or previously, for when the old tuner is removed, a condenser can be mounted in its place on the panel, and the tuner described here can be mounted at a convenient place back of the condensers on the baseboard or subpanel. The change would be well worth while in view of the better results that can be secured.

THE REINARTZ CIRCUIT

A type of regenerative circuit that at one time enjoyed great popularity is the Reinartz circuit illustrated in Fig. 11. The circuit is another modification of the Weagant circuit. It is excellent for distance and is easily tuned.

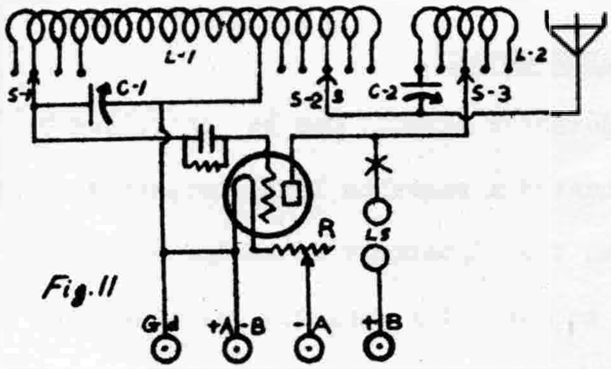


Fig. 11

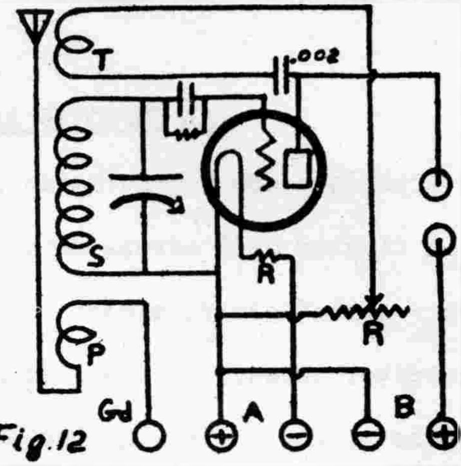


Fig. 12

The coil can be wound either in the spiderweb or solenoid form, the latter generally being preferable. It is wound on a bakelite or rubber tube 3½ inches in diameter and 4 inches long. No. 24 double silk or cotton covered wire can be used. Beginning at one-fourth inch from one end of the tube, 50 turns are wound with taps brought out at the 15th, 30th and 45th turns. This coil will thus consist of two ends and three taps, all of which are connected to the switch contacts of the plate switch.

The second coil is started about one-eighth inch from the plate coil and consists of 60 turns wound in the same direction. Taps are taken off at the 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th turns. All of these taps except the 10th are connected to the aerial switch contacts. The 10th tap is connected to the ground. From the 10th turn on the winding continues until the 40th turn is reached, where another tap is taken off. Taps are also taken off at the 45th and 55th turns. The coil is thus continuous and consists of 60 turns in all. The last five taps

are connected to the contacts of the grid switch.

The condenser C-1 is a 23-plate (.0005 Mfd.) and C-2 an 11 plate (.00025 Mfd.) condenser. The rest of the circuit is of standard construction. Care must be taken in assembling the set to see that all the taps are connected to the proper switch contacts as is in the figure.

AN IMPROVED RESISTANCE CONTROL

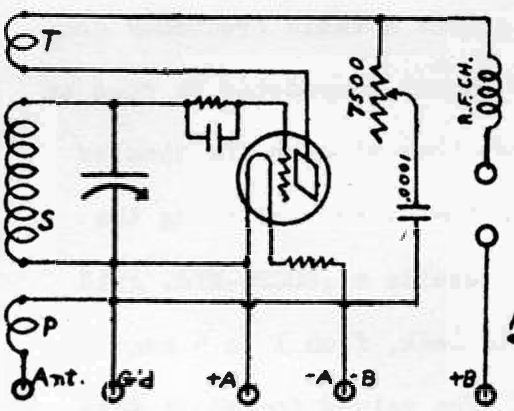
It was explained how regeneration in a detector circuit can be controlled by using a fixed tickler coil across which is shunted a variable high resistance. This method is very satisfactory, except that often the adjustment is rather critical with some detector tubes. Another method is to connect a variable resistance in series with the tickler. This method also forms a very smooth control, but at the lower frequencies (higher wave lengths) it sometimes is rather unstable, because as the resistance is changed the plate pressure is also varied.

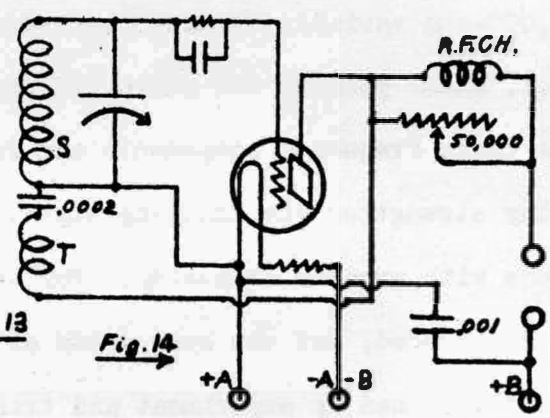
An excellent scheme for controlling regeneration is illustrated in Fig. 12. Here the plate circuit is divided and the audio frequency current is sent directly into the primary of the first audio transformer and to the positive terminal of the B-battery. The B + pressure on the plate of the detector tube thus remains unchanged. The other branch of the plate circuit leads through a .002 Mfd. fixed condenser to the fixed tickler coil "T" and through the variable resistor "R" to the positive side of the filament. The resistor "R" should have a value of 2500 ohms, and acts like a control valve in regulating the amount of current flowing through the tickler coil. This method of control is very smooth and quite stable at both higher and lower frequencies.

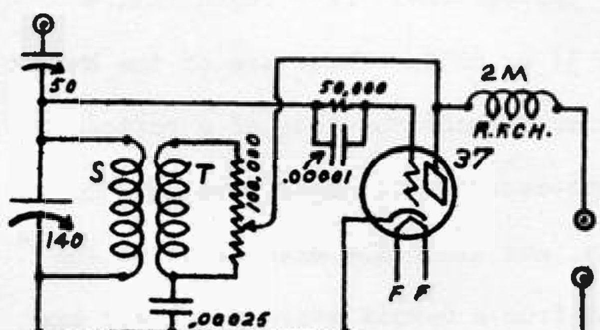
The fixed condenser blocks the audio currents from going through the tickler, while the impedance of the transformer primary blocks the radio frequency currents and causes them to pass through the condenser and fixed tickler coil where they effect regeneration. It will be found that this method is undoubtedly the simpler and most stable of all methods of controlling regeneration.

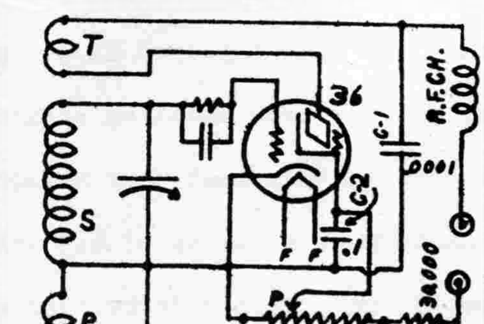
OTHER IMPROVED RESISTANCE CONTROL METHODS

Two improved methods of resistance control specially applicable to regenerative systems in short wave receivers, are illustrated in Figs. 13, 14 and 15. These methods permit very smooth and quiet control and cause no appreciable detuning effects, that is, variations in the degree of regeneration do not seriously affect the tuning of the secondary circuit.









The tuning coil consists of a primary, secondary and tickler, and for broadcast reception is wound according to the same specifications as given in a previous paragraph for circuit No. 8, except that it is connected into the system as illustrated in Fig. 13. For short wave reception the coil specifications are given in a later paragraph. The regeneration control unit in Fig. 13 consists of a small fixed condenser having a capacity of .0001 Mfd. in series with a variable resistor of 7500 ohms.

The circuit arrangement illustrated in Fig. 14 also employs the same type of tuning coil, except that a small fixed condenser having a capacity of .0002 Mfd. is connected between the tickler and secondary coil. The control unit consists of a 50,000-ohm variable resistor connected across a radio frequency choke coil. This R.F. choke permits the audio frequency signal components to pass on but blocks the radio frequency components and forces them through the tickler coil. Here they strengthen the incoming signals so that these can swing the grid of the tube with greater intensity. For best results a .00025-Mfd. grid condenser is recommended, but the best value of grid leak, from 1 to 5 megohms, can readily be determined by experiment and trial. The values for short wave receivers are given in a later paragraph.

The circuit illustrated in Fig. 15 is a typical short wave regenerative circuit system. The tube employed is a type 37 or 6C5G. These are of the heater type; that is, the electron emitting element or cathode consists of a radio-active cylinder or sleeve that is heated by a current-carrying filament passing through it. The filaments have a rating of 6.3 volts, and since the cathode is of the indirectly heated type, either direct current from a 6-volt storage battery can be used or alternating current from the 6.3-volt secondary of a filament transformer. It will be noticed that the filament circuit is entirely independent from the rest of the circuit system.

The tuning coils, which consist merely of a tuned secondary "S" and a tickler "T", are of the standard plug-in type with 4-pin bases fitting into a regular 4-hole standard socket. The antenna series condenser is a 50-Mmfd. (.00005 Mfd.) midget condenser, and tuning condenser is a standard 140 Mmfd. (.00014 Mfd.) short wave condenser. A .0001 Mfd. (100 Mmfd.) grid condenser and 50,000-ohm grid leak are recommended. The R.F. choke in the plate circuit should have an inductance of at least 2 millihenries.

The regeneration control system is of the parallel type, and consists of a 100,000-ohm potentiometer shunted across the tickler coil with a .00025-Mfd. (250 Mmfd.) fixed condenser in series with the circuit. The R.F. choke forces the radio frequency currents through the tickler coil, while the potentiometer controls regeneration by shunting the excess feed-back currents around the tickler. This is a very smooth control arrangement. By using plug-in coils of different sizes various wave length bands can be tuned in, as will be explained in a later paragraph.

REGENERATION WITH SCREEN GRID TUBES

A screen grid tube, it was previously explained, is a 4-element tube or tetrode, and contains a second grid which is in the form of a screen around the plate. This screen grid normally carries a positive potential, but by varying this potential between zero and its rated maximum value, it can be used as a control element for regulating the output of the tube. Consequently it can also be made to serve as a regeneration control unit.

A regenerative detector system employing a screen grid tube in which regeneration is controlled by varying the screen grid voltage, is illustrated in Fig. 16. The tuning coil consisting of a primary, secondary and tickler (P., S. and T.) is also wound according to the specifications given in a previous section for circuit No. 8. The tube is a type 36 indirectly heated screen grid tube having a heater filament voltage of 6.3 volts. The filament current can thus be supplied by a 6-volt storage battery (the kind used in most automobiles) or alternating current can be used from a 6-volt filament transformer. A type 24A tube can be used instead, but in this case a $2\frac{1}{2}$-volt filament supply is needed, preferably a $2\frac{1}{2}$-volt filament transformer. With both the type 36 and 24A tubes 5-pin bases are used as illustrated in Fig. 17, the control grid connection in each case being brought out to a metal cap at the top of the tube. The filament circuit, it will again be noticed, is entirely independent of the rest of the circuit system.

A D.C. potential of 90 volts (two 45-volt B-batteries in series) is applied to the plate of the tube as illustrated, with a radio frequency choke coil in series in the line. But since only 55 volts are needed for the screen grid of the tube, a special voltage dropping or "bleeder" circuit is used. This consists of a 30,000-ohm fixed resistor "R" in series with a 50,000-ohm potentiometer "P" connected directly across the 90-volt B-supply. A very small current of only a few milliamperes, known as the "bleeder" current, flows through this circuit. As this bleeder current flows through the 30,000-ohm resistor, it experiences a 35-volt drop, so that the potential at the No. 1 end of the potentiometer is 55 volts. The No. 2 end being connected directly to -B or ground is at zero potential. There is thus a drop of 55 volts across the potentiometer. Since the screen grid of the tube is connected to the slider on the potentiometer, the potential applied to the screen grid will depend upon the position of the slider. If the slider is moved clear to the No. 1 end, the potential applied to the screen grid is 55 volts. As the slider is moved toward the No. 2 end, this potential decreases, and becomes zero at the extreme end.

Since the potential of the screen grid can thus be varied between 0 and 55 volts, the potentiometer connected as illustrated forms an excellent control for the amount of feed-back or regeneration. This system has the advantages that it permits a very smooth and gradual variation in the regeneration and at the same time it does not affect the tuning of the secondary circuit. It is, therefore, employed a great deal in short-wave regenerative receivers using screen grid tubes. The screen grid tubes also produce a higher amplification gain and deliver louder signals.

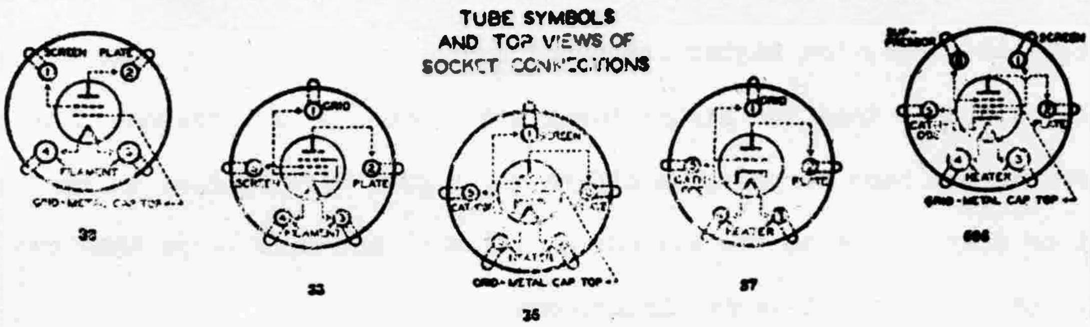


Fig. 17. Socket terminal connections viewed from above for type 32, 33, 36, 37 and 6C6 tubes.

USE OF R.F. CHOKES AND BYPASS CONDENSERS

Radio frequency chokes are small air core inductance coils that offer a high impedance to the passage of high frequency currents but permit the free passage of audio frequency currents. They consist of several hundred turns of fine wire wound on a suitable small bobbin. The winding, however, must be arranged so that the distributed capacity is maintained at a minimum; otherwise the effectiveness of the choke will be impaired.

Since the impedance or choking effect of such a coil increases with the frequency, at the high frequencies used in radio transmission, the impeding or retarding effect is very great. It is this feature that explains their use in the plate circuit of a detector tube, for they serve to keep the unrectified high frequency currents out of the audio system. At the same time some means must be provided to return these high frequency currents to the cathode or filament, and for this purpose a small fixed condenser is used as a shunt or bypass.

In Fig. 16, the R.F. choke keeps the radio frequency currents out of the headphones or audio transformer primary, while the condenser C-1 offers an easy and low impedance by-pass return to the cathode. R.F. chokes ranging from 2 to 85 millihenries are used, depending upon the nature of the circuit. These inductance values are not high enough to offer appreciable opposition to the passage of audio frequency currents. The by-pass condenser ranges in value from .0001 to .001 mfd. If larger sizes are used, the higher frequency audio signals will be able to get through with the result that the higher tones are subdued or suppressed. The condenser C-2 serves the same purpose, it offers all signal oscillations in the screen grid circuit an easy return to the cathode or filament and thus keeps them out of the B-supply where they might cause disturbance.

EXAMINATION QUESTIONS ON FOLLOWING PAGE