# Amplification without Distortion

Acme Apparatus Company

EIGHTH EDITION

# Amplification without Distortion



## A Discussion on Radio with Particular Reference to the Construction and Operation of Radio Audio and "REFLEX" Amplifiers and Sets.



Have you ever stopped to consider what makes it possible for you to hear the distant broadcasting station, to fill the room with music, to communicate with the amateur hundreds of miles away? It is amplification—the key to Radio.

Amplification is used on both the transmitter and receiver, and with it the singer's voice in New York is transported to the farm in Ohio, or the President of the United States talks to the whole country just as though he were in millions of homes at the same time. But Radio without amplification would be a ship without a sail!

Amplification eliminates distance and permits a room or hall full of people to be entertained simultaneously, but the limits of radio and amplification should be clearly understood, especially in regard to distance. The transmission range of radio varies greatly between day and night, city and country, summer and winter, and from night to night, and in such a manner that no exact range can be specified for any particular set.

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At times the most simple radio set will pick up broadcasting stations at considerable distances away, but usually this reception is a freak, and cannot be duplicated at will. As the set becomes more elaborate (that is, as amplification is added) the reliable distance over which it will operate becomes greater and greater up to a safe estimate of 300 to 500 miles in the winter evenings when using a loud speaking telephone and loop antenna. By reliable distance is meant reception over the same distance night after night for a month or so. On some of these evenings, stations a thousand miles away will be heard, but the operator cannot be sure of tuning them in, cannot say to a room full of people, "I will now let you listen to such and such a station one thousand miles away."

### *Beware of Extravagant Claims*

On the purchase or building of a set, beware of extravagant claims, and do not expect the unusual all the time. Obtain reliable apparatus and you will have a dependable radio set which will provide entertainment at will. Use amplification for distance and volume.

### *Distortion and Amplification*

It is not enough, however, just to amplify. With the vacuum tube, amplification can easily be obtained, but to amplify without distortion is a feat which requires skill and knowledge acquired by long study and development. When you hear the opera singer's voice from New York sound like cat calls, you have amplification — but you also have distortion. The source is excellent, but the energy of the voice goes through so many pieces of apparatus and changes in form that, unless great care is exercised, it reaches your ears garbled and unrecognizable. Distortion causes more trouble in radio than static, yet books have been written about static, and distortion seems to have been taken for granted. Static is a natural, uncontrollable function of the elements; distortion is a controllable function of man-made apparatus.

Most of the books on Radio neglect the question of distortion, but reference is here made to Radio Engineering Principles, Lauer & Brown, McGraw-Hill Company, page 251:

> "In order to obtain a perfect speech reproduction, it is necessary that the current set up in the telephone receiver circuit at the receiving station be exactly and in all details proportional to the current in the microphone circuit at the transmitting station. It is therefore essential that no distortion whatever of the microphone current variations be permitted to occur in the amplification of the microphone current, in the modulation of the generated oscillations, in the transfer of these modulated oscillations to the transmitting antenna circuit, in the transmission of the waves between the transmitting and receiving stations, in the transfer of energy between the receiving antenna and the detector and amplifier circuits coupled thereto, and finally in the rectification and amplification of the received signals. If at any one of these stages a distortion of the speech is allowed to take place, the sound at the receiving station will not be a true reproduction of the voice at the transmitting station, and the speech will be distorted to a greater or less extent and may even become entirely unintelligible. The engineering which is necessary at each stage is therefore taken up briefly in the following paragraphs."

and on page 254:

> "The above discussion on distortion is far from complete and merely points to several of the more important sources of speech distortion. It is impossible in a book of this scope to enter into greater details, but this subject is one requiring careful consideration in designing actual circuits."

The Acme Apparatus Company have devoted the majority of the time of their engineering and experimental departments to the study of amplification wihout distortion, and as pioneer transformer and radio engineers and manufacturers have produced a line of amplifying apparatus and transformers which accomplish the results desired.

### *Good Broadcasting Stations Are Not Distorted*

The modern broadcasting station transmits radio telephony with practically no distortion; that is, the public have available a source of radio energy for entertainment and education. The receiving process may briefly be described. The receiving antenna absorbs a small portion of the available radio energy, bringing it unchanged to the living-room table. Here it is transformed in one of several ways, depending on the type of radio receiver used, into audio energy, but is usually amplified first.

The next step is to decide from what distance one wishes to receive broadcasting or signals, and whether head phones or a so-called loud speaker will be used. Let us start with the simple set known as the crystal detector outfit.

### *The Simplest Receiving Set*

A crystal detector may be connected to a vario-coupler, as shown in Figure 5 and when using head phones, very good reception may be obtained. The slight chances of distortion lie only in the head phones, as the crystal detector is almost a perfect detector; in other words, the radio energy is changed to audio without distortion. As a rule, head phones have a natural audio period which makes voice frequencies of this period louder than those of other periods. This is known as resonance or the relatively free passage of energy at one frequency and the suppression of energy at other frequencies. On the head phones, however, this resonance phenomena is considerably reduced when worn against the ears, on account of damping or suppression of energy at all frequencies.

The crystal detector set is greatly limited in reception distance and restricted to the use of head phones. Therefore, in order to increase its receiving range or to add a loud speaker, amplifying apparatus must be employed, bringing in a new source of distortion unless care is exercised in the selection and use of this apparatus.

### *For Greater Distance*

To increase the range of a crystal set, radio frequency amplification should be used; that is, the energy is increased at the receiving station while it exists as radio, after transfer by the receiving antenna and before rectification or change from radio to audio by the crystal detector. For such amplification, as shown in Figure 6 a vacuum tube, a radio frequency amplifying transformer, and

accessory apparatus are necessary, but with the proper apparatus, correctly connected, no distortion occurs, even though several stages of amplification are used.

The next simple set is the single vacuum tube detector set. Here the complicated nature of the detector tube characteristics, as compared with the crystal detector, allows a new source of distortion unless properly used. More adjustments and variables enter into the operation, and its ability to oscillate opens up another phase. Just how to add radio frequency amplification to a vacuum tube detector is shown in Figures 7 and 15.

### *For Greater Volume*

To increase the volume of a crystal detector or vacuum tube set, audio frequency amplification must be used; that is, the energy is increased at the receiving station after it has been changed from radio to audio by the detector. As shown in Figure 8, a vacuum tube, audio frequency transformer, and accessory apparatus are necessary. Fig. 14 shows how to increase the range and volume of a crystal set using one tube. Distortion is much more liable to occur in an audio frequency amplifier than in a radio frequency amplifier because the energy is being handled at frequencies most easily distorted.

### *The Heart of the Amplifier*

The transformer is the heart of the amplifier. Here the voice currents are transferred from one circuit to another through a magnetic field. These two circuits are not conductively connected. Before the days of broadcasting, amplifying transformers were purposely made to have an audio resonance around 1,000 cycles, so that the prevailing spark frequencies used in radio telegraphy would have free passage through them. But telephony deals with many frequencies simultaneously so that it becomes necessary to eliminate resonance from the transformer. Resonance in the transformer allows one or a few frequencies to come through much more easily than others, causing great distortion. If two or three stages of audio frequency are used, any distortion occurring in the first stage is amplified by the succeeding ones in addition to whatever distortion these succeeding ones introduce. Acme Transformers do not distort.

### *Resonance in Radio*

To understand the loud speaker, the meaning of resonance must be thoroughly appreciated. How distortion may occur in a telephone receiver or head set has already been mentioned. This is another example of resonance, which may be termed the friend and foe of radio. Without it we could not have radio, because we could not efficiently transmit or receive, yet with it we may have distortion. Hence resonance is a friend only while the energy exists at radio frequencies (example, tuning and selectivity), and a foe while it exists at audio frequencies (example, distortion).

A loud speaker is a telephone receiver removed from the ear and equipped with a horn or concentrator of sound similar to a megaphone. Horns, too, have resonant points unless properly constructed.

### *Low Losses and Amplification go Hand in Hand*

Realizing that the principles of radio are fixed, but that the efficiency and quality of radio can be improved the Acme Research Laboratory is devoting its time to reducing losses for more amplification without distortion.

### *Summary*

In a crystal detector or vacuum tube set with radio frequency amplification, audio frequency amplification, and Loudspeaker, properly connected and with properly constructed parts, the broadcasting is reproduced identically as transmitted.

To summarize, with improper apparatus or connections, distortion may occur at the following points:

*Tuner*
*Radio Frequency Amplifying Transformer*
*Vacuum Tubes*
*Detector*
*Audio Frequency Amplifying Transformer*
*Telephone Receiver*
*Loud Speaker*
*Horn*

There is another source of distortion which comes into the best of sets and which, under existing conditions, cannot be eliminated. This distortion is caused by radiating receivers or other broadcasting stations of approximately the same wave length interfering with the station from which the entertainment is being received. Fortunately, it does not always exist and can often be corrected by adjustments.

The Acme Apparatus Company manufactures a complete line of amplifying apparatus with the exception of vacuum tubes, and its products demonstrate their belief in amplification without distortion, and low losses.

# RADIO ESSENTIALS AND SET BUILDING

### *Before You Build a Set Read These Pages*

Just as every automobile has a steering wheel, engine, transmission, and differential for motion, so every efficient radio set built or bought has tuning, radio frequency amplification, detection and audio frequency amplification for reproduction. The only changes in automobiles have been in styles and efficiency and these are the only changes we will have in radio sets. In both cases the principles will without doubt remain the same for years.

The key to radio is amplification without distortion and low losses and amplification go hand in hand.

The Acme Apparatus Company, a pioneer organization of transformer and radio engineers and manufacturers, has built up a research department to study amplification without distortion and how to reduce losses to minimum in radio apparatus. The designing engineers therefore have a source of information which insures the manufactured product being correct technically as well as mechanically.

### *Tuning Circuits*

Radio broadcasting may be collected on either an aerial or loop. The increased power of broadcasting stations, increased efficiency of radio receiving apparatus, the desire for simpler tuning, the interference from radiating receivers, static and spark stations, the ease of calibration and the lack of antenna space has made the loop the most popular collector of broadcasting.

With a loop the tuning circuit consists of only the loop itself and a .0005 m. f. variable condenser. In this way single handled tuning is obtained, and the stations always come in at the same dial setting.

Using a .0005 m. f. variable condenser the loop inductance should be .16 millihenries so that the broadcasting range of 200 to 550 meters may be covered.

### *Loops*

The amount of energy picked up by a loop is proportional to the area of the loop, the number of turns, and to the resistance of the complete circuit of loop and condenser. Both of these pieces of apparatus must therefore be low loss.

### *How to Make a Loop*

If a loop is to be made, choose the size desired and use for wire either insulated Litzendraht, equivalent to 16 to 20 B. & S. solid wire, No. 18 equivalent stranded insulated or No. 18 solid insulated, given in the order of their efficiency.

Below are given the turns and spacing for loops of various sizes:

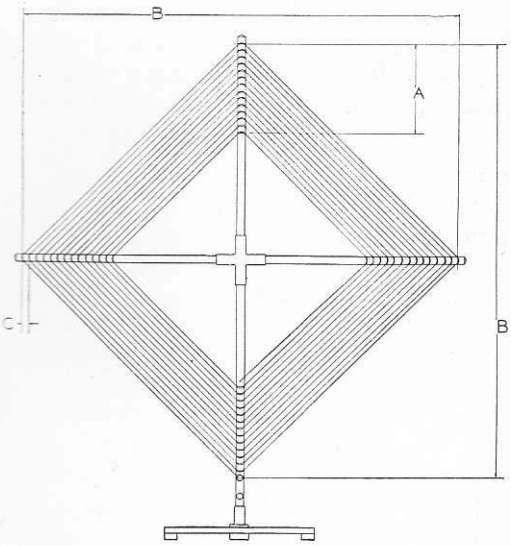



*Fig. 1*

Ratio B/A=4.77 must be constant

A=(number of turns-1) x spacing

| *Turns* | *Spacing* "C" | *Crossarm Length* "B" | *Wire Length* |
|---|---|---|---|
| 11 | 1 25/64" | 66" | 135' |
| 12 | 1" | 52" | 117' |
| 13 | 3/4" | 43" | 105' |
| 14 | 9/16" | 35" | 92' |
| 15 | 29/64" | 30" | 81' |
| 16 | 3/8" | 26 13/16" | 77' |
| 17 | 9/32" | 21 1/2" | 67' |
| 16 | 1/4" | 16 3/4" | 52' |

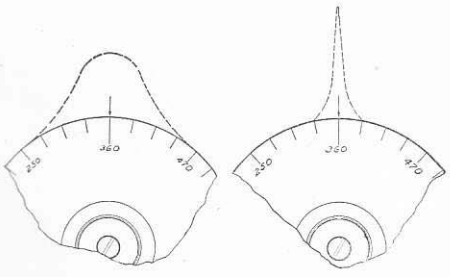
When making the smallest size loop have eight turns on each side of loop. Begin at the outside cross over at the inside and end at the outside.

Keep loop leeds short as possible.

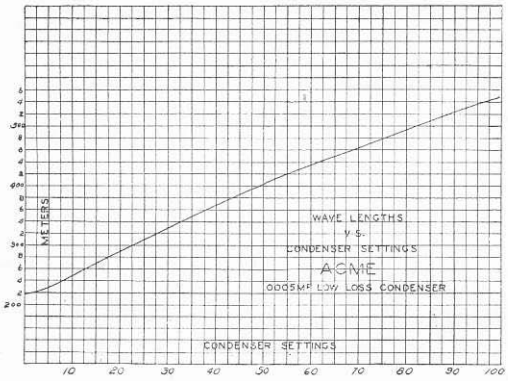
Keep them separated 2 inches.

## *Condensers*

Just as the loop is important in a tuning circuit, so is the condenser. When getting a condenser there are certain features to look for in order to get a low loss piece of apparatus. First of all the condenser must be electrically efficient, which means that the insulation between stationary and movable plates must be made of a dielectric having low losses, such as hard rubber. It must be in a part of the electrostatic field where the density is a minimum. All plates of like polarity should be soldered together and the shaft should be connected to the terminal by means of a flexible connection. Metal head condensers are preferable to insulated head condensers. The condenser should be enclosed so that dust can not get on the plates as dust is a high loss dielectric and often causes short circuits. The plates of a condenser when silver plated give the best results because silver oxide is a conductor while other metallic oxides are dielectrics. The movable plates furthermore, should be of the logarithmic type so as to give a straight line setting curve when used with a fixed inductance (see cut).




High Loss Condenser  Low Loss Condenser



Mechanically a condenser deserves considerable attention to insure continuous operation. Verniers are essential for fine tuning, but the majority of them have considerable back lash due to gears. This makes the friction type of vernier much more preferable and furthermore, eliminates the noises often found with other types.

### *Aerials*

Although aerials collect more energy, as a rule, than loops they also collect more interference and noise, leaving the interference or noise signal ratio greater than that of a loop.

### *How to Add an Aerial to a Loop Set*

Where interference is not a factor in reception an aerial may be added to a loop set to give increased range. Below are given several ways of accomplishing these results with the preference in favor of Fig. 2.

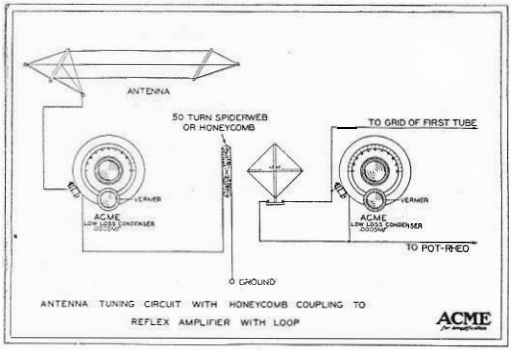



*Fig. 2*

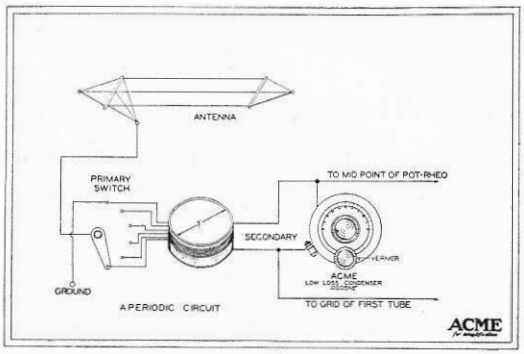



*Fig. 3*

Take specifications for coil in Fig. 3 from Fig. 13, ignoring remainder of Fig. 13.

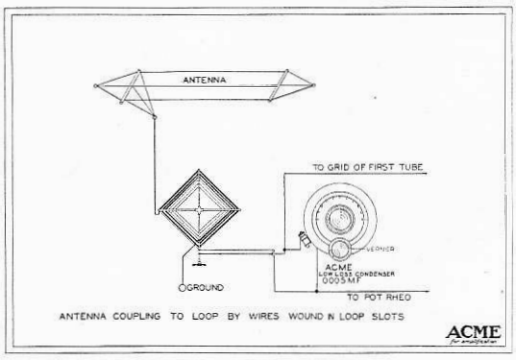



*Figure 4*

### *Amplification*

After tuning comes amplification at radio frequencies, detector (rectification) and then further amplification at audio frequencies. Radio frequency amplification gives distance and audio frequency amplification gives volume.

### *Reflex Amplification*

Radio and audio frequency amplification can be obtained on the same vacuum tube and is then called Reflex amplification. This system allows a great economy in vacuum tubes and is just as efficient as straight radio audio amplification if not more so.

The Acme Apparatus Co. have spent a great deal of time on Reflex circuits and recommend them for best results, because they best meet the features every radio set should have.

### *Features Every Radio Set Should Have*

No matter what radio set is built or purchased it should have the following features for satisfaction:

1. Quality
2. Volume
3. Range
4. Ease of operation
5. Ease of construction
6. Non-radiating
7. Sharp tuning
8. Ruggedness
9. Small upkeep expense
10. Low initial cost

### *Radio Frequency Amplification*

Tuning circuits are always followed by a vacuum tube which is usually used as an amplifier. Immediately following this tube, radio frequency amplification should be employed for increasing the strength of broadcasting. There are four methods of getting radio frequency amplification given here in the order of their efficiency.

1. Tuned transformer radio frequency amplification (most efficient)
2. Fixed transformer, radio frequency amplification
3. Inductive coupling
4. Resistance coupling

### *Tuned R. F. Amplification*

Tuned transformer radio frequency amplification has until recently been objectionable on account of additional adjustments and the necessity of using some means of stablizing or prevention of oscillation, most of which are not applicable over the whole broadcast range and which accomplish the results with considerable loss in energy.

### *Fixed Transformer R. F. Amplification*

With fixed transformer radio frequency amplification one efficient transformer cannot be made to cover the whole broadcast range, so it is necessary to use two or three, each one amplifying best at a different wave length so chosen that when connected in cascade equal amplification is obtained over the whole broadcast range.

### *Detection*

There are two kinds of detection or rectification used in Radio today — the crystal detector and the vacuum tube detector. Both forms of detection are distortionless when properly used. The advantage of the crystal detector is the saving of a vacuum tube, and the disadvantage, the adjustment and the chances of getting poor mineral.

When using a vacuum tube detector of the UV 200 or 300 type always use a potentiometer. If Pot Rheo is used use the 6 ohm rheo. type.

There has recently appeared on the market a vacuum detector tube known as the Sodion tube, which has great sensitivity when used in the circuit given in this book.

### *Audio Frequency Amplification*

After detection, comes the most important form of amplification for distortionless volume on a loud speaker, audio frequency amplification, for it is this range of frequencies 50 to 5000 which is most easily affected.

Resonance, or the relatively free passage of energy at one frequency and the suppression of energy at other frequencies, is the cause of most distortion at audio frequencies. Resonance on the other hand is necessary for radio at radio frequencies.

Never try to use over three stages of audio frequency amplification, in fact with efficient transformers no more is needed.

Resistance coupled amplifiers are often mentioned in periodicals, but are too expensive on account of the number of vacuum tubes needed for equal results with transformer coupled amplification. This type of amplifier is also very inefficient as it requires twice the "B" battery potential used in the transformer coupled type. Transformer audio frequency amplification has now been brought to a point where distortion is no longer a factor leaving no advantage in favor of resistance coupled.

Some discussion has been carried on during the past year relative to the correct ratio of audio frequency transformers and different ratios. This discussion has been completed with the decision recognized by radio engineers that the same ratio transformer should be used in each stage provided the proper primary impedence is used, and that a ratio of from 4 to 4 1/2 to 1 is the optimum value for maximum amplification without distortion, as higher ratios introduce distortion, while lower ratios are inefficient.

## *AUDIO FREQUENCY AMPLIFYING APPARATUS AND CIRCUITS*

### *How to Get the Most Out of Your Audio Amplifier*
### *"Audio for Volume"*

While the connecting together of a set of parts for an audio frequency amplifier is relatively simple, there are certain precautions which should be taken in order to obtain maximum efficiency and freedom from distortion. These are embodied in the diagrams given in this booklet and should be followed exactly to obtain the best results.

A properly designed audio frequency amplifying transformer for use on voices and music should have no marked resonance over a band of from 50 to 5,000 cycles.

When using transformers in which the above points have been disregarded, it is necessary to use resistences, condensers, different ratios in the different stages, and other expedients to reduce distortion. All of these cause losses and diminution of signal strength. As none of these things are necessary with the Acme Audio Frequency Transformer, they are not shown in the circuit, except in Reflex circuits where they are used for other purposes.

The following points should be carefully observed in constructing an amplifier of maximum efficiency:

1. The grid of the tube should be connected to the outside leed of the secondary (3rd Binding Post). Marked G. This leed should be as short as possible and run at right angles to other closely adjacent leeds.
2. When using potentials of 66 volts or less on the plate, good results are obtained with all of the standard tubes now on the market by connecting the inside leed (4th Binding Post) marked A — of the secondary direct to the negative side of the "A" battery. With potentials over 66 volts, a grid bias or "C" battery should be used, as shown in Figure 10. The value of this battery potential will vary with the "B" battery potential and type of tube within limits of 2 to 12 volts. The exact value for best results should be found by trial, or the tube manufacturers instructions. This is extremely important with UV 199 tubes.
3. As the stray field from a properly designed transformer is very small, shielding is unnecessary.
4. The rheostat should always be connected in series with the negative side of the filament, and the inside of the secondary (A-) connected to the battery side of the rheostat.
5. At the present time there is considerable misinformation being circulated regarding the advantage of using transformers having different ratios — that is, 9 to 1, 3 to 1, 5 to 1, etc. — in the different steps of a multistage audio frequency amplifier.

This is an attempt on the part of the writers of the articles in question to reduce the inherent distortion in the ordinary resonant amplifying transformers by combining transformers having different resonance points. For instance, a 9 to 1 transformer having a resonance point at say 1,200 cycles is combined with a 5 to 1, perhaps, having a resonance point at 800 cycles, and if a third stage is used, a 3 to 1 is added with a resonance point at possibly 600 cycles. Needless to say, this is only a compromise to somewhat broaden the ultimate resonance curve and the results will not be comparable with those obtained when two or three identical transformers of proper design are used.

Different ratio transformers are also advocated in an endeavor to prevent overloading the tubes in a multistage amplifier. Since this method can only succeed by using an inefficient transformer in the first stage, it should never be considered, as a large portion of the available energy is wasted.

The proper way to prevent overloading of the tubes on strong signals is to use a somewhat lower voltage on the first tube, increasing on the second and reaching a maximum on the third, as shown in Figure 10. It is seldom necessary to do this when employing but two stages of audio frequency amplification unless extremely loud signals are being received. This is not necessary in a Reflex amplifier.

It is also sometimes advisable when using a three stage amplifier to connect two tubes in parallel in the last stage. This procedure eliminates all chance of overloading and delivers ample energy for the average loud speaker.

6. Due to the resistance of the "B" battery at audio frequencies, it is advisable to connect a 1 m. f. condenser across it.

7. The low voltage tubes now available are very microphonic and ring when any part of the set is touched. This is due to their delicate grid structure, and may be almost entirely eliminated by acoustically insulating their sockets. Soft rubber washers between the socket and its support will do this.

## *MOST COMMON CAUSES OF IMPROPER OPERATION OF AN AUDIO FREQUENCY AMPLIFIER*

### *What to Look for in an Inefficient Audio Amplifier*

1. Inside of secondary (4th Binding Post) marked A — improperly wired to positive instead of negative side of "A" battery.
2. Defective tube. See that elements do not touch each other. The fact that the tube lights is no proof that it is a good amplifier.
3. Discharged or low voltage "A" or "B" battery.
4. Open transformer winding.

   Note: This may be ascertained by connecting each winding in turn in series with a "B" battery and pair of phones. If a sharp click is not heard, the winding is open, and the complete transformer should be returned to the manufacturer for replacement. After five years' research this difficulty has been practically eliminated in Acme Transformers.
5. Loose connections or open circuit in wiring. All connections should be soldered, using resin flux. If this is not possible, the wires should be scraped clean and securely clamped under the binding posts or screws.
6. Loose connections or dirty contacts on jacks. Filament control jacks, if used, must be cleaned at frequent intervals to prevent a high resistance contact and consequent low voltage on the tube filaments.
7. If unusual noises such as squeals, howls, etc., are heard, their location may be ascertained by disconnecting the aerial or loop. If the disturbance stops when this is done, it is coming from outside and is probably caused by oscillating receivers, beating carrier waves, grounded electric lighting wires, etc., and is beyond the control of the operator. If it does not stop when the aerial or loop is disconnected, the trouble is in the set and is probably due to:

   *Low "A" or "B" battery. Defective tube.*

   *Use of resonant transformer. Leaks across wiring due to use of corrosive soldering flux.*

   *Improper wiring, connections, or arrangement of parts.*

See note on page 21 regarding Acme Service.

# Instructions for Constructing and Operating Reflex Amplifiers

First of all, do not expect the extraordinary on the first night that any new radio receiving set is operated. The transmission of long distance radio is affected by many things, and the skill of the operator of the receiving set has a marked effect on its range. It is somewhat similar to driving a strange automobile, at first the car does not seem to respond and handle as well as your own, but after a while its flexibility and ease of operation are quite apparent and often astonishing.

The "Reflex" amplifying circuits given in this booklet have all been tested and are recommended to those desiring the best results. They should be followed as closely as possible, and under no circumstances should plate variometers or ticklers be introduced in an effort to obtain regeneration. If this is done, distortion will result, impairing the quality of the received speech and music, and the distance over which broadcasting can be received will be reduced.

### *Antenna*

The function of the antenna is, roughly, to provide a "pick-up" for the incoming oscillations. Were it not for static, radiating receiving sets, carrier wave beats, and other forms of interference, the best antenna for broadcast reception would be a single wire about 100 to 150 feet in length from the instruments to the extreme end suspended as high as possible. But due to the above stated reasons, the use of this type of antenna should be limited to the less sensitive types of receivers or to points at some distance from centers of population.

With the more sensitive receivers, the interfering noise may be reduced at some sacrifice of signal strength by using a smaller antenna. A small indoor antenna or loop gives excellent results with the more sensitive sets.

For all the year round radio, the use of a small antenna or loop is preferable, due to interference. The small antenna may consist of either a wire run down a hallway 20 to 30 feet in length and connected to the set through a load coil system such as shown in Figs. 1, 2, 3 and 12, or a loop used as antenna. The way to make a loop is shown on Page 7. Steel framed or metal lathed buildings sometimes reduce the pickup of a loop too much. If you live in such a building and don't get strong signals put up a short antenna.

**Do not connect a loop to a set with twisted lamp cord or telephone receiver cord. Use separate insulated wire spaced at least 2 inches apart.**

How to use an antenna on a Reflex Amplifier is shown in Fig. 12.

### *Grounding*

The ground connection should be a No. 14 wire run as directly as possible to a water pipe. It should be fastened to the pipe by means of a good clamp.

### *Condensers*

Condensers having low losses should be obtained and preferably be fitted with a noiseless friction reducing mechanism for fine adjustment, particularly in the secondary circuit. A vernier or fine adjustment must be used on the condenser

in a loop receiver. The Acme condenser is particularly designed for radio frequency and reflex receivers.

Keep the condenser at the input side of the set.

Keep the wire from the grid to the STATIONARY plates of the condenser as short as possible.

### *Tubes*

For best results use 201A or 301A tubes.

All of the standard vacuum tubes now on the market may be used with Acme Audio and Radio Frequency Transformers, but special precautions should be taken for the control of the WD 11 and 12 tubes.

It is best to control the WD 11 by using a Twin Rheo, as shown in Figure 14 rather than a potentiometer across the "A" battery. This method of connection provides control by introducing damping in the secondary circuit. This tube is not recommended for radio frequency use.

With tubes having a low internal capacity, such as the UV 199 and DV3, it is necessary to connect a fixed condenser of approximately 10 mmf. capacity across the grid and plate of the first tube. This may consist of a piece of mica .005" thick with two pieces of copper with an overlapping area of about ¼" x 5/16". This will equalize the sensitivity of the set over the entire broadcasting range.

With sets using more than 2 tubes best results will not be gained with WD 11 and WD 12 types. If dry batteries are desired 199 and 299 tubes will give best results.

### *Potentiometer-Rheostat*

It is always necessary to use a potentiometer and rheostat for controlling the operation of the first tube in a fixed transformer radio frequency or reflex receiver.

In order to provide a compact unit for this purpose, the Acme Pot-Rheo was designed, and we recommend its use. Any good rheostat, however, having the proper resistance and a potentiometer having a resistance of from 200 to 400 ohms may be used. Both units must be smooth in operation, otherwise adjustments will be audible in the receivers.

For four .25 ampere tubes use 6 ohm pot rheo.

### *Crystal Detector*

If a crystal detector is used be sure to obtain a good crystal. (Brownlie's Quick Contact is recommended.) A crystal detector is like a "B" battery in that it wears out due to oxidization. A good crystal should be efficient for from six to eight months. You will find that a good crystal will stay in adjustment for a whole evening's entertainment and often for days at a time. Static and loud signals do not knock out a crystal in a radio frequency or "reflex" amplifier on account of the buffer action of the vacuum tubes.

The contact spring should be made of silver wire about No. 32 gauge. If other than silver wire is used it is necessary to clean it at frequent intervals with 00 sand paper rubbed on contact point. Use a light contact.

Do not attempt to clean the crystal with anything. Dust may be removed with a stiff tooth brush. Keep your fingers off the crystal.

**Keep the Crystal Detector away from the output leeds.**

The Acme Apparatus Co. have been searching for a good fixed crystal, but regret to report they cannot find one.

### *Sockets*

Use good sockets as a leak will absorb practically all of the slight amount of energy received by the antenna or loop. Never use fibre base sockets.

### *"D" Coil Unit*

The Acme "D" Coil Unit is a combination of a tuned R. F. transformer and a .0005 m. f. condenser, so that tuned R. F. amplification may be obtained with a single tuning control. How this unit may be used on reflex sets is shown in Figs. 24 and 25.

### *Radio Frequency Transformers*

In order to prevent interaction between radio frequency transformers, they should be mounted end to end in the set.

In Figs. 17, 18 and 19 one pot rheo is shown for all tubes. This is correct for tubes of .3 amperes filament current or less, but if tubes of larger filament current are used, it is necessary to use a rheostat for each.

Recently the wave length range of broadcasting stations has been changed from 360 to 400 meters to 200 to 550 meters. In selecting radio frequency transformers be sure they cover the range. Fig. 23 shows how the Acme Radio frequency transformers do cover the broadcasting range. Use Acme R-2 for the first stage, R-3 for second and R-4 for third.

Although other than Acme transformers may be used in a reflex set we strongly recommend ACME because of their ability to give maximum amplification without distortion. They are designed just right.

### *Tubes and Tube Contacts*

Examine the tube contacts for lead oxide which is a non-conductor. Be sure they are clean.

When testing a set try different tubes if available or change the order of the tubes in the sockets. One defective tube will often allow a set to work to a slight degree.

Any of the available types of vacuum tubes may be used with Acme Transformers and will give results depending upon the characteristics of the tubes themselves. In other words to obtain the advantage of dry battery operation it is necessary to make some sacrifice of sensitivity and intensity. All types of vacuum tubes should be operated at their rated voltage.

No matter what circuit you use your tubes will deteriorate if more than rated voltage is applied to the filaments.

### *Variable Condensers*

Many radio frequency and reflex sets fail to operate efficiently because of a high loss variable condenser in the tuning circuits. During the last two years the Acme Apparatus Company has seen many radio frequency and "reflex" sets constructed by broadcast listeners, and the majority of those which failed to operate were found to contain high loss variable condensers. In order that the full efficiency of Acme Transformers may be obtained, we found it necessary to manufacture and sell a condenser of equal efficiency, as a radio receiving set is weakest at its weakest part. The collection of dust in a variable condenser

introduces a poor dielectric and greatly increases the losses. Clean your condenser often, unless it is enclosed in a dust proof container as the Acme.

### *By-Pass Condensers*

The By-Pass Condensers shown in the diagrams should be the mica type except in the case of the 2 m. f. condenser, which may be the ordinary telephone paper condenser. This latter condenser serves as a by-pass for both high frequency currents to prevent losses and for low frequency currents to prevent audio howls.

### *B Batteries*

Use from 66 to 90 volts

Although the same B batteries are shown for both vacuum tube detector and amplifier, better results will be obtained by using a separate B battery for each, as some B batteries are of such high resistance, variation in amplifier current affects the detector. If a separate detector B battery is used, the negative of the amplifier B battery should be connected directly to the positive of the A battery.

Under no circumstances should so-called protective resistances be used in series with the "B-Battery" as they will cause howling and squealing.

The plate current necessary for operating the vacuum tubes available is of such a high order that a storage "B" battery is desirable for operating results and economy.

Use a C battery for B battery and tube economy and better quality.

### *Wiring*

All leeds, especially those to the grid and plate should be made as short as possible, and should not run parallel to other leeds for any great distance. The best leeds are made by using No 14 solid wire, bent into shape and fastened securely. Never attempt to wire up a Reflex set using flexible leeds connecting together a heterogeneous arrangement of parts.

A shield may be made by placing a piece of spaghetti over the wire and over the spaghetti a piece of Belden braid or light weight copper tubing. (See next page). The braid or tubing should terminate ½" from the ends of the spaghetti and be grounded to the negative side of the A battery.

When grounding this shield use only resin flux on account of the chances of leaks.

If the B battery leeds are long put a 2 m. f. telephone condenser across the terminals at the set as a by-pass for the radio frequency currents.

### *Soldering*

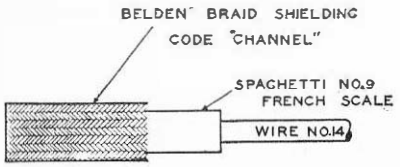
If connections are soldered use RESIN FLUX. If not familiar with soldering, however, all wires should be scraped clean and securely fastened to screws or binding posts.

### *Caution*

Be sure that the grid wire of the first tube is connected to the STATIONARY plates of the variable condenser. Failure to do this may cause almost total failure, due to body capacity effects.

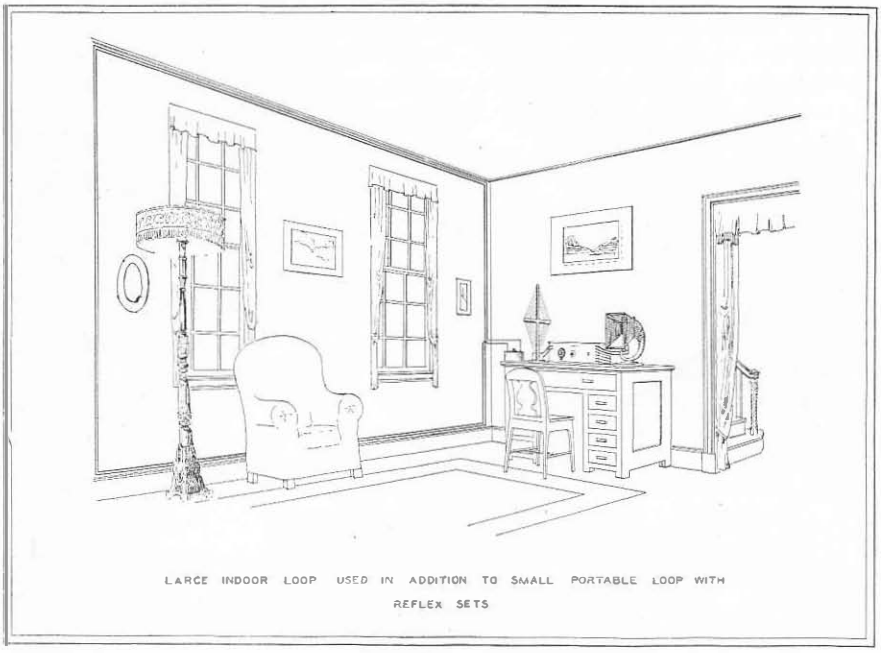
### *Ten Year Efficiency*

Radio engineers are prone to judge apparatus by a test showing its efficiency at that particular moment neglecting the five or ten year efficiency. When buying radio apparatus, ask yourself "will it stand up", "is it guaranteed".




### *Follow the Diagrams Exactly*

If you make a set according to the diagrams given in this pamplet, follow them exactly. The continued success of the Acme Apparatus Company depends upon your getting results, and, therefore, we have spent considerable time in the laboratories to get the circuits right. We have tried to cover all the points regarding reflex sets in this pamphlet but we wish to again remind you that our engineering department is at your service for further information.



LARGE INDOOR LOOP USED IN ADDITION TO SMALL PORTABLE LOOP WITH REFLEX SETS

### *NOTE: On Increasing the Range and Selectivity of a Loop Set*

Where the interference becomes a more or less negligible factor the loop set may be increased in range and selectivity by the use of a larger loop and variable condenser. The larger loop may be made by using about 100 feet of wire put up in the form of a one or two turn loop in a convenient part of the house, such as along the ceilings of two rooms, down the walls, and along the floor, connecting the two free ends to a .0005 variable condenser. This large loop has greater pick up and the coupling between it and the loop attached to the set is of such a loose order that sharp tuning may easily be obtained. The tuning adjustments then become two condensers and the coupling between loops.

This method is recommended where small loops (2 ft. per side and under) are used. See cut above.

**These loops are not directly connected together.** They act as a large variocoupler.

# How to Operate a "Reflex" Receiver

1. After wiring up a "Reflex" receiver and putting the tubes in the sockets connect the "A" battery across the "B" battery terminals to make sure that they are not directly connected to the filaments. If they are the tubes will light, if not, it is then safe to put the "B" battery and "A" battery on.

2. Light the tubes by turning on the rheostat; gently tap each of the tubes and note if a ring is heard in the phones or loud speaker. This is by no means an indication of the sensitivity of the set, but shows whether or not the audio amplifier is working.

3. Tune in any signal or broadcasting station and adjust the crystal (if one is used) to a point of maximum sensitivity.

4. For tuning in stations on an antenna, set the coupler to maximum coupling, turn the potentiometer arm to the positive end, rotate the secondary condenser until a station is heard and then tune the antenna circuit to maximum intensity with the antenna condenser. If no signals are heard or if louder signals are desired turn the potentiometer arm towards the negative end up to the point where the set squeals, the most sensitive operating point being slightly back towards positive from this position.

You will find that the potentiometer can be turned nearer the negative end on the longer wave lengths.

After a few nights' operation you will know just how much you can turn the potentiometer arm for maximum sensitivity for each setting of the secondary or loop condenser.

For sharper and more exact tuning reduce the coupling until the signal is just audible, then retune both primary and secondary. A little practice will show just what coupling value is best for a given station.

For loop tuning, place one hand on the condenser and the other on the potentiometer knob. Turn the condenser until a station is heard and turn the potentiometer arm toward the negative side for louder signals or greater sensitivity. These are the only tuning adjustments necessary outside of turning the loop.

With either the loop or antenna any given station may be tuned in at will after once being heard if a record is kept of the final adjustments.

## *Operation of Tuned R. F. Reflex*

To operate the "D" coil set shown in Fig. 24 begin by turning filament switch to on position.

Turn Rheostat to about 90 on the scale.

The S-13 Sodion Tube requires about a minute to warm up.

Turn potentiometer arm clockwise until hiss is heard.

With the left hand on vernier of variable condenser of D Coil Unit (called station selector, and right hand on vernier of free variable condenser (called sensitivity control) rotate the dials as follows:—

Set Sensitivity control dial (one on right) to 100. (The condenser dial markings are arbitrary.)

Rotate left hand dial slowly one way or the other and at the same time rotate right hand dial downward in dial numbers toward the oscillating point. The oscillating point is shown by a sharp click in the speaker. Beyond the oscillating point nothing can be heard.

Never approach the oscillating point from 0 on the dial up.

The left hand dial is for tuning only and its settings are in wave lengths and are constant. The right hand condenser is for sensitivity control.

In case of severe interference maximum selectivity may be obtained by revolving the loop and if this is not sufficient rotating the potentiometer knob in a counter clockwise direction and simultaneously rotating the right hand condenser dial nearer the oscillating point will effect the desired results.

## *MOST COMMON REASONS FOR FAILURE IN OPERATION OF A RADIO FREQUENCY OR "REFLEX" RECEIVER*

### *What to Look for in an Inefficient Radio or "Reflex" Receiver*

1. Short circuited lightning arrester.
2. Loose and high resistance connections in antenna, and defective insulation.
3. Low values of inductance in primary and secondary circuits of variocoupler — loose connections to rotor — short circuited turns in primary or secondary.
4. High loss, inefficient condensers.
5. Defective vacuum tube.
6. Discharged or low voltage storage battery.
7. High resistance leeds from storage battery to filament connection on sockets, causing low voltage at tube.
8. Dirty tube contacts.
9. Use of corrosive soldering flux, causing leakage.
10. Incorrect connections.
11. Use of tickler coil or plate variometer in an attempt to obtain regeneration.
12. Long leeds, particularly grid and plate connections.
13. Poor crystal detector.
14. Exhausted or low voltage "B" battery.
15. Open potentiometer winding.
16. Poor ground or high resistance ground connections.
17. Incorrect transformers. For broadcast reception, these should be — Acme R-2 first stage, Acme R-3 second stage, and Acme R-4 third stage.
18. Poor grade of spaghetti.
19. Jacks in the Radio frequency circuits.
20. Use of too heavy cat whisker.
21. Use of incorrect loop leeds.
22. Attempt to combine R. F. transformer with regenerative set.
23. Poor soldered joints.
24. "A" Battery reversed.

If, after following the above instructions, satisfactory results are not obtained, the Acme Apparatus Company will be pleased to have you communicate with their Engineering Department, describing the complete set and accessories with a sketch showing the location of the parts.

The Acme Apparatus Company does not consider a sale complete until the customer is satisfied. All Acme products are guaranteed against defects in workmanship and material, and should any such develop, will be repaired or replaced free of charge upon return to the factory with the guarantee tag attached for reference.

Sets may be brought to any of the Acme service stations, listed on the back, for test and repair. **Do not** ship sets to us as they are liable to be severely damaged.

## *DIAGRAMS OF RADIO FREQUENCY SETS AND AUDIO AMPLIFIERS*

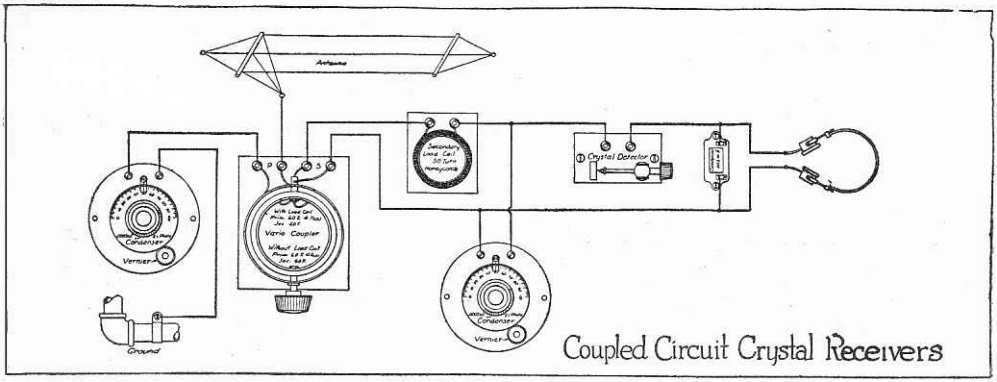



*Figure 5*

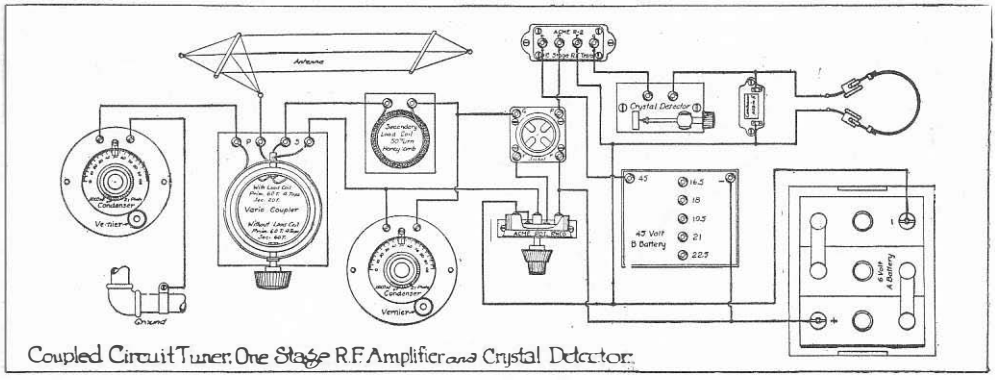



*Figure 6*

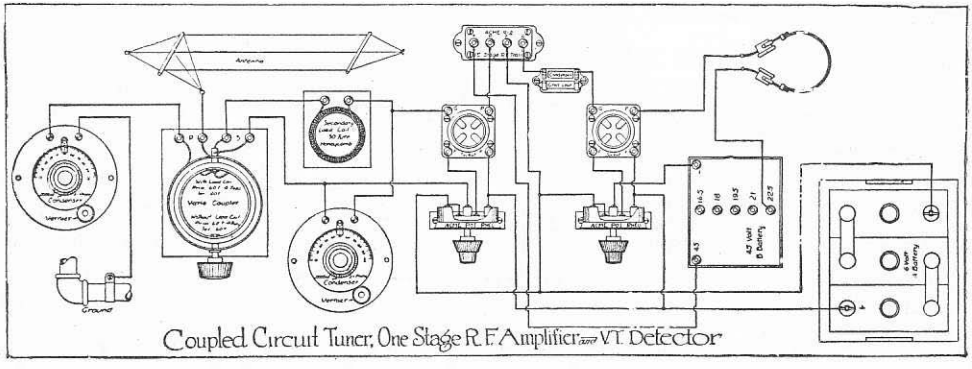



*Figure 7*

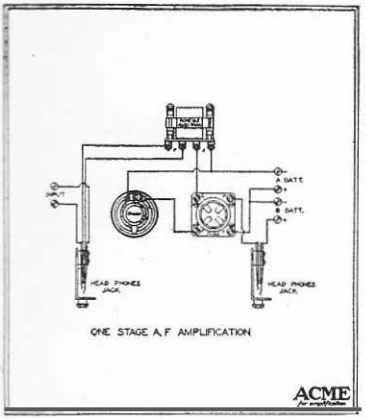



*Figure 8*

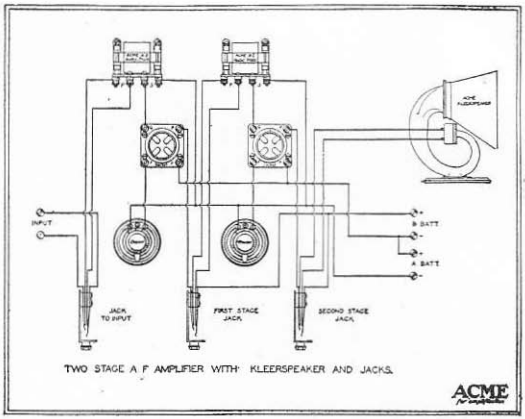



*Figure 9*

Either of the above circuits may be used with that shown in Fig. 11 by connecting the INPUT of the A. F. AMPLIFIER in place of the head phones shown in Fig. 11.

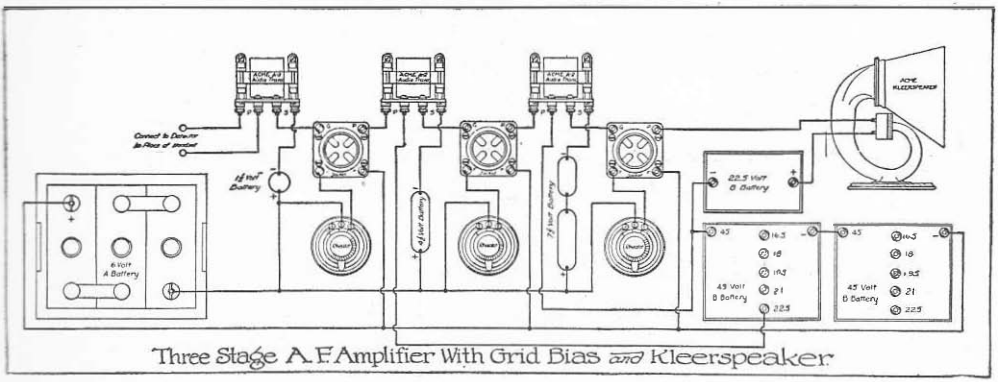



*Figure 10*

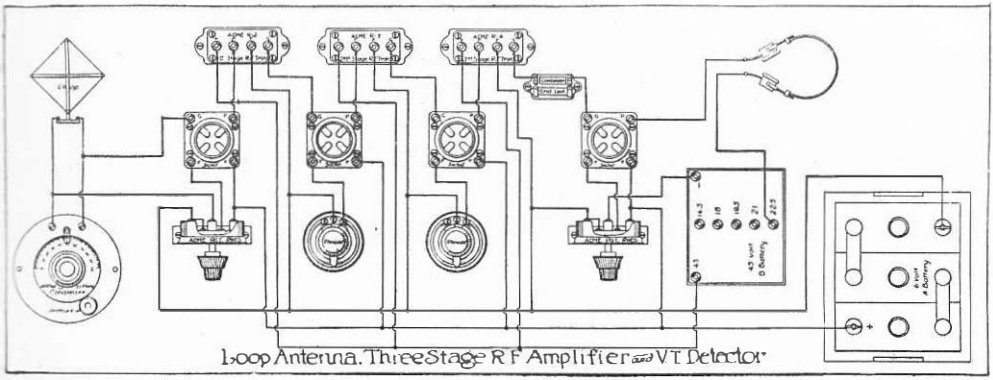



*Figure 11*

## *ANTENNA TUNING CIRCUIT FOR REFLEX SETS*
### *Shown in Figs. 15, 16, 17, 18*

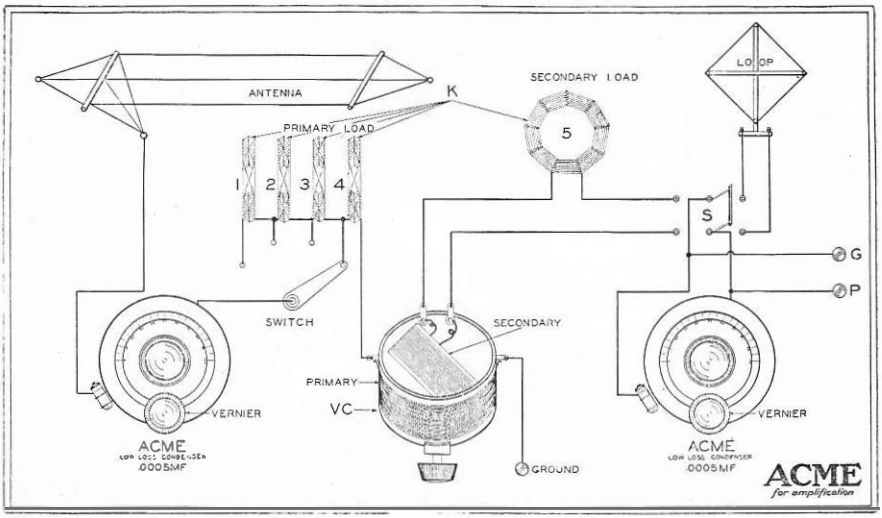



*Figure 12*

### *Loop and Antenna Tuning Circuit with Change-Over Switch*

VC—"Shamrock Acme Reflex Coupler." Stator 28 turns No. 22 Enamelled spaced 1-32 inch, Rotor 18 turns No. 22 Enamelled spaced 1-32 inch.

S—Miniature D. P. D. T. switch to change from loop to antenna. Do not use Jack.

K—Spider Web Coils or equivalent. Coils No. 1, 2 and 5, 50 turns each, coil No. 3, 35 turns and coil No. 4, 25 turns. Mount primary load coils 7 inches from secondary load coil and at right angles to them.

G—Connect to grid of first tube.

P—Connect to Mid-Point of Pot-Rheo.

Note—The primary coils are for use with different antennas. For one antenna use one coil as found by trial.

For use with Reflex Amplifiers shown in figures 15, 16, 17 and 18.

## *LOOP TUNER WITH FILTER*

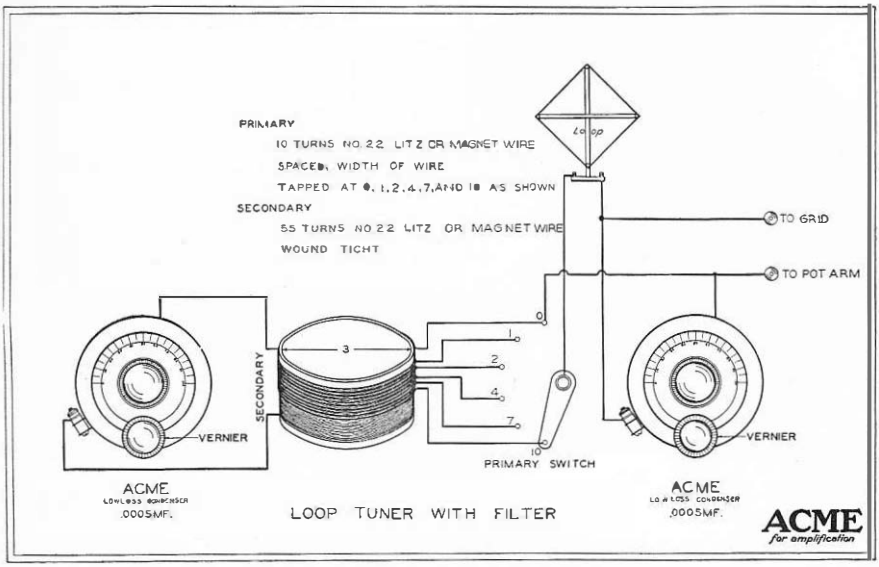



*Figure 13*

If interference is experienced when using a loop, the above circuit will be found to give an extremely efficient filter. Such interference may come from local broadcasting stations too powerful to otherwise cut out on such sensitive sets as Reflex.

The filter shown above is operated as follows:

1. With the filter coil switch at O tune in the undesired station to maximum intensity as usual.
2. Cut in two or more turns of the filter coil and adjust the filter condenser until the signal is absorbed in the filter circuit.
3. Proceed in the regular way to tune in other stations.

It is important that the specifications for the above coil be closely followed. The primary must be wound as close as possible to the end of the secondary which is connected to the movable plates of the condenser.

## *REFLEX AMPLIFIERS*

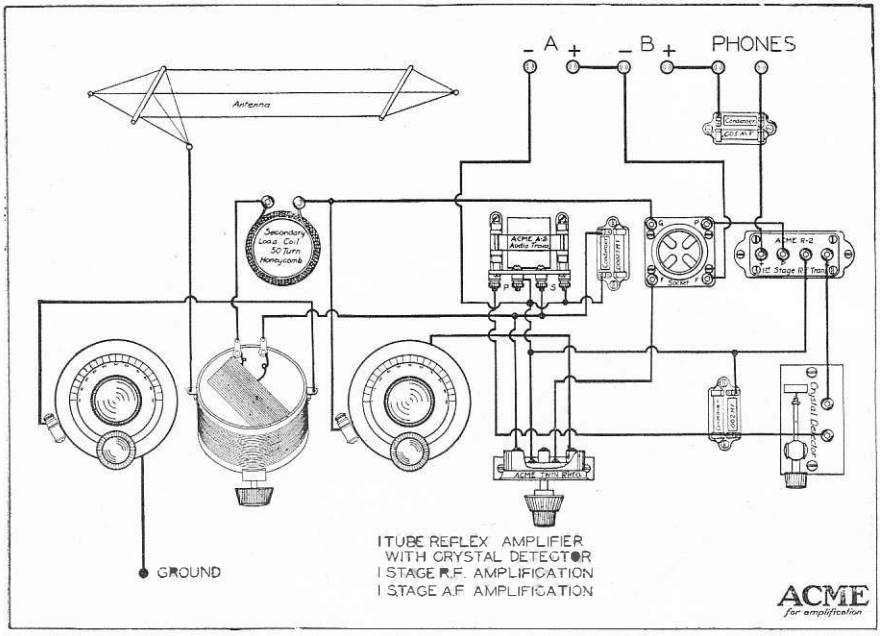



*Figure 14*

The above circuit is the simplest type of "Reflex" amplifier. This set is extremely simple to operate and when dry battery tubes are used it is readily portable for use in automobiles, summer camps or cottages.

Loud speaker signals of moderate intensity are readily obtained from local stations when an antenna of moderate size is used. Under similar conditions using head phones, a large receiving radius is obtained with the well known superior tone quality present when radio frequency amplification is used to obtain distant signals.

As it is undesirable to have a variable grid bias on a tube used simultaneously for radio and audio amplification the non-inductive Twin-Rheo is shown for the tube control.

Note: Use honeycomb coil shown in diagram only with variocouplers having less than 20 turns on rotor. The ordinary variocoupler needs no loading coil.

For list of parts see page 36.

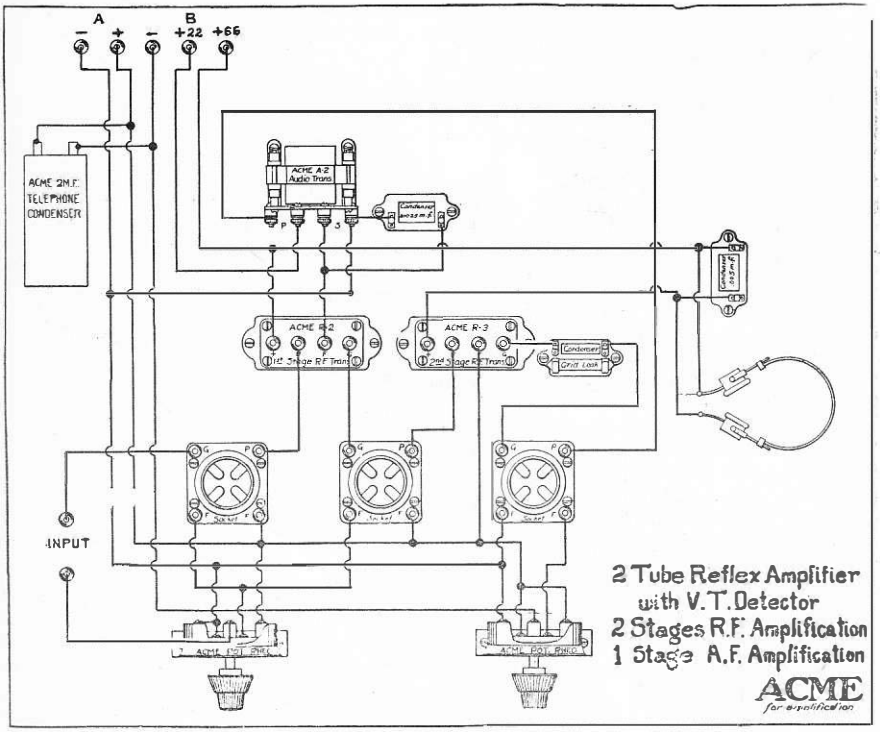



*Figure 15*

The above Reflex amplifier is designed for use by the novice desiring to hear distant stations reliably with a minimum expenditure. It may be used with either an aerial or loop. See Fig. 20. If loud speaker signals are desired a two stage audio amplifier shown in Fig. 8 should be added.

For list of parts see page 36.

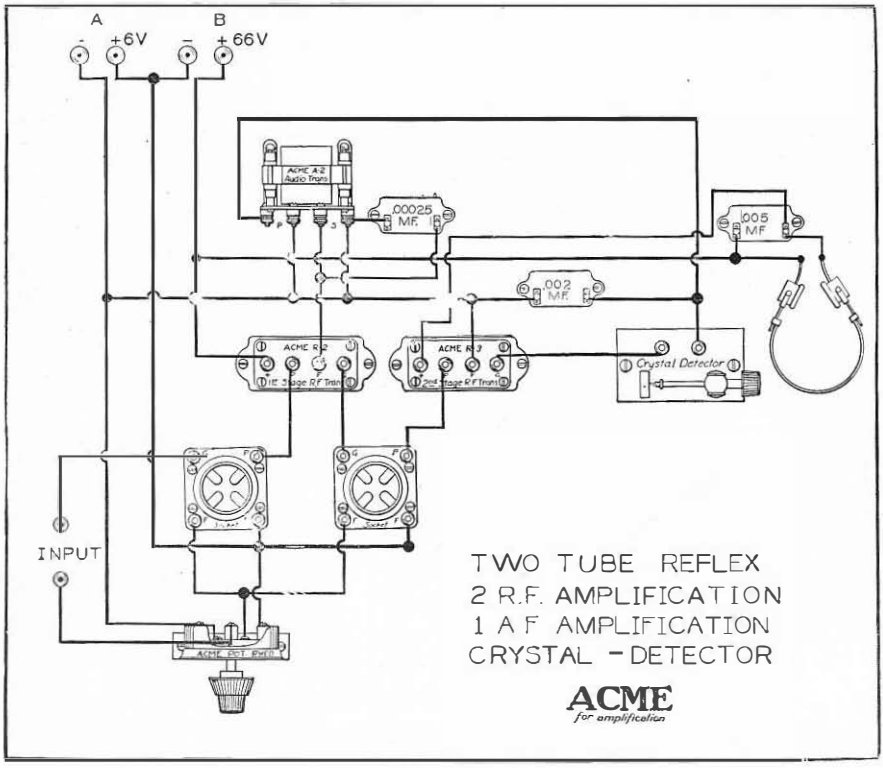



*Figure 16*

The above Reflex amplifier has become very popular for head phone operation on distant stations and for loud speaker operation on nearby stations. It may be used with either aerial or loop. See Fig. 20. If louder signals are desired a two stage amplifier shown in Fig. 8 should be added.

For list of parts see page 36.

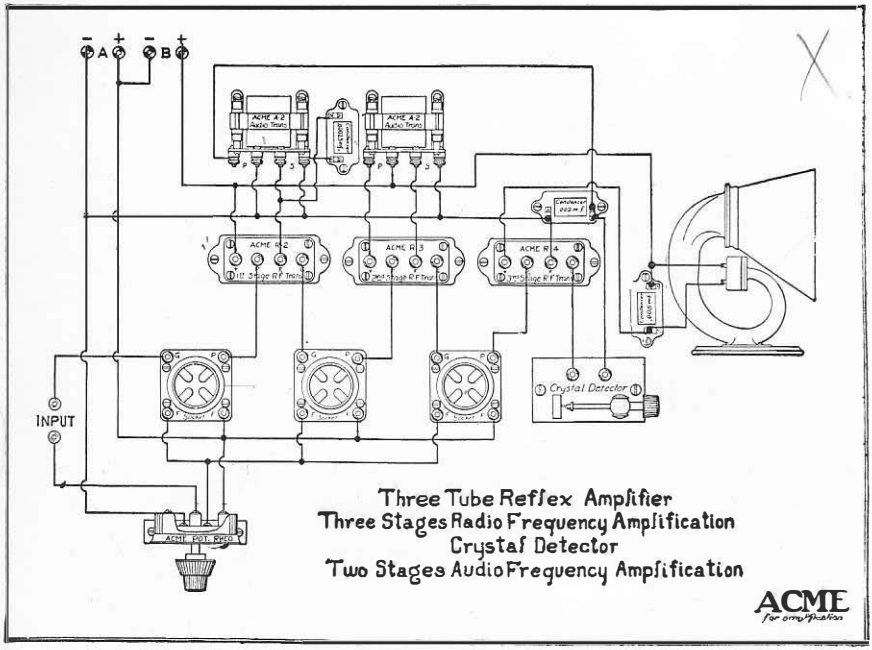



*Figure 17*

The above Reflex amplifier will give the maximum results obtainable with three tubes. A crystal detector is used to insure distortionless tone quality, ease of adjustment and freedom from foreign noise. While it may be used on an antenna, excellent results will be insured by using a loop exclusively. See Fig. 20.

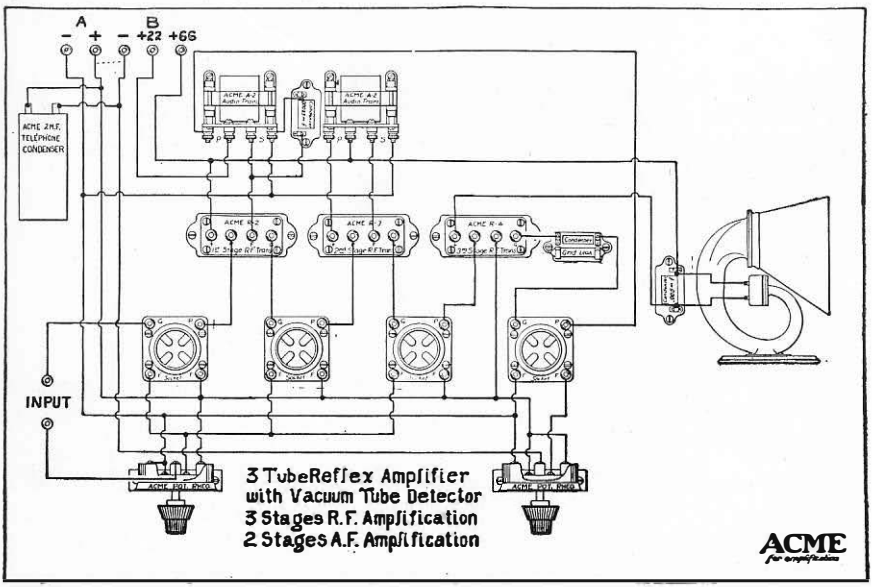



*Figure 18*

The above Reflex amplifier is the same as that shown in Figure 17, except that a V. T. detector is shown for the use of those preferring it to a crystal. Louder signals will be obtained at some sacrifice of quality, ease of adjustment and quietness.

In both of the above circuits it is advisable to shield the lead connecting the first audio transformer to the detector. The method of shielding is shown in Fig. 19.

For list of parts see page 36.

## *FOUR TUBE WITH C BATTERY*

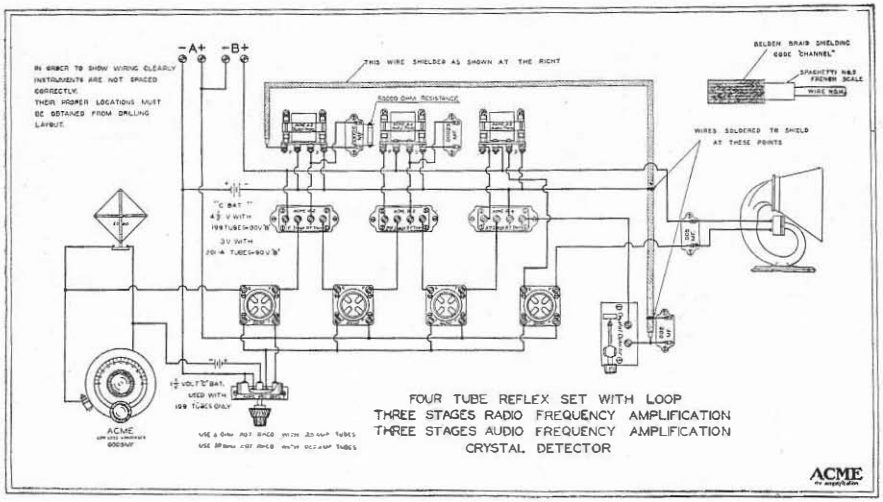



*Figure 19*

The circuit shown in Fig. 19 has to date been extremely popular and has become known as the Acme Four Tube Reflex Set. This circuit gives the most serviceable, sensitive set using four tubes up to date. Thousands have been built and are in operation. For list of parts see page 36.

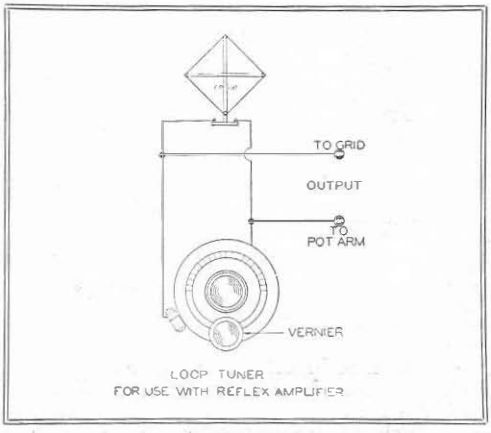



*Fig. 20*

### *Loop Tuner Circuit*

When a loop tuner is used with the circuits used in Figs. 15 to 18 inclusive a loop and condenser only are necessary connected as shown here. How to make a loop is shown on page 7. Litzendraht wire is well worth while for any loop.

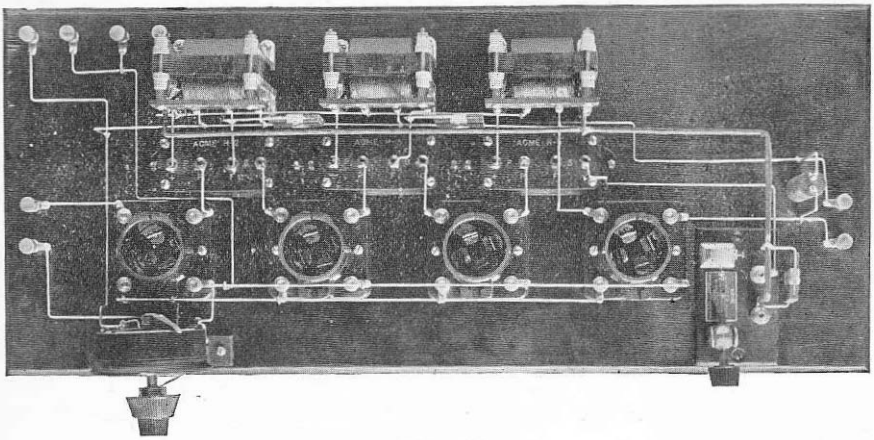


*Figure 21*

## *Four Tube "Reflex" Amplifier*

*(See Figure 19 for Diagram)*

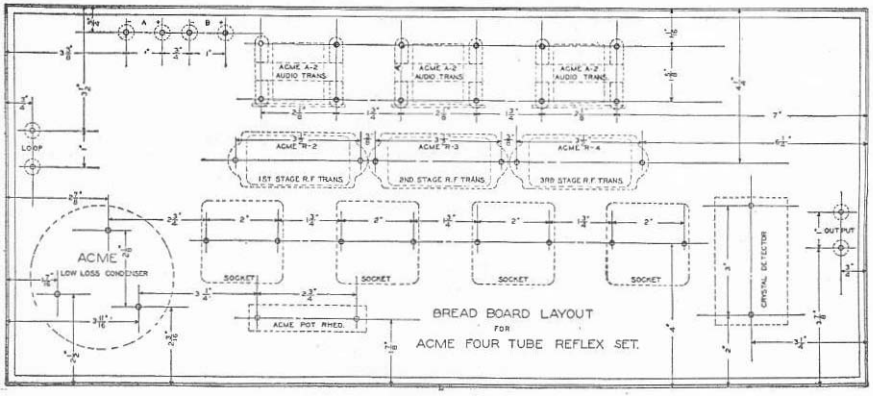



*Figure 22*

## *Layout for Four Tube "Reflex" Amplifier*

### *Tuned Radio Frequency With Reflex*

The Acme Apparatus Co. is constantly at work to increase the efficiency of radio sets, always bearing in mind the man who has already purchased parts. This edition of the booklet "Amplification Without Distortion" contains the latest improvement in the form of tuned Radio Frequency Amplification, added to Reflex.

The apparatus developed for this purpose is the "D" Coil transformer and condenser and may be used in front of the regular four tube Acme Reflex set or in the newer model shown in Fig. 23 which uses a vacuum tube detector.

When used with the four tube Acme Reflex it provides a single stage of tuned R. F. amplification and gives much greater distance and makes the set very selective. With this combination all of the tuning is done with the "D" coil unit so that there is still only one tuning dial. The other condenser becomes a stabilizer and the markings on the dial are no longer significant.

### *How to Add the "D" Coil Unit to a Reflex Set*

If you now have a loop reflex set and want greater distance and selectivity, Fig. 23 shows how to add the "D" Coil unit for results. The additional apparatus is listed below:

1 "D" Coil Unit
1 Socket
1 201A or 301A vacuum tube
1 .0004 m. f. condenser
1 1 m. f. by pass condenser

Notice that the potentiometer is disconnected and no longer used, and the positions of the R-2 and R-3 transformers are reversed.

### *The Loop Must Be Right*

In order to operate the "D" coil unit efficiently it is necessary to have the loop 16 m. h. inductance and to have it wound with low resistance R. F. wire such as 24-32 s. c. Litzendraht (see page 1 for Loops).

### *Acme Loops*

In order that a loop having the correct amounts of inductance, distributed capacity, etc., may be easily obtained the Acme Apparatus Co. manufactures a loop which will cover the whole broadcast range when used with a .0005 variable condenser.

The list price of this loop is $8.00.

### *FULL SIZE PRINTS*

For those desiring to build Reflex Sets with panel and cabinet other than the Acmeflex Kitsets, full size drawings may be obtained from the Acme Apparatus Co., Cambridge, Mass., postpaid as listed below.

No. 1 Four Tube Reflex Set for Loop Operation (2 prints) .....$.50 per set
No. 2 Four Tube Reflex Set for both antenna and loop (2 prints) .$.50 per set
No. 6 "D" Coil R.F. with Reflex & Sodion Tube (2 prints) .....$.50 per set
No. 7 Single Stage of wired R.F. with "D" coil (1 print) .....$.25 per set

Please order prints by number.

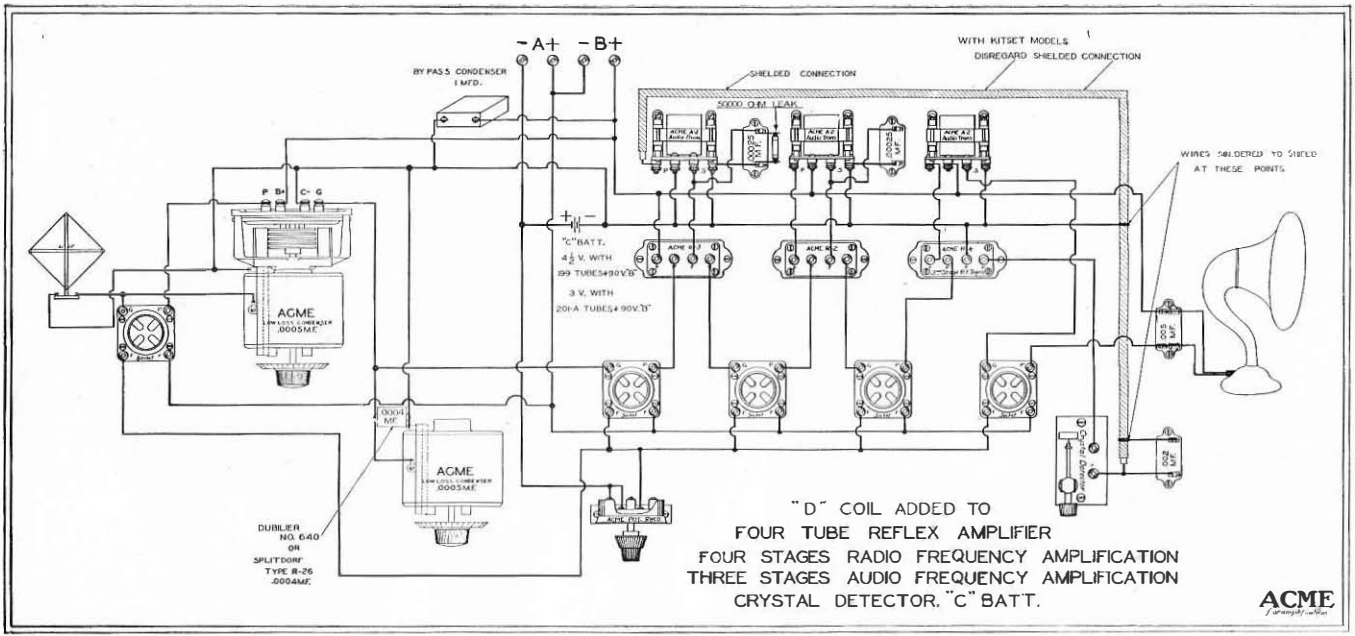

-A+
-B+
BY PASS CONDENSER
1 MFD.
SHIELDED CONNECTION
WITH KITSET MODELS
DISREGARD SHIELDED CONNECTION
50000 OHM LEAK
WIRES SOLDERED TO SHIELD
AT THESE POINTS
P B+
C- G
"C" BATT.
4½ V. WITH
99 TUBES+90V.B
3 V. WITH
201-A TUBES+90V.B
ACME
.0005 MF.
.0004
MF.
DUBILIER
NO. 640
OR
SPLITDORF
TYPE R-26
.0004 MF.
"D" COIL ADDED TO
FOUR TUBE REFLEX AMPLIFIER
FOUR STAGES RADIO FREQUENCY AMPLIFICATION
THREE STAGES AUDIO FREQUENCY AMPLIFICATION
CRYSTAL DETECTOR, "C" BATT.
ACME

*Figure 23*

## *THE NEW MODEL REFLEX SET WITH "D" COIL UNIT*

Fig. 24 shows the new model Reflex Set with the "D" coil and sodion tube detector. This set has one stage tuned R. F., two stages fixed transformer R. F., and two stages of audio amplification. All the tuning is done with the "D" coil unit and the second condenser acts merely as a stabilizer to control oscillation.

This set is extremely sensitive and will pick up the weak signals from very distant stations. For this reason its sensitivity must be controlled by means of the potentiometer on the sodion tube.

The ability to control the sensitivity of the set, in addition to the directional effect of the loop antenna give a higher degree of selectivity than is usually found in Radio sets.

### *List of Parts Required for the Five Tube Reflex Set*

1 .16 M. H. Loop
1 Acme "D" Coil Unit
1 Acme .0005 m. f. condenser
2 Acme A. F. transformers Type A-2
1 Acme R. F. transformer Type R-3
1 Acme R. F. transformer Type R-4
1 Acme Pot Rheo. 6 ohm Rheo. 100 ohm Pot.
5 Good sockets
1 Dubilier Condenser Type 640 .0004 m. f.
1 1 m. f. by pass condenser
1 1 ohm acme fixed resistance unit
1 5 ohm acme fixed resistance unit
1 Sodion tube adapter
1 S-13 sodion tube
2 ft. Spaghetti No. 9, French scale
2 ft. Belden braid code "channel"
1 filament switch
12 ft. No. 14 solid wire
4 201A or 301A vacuum tubes

## *TWO REFLEX CIRCUITS*

The Acme Apparatus Company have worked the reflex circuit out in two ways.

1. Four tube reflex circuit with crystal detector, having three stages of radio frequency amplification with fixed transformers (R2, R3, R4) and three stages of audio frequency amplification (3, A-2's) (Fig. 19).

2. Five tube reflex circuit with vacuum tube detector, one stage of tuned transformer Radio frequency amplification (D coil Unit), two stages of fixed transformer radio frequency amplification (R3, R4) and two stages of audio frequency amplification (2 A-2's) (Fig. 24).

All parts required for each of these circuits except the tubes, batteries, cabinet and loudspeaker have been put up in the form of Kit Sets. Model A for four tube set and Model S for five tube set.

The Kitsets are complete in every detail, containing panel, baseboard, all parts, screws, the loop, clear instructions and full sized drawings which show just how to put it together.

### *Kit Can Be Assembled Without Solder*

It has been worked out so that the whole set and loop can be put together without any solder and only two tools, a screwdriver and a pair of pliers are necessary and they're in the kit too.

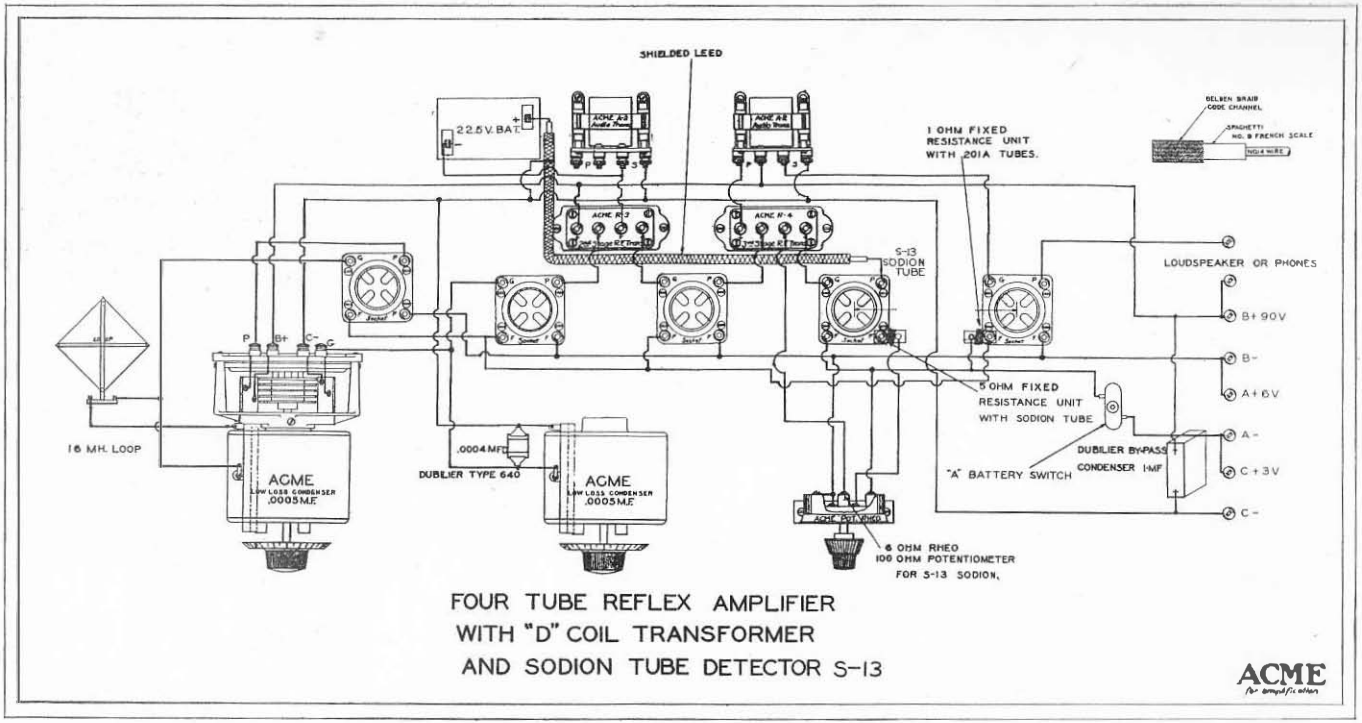

SHIELDED LEED
22.5 V. BAT.
1 OHM FIXED
RESISTANCE UNIT
WITH .201A TUBES.
BELDEN BRAID
CODE CHANNEL
SPAGHETTI
NO. 8 FRENCH SCALE
S-13
SODION
TUBE
LOUDSPEAKER OR PHONES
B+ 90V
B-
A+ 6V
A-
C+ 3V
C-
5 OHM FIXED
RESISTANCE UNIT
WITH SODION TUBE
DUBILIER BY-PASS
CONDENSER 1 MF
"A" BATTERY SWITCH
16 MH. LOOP
ACME
LOW LOSS CONDENSER
.0005 M.F.
.0004 MFD.
DUBILIER TYPE 640
ACME
LOW LOSS CONDENSER
.0005 M.F.
6 OHM RHEO
100 OHM POTENTIOMETER
FOR S-13 SODION.
FOUR TUBE REFLEX AMPLIFIER
WITH "D" COIL TRANSFORMER
AND SODION TUBE DETECTOR S-13
ACME

*Figure 24*

## *LIST OF APPARATUS USED IN REFLEX AMPLIFIERS*

### *List of Apparatus for Fig. 14*

1 Acme A. F. Transformer
Type A-2
1 Acme R. F. Transformer
Type R-2
1 Acme Twin Rheo
2 Acme Low Loss Condensers .0005 M.F.
1 Vario Coupler
1 50 Turn Honeycomb Coil
1 Good Crystal Detector
1 Good Socket
1 .005 m. f. Mica Condenser
1 .002 m. f. Mica Condenser
1 .00025 m. f. Mica Condenser
7 Binding Posts
20 ft. No. 14 solid wire

### *List of Apparatus for Fig. 15*

1 Acme A. F. Transformer
Type A-2
2 Acme R. F. Transformers
Type R-2, R-3
2 Acme Pot Rheos'.
6 ohm with .25 amp. tubes
30 ohm with .060 amp. tubes
3 Good Sockets
1 Acme 2 m. f. Telephone Condenser
1 .00025 m. f. Mica Condenser
1 .005 m. f. Mica Condenser
1 Grid Leak and Condenser
9 Binding Posts
10 ft. No. 14 Solid Wire
1 set Good Head Phones

### *List of Apparatus for Fig. 16*

1 Acme A. F. Transformer
Type A-2
2 Acme R. F. Transformers
Type R-2, R-3
1 Acme Pot Rheo.
6 ohm with .25 amp. tubes
30 ohm with .060 amp. tubes
2 Good Sockets
1 Good Crystal Detector
1 .00025 m. f. Mica Condenser
1 .002 m. f. Mica Condenser
1 .005 m. f. Mica Condenser

### *List of Apparatus for Fig. 17*

2 Acme A. F. Transformers
Type A-2
3 Acme R. F. Transformers
Type R-2, R-3, and R-4
1 Acme Pot Rheo.
6 ohm with .25 amp. tubes
30 ohm with .060 amp. tubes
3 Good Sockets
1 Good Crystal Detector
1 .00025 m. f. Mica Condenser
1 .002 m. f. Mica Condenser
1 .005 m. f. Mica Condenser
10 ft. No. 14 Solid Wire
8 Binding Posts

### *List of Apparatus for Fig. 18*

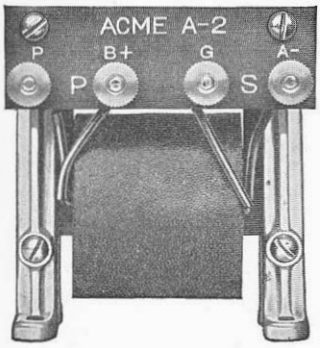
2 Acme A. F. Transformers
Type A-2
3 Acme R. F. Transformers
Type R-2, R-3, and R-4
2 Acme Pot Rheos'.
6 ohm with .25 amp. tubes
30 ohm with .060 amp. tubes
4 Good Sockets
1 Acme 2 m. f. Telephone Condenser
1 .005 m. f. Mica Condenser
1 .00025 m. f. Mica Condenser
1 Condenser and Grid Leak
10 ft. No. 14 Solid Wire
9 Binding Posts

### *List of Apparatus for Fig. 19*

3 Acme A. F. Transformers
Type A-2
3 Acme R. F. Transformers
Type R-2, R-3, and R-4
1 Acme Pot Rheo.
4 Good Sockets
1 Good Crystal Detector
1 .00025 M.F. Mica Condenser with grid leak clips
2 .002 m. f. Mica Condensers
1 .00025 m. f. Mica Condenser
1 .005 m. f. Mica Condenser
10 ft. No. 15 Solid Wire
8 Binding Posts
2 ft. Spaghetti No. 9 French Scale
2 ft. Belden Braid Shielding Code "Channel"
1 50,000 ohm resistance
1 Acme Low Loss Condenser
1 Acme Loop

# LOUD and CLEAR

## With ACME audio frequency amplifying transformers A-2




**Ratio 4.25 to 1**

For loud clear broadcasting use the Acme A-2 Audio frequency transformer. It is the product of transformer, telephone and radio engineers and manufacturers who have devoted much time and expense to the study of amplification without distortion. Although no exact figures are available, we do not hesitate to say that there are more Acme Transformers used in the country today than any other make. The efficiency of the product coupled with our policy of standing back of it has made the Acme Transformer the leader.

**Price $5.00 each**

**ACME**
*for amplification*

# LONG DISTANCE

## With ACME radio frequency amplifying transformers Type R

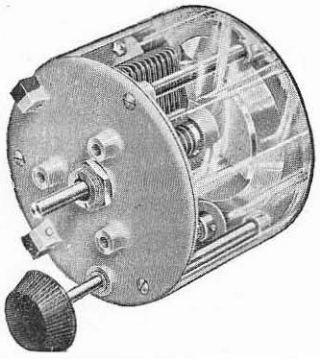

For distant broadcast reception use the Acme Radio frequency amplifying transformer R-2, R-3 and R-4. Months of development work have been put into them by engineers who have been associated with Radio long before broadcasting was contemplated. Radio frequency amplification, especially in the "Reflex" form is coming into general use because with it a loop may be used to reduce static and other forms of interference.

**Price $5.00 each**

**ACME**
*for amplification*

# CONSERVE ENERGY

## The antenna receives only a little energy. Don't waste it



***Enclosed with Dust Proof Covering***

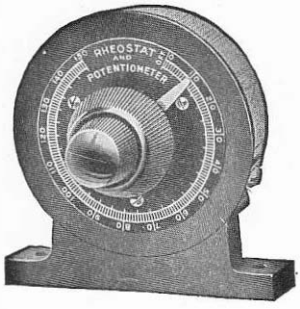
When you consider the small amount of energy picked up by an antenna or loop, it is easy to understand how highly important it is not to waste any of it. The Acme Condenser is desgined to properly handle that little energy and deliver it to the amplifier without appreciable diminution. The Acme condenser embodies many other desirable features which are readily apparent on examination and use.

**Price $6.50 each**

**ACME**
***for amplification***

# ONE for BOTH

## A combined potentiometer and filament rheostat.



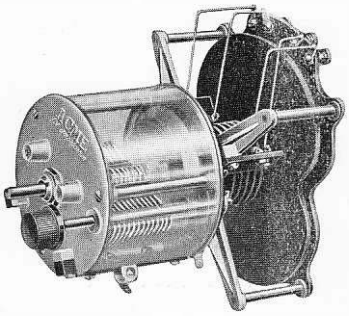

The uses of the Acme Pot Rheo and Twin Rheo are shown in the diagrams of this pamphlet. The advantages of concentric control and economy of space are quite apparent. The design and construction of this unit is of such a high order that it stands out among radio apparatus. Only the best of materials are used to insure proper operation and satisfaction for the purchaser.

**Price $3.00 each**

**ACME**
***for amplification***

# TUNED R. F.

**With an Acme "D" coil unit.**



Tuned radio frequency amplification gives greater distance and selectivity when used with Reflex. In order to keep tuning control to a single unit and increase efficiency the Acme Apparatus Co. developed the "D" Coil Unit which consists of a tuned R.F. transformer mounted on the shaft of an Acme low loss condenser so that it can be tuned simultaneously with the loop circuit. The coil is mounted on bakelite moulded forms and is extremely low in R.F. resistance.

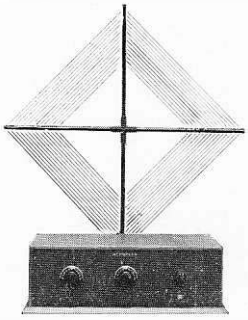
**Price $15.00 each**

**ACME**
*for amplification*

# EASY TO BUILD

**an**

**ACMEFLEX KITSET**



The famous Acme Reflex circuit made so easy that no technical knowledge or workmanship is necessary. You can put it together and operate it on the front porch or take it in an automobile. All of the parts for this circuit and a loop, with full sized drawings and complete instructions are included in this set, and no soldering is necessary. The only tools required for assembling are a screw driver and a pair of pliers which are contained in the kit.

**Price Model A $65.00**
**Price Model S $80.00**

**ACME**
*for amplification*

CONTENTS