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# RADIO PROGRESS

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"Always Abreast of the Times"

IN THIS ISSUE:

Throwing a Crystal Into Fifth Speed
By HORACE V. S. TAYLOR

Forget "A" Battery With Unipower

What Will Tubes Be Next Year?

Golden Girl of Metro on the Air

Cutting Locals Out of RF Sets

The Wonderful Dynosaurodyne

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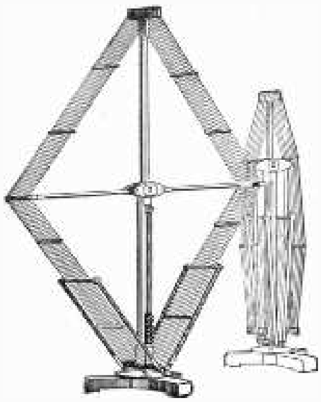
# STATIC ELIMINATION



WITH the approach of summer, every radio fan looks with a certain amount of dread to the Enigma of Radio—Static. For more than a quarter of a century, scientists in many parts of the world have applied their knowledge and skill to the problem of eliminating Static. Most of their attempts have resulted in failure.

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# RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 2 Number 18

Contents for

## DECEMBER 1, 1925



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# Our Next Number Will Be Worth Using as a Christmas Present

Almost everybody was interested in the football games this year. Probably you heard the scores broadcast by your favorite station. How do they pick this up and relay it? Jaspert explains this in his timely article, **"How Football Games Were Broadcast."**

One of the fixtures in radio is the aerial—or so it would seem. However, there have been improvements along this line as well as in receiving sets. Vance will explain this in **"The Last Word in Sending Aerials."**

When you listen to the program coming in smoothly it seems so easy that you doubtless think, "What could be sweeter than being a broadcaster?" However, these gentlemen have their problems just as you do. There is one big one right ahead of them. Read about it in **"Broadcasters Have Live Association."**

Rados has been unusually good in describing the construction of various pieces of apparatus. He has outdone himself in **"Building Your First Radio."** Here we might whisper an aside that many fans might well construct this one, even if it is their second or third.

You hear a lot about fast and slow waves. Does this mean that some reach your aerial quicker than others? By no means. This much misunderstood point is discussed at length in **"Fast and Slow Radio Waves,"** by Taylor.

Even the manufactured sets often have coils which do not fit your aerial and other conditions as well as they might. The coil is one of the most important parts of your outfit. Is yours right, do you think? If you are not sure you will be interested in Nickerson's write-up, **"Coil Calculations."**

Marx has written **"Revamping a Popular Radio."** In it he shows how one of the manufactured sets which has been widely sold has recently been changed in a few respects and in that way greatly improved.

You probably feel that your eyes are the most important sense organs you have. Did you know that recently an electrical eye had been invented which could see a great many things itself. Furthermore, this eye can be arranged to sing, which is more than your own can do. See Arnold's **"The New Electric Eye."**

# RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. 2, No. 18 DECEMBER 1, 1925 15c PER COPY, $3.00 PER YEAR

# Throwing a Crystal Into Fifth Speed

## *Why You Get Fewer Squeals Now Than You Used To*

By HORACE V. S. TAYLOR

SOMETIMES you like to hear a whistle. If it is the 5:15 train coming down the track to take you home, it is a welcome sound, but if it is a continuous whistle coming in through your loud speaker, it is not quite so pleasant.

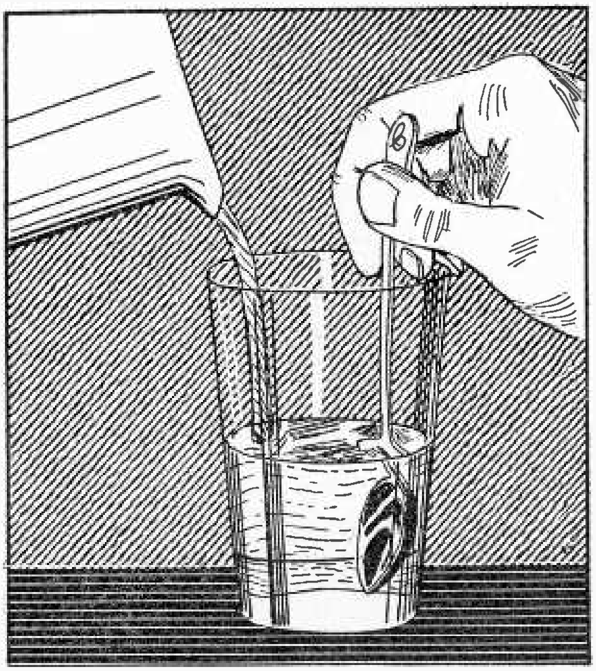

Fig. 1. Tea Glass Shows Principle of Cutting Down a Crystal to Adjust for Speed

The Bureau of Standards, after a long experience, has found that if two stations have waves which are closer together than ten kilocycles (kc) they will cause a reaction, one on the other, which is heard as a high pitched whistle. This spacing of ten kilocycles is constant all over the broadcast range, but the wave length separation which corresponds to it varies from two meters up to ten meters. Indeed, that is one of the advantages of using the kilocycle rating rather than the old way of naming the wave by its length.

### Must Have a Yard Stick

In order to hold the waves spaced by this distance, of course it is necessary to have some sort of a standard to go by. Suppose you were told to put in fence posts just 30 feet apart, how would you be able to locate them unless you had some sort of yardstick or tape to measure the distance? When checking up on the frequency of a station, by far the most accurate way has been found to get a vibration which is correct and then adjust the sending aerial and condenser until it radiates the same waves.

That seems reasonable enough, provided we can find something which will vibrate at the right speed. But remember that the broadcast range varies from 550 kc. to above 1400 kc. Expressed in ordinary language, this is from 550,000 up to 1,400,000 complete oscillations every second. You must admit that that is going some. The ordinary tuning fork sounding middle C on a piano, oscillates only 256 times every second. This must seem like a snail to a man in an airplane by comparison.

### Changing Speed When It Rains

How can you get anything to vibrate at this tremendous speed of around 1,000,000 per second? So far there has been only one practical way discovered

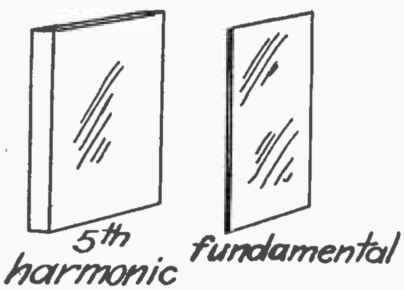


Fig. 2. See How Much Thicker the Sheet of Quartz is for Harmonic

and that is to use a crystal of pure quartz. Only recently the research engineers have discovered how to melt quartz by an electric vacuum furnace in such a way that pure crystals much clearer than glass can be obtained. It has been discovered that such a crystal possesses the remarkable property of shaking at these immensely high speeds, and furthermore, that the speed of vibration or frequency does not change

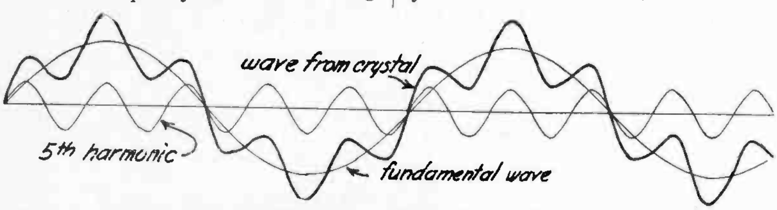


Fig. 3. Here Are the Waves as They Come Raw from the Tuner. They Must be Refined Before Using.

with the weather or the temperature. This is very important, as you would not want your radio stations to speed up their waves on warm days or to slow down whenever it looked like rain.

Now we have found a suitable material to vibrate at the right speed, the question is what size and shape to make it. A tuning fork has a shape which is about the best for the purpose of sending out slow air waves. However, it could never be speeded up to anything line the tremendous velocity needed for radio waves. A shape like an ordinary book with square corners and edges is found to do the work as well as anything. As this is a simple form to manufacture, it is the one which is always used.

### Clinking the Glasses

When it comes to size we run into trouble. Of course, a smaller crystal will vibrate faster than a larger one. You can see this illustrated easily with a glass of iced tea or even of water. Fig. 1 shows a cut of pouring the liquid into a glass while a spoon is used to tap the sides of the tumbler. This gives out a musical clink, clink, as it is struck. If you continue to pour in the tea while you are hitting the glass, you will hear the tone start at a high pitch and gradually drop off lower and lower as the glass gets fuller. When the liquid is up to the top the tone will be lowest of all.

The reason for this change of note is that a big body naturally vibrates at a slower speed (lower pitch) than a small one, so when we experiment with our crystal of pure quartz, we find that the thinner it is the faster it goes. To get up to a million or so is not so bad, but when we want to reach 7,000,000, it requires a slip like a stick of chewing gum except a lot thinner. In fact, the thickness to go at this number of kilocycles will be so small (less than a sheet of paper) that the crystal is very fragile and easily broken.

### Play Them in Bunches

How shall we get around this trouble? It is a good idea to see how they do it in music and perhaps take the hint from that. Suppose we have a parade marching along and the conductor or drum major waves his stick in time with the music. Pretty soon the musicians get to a fast part of the score where the notes follow each other in rapid succession. Does the drum major speed up his arms and jerk them around four or five times as fast as before? By no means. He will group four sixteenth notes together into a single beat and so will wave his stick only one-quarter as fast as the notes pour from the horn of the musician.

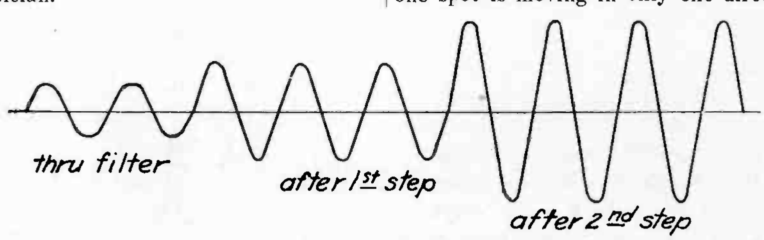


Fig. 4. The Waves of Fig. 3 Are Run Through Three Processes, After Which They Can be Utilized

By beating time only one-quarter as fast as the vibrations are coming there is no loss in the accuracy of the count. The parade continues to swing along with everybody in step, just the same as before. So perhaps we can get a crystal to do the same thing—pick out every fourth wave and emphasize it. However, in this case it has been found that while a crystal working on the fourth beat would do, it is still a shade too thin for practical purposes. By using the fifth instead of the fourth a larger size is indicated which works well in practice.

### Which Crystal is Best?

Fig. 2 shows a picture of the thicknesses for these two crystals—one which beats at about seven million vibrations per second (at the right) and the other which picks out every fifth wave which gives it a speed of one-fifth of that. You can see at a glance that the left hand one is the better to use.

When this crystal is set into motion by putting it between the two plates of a condenser which is used in the grid tuning circuit of a radio tube it will vibrate as shown in Fig 3. There is a main, or slow vibration which is labelled "fundamental," and on top of this is a ripple, five times as fast, named the "fifth harmonic." To understand how these two waves can go on at once look at the ocean where you will see big waves perhaps twenty feet apart and on top of the waves will be a series of ripples, caused by the wind.

### Vibrates Like a Rope

Another illustration is a long clothes line. If you wiggle one end back and forth you can make the rope sway as a whole, but if your hand is a trifle unsteady, you will observe that there are also a series of small waves on top of the big one. Of course, the rope at any one spot is moving in only one direction at a time. In the same way the curves of Fig. 3 are actually combined into the "wave from crystal" where you will see that every spot has only one position at the instant represented in this sketch. Both fundamental and fifth harmonics are being combined, however, just as in the clothes line.

Now it happens that the government

has assigned to Station WGY as an experimental wave, a frequency of 7,160,000 vibrations per second, or 7,160 kc. This corresponds to 41.9 meters of wave length. As just explained, this is beyond the range of any self-respecting crystal. However, to get a vibration of 1,432,000 is not at all difficult. Notice that the ratio here is 5 to 1, which is just pictured in Fig. 3.

### A Million Times is Slow

In checking up on the wave which is being transmitted, it is the fifth speed

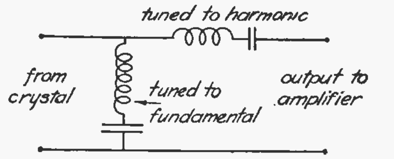


**Fig. 5. Here is the Filter that Strains Off the Scum**

ripple which is used in the sending station and the slow speed fundamental is of no use. In order to prevent its getting into the machinery and causing confusion, it is best to filter out this low vibration. We call it low by comparison although it is shaking back and forth at the tremendous rate of 1,432,000 times a second, or a wave length of 209.4 meters. We shall have more to say about the filter in a few minutes.

After the fundamental has been weeded out, the wave looks just as the ripple did in Fig. 3, except that the effect which we might call a ground swell has disappeared. This is seen in Fig. 4. However, the ripple was faint enough so it would not do much good in any man's size sending apparatus. It has a severe case of anemia. How shall we give it a little strength? You will say right away to run it through an amplifier, and this is just what is done. The first step gives the wave a lot of strength, while the second makes a robust vibration out of it, as shown in Fig. 4.

### It Filters Waves

The filter, which gets rid of the unwanted vibration and lets the desired one through, is not as complicated as it sounds. It consists of nothing but two ordinary radio circuits, each combining a coil and condenser, as appears in Fig. 5. These work just like the tuner of your receiving set. The output from the crystal is fed to the input side of the filter. Right away the waves find a coil and condenser tuned to the 1,432 kc. waves and this you will notice from Fig. 5, returns right back on itself. Thus the low speed undesired wave is short-circuited without ever reaching the output of the amplifier. The high frequency vibration cannot get through this short circuiting tuner, however, as it is way out of tune for it.

Next the wave comes to a coil and condenser which has been adjusted to the fifth harmonic. Naturally, this seems like home to the 7,160 kc. wave and it enters it with the greatest ease. But if any of the fundamental is wandering along too, it finds that it does not fit this particular tuned circuit and can't get in. The result is that a pure wave of the desired speed of vibration comes from the output of the filter and is ready for the first step of the amplifier as already described.

### "Brown Eyes" Does the Work

Now we have got it, what are we going to do with this wave? A glance at Fig. 6 will convey the idea. Here we have a lot of dancers who cannot keep together as there is no music or any way of keeping them in time. But now the orchestra starts up the tune of "Brown Eyes, Why Are You Blue?" Right away the dancers get the time from the music which you must remember is nothing but a vibration at the proper speed.

In the same way the radio apparatus at the sending station does not know how fast to oscillate, and as a result the wave frequency or wave length is apt to shift from day to day. Indeed there was quite a variation up to the time when the crystal was recently introduced. Now, however, the transmitter feeding to the broadcasting aerial hears the music from the orchestra (crystal) and immediately is able to swing into step. As long as the crystal plays its tune in correct time the waves will stay put at exactly 7,160 kc. And as we have already pointed out, the crystal has a mind of its own, and will not change its speed of vibration for temperature, weather, time or any other consideration.

A picture of the apparatus actually used may interest you. Fig. 7 shows how it looks. The action starts in the crystal at the right hand side. This unit is contained in the little cell, which appears right under the coil, in the middle of the right hand corner. The coil just above it is connected to the right hand tube as its control. This tube is the master oscillator and runs at the combined frequency of 1,432 kc., and also 7,160 kc. (209.4 meters and 41.9 meters.)

This combined wave is fed to the filter, which is the combination of coils and condensers seen near the middle of the cabinet. The variable air condenser in the lower right hand corner is the adjustable element, and this group suppresses the fundamental as already explained. The wave passing through the filter (Fig. 4) reaches the grid of the next tube (second from the right) where it is stepped up to much larger volume. From there it runs to the pair of tubes of the second step of amplification. This is a balanced or "push-pull" step, such as is often used as the last stage of an ordinary radio. The output from here is now powerful enough to be used by the

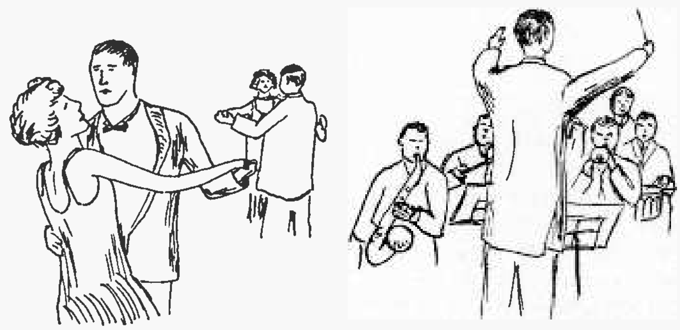

**Fig. 6. Waiting to Get the Time of Vibration. This is Like the Transmitter at the Studio.**

Continued on Next Page

# American Radio Relay League

### SCORNS A CLOUDBURST

Good communication with the outside world was maintained by carrier current, a development of radio, when a cloudburst and flood destroyed railroad, telegraph and telephone lines at Wenatchee, Wash.

The carrier current telephone system recently installed by the Puget Sound Power and Light Company on its high power electric transmission lines over the mountains from Seattle to Wenatchee, was unharmed by the storm, and it was over this new type communication system that news of the disaster first reached the outside world. For several days the only messages reaching or leaving Wenatchee were transmitted by this means.

Carrier current for communication over electric power lines was first used late in 1921, when the General Electric Company installed an outfit on the Adirondack Power Company's lines. So successful was this trial on a 30-mile, 33,000-volt line that a great many of public utility companies in the country have since adopted it.

The apparatus used is similar to a radio outfit, but instead of radiating waves through space in all directions as from a broadcast station, the voice currents are kept concentrated about the power lines, thus insuring privacy and direction of signals. So long as there is a single transmission circuit in operation, communication can be carried on. Ordinary telephone wires, many times smaller than the high power electric lines, generally are first to suffer as was the case at Wenatchee.

### A. R. R. L. GERMAN HAMS TO THE FRONT

Transmitting radio amateurs in Germany are rapidly organizing their section of the International Amateur Radio Union along the same lines that have placed the American Radio Relay League in the forefront of radio amateurs of the world. The German amateurs have drawn up a set of rules governing the activities of transmitting stations, have organized an exchange of technical ideas, and are now getting out a periodical dealing with the activities of their section of the I. A. R. U. This paper lists calls, describes stations and serves as a forum for the discussion of problems.

### A. R. R. L. ZEAL FOR NEW ZEALAND

L. G. Windom, owner and operator of amateur radio station 8GZ, in Columbus Ohio, is making some excellent records in speedy communication between this country and New Zealand. Acting as an intermediate for East Coast stations, Windom has on several occasions taken messages which are relayed to Ivan O'Meara of Gisbourne, New Zealand. Other New Zealand amateurs, to whom these messages are consigned, are able to answer through O'Meara's station, Z2AC. Windom has succeeded in getting replies to the originating stations in the course of a twenty-four hour period. The two principal stations concerned have succeeded in carrying on almost unbroken schedules with this sort of radio traffic. Both men are members of the American Radio Relay League.

### THROWING A CRYSTAL

Continued from Previous Page

transmitting station in tuning its wave.

Although this description fits particularly the high speed vibration, which is being put out experimentally, the same general idea is used in ordinary broadcasting, and indeed who knows when these high frequency (short length) waves will become standard for ordinary broadcast programs?

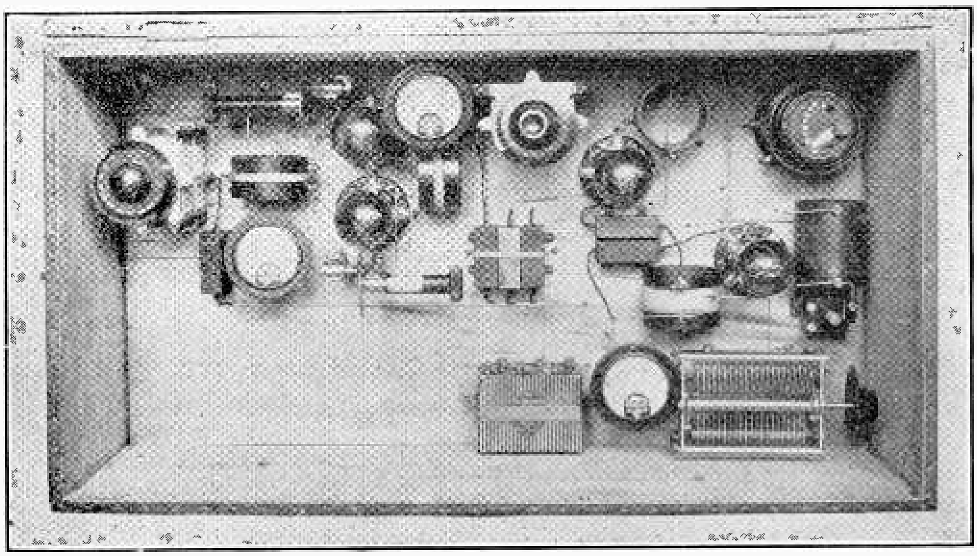

Fig. 7. A View of the Crystal, Tuner, Filter, Amplifier, and Push-pull Tubes.

# What Will Tubes Be Next Year?

## *The New Styles Will Probably Improve Your Set*

By A. K. LAING, Pelham Manor, N. Y.

IF you smashed a wheel on a Ford automobile, would you replace it with a part from the Rolls Royce Company? The latter makes high grade wheels, to be sure, but would it not be better to use a part which was designed to fit your particular needs? In the same way tubes to fit your set will give better music as will be explained.

The subjects discussed in the first half of this article (Nov. 15 issue), losses and wave frequency, circuits and quality, are all manifestations of trends that have been going on in general at least for a year or so, and some for ten years. The change predicted in this paper will mark a complete reversal of policy. But in this case, the difference is only beginning to be felt, and six months ago was practically unknown.

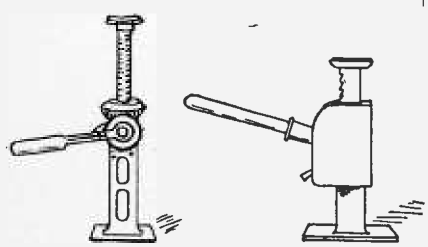

Fig. 1. Light Jack Has Big Lift, While Powerful One Has Small Lift.

### Only One at a Time

Up until very recently, any changes in the general production of tubes have been toward standardization. By this, I do not mean that manufacturers have attempted to produce but one type of bulb. For some years now we have been able to choose between tubes for storage batteries, for dry cells in series, and for single cells. But this classification is a superficial one. The main trouble has been a tendency to try to make one kind of tube function about equally well as radio frequency amplifier, detector, audio frequency amplifier, and "B" eliminator rectifier. When a set was designed for "199" tubes, it was built for these throughout. When it was intended for "201A" tubes, these were used in all stages, and so on.

For years amateurs have clamored for better detectors. Those of us who remember the old Audiotrons and DeForest tubes in long glass envelopes with two leads spraying out from each end, have never ceased lamenting their removal from the market six or eight years ago. They were gaseous (soft) tubes, designed for detectors, and for that only. Nothing was sacrificed to make them useful for amplifiers as well. It happened that they would amplify, but not very efficiently. They were designed for one purpose and performed that one function better than anything that has since appeared.

### Were the Happy Days

You may regard these statements as the exaggerated lamentations of one behind the times, who is dressing the "good old days" in an aura of bliss that they never had. But this is not so. One of the most prized possessions of a friend of mine is an old DeForest detector with both filaments intact, and recent comparative tests with contemporary tubes have shown it to be far and away superior to any of them as a detector. Yet we see advertisements everywhere of the "———" tube, claiming highest efficiency for all uses. This is pure rot. Standardization has been a measure employed by monopoly concerns probably to make their own manufacturing and sales problems easier over a period when there was no competition to be fought against.

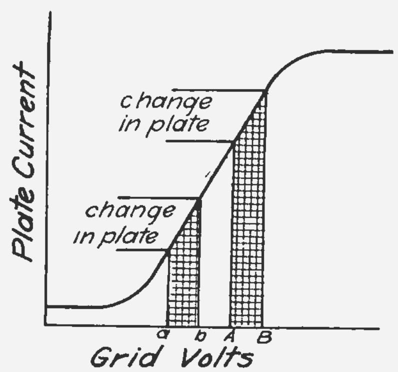


Fig. 2. With Ordinary Amplifier the Grid Bias is Not Important.

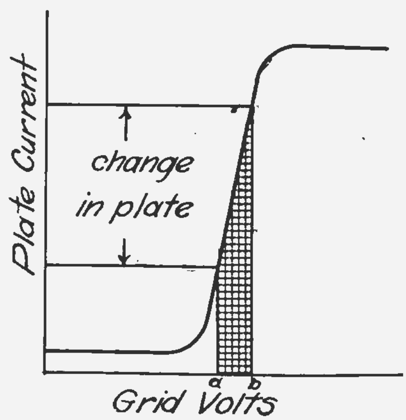


Fig. 3. This Tube is a Powerful Amplifier, but is Quite Critical.

The recent advent of independent manufacturers into the field has changed things a good deal. Some of the independents are content to make practical copies of the standard tubes. Others realize that their best field for success lies in putting out something newer and better. This competition has forced several new tubes from the old monopoly manufacturers. It is significant to note that the majority of these are designed for but one purpose. It is the opening wedge in a coming movement away from general purpose bulbs. In the near future it is reasonable to expect the appearance of special tubes for each of the three normal functions, radio frequency amplification, detection, and audio frequency amplification. The latter have been divided already into ordinary amplifiers and "power" amplifiers; special rectifiers for "B" eliminators have also appeared. The rest will doubtless come shortly. But it is not enough to ask for a special tube for each purpose. Actually, there should be *a different type of tube in every stage.* Let us examine the reason for this.

The power which the tube will pass without distortion is independent of the gain ratio. However, these are to some extent interdependent. A tube with a high ratio is usually restricted to low power, and vice versa. This refers, of course, to tubes of about the same "A" and "B" battery characteristics. This idea will be clearer by referring to Fig 1, which shows two automobile jacks. The one at the left will raise a machine through quite a height. It is light in construction, though, and is not very powerful. The right-hand jack, on the other hand, will lift several tons because it is so powerful. The distance it will raise a weight (gain ratio) is small. Of course a jack might be built which was both powerful and also had a high ratio, but it would be a much larger and heavier device. In the same way a tube which will handle a large volume of music and at the same time has a high ratio, must be of large size, and consume a big "A" and "B" battery current.

for which the tube was designed.

This standardized method of manufacture has restricted all of the better known makes of tubes to a factor of from five to seven. Yet tubes have been designed for laboratory use that have a factor of eighty or more, and there is no theoretical reason that prevents us from making one with an even higher constant. To attain such high values, it is necessary to regulate with considerable care the filament, plate, and especially the grid voltage.

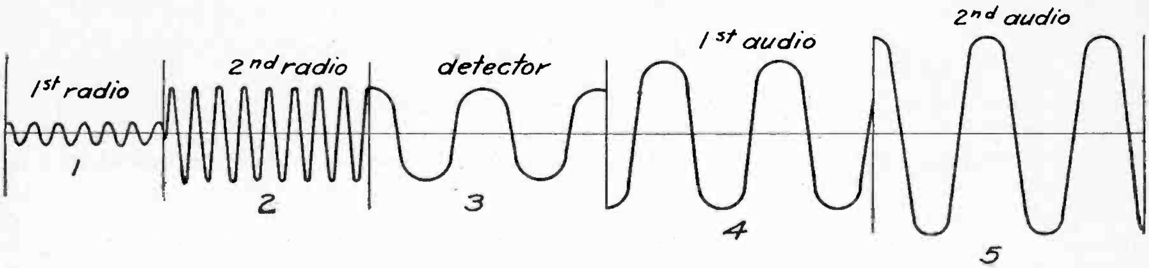


Fig. 4. Each of the Five Tubes in a Neutrodyne Has Its Special Job to Do. Here is Shown What Happens to Waves in Each Bulb.

### Power and Gain Ratio

Aside from the basic theoretical considerations, such as filament emission, grid saturation point, grid-plate capacitance, (condenser action between the elements), etc., there are two major external questions which the tube designer should meet. The first is the amount of power the tube will pass without distortion. The second is the "gain ratio." This term has a meaning similar to "amplification factor." However, the latter is defined as the ratio of change in plate voltage compared with grid voltage needed to cause a given change in plate current. The simpler term, "ratio" will be understood to refer to the gain of output compared with input of the tube.

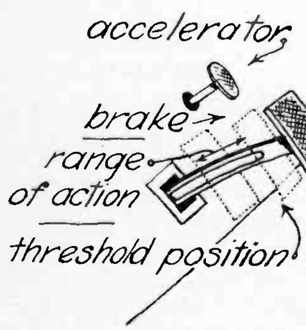


Fig. 5. Your Auto Shows Same Difference as Between Detector and Amplifier.

### Designing Last Tube

In the standardized tubes a compromise has been made between these two considerations. The method used is roughly like this: A tube is designed which will pass as much audio frequency current without distortion as is necessary to operate the average loud speaker at its maximum practical volume. The other characteristics are then balanced up to give the proper internal resistance for audio frequency steps; next the highest gain ratio possible for the specified "A" and "B" battery voltages is worked out. This procedure is quite satisfactory for designing the *last* tube of an audio frequency amplifier, but there is no logic whatever in using the same tube for the first stage of a radio frequency step, which need pass only an extremely small fraction of the current

### Still Has Same Change

A glance at the curve of one of them (Fig. 2) will show why. Here we have the curve showing how plate current or output of the tube varies with the grid voltage or input. Notice that when

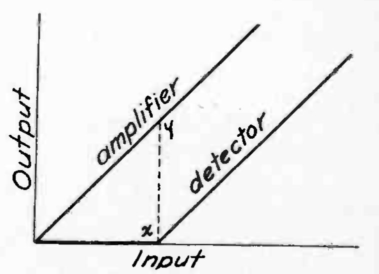


Fig. 6. The Threshold Valve of Detector Appears Here at x.

the grid is changed in pressure an amount "a b" that we get a certain increase in the plate current as shown on the left. If, by putting on a grid bias, or in any other way the voltage of the grid is raised so that the same incoming signal is AB, the plate current, although being considerably higher, will still show exactly the same amount of change as before.

Remember, it is this *change* in plate current which operates your phones. The steady or direct current cannot be heard at all. Since as revealed by Fig. 2, the input may start anywhere from a up to A, and in that whole range give similar and undistorted output, you will see that the exact amount of voltage on the grid or "grid bias" does not make much difference.

### A Sharp S Curve

Now refer to Fig. 3. Here we have a tube with a large gain ratio. The amplification factor may be as much as 80. Instead of having a long and fairly uniform S curve with a comparatively long straight portion near the middle, it has a rather flat form with a sudden sharp jump at the center. The voltages must be regulated so that the grid bias at normal is exactly in the center of this small space, and as a change of a fraction of a volt will throw it off the useful part of the curve entirely, this must be located and maintained with care.

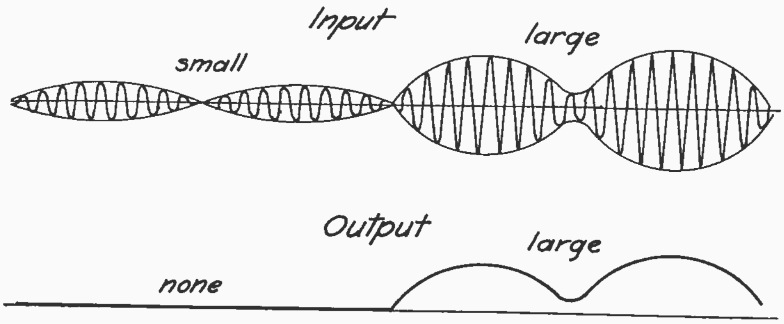


Fig. 7. Upper Curve is Fed to Detector, but the first Part is Too Weak to Make it Work.

With this tube, the grid change in pressure with the incoming signal, ab, is the same as ab in Fig. 2. But just observe what a big change in plate current is obtained as an output. That is the advantage of this high ratio tube. If the grid pressure, ab, were to be shifted to the right in the same way as occurred in Fig. 2, you will see that it would come either at the bend or even beyond it on the flat part of the curve, and we should get a very small amount of amplification as well as great irregularity or distortion. That is why with such a tube it is necesasry to use such great care in adjusting the "B" battery voltage and particularly the grid bias.

### Two Steps Give 400 Times

The advantage of such a tube comes, of course, in the higher amplification per step that can be had with this method. For example, the average good tuned radio frequency or neutrodyne set has a ratio of about twenty times per stage. This is the product, roughly, of the step-up ratio of the transformers or "neutroformers," and the amplification of the tube. Thus the ratio of a two stage radio frequency amplifier is about 20 x 20, or four hundred times.

If, however, we use in the first stage a tube with a gain ratio of eighty, and the customary 4 to 1 step-up transformer coupling it to the detector, the total amplification is around three hundred and twenty times for the one stage, as opposed to twenty for one stage of the present type. Therefore practically the same amplification can be had from one properly designed stage as is at present had from two; and we have, not only a saving in tubes and other apparatus, but also the elimination of one control.

### Omits One Control

If, in turn, the detector tube is designed for an amplification of ten instead of five, and the first audio stage the same, the total gain for a set consisting of one stage radio frequency, detector, and two stages of audio, will be considerably greater than that of the present five-tube sets, (curves appear in Fig. 4) and will have the much to be desired advantage of simplicity in tuning, due to the elemination of a control.

This system has a great deal in its favor and almost nothing against it. It gives in addition to the above-named advantages, greater compactness and lower cost, both of initial investment and upkeep. The sole disadvantage is that it is slightly more difficult to maintain in a condition of balance; but this at most calls for the inclusion of a potentiometer on the radio frequency stage. Thus a control that need be touched only once every week or so, when the batteries get low, is substituted for one that must be tuned for every station.

### That Threshold Value

The advantage of matching a tube to each stage becomes even more pronounced in the case of many tube sets, like the super-heterodyne. Here it is essential that the first detector be one that responds to the most minute currents. This is because of the well known "threshold voltage" effect, which means in plain language that every tube when used as a detector, has a point below which fluctuations on the grid will cause no effect on the plate. This does not occur in amplifying tubes, which will respond to radio frequency impulses a great deal more feeble than the weakest ones that will make an impression on a detector.

You will perhaps grasp this idea a little better after comparing with the controls on a motor car. Fig. 5 shows the accelerator and also the brake pedal. When you step on the gas the engine

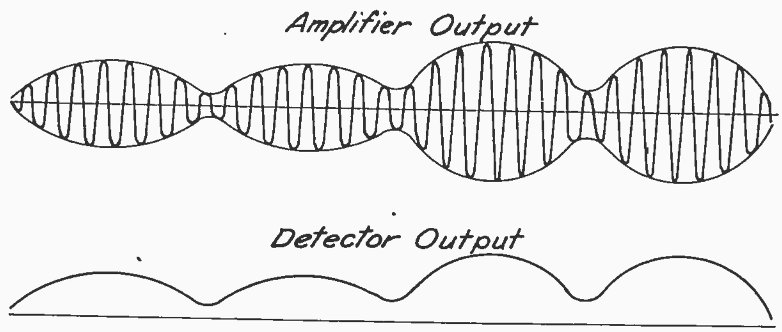


Fig. 8. The Same Wave as Fig. 7 Runs Through the Amplifier as Above. When This Larger Wave Strikes Detector, it All Makes Music.

responds immediately. Even if you depress this joy button only as much as 1/16 of an inch, you will notice that the engine feels it instantly and pulls a little bit harder.

### Slipping on the Brake

With the brake pedal, on the other hand, the first motion does not result in retarding the motion of the car, but only in taking up some of the lost motion or spring in the rods and brakebands. The pedal must be depressed for perhaps a couple of inches before you begin to feel it bite and notice that the car is beginning to slow down. This position of the brake which it first starts to operate, may be called the "threshold value."

A detector has the same characteristic of "lost motion" or "threshold" as has just been described. Fig. 6 compares the input and output of a detector and amplifier. Notice that an input even though very small, will cause a proportionate output through this tube. Thus if the input to the grid is represented by the length, OX, we shall get an output of XY. The detector is quite different. It can receive quite a lot of energy on the grid and still be absolutely dumb in the plate circuit. Thus an input of OX to the detector gives no response at all in the phones. From point X on, the plate has an output, but until this threshold is crossed nothing happens.

### It Swells and Shrinks

In this connection it is interesting to see actual curves as run on a tube with different uses. The upper curve of Fig. 7 shows the input to the grid. We have a high frequency radio wave that swells and shrinks in time to the audio vibration. At first the volume is small and then it gets much larger.

When this tube is connected into the circuit as a detector, the lower curve of Fig. 7 indicates the output. At first, owing to the threshold effect, there isn't any output. After the threshold has been past, because of the larger input, we get current through the plate. Owing to the rectifier action of the detector, of course the radio frequency has been converted into the much slower audio frequency vibration.

### Get it Amplified First

But suppose instead of feeding the input of Fig. 7 to a detector, we had first impressed it on the same tube connected as a radio frequency amplifier. The latter, as already explained, has no threshold effect, and so the output is as shown in the upper curve of Fig. 8. Notice this is just like 7, except that it has much greater amplitude (loudness). Now let us take this output and run it through a detector. The result appears in the lower curve of Fig. 8. All the waves are powerful enough so that they will operate the tube, and detector output is now good both for the soft and the loud music that was played in the upper curve of Fig. 7. Obviously when

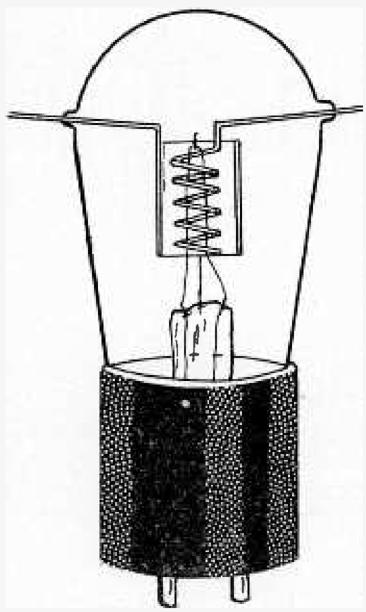

Fig. 9. Here is a Tube Made Abroad with Very Low Condenser Action Between Grid and Plate.

a detector precedes the radio frequency amplifying tubes, as is the case in the super-heterodyne, some signals are entirely lost that might be heard and amplified if there were amplifier tubes ahead of the first detector. This makes it very desirable to have a detector tube in the first socket that is designed for the lowest possible threshold voltage at the sacrifice of all other qualities. The following amplifiers will make up for any other loss in efficiency.

If, also, we should substitute high amplification factor tubes in the intermediate frequency amplifier, it would be necessary to use only about one-half the number to get equivalent results.

### Haven't Told All Advantages

The foregoing discussion is not entirely complete, as it takes up only one aspect of the advantage of matching each tube to its specific stage and purpose. There are a number of other points, such as the proper regulation of internal capacitance (grid-plate condenser) in the early stages of radio frequency amplification, and the matching of the output impedance (plate resistance) of each tube to the transformer that succeeds it. So, all in all, the advantages are a great deal more pronounced than I have stated.

Not the least important field for tube improvement is that of mounting. Even the new "X" sockets and bases are open to much improvement. The greatest present need is for tubes for high frequency (low wavelengths) and radio frequency amplification that have a lower capacitance between the elements. This means that the system of bringing all leads out at one point should be changed. Some of the newer foreign tubes recognize this, and make connections to leads that come through widely separated points in the glass envelope, Fig. 9. One of the best British tubes maintains a space of at least two centimeters (4/5 of an inch) between the points at which adjacent leads leave the glass. Myers is the only American manufacturer who has recognized the wisdom of this procedure. He has been making tubes with terminals at both ends for several years, but he alone has done so.

### It has a Pair of Grids

The above-mentioned British tube presents another feature that American manufacturers have for too long ignored. This is the possibility of including extra elements in one tube to make it do the work of several. The British FE 1 has, for example, an extra grid surrounding the regular one. This makes it possible to use one tube for an outfit that consists of radio frequency amplifier, detector, and audio frequency amplifier. Two of these tubes will take the place of five ordinary ones. This is even better in the elimination of tubes than the common reflex circuits, and because the tubes are more carefully made, the results with this new type of reflex are much better than with the old.

Continued on Next Page

# Forget the "A" Battery With Unipower

## *This Trickle Charger Takes Care of Battery Every Day*

By VANCE

THERE was once a man who *never* forgot. So he never had the trouble of finding that he had forgotten to turn on the charger for his battery, and as a result could not get the program he wanted.

If you don't happen to be this man, perhaps you have found your battery

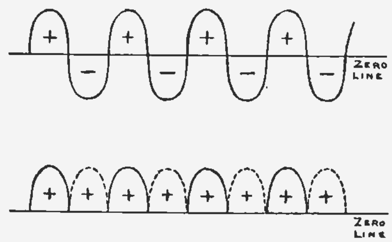


**Fig. 1. The Rectifier Cell Prevents A. C. from Discharging Battery.**

flat at a time when you had visitors and particularly wanted to show off the set. Suppose you had an automatic battery which, when it got hungry for current, would ring a bell, or better yet, would turn itself on so that it was always ready. That would undoubtedly be a pretty good kind of device to have around the house.

### It Will Never Forget

The kind of outfit which I will describe, while not working on exactly that principle, still gives about the same results. The user never has to try to recall whether a charge is necessary, as when the radio set is turned on you will find the music is good and loud. No danger of your filaments having only a dull, sickly glow owing to lack of sufficient voltage.

The "Unipower," as it is called, (made by the Gould Storage Battery Co.) has three essential parts. A regular storage battery with its lead plates and sulphuric acid is what actually supplies current to the vacuum tubes, but owing to the fact that it is charged every day, the capacity of its cells is somewhat less than that of the usual installation.

### Tantalum Metal Does Trick

The second element is the charger. This consists of a hard rubber jar like an ordinary cell with the usual sulphuric acid. Instead of the regular plates, however, we find one terminal is a short piece of lead in the upper part of the jar, while the other is a thin ribbon of the metal Tantalum. This latter is one of the semi-rare elements and is very hard indeed to work. If you try to run a metal drill through it, you have a job on your hands as it resists so that you will seem never to accomplish it. The word comes from the name "Tantalus." You will remember this name in Greek mythology as a man who was always "tantalized." Indeed, the latter word comes from the same root.

This metal has the very unusual property that it will pass current freely in one direction but not the other when it is immersed in an acid solution. In this

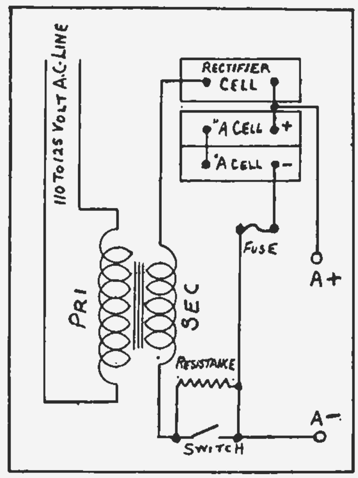


**Fig. 2. Hook-up Shows Resistance Used for Making "Trickle" Charge.**

way it becomes a rectifier, as it converts an alternating current from the series of positive and negative loops (top, Fig. 1)

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## WHAT WILL TUBES BE?

Continued from Previous Page

In some of the topics discussed in the first half, I have been unable to cling to proved fact all the way. The element of deduction has entered to some extent. But in this last discussion nothing has been mentioned that is not reasonable for immediate production, or that has not been fully investigated in the laboratory. These are no fantastic predictions. They are conditions that can be brought about to-morrow, providing the plants for production could be built over night. No great research would be needed. Most of it has already been done.

### Can Have What You Want

The matching of tubes to their specific uses is something that can come about very shortly, as soon as the public makes known the fact that it understands conditions and wants the better apparatus that it can perfectly well have. Granting that patent difficulties exist, these are not insurmountable. The keynote of trade this year has been combination and co-operation, instead of the cut-throat competition of the peak of the boom; the research has been done.

Let the manufacturer know your wants, and he will hasten to be the first to supply them. The public will no longer purchase everything labeled Radio. Manufacturers are hungering for something that will take with everybody. Here are the half-opened doors toward future development. If the manufacturer does not see them, point them out.

## FORGET THE "A" BATTERY

Continued from Previous Page

into a direct pulsating current, as shown at the bottom of Fig. 1 in the full lines. If the leads of the input to the rectifier on the AC side were reversed, the rectifier would still work, but give the curves as shown in the dotted lines.

The third element of the unipower is the control apparatus, which is made up of the switching unit and the ballast resistance. These will be explained in more detail a little later.

### Six Volts A. C. to D. C.

The wiring diagram is shown in Fig. 2. The alternating current line connects to the primary of the step down transformer at the left. The reduced voltage at six, or slightly above, is taken from the secondary winding. Like any transformer, the output is also alternating current, but at the proper potential for charging the batteries. Next in line appears the rectifier at the top of the cut. As already explained, this allows the positive loops to pass, but not the negatives ones.

The rectified current is now suitable for charging the battery and it is fed direct to the latter. A two-cell, four-volt unit, such as is suitable for operating 199 tubes, is illustrated here. Next in the circuit comes the fuse and then a resistance conducts the current back to the secondary. This resistance holds the current down to the proper value for a low or trickle charge. If, for any reason, a higher rate is wanted the switch is closed, which by cutting out the resistance brings the charging rate up to a value about four times as great.

### Grouped Into Unit

The charger and battery are grouped together in a single unit, as shown in Fig. 3. The taller part at the rear is the battery, with a cover over the terminals. In front is seen the rectifier cell with the fuse mounted on top. The little pull switch has its handle projecting through the cover and is used to give the high rate of charge by short circuiting the resistance, as just explained.

At the left you will see a small box with a switch handle projecting from it. This is the control element. It is a standard tumbler switch with four poles, and is arranged for throwing either way. As Fig 4 shows, however, when the switch closes to the right, circuits 1 and 2 are connected, but 3 is left open. In the left-hand position 3 and 4 are joined, while 2 is open.

In operating this device the battery is hooked up to the filament terminals of the radio set with only switch No. 3 interrupting the circuit. The filament control switch, or rheostat, in the radio is left in the on position all the time, night and day. Control of the receiver is had entirely by this unipower control switch. When the latter is thrown to the left, notice that current will be turned on and you will pull in your favorite stations. During this period, lines 1 and 2 are disconnected and so no current is being fed to the battery from your lamp socket. This means that no hum of any kind from the electric light wires will be fed to the radio.

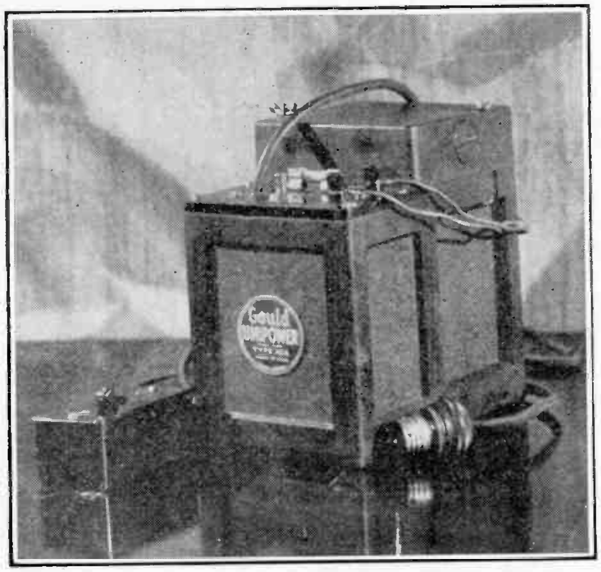


Fig. 3. The Complete Unit is Compact and Easy to Control.

### Starting on the Job

When you are through listening for the evening, you snap the switch to the right. There is no half way position and so when you get tired of the loud speaker you *must* snap the switch to the right to get rid of the music. This turns off the radio, but at the same time completes the circuit through 1 and 2 to the charger. Immediately the transformer and rectifier get on the job and start replacing the current which you have just drawn from the battery.

From this you will observe that if you use your set, say three hours in the evening, that all the rest of the time that day (21 hours) the battery will be charging. Will not this get it too full and damage the plates? No, because the ballast holds the current down to such a low value that it might be left on for a month at a time without doing any harm at all.

A few words about the different elements may be interesting. The transformer employed has a low core loss and is so built that it cannot hum, being supplied with ample reserve of both iron and copper to provide against wide variation in either voltage or frequency of the AC supply.

### Cutting Out the Ballast

You will note that by means of a push-pull switch we can short circuit most of the ballast resistance if we desire a higher charge rate, as may be the case in the event that the radio set has been left on overnight, or for any reason the charging current has not reached the unipower continuously.

The ballast resistance is of the iron wire type, designed with a view to reducing a tendency to high charge rates with high voltage, although it will not give an absolutely flat charge rate. It is not necessary.

An automobile type fuse in the negative battery lead protects the radio set

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