Sept. 26
1931

NEW SCANNING WITH MIRRORS

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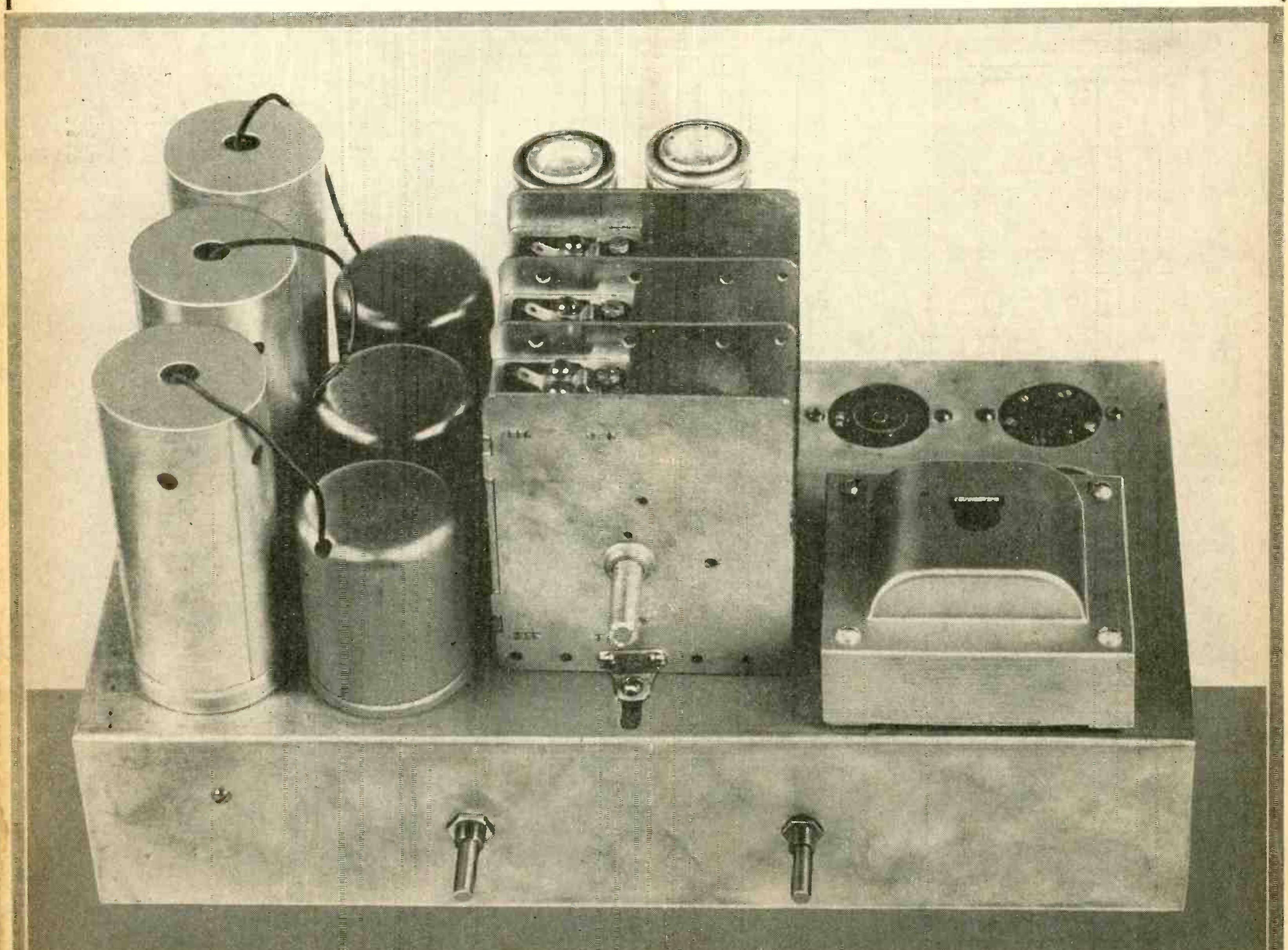

A Five-Tube Midget Chassis for AC Operation That Can Be Built for Less Than $20. See page 11.

Vol. XX No. 2 Whole No. 496
September 26, 1931
[Entered as second-class matter, March, 1922, at the Post Office, at New York, N. Y., under act of March, 1879]
15c per Copy. $6 per Year.

TENTH YEAR
Technical Accuracy Second to None
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A Weekly Paper Published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
(Just East of Broadway)
Telephone, BRyant 9-0558 and 9-0559

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.; Roland Burke Hennessy, editor; Herman Bernard, managing editor; J. E. Anderson, technical editor; L. C. Tobin, Advertising Manager

The New Spiral Mirror Echelon Scanner

Method for Television Reception and Transmission Permits Large-Scale Projection

By J. E. Anderson

[The new method of scanning in television described here offers a practical way of projecting large-scale images with comparatively small apparatus. It was devised by the author more than a year ago and it has also been developed independently in Hungary and demonstrated in Berlin.—EDITOR.]

THE development of television seems to hinge on the discovery of a scanning device which will permit the projection of a strong light on a screen. Many different devices have been tried but all seem to have certain limitations. The best known is the Nipkow disc, which has been tried thoroughly and its definite limitations reached. Then there is the endless belt, which is no better than the disc, as it is only a different geometrical arrangement of the same principle. A slight variation of the endless belt is the drum with the light inside. It is the same in principle and in effect as the endless belt and its limitations are as definite as those of the belt and of the Nipkow disc.

Various arrangements of rotating mirrors have also been tried, and these seem to offer greater possibilities. They are always used when the image is projected. The simplest of all the rotating mirror arrangements is that tried by Dr. E. F. W. Alexanderson of the General Electric Co. The mirrors are arranged at certain angles and distributed around a drum. When the drum rotates each mirror traces a line across the screen and the angular position of the mirrors determines where a line is to be drawn on the screen.

Cathode Ray Scanner

The cathode ray scanner has achieved considerable popularity due to the possibility of eliminating all rotating parts when it is used. This, however, suffers from the defect that the light is not white and at best that it is very feeble. Besides, the equipment is fragile and short-lived. In order to get a uniform distribution of the light over the field it is necessary to arrange a rather complex electrical circuit which will have a linear characteristic, that is, so that the spot of light has the same velocity at every point on the screen.

One of the problems is to get a lot of light on the screen. Peep hole and cathode ray scanners do not admit this. The rotating mirror scanners do, but they are mechanically more difficult to construct so that the light will be uniformly distributed on the screen.

One form of rotating mirror scanner is the mirror spiral or screw. In this there is one mirror for each line making up the image and the individual mirrors are equally spaced angularly as well as axially. The principle of this scanner will be better understood with the aid of Fig. 1. Here *m* is one of the mirrors. It is set so that it makes an angle of 45 degrees with the axis AB of the drum upon which all the mirrors are mounted. An incident beam *i* of intense light is made to pass parallel with the axis AB along the surface of the drum. It is intercepted by the mirror *m* and is reflected in a beam *r* at right angles to the axis AB to the screen SS. As the drum turns the reflected beam also turns, although the incident beam is stationary, and the reflected beam traces a line (ab) across the screen. This scanning line is at right angles to the axis of the drum.

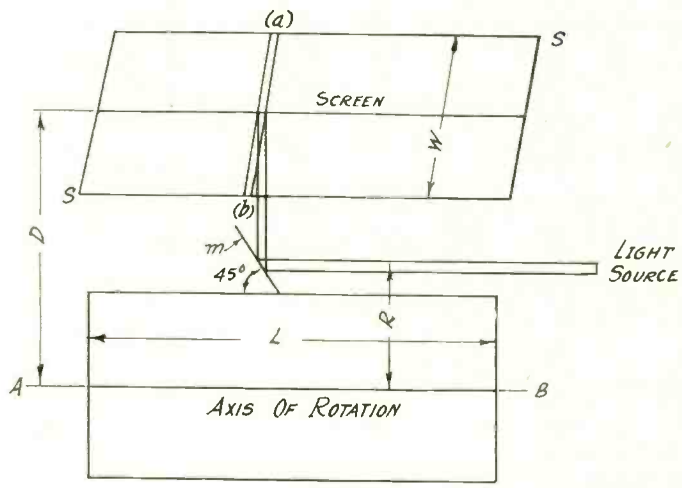

FIG. 1.
This shows the principle of the spiral echelon television scanning device in which a strong beam of light is distributed over a screen.

Shifting of Scanning Lines

The line starts at (a) when the mirror *m* first intercepts the incident beam and ends at (b) when the mirror ceases to interrupt the beam. At the instant the incident beam leaves mirror *m*, the next mirror intercepts the beam and another scanning line is begun at the upper edge of the screen. This line is traced parallel to the first but displaced a small distance, as determined by the axial separation of the two mirrors. As the drum turns more, other mirrors come in the way of the

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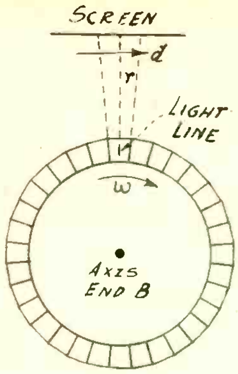

FIG. 2.

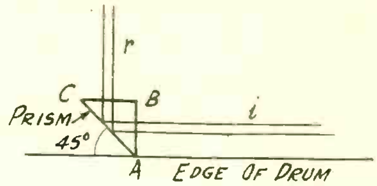

FIG. 3.

End view of the spiral echelon scanning device, at left, showing the faces of the reflecting mirrors as "seen" by a beam of parallel light.

A right-angle prism could be used as reflector if arranged as shown at right. The internal slanting surface is a perfect reflector.

(Continued from preceding page)

incident beam and other lines are traced across the screen. Finally, the last mirror at one end traces a line, and when that is completed, the first mirror at the other end of the drum takes up the beam. Thus while the drum rotates once, the screen is covered with parallel lines, one for every mirror. The number of repetitions of the scanning process is determined by the speed of rotation of the drum, and the numer of lines over frame by the number of mirrors in the spiral.

The length of the image is determined by the axial length of the spiral, that is, by the distance between the two extreme mirrors. The height of the image is determined by the distance between the axis of rotation of the drum and the screen. For any length of drum, or mirror spiral, it is possible to find a distance for the screen which will give a square image, or an image of any desired proportion.

Advantages

The advantages of this scanning device are many. First, the drum may be quite small, as compared with a disc or endless belt scanner. Second (and this is by far the greatest), a very intense beam of light may be distributed over the screen. The full intensity of the light is on the screen all the time in the form of an intense spot or line. Third, projection is possible. Indeed, it is necessary. And the size of the projected image is limited only by the available dimensions and the intensity of the light spot. If we want a 3 foot image, all we have to do is to make the spiral 3 feet long and the length of the reflected beam appropriately long.

It is also possible, in view of the intensity of the light, to use a lens system by means of which a comparatively small image can be enlarged on a larger screen. For example, the original image may be made 3 inches square and by means of the projection apparatus it may be spread over a screen 30 feet square if desired.

Optical Requirements

There are certain optical requirements. The incident beam must be parallel so that it will not spread out. If there were only one mirror, or many mirrors always at the same distance from the source, it would be possible to focus the incident spot on the mirror and again to focus the reflected light on the screen. But the mirrors are not all the same distance from the source. The first is comparatively close to the source. The last is farther away by the length of the spiral. Hence it is necessary either to have a focusing lens with a very long focal distance or to have a collimator which renders the beam of light parallel. With an incident beam of parallel light the spot on reaching a mirror will always be of the same size regardless of the position of the mirror along the axis. Likewise the reflected beam will always cover the same area on the screen. Hence it is advantagous to have an intense point source of light and by means of a collimator to render this parallel.

The modulation of the light beam may be done either in the source or anywhere along the incident beam.

It is obvious that this system lends itself readily to colored television. It would only be necessary to have three drums, with their axes parallel, and three sources of light, independently modulated. The three drums could be driven by the same motor and arranged so that the scanning lines blended.

Design of Drum

Suppose we wish to make a scanner giving a direct image of 3 inches long and 3 inches high, with 60 lines. The length of the spiral of mirrors would then be 3 inches, measuring from the centers of the two extreme mirrors. The axial separation of the mirrors would be 3/60 inch, or 0.05 inch. More accurately, it would be 3/59, since there are 59 spaces rather than 60. The angular separation would be 360/60, or 6 degrees. It is clear that the mirrors must be very small if the length is to be only 3 inches.

To determine the distance of the screen from the center of the drum we have to make use of the fact that the arc is equal to the radius multiplied by the angle, the angle being expressed in circular measure, or in radians. The angle occupied by each mirror is 1/60 of the circle and the circle contains 2π radians. Therefore the angle occupied by each mirror is $\pi/30$ radians. If the distance from the center of the cylinder is D inches, the length of a scanning line is $D\pi/30$, and this should be equal to 3 inches if the picture is to be square. Hence D must be equal to 28.6 inches, or 2 feet and 4.6 inches. If the radius of the drum is 3 inches the distance from the surface of the drum to the screen should be 2 feet and 1.6 inches.

If there are 100 lines instead of 60, each mirror will occupy 3.6 degrees, and the distance from the axis to the screen should be 47.7 inches, which is very nearly equal to four feet. We increased the number of lines in the ratio of 60 to 100 and therefore we have to increase the distance to the screen from the axis in the same ratio.

Formula for Design

We can easily work out a formula for determining the distance to the screen for any length of drum and any number of mirrors to give any ratio of image dimensions. Let the length of the drum be L and let there be N mirrors in the spiral. One dimension of the image will be equal to L. Let the other dimension be W. This will be the length of a scanning line. The total angle in the cylinder is 2π radians and therefore each mirror will occupy $2\pi/N$ radians.

Let the distance from the axis of rotation to the screen be D. Then $2\pi D/N$ is the length of a scanning line. This is to be W. Hence $2\pi D/N=W$ and $D=NW/2\pi$. Now if we want to make the ratio of L and W other than unity we can express the length of a scanning line in terms of the length of the drum and the ratio of L and W. Let $W/L=x$, x being somewhat larger than unity in conformity with standard practice. Then $D=NLx/2\pi$, in which N is the number of mirrors, or scanning lines per image, L is the length of the mirror spiral, x is the ratio by which the length of the scanning line is greater than the length of the cylinder, and 2π is the total angle in a circle, a constant.

The standard value of x is 72/60, or 1.2. Then for this case the formula reduces to $D=0.191NL$. For a square image we would have $D=0.159NL$.

Accuracy of Adjustment Essential

It is essential that all the mirrors be set at exactly 45 degrees and that the beam of parallel light be parallel with the axis of rotation. If one of the mirrors should be set at a different angle, the reflected beam would trace a curve on the screen. This curve might intersect one or more of the other scanning lines which are true. Moreover, the curved line will be far out of place. Referring to Fig. 1, we note that if the angle is less than 45 degrees the reflected beam will enter the region toward the left, reserved for the beams from the mirrors toward the left end. If the angle is greater than 45 degrees, the reflected beam will shoot off toward the right.

Every tiny mirror must be plane. If it is curved, the reflected beam will not move across the screen in proper lines but may only move in an irregular line from one end of the screen to the other. If the curvature of the mirrors should happen to be the same as that of the cylinder, the spot would move in a straight line across the screen parallel with the axis of the cylinder, but it would move in steps. The mirrors must therefore be plane, and the normal to this plane, that is, a line perpendicular to the plane, must rotate at the same rate as the cylinder. If it does, the reflected beam will rotate at the same rate, and if the mirror makes an angle of 45 degrees with the axis of the cylinder, the reflected beam will be at right angles to the axis of rotation.

Accurate Spacing

It is almost as important that the spacing between the mirrors be exact, for if they are not, the scanning lines will not be equally distributed. There will be light and dark streaks across the screen.

Another important feature is that every mirror should be a mirror to both edges, for otherwise there will be a lot of useless margin as the beam transfers from one mirror to the next. There may be some overlapping, provided that the thickness of the mirrors is smaller than the axial separation. It is only that portion of a mirror which can intercept the beam of light which is useful, but this portion should be exactly the same for all the mirrors and should be equal to a whole circle divided by the number of mirror in the spiral.

It would be possible to use total reflecting prisms in place of plane mirrors. These would be bits of rectangular prisms with one face at right angles to the axis of rotation, the face through which the beam of light enters, and one face parallel with the axis, the one through which the reflected beam emerged. The third side would be inclined to the axis at 45 degrees.

Of course it would require more room if reflecting prisms were used than plane mirrors and they would be more difficult to mount. But a greater proportion of the incident light would be reflected to the screen.

It is the spiral of mirrors that is essential. The cylinder is just a convenient support for mirrors.

Small Light Spot Essential

It is clear that the cross section of the beam of light should be very small compared with the area of any one mirror, for otherwise there would be considerable blurring at the edges of the image and two mirrors would be functioning at the same time near the transition. Since the mirrors are very small in the first place, the beam of light should be reduced so that its projection on the mirrors is practically a point. There is one exception. The incident light beam may have extension in the radial direction. This extension should be equal to the axial separation of the mirrors. The reflected beam would then have extension in the direction of progression of the scanning lines. That is, the reflected beam would draw a band of light across the screen like a wide brush draws a line across a surface.

If the incident light beam has considerable extension in the radial direction, the apparent source of light may be a short line of light similar to the scanning line in talking movies. The long dimension of this line should be arranged so that a plane passing through the axis of rotation of the cylinder and the light beam, the line would lie in that plane. To accommodate the line the mirror would have to be made longer. There is no limit in that direction.

Projection of Image

We based the numerical computation previously on the creation of an image 3 inches square. This image may be formed on a translucent screen. A project system could then be used to throw up the image to any desired dimension within the limitations of the intensity of the light. But we could also project it directly. Suppose we wish to make an image 3 feet deep and 3.6 feet wide. Let us see what the required dimensions would be. The length of the spiral would be 3 feet. That is L in our formula. The ratio of W to L is 1.2, so that we may use the simplified formula for determining D. It is $D=0.191NL$, L and D being now expressed in feet instead of inches. We might as well figure on a system of good detail and make $N=100$. Therefore D will equal 57.3 feet. Obviously, this is a greater distance than is available directly in most homes, so we would have to use the system in a theatre. However, it is possible to get a greater effective distance in a small space by using two large reflecting mirrors between the drum and the screen.

If we make the length of the spiral one foot, the distance between the drum center and the screen would be one-third of 57.3 feet, or 19.1 feet. That is quite within the limits of a living room.

Separation of Mirrors

Suppose the length of the spiral is 3 feet. If there are 100 mirrors the separation between two adjacent mirrors is approximately 0.36 inch. That is large enough to permit the use of mirrors of workable dimensions. It would not be necessary to resort to watchmakers' tools to mount the mirrors.

If the length of the drum is about three feet, how great should the diameter be? Should it be of the order of 6 inches or 6 feet? Obviously, we cannot put a six foot drum in the house with the necessary machinery to drive it at a hight rate of speed. The size of the drum is not of great importance, just so we have room to mount all the mirrors on it in a spiral without mutual interference. It would seem that six inches would be large enough.

If there are 100 mirrors along the spiral, the incident luminous line should be such that 100 of them will be 3 feet. Since this line hits each mirror at an angle of 45 degrees, the length of each mirror should be equal to 1.41 times the length of the luminous line. Since the length of the incident line is 0.03 foot, the length of each mirror must be 1.41x0.03, or 0.0423 foot, or slightly more than one-half inch. Of course, it may be one inch long.

Width of Mirrors

The width of each mirror is definitely fixed by the fact that it cannot have more than 3.6 degrees of the total circumference. If we make the distance from the center of the drum to the center of the mirror 3 inches, the width of the mirror at its center can only be 0.1885 inches. If we double the diameter of the drum we also double this dimension of the mirror. But if we double the drum, making it 12 inches in diameter. we get something that is more appropriate in a machine shop than in a drawing room, especially in view of the fact that it will take a good sized motor to keep it spinning at the rate of about 1,200 revolutions per minute. The air commotion set up by the drum, and especially by the mirrors, would be a considerable load on the driving motor.

If the reflecting mirrors are set at 45 degrees, the width of the scanning line traced across the screen is the same as the length of the incident scanning line. If all the mirrors are set accurately, all streakiness of the field on the screen on unmodulated light will be absent.

The appearance of each mirror to the light will be that of a truncated equilateral triangle with the large base near the periphery. This does not prevent the use of rectangular mirrors.

This scanner is like a circular stairway with a center of large diameter, with all steps of equal height and of equal angular displacement, and the entire stairway making one complete turn. A person ascending the stairway would take N steps to get to the top and for every step he would turn through an angle of 360/N degrees. After taking the last step he would be facing in the same direction as at the beginning but he would be Nh feet higher up, in which N is the number of steps and h the height of each step. Because of the similarity of this scanner to a spiral stairway, it is convenient and logical to call it the spiral echelon scanner. The similarity does not apply to the angular setting of the steps. In the scanner each step is set at 45 degrees while in the stairway it is set at 90 degrees.

Direction of Scanning

The accepted method of scanning is that of reading a book, from left to right and from top to bottom. This spiral echelon scanner can be adapted to the standard method as well as to any other. We can scan from right to left or from left to right, and for either from top to bottom or from bottom to top. The direction of rotation of the scanning drum determines the direction of the lines. If we turn the drum clockwise, looking from B to A, the scanning line will be traced from (a) to (b). This is the proper direction, according to convention, if we view the image by transmitted light. If we turn the cylinder in the opposite direction, that is, counter-clockwise looking from B to A, (b) is the beginning of the scanning line and (a) the end. This is the proper direction of scanning if we view the image by reflected light. Both these conclusions are based on the supposition that A is the top of the image and that the light comes from below.

The line (ab) should move from top to bottom, that is, from A to B, as the screw turns. The screw is fixed in position and cannot move in the direction AB or BA. But the mirror that intercepts the light beam moves apparently with the thread. Thus if the rotation of the screw is right-handed, or clockwise, looking from B to A, the screw must be right-handed if the line (ab) is to move down toward B. On the other hand, if the rotation is counterclockwise, looking from B to A, the line (ba) will move from A to B if we use a left-handed screw. Thus we need a right-handed screw for transmitted light and a left-handed screw for reflected light observation.

Arrangement of Axis of Rotation

In Fig. 1 the axis AB of rotation is horizontal and the scanning lines are vertical. This is not the proper way of scanning according to convention. The scanning lines should be horizontal. This necessitates putting the axis of rotation vertical. That is, A is directly over B. There is no difficulty in this mounting.

In Fig. 2 is shown an end view of the drum with the mirrors mounted around it. All the mirrors are shown the same size because they so appear to the light beam because the light is parallel. To the eye, one mirror, the nearest, would appear large and the others would appear progressively smaller as they receded from the eye. The largest and the smallest would be side by side. One of the mirrors shows the projection of the light beam, which is shown to be very thin in the direction of rotation and to be comparatively long in the radial direction. The reflected ray is represented by the dotted line r. The light beam comes from the direction of the observer's eye and is reflected at right angles to the screen. If the direction of rotation is clockwise, as indicated by the arrow (w), the direction of the reflected beam is in the direction of arrow (d). That portion of the screen which lies between the two extreme dotted lines is that covered by each mirror.

In Fig. 3 is shown the method of employing a prism for reflecting the light beam. The edge AB is normal to the edge of the drum and to the axis of rotation and the edge BC is parallel to the axis of rotation. The inclined edge, which is the reflecting surface, is inclined 45 degrees. It is the edge BC, whether it is the plane mirror or the internal reflecting surface of the prism that should have a length 1.41 times the length of the light line or larger than that amount.

Use as Transmitter Scanner

The new scanning device has been described in connection with creating an image at the receiving end. It is clear that it is also useful at the transmitting end, and for this purpose it may be used either for direct pick-up or indirect.

Suppose the entire process be reversed. The light beam is unmodulated and it is reflected to the screen, which now is the object to be transmitted. The light beam will traverse every spot of the selected portion of the object and the light reflected from the object will be modulated. Photoelectric cells placed around the object will receive modulated

(*Continued on next page*)

The Eye Also Scans

By Hollis Baird

SCANNING, a common term in television, believed by many persons to be something new, is really as old as man. The human eye has always scanned and always will.

Without thinking definitely or analytically about it, we would say that when we look at a picture or a scene we see it all at once, but the fact is that we see only a tiny spot. What happens is that our flexible, efficient eyes rapidly travel across and up and down a given scene, registering the various points so rapidly that a complete picture seems to be seen.

Test of Vision

It is easy enough to test this. Hold your hand out straight in front of you and then look at the thumb nail. Now without shifting your eye in the slightest try to determine how much else you can see clearly, not just suggested by, but vividly. You will find that the area comprising the end of your thumb is about all that is sharp.

Now open your hand and decide you want to see all of it. As you do, notice carefully what your eyes are doing and you will see that they are swinging back and forth in various cross directions until they have covered every bit of your hand. Now you have a very definite picture of what your hand looks like yet it was obtained piecemeal.

Taking something more concrete, more nearly like what a television camera must pick up, let us look at a motion picture. As the action goes on you seem to see what is happening on the whole screen but if you will pick out a single spot on the screen and look at it without moving your eyes, as you did when looking at your thumb nail, you will find you are actually seeing but a small part of the picture clearly, the rest being in sort of out-of-focus relation to the main spot of vision. The human eye, however, moves so quickly that it takes in the whole picture in a series of rapid glances and the memory retains these pictures, each piece in its proper place, and the effect seems to be a whole, complete picture.

In television the same thing takes place, the television camera rapidly scanning a scene which in turn is reproduced in the same order by the television receivers.

Eye's Scanning Is Varied

Of course this scanning is much more rapid than the human eye, as the scanning spot cannot pick up as much detail as the human eye will register correctly at one instant and so must travel faster to get in all the points.

Another point of difference is that the human eye needs no definite routine to follow in scanning a scene, for it may move across the top, then down to the bottom and across there, then up at an angle from the lower left to the upper right corner, etc. In television, as in anything mechanical or electrical, an accurate pattern must be followed to be repeated in rapid succession and in order that at the receiver the same pattern may be followed and a picture reproduced which will be the same as the picture picked up at the transmitter.

Thus while television may seem to be a far cry from any human parallel it actually follows the human eye more accurately in its procedure than does a camera which takes in all at once a complete picture. Eye scanning is a fascinating thing to experiment with and should offer a lot of fun for the person who likes to contemplate television problems. Since the apparatus is already part of one's body there is no cost involved. A study of the human methods of taking in a scene is indeed interesting.

Spiral Mirror Echelon

(*Continued from preceding page*)

light. Hence the spiral echelon scanner will operate with indirect pick-up.

Now suppose the object is brightly illuminated. Let an observer place his eye in the path of the beam *i*, that is, let the eye take the place of the arc lamp. As the drum rotates once every part of the object will be visible to the eye. If a photo-electric cell be placed there in place of the eye, the cell will receive a modulated beam of light, the modulation being in the correct order. Hence the scheme works on direct pick-up.

In the preceding paragraph it was said that the entire object would become visible to the eye. Does this mean that the observer would see the object clearly as the drum rotated rapidly? Apparently not. All the light would fall on one spot on the retina and no image would be formed. The observer would only see a speck of light, and if the drum were rotating rapidly this speck would not even be modulated as far as the eye could tell. The light spot would have an intensity proportional to the average intensity on the object. But the photo-electric cell is not so sluggish as the eye and it would follow the variations accurately.

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Television's New Trend

Ultra High Frequencies Favored, Scanning Tube Tried

A DEFINITE trend in television experimental transmission was registered recently when it became known that the two large chains are trying out the cathode scanner, whereby a tube replaces the mechanical systems, particularly the circular scanning disc. These chains, making individual local experiments, also use the scanning disc, and are studying and comparing the results between the two methods.

Another trend was shown in the preference for higher frequencies than ordinarily assigned. It is believed by many, including Dr. E. F. W. Alexanderson, engineer of the General Electric Company, that the future of television lies in the ultra high frequency band, so experimental transmission of voice programs are being made by WGY, Schenectady, N. Y., station of the company, on 5 meters.

WTMJ Gets Permit

The Federal Radio Commission recently granted the application of WTMJ, Milwaukee, Wisc., for a television transmitting permit. The call letters will be W9XD and the assigned frequencies 43.000, 46,000, 48,000, 50,300, 60,000 and 80,000 kc. The frequency extremes are equal in wavelength to 6.973 and 3.748 meters. This is one example of the trend toward the higher frequencies. Usually television requests were for assignment to the band within 2,000 to 2.950 kc., or 149.9 to 101.6 meters. Most of the present transmiteers are in that band.

The ultra high frequencies have the peculiarity of behavior similar to that of light frequencies, as they are obstructed by objects that impede the passage of light, and moreover, like light, they tend to follow the curvature of the earth. Thus they are not subject to the general effects of the Kennelly-Heaviside layer, and there is little fading.

The fact that WTMJ, owned by the "Milwaukee Journal," and which station will have the first television transmitter in that city, was granted permission to use the ultra high-frequencies was taken as an indication that the Commission will look favorably on applications for assignment to such high frequencies for those now bidding for space in the spectrum for television. About 20 applications are on hand, and nearly all are for ultra high frequencies.

There are now 22 licensed experimental television stations, not all of them actively engaged in regular transmission, however, but all are within the Continental short wave band, 1,500 to 6,000 kc.

Television From Highest Aerial

WTMJ also is seeking a channel in this band, 2,850 to 2,950 kc, so that comparison may be made of results in the continental short wave band and the ultra high frequency region. For this station 1,000 watts power is asked.

John V. L. Hogan, New York consultant, will supervise the construction and operation of the experimental stations of WTMJ.

There will be a television transmitter also atop the Empire State Building, New York City, and since this is the world's tallest building, the aerial will be higher above ground than that of any other station of any kind in the world. The National Broadcasting Company will be the operator.

There will be a television transmission and a sound track, so that radio talking movies may be enjoyed. The stations will operate on frequencies above 23,000 kc, waves below 13.04 meters.

The National Broadcasting Company, which will have seven transmitters in operation in different cities, desires to carry on experimental development work on the ultra high frequencies "particularly for the purpose of determining their usefulness for television." Two stations in the Empire State Building would cost $75,000, with $10,000 additional for studios.

The transmitter to be employed for sound accompaniment will be of 2,500-watts power, and is authorized to use the frequencies of 41,500, 51,400, 60,000 to 400,000 and above 401,000 kilocycles. The application states it will be used for experimental transmission of "sound track" speech and music in connection with television research and development in and around New York City.

100 Kc Channel Width

The bands from 43,000 to 46,000, 48,500 to 50,300 and 60,000 to 80,000 kilocycles are assigned for the use of the television transmitter. The Commission has set aside four bands of frequencies 100 kilocycles wide for television experimentation in the continental short-wave band as well as four bands in the ultra high frequencies of the substantially greater widths.

Columbia System Busy, Too

The applications state that work will be completed by about November 30th. It was estimated, however, that the N. B. C. will offer regularly scheduled television programs on an experimental basis within six or eight months. In addition to the N. B. C., other adjuncts of the Radio Corporation of America, are now conducting air tests in visual broadcasting, while R. C. A.-Victor Company is conducting the major portion of the laboratory experimentation.

W2XAB has been opened by the Columbia Broadcasting System, in New York City, and television transmission of some of the programs on the Columbia chain, WABC outlet, are being made. Synchronization with the system's short wave relay station, W2XE, is effected.

With one station already on the air, Columbia, however, plans to diversify its television experimentation, using perhaps a half dozen of the systems. It will watch the research of stations affiliated with it having or seeking television licenses, as well as its own experiments. These experiments will be conducted by Columbia or its affiliates in New York, Philadelphia, Chicago, Los Angeles, St. Louis and Washington, once the authority is obtained from the Commission.

Test of Cathode Scanner

Engineers engaged in television experimentation are inclined more and more to the belief that television ultimately will find its haven in the ultra-high frequencies, where adequate space is available, says "The United States Daily." In the now occupied portions of the radio spectrum the congestion is serious and there hardly is room for television stations which would be enabled to serve the entire country.

Several different systems are being employed in the experimentation, divided into two main classes, the mechanical scanning disc and the cathode ray process with no moving parts. Pictures of 60 lines with 20 frames per second have been recognized as standard, and all except one air experimenter is using that standard. The effort is toward obtaining pictures of good definition and quality without using a channel width of prohibitive size. The Commission has set aside channels of 100 kilocycles in width, or 10 times that of the ordinary broadcast channel, for stations in the continental band.

WGY Programs on 5 Meters Also

Schenectady, N. Y.

Believing the bands of 5 meters and under offer great possibilities in radio, especially in television, Dr. E. F. W. Alexanderson, radio engineer of the General Electric Company, has arranged for broadcasting one hour programs twice a week over W2XAW, operating on 5 meters. These programs, the same as broadcast by WGY, will be sent out from 5 to 6 p.m. every Tuesday and Thursday.

'We have reason to believe that the frequency bands of these short waves are better, especially for television, because reflections, which cause fading and other disturbances, are less," Dr. Alexanderson explained. "Special observations will be made while these tests are going on and we feel the data secured will prove valuable to the advancement of the radio art."

Set Weak in Day Time

MY set works all right at night when the signals from the stations are strong but in the day time I do not get enough. Is there any way in which I can change the set so that it will give just as strong signals in the day time as at night? I am willing to add another tube if necessary. Would a change from grid bias detection to grid leak and condenser detection work out all right? If so, how can it be done the simplest way?—B. W. B.

The simplest way is to add a stage of audio frequency amplification. To change from grid bias to leaky condenser detection you have to change the plate voltage on the detector to a lower value and you also have to provide for zero bias on the tube. Of course, you might also add another stage of radio frequency amplification ahead of the receiver. This may be tuned or untuned, but it is much simpler to make it an untuned stage.

* * *

Charging Storage Battery Backwards

WILL a storage battery be ruined if by accident the charger be connected in the reverse direction and left that way for a considerable time? Is it possible to restore the battery by charging it in the right direction afterward?—W. H. J.

If the charger is connected backwards for any length of time the battery will first be completely discharged and then it will be charged in the opposite direction. It is possible to restore it. The wrong connection is not done by accident, it is done by carelessness. It does not do the battery any good.

Audio Characteristics of

Remedy Proposed for the Starting Howl—

By Herman

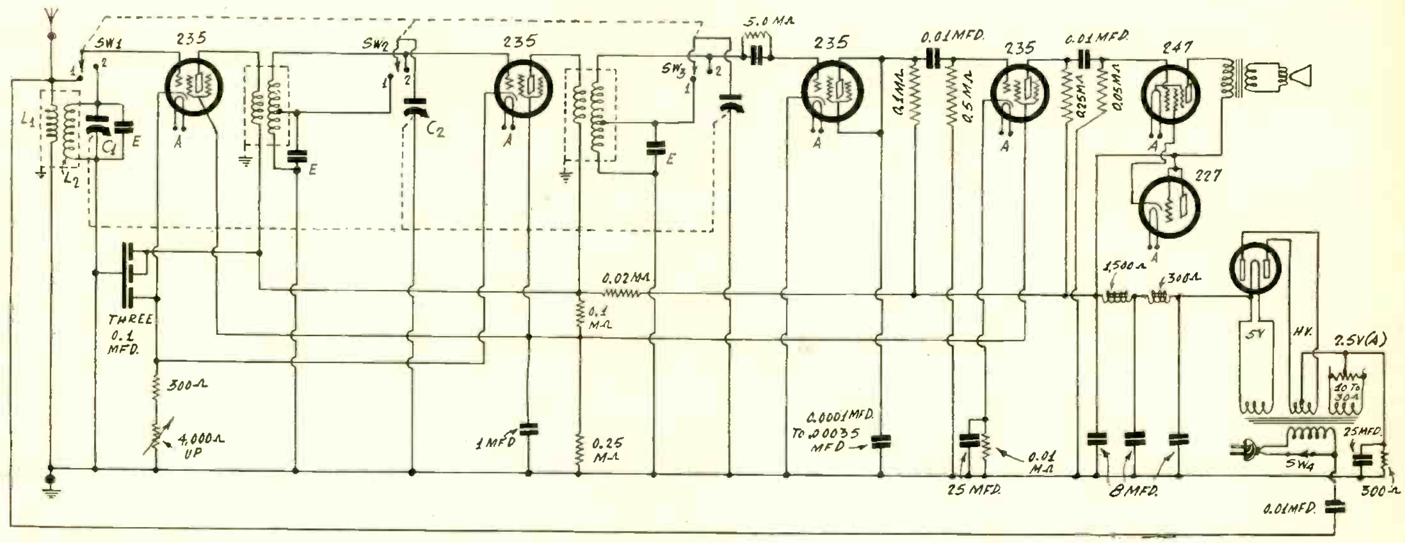

FIG. 1

If a howl is present in a circuit having a resistance coupled amplifier of this type, which howl would exist only at the start, it may be corrected by introducing the 227 tube in the manner diagrammed.

INTEREST in short waves is now running high, even among those who are not constructionally inclined, that is, among the fans or "mere listeners," as the snooty phrase has it, rather than the radio technicians. So simple means are desired for giving some short wave reception that will not bring a flareback.

So many persons who have interest in but no knowledge of short waves think that the results are the same in the thrill region as on the broadcast band, and so many manufacturers intimate results are so much better on short waves, that a so-called outsider who gets a device that brings in short waves may be most unpleasantly surprised.

He should be told that short waves are erratic (a convenient word for avoiding a long technical harangue that would be over his head anyway), and that some days, or preferably nights, he will tune in far distant stations with volume, and then quite a while may elapse before he is able to repeat the performance. Indeed, the set may seem dead on the short wave band at certain periods. This is particularly true of trying to get frequencies at night around 20,000 kc (15 meters).

Much That Is Interesting

Most listening is done at night, therefore if a man has a set that does justice to the broadcast band, and can turn a switch to a given position to bring in the next highest band, he may be able to tune, in one instance, from above 550 meters to a trifle below 200 meters, and in the second instance, from a little above 200 meters to, say, around 60 meters. That will enable him to tune in television (whirling motor noises that may mean little to him but will set him to anticipatory wondering), police signals, which are bound to interest the man of the house, amateur code and voice, ship phone, airplane phone and the like.

The frequency range on the short-wave tap would be from about 1,500 kc to about 4,500 kc, and the following are the purpose assignments, with wavelengths:

1,500 to 1,715 kc (199.9 to 174.8 meters), mobile service.
1,715 to 2,000 kc (174.8 to 149.9 meters), fixed services, amateurs.
2,000 to 2,250 (149.9 to 133.3 meters), mobile services, fixed services.
2,250 to 2,750 kc (133.3 to 109.0 meters), mobile services.
2,750 to 2,850 kc (109.0 to 105.2 meters), fixed services.
2,850 to 3,500 kc (105.2 to 85.66 meters), mobile services, fixed services.
3,500 to 4,000 kc (85.66 to 74.96 meters), fixed services, amateurs.
4,000 to 5,500 kc (74.96 to 54.51 meters), mobile services, fixed services.

While the above table simply gives the classification, it can be seen that two amateur bands can be tuned in. Also, as may be imagined, mobile services will include airplane to airplane talks, ground to airplane and airplane to ground talks, ship to shore, shore to ship and ship to ship talks, while fixed services include television, relay broadcasting, police alarms and other services from non-moving transmitters.

While the 4,000 to 5,500 kc band will not be completed, since tuning will be to 4,500 kc, or 66.63 meters, there will be enough coverage to get the customer interested in short waves, and he will get in general good results, because the frequencies involved are not among the high ones that, shall we say, are erratic. If desired, the short wave tuning may be begun at just above 150 meters, to bring the other extreme to about 50 meters, nosing out a few police senders. It depends on where the tap is located. There will be phenomena and the listener will wonder what's the matter, but he will get something all the time, as the air is filled with transmission on the bands covered, easily obtainable. Besides, with even moderate sensitivity, coverage of the entire United States will be possible, also reception of Canadian short wave transmissions, and perhaps something from Europe once in a while, but this must not be and is not guaranteed.

It is convenient indeed to have at hand the list of television, police radio and the relay broadcasting stations, so here goes:

Television on Regular Schedule

2,000-2,100 kc (149.9 to 142.8 m)

Call Letters	Company and Location
W1XAV	Shortwave & Television Laboratory, Inc., Boston, Mass.
W3XK	Jenkins Laboratories, Wheaton, Md.
W2XCR	Jenkins Television Corp., New York, N. Y.
W2XAP	Jenkins Television Corp., portable.
W2XCD	DeForest Radio Co., Passaic, N. J.
W2XBU	Harold E. Smith, Near Beacon, N. Y.
W9XAO	Western Television Corp., Chicago, Ill.

2,100-2,200 kc (142.8 to 136.3 m)

W3XAD	RCA Victor Co., Camden, N. J.
W2XBS	National Broadcasting Co., New York, N. Y.
W2XCW	General Electric Co., S. Schenectady, N. Y.
W8XAV	Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.
W2XR	Radio Pictures, Inc., Long Island City, N. Y.
W9XAP	Chicago Daily News, Chicago, Ill.
W3XAK	National Broadcasting Co., Bound Brook, N. J.

2,750-2,850 kc (109.0 to 105.2 m)

W2XAB	Columbia Broadcasting System, New York City.
W9XAA	Chicago Federation of Labor, Chicago, Ill.
W9XG	Purdue University, W. Lafayette, Ind.
W2XBO	United Research Corp., Long Island City, N. Y.

2,850-2,950 kc (105.2 to 101.6 m)

W9XR	Great Lakes Broadcasting Co., Downers Grove, Ill.
W2XR	Radio Pictures, Inc., Long Island City, N. Y.

Amplifiers in Midget Sets

Single A-F Stage in Economical Circuit

By Bernard

POLICE RADIO STATIONS

Kc.	M.	Call	Location
2,458	122.0	WPDV	Akron, Ohio
1,712	174.9	WPDO	Auburn, N. Y.
1,712	174.9	WPDN	Beaumont, Tex.
2,410	124.4	KGPJ	Berkeley, Calif.
2,422	123.8	KSW	Buffalo, N. Y.
257	1167.0	WMJ	Butler, Pa.
2,458	122.0	WBR	Cedar Rapids, Iowa
2,470	121.4	KGOZ	Charlotte, N. C.
1,712	175.1	WPDB	Chicago, Ill.
1,712	175.1	WPDC	Chicago, Ill.
1,712	175.1	WPDD	Chicago, Ill.
1,712	175.1	WKDU	Cincinnati, Ohio
2,452	122.2	WRBH	Cleveland, Ohio
1,712	175.1	KVP	Dallas, Tex.
2,470	121.4	KGPN	Davenport, Iowa
1,596	187.9	WKDT	Detroit, Mich.
2,410	124.4	WCK	Detroit, Mich.
2,410	124.4	WPDX	Detroit, Mich.
2,416	124.1	KKPF	El Paso, Tex.
2,440	122.9	WPDF	Flint, Mich.
2,470	121.9	WPDZ	Fort Wayne, Ind.
2,440	122.9	WFEB	Grand Rapids, Mich.
257	1167.0	WJL	Greensburg, Pa.
2,410	124.4	WRDR	Grosse Point Village, Mich.
257	1167.0	WBA	Harrisburg, Pa.
2,410	124.4	WMO	Highland Park, Mich.
1,712	175.1	WMDZ	Indianapolis, Ind.
1,662	121.4	WRDS	Ingham, Mich.
2,422	123.8	KGPE	Kansas City, Mo.
2,470	121.4	WPDT	Kokomo, Ind.
2,440	122.9	WPDL	Lansing, Mich.
1,712	175.1	KGPL	Los Angeles, Calif.
2,440	122.9	WPDE	Louisville, Ky.
2,470	121.4	WPEC	Memphis, Tenn.
2,440	122.9	WNDA	Miami, Fla.
2,452	122.2	WPDK	Milwaukee, Wis.
2,416	124.1	KGPB	Minneapolis, Minn.
438	684.5	WPY	New York, N. Y.
500	509.6	WPY	New York, N. Y.
2,452	122.2	KGPH	Oklahoma City, Okla.
2,470	121.4	KGPI	Omaha, Neb.
1,712	175.1	KGJX	Pasadena, Calif.
2,416	124.1	WPDJ	Passaic, N. J.
2,440	122.9	WPDP	Philadelphia, Pa.
1,712	175.1	WPDU	Pittsburgh, Pa.
2,452	122.2	KGPP	Portland, Ore.
2,416	124.1	WPDH	Richmond, Va.
1,712	175.1	WPDR	Rochester, N. Y.
1,712	175.1	KGPC	St. Louis, Mo.
2,416	124.1	WPDS	St. Paul, Minn.
2,440	122.9	WPDM	St. Petersburg, Fla.
1,712	175.1	KGOY	San Antonio, Tex.
1,596	187.9	KGPD	San Francisco, Calif.
2,410	124.4	KGPD	San Francisco, Calif.
2,410	124.4	KGPM	San Jose, Calif.
1,596	187.9	KGPA	Seattle, Wash.
2,452	122.2	KGPA	Seattle, Wash.
2,470	121.4	KGPK	Sioux City, Iowa
1,712	175.1	WPEA	Syracuse, N. Y.
2,470	121.4	WRDQ	Toledo, Ohio
2,416	124.1	WPDA	Tulare, Calif.
2,452	122.2	KGPO	Tulsa, Okla.
2,410	124.4	KGPG	Vallejo, Calif.
2,410	124.4	WPGW	Washington, D. C.
257	1167.0	WDX	Wyoming, Pa.
2,458	1220.0	WPDG	Youngstown, Ohio

Unusual Tube Use

The fact that some concession is made to short waves is found in present production of broadcast receivers that shave something off the low frequency end to give it to the high end, thereby enabling television to be tuned in. It must be assumed by some manufacturers that the television signals are to be used in conjunction with dissection and projection, but most persons, I assume, tune in the whirling motor crackles, say "television" to the lady of the house or to some visitor, and pass on to some signals that carry a directly readable message or music. Yet for those wanting the television signals for the television that is in them, the circuit can be used, for the audio channel is resistance coupled, and is a good one to boot.

It will be found on inspection of the diagram that there is a shocker in the upper right hand corner and designated a 227 tube. I suppose that most persons who have been looking at radio diagrams for a few years get to that point where they look twice only when there's something they can't immediately fathom. That means probably something that has not been printed before, or at least has never before come to their attention. Well, that 227 tube certainly is a new one, and with the promise that something will be said about it that will convey welcome information to experimenters, we will return to a consideration of the radio frequency channel, at the point concerning television, where we left off.

As I Was Saying

The television signals may come in near the extreme of the dial (100 on most dials, 550 kc or thereabouts if the dial is frequency calibrated). Of course the frequencies applying to the broadcast band will not apply to the short wave band, but the numbers may be used just as well, without association with absolute values of frequencies, just as 0-100 represents relative positions, without absolute values, in other dials.

It is more than possible that the set will have a tendency to oscillate in the short wave region, but the correction for this is in adjustment of the volume control, which governs the bias on the 235 radio frequency amplifier tubes. Both tubes are always in circuit, but the first stage is tuned for broadcasts and untuned for short waves. Three tuned stages for short waves, at high gain, would be impractical. The squealing would be almost uncontrollable. The way out, used in some commercial products, is broad tuning and low amplification.

L1 is the primary of the antenna coupler. For broadcast purposes this serves as a sensitivity booster for the low radio frequencies, since it has an inductance of 1.3 millihenries, and the natural capacity of the antenna ground system across it causes it to resonate just outside the broadcast band (around 500 kc).

The resonance curve is broad, however, and the building up is substantial up to about 700 kc, when the circuit begins to act more like a damper, so that the otherwise over-gainful region from up there is more readily stabilized, and relatively even amplification results, instead of the so-called rising characteristic of tuned r-f (increase in amplification with increase in frequency).

Disposition of Stages

If the antenna circuit starts to act as a damper at 700 kc, you can imagine what happens at the next switch point, when you tune from 1,500 kc up. Therefore this choke has to be removed as a primary input to a tuned circuit, and is made a so-called untuned input. The switch takes care of that in the same operation that throws the tuning condensers in the succeeding sections to the tap on the coils.

Now, the choke input is all right for short waves, particularly waves of the region we are to cover, and besides the antenna is connected directly to the grid, and this pretty much takes away the tuning characteristic, because of the inherent and desirable broadness. Also, it must be borne in mind, some amplification is obtained from the first stage, and, moreover, the two succeeding stages are alike, and therefore easy to trim with equalizers, and requiring no manual trimmer. The trimming may be done for some short wave station, as the two equalizers in the constantly tuned circuits are thus located to make this practical. Then for the broadcast band, a high frequency is selected, say 1,400 kc or so, and the antenna secondary trimmed for that.

This system is not hard to work at all, and while it does require a special switch with its shaft insulated, known commercially as a three point triple throw switch, and needs two tapped coils, and special antenna coil, it is suggested that many receivers can be changed over to this, even if the audio in the present set is unmolested. That is, the tuner of the set can be fixed up, if there are two stages of t-r-f. There are plenty of such sets in the world.

Fixing Up An Old Set

Suppose you have a receiver, or can get hold of some sets where you'd like to improve the resale possibilities, with two stages of t-r-f and a detector. The coil system can be changed over. A 300 turn honeycomb coil can be fastened inside the secondary to replace the present primary (which need not be removed), only care should be taken not to have the nearest turn of the honeycomb less than half an inch away from the nearest turn of the secondary. Add 5 turns to the antenna secondary. The interstage couplers would have their secondaries unwound until one-third of the number of turns remains, when a loop would be made for tapping, to be scraped later for soldering, and then the wire taken off is put back. It may be necessary to put on one turn less, due to having used up some of the wire in making the loop, but this is permissible.

(Continued on next page)

A Midget That Can Be

Single Audio Stage Used After

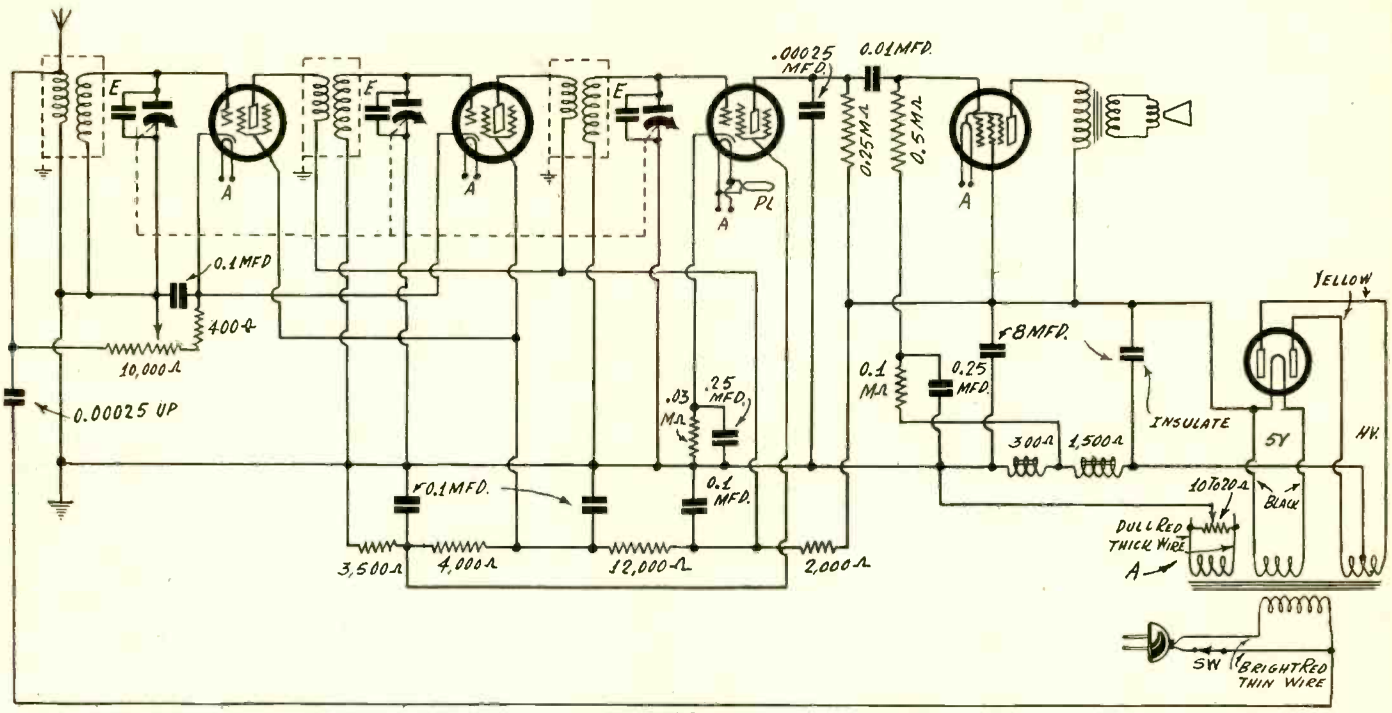

FIG. 2

A modern five tube midget, with high gain radio frequency amplifier working into a power detector, which in turn feeds a 247 pentode. A circuit such as this can be built of parts costing less than $20.

(*Continued from preceding page*)

Then where the volume control was alone, use a volume control with a-c switch attached, thereby being able to locate the coil switch in an otherwise unused position. The tubes need not be screen grid to accomplish the present purpose, either.

The equalizers probably are on the tuning condenser. No need to remove them. Balance the circuit as you find it.

Now On That Mysterious Tube

For the switch connection, remember that the stator of the tuning condenser in the antenna stage goes to and stays at the secondary terminal all the time. The stators of the two succeeding sections do *not* go to any coil terminal permanently, but are connected to lugs on one of the decks of the switch, the corresponding lug being for the coil terminal in one instance and the tap in the other. Thus when the short waves are used the winding not in the tuned circuit remains as a continuation to grid, and it is not a short-circuited winding, neither is it open or dead-ended. It serves a purpose and it does not cause mischief.

The type of detection may remain as it is in the receiver you have.

Suppose, however, you decide to build the circuit as shown in Fig. 1. Then you want to know most certainly what is the object of that 227 tube stuck in the southwest corner of the diagram.

It is well known that instability attaches to high gain resistance coupled amplifiers. It has been found by many that the whole system is self-limiting, for so soon as you attempt to introduce an extra amplifying tube, something happens that requires you to compensate for or balance out the trouble, a soft way of saying that you have to do something to take out the added amplification you have unsuccessfully tried to put in. The trouble may be motorboating of a put-put-put frequency, or it may be a roar.

Now, the tube in the peculiar position is a corrective for a starting roar. Some otherwise excellent resistance coupled amplifiers do not quiet down until after the lapse of about a minute, which shows that something happens to cause audio oscillation, and that the cause is removed when the set is at its full functioning height.

The audio circuit in Fig. 1 consists of three plate circuits: the detector (which is an audio tube), the 235 first audio and the pentode output tube. If the leak values are high, the circuit will motorboat. But with 0.5 meg. in one position and 0.05 meg. in the other (500,000 and 50,000 ohms respectively), there will be no such trouble.

But when the set is turned on at first, there may be a roar. It is most objectionable. The audio quality thereafter is so fine that one might say to himself: "I wish I could find some way of getting rid of that starting roar."

Now, there are several ways of trying to do so experimentally. Naturally, the first thing you think of is reduction of the leak values, starting with the first audio grid leak because it is ten times as high as the value of the other. But you will find that the volume is less without any semblance of a cure for the ailment.

Plate Resistor Does It at a Price

Next you will consider the plate resistor. If this is made higher the feedback will be less. So you try 0.25 meg. instead of 0.1 meg. and the roar is gone, but instead a high frequency interference develops, one that does not die out. This is bad, too. But it does show that the frequency of instability can be shifted, only it is found that a temporary ill has become a permanent one. So the value may be made 0.05 meg., but the amplification is down, though the starting roar is absent.

The detector tube may be removed from the socket while the set is in operation—and the howl not present returns. This shows that the detector tube must be in circuit and functioning if trouble is to be avoided.

Then sooner or later the biasing voltage for the first and second audio tubes will come up for consideration. The pentode bias will be found not to affect the case at all. The first audio bias, however, can be raised high enough (by increasing the resistor value to 20,000 ohms or more) but the volume will decline considerably.

A resistance value of 10,000 ohms permanently, after the starting howl, would be highly satisfactory. If only we could have a resistor that started off at nearly infinite resistance, and slowly petered down to 10,000 ohms!

We become anxious about the actual cause of the trouble, as a matter of technical curiosity, even if we have a solution. The time factor is a clue. The howl does not start the very second the set is turned on, but a few seconds later, and builds up, then lasts about a minute, and dies out. Indeed, it lasts different lengths of time, depending on the make of tubes used. Well, there is a clue for your life! Some tubes have quick heaters, some have slow heaters, and the duration of the howl is directly proportionate to the quickness or slowness of heating—in fact, the howl measures the heating time!

It can be realized, then, that there is no howl at very first because there is not enough current flowing to permit any amplification, but that the howl starts when the amplification sets in, and ceases when the tubes themselves draw the principal or almost exclusive current. If 0.5 ma flows through 5,000 ohms.

Built For Less Than $20

High Gain RF and Power Detector

the bias is 2.5 volts, but if one-tenth of a milliampere is flowing, the bias is only 0.5 volt. Thus as the current increases the bias increases, and here is further confirmation that the increasing of first audio bias provides the remedy, for when the bias mounts to 10 volts (as 0.5 ma through 20,000 ohms), the trouble stops.

So we look around for some contrivance that will have a variable resistance characteristic, a negative temperature co-efficient of resistance, something that makes a whale of a chcange, say from a few hundred thousand ohms (to be safe) to 10,000 ohms, as 5 volts bias will be enough.

Well, a tube seems just the thing, for when the set is turned on no current flows that very instant, but some starts to flow the moment that threshold heat is produced. Thus the current at starting may be less than one-tenth of a milliampere. Let us assume the first discernible current is 1 microampere. If we connect a *227* tube with its plate to cathode of first audio, and cathode and grid of the *227* to ground, we will start off with a resistance of hundreds of thousands of ohms, because the rate of current rise in the *227* is the same as that in the 235 first audio, and the bias resistance does not go down to what we want until the current is up to the full operating value. The two tubes are working under the same principle. But are they working to opposite effects, that is, one serving to neutralize the bad effect in the other, and at any time is the neutralization other than complete?

The Answer

Well, the sad answer is no. One is a heater tube, so is the other. When some current starts to flow in one it starts to flow in the other. Therefore there is no relative retarding effect. The action may be said to be in phase. What we want is a retardation.

Somehow it seems we have overlooked the dissimilarity between the pentode output tube and the heater tubes. The pentode is like a battery type tube of the 201A, 231 and similar models, in that it is a filament type tube. It starts to work approximately at peak the moment the set is turned on, or a fraction of a second thereafter. What we should like to have, as a solution to our difficulty, is a tube of the heater type, a slow heater at that, for the pentode, but there isn't any. What can be done to introduce the effect of the heater type tube on the pentode?

No amplification will be obtained from the pentode, and no signal will pass, if the suppressor grid is not connected, or, the lower the voltage, the less the amplification. The suppressor grid is the one that suppresses the secondary emission, and its connection is equivalent to that of the cathode in heater type tubes (K on socket).

There is nearly always a higher voltage on the suppressor grid, or screen grid as it is sometimes called, than on the plate, because both the plate return and the screen are tied to the same point, and there is a plate load of definite resistance to cut down the applied voltage to an effective plate value. So it is permissible to retard the screen voltage. This may be done by connecting a 227 tube either with plate to B plus, grid and cathode to suppressor grid of the pentode, or, as in the diagram, by constituting the *227* a two-element rectifier, tieing grid and plate together, and putting cathode of the 227 to suppressor grid of the pentode.

Now we have the lagging effect of heater action introduced, and the action may be said to be out of phase during the warming up process of the heater. The internal plate resistance of the 227 tube is very high at the start, hundreds of thousands of ohms, and finally wanes to less than 4,000. Thus at about 7.5 ma the voltage drop would be 30 volts. At first the drop is much greater, but as the *227* heats up the drop becomes less.

Three Stage Audio Proposed

The circuit diagrammed in Fig. 1 was built in compact space, chassis 11¼ inches wide, 8½ inches front to back, with a flap 3 inches high at front and back. This chassis is suitable for installation even in a midget Gothic cabinet of the mantel type, with dynamic speaker, but of course the chassis may be installed in a console if preferred.

Since the solution previously proposed for the starting howl necessitated an extra tube, it is practical to add another stage of resistance coupled audio instead, as then the instability is transferred to another region, the howl is not present at starting, but motorboating may result, and this is correctable by lowering the grid load resistors ahead of the pentode. For three stages the values might be 0.25 meg. for the detector and first audio plates, 0.05 meg. for the grid circuits of the first, second and third audio tubes.

However, complete stabilization of the three stage resistance coupled audio amplifier is an experimental task, and the constructor should either follow an authenticated circuit, where the experimental work has been done for him, or should have the knowledge and the desire to do his own experimenting. Some data on the three stage system will be published in another article of this series.*

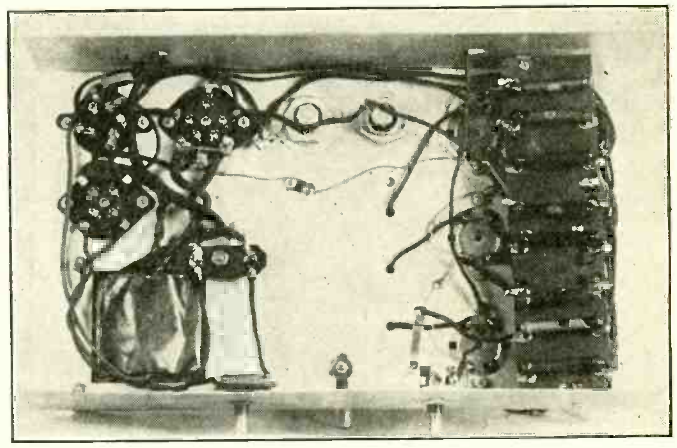

FIG. 3

View of the under side of the chassis of the circuit diagrammed in Fig. 2. There is very little wiring to be done, as few parts are used, and all parts to which connections are to be made are very accessible.

A Good Midget, Five Tubes

No trouble of either nature, that is, slow oscillation called motorboating, or quicker oscillation, called howling or blasting, will be experienced from a single stage of audio with pentode output. Fig. 2 shows the circuit diagram of such a midget. It can be built complete, including speaker and cabinet, but less tubes, at less than $20, and it will be found to be a good set, as it has been thoroughly tested.

It introduces a regenerative condition into the audio system for dispensing with large values of bypass capacity, and still reproducing good tone quality. The radio frequency amplifier is of the very high gain type, therefore the detector is a negative biased one, and it works into the output tube through the coupling resistors.

Bias for the first and second radio frequency amplifiers is varied by moving the arm of the resistor, using a knob for the purpose ,and at the same time input is cut down when the bias is increased. This constitutes a volume control working in the right direction. The primaries have a large number of turns, compared to primaries for general purpose tubes, and thereby the gain becomes great. Also, the antenna primary winding is a radio frequency choke coil of relatively high inductance, so that the sensitivity of the radio frequency channel is approximately equal throughout the brodcast band.

This set tunes in the complete broadcast band.

How Hum is Kept Low

It can be seen that the circuit is an economical one. The voltage divider consists of a chain of small wattage resistors, of about ½ or 1 watt rating, the familiar pigtail type. Thus the maximum voltage is applied to the pentode and the detector plates, while a lower voltage (around 200 volts) is applied to the plates of the r-f tubes, the screen voltage for the r-f is about 75 volts, and for the detector around 50 volts or a little less. These screen voltages can not be accurately measured on the usual run of meters.

This circuit has been engineered by Polo Engineering Laboratories, and has been tested for tone, sensitivity and selectivity, and found to meet the requirements.

The hum level is kept very low by means of a resistor-capacity filter in the gird circuit of the pentode (0.1 meg. and 0.1 mfd.), while the positive feedback introduced into the pentode is used to cancel the negative feedback through the biasing portion of the field coil of the dynamic speaker. This portion has a d-c resistance of 300 ohms, resulting in about 17 volts negative bias.

The values of the constants are stated on the diagram. The five tubes used are two 235, one 224, one 247 and one 280. Normally, since this is an a-c set, no aerial is needed, besides the one present by virtue of a fixed condenser connected to the a-c line. This condenser may be of any capacity from 0.00025 mfd. up to 0.3 mfd. Wrap insulating tape around it, so as to insulate the line side carefully.

*[*See next week's issue*.—EDITOR.]

A Compact Circuit, 30-5

Dynatron Oscillator, Variable Mu

By Henry E

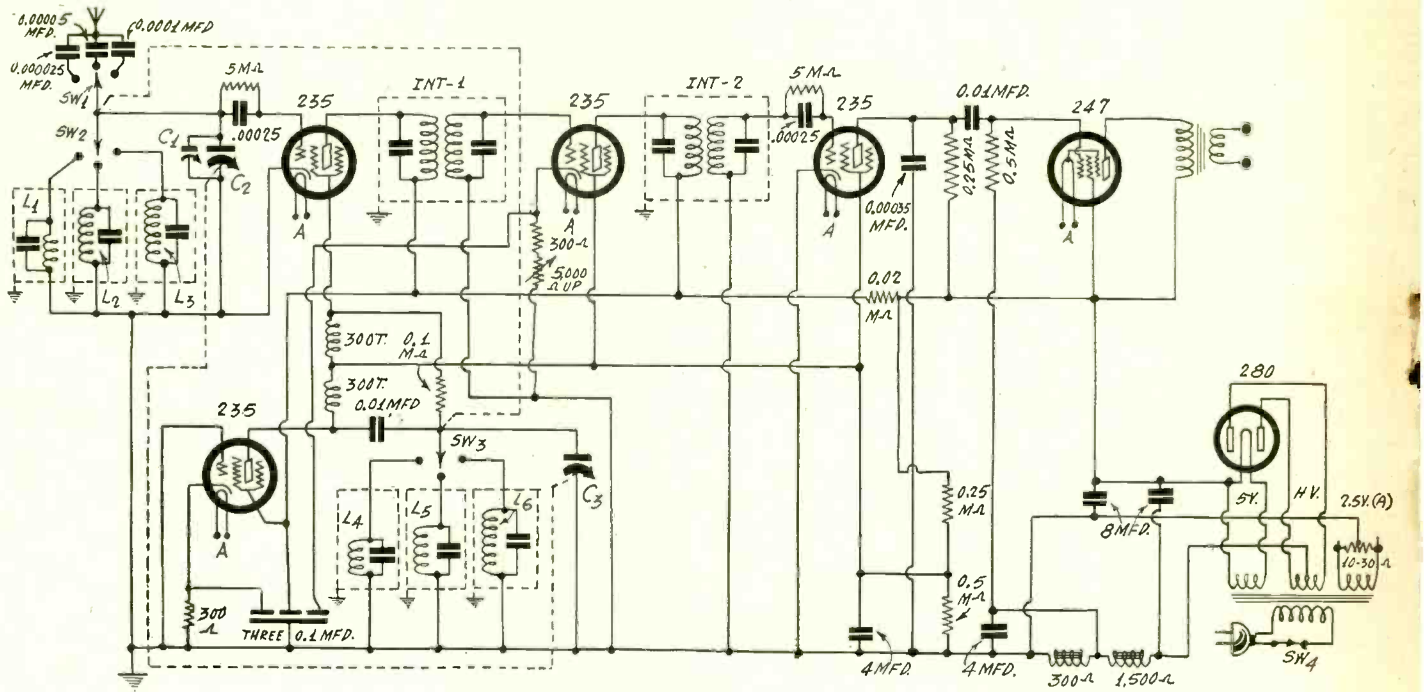

FIG. 1

This circuit may be built for 30-550 meter coverage, or as a strictly short wave receiver, 15 to 200 meters. A dynatron oscillator is used. The chassis may be housed in a midget cabinet or in a console.

THE circuit design shown in Fig. 1 may be used either as a combination broadcast and short-wave receiver, 550 to 30 meters, or as a short-wave receiver, above 200 to 15 meters, without plug-in coils.

Because the number of tubes is held down to six, the two detectors are of the grid leak type for sensitivity reasons.

Modulator and oscillator are tuned by a two-gang 0.00035 mfd. condenser, C2 and C3, with straight frequency line plates, for then the circuits are more readily made to tune properly despite the wide frequency coverage. However, a manual trimming condenser, C1, is advisable, and may be of any capacity from 30 mmfd. to 70 mmfd.

The fixed condensers across the tuning coils are equalizers, and simply represent equalization independently made for each coil. By that system it is virtually practical to dispense with the manual trimmer across the modulator, except that on very weak stations it is often helpful to get just that little extra kick necessary for intelligibility.

Avoids Dial Dead Spots

Each coil is individually shielded, which helps get rid of the nuisance of dead spots on the dial, which result primarily from absorbtive tuned circuits in inductive relationship to the coil actually intended to be exclusively in use. In other words, one or more of the other coils may be close enough to the one in use to act as a wave trap, not only at the fundamental period of the extraneous coil but at harmonics thereof.

By using series antenna condensers it is practical to dispense with a primary, as the condensers can be of such capacity as to afford the desired coupling, no more, no less. Switching is thus simplified. Therefore for the lower radio frequencies (higher wavelengths) a larger capacity is used than at the other positions. However, if equalizers are used in the series circuit, of 20-100 mmfd. capacity, one may be set at maximum, setscrew turned all the way down, for 0.0001 mfd., and the two others may be set at less than maximum. Actual experience will show what is the preferable setting for these two others, but it will not be found to be critical.

The oscillator is a screen grid tube used in dynatron fashion. This requires that the screen voltage be higher than the plate voltage for the oscillator, and is accomplished by simple reversal. The voltage to the screens of the other 235 tubes is the plate voltage for the oscillator, and the voltage for the plate of the other 235 tubes is that for the screen of the oscillator.

Resistor Couples Circuits

If the output is 250 volts direct current, or thereabouts, it is feasible to put the entire voltage on the plates of all the tubes except the oscillator, where this voltage goes to the screen, while the screen voltage for the other tubes, and for plate of the oscillator, may be 100 volts. However, if a series resistor is introduced in the B plus lead (see 0.02 meg. in diagram) to the screen grid tubes, the more frequently used lower voltage of 180 volts or thereabouts may be applied. The screen voltage will be proportionately lower, the ratio being about 1 to 2.5.

The coupling between oscillator and modulator is effected by putting an unbypassed radio frequency choke coil, say a 300 turn honeycomb, or 1.3 millihenries, in the screen lead of the modulator, and connecting from this screen to the stator of the oscillator tuning condenser a pigtail resistor of about 0.1 meg. (100,000 ohms).

This condenser, and the oscillator tuning coils, are in the plate circuit, because the dynatron oscillator must have its plate tuned. With the voltages as specified, and the tuning likewise, the tube will oscillate, because its resistance is rendered negative.

The similar choke coil in the plate circuit of the oscillator is there simply to permit easy grounding of the rotor of the oscillator tuning condenser. The direct voltage of the plate is kept off this tuning condenser by a 0.01 mfd. fixed condenser, although larger capacity may be used here, preferably of mica dielectric.

One Intermediate Stage

This series condenser reduces the effective capacity in the plate circuit, hence the 0.00035 mfd. section in the oscillator is never quite 0.00035 mfd. This is all right, because the higher oscillator frequency is to be used for establishing a difference

50 or 15 to 200 Meters

Amplification and Pentode Output

. Herman

between oscillator and modulator equal to the intermediate frequency, which is 175 kc.

There are two intermediate frequency coils used, Int-1 and Int-2, but there is only one intermediate stage, as the second coil simply couples the intermediate tube to the second detector. However, both transformers have primary and secondary tuned, so there are four tuned circuits. Add the two tuned circuits in the mixer and you have a total of six tuned circuits.

Six coils are used in individual shields, and the shields are grounded. If a metal chassis is used, this may be grounded, and attachment of the shields to the chassis will constitute shield grounding, although it is considered better practice also to run a lead from shield to ground binding post additionally. This is not always convenient, if the shield is aluminum hence won't take solder, as the connection to chassis will be as good as a mechanical connection to the shield from a lead from ground post.

The coil switching may be accomplished in any of several ways, but the one selected is simple and dependable, and consists merely of bringing the stator of the tuning condenser to the desired coil, meanwhile cutting in the series antenna condensers. Since the opposite end of the coil is grounded, no adventitious current will flow in the coil, the intended current being confined to the coil in use, if the shielding is adequate on the others.

For broadcast use the modulator coil, using 1 inch diameter, may consist of 127 turns of No. 38 enamel wire, and the shield may be about 2½ inches diameter, 2¼ inches high, but not smaller. It may be larger. This is L3. The L6 oscillator coil may consist of 90 turns of the same kind of wire on the same diameter.

For the next band, lower than 1,500 kc to about 4,500 kc, the modulator coil L2 may consist of 45 turns and the oscillator L5 of 43, using No. 28 enamel wire.

For the third coil system, L1 and L4, the number of turns may be 17, and the wire No. 18 enamel.

Different insulation, and even different diameter wire, may be used without materially changing the result.

If the set is to be used for short waves only, the two preceding pairs of coils are wound, while the third pair consists of 6 turns of No. 18 enamel wire for each coil.

The construction of the circuit, using these coil data, should not be attempted unless the tuning condenser is 0.00035 mfd. two-gang, straight frequency line, for different values of inductance would have to be used (fewer turns) for 0.0005 mfd., while with three coils suitable ranges would not be covered by a smaller capacity than 0.00035 mfd., and besides padding would be required for other than s-f-l plates.

The modulator is a 235 tube, and so is the second detector, for this is practical where grid leak detection is used, and indeed it is possible to get satisfactory results from the 235 as a negative bias detector, even though the tube in general has what is termed a non-detecting characteristic. This simply means that it does not become an overwhelming detector when used as an amplifier and thus bring about crosstalk and other interinterference. Instead, the heightening bias increases the selectivity while reducing the volume, all this without objectionable detection.

Therefore the variation of the bias on the 235 for volume control is entirely satisfactory, indeed has come to be nearly standard, since varying the screen voltage, while it reduces the volume, too, when the screen voltage is lowered, happens to reduce the negative bias at the same time. Thus for very loud stations, where extra selectivity is needed, less selectivity is present. Not so of the varied grid bias method used here.

Loud Enough

The tube as intermediate frequency amplifier permits of good results even though only one intermediate stage is used. There was a time when three intermediate stages were regarded as almost a necessity, but with the high amplification of present-day variable mu tubes, the variable selectivity factor, and the practice of tuning both plate and grid circuits when they are maintained at very loose coupling to render this double system effective, one intermediate stage produces good results. In fact, there are many midget superheterodynes on the market that have only one intermediate stage, if indeed most of them do not have only one. And the output is loud indeed. So here.

The 247 pentode output tube will not be overloaded, rather the detector will overload first, but the volume control will take care of that.

The now popular method of putting the B supply choke in the negative leg is used. If this choke has a tap at a suitable point, the voltage drop between tap and ground may be used for biasing the pentode. In that case the center of the 2.5 volt winding goes to the ground, which is positive in respect to the choke tap, because all the B current flows through the entire choke, from B minus to ground. Note, therefore, that B minus is not grounded. However, the chassis is grounded, the grid returns of the other tubes are made to this point, and those other tubes, if they take a bias, get that bias independently through the drop in cathode resistors.

The choke system requires that the electrolytic condenser from positive B to negative B have its can or case insulated from a grounded chassis, otherwise there would be no condenser at the rectifier output. It is called an output here in reliance on a familiar term, although because of the B minus connection it is more nearly correct to say it is the input, since the current is flowing from positive rectifier (filament) to negative (B minus).

The set will fit in a midget cabinet of the orthodox Gothic arch type of construction, and that goes for the speaker, too, which is a small dynamic, with output transformer built in (upper right-hand side of diagram), and with the field coil, 1,800 ohms tapped at 1,500 ohms, leaving 300 ohms for pentode bias. The field coil is used also as the B supply choke.

LIST OF PARTS

Coils

Six independently shielded coils as described.
Two 300 turn honeycomb radio frequency choke coils.
Two intermediate frequency transformers, primary and secondary tuned (175 kc).
One output transformer for pentode 247 (built into speaker).
One B supply choke coil, 1,800 ohms, tapped at 1,500 ohms (speaker field coil).
One power transformer, to handle six tubes, including 247 and 280.

Condensers

Nine equalizing condensers, 20-100 mmfd. (four others are built into the intermediate transformers).
Three 0.1 mfd. condensers in one case (black common lead goes to ground).
Two 0.01 mfd. fixed condensers, mica dielectric.
One two-gang 0.00035 mfd. condenser with straight frequency line plates.
One 60 mmfd. manual training condenser.
Two 0.00025 mfd. grid condensers with clips.
Two 8 mfd. electrolytic condensers (special insulator for each of them).
Two 4 mfd. electrolytic condensers in one case.

Resistors

Two 300 ohm flexible biasing resistors.
Two 5 meg. tubular grid leaks.
One 0.1 meg. (100,000 ohms) pigtail resistor.
Two 0.25 meg. (250,000 ohms) pigtail resistors.
Two 0.5 meg. (500,000 ohms) pigtail resistors.
One 0.02 meg. (20,000 ohms) pigtail resistor.
One potentiometer or rheostat, 5,000 ohms or more maximum.
One center tapped low resistance (10 to 30 ohms).

Other Parts

One vernier dial, with pilot lamp and full-vision escutcheon.
One a-c cable and plug.
One coil switch, three point, triple throw (three decks, three positions on each deck, shaft insulated from everything); knob.
One knob for volume control to match coil switch knob.
One metal chassis, 13 inches wide by 9½ inches front to back; elevating flops at front and rear, 3 inches high.
Five UY sockets and one UX socket.
One front panel, to suit needs of console (or one midget cabinet).
One dynamic speaker, with output pentode transformer built in, and having 1,800 ohms field coil, tapped at 1,500 ohms.

Impedance Computation

Result of Resistance and Capacity in Parallel

By Burton Williams

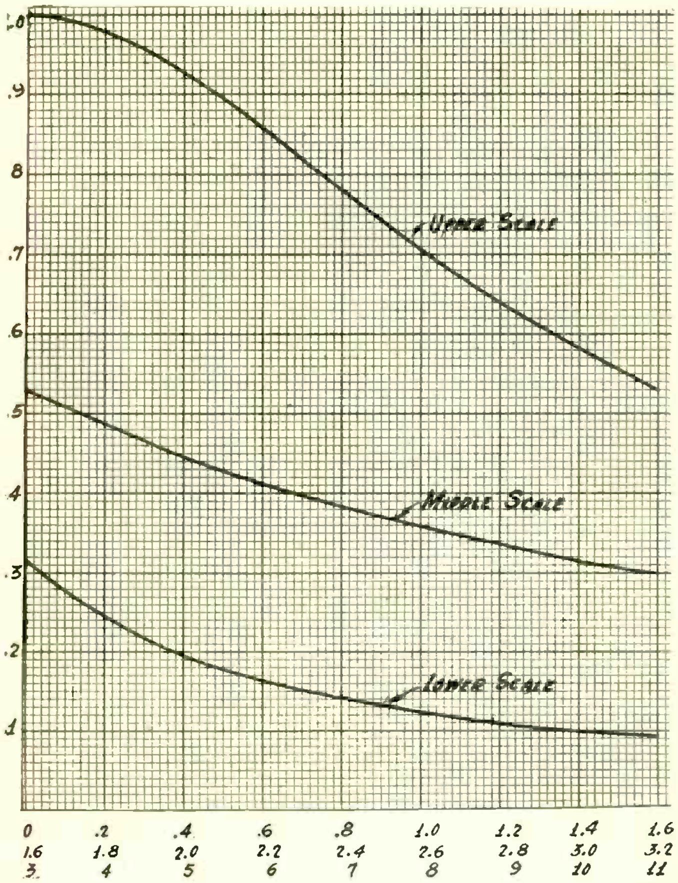

FIG. 1

These curves represent in graphical form the data contained in Table I in which x is the product of the resistance in ohms, the capacity in farads, and the frequency in radians per second.

WHEN a resistance and a condenser are connected in parallel the impedance of the two is always less than the impedance of either, and the impedance depends on the frequency as well as on the resistance and the capacity. The impedance Z of the combination is given by the expression $Z=R/(1+R^2C^2w^2)^{1/2}$, in which R is the resistance in ohms, C the capacity in farads, and w is 6.2832 times the frequency in cycles per second. Stated in words the impedance is the resistance divided by the square root of the sum of unity and the product $(RCw)^2$.

It will be noticed that the value of the denominator in the expression is the same for a large number of combinations of resistance, capacity and frequency. If we substitute x for RCw, the expression for the impedance becomes $R/(1+x^2)^{1/2}$. Therefore, if we tabulate $1/(1+x^2)^{1/2}$ for different values of x we have a simple means of computing the value of the impedance for any value of R. All we have to do is to compute RCw, or x, look up the corresponding value of $1/(1+x^2)^{1/2}$ and multiply it by R. Even better than to tabulate is to plot a curve of x against $1/(1+x^2)^{1/2}$.

It will be noticed that the critical range of x is between 0.1 and 10. If x is smaller and 0.1 the impedance may be taken as the resistance alone, without making an error of as much as one per cent. Likewise, if x is larger than 10 the impedance may be taken as the reactance of the condenser alone. That is, if x is less than 0.1, Z=R, and if x is larger than 10, Z=1/Cw. Therefore we need tabulate the value of $1/(1+x^2)^{1/2}$ only between 0.1 and 10.

The three curves in Fig. 1 give the values of $1/(1+x^2)^{1/2}$ from zero to 11. The table also gives the value of the expression for certain selected values of x, the values used in plotting the curves.

Let us take a few examples to illustrate the use of the table or of the curves. Suppose we have a resistance of one megohm shunted with a condenser of 0.01 mfd. and we wish to know the impedance at the frequency of 550,000 cycles. Instead of using farads and cycles per second we can use microfarads and megacycles per second without altering the value of x. Hence we have $x=0.01\times0.55\times6.2832\times1{,}000{,}000$. That is, x equals nearly 35,000. This is certainly greater than 10. Hence the impedance of the combination at that frequency is simply the reactance of the condenser, or Z=1/Cw.

Since C=0.01 mfd. and $w=6.2832\times550{,}000$, Cw=0.0346. Therefore Z=28.9 ohms.

Let us take another example. Suppose we have a resistance of 300 ohms shunted by a condenser of 0.01 microfarad. What is the impedance at 100 cycles per second? Computing the value of x we find it to be nearly 0.0019. This is much smaller than 0.1 and for that reason the impedance is equal to the resistance alone, that is, Z=300 ohms.

Now suppose we increase the condenser capacity in this case to one microfarad, leaving the resistance at 300 ohms and the frequency at 100 cycles per second. Computing the x we find it to be 0.188. This is larger than 0.1 and smaller than 10. Hence it lies in the critical range and we have to use either the tabulated values or the curves. The particular value of x is not given directly in the table so we resort to the curve. We find for $1/(1+x^2)^{1/2}$ 0.982. We multiply this by 300 ohms to get the impedance and therefore Z=294.6 ohms. Because x was small the reduction in the impedance was not great.

Again, suppose that we have a resistance of 1,000 ohms shunted by a condenser of 8 mfd. What is the impedance at 50 cycles per second? Computing the value of x we find it to be 2.51. This, also, is in the critical range and therefore we have to use either the table or the curves. It is not given directly in the table so we use the curves. Opposite x=2.51 we find 0.37, which we multiply by 1,000 to get the impedance. Therefore Z=370 ohms. The reduction in the impedance was not great because x was not large.

Suppose we want to know the impedance of 1,000 ohms and 8 mfd. in parallel at a frequency of 400 cycles per second. Computing the value of x we find it to be 20.1. This is larger than 10 and therefore the impedance is that of the condenser alone. That is, Z=1/Cw. C=8/1,000,000 and $w=400\times6.2832$. Hence Cw=49.7 and Z=0.0201 ohm.

A problem that often arises is that of determining the impedance of a small by-pass condenser in shunt with a coupling resistance at a high audio frequency. For example, suppose the coupling resistance in the plate circuit of a detector is 250,000 ohms and that the by-pass condenser across it is 0.00025 mfd. What is the impedance of this combination at 10,000 cycles? This arises because it determines the amount of reduction in the amplification at the frequency in question.

For computing x we have C=0.00025 mfd., R=250,000 ohms, and $w=6.2832\times10{,}000$. Therefore x=3.93. This is in the critical range and hence we use either the table or the curves. The value of x is so near 4 that we may take this value in the table. It is 0.243. Hence $Z=250{,}000\times0.243$ ohms, or 60,700 ohms. If we use the curves we find 0.2465 instead of 0.243. Hence for x=3.93, Z=61,600 ohms.

Those who do not care to enter the curves for finding the value of $1/(1+x^2)^{1/2}$ for any particular value of x may obtain them by interpolation from the tabular values. While this is not quite so accurate as the curves, theoretically, about the same accuracy can be obtained practically, and in any case all the accuracy that is required.

Suppose the value of x is 0.15. This is not given in the table but the values for 0.1 and 0.2 are given. Since 0.15 lies half way between the two tabular values the value corresponding to 0.15 is the mean of 0.994 and 0.980, or 0.987. This method may be used for any two adjacent tabulated values.

TABLE I

x	$1/(1+x^2)^{1/2}$	x	$1/(1+x^2)^{1/2}$	x	$1/(1+x^2)^{1/2}$
0	1.000	1.2	0.64	1	0.707
0.1	0.994	1.4	0.581	2	0.447
0.2	0.980	1.6	0.530	3	0.316
0.3	0.957	1.8	0.486	4	0.243
0.4	0.928	2.0	0.447	5	0.196
0.5	0.894	2.2	0.413	6	0.1645
0.6	0.857	2.4	0.385	7	0.1414
0.7	0.819	2.6	0.359	8	0.1241
0.8	0.780	2.8	0.336	9	0.1105
0.9	0.743	3.0	0.316	10	0.0994
1.0	0.707	3.2	0.298	11	0.0944

[The values for $1/(1+x^2)^{1/2}$ must be multiplied by the resistance to obtain the impedance of the combination resistor and capacity.]

Experiments with Supers

A Search for Sensitivity with Few Tubes

By Einar Andrews

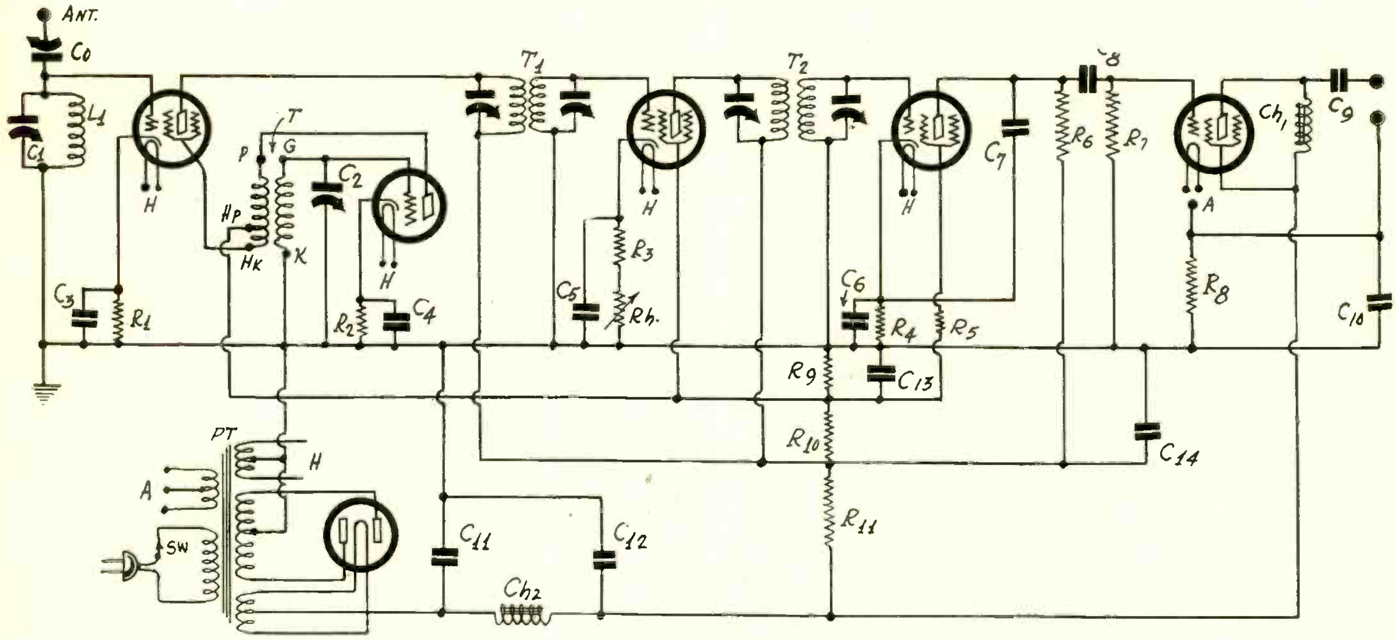

FIG. 2

This five-tube superheterodyne is the result of modification of that in Fig. 1 as suggested by experiments on the circuit published last week.

[*This is the second and concluding instalment of the article on Experiments with Short-Wave Superheterodynes, the first of which appeared last week.*—EDITOR.]

IN experimenting with the short-wave super published last week, on page 16, it was found that it was more sensitive than was necessary and that on account of the high amplication there was uncontrollable oscilation in the intermediate frequency amplifier. When a tube in the i-f circuit was eliminated the resulting circuit was superior. As a further experiment the first tube, a radio frequency amplifier in front of the modulator, was eliminated. The circuit remained satisfactory for short-wave reception, both from the point of view of sensitivity and of selectivity.

Eliminating these two tubes and making other minor and appropriate changes in the circuit, the resulting circuit is like that shown in Fig. 2. In this a small adjustable condenser Co is put in the antenna circuit to minimize the antenna resistance and capacity on the tuned circuit consisting of C1 and L1. The oscillator circuit remains exactly as it was.

The volume control was transferred to the cathode circuit of the only 235 tube remaining in the intermediate frequency amplifier. It consists of an adjustable 10,000 ohm resistance in addition to the regular 300 ohm grid bias resistance.

Function of Tubes

There are six tubes in the modified circuit, counting the rectifier. This is about the minimum that can be used in a superheterodyne, and the only reason that the circuit is sensitive is that the tubes employed are good amplifiers and detectors.

The first tube is a 224 and it is used as modulator, or first detector. The second tube is a 227 and it is the oscillator. The third is a 235 variable mu tube, which serves as intermediate frequency amplifier. The fourth tube is also a 224 and it is the detector proper. The fifth tube is a 247 pentode power tube. The sixth tube is the rectifier, a 280.

Although there is only one intermediate frequency amplifier there are two intermediate frequency tuners, both adjusted accurately to the same frequency, about 450 kc.

The designations of the various parts are different in Fig. 2 from those in Fig. 1, but the list of parts give the values for Fig. 2.

The disposition of the oscillator coil terminals is indicated in Fig. 2. It is understood that the oscillator coil is wound on a form that plugs into a UY socket. The antenna coil L1, having only one winding, can be wound on a form that fits a UX socket, the G and F— prongs being used only.

The plate circuit of the power tube in this receiver has been arranged so that there is a minimum of feed-back, both into the grid circuit of the tube itself and into the grid circuit of the detector. The choke coil Ch1 stops most of the signal current from getting into the power supply and the greater part of the current passes through C9, the loudspeaker, and to the cathode. It goes directly to the midpoint of the filament of the power tube rather than to the negative side of the B supply. This is to prevent as much degenerative feed back as possible. The 8 mfd. condenser C10 across the bias resistance aids considerably in reducing the reverse feed back. As far as the feed back to the detector is concerned it does not make any difference whether the return of the speaker is made to the top or the bottom of R8.

LIST OF PARTS
For Fig. 2

Coils:

L1—One set of plug-in coils.
T—One set of oscillator plug-in coils.
T1, T2—Two 450 kc shielded and tuned intermediate frequency transformers.
Ch1, Ch2—Two 30 henry choke coils.
PT—One power transformer.

Condensers:

Co—One 100 mfd. variable condenser.
C1, C2—Two 200 mfd. midget tuning condensers.
C3, C4, C5—Three 0.1 mfd. by-pass condensers.
C6—One 2 mfd. by-pass condenser.
C7—One 0.00025 mfd. condenser.
C8—One 0.1 mfd. condenser.
C9—One 4 mfd. condenser or larger.
C10—One 8 mfd. condenser or larger.
C11, C12—Two 4 mfd. electrolytic condensers, or larger.
C13, C14—Two mfd. by-pass condensers or larger.

Resistors:

R1, R3—Two 300 ohm bias resistance.
R2—One 2,000 ohm resistance.
R4—One 16,000 ohm resistance.
R5—One 100,000 ohm resistance.
R6—One 0.25 megohm resistance.
R7—One 0.5 megohm grid leak.
R3—One 400 ohm bias resistance.
R9—One 5,000 ohm resistance.
R10—One 4,000 ohm resistance.
R11—One 5,000 ohm resistance.
Rh—One 10,000 variable resistance.

Other Parts:

Five UY sockets.
One UX socket.
Sw—One line switch attached to Rh.
One vernier dial for C2.
One knob for C1 to match knob on Rh.

Adjusting Circuits for

Automotive Type Tubes Are Suitable for Universal

By Brunsten

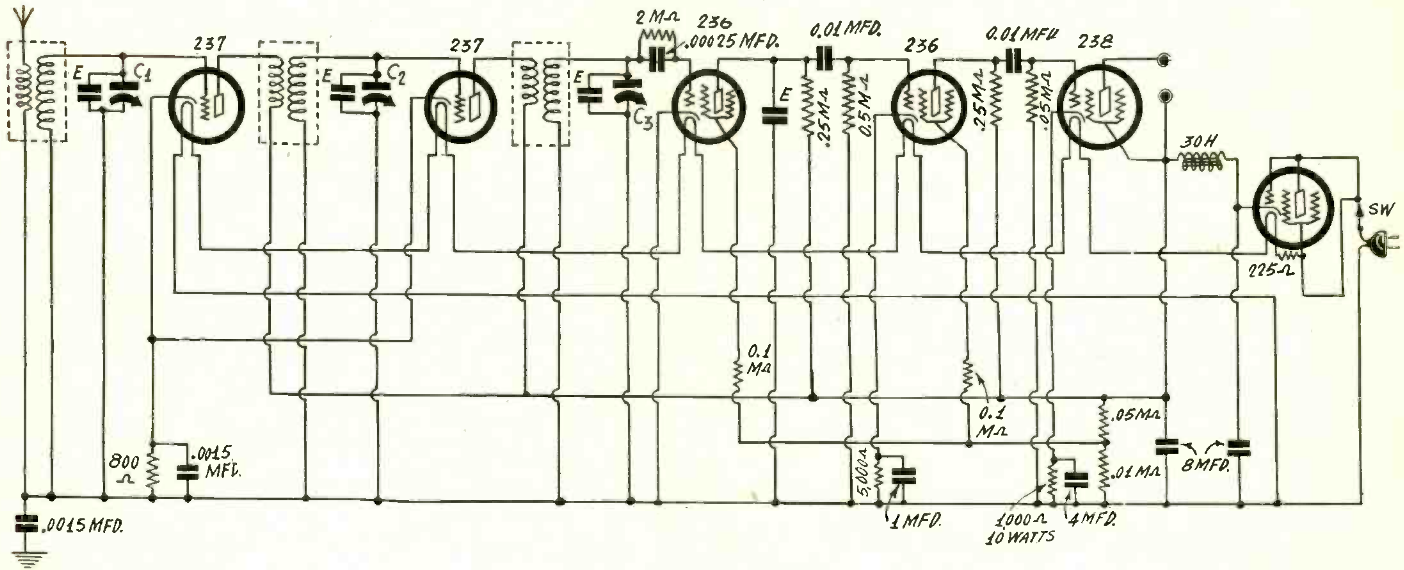

Fig. 1
The automotive tubes are especially adaptable to circuits designed to operate either on alternating or direct current. This circuit may be used on either with slight change.

REQUESTS are often made for receivers which may be used either on direct or alternating current. Such receivers will work satisfactorily only when heater tubes are used throughout, and the automotive tubes are almost ideal for the purpose. The key to such circuits is in the connection of the heaters to the power supply.

In Fig. 1 we have a six tube receiver employing automotive tubes with the heaters all connected in series. This connection may be made without any complications because all the tubes in the series take the same heater current, namely, 0.3 ampere. The terminal voltage of all these tubes is also the same, 6.3 volts or a little more. If six of these tubes are connected with their heaters in series, the total voltage required is 6x6.3, or 37.8 volts. This could be supplied by a secondary winding on a transformer or it could be supplied directly from either a d-c or a-c line provided that a suitable ballast is connected in series to drop the excess voltage.

Line Ballast

Suppose the voltage of the line is normally 115 volts. The tubes require 37.8 volts. Hence the excess voltage is 77.2 volts. Since the current is 0.3 ampere and the resistance of the ballast must be 77.2/0.3, or 257 ohms. If the line voltage is only 110 volts the required ballast would be approximately 240 ohms. If this resistance is selected the tubes will be safe even if the voltage should rise as high as 120 volts, giving each tube 6.9 volts, for even if the voltage per tube is 8 volts the tubes are not in danger. This wide variation in the allowable terminal voltage of these tubes obviates the necessity of providing an adjustable ballast to allow for line voltage fluctuation.

In case fewer tubes are used the resistance of the ballast should be increased by 21 ohms for each tube omitted, for the resistance of the heater of each tube is 21 ohms. This statement is made because if the circuit in Fig. 1 is used on a d-c line the last tube, which is a rectifier, is not needed. The ballast resistance there shown is 225 ohms. Hence the designer of that circuit allowed a higher terminal voltage for each tube than the 6.3 normal.

If the circuit in Fig. 1 is to be used on a d-c line it is only necessary to remove the rectifier tube, connect a 21 ohm resistance across the gap left by the removal of the heater, and to connect a wire from the positive side, that is, plate and grid, and the cathode of the tube. This change could easily be effected by plugging in a dummy in the socket, the dummy containing the 21 ohm resistance as well as the short-circuit wire. The filter would be needed for direct current as well as for rectified current.

Low Plate Current

The rectifier tube is shown to be a screen grid tube. It would be simpler to use a 237 tube. There is no change in the hook-up in making this alteration except that the screen grid is disregarded.

The plate current in a set of this type is extremely low in view of the fact that resistance coupling is used in the audio frequency amplifier. For this reason a 237 tube used as a two-element rectifier is able to supply it all.

If a receiver is to be operated either on a storage battery or on alternating current, it is necessary to connect the heaters in parallel. For a-c operating the required 6.3 volts should be supplied by a winding on the power transformer, and this winding should be able to deliver a current equal to 0.3 times the number of tubes. For example, if there are six tubes the current would be 1.8 amperes. A suitable winding for this is a 7.5 volt winding intended for a 250 power tube or a 281 rectifier tube filament. While this voltage is higher than it is advisable to use, it is perfectly safe. However, it can be cut down very easily. To cut it down to 6.3 volts from 7.5 volts we have to use 2/3 ohms for six tubes, 0.8 ohm for five tubes, one ohm for four tubes, 4/3 ohms for three tubes, 2 ohms for two tubes, and 4 ohms for one tube. The best way is to have a 6 ohm rheostat which may be set at any desired value.

If the filaments are connected in parallel they may be connected directly across a six volt storage battery without any ballast. If the rheostat mentioned above is used, it may be set at zero.

To switch from alternating to direct current two binding posts can be provided for the heater circuit. To these posts the leads from the six volt battery or the secondary of the transformer may be connected as needed.

When the heaters are connected in parallel, the plate voltage should be provided either with a battery or with a regular B supply, which in this case should preferably be one using a 280 rectifier tube.

Oscillation in Midgets

When building midgets such as that shown in Fig. 2 there is often audio frequency oscillation which is very annoying. In some circuits this oscillation occurs only a few minutes after the power has been turned on. While it lasts it is very intense and kills all reception. After all the tubes are fully heated the noise suddenly stops and the receiver functions normally. This noise is very often difficult to overcome because it occurs at such a low frequency that by-pass condensers are quite ineffective.

The trouble in most instances occurs when the audio frequency amplifier is resistance coupled and when it contains three plate circuits, counting that of the detector as one. It will be found that the detector tube does not really contribute to the cause of the oscillation but rather that it is the detector that ultimately stops it. That the detector does not

Stability and Versatility

Current Operation—Getting Rid of Oscillation

Brunn

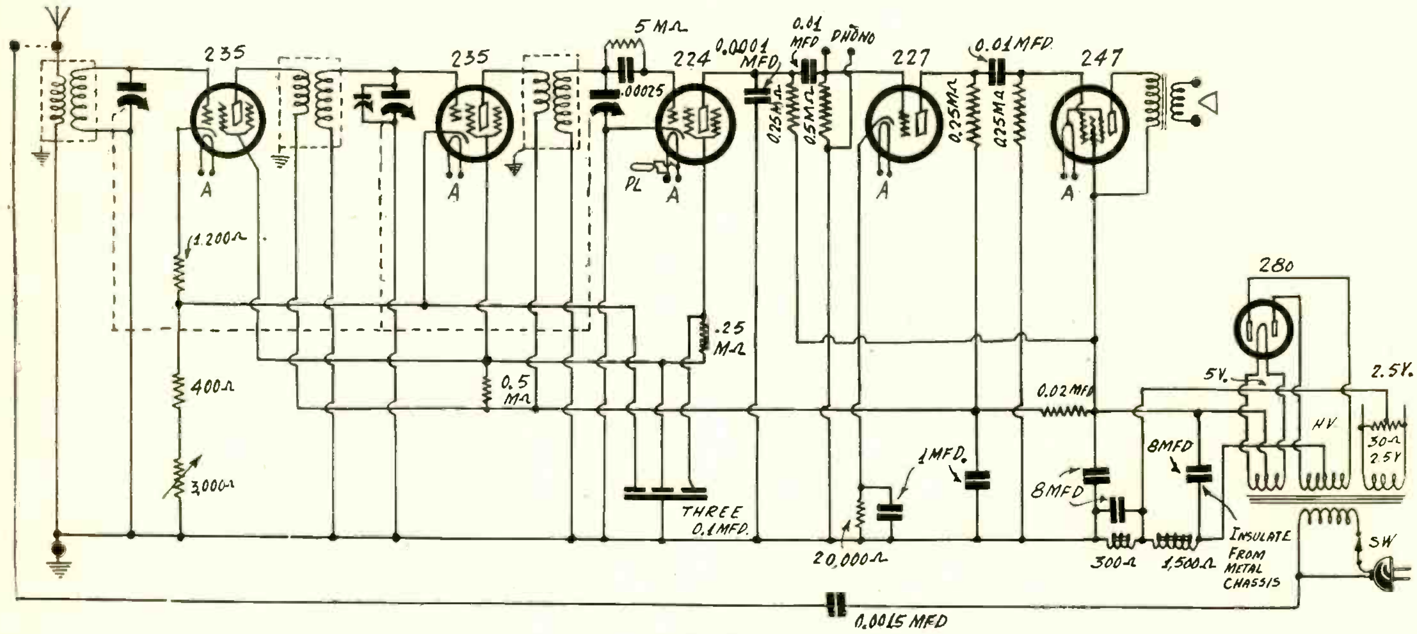

Fig. 2

Circuits having audio amplifiers like this one are subject to motorboating, either transient or permanent, and precautions are necessary to avoid the trouble.

cause it can be tested by removing the tube. If the power has been on long enough for the circuit to settle down to normal operating and then the detector is removed the oscillation immediately starts. This shows that the warmed-up detector really stops the noise.

Theory of Motorboating

The theory of motorboating explains the phenomenon. The feed back takes place through the common impedance, common to the two remaining plate circuits and also common to the two remaining grid circuits. The common impedance is particularly in series with the plate coupling resistance of the detector. If this resistance is removed the trouble ceases, but, of course, that is no solution. If the plate coupling resistance is short-circuited, the oscillation keeps on. When that is shorted there is only the common inpedance left, and through this there is a strong signal current from the power tube. The feed back current is in such phase that the circuit becomes an oscillator. If a condenser large enough were connected across the common impedance, that is, across the output of the power supply, the oscillation could not take place, but since the frequency of the oscillation is very low, there is no practical condenser large enough to stop it.

The reason the detector stops the oscillation just as soon as the tube is sufficiently warmed up is that it partly short circuits, not only the plate coupling resistance, but also the common impedance. While the detector is out of the circuit, or while it is cold, the plate to ground resistance is infinite and there is no short-circuiting effect. As soon as the tube is warmed up its internal resistance is comparatively low and so it partially shorts the output.

Short-Circuiting Desired

This short-circuiting does not mean that the detector does not work efficiently into the resistance load. Indeed, the reverse is the case. The lower the internal resistance of the detector compared with the load resistance the more effectively it works. The same holds true of an amplifier tube working into a high resistance.

The problem is not to prevent oscillation when all the tubes are working normally, but to stop it during the warming up period. This may be done in several ways, all more or less unpractical. For example, it may be done by retarding the warming up period of the power tube, or of the audio frequency amplifier, so that the detector tube is the first to warm up. This requires a fast heating detector and a slowly heating audio frequency amplifier or power tube. By means of relays it would be possible to hold back the plate voltage until all the tubes have warmed up. But a relay complicates the circuit and for that reason is unpractical. If the power tube is a filament type tube, as most of them are, it would be possible to hold back the filament current until the heater tubes have warmed up. This, too, requires a relay of some sort, either automatic or manually operated. As was said, most of the methods of stopping the oscillation are unpractical.

A Practical Method

Of course, it is always possible to stop motorboating, initial or permanent, by reducing the amplification on the low notes where the oscillation occurs. But this is not desirable for that would defeat the object of resistance coupling, which is getting the low notes full strength.

One way of stopping the oscillation, at least in most cases, that does not reduce the low note amplification more than the high amplification is to omit the by-pass condenser across the bias resistance in the audio frequency amplifier. In Fig. 2 the condenser to be omitted is the one microfarad condenser across the 20,000 ohm resistance in the cathode lead of the 227 tube. There is a reduction in the amplification, to be sure, but it is the same at all frequencies and the quality is not impaired. Besides, the reduction is not so great as would at first appear because there is a certain amount of feed back through the common impedance.

As in all cases of motorboating there is no one thing that will work in every instance. When the trouble is encountered it is necessary to experiment a little to find out what the remedy is in that particular case. One thing that has been found beneficial is to rearrange the plate circuit of the last tube so as to detour as much of the low notes as possible from the common impedance. It is primarily the signal current in the output tube that must be kept out of the B supply. If the plate voltage is fed to the last tube through an inductance of very high impedance very little of the signal current will go through the choke and hence through the common impedance. Then if we connect the speaker, either directly or through a transformer, in series with a larger condenser from the plate of the even at low frequencies, will go through the speaker circuit and back to the cathode with going through the common im- and back to the cathode while going through the common impedance.

Thus there will be practically no feed back. The output circuit is therefore made similar to the grid circuits of the preceding tubes with the exception that the return is made to the cathode instead of to ground. However, even if the speaker were returned to ground there would be no regenerative feed back, although there would be reverse feed back in the power tube itself. To avoid this reverse feed back the speaker should be returned to the cathode. By cathode is meant the center point of the filament of the power tube, for the filament is the cathode.

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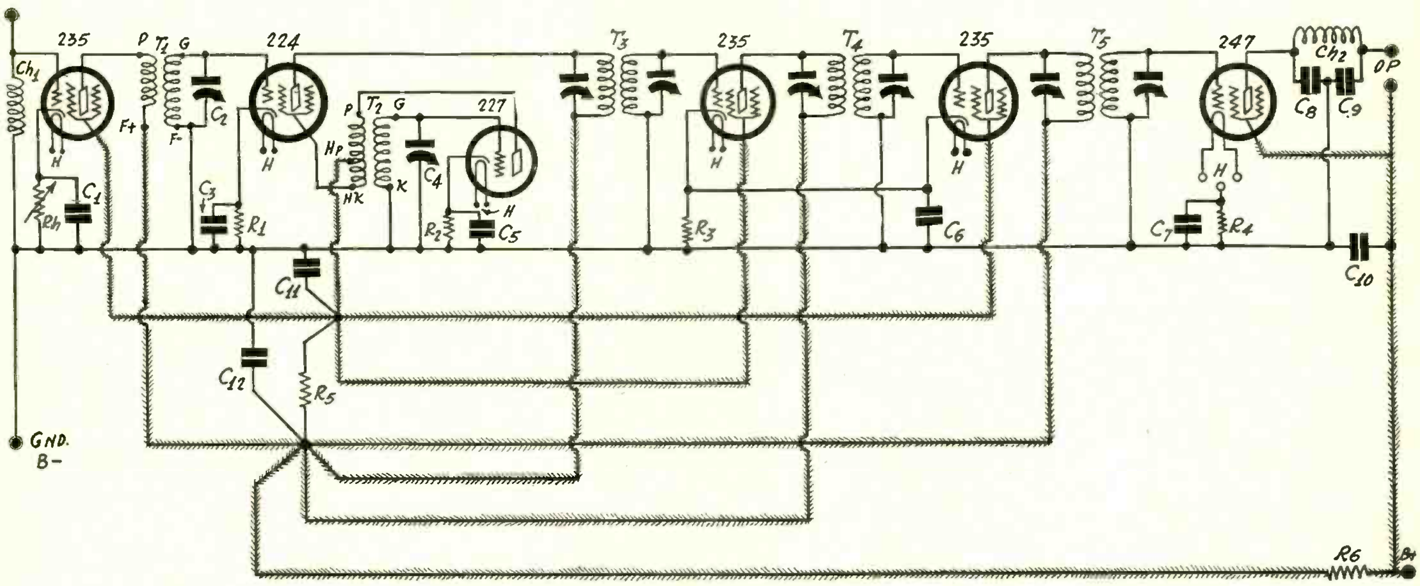


FIG. 952

This is the circuit of a superheterodyne tuner especially designed for short-wave reception. A similar receiver will be described in detail in a near future issue.

Determining Necessary Wattage Ratings

WILL you kindly explain how to determine the wattage rating of resistors such as grid bias resistors, plate resistors and voltage dividers?—B. E.

The wattage dissipated in a resistance of any kind is equal to the resistance in ohms times the current in amperes squared. The value thus obtained should be multiplied by a factor of at least 4 to give the wattage rating. The four is a safety factor. For example, suppose the current flowing in a grid bias resistor of 2,000 ohms is 20 milliamperes. The current in amperes is 0.02. Hence the wattage is 2,000x (.02x.02), or 0.8 watt. Multiplying this by 4 we get 3.2 watts. One would specify a 2,000 ohm, 5 watt resistor. A one watt resistance would work provided that it was not over rated and also provided that it was well ventilated in the receiver.

* * *

A Short-Wave Super

IF you have a circuit for a short-wave superheterodyne using 235, 224 and 247 tubes, will you kindly publish it, as I am about to build such a receiver. If you will refer me to a back issue containing such a diagram, that will be just as good as I have all the back issues for a long time.—A. W. A.

You will find such a diagram in Fig. 952. The circuit goes only as far as the second detector, but from there on you can use any audio frequency amplifier. A pentode is shown as detector, but it is better to use a 227 for this purpose and save the pentode for the audio frequency amplifier. The connections of these tubes are different. The screen of the pentode becomes the cathode of the 227 and R4, the bias resistor goes to the cathode in each case. That is, R4 must be connected to the K of the 227. A complete description of a short-wave superheterodyne very similar to this will appear in an early issue.

* * *

Computing Impedance of Resistance and Condenser

THE impedance of a grid bias resistance and the condenser across it should be as small as possible. Is there a simple rule by which to choose the condenser to use for any particular frequency and bias resistance? If so, please give it.—P. C.

The impedance of the combination is $R/(1+R^2C^2w^2)^{1/2}$, in which R is the resistance in ohms of the bias resistance, C the capacity of the condenser across it in farads, and w is 6.2832 times the frequency of the current. In order that the condenser should reduce the impedance materially it is necessary that $(RCw)^2$ be large in comparison with unity. We might say that it should be 100 times as large. If that is the case the impedance is practically the same as that of the condenser alone, that is, 1/Cw. When we have fixed the frequency and the resistance we can easily find the capacity that will make unity negligible in comparison with the product in question. Suppose the resistance is 1,000 ohms and that the frequency is 50 cycles. We then have 50x6.2832x1,000C = 10, 10 being the square root of 100. Thus C should be 31.8 microfarads. Of course, we can make it as much larger as we please. The formula at the beginning of the paragraph is the one to use in general. It holds for any case where a condenser is connected across a resistance.

* * *

Determining Ohms per Volt.

I HAVE a milliammeter for use as a voltmeter, but I don't know what resistances to use in series. In other words, I don't know the ohms per volt. How can I determine it?—J. V. M.

If the instrument is a milliammeter the ohms per volt is the reciprocal of the full scale reading. For example, if the milliammeter has a range of O-10, the ohms per volt is 1/.010, or 100. It is necessary to change the reading at full scale to amperes before the reciprocal is taken. If there is no current calibration on the scale measure the current which will just make the meter read full scale. For this you need another milliammeter.

* * *

Audio Frequency Regeneration

WOULD it be possible to regenerate in the audio frequency amplifier so as to offset the loss of amplification at the low notes due to inadequate by-passing or to the use of too small isolating condensers? If so, will you kindly suggest a circuit arrangement?—S. G.

It is possible but not very practical. The regeneration would have to be greatest at the lowest audio notes and then decrease gradually as the frequency increases. A circuit arrangement that would do this would not be very simple. It is much easier to avoid the suppression of the low notes in the first place.

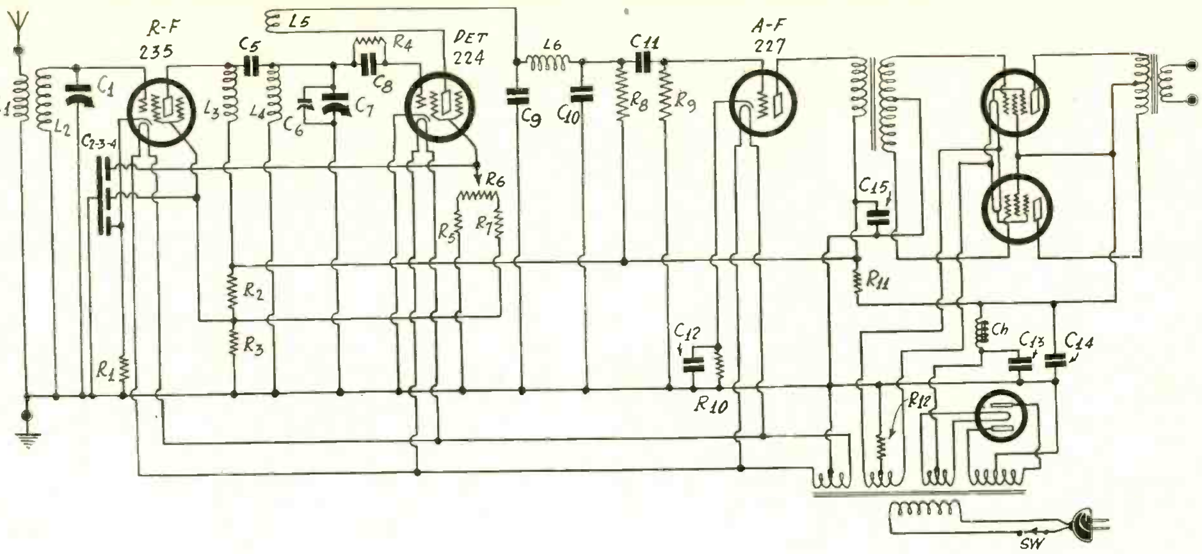
* * *

High Notes Suppressed

I HAVE a resistance coupled amplifier in which I use a quarter megohm resistance in the plate circuit of the detector. If I connect a small condenser across this resistance I notice that the volume goes up but it seems that the low notes become stronger. Is this just imagination or is there any theoretical reason for it? It seems that the larger I make the condenser the lower the pitch.—B. W. O.

It is more than imagination, for there is a very good reason why the pitch seems to go down. The larger the by-pass condenser the more of the high frequencies are by-passed and therefore the stronger relatively will the low notes appear. Also, as the condenser is increased the detecting efficiency goes up, but this is most on the low notes. A 250 mmfd. condenser across

FIG. 953
Two pentodes in push-pull preceded by a 227 single-sided amplifier, which in turn is coupled to the detector by means of resistance, like this circuit, make a good audio frequency amplifier for any receiver.



a quarter megohm resistance will reduce the amplification at 10,000 cycles, as compared with that at very low frequencies, to about ¼. This is equivalent to about 12 decibels. At 5,000 cycles the reduction is 6.86 db. The loss in both cases is considerable.

* * *

Receiver with Pentode Push-Pull

WILL you kindly show a diagram of a receiver in which two 247 pentodes are used in push-pull. I am primarily interested in the circuit beyond the detector. I would prefer resistance coupling between the detector and the first audio frequency amplifier.—T. G. R.

The receiver diagrammed in Fig. 953 contains the type of audio frequency amplifier you request.

* * *

Design of a Tube Tester

I AM building a simple tube tester with which I wish to be able to test all tubes with the exception of the 7.5 volt tubes. I have a transformer which gives exactly 5 volts. I wish to use this on all the tubes and put a resistance in series with the winding to cut the voltage down when needed. I tried a 75 ohm rheostat but this gets too hot on some of the tubes. How can I arrange it?—W. J. D.

You either need a power rheostat of about 75 ohms, one that will carry at least 1.75 amperes without getting too hot, or else you should use two rheostats in series, one to take care of the low-current tubes and one the high-current tubes. The rheostat for the low current tubes can be a 75 ohm one and the other may be a 6 ohm rheostat. The higher resistance rheostat need not carry more than 0.25 ampere but the other should be able to carry about 2 without heating up. When you test tubes drawing more than 0.25 ampere set the 75 ohm rheostat at zero and put a short across it.

* * *

Scanning in Television

WHEN a camera is used to form an image to be scanned for television is it possible to use the flying spot method on the image or must the scanning be done with the natural amount of light in the image?—W. L.

The flying spot method cannot be used on the image but it may possibly be used on the object. But the camera method is more adaptable to the direct scanning using the natural amount of light and extremely sensitive photoelectric cells.

* * *

By-pass Value of Condensers

DOES a by-pass condenser of 0.01 mfd. across a 300 ohm resistance in the radio frequency amplifier of a broadcast set actually do any good or is it merely used for theoretical reasons?—R. N.

It reduces the effective impedance of the resistance to less than 30 ohms at 550 kc. This is enough to justify its use, and at higher frequencies the reduction is greater. At 1,500 kc., for example, the effective impedance is only 10.6 ohms. It is better, however, to use a condenser of 0.1 mfd. This capacity reduces the 300 ohms to 2.89 ohms at 550 kc. and to 1.06 ohms at 1,500 kc. As the capacity is increased the impedance of the resistance-capacity combination simply becomes the reactance of the condenser. If R is the resistance in ohms, C the capacity in farads, and w 6.2832 times the frequency in cycles per second, the criterion is whether RCw is much larger than unity. If it is, then it is worth while to use the condenser. By "much" here is meant about ten times larger. This applies to audio frequencies as well as to radio frequencies. This gives a simple rule for determining the needed by-pass capacity in any case. For audio frequencies we might let the lowest value of w be 100, that is, let the lowest frequency be 15.9 cycles per second. Then the rule becomes 100CR=10, or CR=0.1. CR is the time constant of the resistance and capacity combination, and the rule then is that the time constand should be at least 0.1. Suppose, then, that the resistance has a vlue of 2,000 ohms. This would call for a by-pass condencer of 50 mfd. It is seldom that this capacity is used. A capacity of 2 mfd. is more common. This reduces the impedance at 15.9 cycles per second only by about 8 per cent.

* * *

Mode of Vibration of Loudspeaker

IN what manner does the diaphragm of a loudspeaker vibrate, for example, that of a dynamic speaker? Does it move back and forth as a unit, or like a piston, or does it vibrate in sections? About what is the amplitude of the motion when the speaker is emitting a loud sound?—W. J. L.

The diaphragm moves in every way, almost, depending on the frequency of the force driving it, on the air load on it, and on the stiffness. At very low frequencies it may move like a piston, every part of the surface moving in the same direction every instant. At higher frequencies it is likely to vibrate in a very complex manner. For example, there may be radial nodes where there is no motion. On one side of these nodes the motion is outward when it is inward on the other. Then there may also be concentric nodes, assuming that the driving force is applied at the center. Inside one of these nodes it will move in one direction, while outside the node it will move in the opposite. At the node, of course, there is no motion at all. A stiff diaphragm will act more like a piston than a flexible one. The amplitude of the vibration at any point on a loud sound depends entirely on what is a loud sound and on the frequency. The lower the frequency the greater the amplitude and the louder the sound the greater the amplitude. It may move an eighth of an inch or more but it may emit a loud sound even if the motion is no more than 0.001 inch.

* * *

Grid Bias Supply

WOULD you recommend the use of a grid battery eliminator for 247 pentode tubes in preference to the use of a grid bias resistor? You have described such circuits and recommended them for 245 and 250 tubes. As I understand it, there would be no reverse feed back through the grid bias if the grid battery eliminator were used. Is that correct?—F. W. C.

If two 247 tubes were used in push-pull there is no object of using a grid battery eliminator for there would be no feed back. For a single tube it would be advantageous since the grid bias would be provided without the usual feed back. The only question is which it would be cheaper in the long run, to use a grid battery eliminator or large by-pass condenser. It would seem that electrolytic condensers would be cheaper. When 245 and 250 tubes are used, singly or in push-pull, there is the added consideration of operating cost. The power dissipated in the bias resistance would be greater than the cost of operating a grid battery eliminator.

* * *

Hum in Short-Wave Receiver

THERE is a great deal of hum in the output of my short-wave receiver, which is operated with AC on the heater tube and rectified current on the plates. Do you think that the hum is due to insufficient filtration in the B supply or does the hum get in by way of the heaters?—T. U. F.

Chances are that it gets into the signal both ways. This is particularly the case if you use oscillation or regeneration in the circuit. Ground the center points of the heaters and also try more filtering of the B supply. A large electrolytic condenser across the output of the B supply and a larger condenser across the filter next to the rectifier should help a great deal in reducing the hum.

A THOUGHT FOR THE WEEK

MANY new trade and high schools all over the country are adding technical instruction in radio to their regular curriculum. These are in addition to the schools which last year included radio studies in their courses. How do we know? Our subscription records indicate that radio instructors are using RADIO WORLD *as a text book in these courses. We make obeisance in acknowledgement of the compliment and again insist on the obvious fact that a radio publication must give real service if it is to be worthy of the name.*

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Resistance Audio

WITH the advent of the midget set and the pentode output tube there has come about a widespread use of resistance coupling in the audio channel, but most of the midgets, and some of the other sets, have only one stage of audio. This is feasible, of course, if the radio frequency gain is high enough, for it makes small difference in what level the gain is accomplished, radio frequency or audio frequency, the increased amplitude being about the same. Yet more audio amplification may possess advantages, especially where one desires high volume from distant stations, or has a receiver that dips into the short waves, where many of the signals are not so loud as we encounter from powerful stations on the broadcast band not too far away geographically.

It is probably true that confinement to single stage audio is the result of troubles found in two stage and three stage resistance coupled amplifiers, particularly alternating current sets where there is ever present some sort of voltage divider, and certainly a B supply choke coil, both of which constitute a common impedance that may result in uniting circuits that should be kept electrially apart.

Such unhappy union brings about oscillation at audio frequencies, and it has different names, depending on the frequency of oscillation. Besides, the instability may not be ever-present, but simply an objectionable start, subsiding nicely after a few minutes. Commercially there is a serious, even fatal, drawback to preliminary oscillation hardly less than to permanent oscillation. So it seems time that the engineers busied themselves with the problem of stabilizing the regular resistance coupled channel of multiple stages so that such channels will become commercially practical.

The feedback conditions in the audio amplifier may be calculated, but it is no disrespect to theory to state that sometimes experimental results contradict the computation. And of course the experimental results are the facts.

Close adherence to given constants would have to be imperative, for the inductance of the B supply choke constitutes an important factor, as well as do the values and positions of the voltage limiting resistors. Where feedback is encountered that is negative, it may be balanced by an equal amount of positive feedback. It should be encouraging, rather than otherwise, that the direction of feedback is usually predominatingly positive in multi-stage resistance coupled audio amplifiers, despite the negative phase of the feedback through the grid biasing resistors.

Commercial production may require a circuit less exacting as to high voltages than the non-reactive amplifiers, from which those amplifiers with isolating condensers between plate of one tube and grid of the next may be distinguished by calling them reactive, on account of the condensers.

The theory regarding resistance coupling is undergoing a change, and before the year is out a different complexion surely will be generally accepted. Worries over time constants of condenser-resistor circuits have ceased, since experiments with great variation of the constants did not produce the predicted remedies. Rather, eyes will be focused on regeneration, as that is inherently present in the multi-stage amplifiers, just as it is a starting vice in the design of radio amplifiers. The leak values may be low, yet low notes come through abundantly, due of course to regeneration, a factor previously overlooked in calculations.

Whenever a designer builds his first model of a radio set, he expects it to squeal at radio frequencies, and rather hopes it will, for he has remedies ready, and he knows that first the circuit must be over-keen before it will emerge stabilized but keen enough. There is no reason why there should not be the same zealous regard for the regeneration naturally abundantly present in the resistance audio channel, for that may be tamed just as radio frequency oscillation was tamed by various methods, starting with the Neutrodyne in 1924. It was a great day for radio when the squealproof set came out, the squealing referred to being of the radio frequency variety.

And so we now await the day when the neutralized two stage or three stage resistance coupled amplifier will be announced. The work has to be done some day, and a start should be made right now, first because excellent tone reproduction will result, and second because for impending television purposes a high grade resistance coupled amplifier will be needed anyhow.

The present method in some television receivers is to use low values of plate resistors on screen grid tubes, which reduces the amplification severely, compared to what it might be could the full gain be safeguarded against oscillation. These resistors, contemptuously referred to by some as short-circuiting plate loads, should be superseded by resistors of mature and healthy values, and the truant impulses of the audio amplifier subjected to scientific discipline.

Small Shields

SHIELDS nearly always are recommended to be as large as practical, for radio frequency coils. But the space limitations of modern receivers puts a severe yoke on a neck that would stretch out a bit. In fact, many sets have shields of 2 inches, 2.25 inches or 2.5 inches diameter, and few have shields of 3 inches diameter or more.

However, the subject is not exhausted when one laments that the shields are too small. They may not be. Perhaps they merely seem too small. Manufacturers allow usually from 0.5 to 1 inch distance between the coil form and the shield wall, measured on the diameter, and yet the full wave band is covered and results are not so bad.

The subject resolves itself into a consideration of the degree of shielding. The effect of all shielding of radio frequency coils naturally is that of eddy currents. Shielding would be accomplished if another coil were put outside the tuned one, and this other coil short-circuited, with terminals grounded. The shield therefore may be regarded as a short-circuited turn of a cup-like sheet of wire, if that doesn't mix the language too much.

So if the shield is small it may be so constituted and the coils so placed that the shielding is not complete. Therefore there will be some feedback. But a proportion can be established so that there is not enough feedback to start oscillation at any frequency tuned in. Hence semi-shielding may be a correct term for the practice now in use.

Sets are built with the radio frequency coils nearly as close together as the shield diameters permit. There is bound to be some coupling between or among coils, despite the shields, since aluminum or some alloy made up principally of zinc will more likely be used, with thin walls, rather than thick walled copper. So after all, it is like so many other things in radio, a question of establishing the proper balance.

Television's Curve

TELEVISION has its ups and downs. It gets a great deal of publicity during one short spell, and hardly any during a succeeding longer spell. When the newspapers and the radio press are replete with television notices, articles, discussions and comparisons, people on the street ask radioists what about television. But when the furor is over there is a long public sleep over television.

The scientific pace or advance of television is virtually independent of the amount of space devoted to the subject in the press. More than three years ago a television demonstration was given by Bell Telephone Laboratories of as fine a television result as one could ask, but there was no commercial possibility in it. In other words, the thing could not be produced for the public, as an installation would cost thousands of dollars.

Hope is pinned on the cathode scanner, but it has limitations. It offers the promise of scanning without mechanical operation, without a large circular plate spinning 'round and 'round. It does not afford much light, not a white enough light, but perhaps the day soon will come when a scanning tube of consequence will be announced. Or maybe some system of scanning with mirrors, as that invented by our Mr. Anderson and described by him in this issue, will become the accepted practice.

Meanwhile other problems beckon. Still nothing much has been accomplished to make television reception dependable over a wide area. It is almost strictly a local reception proposition now, but again perhaps some day there will be such a thing as DX television, without apologies for fading, ghosts and other distractions.

Trade on its Toes

THERE is no depression of interest in radio, a fact demonstrated, if it needed any demonstration, at the recent Radio-Electrical World's Fair at Madison Square Garden. It is a complaint to radio that it has been able to meet the requirements of the day, as to price, and that nobody need be without a set because a large amount of money is necessary to obtain one.

Only three years ago individual speakers, in handsome cabinets, known as floor model speakers, were listed at $175, and were selling fairly fast, for they represented the best up to that time. Compare $175 for only a speaker (albeit in cabinet), with the price of a midget set of today, say, $37.50 complete with tubes. There is a dynamic speaker in the set, too, and everything is housed in a small mantel cabinet.

This is a sharp comparison, but it proves that the industry is versatile and energetic. Since more midgets are being sold than consoles, naturally the industrial leaders in radio turn to the fast-selling merchandise.

It is to be regretted, however, that so little attention has been paid to the home constructor by those who have parts that could be used well in midgets. It is virtually impossible to obtain a kit with which to build a midget, but RADIO WORLD is trying to induce parts manufacturers to cater to their customers as they should, and has met with some promise of success so far.

Sparkles

By Alice Remsen

THE MARINER

(Harbor Lights, WJZ, 10:30 P.M. Sundays)

BLUE sky! White spray! Green sea!
A sail in sight! A gull in flight!
These things are home to me.
To scud before the breeze
With sails unfurled, this is my world;
I am content with these.

The spindrift in my hair;
The wind and tide, the stars to guide,
With these the deep I dare
Blessed by Fate to roam,
My buoyant boat, when I'm afloat,
Is wife, is love, is home!

A. R.

* * *

Ford Bond, the Soft Voiced, Southern Announcer of NBC, has turned song writer. He wrote the words and music of "Deep River Rhythm," which has made an instantaneous hit.

* * *

Will Osborne Is returning from several weeks' tour of United States and Canada. He will resume his Fall and Winter broadcasts over the Columbia System.

* * *

Hope You Heard Dave Dreyer last Monday on WABC. Dave writes for the Berlin office, is one of my favorite song-writers and a jolly good fellow into the bargain.

* * *

Station KMOX, in St. Louis, is heard regularly in New Zealand. In one day 35 fan letters were received from that far-off country. The St. Louis station also has a vast audience in Central and South America. Because of the many listeners in Latin-America, KMOX will broadcast a special series of programs for them this Fall.

* * *

Glad to Learn That Lanny Ross is now appearing in a new series of broadcasts each Wednesday, from 7:15 to 7:30 p.m., over WJZ and is supported by an instrumental trio. This lad has one of the most appealing male voices in radio. He is heard also each week day on WEAF from 12:00 to 12:15 p.m.

* * *

Harold Branch, NBC Tenor, and Ruth Pepple, NBC pianist, **are an ideal married couple.** Ruth thinks Harold is the greatest tenor ever, and I caught Harold turning the music for Ruth on a recent program. He stood by for half an hour, reading every note with her. At the conclusion of the program he sighed and said, "Ruth, darling, you never played better."

* * *

Eddie Cantor Will Be Guest Star on the Chase and Sanborn programs for the next few Sundays. He will sing the song hits of his stage vehicles. WEAF 8:00 p.m.

* * *

Harry Frankel (Singing Sam) has a library of old-time songs, sent to him by his many admirers, comprising over 1,500 selections, mostly sob ballads. And how that boy can sing them! He puts a heart throb into every note. Heard him do "Sleepy Valley" for an old lady on her eighty-fifth birthday last week. It was the sweetest piece of work I've heard in a long time.

A New Program on WOR is Tommy Christian's "Thirty Minute Revue," in which Beth Challis and Jack Arthur, two of WOR's popular singers, will be featured. Christian's orchestra furnishes the musical background. Sunday afternoons at 4:30.

* * *

George Shackley intends to keep his Choir Invisible—invisible, in spite of television. He refuses to destroy the ephemeral, phantom-like illusion that surrounds this very beautiful hour, which he created to suggest retrospection in the mind of the listener.

* * *

SIDELIGHTS

LEE MORSE has made more than two hundred and fifty phonograph records. . . . RUSS COLOMBO is described as being "sartorially perfect." . . . NAN DORLAND would rather play billiards than dance. . . . FRANCIS X. BUSHMAN was at one time a professional wrestler. . . . RALPH KIRBERRY is an expert rifle and pistol shot. . . . SOPHIE BRASLAU likes Rudy Vallee's singing. . . . CARLYLE STEVENS used to be a play-broker. . . . UNCLE DON almost lost his spiffy car four times. Now he has a special guard for it while broadcasting. . . . PAUL RAVELL collects snake skins. . . . BASIL RUYSDAEL owns one of the finest collections of Oriental literature extant. . . . HARRY SALTER was formerly a chemist. . . . HENRY BURBIG uses the two finger hit and miss system on his typewriter. . . . DAVID ROSS likes to fish. . . . ADELE VASA has a voice range of three octaves. . . . MARIA CARDINALE is very fond of peach preserves and peach ice cream; in fact, she's a peach herself.

* * *

BIOGRAPHICAL BREVITIES

JAMES HAUPT

James Haupt's father, a Protestant minister, opposed his son on two issues in boyhood and early manhood:

First, he insisted that his son should not profane the Sabbath by playing rowdy games, so James began playing the family organ as a diversion on Sundays.

Secondly, after he had developed his musical talent, his father objected to his choosing a musical career in preference to wearing the cloth.

However, the parental objection was obliterated when James, as a tenor in a male quartette, appeared during a theatrical engagement in St. Paul, his home town. His father, who sat in the audience, was highly pleased and started boasting of his son.

"He was one of the produest fathers I ever saw," Haupt says today, "and since then he has never opposed me in anything."

By a devious path Haupt became an NBC staff tenor. He was born in St. Paul, December 2nd, 1891, the son of the Rev. and Mrs. Alexander J. D. Haupt. His parents now reside in a suburb of Milwaukee, Wis. At eight years of age he played several hymns on the organ by memory, at ten he started taking piano lessons.

At fifteen years of age James began studying at Thiel College, Greenville, Pa., from which he obtained an A.B. degree. He then attended the Chicago Seminary. The list of languages he studied discloses his classical education. Latin, Greek, German and Hebrew were among them. Since then he has learned Italian, French and Swedish, having made several phonograph records in the latter tongue.

For two years he taught music, maintaining studios in St. Paul and Minneapolis; directed three choirs and continued organ and vocal studies.

During the World War he enlisted as a private and became song leader in the machine gun battalion of the Thirtieth Division. At the time of the signing of the Armistice he was scheduled for service in Siberia.

Before being discharged James organized a quartet which later signed for a Chautauqua tour. Edwin Whitney, NBC dramatist, was a member of the same company. The quartet finished their tour at Glendive, Mont., then signed a vaudeville contract.

Haupt came to New York in 1923 and sang in a quartet with Graham McNamee, then broadcasting over WEAF. He was induced by Graham to try broadcasting. He did so. Since them he has filled the roles of orchestral conductor, pianist, production man, vocalist, dramatist, continuity writer, announcer and musical arranger for NBC programs. He has been featured in Gilbert and Sullivan operas, and in grand operas over the air; has given recitals in Aeolian Hall, New York; in Chicago, Minneapolis and Birmingham. He married a very beautiful girl, and has one lovely child. Never anything but "Jimmy" to his friends, has a delightful sense of humor, never at a loss for a funny story—in fact, is what you call a "regular fellow."

* * *

ANSWERS TO CORRESPONDENTS

MARTIN F. STRAUB, N. Y. C.—Frank Parker is his real name. You may obtain an autographed photo of him by writing to him in care of NBC, 711 Fifth Ave. There is no charge for this service.

H. F. L., Garden City, L. I.—The Street Singer's real name is Arthur Tracey. He is very tall and slender.

MRS. MILLS, Jersey City, N. J.—Edwin Whitney plays the role of Captain Jimmy Norton in "Harbor Lights." Leslie Joy, Walter Soderling, William Shelley, Joseph Granby and Florence Malone are the other players. Yes, I do think it is a fine broadcast.

* * *

SUNDRY SUGGESTIONS FOR WEEK COMMENCING SEPT. 27TH

Sun.: Sept. 27th—The Nomads......WJZ 11:00 a.m.
Sun.: Sept. 27th—Footlight Echoes WOR 10:30 p.m.
Mon.: Sept. 28th—Gene and Glenn................ WEAF 8:00 a.m.
Mon.: Sept. 28th—Frank Parker and Guest Star.. WABC 7:15 p.m.
Tues.: Sept. 29th—Eddy Brown, violinist........... WOR 9:30 p.m.
Tues.: Sept. 29th—Little Jack Little.............. WEAF 11:00 p.m.
Wed.: Sept. 30th—Singing Sam.................... WABC 8:15 p.m.
Wed.: Sept. 30th—Moonbeams.....WOR 11:30 p.m.
Thurs.: Oct. 1st—Julia Sanderson and Frank Crumit ....WJZ 9:00 p.m.
Thurs.: Oct. 1st—Weaver of Dreams.............. WOR 10:00 p.m.
Fri.: Oct. 2nd—March of Time....WABC 8:30 p.m.
Fri.: Oct. 2nd—RKO Theatre of Air.............. WEAF 10:30 p.m.
Sat.: Oct. 3rd—Street Singer.....WABC 2:00 p.m.
Sat.: Oct. 3rd—Little Symphony...WOR 8:00 p.m.
Sat.: Oct. 3rd—Alice Remsen......WOR 9:15 p.m.

(If you would like to know something of your favorite radio artists or announcers, drop a card to the conductor of this page. Address her, Miss Alice Remsen, Radio World, 145 West 45th St., New York, N. Y.)

New Corporations

Radio-Vision Development Corp. of America, New York, N. Y., research, experimental work—United States Corporation Co.
United Radio and Electric Corp., Irvington, N. J., radios and electrical supplies—Atty. I. Henry Coyne, Newark, N. J.
Monroe Radio & Electric Corp.—Atty. N. Relin, Rochester, N. Y.
Motorphone Radio Corp. of America, electrical appliances—Atty. L. D. Schwartz, 150 Nassau St., New York, N. Y.
Oxford Products Co., Wilmington, Del., radio, wireless sets—Corp. Trust Co.
Triad Television and Manufacturing Co., Inc., Wilmington, Del., patents—Corporation Trust Co.

"Defines" 10 Kilocycle Selectivity

FINDING a technical mistake in your Radio University Department does not qualify me for anything, but I found a wrong answer to a question asked by W. L. B. The question was:

"What is really meant by 10 kilocycle selectivity? There are many references to it in radio literature and advertisements, but I have never seen any definition of selectivity that could make the expression mean anything."

To which your answer was:

"The expression does not mean anything."

Tsk, tsk, tsk! How could a department as reliable as the Radio University make such a gross mistake? Well, I'll tell you what 10 kilocycle selectivity means:

Nowadays the dials of the modern radios are marked off in divisions of 10 kilocycles. Turn your radio to the kilocycle on which your local station comes in. Turn the volume on all the way. Then turn the dial to the next mark on the scale and if your local station is cut out altogether and a new one comes in, your radio has 10 kilocycle selectivity.

For instance, our local station comes in at 1150 kilocycles. Our dial is marked off in 10 kilocycle divisions. When we turn it to 1150 kilocycles WHAM comes in; then when we turn the volume on all the way and turn dial to 1160, we receive a program from WOWO free from interference from our local station WHAM. This is 10 kilocycle selectivity.

GUY CIARALDI.
151 E. Main St., Rochester, N. Y.

* * *

Ain't It the Truth?

SAYING the truth, despite popular belief in a falsehood, is commendable. Therefore I compliment you for saying that the phrase "10 kilocycle selectivity," standing alone, is meaningless. The missing quantity is the voltage at the input.

Take a set that tunes in WLW, Cincinnati, and tunes out WOR, Newark, N. J., which some folks think represents 10 kc selectivity because the stations are 10 kc apart. Put that set at some point a few blocks from either station and note the result. The station nearby comes in from 0-100 on the dial. Now if there is such a thing as 10 kc selectivity, and a set has it, why, it has it, and does not lose it in transportation.

DUDLEY FRANK.
Newark, N. J.

* * *

All Work for Him

HAVING just read the letter of Thos. H. Blanchard in September 5th Forum, I must say his experience is just the reverse of mine, as I have hooked up many Radio World circuits since 1923 and have yet to try one that did not work. Of course some were much better than others. At present the radio used in our home is "Radio World 1925 Single Control Superdyne," and it is hard to beat for natural tone and quiet reception, especially when used with a home-built air column speaker with good unit.

C. G. SCHLEGEL.
Kenesaw, Neb.

* * *

The Office Boy's Friend

SOME few months ago I began buying RADIO WORLD weekly from the newsstands. Realizing Winter months will be here in short order I have looked for dope on a superheterodyne each week but to no avail. Mr. Herman in his July 4th article was on the right track but it seems he hit a derail switch.

It certainly must be an obvious fact to you that your readers are looking for an article, complete in every detail, on such a set. This set should be a superhet with built-in converter, tested and proved

Forum

before details are printed. If your high-salaried R. E.'s and E. E.'s are unable to cope with such a problem, I would suggest you lay them off for one month, using the money saved to purchase a set on the market and have the office boy dissect it, giving us readers the details.

The University Club should be open to all, with a nominal charge per question, unless a membership is held by University subscribers. This would be fair to readers who might have just a few questions to ask during the year, leaving the membership plan open to service men, etc.

R. L. STANLY.
2726 Redondo Blvd., Los Angeles, Cal.

* * *

Modesty in Pricing

GLAD to see someone is agitating for midget kits. However, for them to be worthwhile the price must be very low. I just completed a 6 tube set, including magnetic speaker for $11.86. Many distress and surplus parts were used but all good. A parts manufacturer should be able to put out a good midget for $5 to $10; a superhet midget for $20.

E. ARNOLD.
42 W. Fordham Rd., New York, N. Y.

* * *

For Midgets

I AM a constant reader of RADIO WORLD and couldn't help reading the editorial on "Kits for Midgets." I agree with you in getting the manufacturers to get these kits in such a form so that the regulars can buy them. It seems as if everything that comes out in kits lately is something for the rich fellows and lets the rest of us fellows out of the picture.

In some of your issues you describe what parts to use, and in some cases what to substitute. I have looked at the midget that you have in a recent issue. I am rather interested in it. Most of us can afford to spend in the neighborhood of about $20 to $25 on kits, so why not have them?

And, again, it is a blessing to have a set in the home, whether small or large—preferably small.

I hope that in the future we shall see more of midgets in use. Instead of resistance coupled audio I am much in favor of transformer coupling.

DAN GEORGEVICH.
Butte, Mont.

* * *

How to Succeed

AFTER reading certain criticisms from other readers of RADIO WORLD which the editor has been so consistent as to publish, I can no longer restrain myself from writing, and this is directed to disgruntled readers who complain that they cannot make the short-wave circuits work, cannot get enough information from circuit diagrams to construct a receiver, etc.

Let me say that if you haven't infinite patience, eternal perseverence, just let the short waves alone altogether and confine your activities to operation of factory-built broadcast receivers. Your letters all indicate complaining readers lack persistence, patience and precise workmanship necessary to anyone who ever learned anything about radio. If readers will carefully study the circuit diagrams, know them real well before starting the hook-up, be sure of parts (I mean be certain of values of capacities, inductances, resistances and shielding), buy them from a reputable supply house, insist that all parts are properly identified and then be sure about every joint, every connection, the circuit is going to work, that's all!

The writer is an automobile mechanic, and at the first of this year was only mildly interested in radio but had no work in the shop and decided to improve a lot of dead time by learning to service broadcast receivers. Since then he has made no less than five RADIO WORLD hook-ups, four of them short wave receivers, and they all worked admirably. I have heard every continent excepting Africa, with a converter designed by Herman Bernard. Three 27 tubes are used, working into an Atwater Kent "60" broadcast receiver.

True, I must quarrel with a radio goods wholesaler who will allow his shipping clerks to substitute parts without notation (and some of them will send you just anything), and I have had the wrong value of biasing resistor, unmarked and unidentified, put me off for days and days.

I claim that RADIO WORLD can give you more real sound information about construction and servicing of radio, and of the fundamentals of operation, than any other publication in existence, but I don't expect to get it all from a few issues.

HAROLD SCOTT.
Marmarth, N. D.

* * *

More Praise for Coil Article

CONGRATULATIONS on "Design of R-F Coils," by J. E. Anderson, appearing in August 22nd issue. I know I voice the sentiments of a countless number of your readers when I say that it is precisely what we have been praying for.

Well written in a clear and comprehensive style, with numerous examples, expoundings and practical applications, it leaves no doubt in the mind of anyone who has but a hazy idea of what it's all about.

A few more articles like this and those of us who choose to "pin E. E. and R. E. after our names" will be in a better position to readily answer and explain radio's manifold mysteries.

Keep it up!

EDWARD W. BAYARD, E.E., R.E.
743 Heights Boulevard, Houston, Tex.

* * *

Keen for Two Dials

LET'S have some more real dope on a good broadcast super that will compare favorably with the commercial stuff in killing image repeats and affording sensitivity. Let it be two dial, but let it be plenty sensitive and free from the erstwhile called harmonics. You've been promising us a receiver like this a long time. It ought to hatch pretty soon. Give us the one best—not a flock of optional circuits. Two dial tuning never scared an old timer.

E. B. HURD.
316 E. Broadway, Alton, Ill.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y.

H. T. Irwin, Jr., 404 Beaver Rd., Edgeworth, Pa.
Louis Lueth, Prop., Leuth Electrical Shop, 218 W. Messenger St., Rice Lake, Wis.
Ira J. Reed, Reed Electrical Service Co., Automotive Service & Parts, 201 W. Superior St., Kokomo, Ind.
L. B. Bass, 308 N. W. 21st St., Oklahoma City Okla.
Kay Brewer, P. O. Box 534, Monrovia, Calif.
W. H. Ewin, Radio Shop Repairs Co., 4 Whitney Pl., Livingston, N. J.
R. L. Horton, 104 Gidding, Clovis, New Mex.
R. W. Good, 358 Church St., Indiana, Pa.
George Minksane, Jr., 3463 West 17th St., Cleveland, Ohio.
Steven Evanoff, 2231 So. Spaulding Ave., Chicago, Ill.
J. A. Bodkin, 1775 Broadway, New York, N. Y.
Wm. D. McInnis, 1014 W. 76th St., Los Angeles Calif.
Paul Moran, 1400 Juneway Terr., Chicago, Ill.

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