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RADIO WORLD

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The First and Only National Radio Weekly

Eleventh Year—542nd Issue

SOCKET DIAGRAMS FOR NEW TUBES

PUSH-PULL RESISTANCE A-F

BIG ADVANCE IN SENDING TELEVISION

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RADIO WORLD

The First and Only National Radio Weekly
ELEVENTH YEAR

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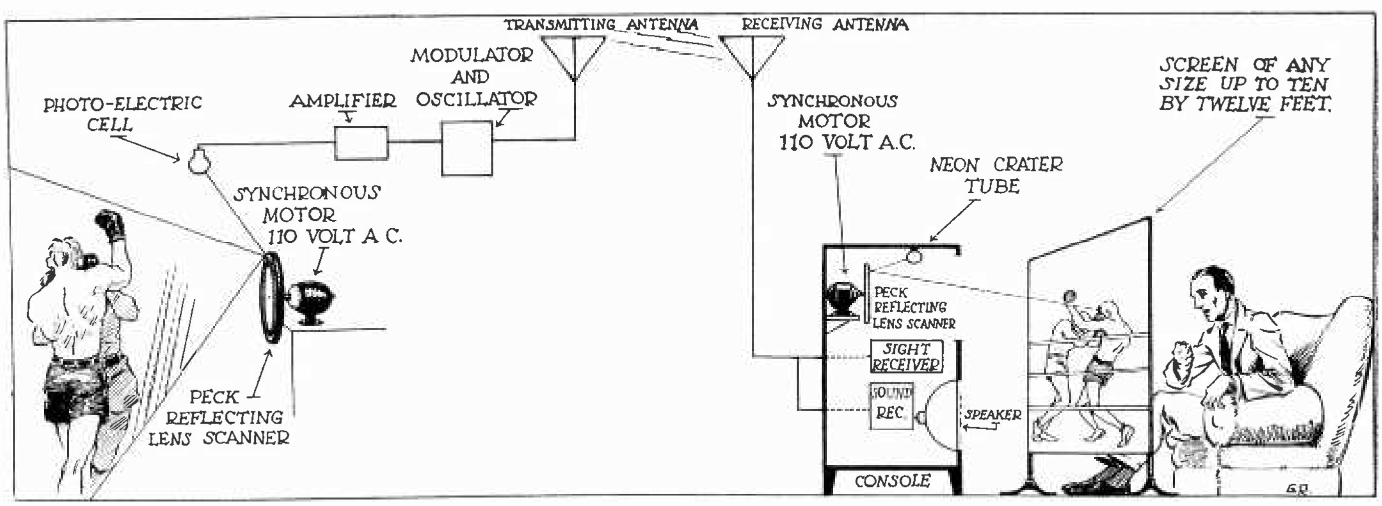
Peck Extends Scanner

Direct Pickup for Sender Leads Field

By Neal Fitzalan



The subject to be scanned consists of two fighters. The Peck reflecting-lens scanner picks up the entire image at the disc, while the synchronous motor spins the disc. The lenses are tilted. Their reflection is to a masked photo-cell, through the aperture of which only picture elements are admitted, not the whole view, due to the lens tilts. The transmission and reception from then on are standard.

TELEVISION is making real progress. Just a few months ago it appeared as if practical television was many years in the future. Today it seems not quite so far away.

Some time ago we described a system of scanning devised by William Hoyt Peck, optical and moving picture expert. This system was the only one out of a large number that has made any impression on the writer. The first demonstration a few months ago was not so good, for there were obvious defects in the details. For example, the light source was weak and the alignment of the scanning elements was imperfect. Yet the principle of the scanner was obviously sound. It was clear even then that the chief defect was with the transmitter rather than with the Peck scanner.

The latest demonstration was very favorable. The light source had been strengthened, the imperfections in the scanner removed, and the details of the image heightened. The second demonstration showed even more clearly than the first that the transmitter is now the weaker point of television. For all the crudeness of the transmitted signal half a dozen critics sat for two hours and enjoyed the reception, not because of the merits of the pictures transmitted but because of the excellence of the scanner. This sustained interest was in the face of absence of the sound accompaniment.

Peck Transmitter Scanner

Had the improved scanner been the only part of the second demonstration, there would have been little to add to the facts reported after the first demonstration. Little would have been added to the future possibilities of practical television. But Mr. Peck showed how his system can be applied to the transmitter. He showed it in principle only, but that was enough to convert at least one severe critic from a scoffer to an enthusiast. Yes, Mr. Peck has turned that corner around which we have been told so long that practical television was lurking. In respect to the receiver he has done it in fact and in respect to the transmitter he has done it in principle. It will not be long before he has applied that principle. There is no reason why it should not work, for it is based on sound optics, which Mr. Peck knows so well, and it is the same principle as that used at the receiving end.

The obvious defect of the transmitter is the use of flying spot method of scanning. There are extreme highlights and shadows. No details to speak of. A pretty young woman will sometimes appear like a bearded Russian, a handsome young announcer may appear like an emaciated scarecrow, or even like a skeleton. As Mr. Peck pointed out, the effect of the flying spot method of scanning is like the use of a flashlight in a dark room where the walls are perfectly black and non-reflecting. The effect is weird. And the flashlight analogy does not fully give the effect, for the contrasts are not as great as they are when the subject is illuminated by an intense ray of light.

Indirect Pick-up the Secret

Good pictures cannot be transmitted until the subject is flood-lighted in the

(*Continued on next page*)

(Continued from preceding page)
same manner as it is done in moving picture studios. There must be a great deal of light on the subject and it must be thoroughly diffused. All extremes of light and shade must be eliminated. This requires illumination from the front, sides, top, bottom, and even from the back. Even the light sources used must be diffused so that there will be no sharp shadows. This method of diffused illumination is used in all well-equipped photographic studios, except when odd, and certain modernistic pictures are made.

The need for indirect pick-up has long been recognized but it has not been used extensively in television because it has not been possible to get sufficient illumination on the subject to actuate the photo-electric cells, not even the most sensitive so far developed.

It is here where the Peck scanner seems to solve the problem completely, not by using more sensitive photo-electric cells than heretofore known, not by using illumination so intense as to burn up the actors, but by making good use of the light there is, after that light has been made as strong as is tolerable, and thoroughly diffused.

A Law in Optics

Light from any source spreads out in all directions and its intensity varies inversely as the square of the distance. Double the distance from the source and the amount of light that falls on a given area is only one-fourth as great. Make the distance three times as great and the light falling on the same area is only one-ninth as great as it was before. But we are not confined to the use of the same area. The spot on the scene to be transmitted may have an area of one square centimeter, and with a given illumination a given amount of light is reflected from that area, depending on the reflecting coefficient. If all that light could be directed into the photo-electric cell there would be enough to operate that device, but if only one millionth of the light is directed into the cell there is no response. Hence the problem reduces to that of gathering as much of the reflected light from the elemental area as possible.

In photography this is done by using a high speed lens, one that can be opened wide. The speed of a lens is usually given in terms of its aperture and its focal length, and is expressed as F/4.5, F/3, etc. The F stands for the focal length of the lens and the numeric for the relative diameter of the opening. For example, if the speed of the lens is F/4.5, the focal length of the lens is 4.5 as great as the opening. The speed of a lens is given in terms of the greatest opening with which it may be worked. A lens that has a speed of F/3 can be operated at F/32 if desired by setting the diaphragm accordingly. Lenses used for night photography have speeds as great as F/1 or greater. Mr. Peck's lenses have a speed of F/0.7.

More Light Admitted

The greater the opening the more light is admitted to the plate because the wide opening intercepts a greater amount of the light coming from any point on the object. The area of the opening determines the amount of light intercepted, and the amount is proportional to the square of the diameter of the opening.

This principle is applied in the design of astronomical telescopes. The surface of a planet may be regarded as an elemental area from which a given amount of light is reflected. If the lens used has a diameter of 100 inches, the image of the planet is seen with a given illumination. If the diameter of the lens is made 200 inches the amount of light from that planet is four times as great and the planet appears four times as brilliant. A star may be considered as a point source of light. With a lens 100 inches in diameter a star a given distance away can just be seen. With a 200 inch lens an equal star four times as far away can be seen. Or, if there is no limit to the number of stars, and if the stars are uniformly distributed, four times as many stars can be seen with a 200 inch lens as with a 100 inch lens. That is the reason telescope lenses are always made larger and larger. The same law of optics holds in television transmission as in astronomy.

Mr. Peck plans to use these principles by employing high-speed lenses in the transmitter scanner. As far as the construction of this scanner is concerned, it is the same as that of the receiver, but it works in the opposite direction. Instead of making the lenses distribute the light from a point source over a screen, they are made to collect distributed light into a point, and that point is the photo-electric cell.

When any one of the lenses in the disc is in a fixed position, it gathers a large amount of light from a given elemental area on the object and sends that light into the cell. As the lens moves across the object all the elemental areas in a row come before the lens and the lights from each in succession is sent into the photocell. The next lens does the same thing a moment later and one row lower down, and so on. As the scanning wheel rotates once, every elemental area in every row comes before a lens in proper sequence and the light from each is directed into the photocell. It is only necessary to arrange the optical system so that the only image that enters the photocell aperture is the image of the elemental area desired, and not the whole picture. This is done by masking the photo-electric cell. If the image of the whole picture entered the cell there would be no scanning.

Depth of Focus

It would seem that with the flying spot there would be no difficulty with depth of focus, but for some reason pictures transmitted with this method appear to have no depth at all. The tip of an actor's nose may be in focus while his eyes are only a blur, or in a profile his ears may be a blur while one eye is in focus. This may be caused by auxiliary lens equipment.

Mr. Peck states that with his system of high-speed lenses there will not be a corresponding difficulty. This may be because the image does not have to form in any particular plane, just so the light from the elemental area enters the photocell. He says that everything beyond 6 inches is in focus.

In some indirect systems a high-speed lens is used to form a brilliant image on a screen, or simply on an imaginary plane at which the photographic plate would have to be placed to give a clear image. This image is then scanned. In this scheme the high-speed lens would undoubtedly have a small depth of focus because the light rays from the object would cross at the focal plane at a large angle and any movement of the "photographic plate" would cause a large change in the definition. This fact is well known to photographers who use high-speed lenses.

Magnet Wire Table

Of considerable use to the experimenter, and occasionally of great value to the service man, is the magnet wire table, printed herewith. There are various tables, compiled by wire manufacturers, standards boards and the like, and there is a small difference in the numbers of turns per inch and other factors. The accompanying table was prepared by RADIO WORLD laboratories, and represents average values as obtained from hundreds of specimens of wire tested.

If one has a close-wound coil and knows the outside diameter of the tubing and the size of the wire, he can determine the number of turns, even though as much of the winding is hidden, as by a primary over a secondary, and compute the inductance.

Suppose the wire of a burnt-out radio frequency coil is to be replaced. The unmber of turns can be duplicated simply by measuring the axial length of the winding and ascertaining the wire size. Many service men know the more familiar wire sizes, especially the popular enamel-covered, by sight.

Suppose that one has to replace low value of resistance to carry small or moderate current. One may use No. 30 wire, any type, on the basis of 0.1 ohm per foot, as the table discloses the 1,000-foot ohmic value for continuous current is 103.20 ohms.

The magnet wire table herewith is based on measurements at 68° Fahrenheit. Different temperatures will give slightly different results. In practice some slight variations are to be expected from the tabulated values, including particularly turns per inch, as the number of turns stated is based on accurate machine winding. Even so, slight variations will arise from difference in the size of wire of any one type.

Abbreviations: *B & S*, Brown & Sharpe, same as American wire gauge. There are six other gauges in use, but *B & S* is used in radio in the United States. *SS* is single silk, *DS* double silk, *SC* single cotton and *DC* double cotton. For direct current *CC* is used to avoid confusion with *DC*. that represents double cotton. *CC* stand for continuous current, which is synonymous with direct current.

Turns Per Linear Inch

B. & S. Gauge	*cc. Ohms per 1,000 Feet*	*Single Silk*	*Double Silk*	*Single Cotton*	*Double Cotton*	*Enameled*	*Enameled SS*	*Enameled DS*	*Enameled SC*	*Enameled DC*
14	2.525			15.6	13.6	15.2			14.1	13.3
15	3.184	16.9	16.3	16.1	15.1	17.0			15.6	14.8
16	4.016	18.9	18.2	17.9	16.7	19.1	18.4	17.7	17.4	16.3
17	5.064	21.2	20.3	19.9	18.2	21.5	20.5	19.7	19.3	17.9
18	6.385	23.6	22.6	22.1	20.2	23.9	22.8	21.8	21.4	19.7
19	8.051	26.3	25.1	24.4	22.2	26.8	25.4	24.2	23.6	21.5
20	10.15	29.4	27.8	27.0	24.3	30.1	28.4	26.9	26.1	23.6
21	12.80	32.7	30.8	29.8	26.7	33.7	31.6	29.8	28.9	25.9
22	16.14	36.6	34.2	33.0	29.2	37.7	35.0	32.8	31.7	28.1
23	20.36	40.6	37.7	36.2	31.6	42.3	39.0	36.4	34.9	30.6
24	25.67	45.2	41.6	39.8	34.4	47.1	43.1	39.8	38.1	33.1
25	32.37	50.2	45.8	43.6	37.2	52.9	47.8	43.8	42.8	35.8
26	40.81	55.8	50.5	47.8	40.1	59.1	52.9	48.0	45.7	38.6
27	51.47	61.7	55.5	52.0	43.1	66.2	58.4	52.9	49.7	41.4
28	64.90	68.4	60.9	56.8	46.2	74.1	64.5	57.8	54.0	44.4
29	81.83	75.1	67.1	61.3	49.2	83.3	71.4	64.1	58.8	47.6
30	103.20	83.1	73.2	66.5	52.5	92.2	77.8	69.2	63.0	50.3
31	130.10	91.5	79.3	71.9	55.8	103.4	85.6	75.3	68.1	53.5
32	164.10	100.5	86.5	77.2	58.9	115.6	93.8	81.6	73.2	56.6
33	206.90	110.1	93.6	82.8	62.1	129.3	102.7	88.2	78.5	59.7
34	260.90	120.4	101.0	88.4	65.3	144.9	112.3	95.2	84.0	62.8
35	329.00	131.4	108.5	94.3	68.4	162.3	122.5	102.4	89.6	65.9
36	418.80	142.8	116.2	100.0	71.4	181.8	133.3	109.8	95.2	68.9
37	523.10	155.0	124.2	105.8	74.3	202.4	144.1	117.1	100.6	71.7
38	659.60	167.7	132.2	111.6	77.1	227.7	156.4	125.1	106.4	74.6
39	831.80	180.5	140.2	117.2	79.8	252.5	167.7	132.2	111.6	77.1
40	1,049.00	194.5	148.3	122.8	82.3	280.1	179.5	139.4	116.6	79.5

Is Wide Band Necessary?

100 kc Channel Held Adequate for 180 Lines

By Capt. Peter V. O'Rourke

LAST WEEK we explained two possible methods of sending and receiving both sound and vision on the same channel. One method depended on dividing the band into two parts, one reserved for the sound and the other for the vision. This method requires very sharp tuning of the sound channel to eliminate the noise from the vision channel. The other method depended on the use of a sub-carrier and single sideband transmission of the sound. A local oscillator operating at 43 kc was first modulated with sound and then the upper sideband of this was impressed on the common carrier for sound and television. In this method the sound will be represented by supersonic frequencies at the fringes of the television channel. It requires the use of an oscillator at the receiving end for converting the supersonic frequencies to audible frequencies. The detector in the television will contain the high frequency sideband above the television signal and it requires a second oscillator and a detector to produce the sound.

Another Method

Another method has been suggested by William B. Lodge, chief engineer of the Columbia sight-sound station W2XAB. This method is closely analogous to the single sideband method previously described, although it appears that the receiver oscillator is not essential. The scheme is to modulate a 45 kc wave with the sound and then impress the modulated wave on the television carrier. In this way the common carrier will carry the television signal and the modulated sound sub-carrier, the sub-carrier with its modulation lying on the fringes of the channel.

When this scheme is used the television signal is tuned in by tuning to the common carrier and the sound may be brought in by tuning to either the upper or the lower sub-carrier. This requires explanation, for the term sub-carrier as here used does not have the same significance as it did before. The sub-carriers now are two frequencies greater or less than the common carrier by 45 kc. That is, one is 2,845 kc and the other is 2,755 kc when the common carrier is 2,800 kc. If the sound receiver is tuned to either of these sub-carriers the sound should come through.

It requires a very selective receiver to pick out either sound carrier to the complete exclusion of the television noise and a superheterodyne is suggested as the only practical means of achieving the selection. But it is by no means certain that the reception of sound will be satisfactory for there has been double modulation and only one detection.

In the other method of reception the combined signal is first detected with an ordinary detector, provided it is capable of detection of frequencies up to about 50 kc. One of the components of the output of this detector is the original sub-carrier of 45 kc. This might be regarded as a 45,000 cycle "tone" modulated with a tremulo, the tremulo being the sound. This 45 kc frequency is selected by a sharp circuit and is amplified. Then it is detected again with an ordinary detector. The receiving oscillator is not required in this case because the 45 kc carrier is modulated in the same manner as any other broadcast wave. That is, the lower sideband has not been suppressed.

A Simpler Method

This method suggested by Mr. Lodge is undoubtedly simpler than the sideband suppression method but it does not utilize the channel space as efficiently. Suppose the original oscillator is 45 kc and the sound frequencies impressed on it extend up to 5,000 cycles. The sidebands will then extend from 40,000 to 50,000 cycles. If the vision sidebands extend to 43 kc either side of the common carrier, there will be an overlapping of 3 kc in each side band, in which regions the vision and the sound will interfere. And even so the highest sound frequency is only 5,000 cycles. When the lower sideband is suppressed and the sub-carrier is made 43 kc, there will be no overlapping and still the highest audio frequency may be as high as 7,000 cycles. But the simpler arrangement of the circuits, both at the transmitter and at the receiver, may make Mr. Lodge's circuit preferable.

The selection of the 45 kc carrier is not difficult because of the low frequency. It is possible to use 45 kc intermediate transformers such as were used in the early superheterodynes. There may be a slight difficulty in separating the 45 kc signal from the television sidebands without cutting out too much of the television detail. This must be done with suitable filters. A high pass filter with a sharp cut-off will permit all frequencies above 43 kc to pass to the 45 kc tuner and will prevent all frequencies below that from passing.

Detail of Pictures Received

It is customary to determine the channel width necessary to transmit a satisfactory television picture on the basis of picture elements. For example, if there are 60 lines per frame and 20 frames per second, the picture is said to contain 60x60 picture elements per frame and 60x60x20 picture elements per second. That is, there are 72,000 picture elements per second, and it should require a sideband width of 72 kilocycles. Only about half that is allowed. The determination of the required width on the basis of picture elements, arrived at in this manner, is faulty and leads to a much wider band than is necessary. We do not say that it is not desirable.

The picture element conception is derived from the half tone process. If we were to break the picture up in the same manner as a half tone is broken up, the basis of figuring the required frequency band would be approximately correct, but it would not be wide enough. In television scanning the picture is not broken up into a half tone checker board pattern but into strips. We should speak only of picture element strips. If in any one strip there is no change in the high lights and shadows there would be no change in the current in the photo-electric cell and the frequency band required would have to be based on the number of strips and the number of frames per second. That is, for a 60 line, 20 frame picture we would only need about 1,200 cycles.

But each strip is not uniform. Hence we need a higher frequency. In a well illuminated average scene there are no sharp contrasts anywhere so the additional frequency band required is not great. If we were to send a printed page, or a series of alternate vertical white and black bands, then we would have to have a wide frequency band. But sending such stuff is not television, though it may be used as a means of testing the capability of the system for reproducing detail.

If we are to have a wide frequency band for television transmission, we can make much better use of it by increasing the number of lines in the picture than by allowing for any possible vertical black and white stripes across the field.

When the scanning element traces a line across the object it does so continuously, not in starts and stops. The scanner enters new areas gradually and there are no sudden chnages in the illumination and hence no sudden requirements of the electrical system. The edge of a shadow in a properly illuminated scene is not sharp. The illumination changes gradually from one tone to another. Moreover, the effect of the illumination on the photo-electric cell, and hence on the electrical system, is differential for the most part. There is a change at both sides of the exposed area, and these changes are in opposite directions, in most cases. This fact reduces the frequency band requirements. Exceptions noted above are print and vertical black and white stripes. In such exceptional cases the only effect of inadequate frequency band is blurring of the edges, similar to that produced by astigmatism.

Rapid Changes

There are two times when there are rapid changes in the signal intensity. One occurs when the scanner changes from one line to the next. Not only may there be a complete break in the signal but there is a change because the light values at one edge of the object may be considerably different from those at the other edge, even though the change from one to the other, across the picture, may be very gradual. A complete break can be prevented by causing a small overlap of scanning elements. The tail end of scanning element No. 5, for example, may be still active when the front end of scanning element No. 6 begins to function. Also, if the scene is well and uniformly illuminated there should be little change in intensity. Still, the differences are the picture so they cannot be ignored.

The other time when there is a sudden change is at the end of one frame and at the beginning of the next.

The conclusion is that we do not need nearly as wide a frequency band for good television transmission and reception as that demanded on the half tone conception of scanning, a conception that is entirely fictitious. We shall need a wider band when the number of lines has been increased, but even if the number of lines is doubled or trebled it is very likely that the 100 kc width is ample, assuming proper illumination of the scene to be transmitted and the proper design of the scanning devices at the transmitter and at the receiver.

It is not intended to deny that for greater detail a wider frequency band is required. That is rather asserted. But in order to make a wider band necessary we must decrease the elemental area, first by increasing the number of lines per frame and then by decreasing the scanning spot area in the direction of motion, or in the direction of a line.

Push-Pull Resistance-Coupled Load

By Brunsten

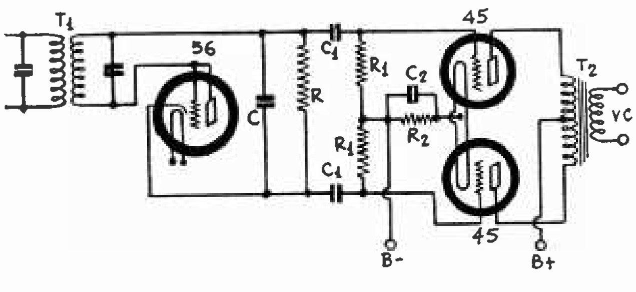


FIG. 1

This is an arrangement whereby a push-pull amplifier may be coupled with resistances to a diode detector. It is essential that the cathode of the detector be not grounded.

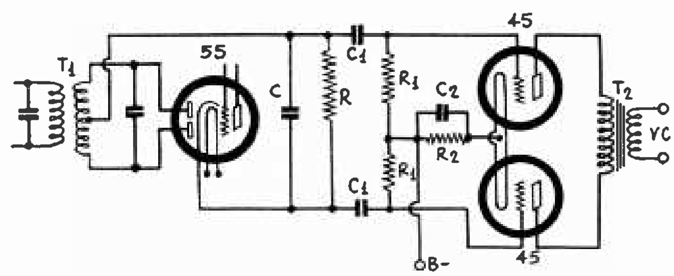


FIG. 2

This circuit is like that in Fig. 1 except that a 55 tube is used as a full-wave rectifier. The same precaution regarding the cathode is necessary, and the grid and plate should be left unconnected.

MANY RADIO fans have attempted to get more sensitivity out of superheterodynes by adding a second stage of intermediate amplification. At the same time they have attempted to get first rate quality without overloading. They have not been successful because the gain in the intermediate amplifier has been so great that it was impossible to control the volume. Bad distortion resulted.

The assumption, of course, is made that the amplifier tubes are the latest screen grid tubes, which have a very high gain. It is usually the second detector that overloads. Hence if two intermediate amplifiers are used, they should be followed by a detector that will stand at least as much as the amplifier tubes, and also to follow the detector with an audio amplifier that will handle the volume.

It has always been a desire of those who want good quality to use resistance and push-pull coupling in the audio amplifier, that is, resistance coupling between the detector and the push-pull output tubes.

Push-Pull Output

There is only one way of coupling a detector by means of resistances to a push-pull stage, and that is by using a diode detector with a tube that has a cathode. Such a detector will stand a strong signal without overloading. Its sensitivity is not nearly so great as that of a detector utilizing a pentode, for example, the 57 working into a high resistance load, but the lack of sensitivity in the detector is made up by using the second intermediate amplifier.

The circuit in Fig. 1 illustrates a diode detector working into a push-pull audio amplifier. For detector tube the 56 is used, which is of the cathode type. The input to this detector is the signal voltage developed across the secondary of T1, which is supposed to be the third intermediate frequency transformer in the circuit. The load on the detector consists primarily of the resistance R, which should have a value of 0.5 meg. A high audio signal voltage will develop across this resistor when a strong modulated radio signal is impressed. However, we have to use a filter to take out the ripple, and condenser C serves this purpose.

In detectors of this type it has been customary to use a rather large value for this capacity in order to remove the ripple thoroughly. This is not desirable because if it is large it will also remove the higher audio frequencies. It is because of this that the diode has often been condemned. For broadcast signals, as well as for the higher signal frequencies, the condenser should not be larger than 100 mmfd. when connected across a resistance of 0.5 meg., although standard tube specifications recommend 0.00015 mfd. For intermediate frequencies it may be a little larger, but even for intermediates as high as 400 kc it is not desirable to make the condenser more than 150 or at most 200 mmfd., though 0.006 mfd. is commonly recommended.

Tone Control

Incidentally, condenser C offers a simple means of providing a tone control in the receiver. All that is necessary is to increase the capacity, for the only reason for limiting its value is to allow the high audio notes to come through. If we don't want the high notes, all we have to do is to use a larger condenser. It would not be practical to make the condenser continuously variable, like a tuning condenser, but the tone control could be effected nicely in steps by having a switch and a number of condensers of different capacities. Or, if it is only a question of getting either natural or "mellowed" tones we could have two condensers, one of about 150 mmfd. and one of about 0.001 mfd. The effect of a 0.001 mfd. condenser at 10,000 cycles is to cut the output power to 0.1 per cent, compared with the extremely low audio frequencies. At 5,000 cycles the output power amounts to 0.4 per cent. That is almost complete cut-off. If such reduction is not desired, a smaller condenser than 0.001 mfd. can be used.

When the intermediate frequency is 400 kc, a 150 mmfd. condenser across the 0.5 meg. resistor will cut out the ripple to the extent of 36,000. That is, it leaves one part in 36,000, which means that the voltage across R is practically free from carrier ripple. As far as ripple filtering is concerned, therefore, an even smaller condenser can be used if it is essential to get the high audio notes through the amplifier, as it would be in a television receiver.

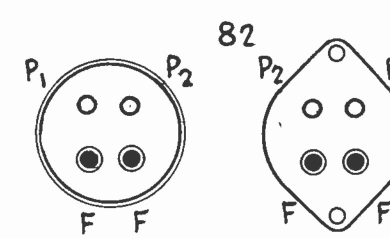
Low Note Detection

The low note detection is perfect, for condenser C has no effect in suppressing low frequencies. Still, the excellence of an audio amplifier is often judged by the low notes it reproduces, so we might as well preserve them as far as possible. If we make the stopping condensers C1 large and also the grid leaks R1 large, we do not suppress the low notes. We are justified in making the condensers 0.25 mfd. each, and the grid leaks half megohm each. If blocking of the grids occurs with these resistors we have to use lower values and thus sacrifice some of the low note gain.

New Rectifiers in

82

Mercury Vapor Rectifier



2.5-volt filament, 125 maximum d-c ma at 400 v. max.

Filament Voltage	2.5 Volts
Filament Current	3.0 Amperes
Maximum A-C Voltage per Plate	500 Volts, RMS
Maximum Peak Inverse Voltage.	1,400 Volts
Maximum D-C Output Current, Continuous	125 Milliamperes
Maximum Peak Plate Current..	400 Milliamperes
Tube Voltage Drop, Approximate	15 Volts

A-F; Resistor Is Useful For A-V-C

Brunn

It is particularly desirable to retain the low note gain up to the grids of the two power tubes because it is suppressed to a certain degree in the push-pull output transformer and to a still greater degree in the loudspeaker.

While the output tubes are indicated as two 45s they may, of course, be any two good output tubes, provided that the voltages applied are suitable for the tubes used. However, the 45s are excellent tubes.

Signal Voltage Division

The essential part of the coupler between the diode detector and the push-pull amplifier is that neither side of the detector be grounded to the signal frequencies. Both ends of R must be "hot." The middle point may be grounded if desired, although it is not necessary, provided that the junction of the two R1 resistors is grounded.

The signal voltage is developed across R, but practically the same voltage exists across the two R1 resistors. At any instant the audio signal current flows through R1R1 in the same direction. Therefore, when the upper grid is positive with respect to the center point the other grid is negative. In other words, the two grids are at opposite potentials, or the signals voltages are 180 degrees out of phase. This is essential to push-pull operation. The same current flows through both R1 resistors, and since they are equal in value the absolute values of the voltages are equal. This is also necessary in push-pull. The statement that the currents in the two resistors are equal assumes that no grid current flows. Hence the tubes must be biased enough to insure that neither tube takes current on the peaks. The bias may be provided by a resistor R2, which should be 1,000 ohms for two 45s, or by means of batteries, using 50 volts, or as near that as can be obtained with batteries.

Automatic Volume Control

It is possible to utilize the drop in R for automatic volume control. To do this the exact center of the resistance must be found, which can be done by making R of two equal resistors of 250,000 ohms each. This point should then be grounded, or should be connected to the cathodes of the controlled tubes. The variable control voltage can then be obtained from the plate-grid side of the rectifier circuit, that is, from the top of R, or from a tap somewhere between this point and ground.

The grid returns cannot be connected directly to this point for that would cause unbalance. They should be connected to the point selected through a high resistance as is customary. It is preferable to obtain the automatic bias from some other rectifier rather than from R.

Even when no a-v-c is connected to R there is a certain unbalance in the circuit because the rectifier is not symmetrical. There may be more capacity between ground and one end of R than between ground and the other end. One would suspect a greater capacity between the cathode of the 56 and ground than between the top of R and ground. Any unbalance due to capacities can easily be overcome by connecting a very small adjustable condenser across one of the R1 resistors, for example, the upper one.

The unbalance is not serious for it would affect the higher audio frequencies only where true push-pull action is not essential due to the fact that the amplitudes involved are very small.

Output Required

The output required of the detector is twice the maximum input voltage of the power tubes. If 45's are used the total voltage across R would be 100 volts. This is peak value. Since the value of R is 0.5 megohm, the maximum current in R would be 0.2 milliampere, peak value. The 56 will easily handle that, and much more if necessary.

The voltage across the secondary of the tuned circuit should be considerably higher than this, for there will be some drop in the tube. Moreover, the carrier is not 100 per cent modulated, even on the lowest notes, and we have to allow some for the difference between the actual modulation and complete modulation. We might say that the root mean square of the signal voltage should be 100 volts, which would make the peak voltage 141 volts.

How much radio frequency current would have to flow in the secondary circuit to produce a root mean square voltage of 100 across the circuit? Let us suppose that the tuning condenser across the secondary is 100 mmfd. and that the frequency involved is 400 kc. The impedance of the condenser therefore is nearly 4,000 ohms and the root mean square current would have to be 25 milliamperes, which is not much.

The question why a 56 rather than a 55 is used as the diode may arise. Is not a 55 a full-wave detector and could not that be used more advantageously? The full-wave rectifier feature of the 55 would be of no advantage in so far as the audio stage is concerned, but the 55 could be used advantageously just the same. In Fig. 2 is the same circuit as in Fig. 1 with the exception that the 55 is used as full-wave detector. The extremes of the secondary windings are connected to the diode plates, one to each, and the center point of the winding is connected to the output resistance R.

The cathode is connected to the other side of the resistance, just as in the other circuit. It will be noticed that the control grid and the plate of the tube are not used. They are entirely superfluous. They might be connected to the rectifying elements, for example, the control grid to one diode plate and the plate to the other. But this would make the rectifier unbalanced and better results would be obtained by leaving them unconnected.

The only advantage of using the 55 is that the rectifier is full-wave. This fact reduces the ripple in the load resistance R and a smaller value of C could be used. But the full-wave connection also has a disadvantage in the output voltage would only be half as great for a given voltage across the secondary of the input circuit. To get the same voltage out it would be necessary to double the intensity of the signal. In case the amplification in the circuit is so great that the circuit is unmanageable, it may be an advantage to cut the output in this manner.

Grid-Plate Left Open

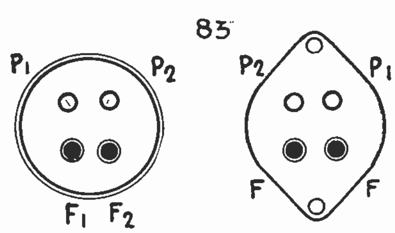
Apparently, there is no way of utilizing the control grid and the plate of the 55 without upsetting the balance. To make use of it as an amplifier we would have to apply a voltage on the plate, and to get plate current it would be necessary to make a connection to the cathode. If this is done directly we kill the lower side of the push-pull stage. If we connect an impedance, either a high resistance or a high inductance, between the cathode and return of the B supply, we immediately upset the balance to an extent depending on the impedance we insert. Hence it is better to leave the triode elements unconnected.

Now that diode detection is gaining in popularity, the push-pull arrangement here shown should also meet with approval by those who are particular about the quality of the output of their receivers. The lack of sensitivity in the diode is no greater a deterrent in the push-pull circuit than in the single-sided circuits, and it is made up for by the increased sensitivity of the modern amplifier tubes.

Numerical Order

83

Mercury Vapor Rectifier



5-volt filament, 250 maximum d-c ma at 400 v. max.

Filament Voltage	5.0 Volts
Filament Current	3.0 Amperes
Maximum A-C Voltage per Plate	500 Volts (RMS)
Maximum Peak Inverse Voltage	1,400 Volts
Maximum D-C Output Current, continuous	250 Milliamperes
Maximum Peak Plate Current..	800 Milliamperes
Tube Voltage Drop (approx.)...	15 Volts

(Use 1 mlh. minimum r-f choke in each tube plate leg if set is very sensitive.)

BUYS BRUNSWICK STOCK

United Radio Service, 619 West 54th Street, N. Y. City, announces through H. B. Williams, head of the New York office, the purchase of the entire Brunswick replacement stock of the Gray Company of New Jersey. This augmented stock will amply take care of replacement parts and orders for the domestic and foreign accounts.

Class B Amplifiers Find Wide Circuits F

By Einar

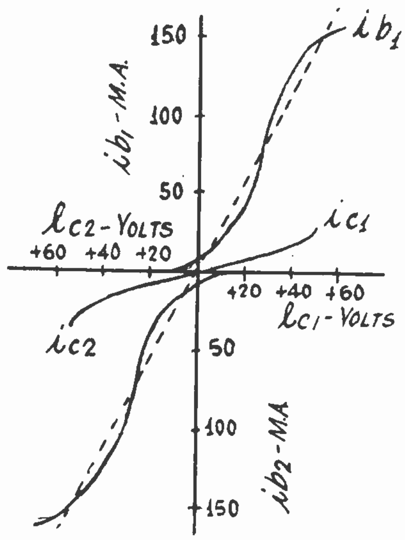


Fig. 1

Load characteristics of a Class B amplifier using two 46 type tubes with zero bias on the grids. The dashed lines represent, approximately, the current in the secondary of the output transformer.

IN THE July issue of "Proceedings of the Institute of Radio Engineers," Loy E. Barton, of the Radio Corporation of America, discusses the application of Class B amplifiers to radio receivers, with emphasis on the 46 tube, which has been developed especially for this purpose. The advantages of Class B amplifiers are a greater output of sound power for a given input of d-c power, ability to handle higher peak signal voltages without distortion, and the practicability of sacrificing some of the extra power for refinements in the loudspeaker to produce a better frequency characteristic. A disadvantage pointed out is that on low signal levels there is a higher distortion.

The Class B amplifier was first utilized in a commercial battery operated superheterodyne in which two 230 tubes in the output stage delivered 1.25 watts of sound power. This was an eight-tube receiver which was described by the same author about a year ago. The Class B amplifier has also been used successfully in automobile receivers, the author points out.

Requirements of Class B Amplifiers

One of the difficulties met on the design of Class B a-c operated amplifiers was the grid bias. A Class B amplifier cannot be self-biased because the plate current varies over wide limits, from zero to a very high value. If self bias were used, it would vary according to the plate current. At zero signal voltage the bias would be practically zero, and that would occur twice during every signal cycle. At the peaks of the signal voltage the bias would be very high. This variation in bias would be equivalent to a reduction in the signal, and could well result in an "amplifier" that would reduce rather than strengthen the signal.

The use of a drop in a resistance in the B supply would be open to the same objections, although not to quite the same degree. Nevertheless the bias would vary sufficiently seriously to affect the performance. Batteries could be used for bias, and they would be satisfactory as far as performance of the Class B amplifier is concerned, but they are out of place in an a-c operated receiver, and nobody wants them. The solution to the bias problem, Mr. Barton points out, is the design of a tube that requires no bias. The 46 is that tube. Other tubes have also been announced that have the same characteristics in this respect.

Still another requirement for successful operation of a Class B amplifier is good regulation in the B supply. It is essential that the variation in the plate voltage applied to the tubes as a result of changes in the current drawn should be as low as possible. To meet this condition the mercury vapor rectifier, like the 82, was designed. This tube has a constant internal voltage drop of 15 volts regardless of the current drawn. To make good use of this low internal resistance it is important that the resistance of the high voltage winding of the power transformer be as low as possible, and also that the resistance of any filter choke that may be put in the line be low. If these conditions are met, the regulation of the B supply will be satisfactory.

Use of Driver Stage

Operation of the power tubes without grid bias results in grid current flow during that half cycle the tube is active because the grid is then positive. This grid current is considerable and may amount to 25 milliamperes at the signal peaks. Hence it requires power to drive the power stage and a power driver stage, consisting either of a single power tube or two tube in push-pull. If the grid current is not to cause a reduction in the voltage applied to the grids of the Class B stage, the voltage regulation of the grid circuit must be good. That is, there must be no high impedance in the grid circuit. This requirement is met by using a step-down transformer between the driver and the Class B amplifier, a transformer that matches the impedance of the plate circuit of the driver tube with the grid impedance of the driven tubes. The secondary has a low impedance and when the driver is a 46 operated as a triode, the ratio of step-down is about 6-to-1 for each half of the secondary winding.

A Class B amplifier is not push-pull in the strict sense for there is no differential effect, except in a small region near the operating point, where both tubes take a little plate current. The Class B amplifier is more like two grid bias detectors working in opposite directions. One tube sends an undirectional current through the plate circuit during one-half cycles and the other sends a similar current through the plate circuit during the other half cycles. The two pulses combine in the primary of the output transformer and result in an alternating current in the secondary of that transformer. The two tubes together do not act as a detector but as a true amplifier.

Amount of Distortion

At first thought one might suppose that the distortion in such an amplifier is very great. This is not the case, however, if the design of the circuit is correct. Curves given by Mr. Barton show that for an amplifier designed for maximum output any one of the harmonics does not contain more than 5 per cent, and only the third harmonic approaches that amount of distortion when the output power is 24 watts. The distortion is minimum when the output power is about 4 watts, and then the sum of all the harmonic distortion values does not amount to 5 per cent. This amount of distortion is not noticeable to most people. Around one watt output the distortion is rather high, possibly amounting to more than 5 per cent. At 12 watts total harmonic distortion in the 2nd, 3rd, 5th, 7th, and 9th harmonics is about 6.6 per cent. The fourth and the sixth harmonics contain so little energy that the percentage is not given. The distortion in the second harmonic is due to lack of complete balance of the amplifier.

As far as the total amount of distortion is concerned it is no greater in the Class B amplifier than in a Class A, when both have been designed for maximum output, but the output of the Class B under these conditions is many times greater. And this greater output is obtained at no greater input of d-c power. That is, the Class B amplifier is much more economical in plate power than the Class B.

This greater economy does not take account of the fact that a driver stage is needed. Some of the saving in power in the output stage is used up in the driver. Moreover, the cost of building a Class B amplifier is somewhat higher than the cost of building a Class A circuit. Even with these disadvantages the points in favor of Class B are sufficient to justify its use, provided that the design is properly carried out.

Performance Curves

In Fig. 1 is a set of performance curves as given by Mr. Barton. The set above the horizontal axis pertain to one of the tubes and the set below the axis pertain to the other tube. Curve ic1-ic2 represent the grid current and ib1-ib2 the plate current. The grid current curve passes through the origin because when the bias is zero there is no grid current. The plate curves do not pass through the origin because at the zero bias there is a small amount of plate current in both tubes. The dashed line which nearly coincides with the plate current curves passes through the origin. This line nearly represents the current in the secondary of the output transformer, at least it does near the origin where the bias is low.

The ideal plate current characteristic would be such that beyond the points where plate current flows in both tubes the line should be straight so that the dashed line would coincide with the actual line, and in the region where plate current flows in both tubes, the characteristic should follow the square law. If the characteristics were of this type there would be no distortion. But, as will be seen, there is a considerable deviation from it since the dashed line does not coincide with the actual line. The deviation near the origin is to be expected since the curves nearly follow the square law. But this deviation does not necessarily represent distortion, for it is the difference between the instantaneous values of the two currents that counts. If the dif-

Use; or Positive and Negative Grids

Andrews

ference is taken the actual curve nearly coincides with the dashed line. In so far as it does not, there is distortion.

Coupling Transformer

Mr. Barton points out that the design of the step-down transformer depends on the particular driver that is used and on the power that is required in the output. Thus if a 46 tube is used as driver and the power required is the maximum, the step-down ratio should be 6-to-1 for each half of the secondary. But if two 227 tubes in push-pull are used as driver, with maximum plate voltage and plate current, the transformer should have a step-down ratio of 8-to-1 for each side of the circuit, or the same ratio for the entire transformer.

The use of Class B amplification with independent grid bias does not impose any particular difficulties in the design, for a power driver is not necessary. The two tubes in the Class B amplifier are biased to the cut-off point, or very near it, and the signal voltage is limited to the bias applied. That is, if the bias is 50 volts, the peak of the signal voltage is not allowed to exceed this value. Thus at no time does grid current flow, and only voltage is required to operate the grids of the two Class B tubes. No power will be dissipated in the grid current of the Class B amplifier.

Obtaining the Bias

Since the tubes cannot be self biased and we do not want to use a battery, we have to provide some other means of obtaining the bias. The simplest way is to use a small rectifier and filter. The voltage for this may be taken from the line supplying the power pack and the rectifier tube may be any three element tube for which the proper filament voltage is obtainable. For example, it may be a 26, a 201A, a 230, a 227, a 56, or any other similar tube. If the filament voltage is the same as that required by the tubes to be biased the same filament winding may be used. Or, if the voltage required is less than that, the same winding can still be used provided a suitable ballast resistor is used.

For transformer we may use a one-to-one audio transformer. The hook-up is shown in Fig. 2, which also includes the values of resistors and condensers that will be suitable. The drop across the 0.25 megohm load resistance on the grid bias rectifier may be much too high for biasing the Class B amplifier and for that reason the load resistance is made in the form of a potentiometer, with the grid returns of the biased tubes connected to the slider. Thus any desired bias can be obtained. This arrangement offers the advantage of using the tubes either as a Class A or a Class B amplifier by merely changing the position of the slider. When the bias is high enough to cut off the plate current the amplifier is Class B and when the bias is about half that which cuts the current off the amplifier is Class A. In both cases the tubes are used as low voltage amplifiers, that is, one of the grids of each tube is connected to the plate of that tube.

C Bias Rectifier

In the C bias rectifier, the choke coil marked 100 H may be the secondary of any audio frequency transformer. Incidentally, the slider of the potentiometer should never be set at zero bias for that would damage the tubes. The only time when the bias may be zero is when the grids are connected together so that the cut-off is near zero bias. But under those conditions no bias is needed and a driver stage is.

If there is a high frequency oscillator present in the receiver, either as beat frequency generator in the mixer or as a separate generator, the 55 tube can be used as grid battery eliminator, and it may be powered by the high frequency oscillation. A way of using the 55 is illustrated in Fig. 3. A special winding is put on the oscillator coil and then this is connected in the diode circuit. The drop in R, filtered by C, is used for biasing the power tubes by connecting the grid returns of these tubes to the point marked "C—". The only question is whether the drop in R will be high enough for the bias required. The voltage will depend on the intensity of oscillation in the 55 and it can be varied by varying the voltage on the plate of that tube.

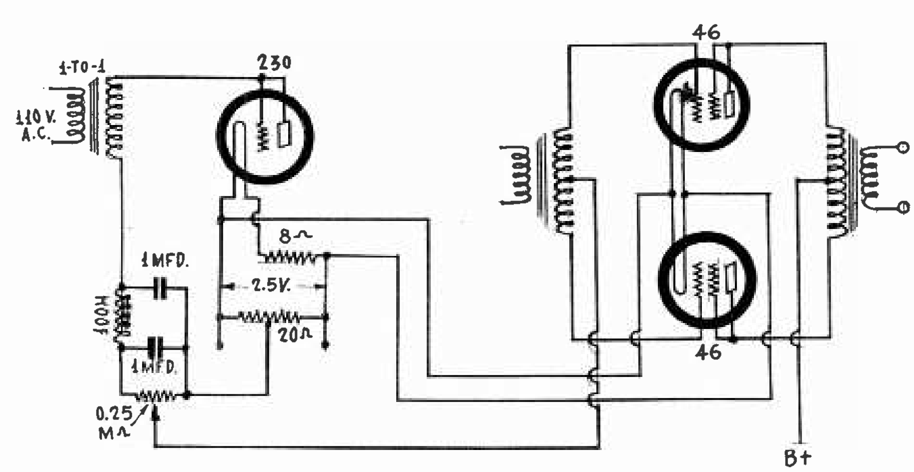


FIG. 2
The circuit of a Class B amplifier with high negative bias on the grids, the bias being obtained from a special small rectifier utilizing a 230 type tube.

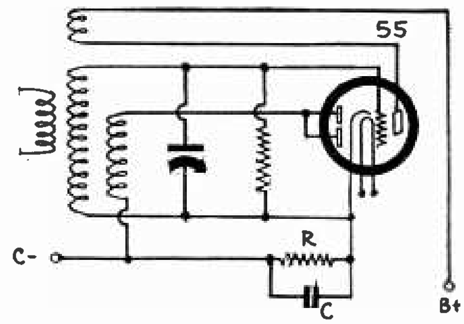


FIG. 3
In this circuit the 55 tube is used as oscillator and rectifier of its own generated current. The rectified and filtered output may be used for biasing the grids of the power tubes.

When the 55 is used as rectifier and oscillator there will be a short time while heavy current will flow in the power tubes, because the heat up to operating temperature before the 55. However, this period is short, so there will be no damage to the tubes. In the event a filament type rectifier tube is used, as in Fig. 2, the response is almost instantaneous for the rectifier tube heats up just as quickly as the power tubes.

Transformers Required

When the Class B amplifier tubes are negatively biased to the cut-off point no power driver is needed, as was stated, and no special coupling transformer. The push-pull coupling transformer is of the regular type. The tube ahead of this transformer does not have to deliver any more power than it would if the output stage were a Class A amplifier. It would have to deliver a much higher voltage, about twice as high as if the amplifier were Class A. This high voltage may be the result of a high step-up ratio in the transformer or of a strong signal impressed on the primary. It may be necessary to use an extra amplifier in the circuit somewhere which may be an r-f, an i-f, or an a-f stage, in order to get enough voltage on the output tubes. A voltage amplifier would be more effective than a power amplifier in raising the signal voltage, for there would be no step-down transformer, but a step-up transformer, and there would be no grid power loss. Moreover, there may be a gain due to resonance if the extra stage is an r-f or and i-f.

Let Us Stop—

Delivering sets without first testing them.
Connecting sets to old aerials that are noisy and inefficient.
Forgetting to loosen the chassis hold-down bolts.
Using steam pipes and gas pipes as grounds.
Failing to instruct customer in correct operation.
Returning sets with nothing wrong but a tube.
Knocking the job done by the last serviceman.
Arguing with the customer.

—*"Philco Serviceman."*

Crossing of the Carrier

A Common Trouble in Padded Oscillators

By J. E. Anderson

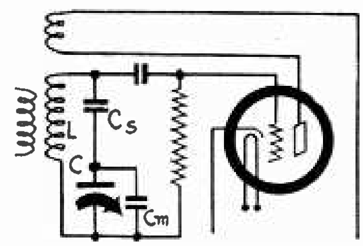


FIG. 1

A typical superheterodyne oscillator padded to track with the r-f tuner. Incorrect adjustment at the high frequency end, leading to crossing of the carrier, is a common trouble.

THERE is plenty of trouble in adjusting a superheterodyne when the oscillator condenser is ganged with the r-f condenser. A common complaint is that the set will work all right at the high frequency end and also at the low frequency end. For example, if it is adjusted at 570 kc and at 1,500 kc, it will work all right from 550 to 600 kc and from 1,400 to 1,500 kc, but in between the set is dead except for a lot of heterodyne whistles. What is the trouble?

The fact that there are many whistles present shows that the oscillator is working all right. If the set did not whistle in the insensitive region we would suspect that the oscillator went dead in this range, but this possibility is ruled out. The r-f amplifier also is all right, let us assume, for there is seldom any trouble there.

Therefore the oscillator and the r-f amplifier work all right. Yet the set is dead over most of the band, except for whistling. The only conclusion to be reached from the evidence is that the oscillator does not generate the right frequency. Moreover, the fact that there is whisting suggests that the oscillator frequency is about equal to the signal frequency, except at the two ends.

Crossing of the Carrier

We know that in a superheterodyne the oscillator frequency can be either greater or less than the signal frequency by the intermediate frequency, and the signal will come in about equally well. Now suppose that the oscillator will not tune to the high frequency required. For example, let us assume that the intermediate frequency is 175 kc. The oscillator should tune up to 1,675 kc in order to bring in a 1,500 kc signal. But it may be that the oscillator will not even reach 1,500 kc, much less 1,675 kc. In that case the adjustment of the trimmer condenser, Cm in Fig. 1, will be made to a frequency 175 kc less than 1,500 kc, or 1,325 kc. That is, if the adjustment is made without the aid of an oscillator set at the required high frequency. When the receiver oscillator is set at 1,325 kc the signals in the immediate vicinity of 1,500 kc will come in fine, but as soon as the variable condenser is turned toward lower signal frequencies there will be no response.

Before explaining why this is so, let us refer to the adjustment of the series condenser. This is made, let us say, at 570 kc. The signal is brought in strong, and in the immediate vicinity other signals will also come in with fair strength. But the strength will decrease rapidly as the tuning condenser is turned to higher frequencies. Because the inductance in the oscillator is much lower than the inductance in the r-f circuits, the mistake of adjusting the series condenser to establish an oscillator frequency 175 kc less than 570 cannot be made. At the high frequency end the mistake is easily made.

When the circuit is properly adjusted at the low frequency end and improperly made at the high frequency end, the oscillator frequency must at some point between the two adjustment points be equal to the signal frequency. That is, the oscillator frequency crosses the signal frequency. This crossing may occur at 1,000 kc. At this point the squealing should be most intense and the signals received, if any, should be weakest, because the intermediate frequency generated is zero instead of 175 kc.

Explanation of Crossing

The calibration curves of the oscillator and r-f circuits under the two conditions are illustrated in Fig. 2. C represents the capacity of the tuning condenser. Hence the left side of the curve represents the highest signal and oscillator frequencies. The curve marked "RF" represents the calibration curve of the r-f tuner, assuming a condenser of approximately straight line tuning. The upper curve, marked "Osc. correct," represents the calibration curve when the padding has been done correctly at both ends. At both it is higher than the RF curve by the same amount and at all points between the two curves are at about the same distance apart. That is, the curves are parallel. Hence the set is about equally sensitive at all settings of the condenser.

The curve marked "Osc. incorrect" represents the calibration curve of the oscillator when the series condenser has been adjusted correctly, but when the trimmer condenser has been adjusted so that the frequency is less by the intermediate frequency than the signal frequency. At the two ends of the tuning band the curves are at the same distance apart because the adjustment has so been made. But in the middle, where C may have the value C1, and where the frequency of the signal may be 1,000 kc, the two curves cross. It is obvious that under these conditions the set will be dead over most of the tuning band except for a bedlam of squeals.

Cause of Crossing

The cause of the crossing of the oscillator and the signal frequencies, of course, is the selection of the lower oscillator frequency at the high frequency end, that is, the lower of the two at which the signal will come in. This selection is done either through carelessness or because the oscillator will not reach the higher frequency. When it will not reach the higher frequency the trouble is usually that the distributed capacity in the oscillator is too high. But when the coil and condenser have been used successfully in other circuits of the type, it is not likely that the oscillator will not reach the higher frequency if the adjustment is done right.

When a condition like this is met the trimmer condenser on the oscillator should be opened just as widely as possible and the 1,500 kc signal should be brought in with the trimmers on the r-f condensers. That insures that the capacity in the oscillator is as low as possible. But even then it is possible to commit the error.

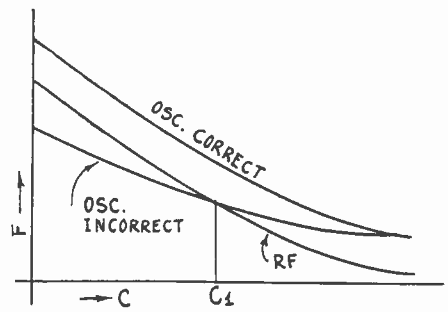


FIG. 2

This show what happens when the padding has been done correctly and when done so as to produce crossing of the carrier

A way of avoiding committing the error is as follows: Set the oscillator trimmer at minimum, or wide open. Then tune in 1,500 kc with the trimmers on the r-f condensers. Now adjust the oscillator trimmer until the zero beat is heard, that is until the oscillator frequency is equal to the signal frequency. The squeal can be heard through the i-f tuner if the signal impressed is strong, but if it cannot, convert the set to a t-r-f set by switching the grid clips. Then the squeal can be heard because it does not have to go through the i-f tuner, provided, of course, that the oscillator is not killed.

Having made certain that the two frequencies are equal, return the circuit to a superheterodyne, if the i-f had been cut out, and then tune in the 1,500 signal with the trimmer on the oscillator alone, but turn it ONLY in the direction of decreasing the capacity. That is, turn the screw to the left until the signal comes in. This tuning direction is essential or the method fails.

If the oscillator trimmer cannot be opened enough to bring in the 1,500 kc signal, the distributed capacity in the oscillator is too high and it is necessary to change the coil. This may be done by putting more insulation between the tuned winding and the other windings, or by getting a new coil. If the coil has been used successfully in other receivers there is no reason why it should be necessary to make any changes. The readjustment of the trimmer condensers should be sufficient.

Probability of Crossing

The probability of crossing the oscillator and signal frequencies by improper adjustment of the padding is greater the lower the intermediate frequency. If the intermediate is high it is not likely that the trimmer condenser will have sufficient range to bring in both settings of the oscillator. When the intermediate is low, on the other hand, it requires only a slight change in the trimmer condenser to tune from one to the other.

The crossing of the carrier by the oscillator frequency has caused more trouble to fans, and even to engineers, than any other thing in superheterodynes when the condensers are ganged. Therefore the cause of the trouble deserves consideration so that the remedy may be applied.

Crossing of the carrier by the oscillator is characterized by insensitivity in the middle of the tuning band and considerable heterodyne squealing in the insensitive region.

A Pocket Crystal Set

Tunes in Only Strong Locals

By Paul Erwin

SOME PERSONS are still holding crystal receivers, not for home use particularly, but for "novelty." They are the oldest radio receivers we have but still they are a novelty to those who have never built them. One of the objects now of those who build them is to see how small they can be made and still bring in signals.

The largest part of such a receiver is the headset, but if only a single unit is employed even this occupies little room.

The simplest crystal set is one having a fixed condenser and a variable tuning coil in which the inductance is varied by sliding a contact over the wires bared. This was one of the early methods of tuning, before variable condensers came into use. A circuit of this type is shown in Fig. 1. The antenna is connected to the slider on the coil and a fixed condenser of 125 mmfd. is connected from the antenna to ground, in shunt with the used part of the coil. Incidentally, the circuit will work without this condenser if the antenna is long for the antenna capacity will be sufficient to tune the set. But with a short antenna the condenser is necessary.

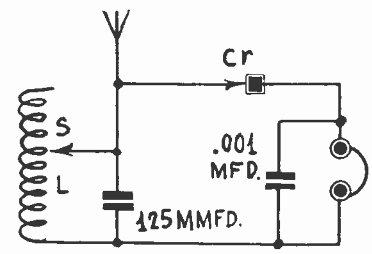


FIG. 1

A simple circuit of a crystal receiver in which the tuning is done by sliding a contact over a coil. It is suitable for a vest pocket receiver.

Rectification Detection

The crystal detector rectifies the signal current so that only d-c pulses of current flow through the speaker. The by-pass condenser across the speaker will accept the current pulses and will discharge through the speaker while the rectifier is not active. The crystal acts just the same way as a 280 type rectifier when connected in half wave fashion, the inductance of the speaker acts as the filter choke, and the condenser across the speaker as the by-pass condensers in the B supply. The inertia of the diaphragm also adds to the effective inductance, and it is probable that this is more effective than the inductance of the speaker winding. At any rate, the speaker and the condenser across is will smooth out the radio frequency pulses and the current variation in the speaker is only that due to the modulation on the carrier wave. The circuit will also work without the 0.001 mfd. condenser across the speaker because there is enough capacity in the leads and in the speaker winding to take care of the by-passing. Thus in the simplest form of crystal set all we need is a tuning coil with a sliding contact, a crystal rectifier, and a headset.

Range of Tuning

The range of a tuner of this simple type is not as wide as that of a tuner containing a variable condenser of the size now ordinarily used. This is because the capacity is fixed and rather large and the inductance cannot be reduced indefinitely. There are two reason why the inductance cannot be lowered. The first is that the antenna has a certain inductance and over this we have no control. The second is that as the inductance in the coil is reduced the input the rectifier is reduced, and when the slider is set so as to cut out the coil entirely there is no input at all. Still the antenna circuit has a natural frequency.

Design of Coil

A way to extend the range is to use a little capacity in the circuit as possible, that is, omitting the condenser across the coil, and to use a short antenna. Then the inductance of the coil should be made large, that is, its maximum inductance. Using a large inductance has the advantage of impressing a strong signal on the crystal.

For a novelty set it is not necessary to cover the entire broadcast band and the coil may be made small. If a few stations come in the circuit will usually be satisfactory. Incidentally, if only one station is desired the circuit can be simplified still more by omitting the slider arrangement. The coil can be adjusted once for all for the particular station desired, and this adjustment may be made by varying the turns. This simple arrangement has one disadvantage, it requires the use of the same antenna all the time, for the antenna is an essential.

Fig. 2 (next week) will show a picture of a simple crystal set which one fan built. It is so small that it fits easily into the vest pocket as can be seen from the view at the left. A better idea of the size is obtained from the hand. It is about the size of a cigar lighter.

The frame is made of light wood approximately two inches high, two inches wide, and half inch thick. It is rounded at the edges to make winding easier. At each end is a flange, also made of wood, to keep wires from slipping and also to provide a base to stand on and a top for holding the crystal and terminals.

The winding space between the two flanges is filled with No. 26 enameled copper wire. The turns should be put on as closely as possible and after the winding they should be covered with a binder of some kind. In the absence of anything better gasket cement can be used. This will hold the turns firmly in place as soon as the stuff is dry, but it will take some time for it to dry and the application will be a bit messy. Binders especially made for radio coils, usually a solution of celluloid in amyl acetate, are good. Collodion, usually recommended, is not so good for the coating will strip off.

When the coil is thoroughly dry, scrape off the binder and the insulation in a strip along the side for the slider. Do not scrape off too much but only the ridges of the wires. In case a slider is not to be used it is necessary neither to scrape off the insulation nor to apply the binder.

Standard Color Code for Resistors

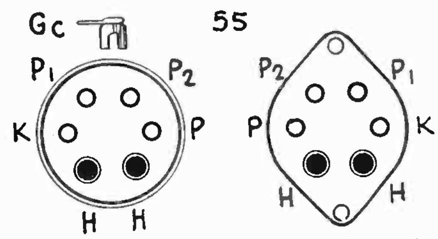
Megohms	*Ohms*	*Body*	*Dot*	*End*	*Megohms*	*Ohms*	*Body*	*Dot*	*End*
.005	500	Green	Brown	Black	.075	75,000	Violet	Orange	Green
.00075	750	Violet	Brown	Green	.09	90,000	White	Orange	Black
.001	1,000	Brown	Red	Black	.1	100,000	Brown	Yellow	Black
.002	2,000	Red	Red	Black	.15	150,000	Brown	Yellow	Green
.003	3,000	Orange	Red	Black	.2	200,000	Red	Yellow	Black
.004	4,000	Yellow	Red	Black	.25	250,000	Red	Yellow	Green
.005	5,000	Green	Red	Black	.3	300,000	Orange	Yellow	Black
.006	6,000	Blue	Red	Black	.5	500,000	Green	Yellow	Black
.007	7,000	Violet	Red	Black	.75	750,000	Violet	Yellow	Green
.008	8,000	Gray	Red	Black	1.	1,000,000	Brown	Green	Black
.009	9,000	White	Red	Black	1.5	1,500,000	Brown	Green	Green
.01	10,000	Brown	Orange	Black	2.	2,000,000	Red	Green	Black
0.12	12,000	Brown	Orange	Red	2.5	2,500,000	Red	Green	Green
0.15	15,000	Brown	Orange	Green	3.	3,000,000	Orange	Green	Black
0.2	20,000	Red	Orange	Black	4.	4,000,000	Yellow	Green	Black
.025	25,000	Red	Orange	Green	5.	5,000,000	Green	Green	Black
.03	30,000	Orange	Orange	Black	6.	6,000,000	Blue	Green	Black
.04	40,000	Yellow	Orange	Black	7.	7,000,000	Violet	Green	Black
.05	50,000	Green	Orange	Black	8.	8,000,000	Gray	Green	Black
.06	60,000	Blue	Orange	Black	9.	9,000,000	White	Green	Black
					10.	10.0000,000	Brown	Blue	Black

The standard adopted for resistors, whereby they are color coded, comprises ten colors, with numbers from 0 to 9 for each different color. The location of the color gives the digit sequence. The body color represents the first figure, one end is colored for the second figure, while a stripe or dot designates the number of ciphers to follow. The above table gives the colors, with two expressions for the resistance, megohms and ohms.

SUMMARY OF CHARACTER[...]
SOCKET ILLU[...]

DETECTORS AND AMPLIF[...]

55
Duplex Diode-Triode
TRIODE UNIT



TOP VIEW BOTTOM VIEW

P_1 and P_2 **are respective anodes of two diodes. Cathode is common to both and to** G_c **for d-c voltages.**

(Class A Amplifier)

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Grid Voltage	—20 Volts
Amplification Factor	8.3
Plate Resistance	7,500 Ohms
Mutual Conductance	1,100 Micromhos
Plate Current	8 Milliamperes
Power Output (5% 2nd harmonic distortion)	200 Milliwatts

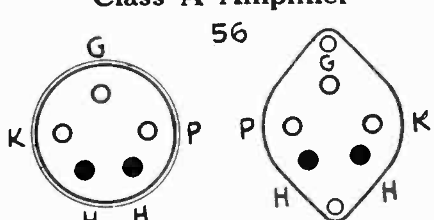
Plate coupling resistor for triode 100,000 ohms, not critical. Grid leak should not exceed 1.0 meg. Bias of —20 volts for transformer coupling; for resistance coupling around —9 volts.

DIODE UNITS

Two diode plates are placed symmetrically around a cathode, the sleeve of which is common to the triode unit. Each diode plate has its own base pin.

With an applied d-c plate voltage of 10 volts, the space current per plate with no external load should exceed 0.5 milliampere.

56
Class A Amplifier



TOP VIEW BOTTOM VIEW

G **is the control grid**

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Grid Voltage*	—13.5 Volts
Amplification Factor	13.8
Plate Resistance	9,500 Ohms
Mutual Conductance	1,450 Micromhos
Plate Current	5 Milliamperes

**If a grid coupling resistor is used, its maximum value should not exceed 1.0 megohm. Plate coupling resistor may be 50,000 to 100,000 ohms, with bias about 9 volts. The 13.5 volts are for transformer coupling.*

56
Leak-Condenser Detector

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	45 Volts
Grid Condenser Capacity	0.00025 Mfd.
Grid Leak Resistance	1 to 5 Megohms

Grid is returned to cathode through grid leak. Plate couping resistor may be 50,000 to 100,000 ohms.

56
Biased Detector

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Grid Voltage*	—20 Volts Approx.
Plate Current	(Adjusted to 0.2 ma. with no a-c input signal)

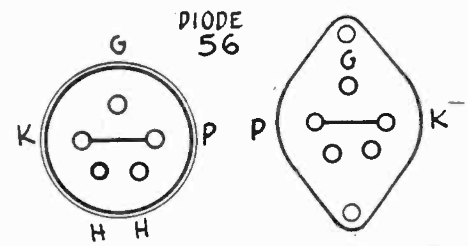
If a grid coupling resistor is used, its maximum value should not exceed 1.0 meg. Plate coupling resistor may be from 50,000 to 100,000 ohms.

56
Oscillator

Heater Voltage	2.5 Volts
Heater Current	1.0 ampere
Plate Voltage	90 Volts Max.
Grid Voltage	0 Volts

A grid leak and condenser, 0.1 meg. and 0.00025 mfd., aid frequency stability. Grid returned to cathode.

56
Diode Detector



TOP VIEW BOTTOM VIEW

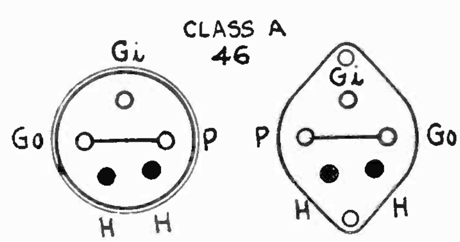
Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere

KP is Cathode, G is Anode.

The 56 may be employed as a two-electrode detector preferably by connecting the plate to the cathode for the one electrode and using the gri[d] for the other. With this arrangement, a-c inpu[t] voltages as high as 40 volts RMS may be applie[d] between grid and cathode.

POWER AMPLIFIERS

46
Class A Amplifier



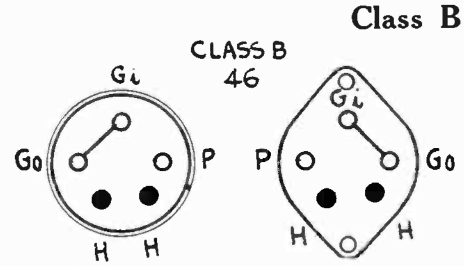
TOP VIEW BOTTOM VIEW

Go—**outer grid of internal tube structure**
Gi—**inner grid**
P and Go **are interconnected**

Filament Voltage	2.5 Volts AC
Filament Current	1.75 Amperes
Plate Voltage	250 Max. Volts
Grid Voltage (grid adjacent to plate tied to plate)	—33 Volts
Amplification Factor	5.6
Plate Resistance	2,380 Ohms
Mutual Conductance	2,350 Micromhos
Plate Current	22 Milliamperes
Load Resistance (Optimum for max. undistorted power output)*	6,400 Ohms
Max. Undistorted Power Output	1.25 Watts

**Approximately twice this value is recom[...]mended for load of driver for Class B stage.*

46
Class B Amplifier



TOP VIEW BOTTOM VIEW

Go—**outer grid of internal tube structure**
Gi—**inner grid**
Go and Gi **are interconnected**

Filament Voltage		2.5 Volts AC
Filament Current		1.75 Amperes
Plate Voltage	300	400 Max. Volts
Grid Voltage (both grids tied together)	0	0 Volts
Plate Current	4	6 Milliampere[s]
Peak Plate Current	150	200 Milliampere[s]
Load Resistance per Tube	1,300	1,450 Ohms
Max. Signal Voltage	40	41 Volts RMS
Max. Continuous Power Output (2 tubes)*	16	20 Watts
Max. Plate Dissipation (avg. per tube)	10	10 Watts

**Power measured across indicated value [of] resistor in plate circuit of each tube, with i[n]dicated signal applied through 250 ohm resistan[ce] in the grid circuit.*

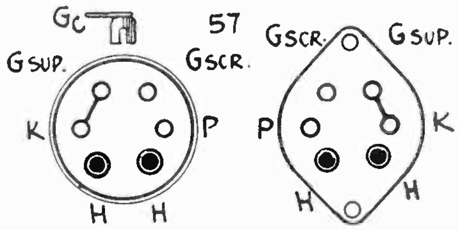
RECTIFIERS IN NUMERICAL ORDER

(See details on pages 6 and 7.)

STICS OF NEW TUBES;
STRATIONS OF TYING GRIDS

RS IN NUMERICAL ORDER

57
Class A Amplifier



TOP VIEW BOTTOM VIEW

$G_{SUP.}$—suppressor grid
$G_{SCR.}$—screen grid
$G_{SUP.}$ usually is connected to K but may go to negative voltages.

The 57 is especially useful for resistance-coupled audio if input signals are low.

57 AMPLIFIER CHARACTERISTICS

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Screen Voltage	100 Volts Max.
Grid Voltage	—3 Volts
Amplification Factor	Greater than 1500
Plate Resistance	Greater than 1.5 Megohms
Mutual Conductance	1.225 Micromhos
Grid Voltage for Cathode Current Cut-off	7 Volts Approx.
Plate Current	2.0 Milliamperes
Screen Current	1.0 Milliampere Max.

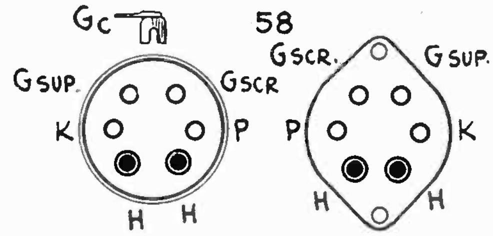
57
Biased Detector

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Screen Voltage	100 Volts Max.
Grid Voltage	—6 Volts Approx.

Plate Load—250,000 ohms or 500 henry choke shunted by a .25 megohm resistor. For resistance load, plate supply voltage will be voltage at plate plus voltage drop in load caused by specified pate current.

Plate Current—Adjusted to approximately 0.1 milliampere with no a-c input signal.

58
Class A Amplifier



TOP VIEW BOTTOM VIEW

$G_{SUP.}$—supressor grid
$G_{SCR.}$—screen grid
$G_{SUP.}$ usually is connected to K but may go to negative voltages.

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Screen Voltage	100 Volts Max.
Grid Voltage	—3 Volts Min.
Amplification Factor	1,280
Plate Resistance	800,000 Ohms
Mutual Conductance	1,600 Micromhos
Mutual Conductance	
At —40 Volts Bias	10 Micromhos
At —50 Volts Bias	2 Micromhos
Plate Current	8.2 Milliamperes
Screen Current	3.0 Milliamperes Max.

N NUMERICAL ORDER

89
Power Amplifier
CLASS A TRIODE

Heater Voltage	6.3 Volts
Heater Current	0.4 Ampere
Plate Voltage	160 Volts
Grid Voltage (grid No. 1 only)	— 20 Volts
Load Resistance (optimum for max. U.P.O.)**	7,000 Ohms
Amplification Factor	4.7
Plate Resistance	3,000 Ohms
Mutual Conductance	1,570 Micromhos
Plate Current	17 Milliamperes
Undistorted Power Output (5% 2nd harmonic)	300 Milliwatts

***Approximately twice this value recommended for load of driver for Class B stage.*

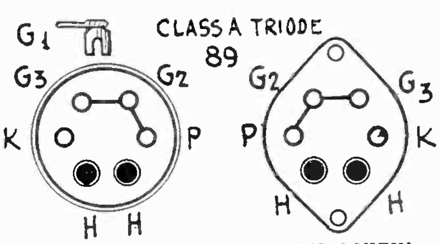
89
Power Amplifier
CLASS B TRIODE

Heater Voltage	6.3 Volts
Heater Current	0.4 Ampere
Plate Voltage	180 Volts Max.
Grid Voltage (grids No. 1 and No. 2 together)	0 Volts
Plate Current per Tube	3 Milliamperes
Peak Plate Current per Tube (max.)	75 Milliamperes
Max. Grid Dissipation per Tube	0.35 Watts
Max. Continuous Power Output (2 tubes)	6 Watts
Load Resistance per Tube	3,400 2,350 Ohms
Average Power Output (2 tubes)	2.5 3.5 Watts

89
Power Amplifier
CLASS A PENTODE

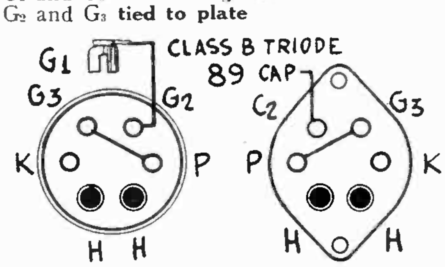
Heater Voltage		6.3 Volts
Heater Current		0.4 Ampere
Plate Voltage"	163	180 Volts
Screen Voltage (grid No. 2)'	163	180 Volts
Grid Voltage (grid No. 1)	—17	—18 Volts
Load Resistance	9,000	8,000 Ohms
Amplification Factor	125	135
Plate Resistance	79,000	82,500 Ohms
Mutual Conductance	1,575	1,635 Micromhos
Plate Current	17	20 Milliamperes
Screen Current	2.5	3.0 Milliamperes
Power Output	1.25	1.5 Watts

"Maximum plate voltage = 180 volts.
'Maximum screen voltage = 180 volts.



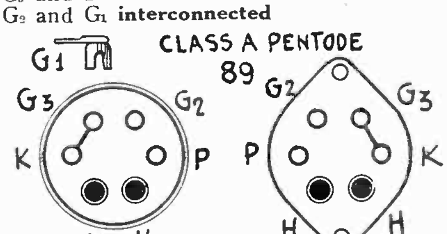
TOP VIEW BOTTOM VIEW

G_1 is control grid, tube cap
G_2 and G_3 are extra grids
G_2 and G_3 tied to plate



TOP VIEW BOTTOM VIEW

G_1 is control grid, tube cap
G_2 and G_3 are extra grids
G_3 and P interconnected
G_2 and G_1 interconnected



TOP VIEW BOTTOM VIEW

G_1 is control grid, tube cap
G_2 and G_3 are extra grids
G_3 and K interconnected
G_2 is screen

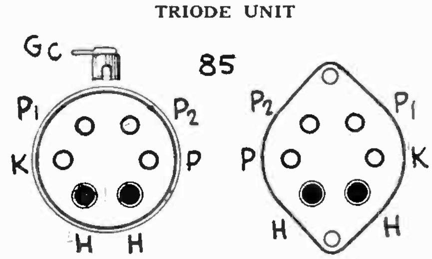
58
First Detector in Super

Operating Conditions with Adjustable Grid Bias:

Heater Voltage	2.5 Volts
Heater Current	1.0 Ampere
Plate Voltage	250 Volts Max.
Screen Voltage	100 Volts Max.
Grid Voltage (with 9-Volt Oscillator Peak Swing)	—10 Volts Min.

Note: With an oscillator peak swing of 1 volt less than the grid bias, these values are not critical and may be chosen to meet receiver design requirements.

85
Duplex Diode-Triode
TRIODE UNIT



TOP VIEW BOTTOM VIEW

(Class A Amplifier)

Heater Voltage	6.3 Volts
Heater Current	0.3 Ampere
Plate Voltage	250 Volts Max.
Grid Voltage	—20 Volts
Amplification Factor	8.3
Plate Resistance	8,300 Ohms
Mutual Conductance	1,000 Micromhos
Plate Current	7 Milliamperes

Plate coupling resistor for triode 100.000 ohms, not critical. Grid leak should not exceed 1.0 meg. Bias of —20 volts for transformer coupling; for resistance coupling, around —9 volts.

The 85 is primarily intended for mobile service.

DIODE UNITS

Two diode plates are placed symmetrically around a cathode, the sleeve of which is common to the triode unit. Each diode plate has it own base pin.

With an applied d-c plate voltage of 10 volts, the space current per plate with no external load should exceed 0.5 milliampere.

DETECTORS AND AMPLIFIERS IN NUMERICAL ORDER

Type Number	Purpose	Base	Type Cathode	Filament (or heater) Rating: Volts	Amperes	Supply	Plate Max. Volts	Screen Max. Volts	Plate Supply Volts	Negative Grid Bias Volts: D C on Fil.	A C on Fil.	Screen Volts ( ) = Current ma	Plate Current Milliamp.	A C Plate Resistance Ohms	Mutual Conductance Micromhos	Voltage Amplification Factor
11	Detector* or Amplifier	WD-11	Filament	1.1	0.25	D C	135	...	90 135	4.5 10.5	... ...	... ...	2.5 3.0	15,500 15,000	425 440	6.6 6.6
12	Detector* or Amplifier	UX	Filament	1.1	0.25	D C	135	...	90 135	4.5 10.5	... ...	... ...	2.5 3.0	15,500 15,000	425 440	6.6 6.6
55	Detector†* Diode Unit	6-pin	Heater	2.5	1.0	A C or D C	One diode anode, or both anodes tied together, may be used for half-wave detection, or two anodes for full-wave detection, either type with a-v-c additional. See Radio World, July 16, 1932. With 10 v. d-c applied, the space current should exceed 0.5 ma. Limiting series resistor, 0.5 meg., recommended, bypassed by 0.00015 mfd. for t-r-f, 0.006 mfd. for supers of usual intermediate frequencies.									
55	Amplifier Triode Unit						250§*	...	250	20	20	...	8	7,500	1,100	8.3
56	Detector* or Amplifier	UY	Heater	2.5	1.0	A C or D C	250§§	...	250	13.5	13.5	...	5	9,500	1,450	13.8
56	Biased Detector	UY	Heater	2.5	1.0	A C or D C	250§§	...	250	20	20	...	Plate current to be adjusted to 0.2 ma. with no input signal		...	...
57	Radio Freq. Amplifier	6-pin	Heater	2.5	1.0	A C or D C	250	100	250	3**	3	100 (1.0)	2.0	11.5 meg.	1,225	+1,500
57	Biased Detector	6-pin	Heater	2.5	1.0	A C or D C	250†	100	250	6	6	100 (0.03) (ma)	Plate current to be adjusted to 0.1 ma. with no input signal		...	...
58	Radio Freq. Amplifier**	6-pin	Heater	2.5	1.0	A C or D C	250	100	250	3	3	100 (3.0)	8.2	800,000	1,600	1,280
85	Detector†* Diode Unit	6-pin	Heater	6.3	0.3	A C or D C	One diode anode, or both anodes tied together, may be used for half-wave detection, or two anodes for full-wave detection, either type a-v-c additional. See Radio World, July 30, 1932. Limiting series resistor, 0.5 meg., recommended, bypassed by 0.00015 mfd. for t-r-f, 0.006 mfd. for supers of usual intermediate frequencies.									
85	Amplifier Triode Unit						250§*	...	250	20	20	...	7	8,300	1,000	8.3
112-A	Detector* or Amplifier	UX	Filament	5.0	0.25	D C	180	...	90 135	4.5 9.0	... ...	... ...	5.2 6.2	5,600 5,300	1,500 1,600	8.5 8.5
V-199	Detector* or Amplifier	UV-199	Filament	3.3	0.063	D C	90	...	90	4.5	...	...	2.5	15,500	425	6.6
X-199	Detector* or Amplifier	UX	Filament	3.3	0.06	D C	90	...	90	4.5	...	...	2.5	15,500	425	6.6
200-A	Detector	UX	Filament	5.0	0.25	D C	45	...	45	Grid Return to (—) Filament		...	1.5	30,000	666	20
201-A	Detector* or Amplifier	UX	Filament	5.0	0.25	D C	135	...	90 135	4.5 9.0	... ...	... ...	1.5 3.0	11,000 10,000	725 800	8.0 8.0
222	Radio Freq. Amplifier	UX	Filament	3.3	0.132	D C	135	67.5	135 135	1.5 1.5	... ...	45 67.5	1.5 3.3	850,000 600,000	350 480	300 290
222	Audio Freq. Amplifier	UX	Filament	3.3	0.132	D C	135	67.5	180†	1.5	...	22.5	0.3	2,000,000	175	350
224	Radio Freq. Amplifier	UY	Heater	2.5	1.75	A C or D C	275	90	180 180 250	1.5 3.0 3.0	1.5 3.0 3.0	75 90 90	4.0 4.0 4.0	400,000 400,000 400,000	1,050 1,000 1,025	420 400 615
224	Biased Detector	UY	Heater	2.5	1.75	A C or D C	275	90	275‡	5 approx.	5 approx.	20 to 45	Plate current to be adjusted to 0.1 ma. with no input signal		...	...
224	Audio Freq. Amplifier	UY	Heater	2.5	1.75	A C or D C	275	90	250*	1.0	1.0	25	0.5	2,000,000	500	1,000
226	Amplifier	UX	Filament	1.5	1.05	A C or D C	180	...	90 135 180	5.0 8.0 12.5	6.0 9.0 13.5	... ...	3.8 6.3 6.3	8,600 7,200 7,000	955 1,135 1,170	8.2 8.2 8.2
227	Detector* or Amplifier	UY	Heater	2.5	1.75	A C or D C	275	...	90 135 180 250	6.0 9.0 13.5 21.0	6.0 9.0 13.5 21.0	... ...	2.7 4.5 5.0 5.2	11,000 9,000 9,000 9,250	820 1,000 1,000 975	9.0 9.0 9.0 9.0
227	Biased Detector	UY	Heater	2.5	1.75	A C or D C	275§	...	275	30.0	30.0	...	Plate current to be adjusted to 0.2 ma. with no input signal		...	...
230	Detector* or Amplifier	UX	Filament	2.0	0.06	D C	90	...	90	4.5	...	...	1.8	13,000	700	9.3
232	Radio Freq. Amplifier	UX	Filament	2.0	0.06	D C	150	67.5	135	3.0	...	67.5	1.4	1,150,000	505	580
232	Biased Detector	UX	Filament	2.0	0.06	D C	120	67.5	175	6 approx.	...	6.75	Plate current to be adjusted to 0.2 ma. with no input signal		...	...
232	Audio Freq. Amplifier	UX	Filament	2.0	0.06	D C	150	67.5	180†	22.5	0.25	...	..	....	...	...
234	Radio Freq. Amplifier**	UX	Filament	2.0	0.06	D C	180	67.5	180 135 90 67.5	3** 3 3 3	... ...	67.5 67.5 6.75 67.5 (1.0)	2.7 2.7 2.8 2.8	200,000 500,000 600,000 1.0 meg.	560 580 600 600	224 290 360 620
235	Radio Freq. Amplifier**	UY	Heater	2.5	1.75	A C or D C	275	90	180 250	1.5 3.0	1.5 3.0	75 90	5.8 6.5	350,000 350,000	1,100 1,050	385 370

DETECTORS AND AMPLIFIERS IN NUMERICAL ORDER (Continued)

236	Radio Freq. Amplifier	UY	Heater	6.3	0.3	D C	180	90	90 135 180	1.5 1.5 2.5	... ...	55 67.5 90	1.8 2.8 3.5	450,000 450,000 450,000	825 1,025 1,075	370 460 485
237	Detector* or Amplifier	UY	Heater	6.3	0.3	D C	180	90	90 135 180	6 9 13.5	... ...	... ...	2.6 4.3 4.7	11,500 10,000 10,000	780 900 900	9.0 9.0 9.0
239	Radio Freq. Amplifier**	UY	Heater	6.3	0.3	D C	180	90	90 135 180	3** 3** 3**	... ...	90(1.3) 90(1.3) 90(1.2)	4.4 4.4 4.5	375,000 540,000 750,000	960 980 1,000	360 530 750
240	Voltage Amplifier	UX	Filament	5.0	0.25	D C	180	...	135† 180†	1.5 3.0	... ...	... ...	0.2 0.2	150,000 150,000	200 200	30 30

*For grid-leak detection—plate volts 45, grid return to + filament or to cathode.
†Applied through plate coupling resistor of 250,000 ohms.
*Applied through plate coupling resistor of 200,000 ohms.
**Minimum negative bias given. Usually adjust able. First detector in superheterodynes at 10 volts negative bias or adjustable.
§§Applied through a plate coupling resistor of 50,000 to 100,000 ohms. Bias resistor 100,000 to 150,000 ohms.
§Applied through plate coupling resistor of 50,000 ohms.
‡Applied through plate coupling resistor of 250,000 ohms or 500 henry choke shunted by 0.25 megohm resistor.
✚Applied through plate coupling resistor of 100,000 ohms.
†*Three tubes in one, consisting of two diodes and a triode amplifier.
§*Applied through plate coupling resistor of 100,000 ohms (not critical); bypass condenser 0.00015 mfd., plate to cathode for t-r-f, 0.006 mfd. for supers of usual intermediate frequency. Grid leak should not exceed 1.0 meg.

POWER AMPLIFIERS IN NUMERICAL ORDER

				Rating: Filament (or heater)						Negative Grid Bias Volts								
Type Number	Purpose	Base	Type Cathode	Volts	Amperes	Supply	Plate Max. Volts	Screen Max. Volts	Plate Supply Volts	D C on Fil.	A C on Fil.	Screen Volts ( ) = Current	Plate Current Milliamp.	A C Plate Resistance Ohms	Mutual Conductance Micromhos	Voltage Amplification Factor	Ohms Load for Slated Power Output	Power Output Milliwatts
46	Power Amplifier †Class A	UY	Filament	2.5	1.75	A C or D C	250	...	250	31.5	33	...	20	2380	2350	5.6	6400	1250
46	Power Amplifier ††Class B	UX	Filament	2.5	1.75	A C or D C	400	...	400	0	...	...	200 peak				1300	2000 per tube max. (2 tubes)
89	Power Amplifier (1) Class A	6 pin	Heater	6.3	0.4	A C or D C	160	...	160	20	20	...	17	3000	1570	4.7	7000	300
89	Power Output (2) Class A	6 pin	Heater	6.3	0.4	A C or D C	180	163 180	163 180	17 18	17 18	163(2.0) 180(3.0)	17 20	79500 82500	1575 1635	125 135	9000 8000	1500
89	Power Output (3) Class B	6 pin	Heater	6.3	0.4	A C or D C	180	...	180	0	0	...	3 to 75					6000 max. (2 tubes)
112-A	Power Amplifier	UX	Filament	5.0	0.25	A C or D C	180	...	135 180	9.0 13.5	11.5 16.0	... ...	6.2 7.6	5300 5000	1600 1700	8.5 8.5	8700 10800	115 260
120	Power Amplifier	UX	Filament	3.3	0.132	D C	135	...	90 135	16.5 22.5	... ...	... ...	3.0 6.5	8000 6300	415 525	3.3 3.3	9600 6500	45 110
171-A	Power Amplifier	UX	Filament	5.0	0.25	A C or D C	180	...	90 135 180	16.5 27.0 40.5	19.0 29.2 43.0	... ...	12.0 17.5 20.0	2250 1960 1850	1330 1520 1620	3.0 3,0 3.0	3200 3500 5350	125 370 700
210	Power Amplifier	UX	Filament	7.5	1.25	A C or D C	425	.	250 350 425	19.8 27.0 35.0	22.0.. 31.0 39.0	... ...	10.0 16.0 18.0	6000 5150 5000	1330 1550 1600	8.0 8.0 8.0	13000 11000 10200	400 900 1600
231	Power Amplifier	UX	Filament	2.0	0.130	D C	135	...	135	22.5	...	...	6.8	4950	760	3.8	9000	150
233	Power Amplifier	UY	Filament	2.0	0.26	D C	135	...	135	13.5	...	135(3.5)	14.5	50000	1350	70	7000	650
238	Power Amplifier	UY	Filament	6.3	0.3	D C	135	135	135	13.5	...	135(2.5)	9.0	102000	975	100	13500	525
245	Power Amplifier	UX	Filament	2.5	1.5	A C or D C	275	...	180 250 275	33.0 48.5 54.5	34.5 50.0 56.0	... ...	27.0 34.0 36.0	1900 1750 1670	1850 2000 2100	3.5 3.5 3.5	3500 3900 4600	780 1600 2000
247	Power Amplifier	UY	Filament	2.5	1.75	A C or D C	250	250	250	15.0	16.5	250(7.5)	32.0	35000	2500	90	7000	2500
250	Power Amplifier	UX	Filament	7.5	1.25	A C or D C	450	...	250 350 400 450	41.0 59.0 66.0 80.0	45.0 63.0 70.0 84.0	... ...	28.0 45.0 55.0 55.0	2100 1900 1800 1800	1800 2000 2100 2100	3.8 3.8 3.8 3.8	4300 4100 3670 4350	1000 2400 3400 4600
841	Power Amplifier Class A	UX	Filament	7.5	1.25	A C or D C	* 425	... ...	425 1000	5.8 9.2	... ...	... ...	0.7 2.2	63000 40000	450 750	24 26	250000 250000	... ...

†UY socket K spring tide to P spring.
††Both grids tied together (socket G and K). Class B is a form of push-pull. Maximum continuous power output. two tubes. 16 to 20 watts.
*Supply voltage may exceed 425 by the voltage drop in the plate load.
**1,000 volts applied; 575 volts dropped in plate load, so effective plate voltage will be 425.
(1), triode, Class A. Two grids in line with heaters tied to plate. Control grid is cap of tube.
(2), pentode, Class A. Grid next to socket cathode tied to cathode. Grid adjoining socket plate is screen. Cap is control grid.
(3). Class B output triode. Grid next to cathode on socket tied to plate. Grid next to plate tied to control grid, i.e., cap. Two tubes used. Currents given for one.

RECTIFIERS IN NUMERICAL ORDER

280	Full-Wave Rectifier	UX	Filament	5.0	22.0	A C	1 { A C Voltage per Plate (Volts RMS)..............350 } D C Output Current Maximum MA).............125 2 { A C Voltage per Plate (Maximum Volts RMS....400 } D C Current (Maximum MA).....................110 3 { A C Voltage per Plate (Maximum Volts RMS)....550 } D C Output Current (Maximum MA).............135 This rating is permissible only with filter having an input choke of at least 20 henries.
281	Half-Wave Rectifier	UX	Filament	7.5	1.25	A C	A C Plate Voltage (Maximum RMS).............700 D C Output Current (Maximum MA)............. 85
82	Full-Wave Mercury Vapor Rectifier	UX	Filament	2.5	3.0	A C	A C Plate Voltage (Maximum Volts RMS)........500 D C Output Current (Maximum MA).............125 Approx. tube voltage drop, 15 volts.
83	Full-Wave Mercury Vapor Rectifier	UX	Filament	5.0	3.0	A C	A C Plate Voltage (Maximum Volts RMS)......500 D C Output Current (Maximum MA).............250 Approximate tube voltage drop...................... 15

Kilocycles to Meters, or Meters to Kilocycles

(See Explanation on Following Page)

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
10	29,982	1,010	296.9	2,010	149.2	3,010	99.61	4,010	74.77	5,010	59.84	6,010	49.89	7,010	42.77	8,010	37.43	9,010	33.28
20	14,991	1,020	293.9	2,020	148.4	3,020	99.28	4,020	74.58	5,020	59.73	6,020	49.80	7,020	42.71	8,020	37.38	9,020	33.24
30	9,994	1,030	291.1	2,030	147.7	3,030	98.95	4,030	74.40	5,030	59.61	6,030	49.72	7,030	42.65	8,030	37.34	9,030	33.20
40	7,496	1,040	288.3	2,040	147.0	3,040	98.62	4,040	74.21	5,040	59.49	6,040	49.64	7,040	42.59	8,040	37.29	9,040	33.17
50	5,996	1,050	285.5	2,050	146.3	3,050	98.30	4,050	74.03	5,050	59.37	6,050	49.56	7,050	42.53	8,050	37.24	9,050	33.13
60	4,997	1,060	282.8	2,060	145.5	3,060	97.98	4,060	73.85	5,060	59.25	6,060	49.48	7,060	42.47	8,060	37.20	9,060	33.09
70	4,283	1,070	280.2	2,070	144.8	3,070	97.66	4,070	73.67	5,070	59.13	6,070	49.39	7,070	42.41	8,070	37.15	9,070	33.06
80	3,748	1,080	277.6	2,080	144.1	3,080	97.34	4,080	73.49	5,080	59.02	6,080	49.31	7,080	42.35	8,080	37.11	9,080	33.02
90	3,331	1,090	275.1	2,090	143.5	3,090	97.03	4,090	73.31	5,090	58.90	6,090	49.23	7,090	42.29	8,090	37.06	9,090	32.98
100	2,998	1,100	272.6	2,100	142.8	3,100	96.72	4,100	73.13	5,100	58.79	6,100	49.15	7,100	42.23	8,100	37.01	9,100	32.95
110	2,726	1,110	270.1	2,110	142.1	3,110	96.41	4,110	72.95	5,110	58.67	6,110	49.07	7,110	42.17	8,110	36.97	9,110	32.91
120	2,499	1,120	267.7	2,120	141.4	3,120	96.10	4,120	72.77	5,120	58.56	6,120	48.99	7,120	42.11	8,120	36.92	9,120	32.88
130	2,306	1,130	265.3	2,130	140.8	3,130	95.79	4,130	72.60	5,130	58.44	6,130	48.91	7,130	42.05	8,130	36.88	9,130	32.84
140	2,142	1,140	263.0	2,140	140.1	3,140	95.48	4,140	72.42	5,140	58.33	6,140	48.83	7,140	41.99	8,140	36.83	9,140	32.80
150	1,999	1,150	260.7	2,150	139.5	3,150	95.18	4,150	72.25	5,150	58.22	6,150	48.75	7,150	41.93	8,150	36.79	9,150	32.77
160	1,874	1,160	258.5	2,160	138.8	3,160	94.88	4,160	72.07	5,160	58.10	6,160	48.67	7,160	41.87	8,160	36.74	9,160	32.73
170	1,764	1,170	256.3	2,170	138.1	3,170	94.58	4,170	71.90	5,170	57.99	6,170	48.59	7,170	41.82	8,170	36.70	9,170	32.70
180	1,666	1,180	254.1	2,180	137.5	3,180	94.28	4,180	71.73	5,180	57.88	6,180	48.51	7,180	41.76	8,180	36.65	9,180	32.66
190	1,578	1,190	252.0	2,190	136.9	3,190	93.99	4,190	71.56	5,190	57.77	6,190	48.44	7,190	41.70	8,190	36.61	9,190	32.62
200	1,499	1,200	249.9	2,200	136.3	3,200	93.69	4,200	71.39	5,200	57.66	6,200	48.36	7,200	41.64	8,200	36.56	9,200	32.59
210	1,428	1,210	247.8	2,210	135.7	3,210	93.40	4,210	71.22	5,210	57.55	6,210	48.28	7,210	41.58	8,210	36.52	9,210	32.55
220	1,363	1,220	245.8	2,220	135.1	3,220	93.11	4,220	71.05	5,220	57.44	6,220	48.20	7,220	41.53	8,220	36.47	9,220	32.52
230	1,304	1,230	243.8	2,230	134.4	3,230	92.82	4,230	70.88	5,230	57.33	6,230	48.13	7,230	41.47	8,230	36.43	9,230	32.48
240	1,249	1,240	241.8	2,240	133.8	3,240	92.54	4,240	70.71	5,240	57.22	6,240	48.05	7,240	41.41	8,240	36.39	9,240	32.45
250	1,199	1,250	239.9	2,250	133.3	3,250	92.25	4,250	70.55	5,250	57.11	6,250	47.97	7,250	41.35	8,250	36.34	9,250	32.41
260	1,153	1,260	238.0	2,260	132.7	3,260	91.97	4,260	70.38	5,260	57.00	6,260	47.89	7,260	41.30	8,260	36.30	9,260	32.38
270	1,110	1,270	236.1	2,270	132.1	3,270	91.69	4,270	70.22	5,270	56.89	6,270	47.82	7,270	41.24	8,270	36.25	9,270	32.34
280	1,071	1,280	234.2	2,280	131.5	3,280	91.41	4,280	70.05	5,280	56.78	6,280	47.74	7,280	41.18	8,280	36.21	9,280	32.31
290	1,034	1,290	232.4	2,290	130.9	3,290	91.13	4,290	69.89	5,290	56.68	6,290	47.67	7,290	41.13	8,290	36.17	9,290	32.27
300	999.4	1,300	230.6	2,300	130.4	3,300	90.86	4,300	69.73	5,300	56.57	6,300	47.59	7,300	41.07	8,300	36.12	9,300	32.24
310	967.2	1,310	228.9	2,310	129.8	3,310	90.58	4,310	69.56	5,310	56.46	6,310	47.52	7,310	41.02	8,310	36.08	9,310	32.20
320	936.9	1,320	227.1	2,320	129.2	3,320	90.31	4,320	69.40	5,320	56.36	6,320	47.44	7,320	40.96	8,320	36.04	9,320	32.17
330	908.6	1,330	225.4	2,330	128.7	3,330	90.04	4,330	69.24	5,330	56.25	6,330	47.36	7,330	40.90	8,330	35.99	9,330	32.14
340	881.8	1,340	223.7	2,340	128.1	3,340	89.77	4,340	69.08	5,340	56.15	6,340	47.29	7,340	40.85	8,340	35.95	9,340	32.10
350	856.6	1,350	222.1	2,350	127.6	3,350	89.50	4,350	68.92	5,350	56.04	6,350	47.22	7,350	40.79	8,350	35.91	9,350	32.07
360	832.8	1,360	220.4	2,360	127.0	3,360	89.23	4,360	68.77	5,360	55.94	6,360	47.14	7,360	40.74	8,360	35.86	9,360	32.03
370	810.3	1,370	218.8	2,370	126.5	3,370	88.97	4,370	68.61	5,370	55.83	6,370	47.07	7,370	40.68	8,370	35.82	9,370	32.00
380	789.0	1,380	217.3	2,380	126.0	3,380	88.70	4,380	68.45	5,380	55.73	6,380	46.99	7,380	40.63	8,380	35.78	9,380	31.96
390	768.8	1,390	215.7	2,390	125.4	3,390	88.44	4,390	68.30	5,390	55.63	6,390	46.92	7,390	40.57	8,390	35.74	9,390	31.93
400	749.6	1,400	214.2	2,400	124.9	3,400	88.18	4,400	68.14	5,400	55.52	6,400	46.85	7,400	40.52	8,400	35.69	9,400	31.90
410	731.3	1,410	212.6	2,410	124.4	3,410	87.92	4,410	67.99	5,410	55.42	6,410	46.77	7,410	40.46	8,410	35.65	9,410	31.86
420	713.9	1,420	211.1	2,420	123.9	3,420	87.67	4,420	67.83	5,420	55.32	6,420	46.70	7,420	40.41	8,420	35.61	9,420	31.83
430	697.3	1,430	209.7	2,430	123.4	3,430	87.41	4,430	67.68	5,430	55.22	6,430	46.63	7,430	40.35	8,430	35.57	9,430	31.79
440	681.4	1,440	208.2	2,440	122.9	3,440	87.16	4,440	67.53	5,440	55.11	6,440	46.56	7,440	40.30	8,440	35.52	9,440	31.76
450	666.3	1,450	206.8	2,450	122.4	3,450	86.90	4,450	67.38	5,450	55.01	6,450	46.48	7,450	40.24	8,450	35.48	9,450	31.73
460	651.8	1,460	205.4	2,460	121.9	3,460	86.65	4,460	67.22	5,460	54.91	6,460	46.41	7,460	40.19	8,460	35.44	9,460	31.69
470	637.9	1,470	204.0	2,470	121.4	3,470	86.40	4,470	67.07	5,470	54.81	6,470	46.34	7,470	40.14	8,470	35.40	9,470	31.66
480	624.6	1,480	202.6	2,480	120.9	3,480	86.16	4,480	66.92	5,480	54.71	6,480	46.27	7,480	40.08	8,480	35.36	9,480	31.63
490	611.9	1,490	201.2	2,490	120.4	3,490	85.91	4,490	66.78	5,490	54.61	6,490	46.20	7,490	40.03	8,490	35.31	9,490	31.59
500	599.6	1,500	199.9	2,500	119.9	3,500	85.66	4,500	66.63	5,500	54.51	6,500	46.13	7,500	39.98	8,500	35.27	9,500	31.56
510	587.9	1,510	198.6	2,510	119.5	3,510	85.42	4,510	66.48	5,510	54.41	6,510	46.06	7,510	39.92	8,510	35.23	9,510	31.53
520	576.6	1,520	197.2	2,520	119.0	3,520	85.18	4,520	66.33	5,520	54.32	6,520	45.98	7,520	39.87	8,520	35.19	9,520	31.49
530	565.7	1,530	196.0	2,530	118.5	3,530	84.94	4,530	66.19	5,530	54.22	6,530	45.91	7,530	39.82	8,530	35.15	9,530	31.46
540	555.2	1,540	194.7	2,540	118.0	3,540	84.70	4,540	66.04	5,540	54.12	6,540	45.84	7,540	39.76	8,540	35.11	9,540	31.43
550	545.1	1,550	193.4	2,550	117.6	3,550	84.46	4,550	65.89	5,550	54.02	6,550	45.77	7,550	39.71	8,550	35.07	9,550	31.39
560	535.4	1,560	192.2	2,560	117.1	3,560	84.22	4,560	65.75	5,560	53.92	6,560	45.70	7,560	39.66	8,560	35.03	9,560	31.36
570	526.0	1,570	191.0	2,570	116.7	3,570	83.98	4,570	65.61	5,570	53.83	6,570	45.63	7,570	39.61	8,570	34.98	9,570	31.33
580	516.9	1,580	189.8	2,580	116.2	3,580	83.75	4,580	65.46	5,580	53.73	6,580	45.57	7,580	39.55	8,580	34.94	9,580	31.30
590	508.2	1,590	188.6	2,590	115.8	3,590	83.52	4,590	65.32	5,590	53.64	6,590	45.50	7,590	39.50	8,590	34.90	9,590	31.26
600	499.7	1,600	187.4	2,600	115.3	3,600	83.28	4,600	65.18	5,600	53.54	6,600	45.43	7,600	39.45	8,600	34.86	9,600	31.23
610	491.5	1,610	186.2	2,610	114.9	3,610	83.05	4,610	65.04	5,610	53.44	6,610	45.36	7,610	39.40	8,610	34.82	9,610	31.20
620	483.6	1,620	185.1	2,620	114.4	3,620	82.82	4,620	64.90	5,620	53.35	6,620	45.29	7,620	39.35	8,620	34.78	9,620	31.17
630	475.9	1,630	183.9	2,630	114.0	3,630	82.60	4,630	64.76	5,630	53.25	6,630	45.22	7,630	39.29	8,630	34.74	9,630	31.13
640	468.5	1,640	182.8	2,640	113.6	3,640	82.37	4,640	64.62	5,640	53.16	6,640	45.15	7,640	39.24	8,640	34.70	9,640	31.10
650	461.3	1,650	181.7	2,650	113.1	3,650	82.14	4,650	64.48	5,650	53.07	6,650	45.09	7,650	39.19	8,650	34.66	9,650	31.07
660	454.3	1,660	180.6	2,660	112.7	3,660	81.92	4,660	64.34	5,660	52.97	6,660	45.02	7,660	39.14	8,660	34.62	9,660	31.04
670	447.5	1,670	179.5	2,670	112.3	3,670	81.70	4,670	64.20	5,670	52.88	6,670	44.95	7,670	39.09	8,670	34.58	9,670	31.01
680	440.9	1,680	178.5	2,680	111.9	3,680	81.47	4,680	64.06	5,680	52.79	6,680	44.88	7,680	39.04	8,680	34.54	9,680	30.97
690	434.5	1,690	177.4	2,690	111.5	3,690	81.25	4,690	63.93	5,690	52.69	6,690	44.82	7,690	38.99	8,690	34.50	9,690	30.94
700	428.3	1,700	176.4	2,700	111.0	3,700	81.03	4,700	63.79	5,700	52.60	6,700	44.75	7,700	38.94	8,700	34.46	9,700	30.91
710	422.3	1,710	175.3	2,710	110.6	3,710	80.81	4,710	63.66	5,710	52.51	6,710	44.68	7,710	38.89	8,710	34.42	9,710	30.88
720	416.4	1,720	174.3	2,720	110.2	3,720	80.60	4,720	63.52	5,720	52.42	6,720	44.62	7,720	38.84	8,720	34.38	9,720	30.85
730	410.7	1,730	173.3	2,730	109.8	3,730	80.38	4,730	63.39	5,730	52.32	6,730	44.55	7,730	38.79	8,730	34.34	9,730	30.81
740	405.2	1,740	172.3	2,740	109.4	3,740	80.17	4,740	63.25	5,740	52.23	6,740	44.48	7,740	38.74	8,740	34.30	9,740	30.78
750	399.8	1,750	171.3	2,750	109.0	3,750	79.95	4,750	63.12	5,750	52.14	6,750	44.42	7,750	38.69	8,750	34.27	9,750	30.75
760	394.5	1,760	170.4	2,760	108.6	3,760	79.74	4,760	62.99	5,760	52.05	6,760	44.35	7,760	38.64	8,760	34.23	9,760	30.72
770	389.4	1,770	169.4	2,770	108.2	3,770	79.53	4,770	62.86	5,770	51.96	6,770	44.29	7,770	38.59	8,770	34.19	9,770	30.69
780	384.4	1,780	168.4	2,780	107.8	3,780	79.32	4,780	62.72	5,780	51.87	6,780	44.22	7,780	38.54	8,780	34.15	9,780	30.66
790	379.5	1,790	167.5	2,790	107.5	3,790	79.11	4,790	62.59	5,790	51.78	6,790	44.16	7,790	38.49	8,790	34.11	9,790	30.63
800	374.8	1,800	166.6	2,800	107.1	3,800	78.90	4,800	62.46	5,800	51.69	6,800	44.09	7,800	38.44	8,800	34.07	9,800	30.59
810	370.2	1,810	165.6	2,810	106.7	3,810	78.69	4,810	62.33	5,810	51.60	6,810	44.03	7,810	38.39	8,810	34.03	9,810	30.56
820	365.6	1,820	164.7	2,820	106.3	3,820	78.49	4,820	62.20	5,820	51.52	6,820	43.96	7,820	38.34	8,820	33.99	9,820	30.53
830	361.2	1,830	163.8	2,830	105.9	3,830	78.28	4,830	62.07	5,830	51.43	6,830	43.90	7,830	38.29	8,830	33.95	9,830	30.50
840	356.9	1,840	162.9	2,840	105.6	3,840	78.08	4,840	61.95	5,840	51.34	6,840	43.83	7,840	38.24	8,840	33.92	9,840	30.47
850	352.7	1,850	162.1	2,850	105.2	3,850	77.88	4,850	61.82	5,850	51.25	6,850	43.77	7,850	38.19	8,850	33.88	9,850	30.44
860	348.6	1,860	161.2	2,860	104.8	3,860	77.67	4,860	61.69	5,860	51.16	6,860	43.71	7,860	38.14	8,860	33.84	9,860	30.41
870	344.6	1,870	160.3	2,870	104.5	3,870	77.47	4,870	61.56	5,870	51.08	6,870	43.64	7,870	38.10	8,870	33.80	9,870	30.38
880	340.7	1,880	159.5	2,880	104.1	3,880	77.27	4,880	61.44	5,880	50.99	6,880	43.58	7,880	38.05	8,880	33.76	9,880	30.35
890	336.9	1,890	158.6	2,890	103.7	3,890	77.07	4,890	61.31	5,890	50.90	6,890	43.52	7,890	38.00	8,890	33.73	9,890	30.32
900	333.1	1,900	157.8	2,900	103.4	3,900	76.88	4,900	61.19	5,900	50.82	6,900	43.45	7,900	37.95	8,900	33.69	9,900	30.28
910	329.5	1,910	157.0	2,910	103.0	3,910	76.68	4,910	61.06	5,910	50.73	6,910	43.39	7,910	37.90	8,910	33.65	9,910	30.25
920	325.9	1,920	156.2	2,920	102.7	3,920	76.48	4,920	60.94	5,920	50.65	6,920	43.33	7,920	37.86	8,920	33.61	9,920	30.22
930	322.4	1,930	155.3	2,930	102.3	3,930	76.29	4,930	60.82	5,930	50.56	6,930	43.26	7,930	37.81	8,930	33.57	9,930	30.19
940	319.0	1,940	154.5	2,940	102.0	3,940	76.10	4,940	60.69	5,940	50.47	6,940	43.20	7,940	37.76	8,940	33.54	9,940	30.16
950	315.6	1,950	153.8	2,950	101.6	3,950	75.90	4,950	60.57	5,950	50.39	6,950	43.14	7,950	37.71	8,950	33.50	9,950	30.13
960	312.3	1,960	153.0	2,960	101.3	3,960	75.71	4,960	60.45	5,960	50.31	6,960	43.08	7,960	37.67	8,960	33.46	9,960	30.10
970	309.1	1,970	152.2	2,970	100.9	3,970	75.52	4,970	60.33	5,970	50.22	6,970	43.02	7,970	37.62	8,970	33.42	9,970	30.07
980	303.9	1,980	151.4	2,980	100.6	3,980	75.33	4,980	60.20	5,980	50.14	6,980	42.95	7,980	37.57	8,980	33.39	9,980	30.04
990	302.8	1,990	150.7	2,990	100.3	3,990	75.14	4,990	60.08	5,990	50.05	6,990	42.89	7,990	37.52	8,990	33.35	9,990	30.01
1,000	299.8	2,000	149.9	3,000	99.94	4,000	74.96	5,000	59.96	6,000	49.97	7,000	42.83	8,000	37.48	9,000	33.31	10,000	29.98

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Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Class B Amplifier Condition

THE FOLLOWING STATEMENT appeared in a magazine in an article discussing Class B amplifiers: "Dry batteries are frequently used to supply grid bias to Class B amplifiers, but due to the grid current they are virtually on 'charge' during operation, so that they slowly build up abnormal voltages and become noisy in a relatively short time." It is not within my experience that B or C batteries can be put on charge even intentionally, to build up the voltage.—W. A. B., Hempstead, N. Y.

The B or C batteries are primary batteries and can not be recharged. Another point about the quotation, that you do not query specifically, is that concerning grid current. The only occasion for using dry batteries for biasing the Class B tubes would be to impress a negative bias so high that the plate current is virtually cut off, except and until the signal voltage swings it positive in respect to the steady negative bias. But this is negative even in respect to the usual bias recommended for Class A amplification, and even if the swing is much beyond that, there should be no grid current. The 46 has been brought out to avoid the necessity for a separate biasing supply (C eliminator) or batteries, and the plate current at zero is nearly zero because the plate resistance is so high. Hence in operation the grids always are positive in respect to B minus, and much grid current may flow—always there will be some. The high negative bias system, using different tubes, and biasing batteries, or C eliminator, does not produce this grid current flow. For instance, if the '45 tube is used, the negative bias would be a little more than 120 volts, and there would be no grid current until the grid actually swings positive, which it is never likely to do in a home receiver.

* * *

High Bias for Vari-Mus

IN THE JULY 30th issue of RADIO WORLD, in the Radio University section, page 16, I noticed a question from D. B., Ames, Iowa, regarding his set and the trouble he had with the bias on the r-f tubes. But what I am wondering about is why he has 6 volts on the grids of the variable mu tubes, in the r-f amplifier. He has a 600-ohm limiting resistor, and gets 6 volts negative bias. The tube chart specifies 1.5 volts bias for this tube at 180 plate potential and 75 screen. It specifies only 3 volts bias at 200 volts plate and 90 screen. Why the 6 volts bias then? I noticed you did not question this in the article. I thought you might know of some reason for this high bias. I use 150-ohm limiting resistor for three tubes—H. J. Richardson, Atlantic, Iowa.

The bias values specified in the tube charts have to do with minimum bias. For certain plate and screen voltages the negative bias should not be less than specified values. When dealing with remote cut-off tubes it is obvious that the value of bias may be considerably greater than the recommended value, as the mutual conductance does not decline rapidly with bias increase. Even at 30 volts negative bias the mutual conductance is not zero. One reason why biases higher than those specified in tube charts sometimes must be used is that the shielding and filtering are not as complete as they might be and the amplification has to be reduced accordingly, to make the set stable and operable. Increasing the bias is one permissible way of doing this, when using variable mu tubes.

* * *

Screen Voltage for 57

WHEN THE 224 was used as detector or audio amplifier I remember that you were the first to point out that the screen voltage may be considerably less than the value then recommended in tube-charts, and improved detecting efficiency would result. Is the same true of the 57 tube?—H. T., Pensacola, Fla.

We have not completed our laboratory tests of the 57, but when we do so we shall publish the curves, and state the result interpretively. Meanwhile, however, experiments made on receivers show that in general the same situation obtains. One reason low screen voltages afford good results is that there is a smaller impedance through which negative feedback takes place, and even when this impedance is part of a normally low-resistance voltage divider, although the reduction is greater in proportion when the series resistor method is used for lowering the B voltage to screen values. Low notes are amplified much better when this impedance is low, and the problem is to get it low enough to obviate the need for large bypass capacities, or, rather, so that only impractically large capacities (100 mfd., for instance) would reduce the already low impedance any considerable amount. The lower screen voltage seems a detriment to a first detector of a superheterodyne, for of course there only radio frequencies are concerned. The detector of audio frequencies, or audio frequency amplifier, is what is meant exclusively, in relationship to the low-screen voltage discussion.

* * *

Tracking Fails Him

IN THE SUPERHETERODYNE I have built I have had no end of trouble in tracking, although you have printed an article on how to track ("Padding an Oscillator," April 16th, 1932, issue). Here are the symptoms. The intermediate frequency being 386 kc, the tuner settings 89 for WMCA, 72 for WEAF, 65 for WJZ and 43 for WABC, 12 for WFOX. I can not get the oscillator to track. If I set the series padding condenser so that everything is O. K. at WMCA then WEAF comes in at 65, with a squeal, instead of at 72, and there is the same trouble, in the same direction, to about 1100 kc, after which results are pretty good. When I adjust for the low frequency end I set the padding condenser, and for the high frequency end I adjust the trimmers on the r-f and first detector tubes. As a test, an exception, I adjusted the oscillator trimmer too at this end, but found that the other end was thrown off. A solution would be deeply appreciated.—J. E., Mt. Vernon, N. Y.

There is too much inductance on the oscillator secondary. When you set the series padding condenser for WMCA, 570 kc, you have proper tracking for this one frequency, dial reading 89. Thus the oscillator is working at 956 kc, the sum of the signal and intermediate frequencies. It could not be the difference because that is far out of scope. When you check at WEAF, 660 kc, you find that the dial setting is 65, instead of 72. Therefore at 65 the oscillator frequency is 1046 kc, whereas to bring in WJZ, 760 kc, at this point, as determined by the tuner tests you made, the oscillation frequency generated should be 1146. So your oscillator frequencies are too low, and this result obtains when the inductance of the oscillator secondary is too high. As you get nearer the higher frequencies of the broadcast band the series padding condenser becomes less and less effective, until near the end it has virtually no effect, because it is a large condenser in series with a much smaller one. The additional fact that you must turn down the r-f trimmers confirms the finding that the oscillator secondary has too much inductance. You may select a test frequency of 1500, 1400 kc or similar frequency and remove turns from the oscillator secondary until the dial setting as found on the tuner results in greatest volume to bring in the test frequency, with the oscillator trimmer half way out. After this is done do not molest the oscillator trimmer, but adjust the padding condenser for WMCA. Since you have tied down one extreme, and now the other, the tracking should be good. The trimmers for r-f and modulator may be reset after the padding has been done for WMCA. Remember that if stations come in on the super at too low dial settings, after correct padding for the low frequency end, there is too much inductance on the oscillator secondary.

* * *

Common Bias

SINCE THE 57 TUBE takes 6 volts negative bias for detection, and since the 56 as oscillator may take the same plate voltage as goes to screens of the other tubes, and thus may be biased 6 volts harmlessly, may I not use the same biasing resistor and bypass condenser for both purposes?—R. D. W., Portland, Me.

Yes, this is practical, but it is not recommended for circuits that are either experimental or are of your own design, since full freedom to alter biases should be preserved, especially as circumstances may require that bias changes be made in opposite directions, which cannot be done under the common bias method. When oscillation trouble arises in circuits that should be stable it is often very convenient to increase the negative bias to get rid of the trouble. Also, the detecting point need not necessarily be 6 volts for the 57, even at rated screen and plate voltages. If the tube is used as first detector 6 volts are suggested, but if for a detector in a t-r-f set, the biasing voltage may be lowered. About 3.5 volts was found to be a very sensitive bias point.

Kilocycle-Meter Conversion Table

[*Refer to Table Printed on Preceding page*]

The conversion table printed on the preceding page is highly accurate, because worked out by the factor 299,820. Most tables are based on the factor 300,000, which is erroneous to 6 parts in 10,000.

The table is entirely reversible, for instance, 10 meters equal 29,982 kc., or 29,982 meters equal 10 kc. Any quantities not included in the table may be read by shifting the decimal point. If moved to the right for frequency the point is moved to the left for wavelength, and vice versa. The shift is therefore in opposite directions.

The factor 299,820 is based on the velocity of a radio wave, which is equal to the velocity of light, or 299,820,000 meters per second. By dropping the three ciphers (dividing by 1,000), the factor 299,820 is used, and the answer reads in kilocycles.

Wavelength in meters is equal to velocity divided by frequency. Frequency in cycles is equal to velocity divided by wavelength.

A THOUGHT FOR THE WEEK

SONGWRITERS are coming into their own. What a difference between the days of Stephen Foster, who lived in Bowery lodging houses, and the lesser writers of today, many of whom drive autos, live in smart country houses and belong to expensive clubs. The thought comes on the heels of the announcement that the American Society of Composers, Authors and Publishers, which controls the copyrights of most of our modern music, wants the broadcasters, who now are paying $900,000 a year in royalties, to turn over to the society 5% of the gross amounts paid for programs by commercial sponsors.

Don't make any mistake about one thing—the A. S. C. A. P. has most of the valuable copyrights tied in a hard knot. But its members know that the broadcasters have one questionable resort—they could cut out all copyrighted material over the air and play only the classic and popular numbers which long ago passed out of the copyright stage, and also that they have the privilege of hiring their own composers and authors and evolving an entirely new list of songs and compositions and controlling the copyrights themselves under an arrangement with the writers. How little they think of this plan is evidenced by the fact that they have offered the A. S. C. A. P. a lump sum of $1,250,000 for the year beginning September 1 next.

It's a pretty fight as it stands—and here's a wager of an Irving Berlin against a Schubert that between now and Labor Day the whole thing will be ironed out—one side getting as much as it can and the other paying as little as it must.

RADIO WORLD

The First and Only National Radio Weekly

Eleventh Year

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 and business manager; J. E. Anderson, technical editor; J. Murray Barron, advertising manager.

Peck's Pickup

THIS is hardly the time to expect much enthusiasm regarding television, since it is the off-season of radio, amid a depression besides, and there has been much barking up the television tree from which not much emerged. Yet science has to move on its grinding way, like a glacier, and if the times are not propitious they are out of step with science.

So it behooves all interested in television's present and future status to study the development of William Hoyt Peck, who recently evolved a scanning system for use at the transmitter. This follows a similar system he successfully demonstrated six months ago for reception purposes.

The transmitting scanner consists of a wheel or disc, reflecting lenses being placed circularly just inside the periphery. The lenses are tilted in their beds so that scanning results, hence the circular formation, instead of the spiral. The subject is flood-lighted. The disc is rotated, the subject is reflected in the lenses to a single photo cell, and by masking the cell only one picture element at a time can get through the aperture. This prevents reflecting the entire picture into the cell at all times, whereby no scanning would be possible.

Any one who has viewed television as sent out today realizes that it is far below the standard required for establishing television on a commercial rather than merely experimental basis. The flying spot method of pick-up retouches the picture with all the blemishes of a desecrator. Some direct pickup method is assuredly necessary, and Mr. Peck, noted optical authority, who has commercialized his optics in the moving picture field, now offers television its first real transmission opportunity, enabling pictures to be sent out that can be on a par with the best receiving scanning system.

Now when Mr. Peck starts his reflecting lens disc going at his New York hotel headquarters his demonstration is so excellent that his system, faithful and impartial, shows up the defects of the transmission pickup in a manner to smite the conscience of the transmitting stations.

Better Timing

EDDIE TOLAN, Detroit negro, won the 100-meter dash at the Olympic Games at Los Angeles in 10.3 seconds, equalling the world record. But did he? That is, did he run the distance in just 10.3 seconds, and if so, how does any one know?

Stop watches are used by the timers. For each race there are three timers. That in itself is an admission that there is a basis for error. In fact, there are at least two bases. They are the inaccuracy of the timepieces and the difference in nervous reactions. A third possible error arises from the fact that the watches 100 per cent accuracy assumed, stop down to only one-tenth of a second, and though this used to be considered pretty close work, precision methods have made tenth-second timing obsolete as a work of science, though still prevailing at athletic games.

It is to be hoped that at the next Olympic meet that photo-electric cells will be used in conjunction with the timing. There would be no need to check one against another, as in a system of admitted inaccuracy, but the time of the winner would be established as a certainty, easily to one one-hundredth of a second, and if desired even to one one-thousandth of a second. Moreover, the finishes would be recorded, which could be done photographically in conjunction with the cell, so there would be no dead heats, which we believe are nearly always optical rather than real. With a photo-cell timing system, at the speed of Tolan in his winning race, if he had been only 0.4 inch ahead of Ralph Metcalfe, instead of an obvious matter of inches, that fact could have been recorded, in terms of time. It is altogether reasonable to expect that two runners only 0.4 inch part at the finish would be decreed to have run a dead heat by all present systems.

At present, taking the timing system as it exists, a sprinter has to better a record by at least one-tenth of a second before he breaks the record. It does not seem fair that if he betters it by only one-twentieth of a second that he should be denied the honor of world record holder, or indeed perhaps be timed at one-tenth of a second slower than what he actually accomplished, which can happen due to nervous and chronological handicaps of timers and their pieces.

It becomes increasingly difficult for runners to break records, as each year they have to compete against more and more previous competition. The photo-cell timer would make their record-quest easier and, more important, really scientific.

Band Extension

There is preliminary discussion, in which the United States has an unreleased report of a commission, about extending the broadcast band to lower frequencies. It is hoped no hasty action will be taken, even though Europe is expected to extend its band.

Forum

The Voices of Los Angeles

I HAVE BEEN WONDERING lately what you were trying to slip over on us in describing with such laudation a supposedly new radio circuit by Father Daley. If you could remember back to about 1926 you could recall this same circuit described in radio magazines by Loftin and White. That system of stage coupling and phase shifting is surely not new.

Also, if a person goes by the hookup as you gave it and the descriptive matter with it as a guide, he could only conclude that the set as you describe it is an impossibility to build. Either you or Father Daley are holding out on data, or else you are careless. You could not build the set as diagramed with the standard model of metal shaft tuning condensers shown in the picture and nowhere in the reading matter do you state that all rotors must be insulated from each other as well as from the stators, ground and B minus. One would suppose from the articles that standard condensers were used. I have yet to find a condenser on the market such as are shown in the pictures which does have the rotors segregated. The Remler is so built but it looks nothing like the pictures.

Also why the articles about those nice new tubes and hookups, when there are no such animals, and maybe never will be.

RADIO WORLD is a nice little magazine but you surely do go off half cocked sometimes and fill up the space with stuff that you know no one will ever be able to put to use. You know right well that you nor any one has ever built some of the stuff you describe, and no one ever could. Any one can draw a diagram. Best wishes.

B. P. BOONE,
Los Angeles, Calif.

"Examination of the circuit invented by Father Daley reveals a similarity to the Loftin-White method of constant coupling which appeared first in the August 21st, 1926, issue of RADIO WORLD. . . . Father Daley's circuit uses more stages. . . . Therefore the results are not necessarily identical."—RADIO WORLD, June 25th, 1932, page 11, col. 2.

All diagrams showed the condenser rotors were not conductively coupled, and the receivers illustrated contained condensers of familiar appearance but the insulation existed nevertheless. Perhaps the insulation should have been stressed.

The new tubes do indeed exist and are advertised regularly in our columns, excepting the Wunderlich tube, manufactured by Arcturus Radio Tube Corp., 720 Freylinghuysen Ave., Newark, N. J.

* * *

I CONSIDER RADIO WORLD the best publication to be had at any price.

JOHN BARRON,
Prop., Radio Standard Laboratories,
3320 W. Temple St., Los Angeles, Calif.

* * *

Values Tube Data

YOUR PROMPT and comprehensive information about new tubes and their uses is deeply appreciated. In working with the new tubes there are two requirements. One is that the technical data about the tubes be at hand. In furnishing this you have done your part. The other is that experience with the tubes is necessary. In part you contribute to this, also, but the experimenter has to do a lot of work himself on original circuits, as no one source can develop all the uses.

I must say that the constant-voltage-drop features of the new mercury vapor rectifiers is very welcome. I see that the 83 is like the 82, only it stands more current. My own experience is that the 82 should be worked under 100 ma, and I can see why the other tube was brought out.

BERTRAM REINITZ,
18 Twenty-first Street,
Brooklyn, N. Y.

STATION SPARKS

By Alice Remsen

The Gift of Love

For Charles Carlile

WABC, Mondays, Wednesdays and Fridays, 11:00 p.m.

Dear, when you came to me on wings of song,
You brought me heaven's gift of love along.
Banished my sorrow, brought me happiness,
Fraught with the passion of your sweet caress.

I had no faith until you taught me how to pray;
I could not see until you came to light my way;
My ears were deaf to every melody divine,
Until your voice had wrought sweet harmony with mine.

Now I am rich beyond all human need;
Now I have faith that needs no book nor creed;
Now my blind eyes at last have learned to see,
Since you have brought your gift of love to me. —A. R.

* * *

CHARLES CARLILE, Columbia's romantic tenor, has brought the gift of love into many a listener's heart with his beautiful singing of old and new love songs. Mr. Carlile has an irresistible appeal in his voice that should bring him to the favorable attention of some sponsor needing a singer of his type.

* * *

News of the Studios

Listened in to Virginia Rea, formerly known as Olive Palmer, on a recent NBC Artists Service Concert, and found her voice just as beautiful as ever, but alas, the lyrics of her numbers are still indistinguishable; in coloratura work this fault may be condoned, but in ballads and lyrical compositions it is unpardonable. Miss Rea has faultless production of tone and I'm sure, with a little work, she could very easily acquire better articulation, without sacrificing the purity of her lovely voice.

* * *

The Death Valley Days sponsor decided a short while ago that a change of program might be a good thing, so went ahead and put on a musical program instead of the usual dramatic sketch. More than 6,000 letters came in, protesting against the change; now they are running a contest to decide the issue, and it looks very much like drama winning over music.

* * *

WABC

Arthur Tracy has been selected to take the place of Alex Gray on the Chesterfield program, during the latter singer's vacation. Tracy recently lost a suit brought against him by his former manager; thereby establishing a precedent in radio, and proving that all contracts are not so much paper, and that if you enter into an agreement, the wisest plan is to live up to it.

Columbia's "Funnyboners" refuse to rest these tepid days—just in one day they recently took part in two broadcasts, made four vaudeville appearances and then spent several hours before a camera making a motion picture short.

* * *

WOR

Had a delightful time at Playland, Rye Beach, N. Y., recently. Will Osborne, whose delightful dance music is relayed over WOR, directs his Playland orchestra in the beautiful Casino ballroom overlooking the ocean; the cuisine leaves nothing to be desired; the service is excellent and charges moderate. Will Osborne is an attractive looking youngster, full of pep, with a pleasing personality and a definite rhythm to his conducting; his boys are smart, fine musicians and good-humored workers. His music may be heard via WOR, Sundays, 7:00 p.m.; Mondays, Tuesdays, Wednesdays, Thursdays and Fridays at 6:30 p.m.; and Saturdays at 9:45 p.m. Tune in; you'll like him!

* * *

An Italian "Amos 'n' Andy" act comes to WOR in the persons of Tony, played by William Edmunds, and Angelo, played by Bruce Carter, who is also the author of the sketches. It is a vivid, colorful characterization of two typical sons of Italy, whose pilgrimage to America to further their musical talents has met with disappointment and who have turned to the ice, coal and wood business to find a livelihood. They may be heard every Tuesday and Thursday at 5:45 p.m.

* * *

Sidelights

TITO GUIZAR, Columbia's Mexican tenor, captained a baseball team when he was a student at the University of Mexico. . . JAY C. FLIPPEN has a parody for every popular song as soon as it comes out. . . LeBERT LOMBARDO has purchased a forty-foot cruiser. . . JACK ARTHUR CAMPBELL HART has bought a speed boat. . . CONNIE BOSWELL always takes an hour and a half in which to eat her dinner. . . LOU RADERMAN shot a 79 the other day. . . BURNS AND ALLEN have completed their roles in "The Big Broadcast" and are on their way to New York. . . IRENE BEASLEY took her vacation in her recently purchased roadster; she went to Memphis to see her folks. . . NATHANIEL SHILKRET and ROBERT SIMON are collaborating on an operetta for motion pictures. . . WILLIAM HALL spends five hours daily in swimming pool and gymnasium; he tips the scales at 204 and is six feet, five and a half tall. . . DALE WIMBROW is making personal appearances over various local stations. . . RUTH ETTING likes to sun herself. . . DONALD NOVIS likes to fish, swim, ride and play tennis. . . LANNY ROSS writes songs; good ones, too. . . PHILLIPS H. LORD has purchased a new estate at Willet's Point, Long Island. . . PATTI PICKENS admires Ed Wynn and is somewhat of a punster herself. . . JOHNNY MARVIN was born in a covered wagon in what is now Oklahoma. . . OLSEN and JOHNSON both went to Northwestern University. . . AILEEN CLARK is a wizard at checkers. . . WILLIAM DALY was once a magazine editor. . . DARL BETHMAN has the longest name in radio—it is Charles Friedrich Eitel Darlington Ludwig Von Bethmann Hollweig; he got that way as the descendant of a German baron. . . LOWELL THOMAS keeps a pair of bucking bronchos on his Dutchess County farm. . . JOHN GARRICK was born in Brighton, England. . . WESTBROOK VAN VOORHIS has won many medals for revolver and rifle shooting. . . JACK ARTHUR ran away from school to join the Canadian troops and go to war. . . MARIE O'FLYNN starred in the movie version of "Jane Eyre". . . DAVE CASEM got forty-six sea bass in two hours during his vacation at Wildwood, N. J.

The Radio Rialto

Still hotter than blazes, the only cool places in the world are the radio studios of major stations—they have excellent cooling systems. . . . In the elevator at NBC: Who's that? Oh, yes, George Dilworth. "How are you, George? and how's Gitla?—vacation, lucky chap, where? Nova Scotia! Don't I envy you!" . . . On the 13th floor: What's the argument? Oh, just a couple of pianists talking about golf scores; Joe Kahn and Milan Smolen, both good players—piano I mean. . . . There's Tom Neeley, of the program department, always in a hurry; if he gets much thinner he'll float . . . and Bill Young, ditto, ditto, ditto! . . . Since the cut in personnel, everybody at NBC is doing the job of at least two men, with cut salaries, too. . . What a woild! . . . On the 12th floor, studios X.Y.Z. . . Auditions in progress; a few scared looking tyros sitting outside the fatal doors. . . Not much chance for them, but hope springs eternal—especially in radio. . . I know that mop of silver hair —Kelvin Keech, the ukulele-playing announcer. . . . There's Johnny Royal walking down the corridor; he looks thinner than when last seen in Cleveland, in the good old days of vaudeville and no worry. . . . "Hello! Marcella Shields, what say to a bite downstairs in the drug store?"... "Gee, Alice," says Marcella, "I'd like to spend all day in this elevator; the breeze is simply grand" . . . After iced tea and a cheese sandwich out on the old hot pavement (I mean sidewalk) again.

Over to Columbia. . . Much quieter here. . . Cool reception room with lots of windows, on the 22nd floor. . . What a nice-looking boy Fred Uttal is; good announcer, too, and can he imitate the Colonel and Budd—I'll say he can. . . "Hello, Helen Nugent and Evelyn McGregor," two contraltos, but they're friends just the same; but that's nothing to go by; I'm a contralto, too, and I like 'em both. . . Some mail for me. Oh, gosh! That ends my rambling for the day; but just a second—here's a letter from a very dear fan of mine and in it is a comment on the modesty of Bob Taplinger; seems to radiate through his "Meet the Artist" program. . Yes, Bob is a very unassuming chap, sincere and likable. Don't blame you for never missing him. . . Well, for land's sake, if it isn't the Honorable Judge John White—in other words, Johnny White, of Feist's! . "Hello, Johnny! That Masquerade song of yours is a peach. What! You've got some new ones? All right, I'll be over tomorrow"—and that's that down Radio Row!

* * *

Biographical Brevities

Fred Uttal

Born in New York in 1906. . . Father was manager of a large shoe company. . . After completing high school, attended Columbia University. . . Became a salesman for most everything. . . Every city in the United States with a population of over 150,000 inhabitants has seen Fred on at least four occasions. . . Red caps used to call him by his first name. . . Has sold punching bags, enamel ware, greeting cards and electric dish-washers. The dishwasher called a halt on his career as traveling salesman

Then for two years he acted and directed in motion pictures; finally drifted into a WABC studio, took an audition and an hour later was on his way to Jones Beach to broadcast his first program. . . Hopes some day to be a writer. . . His hobby is an unusual one, likes to paint scenery for amateur theatricals. . . His spare time, if any, is spent reading biographies. . . He is tall—six feet—and very attractive—all the marks of a football player—except the bruises—wavy dark brown hair and deep-set brown eyes. . . Swimming and boating favorite sports. . . No superstitions. . . Hates formality. . . Fond of animals, with one exception—poodles! . . . Fond of a joke.

NATIONS UNITE TO SCAN WAVES IN THE ARCTIC

Washington.

The United States Government is preparing to send a group of scientists to the Arctic where, during the Second International Polar Year which extends to August 31, 1933, they will join with scientists from many nations in an effort to unlock the secrets held in this frozen region which have a direct bearing on commerce and communications, according to Capt. R. S. Patton, Director of the Coast and Geodetic Survey of the Commerce Department.

Important data having a bearing on the development of radio communication, through the study of the Kennelly-Heaviside layer; map making, as a result of information about earth's magnetism; the establishment of new airway routes, the Aurora Borealis, and weather forecasting will be gathered by these scientists.

Captain Patton explained that this is the Second Polar Year in history.

U. S. to Establish Station

The importance of this study to industry is indicated by the fact that Congress appropriated $30,000 to the State Department for transfer to the Department of Commerce for expenditure by the Coast and Geodetic Survey for these studies. This sum will be used for the establishment at College, near Fairbanks, Alaska, of a Polar Year Station.

The group of American scientists will be equipped to spend thirteen months.

Captain Patton pointed out that it has recently been found that the magnetic and electric conditions of the earth are very closely related to radio transmission. Radio transmission to a distance is dependent upon the existence of an ionized layer far above the earth which is known as the Kennelly-Heaviside layer, named in honor of its discoverers.

Radio experts say that this layer is in fact far from being a single layer at a constant height. There may be, in fact, several layers at the same time and even with a single layer there are rapid changes in elevation throughout the day.

Enlarged Data

These relations have been carefully studied in the regions where observations are accessible, but science has been handicapped greatly by almost complete lack of such observations, especially in the Arctic and Antarctic. The work to be done this next year at the Polar Station is expected to add greatly to the data on hand.

The commercial importance of further knowledge on this subject lies in the growing commerce in radio communication over long distances. Messages between the United States or Canada, to Europe and to some parts of the Orient, pass through the very regions where a number of the proposed Polar Stations are to be established. The station at Fairbanks is almost in a direct line between Washington and Tokyo.

Set Business Better

Salesmen for independent set manufacturers, featuring very low-priced midgets, report busines is a little better but collections remain slow.

Trade Warned About Shortage

Dealer stocks are low, according to figures compiled by the Department of Commerce. Also, factories have been working on reduced schedules. Therefore the possibility of a shortage of radio sets and parts, when there is a decided upturn in business, has been pointed out to dealers by trade sources. It is not expected the shortage, if it develops, will be serious, or of long duration, but the word has been passed on to dealers so they may act accordingly.

The recent upward trend of the stock market, reflecting the combination of causes developing during the intensive activities to restore business to normal, is taken as an encouraging sign. Moreover, some factories in other lines are increasing their personnel and production. An upturn in other lines, even if scattered, would be felt indirectly by radio by reason of increased consumer purchasing power.

AMATEUR RADIO 20 YEARS OLD

Amateur radio in the United States will be officially twenty years old on August 13th. During the two decades of its legal existence it has developed from a small group of isolated hobbyists to one of the most potent national and international radio influences.

It was the Radio Act of August 13th, 1912, that first recognized radio stations operated by individuals, for purposes other than commercial communication or experimentation, and made arrangements for the licensing of these stations.

Since that time, the number of amateurs in the United States has grown from a few hundred to well over thirty thousand. Even then they were several times more numerous than all other classes of stations; today they are by far the largest transmitting group in radio.

By the first part of 1914 the number of amateurs had increased to about 2,000, so satisfactory was their condition under the new radio law. Enforcement of its provisions by the government extended only to bare essentials; for the most part, they were self-governing, reciprocating this attitude with excellent self-regulation.

It was in 1914 that the amateur organization was founded by Hiram Percy Maxim, famous inventor and sound expert, who adopted the idea of relaying messages by amateur radio as its basis, and called it the American Radio Relay League, with headquarters in Hartford, Conn.

Amateur radio had been in existence long before it received Congressional recognition, however.

AUTOMATIC SOS DEMONSTRATED FOR SHIP'S USE

Washington.

Demonstrations of new automatic radio apparatus, which sends out SOS signals and gives the position and name of the ship without the aid of a wireless operator, have received considerable attention in Hamburg shipping circles, according to a report from Vice Consul Alan N. Steyne, Hamburg, made public by the Department of Commerce.

The new apparatus, designed primarily for ships not equipped with wireless facilities, is said to give the distress signal and the location of the vessel by means of a spark transmitter supplied with current by a hand-driven dynamo. The danger call letters, the data for direction finding, and the name of the vessel are fixed in the instrument, and the position of the ship is inserted in the apparatus, by means of large type figures, it is stated.

Message Read on Drum

The entire message to be transmitted can be read from an illuminated drum so as to prevent an incorrect signal being sent, it is said.

In order to obtain a greater range for the transmitter, three wave lengths are used, 30, 60 and 600 meters. Messages may be sent either in succession or simultaneously, it is claimed. These wave lengths were chosen, it is said, in view of the fact that 600 meters is the main wave length for S. O. S. signals; the 60 and 30 meter lengths afford long distance communication. It is further stated, that the shorter lengths are harmonic with the 600 meter wave and the aerial need not be readjusted for the shorter waves.

A small light for giving optical signals as well as illuminating the scene of the disaster, is mounted on the top of the water-tight cabinet containing the apparatus. Electricity is generated by the hand-driven dynamo giving the lamp a range of 200 meters.

Lifeboat Model

A smaller apparatus, similar to the one now on exhibition is being designed for use in lifeboats, it is said, eliminating all risk of failure due to the battery being submerged in water. The lifeboat apparatus may be operated by any person in the boat by simply turning the handle, and it is said that the housing of the apparatus is so water-tight that operation can continue in a swamped boat.

Tests of the apparatus for the larger boats, conducted in Hamburg, are said to have proved the device sufficiently robust for ship service. Two men operating the hand-driven generator were able to make the required revolutions to produce 100 watts without difficulty.

Tube List Prices

Type	Price List	Type	Price List				
				'22	3.15	58	1.65
				'24-A	1.65	'80	1.05
11	$3.00	'38	2.80	'26	.85	'81	5.20
12	3.00	'39	2.80	'27	1.05	82	1.30
112-A	1.55	'40	3.00	'30	1.65	'74	4.90
'20	3.00	'45	1.15	'31	1.65	'76	6.70
'71-A	.95	46	1.55	'32	2.35	'41	10.40
UV-'99	2.75	47	1.60	'33	2.80	'68	7.50
UX-'99	2.55	'50	6.20	'34	2.80	'64	2.10
'100-A	4.00	55	1.60	'35	1.65	'52	28.00
'01-A	.80	56	1.30	'36	2.80	'65	15.00
'10	7.25	57	1.65	'37	1.80	'66	10.50

STATION HELD AGENT OF LIFE INSURANCE CO.

Charleston, W. Va.

Attorney General Howard B. Lee has ruled that a station that broadcasts insurance talks for compensation based on resultant mail forwarded by the station to the insurance company is an agent of that company engaged in intrastate commerce. State Auditor Lawson requested an opinion. Mr. Lee set forth:

We have before us your letter of the 19th instant with the correspondence of your office with the Holt-Rowe Broadcasting Company of Fairmont, W. Va., regarding the advertisement of the Union Mutual Life Company of Des Moines, Iowa. You are concerned as to whether or not said Union Mutual Life Company is doing business in the State of West Virginia, and whether or not the Holt-Rowe Broadcasting Company of Fairmont, W. Va., is acting in the capacity of an agent of said insurance company.

It is contended that the business done by said Union Mutual Life Company is interstate commerce and that the radio communication requires a uniform system of control throughout the Nation which is exclusively vested in Congress and the agencies created by it.

Called Intrastate Transaction

No doubt this is true if the communication was broadcast from the home office in the State of Iowa, but the method used in broadcasting these advertisements is wholly of an intrastate character.

The Holt-Rowe Broadcasting Company is a West Virginia corporation and does its broadcasting for the Union Mutual Life Company from Fairmont in the State of West Virginia. It uses records and a program in advertising the Union Mutual Life Company of Des Moines, Iowa, and requests that communications be addressed to the Holt-Rowe Broadcasting Company of Fairmont, W. Va., which communications are sent to the Union Mutual Life Company of Des Moines, Iowa, and a compensation paid for each communication to the Holt-Rowe Broadcasting Company.

Agrees with Precedent

The system thus used clearly makes the Holt-Rowe Broadcasting Company an agent for the Union Mutual Life Company and the method of the latter constitutes intrastate business as contrasted with interstate business.

Business thus carried on cannot hide behind the phrase "interstate commerce" and carry on an intrastate business and escape the consequences of the latter.

This opinion is in keeping and not contrary to the holding and rules of the Federal Radio Commission and the case of Whitehurst v. Grimes, 21 F. (2nd) 787, and United States v. American Bond & Mortgage Company et al., 31 F. (2nd) 448, as the questions there involved the power to license which is under the control of Congress. The method of doing business determines the question of whether it is inter or intrastate.

We hold therefore that Holt-Rowe Broadcasting Company is an agent of the Union Mutual Life Company of Des Moines, Iowa, and that the business done by and through the former is intrastate.

20 Countries In World Ham Union

Admission during July to membership in the International Amateur Radio Union, federation of national amateur societies, of the Suomen Radioamatooriliito r.y. of Finland brings the total membership of the Union to twenty countries.

The international federation, organized at the Easter Congress in Paris, 1925, now with member-societies in all the principal nations of the world, represents nearly 50,000 amateur stations, by far the largest body in radio.

Each of the twenty national organizations it unites is non-commercial in character, and devoted solely to the promotion and coordination of two-way amateur radio communication.

The countries represented in the Union, including newly admitted Finland, include: the United States and Canada, by the American Radio Relay League, headquarters society of the Union: Spain, Italy, Germany, Denmark, Poland, Netherlands, New Zealand, Norway, Great Britain, Portugal, Belgium, France, South Africa, Finland, Sweden, Switzerland, Australia.

Station Changes

IN LIST BY FREQUENCIES

Changes in the "List of Broadcasting Stations by Frequencies," published in our issue of June 4th, 1932:

560 kc—WFI. Change owner to WFI Broadcasting Co.
660 kc—Delete WTIC.
680 kc—KPO—Change owner to Nat'l B'dg. Co., Inc.
760 kc—Delete WBAL.
830 kc—WHDH. Change location to Saugus, Mass.
890 kc—Delete KSEI (See 900 kc below).
900 kc—Insert KSEI, Radio Service Corp., Pocatello, Idaho—250 w.
1050 kc—KFBI. Change location to Abilene, Kans.
1120 kc—KRSC. Change power to 100 w, daytime.
1140 kc—WAPI. Change owner to WAPI Broadcasting Corp.
1200 kc—WBHS. Change power to 100 W.
1260 kc—KWWG. Change owner to Frank P. Jackson.
1260 kc—WLBW. Change owner to Broadcasters of Pennsylvania, Inc.
1270 kc—KGCA. Change power to 100 W.
1200 kc—WMBX. Change owner to WMBX B'dg. Corp.
1370 kc—WQDM. Change owner to A. J. St. Antoine and E. J. Regan.
1440 kc—WBIG. Change power to 1 KW—daytime.
1460 kc—WJSV. Change owner to Old Dominion Broadcasting Co.
1500 kc—WWSW. Increase power to 250 W (daytime).
1500 kc—KPJM. Change owner to Scott and Sturm.

SIAM TRIES OUT ADVERTISING IN THREE TONGUES

Washington.

The King of Siam paid a visit to the United States recently, which included social and business journeys, although he came principally to undergo an operation for cataracts.

The King visited broadcasting stations, and while here devoted much time to listening in, besides. He even tried out some short-wave sets and took one of them home with him.

Now, as if the King had obtained some ideas about broadcasting that would be applicable to Siam, the Government-owned station at Bangkok, according to advices to the United States Department of Commerce from its trade representative there, has introduced advertising in programs. Sponsorship has taken hold in Siam, with the approval of the Chamber of Commerce.

There are approximately 13,000 receiving sets in the whole of Siam, according to official estimates, about three-quarters of these being crystal sets. Last year the country imported about $150,000 worth of radio equipment, the chief suppliers being Germany and the United Kingdom, with the United States third.

Although the superior quality of American radio equipment is generally admitted, its higher price serves to curtail extensive sales in Siam. The radio business in Bangkok has been hard hit by the current depression and it is probable that imports of United States equipment will not show any appreciable increase until the economic situation of the country improves.

ECLIPSE TO BE TESTED

The total eclipse of the sun which will occur in the afternoon of August 31st in northern New England and in Canada as far north as Hudson Bay will offer radio scientists an opportunity to study the effect of the sun on radio transmission, especially as it affects the two ionized layers which reflect radio waves. One of these is the Appleton layer and the other, lower down, the Kennelly-Heaviside layer. It will be attempted to discover what causes these layers. If the attempt is successful it is believed that long distance radio service can be much improved.

Time Table of Television Transmitters

Call	Watts	Owner	Lines	Frames	Schedule
		1,600-1,700 kc 187.4 to 176.4 meters			
W1XAV	1,000	Shortwave and Television Laboratories, Inc. .... Boston, Mass.	60	20	3 to 5 p.m., 9 to 11 p.m. EDST daily except Sunday. Sound, 1,550 kc, 10 to 11 p.m., Mon., Thurs., Fri.
W2XR	500	Radio Pictures, Inc. .... Long Island City	60	20	4 to 10 p.m., EDST daily except Sun. and holidays. Sound W2XAR, 1,550 kc, daily except Sundays and holidays, 8 to 9 p.m. EDST.
		2,000-2,100 KC 149.9 to 142.8 meters			
W3XK	5,000	Jenkins Laboratories .... Silver Spring, Md.	60	20	9:00 to 11:00 p.m., EDST; sound track, W3XJ, 1550 kc, same time.
W2XCR	5,000	Jenkins Television Corp. .... New York City	60	20	4 to 6 p,m,, 7 to 9 p.m. EDST, daily; 6 to 10 p.m., EDST Sunday; sound track over WINS; 1,180 10 to 11 p.m., daily. W2XCR temporarily off air.
W2XAP (W3XK)	250	Jenkins Television Corp. .... Portable	60	20	2 to 5 p.m., EDST daily; experimental.
W2XCD	5,000	De Forest Radio Co. .... Passaic, N. J.	60	20	
W9XAO (WIBO, Chicago)	500	Western Television Research Co. Chicago, Ill.	45	15	Varies. Generally (with sound track, WIBO, 570 kc) 1 to 2:30 p.m. 5:15 to 6:15 p.m., CDST; (without sound track) 8 to 9:30 p.m., CDST.
W6XAH	1,000	Pioneer Mercantile Co. .... Bakersfield, Cal.	96	20	5 to 6 p.m., PST daily, except Sat. and Sun. Sat., 5 to 6 and 7 to 8 p.m. PST. Single sideband; 1,550 kc sound track soon.
		2,100-2,200 KC 142.8 to 135.1 meters			
W3XAK	5,000	National Broadcasting Co. .... Bound Brook, N. J.			12 noon to 2 p.m., EDST, Wed. and Thurs.
W2XBS	5,000	National Broadcasting Co. .... New York, N. Y.	60	20	2:00 to 5:00 p. m., 7:00 to 10:00 p. m., EDST, daily except Sundays and holidays.
W3XAD	500	RCA Victor Co. .... Camden, N. J.	..	..	Irregular.
W2XVW (WGY)	20,000	General Electric Co. .... Schenectady, N. Y.	60	20	4:30 to 5:30 p.m., EDST Friday.
W8XAV (KDKA)	20,000	Westinghouse E. & M. Co. .... Pittsburgh, Pa.	60	20	3:30 to 4:30 p.m., EDST, Friday only. Sound track temporarily discontinued.
W6XS (KHJ, Gardena, Calif.)	1,000	Don Lee Broadcasting System .... Gardena, Cal	80	15	6:00 to 7:00 p.m., PST.
W9XAP (WMAQ)	2,500	National Broadcasting Co. .... Chicago	45	15	12:30 to 1:30, 3:00 to 4:30, 5:45 to 6:45, 7:30 to 8 p.m., CDST. Uses 2150 kc.
		2,750-2,850 KC 109.0 to 105.2 meters			
W9XAA (WCFL, Chicago)	500	Chicago Federation of Labor .... Chicago			Starts June 24th.
W9XG, Lafayette, Ind.	1,500	Purdue University .... W. Lafayette, Ind.	60	20	Tues. and Thurs., 2:00 to 2:45; 7:00 to 7:45, 9:00 to 9:45 p.m., CST.
W2XAB (WABC, New York City)	500	Columbia Broadcasting System .... New York City	60	20	8 to 10 EDST, daily except Sat. and Sun. Uses 2,800 kc. Sound and vision on same channel. Vision is on mid-carrier, sound track on extreme. 2800 kc carrier.
		43,000-46,000, 6.973 to 6.518 m. 48,500-50,300 6.182 to 5.961 m. 60,000-80,000 KC 4.997 to 3.748 m.			
W9XD (WTMJ, Milwaukee)	500	The Milwaukee Journal .... Milwaukee, Wis.	45	15	Irregular
W3XAD	2,000	RCA Victor Co., Inc. .... Camden, N. J.	..	..	Irregular.
W1XG	30	Shortwave & Television Co. .... Portable	Irregular	45 mgc.	Daily except Sunday, 3 to 5 p.m.; 9 to 11 p.m.
W2XF	5,000	National Broadcasting Co. .... New York City	Irregular		
W6XAO	150	Don Lee Broadcasting System .... Los Angeles, Cal.	80	15	6 to 7 p.m., PST, except Sun. and holidays—using 44.50 0kc.
W3XK	1,000	Jenkins Laboratories .... Silver Spring, Md.	60	20	
W3XR	500	Radio Pictures, Inc. .... Long Island City, N. Y.	60	20	Irregular.

NEW CORPORATIONS

National Electric & Radio Shoppe, Queens, L. I., N. Y., electric machinery—Atty., J. Drucker, Corona, L. I., N. Y.

Hawthorne Sound System, Inc., Paterson, N. J., reproducing sound apparatus, broadcasting—Atty., Raymond E. Durham, Paterson, N. J.

Labrador Refrigerating Corp., Queens, L. I., N. Y. —Attys., Nadler & Wank, 320 Broadway, New York, N. Y.

Ajax Appliance Corp., Bronx, New York City, electric ranges, refrigerators—Atty., F. S. Weitzner, 215 East 149th St., New York, N. Y.

Passon, Inc., Philadelphia, Pa., sound reproducing devices, musical instruments—Attys., Corporation Guarantee and Trust Co., Dover, Del.

Voght's Ice Cream Service Corp., Bronx, New York City, refrigerators.

Literature Wanted

Lester Nivison, 208 Taylor Place, Ithaca, N. Y.

Francis Dunn, Service Manager. East 30th St. Radio Service, 914½ East 30th St., Indianapolis, Ind.

Frank A. Koehler, 166 Glen St., Brooklyn, N. Y.

Aulick and Emerson, 139 Court Street, Orlando, Florida.

Walter Hrynicki, R. F. D. 3, Box 330, Thorpe, Wis.

Louis Wentel, 416 Garrard, Covington, Ky.

John Hollowell, 410 8th Ave. W., Cedar Rapids, Iowa.

Stanley Titcomb, New Gloucester, Maine.

J. Howard Plowman, 150 American Ave., Long Beach, Calif.

CORPORATION REPORTS

Crosley Radio Corporation—Quarter ended June 30: Net loss after royalties, taxes, depreciation and other charges, $77,698, against $160,257 deficit in preceding quarter and $144,957 loss in second quarter last year.

Grigsby-Grunow Company, exclusive of Columbia Phonograph Company—Six months ended June 30: Net loss after depreciation and other charges, $831,147. Company recently changed its fiscal year and direct comparison is therefore unavailable. Balance sheet as of June 30 showed current assets of $4,044,272 and current liabilities of $890,032.

Stewart-Warner Corporation—Quarter ended June 30: Net loss after depreciation, taxes and other charges, $487,173, against $536,760 deficit in preceding quarter and net profit of $110,937, equal to 8c on 1,295,882 capital shares, 2d quarter, '31.

Quick-Action Classified Advertisements

7c a Word — $1.00 Minimum
Cash With Order

WILL SELL SUPREME ANALYZER, Model 400-A, cheap. Wm. Spartivent, 93 Broadway, Newark, N. J.

CODE LEARNER'S OUTFIT. Peerless Omnigraph Practice Key, Short Wave Set, $10.00. Fred Wooten, Beverly, N. J.

S. GERNSBACK'S "RADIO ENCYCLOPEDIA," SECOND EDITION. A Guide-Book of Radio Information topically arranged in Alphabetical Order. Radio in all its branches, described, explained and illustrated. Size 9 x 12, 352 pages, Red Morocco-Keratol Flexible Binding. Loose-Leaf Arrangement. Price $3.98 postpaid (Foreign and Canada add 35c extra). Radio World, 145 W. 45th St., New York City.

THE FIVE NEW TUBES, 46, 56, 57, 58 and 82, characteristics, installation data, uses, fully described and illustrated in the April 30th issue (7 pages) and in the May 7th issue. Send 30c for these two copies. Radio World 145 West 45th Street, New York, N. Y.

"AMATEUR MOVIE CRAFT," by James R. Cameron. A book dealing with the making and showing of 16 m/m pictures and equipment necessary for same. Paper cover, $1.00; Cloth, $1.50. Radio World, 145 W. 45th St., New York, N. Y.

"A B C OF TELEVISION" by Yates—A comprehensive book on the subject that is attracting attention of radioists and scientists all over the world. $3.00, postpaid. Radio World, 145 West 45th St., N. Y. City.

EBY Ant.—Ground twin binding post assemblies, 30c each. Guaranty Radio Goods Co., 143 W. 45th St., N. Y. C.

"THE CHEVROLET SIX CAR AND TRUCK" (Construction—Operation—Repair) by Victor W. Pagé, author of "Modern Gasoline Automobile," "Ford Model A Car and AA Truck," etc., etc. 450 pages, price $2.00. Radio World, 145 W. 45th St., N. Y. City.

FULL-SCALE PICTURE DIAGRAM OF TWO-TUBE 15-200-METER BATTERY RECEIVER—Printed in Radio World dated April 2, 1932. This is the diagram asked for by so many readers who were interested in the short-wave receiver described in issue of Feb. 27, 1932. Both copies mailed for 30c. RADIO WORLD, 145 W. 45th St., New York City.

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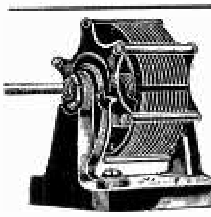

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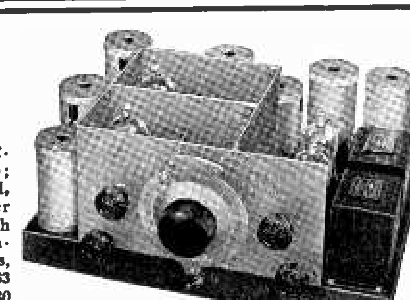

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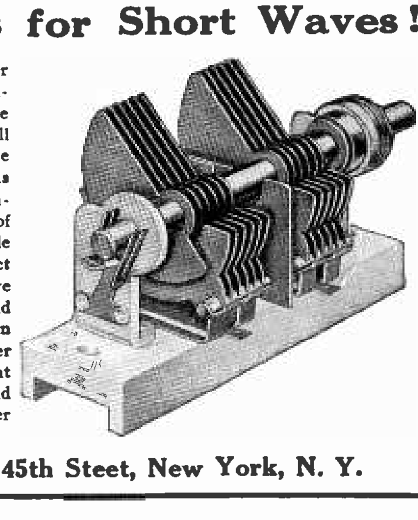

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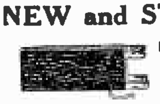

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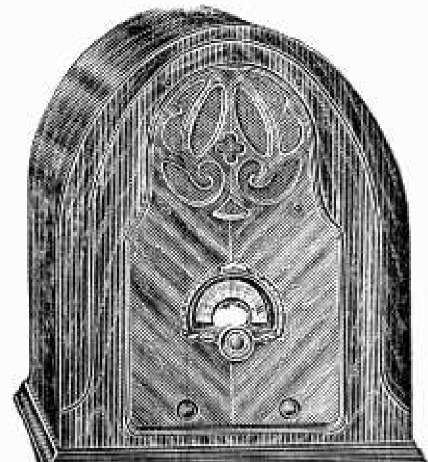

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