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Radio World, 143 West 45th Street, New York, N. Y.
The Stenode’s Comeback

By J. E. Anderson

LAST week we reported on the results of a public demonstration of the Stenode Radiostat, the invention of Dr. James Robinson, of England. The unfavorable tone of that report was the result of entirely unsatisfactory results. The sponsors of the new device realized the failure of the demonstration and knew that adverse criticism was inevitable. Therefore they arranged with certain engineers and newspapermen for a private demonstration of the device and for an opportunity for discussion of its principle with Dr. Robinson and his assistant, Mr. Percy Harris.

The first demonstration was made under the most unfavorable conditions. The private test was made under average conditions, when, it must be admitted, the quality of the Stenode Radiostat receiver was not bad. Indeed, it compared very favorably with that from a modern radio receiver of more conventional make-up.

The Demonstration

Moreover, the test and the discussion brought forth the fact that Dr. Robinson has been misrepresented in published discussions of the new system. Dr. Robinson does not discard the sideband theory but accepts it as it is, together with its consequences. He maintains that the sideband theory has been carried as far as it can be and that there is another way of receiving by means of resonant devices which the sideband theory does not bring out.

During the private demonstration the Stenode Radiostat receiver was set up in a laboratory in the top story of a tall building in New York City, not in the interior of a maze of steel, as in the case of the public demonstration, and it did bring in signals of good quality. Possibly the quality was not quite as good as the quality obtainable with a modern conventional receiver, but the difference was not necessarily the fault of the new system. At any rate, the quality was much better than that obtained with many conventional broadcast receivers.

As to selectivity, there is no question about the superiority of the Stenode Radiostat. A laboratory transmitter, modulated with the output of a phonograph pick-up, was set up about 20 feet from the Stenode receiver. The carrier of this transmitter was adjusted to differ by about 2,000 cycles from that of the station to which the Stenode receiver was tuned.

By means of a control on the Stenode receiver it was possible to shunt the quartz crystal so as to convert the test receiver to a standard Superheterodyne. When this was done, the 2,000 cycle beat frequency was clearly heard above the signal as a loud whistle. But when the crystal was cut in, restoring the selectivity, this whistle was entirely cut out as far as the ear could tell, and this without any appreciable change in the quality.

While the laboratory oscillator was modulated with phonograph music there was no trace of this music in the signal heard on the Stenode receiver. Yet the degree of modulation of this interfering carrier was of the same order of magnitude as that used in broadcasting.

Selectivity Amazing

The fact that the Stenode Radiostat receiver could tune out completely an interfering modulated carrier differing by only 2,000 cycles shows that the new receiver is amazingly selective, and that it could do this and still retain the quality is still more amazing to adherents of the sideband theory.

The high degree of selectivity is emphasized by the tuning arrangement necessary to bring in the desired station. The main tuning condenser had a capacity of 500 mmfd. In shunt with this was a trimmer condenser of a few mmfd., consisting of a single small movable and one fixed plate. The movable (Continued on next page)
New System Explained

(Continued from preceding page)

Principle of Stenode Radiostat

On the face of it the theory of the Stenode Radiostat is very simple. Mathematically it is rather complex, and this writer has not yet seen a satisfactory expression of the theory. Let us try to explain the working of the new receiver on a qualitative basis.

When voltage is impressed on a condenser the charge on that condenser does not assume full value instantly but the charge grows, approximately, to an exponential law. The charge on the condenser, or the voltage across it, would grow as the "growth" curve in Fig. 1, and the current into the condenser varies as the "growth" curve. Both the "growth" curves are exponential and one is just the complement of the other.

When a charged condenser is discharged through a resistance, the current varies, as the "decay" curve and the voltage across it varies in the same manner.

Theoretically it takes an infinite time for a condenser to charge or discharge but practically either process takes place in an extremely short time, the actual time depending on the capacity of the condenser and the resistance in series with it.

The output in a coil after a DC voltage has been impressed is similar to the "growth" curve, and the decay of current in a circuit consisting of an inductance and a resistance is similar to the "decay" curve.

Resonant Systems

When a resonant system is involved the situation is somewhat different but the law of growth and decay of amplitude is the same as the curves in Fig. 1.

Suppose we impress an alternating force on a tuning fork, the frequency of which is exactly equal to the resonant frequency of the fork. The fork will begin to vibrate and it quickly gains a wide amplitude. The rate of growth of amplitude is shown in the "growth" curve. If the fork is highly resonant, that is, has very low losses, the given force will make the maximum amplitude very large after a very short time. If the losses in the fork are higher, the maximum amplitude will not be so great and it will take a longer time to reach it.

When the driving force is suddenly removed, the fork will continue to vibrate, and the amplitude will die down according to the "decay" curve. If the fork is highly resonant, it will take a very long time for it to drop down to zero, and if the losses are great it will stop quickly.

What applies to a tuning fork driven by an alternating force equal in frequency to the natural frequency of the fork, also applies to any other resonant device whatsoever, such as a tuned circuit, a quartz crystal, a pendulum, or a steel rod vibrating laterally or longitudinally. None of these devices are highly resonant, and others are feebly resonant, but they are highly resonant, like a quartz crystal and a tuning fork, and keep on vibrating for some time, while those feebly resonant come to rest quickly.

It might be mentioned that the frequency of the vibrator is not quite the same while it is dying down and while it is being impressed, but there is a close relationship between the frequency of a freely vibrating resonator and the natural frequency of a driven resonator. If the resonator is highly resonant the difference between these two frequencies is extremely small, so that for practical purposes the two frequencies may be called exactly equal.

Application to Code

As another step in the explanation of the Stenode Radiostat let us assume that we impress dashes of driving force to a highly resonant vibrator, each dash consisting of a certain number of waves of equal amplitude having a frequency equal to the natural frequency of the vibrator. We represent the amplitude of the dashes by y in Fig. 2 and the duration by ab, ed, and fp. The time between the dashes represents silent periods when no driving force is applied to the vibration.

Above the signal curve in Fig. 2 is a representation of the growth of the amplitude of the vibration. The driving force is applied at a time equal to zero. The amplitude grows according to the exponential law explained above and reaches a value b when the dash is at an end. The amplitude then begins to decay, but the decay is slow because the system is highly resonant. Hence when the next dash begins at c the amplitude is not zero but has an appreciable value.

When the second dash begins the system is again being supplied with energy and the amplitude begins to grow. At the end of the second dash the amplitude has reached a value d. When the second dash is ended and the energy supply is withdrawn, the decay sets in again and as before the decay is slower than the growth. Hence by the time the third dash begins the amplitude is considerably greater than it was at the beginning of the second dash. During the third dash the amplitude grows to e.

If the process continues a long time, and by long may mean a small fraction of a second, the amplitude of the vibrator will be far the maximum, that it would have been if the driving force had not been interrupted once it started. Then we have a situation such as is represented in Fig. 3, which may be called the steady state condition attained after a considerable time. Fig. 2 is supposed to lie far to the left of the beginning of Fig. 3.

Variation in Amplitude

The growth and decay sections of the curve in Fig. 3 have to be exaggerated greatly just to show the effect. In a highly resonant vibrator the mean amplitude would be considerably greater in proportion to the variation in the amplitude.

During a dash period when driving force is being supplied the amplitude grows to the maximum, which is determined by the ratio of the amplitude y of the driving force and the losses in the vibrating system.

During the spaces the amplitude decays because no energy is being supplied, but energy may be stored in an amplitude as the dashes and spaces occur successively, the rises and falls in the amplitude continue, and it is clear that a rise must be followed by a fall, for otherwise the vibrations would either attain a higher amplitude, which is not possible as long as the driving force is constant, or it would decay, which is not possible as long as the spaces remain in the same duration with respect to the duration of the dashes. Hence after the process has been subjected to alternate dashes and spaces for some time, the amplitude will vary about a mean position slightly less than the amplitude that would result if there were no dead spaces between the active dashes.

It is clear that the variation in amplitude occurs at the same rate as the dashes and that the dashes are recognizable by observing the variation in the amplitude in some manner and by some suitable device. That the variations in amplitude of the vibrator do not constitute clearly defined dashes and spaces is obvious. It is also obvious that the shorter the dashes and spaces, the less the variation in amplitude will be. Thus the higher the rate of vibrations will be, the smaller will the amplitude variation be. This is also arrived at by considering the problem from the point of view of the side band theory. That is, a highly resonant circuit slowly to changes in amplitude of the impressed force of resonant frequency.

An Inverse Ratio

It appears from elementary considerations that the variation in amplitude, for a given impressed force and a given degree of sharpness of resonance, that the variation in amplitude is inversely proportional to the reciprocal frequency. For equal speed of signalling, then, it would be necessary to amplify the variations in the amplitude of the vibrator in direct proportion to the frequency. This means that after detection the audio frequency would have to be amplified in a manner directly proportional to the frequency of the dashes and spaces.

Moreover, to get dashes reasonably well-defined it would be necessary to devise a special type of detector and even then it appears that Dr. Robinson and his co-workers have done this successfully, for they have succeeded in carrying on 200 words per minute telegraphy by means of tuning fork resonators spaced only 50 cycles apart.

Problem of Broadcast Reception

The principle of the Stenode Radiostat has been explained above on the basis of actual dashes and spaces and the driving force continues for a definite time at constant amplitude and then is zero for a definite period.

In the broadcasting this is not the case, for the amplitude of the carrier never drops to zero. Modulation only varies the amplitude, increasing and decreasing with respect to a mean value, the amplitude of the unmodulated carrier.

The theory as worked out for the dashes and the spaces applies only in a qualitative way to the case of continuously varying amplitude of carrier as in the broadcasting.

For the dashes and spaces the mathematical treatment of the problem is simple but an adequate theory for the broadcasting is just too much too complex, and this writer has not yet seen one other than the familiar side-band theory.

(Continued on page 14)
THE fact that interest is so great in reception of short waves does not, of course, infer that interest in regular broadcast waves has been robbed to fatten the other. Rather the short-wave enthusiasm is simply additional.

If this is true it certainly must be acceptable to have a receiver that tunes in both the short waves and the broadcast waves. Several plans of doing this have been suggested, but never have I noted even a suggestion of the present method. Indeed, there is no hint anywhere in radio literature of any such plan of achieving this highly desirable result.

Equal Sensitivity

In brief, the plan consists of building a sensitive tuned radio frequency receiver. Instead of using a single gang discriminator, a three-gang discriminator is used in series with the antenna coil and ground, to cut down the input on the higher frequencies, since the capacity of this condenser then is decreased. The action is automatic as a part of the regular tuning process, since this condenser is simply one section of a gang.

As a supplementary aid to uniformity, an untuned radio frequency transformer is used to couple to the detector tube (extreme right). This transformer is broadly peaked around 500 meters, to build up the response at the lower radio frequencies. Such a transformer may be built of 700 turns on primary and secondary, each, by using any spool with about 3¾-inch hub or thereabouts, that permits slot winding. The wire may be No. 36.

A battery-operated tuner is illustrated, and the operation for dual purposes will be explained now.

Operation Explained

When the switch S1 in the antenna circuit is thrown to the left the aerial is connected to a radio frequency choke coil of 0.00035 mfd. inductance. The same action also may throw the switch S2, so that when the aerial is connected to the first tube in the chain of seven, the three tubes are lighted. These are the short-wave performers. At the same time the equal amplification of the regular broadcast part of the receiver is utilized.

To receive broadcast a wavelength, the antenna switch is thrown in the opposite direction, and the filament supply of the broadcast tubes is cut off, the antenna input being made in usual fashion.

The condensers used for tuning are six in number and are two three-gangs. There is only one dial to tune them. Hence whenever one section is tuned, all six sections are tuned.

A Changing Second Frequency

The question now arises, how are you going to tune in short waves with a device that keeps changing the frequency of the broadcast part of the receiver all the while it is attempting to bring in short waves? Well, that's one place where the invention comes in. Instead of using a fixed second frequency, as is commonly done, a gradually varying second frequency is used, changing from 1,500 to 350 kc, a total change of 950 kc.

To enable successful operation in this fashion, it is necessary that there should be no direct pickup of broadcasts by the broadcast part of the receiver when short waves are tuned in. The remedy is to use a ½ millihenry radio frequency choke, which virtually by-pass broadcast wavelengths, and to resort to shielding and to short leads. Even a sensitivity of 7 microvolts per meter will result in no stray pickup as close as one mile from 3000 to 5000 kc broadcasting station, if the prescribed precautions are taken.

This plan for an all-wave receiver is submitted with the assurance that it works well and meets a real need now felt by experimenters and soon to be felt by set manufacturers and others, as the public demand for short-wave reception, in addition to usual broadcast reception, steadily grows, as it will.

Tube Options

The circuit, if used with the new 2-volt tubes, 230 general purpose and 232 screen grid, should have filament resistance values as stated, but a 6-ohm rheostat should be connected between A minus (3 volts) and the switch S3. Also it would be advisable to have a voltmeter across any one of the filaments. However, if 201A and 222 tubes are used, the resistance values would be as stated for them on the diagram; no rheostat would be necessary and no voltmeter, either.

A different voltage source, 6 volts, would constitute the source of filament supply for 201A and 222 tubes, if used in the other sockets, a 112A may be used for detection, instead of a 210A, without changing the filament resistor's value. This effective bias for detection with the 112A should be around 12 volts, supplied by C batteries.

Plug-in coils may be used with the system outlined, or a fixed coil, if a band of from 48 to 110 meters is sufficient. A fixed coil of 249 inch diameter would consist of 8 turns for the grid winding, 8 turns for the plate winding and 2 turns for the pickup winding. The wire may be No. 25, 24, or 22 silk covered.

Plug-in Directions

If the tube base type of form is used, for plug-in, double the number of turns specified, due to the smaller diameter. A five-prong plug is needed. The tuning capacity may be .0005 mfd., or 0.005 mfd. of any value in between, which will depend, of course, on the capacity of the section of the gang that tunes this extra circuit.

It should be realized that one operation tunes everything—all rotors move whenever any one moves—and that the system is successfully operative because of the precautions taken against broadcast pickup when short waves only are tuned in. The circuit shown is one that has great sensitivity, but it is not necessary to have such a high-gain broadcast amplifier to insure the working of the dual-system. Indeed, it has been worked successfully when using a radio frequency chain consisting of three tuned and one untuned stages, i. e., three stages of TRF and an untuned input to the detector.

This particular model of the three-stage TRF arrangement, thus accounted for four tubes in that channel, plus three in the short-wave dipision, plus two audio and one rectifier, since this was an AC-operated design. The total number of tubes was ten, of which seven were used when broadcast wave lengths were tuned in, and ten when short waves were tuned in. The statement of the number of tubes, in all instances, includes the 280 rectifier.

An Open Invitation

It is the purpose of this article to present the theory, and to reveal the diagram for the first time. The proposition has been worked on for a long time. It is expected that soon a way of embodying the principle will be ready for discussion from a constructional angle, including battery and AC operation, and also including the audio amplifier, omitted now, that there is no novelty in that. Any who are interested in using this system on a receiver to be newly built, or to be rebuilt from any existing receiver, may address questions to me care Radio World, 145 W. 49th Street, New York, N. Y., or come in to see me any Thursday, Friday or Saturday.

Herman Bernard.
Installation and Operation

By Herman

[FIGS. 8 AND 9, REPRINTED FROM PREVIOUS ISSUES, SHOW THE AC AND BATTERY MODEL CONVERTERS, USING THE BERNARD SYSTEM OF MODULATION.]

In the November 8th and 15th issues the construction of a good short-wave converter, the parts for which cost $5 or less, was described. The converter may be built for AC operation, with an external 254-volt filament transformer (not included in the $5 price), or for battery operation, in either instance three 227 tubes are used. The battery model uses a 6-volt storage battery with heaters in series, affording 2 volts to each tube, which is sufficient. This week installation and operation are discussed. (Eron.)

The same directions for installation and operation apply to both the AC and the battery-powered models of the tube short-wave converter, except that for the battery model a 6-volt storage battery is connected across the heater leads, while in the other instance the 254 volts of a filament transformer are connected to the receiver.

Four connections are made to the converter, as previously explained, and as repeated herewith:

1. The aerial is removed from the antenna post of the receiver and is connected instead to the antenna lead of the converter.
2. The ground lead of the converter is connected by a wire to the ground post of the receiver. The ground is left connected to the ground post of the receiver.
3. The output of the modulator (marked "Set Ant. Post" on the diagram) is connected by a wire to the vacated antenna post of the receiver.
4. Positive B voltage is connected to the B plus of the converter. This voltage need be only high enough to insure oscillation, and may be from 67 volts to 90 volts.

When Aerial is Left on Set

If the aerial is left connected to the antenna post of the receiver, and the lead from the converter marked "Set, Ant. Post" is connected also to the receiver's antenna post, signals will be heard, but usually not as loud as if the connection were split (thus isolated). The segregation of the connections, whereby aerial alone goes to the converter, and the converter's output alone goes to the set antenna post, utilizes the stage of short-wave radio-frequency amplification in the converter, which is the other method of connection cuts out of circuit.

Unlike the split connection in the aerial circuit, the ground connection is undivided. The ground of the receiver, using 224 tubes, it will be from 50 to 75 volts, and in most instances the voltage is governable, as the volume control is a potentiometer that permits variation of the screen voltage. If so, put the volume control at or near maximum volume position for working the converter, or connect to the last RF screen, usually independent of a series resistor.

Insulation of Oscillation

Should the receiver provide its screens with a voltage dropped through a series resistor, since the converter draws about 10 milliamperes plate current, this current will flow through the series resistor, lowering the effective plate voltage, and will slightly reduce the effective voltage at the screen grid tubes removed from the receiver.

Current, which you may control by placing a condenser in the receiver. For instances of low voltages around 40 volts, and absence of oscillation, assume inadequate bypassing and connect an air condenser of 1.0 micromfd. from the B plus lead of the converter to ground.

The voltage to use is not critical, as the foregoing intimates. The main object is to attain oscillation. What the voltage is on the detector plate is unimportant, especially if selection is usually recommended as a good detecting or modulating voltage, when the cathode is returned for zero bias, as it is in the AC and battery converter.

The actual work of installation takes only a few minutes, but the incidental factors should be understood, hence the explanations of installation and operation are given rather fully. It must not be assumed from the extensiveness of the explanation that there is anything difficult about it.

Theory of Operation

As for the operation of the converter, here is the theory:

All waves are introduced into the first tube, which is in a stage of untuned radio frequency amplification, but the input choke is of such small inductance, around the same as in short waves, is greatly favored. The amplified untuned, or, one might say roughly, semi-tuned waves, are introduced into the modulator, again without frequency selection. As the second tube is used, varies the frequency of oscillation, and in such a manner that the resultant admixture of the oscillator frequency and the resulting frequency of the modulator, comprises another, but lower, frequency. This frequency is to be produced in the converter, either alone or in conjunction with any receiver that satisfactorily brings in broadcast waves. Nearly all receivers are more sensitive at the higher frequency settings, and this applies particularly to tuned radio frequency receivers, which is one reason for preferring a high broadcast frequency as the intermediate frequency. But if sensitivity is greater elsewhere, use the most favorable setting.

Tendency is to Overload the Set

The tendency will be to press the receiver itself to its condition of maximum amplification, as thus the sensitivity is usually increased. In fact, that very condition was incidentally recommended in volume control. The receiver may be then tuned to or near the setting for maximum volume. However, the principal consideration at first is to bring into some short-wave stations, to make one feel that, after all, the $5 was well spent, and it was not a case of using $5 just to satisfy one's curiosity as to what is inside of a dubious package.

So we shall address ourselves now to the pleasant act of tuning to some short-wave stations. We shall consider whether code or voice is received, but content simply with reception of some kind.

The choice of a high frequency in the receiver for intermediate amplification gives us, of course, a Superheterodyne with an intermediate channel of, say, 1,500 kc. The waves we desire to
tune in will be much shorter, their frequencies much higher, so 1,500 kc is only a small fraction of the frequency of reception. Hence the ratio is high, as it should be.

If the converter is used in tuning, our pleasure is simplified considerably.

**Tuning In**

Turn on the switch of the receiver and also see that the tubes in the converter are lighted. Press in the coil switch at the front of the converter. Then, after waiting for the tubes to heat up, which should not take more than one minute even with slow-heating tubes, listen carefully to your broadcast reception. You may hear a familiar rushing sound in the loudspeaker. If this sound is not pressure control, turn up the volume control on your receiver. If this does not cause the sound to appear, then turn the volume control in the opposite direction, for if the receiver itself can oscillate at the high frequency to which it is tuned, only a quiet hiss will be audible, and indeed you may not be able to tune in a short-wave signal. Be sure that the receiver is not oscillation. If possible, operate it just under the point of oscillation, or, if it is a stabilized receiver, at or near maximum volume position of the volume control.

Now very slowly rotate the tuning dial of the converter. If you have had no previous experience with short-wave reception, recognize right now the well-established fact that it is easier to pass off short-wave signals that are within sensitivity range of your receiving system than it is to tune in. The loudest short-wave station receivable will come in strong at a given position of the converter's dial, and possibly be turned out completely by a movement of that dial equal to only one-eighth of a division.

The converter is not equipped with a vernier dial, but when you pick up a carrier, having its own rhythm, you may resolve this into reception either by careful adjustment of the converter dial, or by a slight adjustment of your receiver dial. It is preferable to use the receiver dial, as this is in itself vernier in its action, and likewise the vernier effect is communicated to the converter at an increased ratio (much finer adjustment).

**Repeat Tuning Points**

After having tuned in a strong signal at one position of the converter dial, try to tune it in at another position of the same dial. About one-third the number of strong stations you can receive will come in at two settings of the oscillator dial. If interference is suffered, either use the alternative setting, whereupon this interference may disappear, but if it does not, another remedy is to change the setting of the receiver dial ever so slightly (thus barely altering the intermediate frequency), and retune the converter. The form of interference usually cured by this intermediate frequency alteration is peculiar to heterodyne reception. It is known as image interference.

Should no signals be receivable, and no indication be obtained that the converter or set is functioning, turn the dial of the set to bring in regular broadcasts, which come in even with the converter hooked up. In fact, the converter acts as a damper for the set in tuning in broadcasts, since it constitutes two stages of radio frequency amplification (the oscillator being ineffective) in this regard, and the modulator being utilized for its amplification properties alone. If stations come in, then the set itself is all right, so look to the connections to or in the converter as the source of your trouble.

**Make the Oscillator Oscillate**

The principal fault to be expected is the wrong connection of the windings in wiring the converter, since if the directions for installation are followed, no mistake can be made here. Check up to determine that the single coil used in the converter has one end of the secondary (10-turn winding) going, not to A, as is usually the case, but to the cathode of the modulator, and that the next tap from this cathode connection goes to ground, while the other extreme of the secondary goes to oscillator grid. The remaining connection, a tap for the grid, is usually at A, but if the connections are right, the only other mistake will be that the plate winding in the oscillator tube is misconnected as to phases, so simply reverse the connections to the grid. If this last correction does not cure the trouble, another possibility is that B and the one that went to B plus now goes to plate of oscillator tube, so that the two are reversed. If all directions are followed as given, and the receiver is functioning, nothing can prevent the converter from working, except failure to connect aerial, or use of poor tubes in the converter. Particularly must a tube be used in the oscillator socket that will oscillate. If you have any half-dead tubes and

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*FIG. 14*

**CODE FOR IDENTIFYING SOCKET CONNECTIONS. VISUALIZE THE TRIANGLE FORMED BY THE LINES FROM HEATERS AND GRID. VIEWED FROM BOTTOM, GRID TOWARD YOU, OR TOP, GRID AWAY FROM YOU, THE RELATIVE RIGID POSITIONS ARE THE SAME. FOLLOW THIS CODE IN WIRING.**

must use them, though they won't oscillate, put them in the modulator and radio frequency sockets. By all means get a tube for the oscillator that positively will oscillate. Your dealer will test a 227 for oscillation if you so request. If in doubt about your tubes, have the dealer test all of them for you.

**Peculiarities of Reception**

Assuming that you get reception now, let us investigate the peculiarities.

You may experience fading. This is something associated with short-wave reception, and particularly the reception of certain stations, and is due to wave behavior in space, a condition beyond your power to remedy. But if you have a receiver equipped with an automatic volume control, this device will compensate to a great extent for the fading, since dissimilar voltages in input create a relatively uniform output.

When you tune in a station it may not be as loud as you desire, therefore you turn up the volume control of your receiver, and at once you hear a gong-like sound, resembling the microphonic performance of tubes in the days when tube manufacturers were not so exacting. This sound is due to coupling between converter and receiver, causing overloading of the receiver's detector. The remedy is to retard the volume control of the receiver until the interfering sound disappears. If after this adjustment, if you retard the control a little too much, the effect in reducing volume will be great. When you get as much volume as is possible, without working the receiver to the hilt and causing howling, you should not try to exceed this limit.

**High Level of Oscillation**

The oscillator tube should be regarded as one that has a large output, compared to its amplification, and even the capacity of the modulator, so that the ratio of oscillator to modulator amplitude may be as great as 1,000-to-1. Hence it is always a good plan to include radio frequency amplification ahead of the modulator, one stage being used in the present converter. Thus the ratio is about 250-to-1. Nevertheless, if you press the receiver too hard, making it amplify more than the conjunctive system permits, you are bound to overload it.

Remember, also, that even with no signal impressed, it is possible to overload a receiver, due simply to the intensity of the oscillator voltage. Be circumspect, therefore, as to the amount of receiver amplification used, and when you have reached the working limit, stop. A very strong signal will overload the modulator as well as the receiver's detector, so stay within limits.

The intensity of the oscillator voltage has been stressed, also the desirability of radio frequency amplification ahead of the modulator, as included in the two designs for $5$ converters, and these facts lead to the conclusion that a long aerial is greatly to be desired.

Many modern receivers operate on short aerials, even on short wires indoors, or from screen mesh built into a console, but for short-wave work use an outdoor aerial, 100 feet or more total.
The circuit diagram of the Brunswick Models 15 and 22, as shown in Fig. 1, reveals the fact this is not a conventional receiver, for it has many distinct features of design. In the first place it utilizes a screen grid tube as detector and in the second it utilizes two 245 tubes in parallel in the last stage, not in push-pull. This two-tube power stage is the only audio amplifier in the circuit and it is coupled to the detector by means of resistance capacity.

Another feature is the coupling between the radio frequency tubes. A 5.4 millihenry choke coil is used in each plate circuit for feeding the plates. Between the plate of one tube and the grid of the next is a 10 mmfd. condenser, the first of which is variable between zero and 10 mmfd., the others being fixed. In the grid circuit of each of these tubes is a tuned circuit. Loose coupling between the tubes is established by means of these small condensers.

Grounding of Heater Circuit

The small variable 10 mmfd. condenser, which follows the first tube, is also used as a volume control. In addition to this volume control there is a Local-Distance switch in the antenna circuit. For local stations the regular antenna is cut out and the primary is connected in series with a .0002 mfd. condenser. In series with the primary in either position of the Local-Distance switch is a 0.95 millihenry choke which acts as a loading coil.

It is customary to ground the mid-tap of the 25 volt heater circuit, either directly or through a resistance, but in the Brunswick Model 15 and 22 one side is grounded. Obviously, grounding one side of this circuit will give less hum than grounding the other, and in some instances less than if the center of the winding is grounded.

The B supply filter is also somewhat unconventional, although the type is used in other receivers. There is a single 5 henry choke in the filter, but this choke is tuned to hum frequency by a condenser of a value suitable to the frequency of the line voltage. This type of filter is very effective in suppressing the main hum component while it permits the higher, and weaker, components to get through. However, condensers across the line are provided to cut out these as well as to aid in the suppression of the principal hum component.

The loudspeaker is coupled to the two power tubes by means of an output transformer but the heavy plate current is kept out of the primary by means of a 1 mfd. condenser and a choke coil, and this choke is the field winding of the dynamic loudspeaker. This is an ingenious arrangement. The field serves as a choke and an impedance coupler in addition to its service as a field coil, and it permits the use of the heavy plate current to energize the field. By suit-
Wart-Warner Receivers

**Watkins**

**FIG. 3**

STEWART-WARNER SERIES 950-960 SCREEN GRID TUBE RECEIVER. IN MANY OF THE SPECIAL FEATURES THIS IS LIKE THE SERIES 900 BUT IT DOES NOT CONTAIN THE BALANCED BRIDGE ARRANGEMENT, THIS BEING UNNECESSARY WITH THE SCREEN GRID TUBES.

ably connecting the leads of the field winding and those of the transformer it is possible to eliminate a large proportion of the hum, and this is another advantage of the arrangement.

**Tone Control**

There is also a tone control associated with this output arrangement. It consists of a 0.4 mfd. condenser in series with a variable resistance of 5,000 ohms maximum value connected from the high side of the transformer primary to the mid-tap of the filament circuit of the power tubes, as well as to the low side of the primary. Thus by varying the 5,000 ohm resistance it is possible to put a condenser of 0.4 mfd. across the primary to reduce the intensity of the high notes or to put 0.4 mfd. and 5,000 ohms across it for normal reception.

Grid bias detection is used, the bias being supplied by a 25,000 ohms resistance between the cathode and ground. This is shunted by a 0.25 mfd. condenser. The plate coupling resistor is 250,000 ohms and the grid leak ahead of the power tubes is half megohm. The plate resistance goes to a 50,000 ohm resistor, shunted to ground by a 1 mfd. condenser, which is used to drop the plate voltage on the detector by 11.3 volts and also to prevent audio frequency oscillation.

Radio Frequencies are prevented from reaching the power tubes by means of a .00015 mfd. condenser from the plate to the cathode of the detector, a .001 mfd. condenser in series with the output lead, another .00015 mfd. condenser to ground, and finally another .001 mfd. condenser. The effective plate voltage on the detector tube is 225 volts.

**Stewart-Warner Series 950**

This is known as the A. C. balanced bridge receiver because of the special arrangement of the couplers between the radio frequency tubes, all of which are 227 type tubes. A small adjustable condenser is connected from the grid of each tube to the cathode, and a small coil coupled to the tuned circuit following the tube is connected in series with the cathode lead to ground. A certain amount of reversed feed-back may therefore be arranged for the radio frequency oscillation.

** Provision is made for both dynamic and magnetic speakers. The field current for the dynamic speaker is taken from the 115 volt supply circuit. The current for the field is not filtered other than by a 1.5 mfd. condenser. The magnetic speaker is connected from plate to plate of the push-pull amplifier.**

A unique feature is that provision is made for both television signals and phonograph pick-up. The terminals for the pick-up unit are so arranged that the detector becomes an amplifier, the unit being connected between the grid and ground. The terminals for the television signals are between the plate of the detector and ground. The volume is controlled by a switch in the antenna circuit and by a variable resistance which controls the bias on the radio frequency amplifier. The antenna switch contains three stops. One stop throws the entire primary in series with the antenna and this is for long distance and weak stations. The second stop short-circuits a portion of the primary, and this is for medium distance stations. The third stop connects the antenna to a condenser one side of which is connected to the 110-volt supply line. This is for local stations since the connection is such that most of the signal energy is shunted by the primary to ground through the condenser.

**Stewart-Warner Series 950 and 960**

In many respects this series of receivers is like that previously discussed but it contains three screen grid radio frequency amplifiers and it does not contain the bridge balancing feature. The output arrangement is essentially the same, being provided with terminals for both dynamic and magnetic speaker. There is also the same provision for phonograph pick-up and for television. The coupling between the detector and the first audio frequency amplifier is resistance-capacity, whereas in the other it was by transformer.

A by-pass condenser of .002 mfd. is connected from the plate of the detector to ground and a radio frequency choke is in series with the output lead of the detector for the purpose of suppressing radio frequencies. The coupling resistor has a value of 30,000 ohms and the grid leak one megohm. The stopping condenser has a value of 0.1 mfd. Since the time constant of the stopping condenser and the grid leak is as high as 0.1 second, it is clear that the amplifier, is effective on very low audio frequencies.

A grid bias resistor of 40,000 ohms is used with the 227 detector. This is in addition to the .001 mfd. grid condenser and 100,000 ohm grid leak. The method of detection is primarily that of strong signal, grid bias type.

**Radio Frequency Coupling**

In addition to the inductive coupling between the primary and secondary of each RF transformer there is a 16.5 mfd. condenser between the plate and the grid, the two types of energy transfer being used to equalize the amplification in the tuning range. The small condensers are adjustable so that the degree of capacitive coupling may be adjusted. These condensers together with the trimmer condensers also help to line up the ganged tuning condensers.

There are two sets of volume control in the circuit, the switch arrangement described under the previous model and a 32,000 ohm potentiometer by means of which the voltage on screens can be varied.

The heater circuit is balanced by means of a 20 ohm potentiometer connected across the 2.5 volt winding supplying the heater tubes and with its moving arm connected to ground. This adjustable feature permits adjustment for no hum or minimum hum.

In these receivers there are directions for changing the filter for use with 40 or 25 cycle current. In every case when the frequency of the current is less than 50 or 60 cycles, the filter condensers required are larger, the aim being to keep the impedance approximately the same. For example, if a condenser is specified at 2 mfd. for use with 60 cycle current, it would be specified at about 4 mfd. for 25 cycles.

November 22, 1930

RADIO WORLD

www.americanradiohistory.com
Affinity of Gas and

By John C.

FIG. 1.

THE FLEMING VALVE, THE EARLIEST FORM OF VACUUM TUBE THAT COMPARES TO THE PRESENT-DAY TUBE WE KNOW. IT IS A DIODE, OR RECTIFIER.

[The following article is the seventh of a series dealing with the historic aspect of the development of the radio transmission and reception art. The first article appeared in the October 11th issue, and presented a condensed resume of important scientific steps that culminated in the successful commercial experiments of Guglielmo Marconi, 1894-1901. The second article appeared in the October 18th issue and consisted of a brief review of early telegraphic systems, including data on the first photo-electric work, and short-wave transmissions with concave and parabolic mirrors, also early stages in the development of the beam transmission system. Progress was traced from the sixteenth century to the eighteenth century. The October 25th installment traced the development of the Leyden Jar, where the first oscillatory currents were obtained, and also told of the manner in which short wave radiations were concentrated by lenses, as compared to reflection methods. The article in the Novem-

Sir Ambrose Fleming made three experiments of note with the vacuum tube. The first and second experiments of this distinguished Briton have been described.

The third experiment with the Fleming valve was the determination of the maximum anode current obtainable after the increase with reduced pressure was stationary. After this point was reached the cathode heating potential was increased, and the result was an increase of anode current, but it was a small change as compared to the result of the first experiment. Another stationery point was found beyond which the anode current did not increase. It was assumed that this point represented the maximum radiation output of the cathode, a fact that was later substantiated when an increase of anode potential produced no further increase of anode current.

The cathode electrode supports originally were of platinum, because this metal has coefficient of expansion similar to the glass of which the tube envelope is made, but the later Fleming valves used the alloy called dumat, which serves the same purpose. This alloy is used today in lamps and vacuum tubes.

As a direct result of the work of Fleming at the University College Laboratory, Cambridge, England, the study of the characteristics of various types of radiation was begun in earnest by astronomers on both sides of the ocean.

The researches of Dr. Karl K. Compton, now of the Massachusetts Institute of Technology, in the field of X-rays, is only one of the offshoots of the study of the science of radiation. The relatively small company of roentgenologists who have added to the stock of knowledge of which this particular branch of physics is daily assuming greater importance to mankind.

Positive Charge Suspected on Surface

We have reviewed the highlights of the theoretical and experimental progress of the earlier steps incidental to the determination of the nature of the behavior of ionized gases, first in air, then in vacuo, and this led to the first form of the radio receiving tube, the Fleming Valve.

Experiments by Dr. Compton were made during 1915-1920, with the object of confirming that a positive charge existed on the surface of a glass envelope that enclosed a source of negative radiation. It was found that this was not exactly the case, the setup as here depicted being used, with the single exception of the type of galvanometer, which is of the telescope and mirror reflected scale variety. The one shown is merely for convenience.

Here is one historic experiment that the reader who is experimentally inclined can copy. The essential apparatus is a standard 50-volt lamp (10 watts), a hundred ohm resistor of the variable type, and four dry cells to afford anode voltage. The galvanometer may be of inexpensive design, say one of a sensitivitv of five microamperes per scale division, or so. The lamp may be heated from AC.

The Compton Experiment

The purpose of this experiment, at first consideration, seems to overlap work already done, if the existence of the effect of the negative radiation is the only objective, but if you will remember a previous remark concerning the deflection observed in the second experiment of Fleming, it will be realized that there is a difference.

One of the outstanding characteristics of all vacuum tube research is that you have to have an alert mind, eye, and ear, to observe small effects, which may easily have big consequences.

The evacuated glass envelope contains a tantalum or tungsten filament, and the metallic coating is of heavy tin foil, closely conforming to the shape of the envelope, and from the surface of this coating at the top, as shown, a wire lead goes to the reversing switch, and from the other terminal of the switch a lead goes to the potential battery positive terminal. The negative terminal is common with the positive filament voltage source which may be the power main, AC or DC.

Here the situation is somewhat different to the preceding cases, since the plate or anode electrode is external to the rest of the tube elements, especially the source of negative radiations.

Test of Polarity

According to theory, the velocity of emission of the negative charges will be high enough, if the temperature of the cathode is sufficiently high, to enable the negative charges to bombard the inside surface of the envelope. This results in the outside

FIG. 2.

THE COMPTON EXPERIMENT, MADE WITH AN ORDINARY TUNGSTEN FILAMENT LAMP, GAVE THE FIRST INDICATION OF THE EFFECT OF SPACE CHARGE.
Electronic Discharge

Williams

surface of the glass envelope acquiring a positive charge by induction. The existence of this state of affairs should result in a current through the glass.

The polarity of this surface charge was tested, by connection to an electrometer, and found to be positive. Following this the circuit was closed through a galvanometer, as shown, but without the high-hand potential battery. The deflection was found to be zero, despite the connection to the positive filament voltage source.

So the previous experiment was repeated, and the electrometer test again showed the metallic coating to be positive.

But it was also found that the degree of positive charge coincided with the potential drop between the ends of the hot cathode wire, taking into account the potential necessary to transfer unit charge from the plane of the cathode to the plane of the glass. It was further found that if the load conditions imposed by the external circuit, namely, those of a resistor equivalent, are less than that of the path through which the charge passes, the required potential must be maintained with an external source of potential, such as the battery shown in Fig. 2.

Thus it was found that there was a gradient of radiation along the hot cathode, from the positive end to the negative end. It was at first thought that this inequality in the emissivity of the cathode would result in the exhaustion of a portion of it first, but it was later found that the total number of charges that negotiated the distance between the cathode and the external anode by far the greatest number fell back on the cathode again, this effect being proportional, roughly, to the square of the applied voltage.

Experiments with a variety of radiators gave different results, so finally it was possible to tabulate the emissivity of a number of substances. This list of the investigation led to the development of the present-day filament, and ceramic coating materials.

How Gas Molecules Behave

What is the structure of gaseous molecules whose behavior under the influence of an electric field, even a weak one, as in the case of the present experiment, is involved?

Theories of molecular and atomic structure have undergone changes, due to new concepts of the electrical constitution of matter. If explanations were made of the relatively historic effects observed years ago, in terms of modern concepts, the result would be a complicated sequence.

The structure of gaseous molecules is held intact by a mutual electric attractive force that is exercised wholly within the sphere of the individual molecule. The application of an electric field under the right conditions results in the disruption of the molecule's structure. The particles can be projected along a definite path without the influence of the force that disintegrated them, the mutual attractive forces tend to reassert themselves, especially if the particles are close enough together, so that the ratio of the center to center distance of the particles to the attractive force is small. This results in recombination of the molecules.

This is well illustrated in an experimental observation of Fleming in connection with research on the Edison 'incandescent lamp filament, made of carbonized bamboo fibre, fashioned in the form of a loop, the terminals of which are clamped by two small copper tubes pinched together, and the whole being then copper plated, after which the assembly is placed within the envelope and sealed off, after exhaustion.

Copper Deposit Appears

During the exhaustion process, the lamp was dimly lighted to help to drive off occluded gases, and finally the tube was sealed off. But during the life of the lamp, it was noticed that a copper deposit appeared on the interior of the lamp, and it grew thicker as time went on. It was at the same time a well-defined line along which there was no deposit of copper.

This was a shadow of the filament, and it was most noticeable when the ordinary carbon deposit was a minimum. But even when the copper had reached its maximum density, the additional carbon coating did not affect it, and after the lamp finally burned out the copper coating's thickness was measurable.

This copper deposit exhibited the characteristic behavior of a molecular radiation between two points, and though no special significance was attached to the observed fact at that time, it is now seen to parallel the Compton effect. This effect observed

A CASE OF MOLECULAR RADIATION, NOW APPLIED TO THE FRONT SURFACING OF MIRROR SURFACES.

by Fleming, with the Edison filament, was really the forerunner of the electron radiation phenomenon of Compton.

Fig. 3 represents the first commercial form of the Edison lamp, and the clear line above referred to is represented by the dotted line in the sketch. This dotted line is not one that is in anyway irregular in appearance. It is manifested in each and every case, and because the effect constituted a defect, it led to the substitution of a different method of fastening the filament wires to the supporting structure, which were finally made of duralm alloy. The joint was secured with a kind of carboferrous paint, which solidified in the form of a small ball on drying.

Positive Charge Established

The precipitation of solid copper on the inner walls of the lamp is directly due to the establishment of a positive charge on this inner surface of the lamp, coupled with the velocity of emission of the particles. The potential available for doing all this is furnished by the potential difference between the opposite ends of the filament, which is 110 volts, the shadow effect being due to the difference of the bulb as the negative end or side of the filament occurs.

One side of the filament acted as a cathode, while the other side was the anode, but it must be borne in mind that the effect was a differential one, as all parts of the filament that were incandescent were at the same temperature, since the cross-section was uniform. Thus it is seen how this effect parallels the Compton experiment, except that the precipitation of a metal in molecular form was not involved in Compton's work.

Study of Gas Discharges

Of the development of the vacuum tube it can be truly said that progress depended on the degree of adaptability of the tube with which you worked, for before the glass-blowing art approached the degree of present-day accomplishment the physicist in many cases was dependent upon his own ability as a glass blower, when it became necessary for him to make alterations to his glassware. This hazarded many a failure, but of all this work there was born a new knowledge which became part and parcel of the tube making industry.

Fig. 4 may not seem to be very much unlike the low pressure tube previously discussed but in reality it is very different, the former being for the purpose of demonstration, while the present tube's form fits it for qualitative work.

Another curious fact about vacuum tubes is that the effects observed in one tube often help to answer the question which the nature of the discharge in another indicated, and thus it is glimpsed how a part of the vacuum tube research rests upon the observations of the discharges in the earlier tubes.

What is important now is the presentation of the form of tube in which the ionization potential of different gases is measured.

(Continued next week)
A Neutalized Tuned Radio Frequency Set

A NEUTALIZED TUNED RADIO FREQUENCY SET
FILTER, IN LINEAR FREQUENCY RELATIONSHIP TO AN ASTATIC COIL BUILDS UP THE VOLUME OF THE CUSTOMARY

THERE are by now certain standard sets which, though they may differ superficially, nevertheless are very similar the same. These sets not only sell, but stay sold and continue to give satisfactory reception year after year.

Therefore why not write up a descriptive article about a set like this?

One of the advantages of this circuit is that a chassis may be built to fit a wide variety of cabinets. A design reasonably trouble free is what is under discussion. The assembly of a standard circuit is simple to the average set constructor, who will have no trouble with it.

Uses Screen Grid Tubes

The assembly is of a variety not strange to the majority of readers.

The input circuit is one of the station selecting type, and its function is that of a modified filter, enabling the first stage to be made more nearly resonant to the desired signal frequency than it is usually with the untuned type of first stage antenna coupler.

The control for this adjustable filter is a small knob of the same size and finish as the usual volume control and switch knob and is located at the left-hand side of the center of the lower part of the front panel. The tuning is accomplished with a four-gang .00035 mfd. variable condenser, whose plates are carefully aligned.

The radio frequency coils are mounted mutually at right angles to each other. There is a small neutralizing condenser for each coil.

The three coils mount right under the radio frequency tubes, with sufficient clearance to enable the connecting wires to be laid in the manner to be prescribed later on.

Detection Circuit

The tubes plug into the tube sockets, which are mounted underneath the panel, so that the tube prongs will project through the panel. This necessitates the drilling of five tube prong holes. You may use a dummy socket as template.

In those circuits with high detector plate voltage a power detector may be used. The circuit will contain suitable means, as well as apparatus for cutting in a phonograph record pickup, regardless of its impedance, the scheme being to regulate the speaker output by means of the usual volume control, and in addition the input to the audio amplifier is by means of two push-pull tubes, a circuit arrangement that follows the detector output, the change-over being made by a small separate switch directly under the main dial, which you rotate to the right for the phonograph record connection and to the left for the reception of broadcasting.

Connections, and the Battery Cable

The audio amplifier consists of an arrangement whereby three tubes follow the detector tube. The output is 245 push-pull.

Provided with a Station Selecting Input

FIG. 1.

This hasty resume of the sets just concluded omitted the usual connections and it might be surmised that all that you have to do is to complete the antenna and ground connection, also the A B & C voltage leads and the job is done. In general this is true but there may easily be the odd case where this is not the only slant on the proposition, and this is specially true in the case of the AC model, where the actual placement of the lead by-pass condensers influences the working of the circuit. Here is where the interpretation of the wiring diagram is likely to go wrong, if at all, and the general rule to follow is that if the diagram calls for the placement of a by-pass condenser at the end of the particular lead, and particularly if you are to by-pass a certain piece of apparatus, do so at the point closest to the part in question, always, unless there as a good reason for using it at some other point.

245 Push-Pull Output

The original model of this circuit appeared in two forms, one of them used a single 171, while the other one used two of them in push-pull. Here we are going to use, push-pull, but substitute 245s.

The power transformer is provided with two 2.5 volt windings, one of 16 amperes, another of 3 amperes capacity. The large-wire winding is loaded with the heaters of five tubes, or a total of 8.75 amperes.

The mid-connection of the two filament windings goes to ground. The 3-ampere winding supplies the filaments of the 245s. The radio frequency coils that follow the first stage tapped coil are the ones that are placed at mutual right angles.

Analysis of the

(Continued from page 6)

When the modulation increases the amplitude of the carrier the energy supplied to the resonant vibrator is continually increasing and the theory for a constant amplitude for a definite period does not hold. But the increasing amplitude of the driving force obviously increases the amplitude of the vibrator, but not as rapidly as the driving force, because part of the driving force is not in phase with the vibrator. It is held back a little. Likewise, when the modulation decreases the amplitude of the carrier, the amplitude of the vibrator obviously decreases also, but not in the same manner as when the carrier stops entirely, because carrier continues.

It appears that the variation in the amplitude resulting from a driving force modulated with a pure tone would be quite different from the variation shown in Fig. 3. The rise in the amplitude would more closely follow the sine wave than the exponential curve shown in Fig. 3. Also, the fall in amplitude of the resonant vibrator would more nearly follow a sine curve than the decay exponential curve shown in Fig. 3. Of course this is just what is desired to produce a pure tone from a carrier.
TRF Receiver
McMillin

to one another. The tapped coil is placed at a distance from the others so that its coupling effect on them is very small.

Use With a Short-Wave Converter

The scope of usefulness of a broadcast receiver is not complete these days if it does not include some means for automatically changing to different wavelengths. The addition of an intermediate frequency for a short-wave converter, and is highly adaptable for an intermediate frequency source.

When you use the short-wave converter the procedure is to tune the broadcast receiver to 1500 kc, or higher, unless the set is more sensitive at a lower frequency.

A model similar to the one herein described was tested by the author on both local and distant stations, when the local stations were plentiful on the air, with very gratifying results. An indoor antenna of bell wire was used. Later on for short-wave reception, with a converter, the same set was tested on the regular outdoor antenna, against a loop-operated Superhetodyne. The TRF set was more sensitive.

From a glance at the drawing, the crossed inductances might seem to indicate a variometer of the old bulky type. The present coil is quite small, not quite two inches in diameter, and occupies about ½ inch behind the front panel, being mounted on the front panel of the tuning condenser. L_1 and L_2 are two windings and need not be shielded. The inductance switch is mounted directly under the tuning condenser dial knob, and the volume control, which is the screen grid voltage potentiometer, is mounted at the right of the tuning condenser at the same level as the astatic variometer's horizontal axis.

Controls

The occurrence of three control knobs might seem at first blush to preage a degree of complication that some of the contemporaneous sets apparently do not possess, but that impression would soon be dispelled if the reader could but see behind the panel of some of the modern sets, as compared to the one depicted here.

In reality the tuning condenser control knob is a kind of voltage control. The tuning knob of the radio receiver is in a strict sense a variometer. The principal control is the screen grid potentiometer, the astatic coil's mutual inductance variation affecting principally the sensitivity of the circuit, an adjustment that in this case does not need to be very exact, unless with local or distant reception. Adjustment is not required usually for the reception of local stations.

Most fans will want to use black-finished surface bakelite for the front panel, if for no other reason than the fact that it is easy to look at, if you have the means at hand to put an artificial finish on either brass or aluminum, such as a grained wood effect, there is no reason why you should not use a front panel of either of these two metals, provided you keep the radio frequency coils at least three inches away from the front panel.

Ground Power Transformer Frame

As usual, the heater wiring is to be of ample cross-section, not smaller than No. 18 B & S, equivalent of the resistance of some copper wire, and that the soldered joints shall be of low resistance, as any tendency toward low heater voltage is usually due to these two things. Also general neatness in the wiring layout is a factor not to be ignored.

And finally the core, or rather the case of the power transformer is to be bored, simply by connecting a short lead soldered to the case directly to the ground lead, preferably close to the point where the regular ground binding post is connected. The transformer in the Polo 245 PT.

Simply because there is an indication that a dynamic speaker field coil is to be connected to the B voltage supply system, in place of the choke coil, is no reason to suppose that any other kind would be overloaded. A reserve of output power is always an asset, because it usually means that the otherwise hard-to-raise station is readily rendered decently audible.

The author has been experimenting with adjustments on the inductor dynamic speaker lately, and has found that of a total of ten units for repair, four had too close an air gap between the armature and the pole faces. This observation is directly at variance with the accepted practice in the case of the regular magnetic unit, which was subject to increasing volume with decreasing air gap distance. The optimum distance for the inductor unit is .010 of an inch.

[More about this circuit will be published in an early issue.]
—Editor]

Bias Resistance Requirements

WHAT should the grid bias resistor be in a 245 tube push-pull amplifier? I have seen different values specified.

If they are all correct the value cannot be very critical.—L. C. R.

One 245 tube requires a bias resistor of 1,500 ohms. Two tubes, either in push-pull or in parallel, both on the same filament winding, require a bias resistor just half this value, or 750 ohms. Since the nearest commercial resistors are 1,000 and 750 ohms, these are used. The value in either case is not critical within 100 ohms, or even 200 ohms. If widely different values are used, there is either an error in the design or there is some special reason for the difference. For example, they may be connected in the circuit so that more than the plate current of the 245 tubes flows through the resistor. In any case the proper resistance is that which when multiplied by the current, in amperes, flowing through it, gives the desired voltage drop. In case the plate voltage is 250 volts, the bias should be 50 volts. When the voltage on the plate, or plates, is 250 volts and the bias on the grid, or grids, one tube draws .025 milliamperes and two draw 64 milliamperes. Hence we have for one tube 50/632 equals 1,560 ohms and for two tubes, 90/604 equals 780 ohms. If the resistor is connected so that more than the plate current of the tube, or tubes, flows, we have to add the extra current, and in each case we get a lower resistance.

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the red terminal. The rectifier tubes and circuits.

VOLTAGE [This is the continuation of the article published last week on rectifier tubes and circuits. The installation last week contained the characteristics of the 280 full-wave rectifier tube.—Editor.]

THE 281 tube is a half-wave rectifier which is used when higher voltages than those obtainable with a rectifier employing the 280 are desired. This half-wave rectifier is rated at 700 volts and 85 milliamperes. Two of these tubes must be used if a full-wave rectifier is desired, and then the output current may be as high as 170 milliamperes.

CHARACTERISTICS OF 281 RECTIFIER

<table>
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<td>Filament voltage</td>
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<tr>
<td>Filament current, amperes</td>
<td>1.25</td>
</tr>
<tr>
<td>Maximum AC plate voltage (RMS)</td>
<td>700</td>
</tr>
<tr>
<td>Maximum DC load current, milliamperes</td>
<td>85</td>
</tr>
<tr>
<td>Maximum length, inches</td>
<td>61/4</td>
</tr>
<tr>
<td>Maximum diameter, inches</td>
<td>21/8</td>
</tr>
<tr>
<td>Socket, standard UX</td>
<td></td>
</tr>
</tbody>
</table>

In this tube the two heavy prongs are the filament terminals and the small, right-hand prong, looking down, is the plate terminal. The small, left-hand prong has no connection in the tube.

The filament is of the oxide coated type and should show a red color when the rated voltage of 7.5 volts is applied across the terminals. Since the filament current is comparatively heavy, the leads from the supply transformer should be of heavy wire and should be as short as practical and all joints should be carefully soldered.

Before removing the tube from the socket the power should be turned off and it should not be turned on until after the tube has been inserted in the socket. These precautions are to avoid surges and excessive voltages.

It is advisable to make certain that the line voltage across the primary of the power transformer does not exceed that for which the transformer has been designed, before the tube is inserted into the socket. This can be ascertained by means of a good A.C. voltmeter reading across the transformer winding. If the line voltage is higher than the voltage for which the transformer has been designed, it is advisable to insert a resistance of suitable value in the line and adjusting this resistance until the voltage across the transformer terminals reads the proper value. If the transformer primary contains taps for different line voltages, the appropriate tap should be used in place of the resistance.

Some transformers are tapped for 105, 110, 115, 120, and 125 volts for cases when the nominal voltage of the line is 115 volts.

Half-Wave Rectifier

When one of these tubes is used as a half-wave rectifier, the power transformer should have one 7.5 volt secondary, preferably center tapped, and one high voltage winding without a center tap. A typical circuit diagram of a half-wave rectifier with filter and voltage divider is shown in Fig. 3. The primary of the transformer in this case is tapped for 107.5, 115, and 122.5 volts, while the high voltage secondary is marked for either 600 or 700 volts, root mean square value.

Two choke coils are shown in the filter, each of 30 henries. These chokes should be designed for a current of about 100 milliamperes.

FIG. 2

AVERAGE OUTPUT CHARACTERISTICS OF THE 280 TUBE, SHOWING THE VARIATION IN THE RECTIFIED VOLTAGE WITH CHANGES IN THE LOAD CURRENT. CURVES ARE SHOWN FOR BOTH CHOKE AND CONDENSER INPUT TO THE FILTER

FIG. 3

ATYPICAL DIAGRAM OF A HALF-WAVE RECTIFIER UTILIZING THE 281 TUBE, WITH FILTER AND VOLTAGE DIVIDER.

Right or Wrong?

QUESTIONS

(1)—A choke coil having an inductance of about ¾ millihenry is not effective in a short-wave converter because its impedance is so low that it is inefficient as a coupler.

(2)—A choke coil of 50 to 100 millihenries is not effective in a short-wave converter, except in the output, because the distributed capacity is so high that the high frequency currents are by-passed.

(3)—When a short-wave converter does not bring in anything but a roar, the trouble is that the detector tube is overloaded and the remedy is to reduce the pick-up between the oscillator and the detector tube.

(4)—The purpose of a baffle board in conjunction with a loudspeaker is to put a load of air on the moving cone.

(5)—A resistance in series with the primary of the transformer following the detector stops motorboating because the plate voltage on the detector is lowered.

(6)—A vernier is a device by means of which a dial may be moved very slowly, or a device which changes the capacitance of a tuned circuit very slowly.

(7)—The core of a dynamic speaker must be made of the highest permeability material, in order to get a sufficiently high field strength.

(8)—A bi-resonator is a dual tuner, or a type of filter in which there are two tuned circuits.

(9)—A high impedance speaker, such as most magnetic speakers, may be connected from plate to plate of the tubes in a push-pull amplifier without loss of coupling efficiency.

ANSWERS

(1)—Wrong. At high frequencies such a choke coil is more effective than a choke designed for use in the broadcast band. At 1.5 megacycles the impedance of a quarter millihenry choke is 2,257 ohms. At higher frequencies the impedance is proportionately higher. A 200 millihenry choke may have a much lower effective impedance at some of the high frequencies because of the high distributed capacity.

(2)—Wrong. Take zero inductance of 50 millihenries and a distributed capacity of 10 mmfd. It has a natural frequency of 225 k.c. and therefore any short-wave frequency
characteristics

Anderson

milliamperes. The first three by-pass condensers should be designed for voltages of about 1,000 volts to provide a safety factor. Electrolytic condensers cannot be used in this circuit unless they be connected in series, because the working voltage will be higher than the break-down voltage of these condensers. When more current than given by a single 281 tube is needed, it is necessary to use two of them in a full-wave rectifier circuit, as shown in Fig. 4. The power transformer required in this case should have one 7.5 volt winding, preferably center-tapped, and capable of carrying more than 2.5 amperes. The high voltage secondary should be center-tapped and the effective voltage across each half should be from 600 to 700 volts. That is, the total rectifier voltage across the secondary should be from 1,200 to 1,400 volts.

This circuit is capable of delivering up to 170 milliamperes and therefore the 30 henry choke coils in the filter should be designed to carry this current or a higher current. The requirements of the condensers in this circuit are exactly the same as those of the condensers in the half-wave rectifier provided the voltage across each of the half-wave rectifier winding is no higher than the voltage across the untapped winding in the half-wave circuit.

Regulation Curves of Full-Wave Rectifier

In Fig. 5 are shown some regulation curves of full-wave and half-wave rectifiers utilizing the 281 tube. For the full-wave rectifier curves are shown for both condenser and choke input to the filter but for the half-wave rectifier curves are shown for only condenser input.

It will be noticed that the regulation is considerably better for the full-wave rectifier, since the curves are not nearly so steep, and also that the output voltage for condenser input is considerably higher than that of choke input.

Wrong?

would be far above the natural frequency. Much off resonance, the impedance of the coil is equal to that of the capacity alone, and at 10 megacycles this is 1,592 ohms.

(3)—Right. At least in most cases. Overloading takes place even when the detector operates on the grid bias principle. Sometimes this overloading may be in the modulator of the converter and at other times it may be in the detector of the broadcast receiver. The remedy in most instances is to loosen the coupling between the oscillator in the converter and the modulator.

(4)—Right. The effect is the same, essentially, as attempting to cut butter with the side of the knife. When there is no baffle, the armature moves through the air just like the knife through butter when the edge is used for cutting. A better analogy perhaps is to move a boat in water. Moving edge-wise is easy because the board cleaves the water. Moving it sidewise is difficult because much water has to move with the board. The effect of the loudspeaker is to move the air back and forth, and as much air as possible.

(5)—Wrong. This effect may in some instances increase the motorboating. It stops it because it prevents feed-back from backing up through the transformer primary.

(6)—Wrong. A vernier is a device by which a dial may be read closer than the finest division, and read accurately. The usual vernier is such that it permits reading to one-tenth of the smallest division.

(7)—Wrong. While it would be desirable to use high permeability material for the core, it is not necessary, for the same field strength may be obtained with the cheapest cast iron core, provided that sufficient magnetizing force is used. It would be cheaper to operate a speaker with a high permeability core, but it would require a higher initial investment.

(8)—Right. This is a name given to a filter circuit designed so as to pass a narrow band of frequencies when the filter consists of two loosely coupled resonant circuits.

(9)—Right. Indeed, the matching may be improved, but whether or not it is, depends on the matching existing between the power tubes and the speaker as well as on the impedance of the circuit and the type of tubes. A magnetic speaker usually has high impedance, which is comparable with the impedance of two ordinary power tubes in push-pull.

These curves show nothing about the thoroughness of the filtering in the different cases. For a given filter, the output of the full-wave rectifier will contain less ripple than the other rectifier, and for a similar filter, insofar as similarity is possible, the choke input gives less ripple than the condenser input. The lower output voltage from the choke input filter is a disadvantage which offsets any advantage in thoroughness of filtering. The main advantage of the choke input is that it protects the rectifier tubes.

If breakdown of the filter condensers is to be avoided it is necessary to choose condensers that are guaranteed to withstand the peak value of the high voltage on each plate of the rectifier tube. The peak value is 1.41 times the RMS or effective value. Hence if the voltage per plate is 700 volts, the peak value is 987.5 volts. This value of voltage will occur when the load current is zero. As an additional precaution against excessive voltage the voltage divider resistance should be chosen so that there is always some bleeder current, say 20 milliamperes. If this is done the maximum voltage will never reach peak value because the load current cannot be less than 20 milliamperes. The regulation curve for 700 volts on the plates at 20 milliamperes shows a voltage of approximately 890 volts, which is well within the working range of a condenser rated for continuous service at 1,000 volts.

REGULATION CURVES OF FULL-WAVE AND HALF-WAVE RECTIFIERS UTILIZING THE 281 TUBE. THE FULL LINES ARE FOR FULL-WAVE RECTIFIER WITH CONDENSER INPUT. THE DOTTED LINES FOR HALF-WAVE RECTIFIER WITH CONDENSER INPUT. AND THE DASHED LINE FOR A FULL-WAVE RECTIFIER WITH CHOKE INPUT.

A TYPICAL DIAGRAM OF A HALF-WAVE RECTIFIER UTILIZING THE 281 TUBE WITH FILTER AND VOLTAGE DIVIDER.
A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions answered by members of University Club are answered. Those not answered in these columns are answered by mail.

Two Stage Push-Pull Amplifier

If you have a circuit of a two-stage amplifier which can be used with the new 2-volt tubes, will you kindly publish it? If any you suggest a remedy on it? Can you persuade Mr. Brunn and Mr. Przybyszewski?

In Fig. 863 is such a circuit. It was intended for use with 201A and 171A tubes but it can be changed very easily to fit the 2-volt tubes. In Fig. 863 the tubes in the push-pull circuit should be 231. The filament voltage should be changed from 6 to 3 and may be supplied by two No. 6 dry cells in series. With 3 volts on the filament battery terminals, ballast resistor R1 should lie between 15 and 17 ohms and ballast resistor R2 should be slightly under 4 ohms. The bias on this tube should be changed to 3 volts and the plate voltage may remain at 150 volts. The bias on the power tubes should be changed to 225 volts and the plate voltage to 135 volts. These are the only changes necessary.

Photo-Cell Characteristics

If a circuit that photo-electric cells give the same output current for all anode voltages, provided that the amount of light that enters is constant? If this is not a fact, how does the current vary? Also, is it a fact that if the anode voltage is kept constant the current varies in direct proportion to the amount of light?—G. M. S.

It is not a fact that the current is independent of the anode voltage. For constant light flux and neglecting the cell, the current increases in much the same manner as it increases in an ordinary vacuum tube when the voltage increases. The manner of change depends on the type of photo-cell, that is, whether it is of the high vacuum or the gaseous types. It is true that the current varies in direct proportion to the light flux, provided that the spectral composition remains constant as well as the anode voltage. By special composition is meant the proportion of the various colors in the light. The current varies with the wavelength of the light and with the color. In gaseous cells the current is not strictly proportional to the illumination.

Overloading the Modulator

I have built a four tube amplifier along the lines described by Brunsten Brun on the 15th issue and I have noticed some peculiar effects, which are not at all pleasant. When the signals are tuned in with both the oscillator and the radio frequency dials there is a loud roar in the speaker, or a very shrill whistle. I have been unable to remove this. Can anyone suggest a remedy?—B. L.

The roar and the shrill whistle are undoubtedly due to overloading of the detector tube. This may be due to the pick-up of the oscillator coil alone or to the combination of this and the signal. The oscillator contributes most of the voltage that overloads. The thing to do is to loosen the coupling between the oscillator tuned circuit and the pick-up coil, which may be done either by moving the pick-up coil farther away or by reducing the number of turns on it. This was explained in the article by Mr. Brunn and the explanation applies equally well to his set and yours. The same phenomenon occurs also in broadcast superhetorodynes.

Design of High Frequency Choke

I wish to construct choke coils of about one millihenry each for a short-wave converter. I have wooden rods about 3/4 inch and am wondering if it would be all right to wind the coil on these. If it is all right how many turns should I use?—H. J.

It is all right and you need about 250 turns of No. 36 double silk covered wire. This will make a winding 2.25 inches long. These coils should be wound with used for antenna impedance in case the input in untuned, or for devices in series with screen and plate leads, or as RF chokes in the plate circuit of a detector for the purpose of forcing the high frequency currents through the tickler. A coil of this diameter has a self-inductance around one microfarad and a natural wavelength of about 59.5 meters. However, it remains effective for shorter waves.

Short-Circuiting Turns

You have published circuits lately in which you have provided a switch in the tuned circuits whereby turns on the coils may be short-circuited for the purpose of extending the range of the turnes. Is not a fact that short-circuiting turns reduce the efficiency of the tuned circuits? We have built led this line with this short but difficult to wind and in some circuits, have found that some instances it is better for short-circuit a part of the coil than to leave dead-end turns. For this reason when a coil is tapped so as to go from broadcast frequencies to higher frequencies, or from a first band to a second band or higher frequencies, it is better to short-circuit the superflous turns than to leave them open. The reason for this is that when a part of the coil is shorted a circuit is formed which consists of an inductance and a resistance and it has been found that no current of appreciable magnitude can flow in the circuit and hence there will be no loss. When the turns are left open the distributed capacity of the shorted turns and the inductance of the turns form a circuit which may resonate with some frequency in the band the active part of the coil is supposed to cover. However, if two or three turns on the coil is bad, shorting a third or a half of the coil is permissible.

Improvising a Center Tap

I have a filament transformer having a five volt secondary which I wish to use for heating the filaments of a couple of 171A tubes. But there is no center tap on the winding and I suppose that without one the hum will be excessive. Can you suggest a way of using this transformer for the purpose I mention without introducing a lot of hum?—C. L. K.

There is a very simple way. Just get a center tapped resistance of about 30 ohms and connect this across the filaments of the 171A tubes and use the tap on the resistance in place of the center tap on the transformer. If you get a resistance with an adjustable tap it is possible to balance out practically all the hum. This method of reducing hum is often used even when there is a center tap on the filament winding because it has many advantages.

Blue Glow in Rectifier Tube

I have a push-pull amplifier and power supply utilizing two 245 tubes and one 280. For a while this circuit worked all right but now as soon as I turn on the power the rectifier tube develops a lot of hum. Is this due to the blue glow and operation is not satisfactory. What is the cause of the blue glow and what can I do to prevent it?—R. B. H.

The voltage on the rectifier tube is too high or the current drawn from it is too high. It may be that you have a defect in the anode or the filter, or to lack of bias.
on the power tubes. Most likely you have a defective rectifier tube. Try one that you know to be good, and that too turns blue cut down on the line voltage by putting in the variable resistance series with the primary. Use 20 or 30 ohms and adjust it until the total voltage across the voltage is divided 300 volts. Also check over the parts in the circuit to make sure that no condenser or resistor is shorted and also check the bias voltage on the power tubes. A gaseous tube will turn blue at much lower voltages than high vacuum tubes, and it may be that your rectifier tube has more gas in it than is good for it. It may also be that your power transformer has been designed for 281 and 250 tubes.

**Calibrating a Short-Wave Converter**

It is practical to calibrate a short-wave converter, and if so how can it be done? I have built one and I find that the same station never comes in the same place on the oscillator dial. The reason is this: If I record the dial setting of the stations I log one day, I don't get the stations at the recorded readings the next day. What is the cause of the variation? - S. G.

The variation in the oscillator dial settings is due, I think, to the decreased output that you use the same intermediate frequency. Every time you change the tuning of the broadcast receiver you change the intermediate frequency. If you want to calibrate the oscillator dial on the short-wave converter you must always use the same setting of the broadcast receiver, not approximately but exactly the same. A change of one-tenth of a division on the broadcast tuner may be equivalent to a change of ten divisions on the oscillator dial. Select some point on the broadcast tuner dial where the receiver is very sensitive and where there is no interference from local stations and use that setting, time after time. While you may use the broadcast tuner as a vernier for the oscillator control, you should always know where its normal position is with respect to the calibration of the oscillator dial.

**Making a Vernier**

I WISH to make a vernier to attach to my tuning dial so that I may be able to read fractions of the finest division on the scale. Can you tell me how to do it and how to read it when it has been done? - F. W.

Make a short scale having 10 divisions, these ten divisions being exactly equal to 9 divisions on the dial. If the dial moves, attach the small vernier in place of the index and mount it so that there is as little clearance between the two scales as possible. When zero on the small or vernier scale is opposite one division on the dial, and the tenth division on the vernier scale should be exactly opposite 59 on the dial. If zero on the vernier scale is a little passed 50 but not a whole division past, look along the vernier scale for the first division line that is exactly opposite one of the dial divisions. If the first is opposite 51 on the dial, the exact reading is 50.1, or the second is exactly opposite 52 on the dial, the reading is 50.2, and so on.

**Power Supply Design**

I have a November 15th issue you published a diagram in connection with the characteristics of the 280 rectifier tube. I wish to build this circuit and would appreciate if you would give the constants of the condensers and the resistances. Also, I wish to use the Pol Roger power transformer and the Polo choke D, D. Condensers C1 and C2, Fig. 1 of the circuit in question should be designed to stand 600 volts or more. The first unspecified condenser should be a capacity of 4 or 8 8 mf. and it, too, should be designed to stand 600 volts or more. The trotyloid condenser of 8 mf. could be used in this position. This, however, should stand only a little over 400 volts. This is high enough because the condenser is placed in case you would receive an over-voltage for a short time. The other condensers may be one or two mf. each and need not be rated at 600 volts. The Pol Roger power transformer has been designed for a job just like this and the Polo chokes can be used to good advantage.

**High-Low Switch Arrangement**

I must receivers there is now a switch by which the volume may be changed from high to low or vice versa. Most of these are in the RF amplifier. Would it not be possible to put this switch in the audio frequency amplifier so that the RF amplifier would be left intact? That, is would not be possible, for example, to arrange the switch so that the loudspeaker would be transferred to the tube circuit of the power supply and at the same time kill the power tubes so that the connection would be made. If I remember correctly the Pol Roger power transformer has been designed for a job just like this and the Polo chokes can be used to good advantage.

**Getting Distant Stations**

Modern receivers have been designed so that they are more sensitive than is required for ordinary reception, and supposed so sensitive that they should be able to pick up foreign stations, such as those in Cuba and Mexico. But they don't do it. Can you suggest a reason for this lack of agreement between laboratory sensitivity and field sensitivity? Also, can you suggest methods whereby the distant stations could be received with better regularity?

Modern receivers have been designed to handle certain sensitivity, say four or five microvolts per meter. It is only necessary to assure that the field strength is that or more around the receiver. If a given receiver is in good operating condition and it does not bring in the foreign stations, you may be sure that the field strength is not as high as field strength required. This lack of field strength may be due to great distance between the receiver and receiver, to a high attenuation of the signals due to atmospheric conditions, or to local shielding of the antenna. It is also possible that the antenna used is not in effect equal to the standard antenna. It may have the wrong height at all or it may have too much capacity to ground, so that the signals are grounded long before they reach the receiver. The best way is to know about the circuit, to receive remote stations with an up-to-date receiver is to provide a first-class antenna and the very best ground. This offers little trouble in the country or in suburban localities but great trouble in apartment houses. As an example, a certain commercial receiver with built-in antenna just barely brought in local high civilization stations in a certain apartment house. When an indoor antenna of about 10 feet of wire running up to the ground and moulding was installed, stations up to 1,000 miles came in regularly. When a wire 20 feet long was run from the antenna post and dropped out of the window, stations in Cuba, Mexico, and California came in strong and clear, the receiver being in New Rochelle, N. Y. To bring in the remote stations it was necessary to tune extremely carefully, for half a division on the dial was sufficient to throw the signals out completely.

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Use the coupon below. Your name will be entered on our subscription and University Club lists by special number. When sending questions, put this number on the outside of the forwarding envelope (not the enclosed return envelope) and also at the head of your properties. 

If you are a subscriber, send $6 for renewal from close of present subscription and your name will be entered in Radio University.

NO OTHER PREMIUM GIVEN WITH THIS OFFER

In sending your queries to the University Department please paragraph and number them. Write on one side of sheet only. Always give your University Club Number.

RADIO WORLD, 145 West 45th Street, New York City. 
Enclosed find $6.00 for RADIO WORLD for one year ($2 nos.) and also enter my name on the list of members of WORLD'S UNIVERSITY CLUB, which gives me free answers to radio queries for 52 ensuing weeks, and send me number indicating membership.

Name
Street
City and State

www.americanradiohistory.com
FIRST MARCONI STATION FOUND; NOW LANDMARK

A little shack near Babylon, Long Island, New York, has been identified as the first commercial wireless station built by Guglielmo Marconi in the United States. It is to be preserved for historical exhibit through the efforts of Major Edwin H. Armstrong, radio pioneer, who discovered it.

Marconi erected the station in the late Autumn of 1900 or the early Winter of 1901. This gives it a date in radio history prior to the inventor's experiments in trans- oceanic radio communications, and previous to flashing the letter "S" across the Atlantic.

10 Words Versus 150 Words

Marconi located his Long Island sending post near the coast, where he could reach incoming ships while they were within 100 miles of New York. The station was operated by the Marconi Wireless Transmission at the rate of about 10 words a minute. The present transmission to all parts of the world is at the rate of 150 words a minute.

After Major Armstrong recently identified the shack he purchased it and offered it to the Radio Corporation of America, the successor to the American Marconi Company.

How It Was Located

Discovery of the existence of the station and verification of the fact it had played a role in early American radio came about partly by coincidence.

The coincidence was that Captain H. I. Round, one of the leading radio engineers of the British Marconi Wireless Company and an associate in Marcon's early work, happened to mention the Babylon station while visiting Major Armstrong at Bayport, Long Island, and expressed curiosity as to what happened to it.

Captain Round and Major Armstrong drove over to the town. They found and identified the shed.

[Picture on front cover]

One-Third of Music On Air Is Jazz Type

From the result of a recent survey of the distribution of radio time, it is found that of the total of 52.9% devoted to the broadcast of musical entertainment, the broadcasting of jazz occupied the 13.5% the remaining being devoted to the dissemination of artistic works.

Despite the apparent plethora of advertising analysis shows that it occupies only 8.64% of the total broadcast time, while the churches lag slightly behind.

This survey was conducted by the White House Conference on Child Health and Protection, and covered 75 stations. The use of radio facilities by churches is said to be on the increase.

TRADILOGRAMS

CAPTAIN SPARKS RETURNS FROM EUROPE

Captain Sparks, of the Sparks-Withington Company, returned from Europe on the Leviathan. During a two months' tour of Europe, as official representative of the Radio Manufacturers Association, Captain Sparks gleaned information he submitted to the R.A. at a meeting of its Board of Directors. Captain Sparks attended several radio shows and exhibitions in Europe.

* * *

D. W. May, President of the May Radio & Television Corp., Radio Distributors in Metropolitan Chicago, has been identified as the successor of the late Robert Dun- can, of Portland, Oregon, known as the Oregon Wildcat. The violation concerns section 29 of the Radio Act, which provides that no person within the jurisdiction of the United States shall utter any obscenity, indecency or profanity by means of radio communication.

The conviction is the outcome of speeches by Duncan, who purchased time over KVEP during the course of his campaign for Congress, for which he was defeated.

Previously to the conviction KVEP was removed from the air by the Federal Radio Commission, last June.

The station was owned by William B. Shaeffer, who, it was testified, operated his station beyond the assigned hours of operation, was not a citizen at the time he obtained the station license, and lastly, there was great frequency variation.

The counter claim was made that as the transmission was owned only 15 watts the station could not be heard far outside of Portland.

Oregon's Wildcat

Guilty of Profanity

Washingon

The Federal Radio Commission has announced the first conviction for profane broadcasting in the case of Robert Duncan, of Portland, Oregon, known as the Oregon Wildcat. The violation concerns section 29 of the Radio Act, which provides that no person within the jurisdiction of the United States shall utter any obscenity, indecency or profanity by means of radio communication.

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N.B.C. Adds WBEN of Buffalo to Chain

WBEN, Buffalo, N. Y., will become associated with National Broadcasting Company effective Saturday morning, November 15th.

WBEN uses 1,000 watts, and has an assigned frequency of 900 kilocycles (331.5 meters).

A THOUGHT FOR THE WEEK

READERS, take advantage of the Free Situation Wanted and Help Wanted announcement on our front page this week. Tell your friends about it. This is a small part of our bit to aid in the present successful national effort to get back to normalcy. Send some one out of work by telling him of the offer.

Yours for more jobs for the jobless!

Transmission Tested by Highway Police

The use of radio communication apparatus for the transmission of intelligence in divisional headquarters is being experimented with by a variety of interests. The latest news of this activity comes from the Division of Motor Vehicles of the State of California, which is carrying out a series of trials of an experimental nature with a special type of light-weight radio receiving equipment which has a useful operative range of over 200 miles.

Preliminary tests show that this equipment enables the chief and other members of the parole force in the highway, regardless of how they are scattered, in the minimum of time.

A preliminary report call for the establishment of a 200-watt transmitter at the highway department traffic school, where the tests are to be continued. The present tests are being made to determine the location of dead spots within the reception range of the transmitter. It is the opinion of the chief of the Division of Motor Vehicles, Frank G. Snook, that highway law enforcement will be revolutionized when the system is finally operative.

Literture Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories to do new work, should send a request for publication of their name and address toHow to submit your suggestions to the editors and learn more about American Radio History.

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20 K A R O D W O R L D November 22, 1936

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Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories to do new work, should send a request for publication of their name and address to How to submit your suggestions to the editors and learn more about American Radio History.

Frank Katcher, 709 Catherine St., Perth Amboy, N. J.
Geo. Hetzel, 866 E. 4rd Ave., New York, N. Y.
J. S. L. Aabrecht, Reft. World, 409 E. 105th St., New York, N. Y.
B. H. Heights, N. Y.
Frederick L. Carlson, Central Radio Sales & Service, 16 Lafayette St., Salem, Mass.
Charles W. McCormick, West St., Reno, Nev.
H. S. Hope, 113 S. Main St., Darlington, S. C.
D. L. Nelson, Route 1, Spicer, Minn.
Howard F. Anderson, 23 Maple St., Torrington, Conn.
T. G. Hewitt, Box 154, Gloucester Heights, N. J.
William A. Hulston, 303 S. Olive St., Pebbley, Calif.
Albert C. Birch, Clerk's Box, Winnipeg, Man.
Claude A. Clark, 826 N. Main St., Charleston, Iowa.
Henry Hall, Ridges, P. O. Canada.
The Radio Shop, Box 603, Sauturce, P. R.
Samuel G. Cohen, 400 So. Grand Ave., Los Angeles, Calif.
Ben Stone, 809 S. Irvine Ave., Huntington Park, Calif.
P. W. Paulson, 92 Greenwood Ave., Bridgeport, Conn.
M. Sullivan, 304 W. 3rd St., Port Clinton, Ohio.
R. Stewart, 1420 Newberry, S. C.
C. Albert, 367 Hanover St., Fall River, Mass.
Rogelio Garcia, 128 Adriatic Ave., Tamaqua, Pa.
J. P. Holloway, Box 517, Portland, Ore.
P. L. Glarner, R. F. D. No. 1, Summersdale, Ala.
E. D. Budd, 313 Bloomington Ave., Minneapolis, Minn.
W. D. Lack, Weatherford, Okla.
D. E. Wilks, 26 Glendale Ave., New York, N. Y.
Wm. F. Parker, Parker Eng. Co., 125 S. 11th St., St. Louis, Mo.
Einar Anderson, 300 Graman Avenue, Mt. Kisco, N. Y.
Bertram Reinitz, 18 East 23rd St., Brooklyn, N. Y.
Harvey Wood, care Post Office, East Rockaway, N. Y.
John C., Williams, 12 Dart St., East Rockaway, N. Y.
William B. Johnston, Hartfort, Conn.
Manson Lists Art's Advance in One Decade

By RAY H. MANSON
Chief Engineer, Stromberg-Carlson Tel. Mfg. Co.

In the ten years that have elapsed since KDKA at Pittsburgh put out the first regular broadcast programs in November, 1920, the public has been made aware of the technique both of broadcasting and of reception. In transmission both the quality of broadcasting and the area served by stations have increased steadily. Whereas 1,000 watts was considered a powerful station in the twenties, 50,000 is the usual output of an extraordianry station. Use of higher power has been made possible largely through the use of improved vacuum tubes as amplifiers.

High Percentage Modulation

Improvements in microphone design and construction have aided greatly in improving the tone quality of the programs sent on the air. Another technical improvement in broadcasting is "high modulation" by which the programs are more "deeply impressed" upon the station's carrier wave and is carried to a greater distance. Advances in radio receiver performance have made loud, clear, crystal sets give way to battery receivers; battery receivers to sets operated by eliminators; and these in turn to sets with full A. C. functioning—radiator type—with amazing rapidity. Tube developments have also aided greatly in perfecting radio receivers.

Fading Minimized

Advances in construction have given tubes greater amplifying power and greater stability together with lower current drain, while mass production has enabled manufacturers to reduce prices substantially.

Automatic volume control, which will reduce the amount of fading signals and "null dial efficiency," giving virtually equal sensitivity and improved selectivity at all points of the dial, are a few of the many new features made possible in the last decade, all adding to the pleasure which one can get from owning a good radio receiver.

Mr. Gruen Proves
He's Broad-minded

Cincinnati, Ohio—Every Thursday night at 8:45 E. S. T., the radio station of the Gruen Watch Makers Guild (WKRC) becomes a part of the Columbia Broadcasting System network which spends 30 minutes extolling the virtues of the Hamilton watch. Thus far, the Gruen advertising department has stuck to its guns and borne it.—From "Advertising Age."

WORTH THINKING OVER

NOW they're swarming over the air. At any rate, a person hearing—and, they say, desiring—the sobriquet of "the Oregon Wildcat," was convicted in Oregon recently for calling some well-known citizens out of their names. He also was charged with being drunk and disorderly during a Sunday school. The Federal Government closed the station which gave the hot-tongued violator his chance to tell an interested and frequently perturbed public his idea of certain fellow-beings. Now all is quiet along the Oregon borders. Cuss Uncle Sam in a print, you must—but look for trouble when Uncle Sam lists in.

What Results Does Television Offer?

A CONSERVATIVE'S REPORT

A
t my location, half a block from street cars, television is fairly good. My two main stations are WIXK, at Washington, on 102 meters, and WZCRC, Jersey City, N. J., 107 meters, WAKR, Radio Pictures, New York, on around 140 meters, is too weak to use. These three stations use 48 lines per picture, 15 pictures per second, but with slightly different height to width ratios. The RCA station, as I believe, New York, on around 145 meters, and another unidentified station on 106 meters, using different line characteristics, come through with sufficient strength to distinguish, but at present I have not made other discs to enable me to see them. Other stations are heard occasionally, but generally weak.

My present receiver consists of two screen grid RF, screen grid plate circuit linear detector, resistance coupled screen grid detector, rectangular black, 245 tube, with neon lamp in series with plate. All filaments are AC fed, and plate voltage of two audio tubes. The detector is of the 48 1/4-inch-kidney, disc one to disc ratio. Aerial 65 feet long, average height above ground 35 feet.

Following is a summary of results I am obtaining: WIXK, Washington, 102 meters, silhouettes only, generally very strong. Most nights had almost no fading. Local harmonic interference makes this station unusable for half of their program three or more nights a week. When clear, pictures are generally fair to good, figures and movements clear for periods only, although fairly understandable most of the time. Occasionally a complete film can be followed with ease. Writing is generally readable. Some nights double images and "full frame" phasing. WZCRC, Jersey City, N. J., 107 meters, half tones. Generally strong. Some nights very strong, no fading. Until a month ago was very clear of interference. Lately badly jammed by harmonics and other television stations. However, results on the whole are surprisingly good. The half-tones for quite long periods, five minutes or more, are quite recognizable, and at times as good as a photograph. Accompanying speech has not been tried yet. Interference, so long as it is not periodiic, such as heterodynes or violet ray, etc., or too continuous, has less effect than one would expect. Pictures can be read about most of the time when the speech is drowned out by noise.

I have endeavored here to give you a true account of my results to date, and they may border slightly on the conservative side. With possibly a closer station, or power into the present ones, results should be tremendously improved.

ROLAND PRICE (VE3DJB),
290 Waverley Rd., Toronto, Canada.

Perfors Technique to News

Please allow me to express my preference for technical matter in your magazine, more constructional matter on the Superhetodyne, and more short-wave stuff, I don't care much for this, for I can get news enough in other magazines and the newspapers, but not the technical stuff.

R. CHAMBERLIN.
Box 42, St. Albans, Vermont.

Two-Way Phoning on Mail Planes

America can now claim the most comprehensive aeronautical radio installation, as Boeing System has notified the Post Office Department all of its fifty planes flown on the Chicago-San Francisco and Seattle-San Diego air mail routes are equipped for two-way voice communication and twenty-two ground stations have been established in fifty states. These stations are owned by Boeing System and operated under a federal permit. Communication between the two stations and between pilots of planes in sight is now possible over 3,144 miles of airway.

Under this system it is possible for travelers on Boeing passenger transports on the San Francisco-Chicago and Seattle-San Diego airways to talk to city numbers by calling a terminal station and asking to be connected with a house or any other number. This is not done, however, as the Department of Commerce permit stipulates that only messages dealing with operation of planes and "protection of life and equipment" shall be sent.

Four Stations Get Order to Quit Air

Washington. The following stations were ruled off the air for failure to apply for license renewal in time, and were warned that any attempt to broadcast would be punishable: WMAY, Kings Highway Presbyterian Church, St. Louis, Mo.; WCWO, The WGAR Broadcasting Co., Springfield, Ohio; KFH, Waldo L. Hawkins and Dr. A. R. Craig, Hawkins-Craig Syndicates, care Western State College, Gunnison, Colo.; KZM, Leon P. Tenney, Hayward, Cali.

Fixed Condensers

Dual-Filament Mica fixed condensers, type 642, are available at following capacities and prices:

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100 | .0001
500 | .001
1000 | .005
5000 | .01
10,000 | .05
50,000 | .10
100,000 | .25
300,000 | .50
1,000,000 | .75
2,000,000 | $1.00
4,000,000 | $1.50
8,000,000 | $2.00
32,000,000 | $5.00

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Set of 10 SOCKET WRENCHES FREE

For turning nuts down or up there is nothing as efficient and handy as a socket wrench. Send this order for three wrenches FREE! Use the three different size sockets, one size on each wrench, and be sure to ask for "dual size" wrenches for hexagonal nuts, enabling use with 3/8, 13/32, 5/32 and 1/8 nuts. Fill the nut into the proper socket and turn down or up. The three different size sockets, one size on each wrench, and be sure to ask for "dual size" wrenches for hexagonal nuts, enabling use with 3/8, 13/32, 5/32 and 1/8 nuts. Fill the nut into the proper socket and turn down or up. The three different size wrenches are guaranteed to work. Send $1.00 for eight wrenches, $2.00 for sixteen wrenches, $3.00 for thirty-six wrenches FREE. Order Cath. MION'S ... at prices stated.

RADIO WORLD, 145 W. 45th St., New York, N. Y.
Enclosed $1.00 for 8 weeks. Send wrenches.

Name ____________________________
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www.americanradiohistory.com
Multi-Tap Voltage Divider

The experience of design and construction will be appreciated by those whose knowledge teaches them it is impossible to design and construe a voltage divider that will serve the purpose of the Multi-Tap Voltage Divider if placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current. Howling and other results are by no means unpleasant. By making connection of grid returns to ground, the lower voltages may be used for negative bias without interference between voltages. Use one 224 tube, cathode in a higher voltage. If push-pull is used, the correct in the biasing section is almost doubled, so the tubes' filament winding would go on at a big half way down on the lower band. Order Cat. MTVD, list price $4.95, net price...

GUARANTY RADIO GOODS CO.
143 W. 45TH ST., NEW YORK, N. Y.

Trouble-Finding Dial FREE!

Here is an 8" diameter dial that you slide around to show trouble in an audio circuit or in supply or power amplifier. Trouble is divided into five groups: distortion, low, dead amplifier, weak signals and hum. By sliding the dial to one of the sixty seven positions the cause of the trouble is read in the slotted opening. Invented by John F. Rider. Send $1.00 for eight weeks subscription for Radio World and get a Trouble-Finding Dial free with instructions on back. If extending an existing subscription please so state.

RADIO WORLD
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Ansonia Gothic Speaker - $3.95

Magnetic speaker in genuine, beautiful walnut cabinet. Order Cat. AN-G at $3.95.

Guaranty Radio Goods Co.
143 West 45th Street, New York, N. Y.

Parts for the Best Circuits

NEW NATIONAL DE LUXE MB-30 SCREEN GRID TUBE This is one of the most sensitive tubes ever made, and 100 times the sensitivity of the screen grid tube. It is a 3-plate type mount in a miniature form. Licensed under RCA patents. Order Cat. MB-30-W, list price $8.60, net price...

MB-29-A TUNER, a smaller version of the MB-30, with instead of six taps in the divider also the pre-selector and band pass filter circuits. Price Cat. MB-29-A, list price $5.95, less tubes; net price...

Wired Model, Cat. MB-29-B, list price $7.95, less tubes; net price...

Wired Model, Cat. MB-29-W, list price $9.95, less tubes; net price...

Wired Model, Cat. MB-29-L, list price $11.95, less tubes; net price...

NATIONAL VELVETONE Push-Pull Power Amplifier, uses one 2SC-455, two 224's and one 227. Amplification is equivalent to a transformer coupling, with output transformer; heater voltage for five tubes; plate voltage for three. A matched unit for the MB-30 or MB-31-A. Phonautograph built in. Velvetone grid wire, licensed by RCA. Order Cat. PTPA, list price $23.90, net price...

HARMARLUND HI-Q-31 — The latest development in external building, a Hi-Q chassis, using a 3-stage transformer coupled amplifier and with the best power detector. Cost $77 list price, two 245's and one 247. All transformers are built-in. Order Cat. HI-Q-31, list price...

Wired Model HI-Q-31—Order Cat. AC-HI-BW, list price $57.93, less tubes; list price $57.67, less tubes; net price...

H-1-04-AC TUNER WITH POWER SUPPLY—List price, Order Cat. AC-31-B, list price...

Wired Model HI-Q-31—Order Cat. AC-HI-BW, list price...

HI-1-31 FOR BATTERY OPERATION—Order Cat. BAT-1-31, list price...

HI-4-3 FOR BATTERY OPERATION—Order Cat. BAT-4-3, list price...

Short Waves

NATIONAL 5-TUBE THRILL BOX—A remarkably sensitive and easy-wire circuit, ideal for someone not equipped for foreign stations. Uses 224 RP, 234 detector, 227 25K audio, 229 push-pull second audio a second separate A supply is required. See below. Standard set of four pairs of coils included with all orders. Sterling speaker. 224 RP and 234 detector are in push-pull, 227 and 25K in series, all transformers built-in. Order Cat. AC-W5-W, list price...

SMALL BATTERY TUNER FOR BATTERY OPERATION—Order Cat. BAT-5-1, list price...

GUARANTY SW HAWK—For one stage of RP and detector; battery operated; uses two 224 tubes or any other pair of battery-operated general purpose tubes. Ca$h! For 15$ to 185$ per pair. Order Cat. AC-W5-W, list price...

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GUARANTY SW HAWK—For one stage of RP and detector; battery operated; uses two 224 tubes or any other pair of battery-operated general purpose tubes. Ca$h! For 15$ to 185$ per pair. Order Cat. AC-W5-W, list price...
**RF Choke in Copper Shield**

A 50-milliampere radio frequency choke coil, in a copper shield, with mounting screw and bracket attached. This choke is excellent for the plate lead of a detector, placed in series with the plate and the load impedance, for keeping RF out of the audio circuit. Also excellent for RF plate lead, between the end of the plate coil and B plus, and for screen grid leads, between screen grid and B plus, for thorough filtering and stasis. This coil will pass 25 ma. In all cases around the shield. Order Cat. SH-RFC. Last price, $1.00; your price,...

**GUARANTY RADIO GOODS CO.**

143 West 45th St., New York, N. Y.

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Get a FREE one-year subscription for any ONE of these magazines:

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- **RADIO INDEX** (monthly, 12 issues; stations, programs, etc.).
- **SCIENCE & INVENTION** (monthly, 12 issues; scientific magazine; popular science and engineering articles).
- **AMERICAN BOY-YOUTH'S COMPANION** (monthly, 12 issues; popular science magazine).
- **BOYS' LIFE** (monthly, 12 issues; popular science magazine).

Select any one of these magazines and get it FREE for an entire year by sending in a year's subscription to RADIO WORLD at the regular price, $6.00. Cash check or money order or stamp to RADIO WORLD, 145 West 45th Street, New York, N. Y. (Just East of Broadway).
Save Money on Tubes! Get a Guarantee Just the Same!

QUALITY tubes at enormously reduced prices enable you to save money and obtain full satisfaction. Any tube will be replaced on request within thirty days of its sale!

These tubes are made by a manufacturer of national reputation and are not "distress merchandise." No tube is shipped until it is carefully checked on a Readrite No. 9 Radio Test Kit.

[# Remit with order for tubes and pay postage]

DIRECT RADIO CO.
Room 504, at 1562 Broadway, New York, N. Y.
(4th and 4th Streets)

DEALERS AND SERVICE MEN
STANDARDIZE ON

LYNCH RESISTORS
For Permanent Replacement, Guaranteed
Write for descriptive catalogue "W"

LYNCH MFG. CO., INC., 177 Broadway, New York

SHORT WAVES FOR $4.87

Real results are obtained from the Super-tone Short Wave Convert. Single tuning control. Not only capacity, no squelch. Works with any broadcast receiver. Parts, as specified by Herman Bernard (Cat. No. SUP-JA), less filament transformer, less 227 tubes, only $4.87. Battery model (Cat. SUP-JB) same price. Remit with order and we pay postage.

Supertone Products Corporation
215 Wallabout Street
Brooklyn, N. Y.

Farrand INDUCTOR DYNAMIC

Your Choice of Nine Meters!

To do your radio work properly you need meters. Here is your opportunity to get them at no extra cost. See the list of nine meters below. Heretofore we have offered the choice of any one of these meters free with a 6-weeks subscription or RADIO WORLD, at $1, the regular price for such subscription. Now we extend this offer.

For the first time you are permitted to obtain any one or more of all these meters free, by sending in $1 for 6-weeks subscription, entitling you to one meter: $2 for 12 weeks, entitling you to two meters; $3 for 24 weeks, entitling you to three meters; $4 for 36 weeks, entitling you to four meters; $5 for 44 weeks, entitling you to 5 meters; $6 for 52 weeks, entitling you to six meters. Return this offer with remittance, and check off desired meters in squares below.

RADIO WORLD, 145 West 45th Street, New York, N. Y. (Just East of Broadway)

DOUBLE RANGE POTENTIOMETER
made by Centralab, designed for volume control. 10,000 and 20,000 ohms. Price, $1.05. Guarantee Radio Goods Co., 143 W. 45th St., New York.

NAME ________________________________
ADDRESS ________________________________
CITY ________________________________ STATE ________________________________