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An A. C. Operated Amplifier with a High Quality Power Output

By A. R. WILSON, Service Department

For those people who demand the most perfect reproduction obtainable, a power amplifier is a necessity. A power amplifier is not intended primarily to increase the volume of a set but rather to make use of amplifying tubes capable of many hundred times the power delivery of the ordinary 201-A Type. When a large amount of energy is delivered to the speaker, low notes and overtones, which heretofore have been either inaudible or distorted, are heard with a fidelity that is really remarkable.

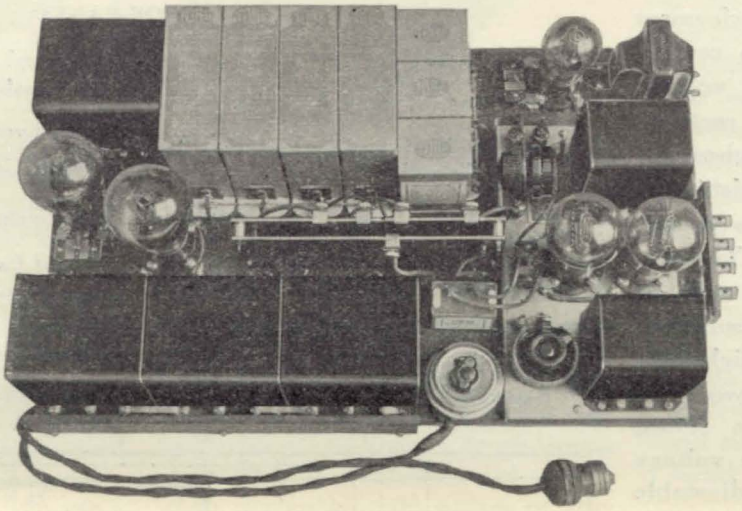

Figure 1
THE GENERAL RADIO A C POWER PACK

Now we are concerned, prior to the input of the last tube, in securing a voltage amplification gain, but at the end of the amplifier we have a device, our loudspeaker, which requires real physical energy to operate it satisfactorily; hence, the power tube.

The introduction of the UX-210 power tube has meant much in the advancement of quality reproduction and when this type of tube is used in a push-pull system, which has the advantage of minimizing or eliminating most of the harmonic distortion caused by the tubes themselves, the reproduction becomes almost perfect. The push-pull system also has the advantage of increasing the power output four or five times. To a certain extent, the greater the power output the better the quality. An unusual fortissimo passage finds the tube handling it with ease, like the hill climbing ability of a high powered motor car. There is enough energy to give the bass notes color and intensity with some to spare.

Why all this power? Let us draw an analogy. Today there is less and less opportunity of driving fast on the public highways and yet greater power is a feature of all motor cars. It is much more comfortable to drive a seventy mile-an-hour car at thirty-five miles an hour than to drive a fifty mile-an-hour car at the same speed. It is the flexibility, the sense of reserve, which makes the more powerful car desirable. This applies to radio. With the 210 type of tube the reader is literally loafing along, even when strong volume is being used.

The General Radio power pack is a complete two stage A. C. operated amplifier, adaptable for use after the output of the detector tube or with a phonograph magnetic pick-up, utilizing transformers with a UX-226 tube in the first stage and two UX-210 tubes in the last stage. The rectifier system has been designed to furnish approximately 750 volts DC when two UX-281 rectifying tubes are employed.

The voltages placed on the plates of the two UX-210 tubes have been made adjustable over a wide range as it was felt that the common practice of connecting the plate of the last stage tube directly to the high voltage side of the rectifying system was not in keeping with the maximum efficiency. In similar devices the grid voltage for the last tube is usually obtained by the voltage drop through a resistance placed in the grid return. This resistance is usually variable and any adjustment

of it affects the plate voltage, consequently the final adjustment is more or less an arbitrary value for both grid and plate voltages. By making the plate voltage variable over a wide range, it permits the tubes to be operated at their maximum efficiency regardless of the load.

The direct current available from the rectifying system is approximately 200 milliamperes. A high current output makes for better voltage regulation and will easily supply sufficient current to operate a multi-tube set with a great reserve of power.

The construction and placement of parts in the General Radio power pack is evident from Figure 1. The 110-volt supply from the house lighting mains is fed into the transformers which step the voltage up several hundred times. This high voltage alternating current is then rectified by two UX-281 rectifying tubes and passed through a filter consisting of one Type 366 choke, two 4 mf. and one 2 mf. condensers. The output is pure direct current such as could be obtained from a sufficient supply of B batteries. This high voltage is then passed through two Type 446 resistors connected in series, which makes any desirable voltage available by means of adjustable sliders. The last stage amplifier, is the General Radio Type 441 Push-Pull Amplifier. This consists of two transformers, sockets, and all necessary parts, completely wired and mounted on a metal baseboard. This simplifies construction somewhat as it eliminates quite a bit of wiring.

The wiring is all straightforward and simple. The only precaution needed is to place some sort of guard over the high voltage side of the power transformer and to use rubber covered wire for all connections. Under no circumstances should anyone attempt to make any adjustments without first turning off the electric current.

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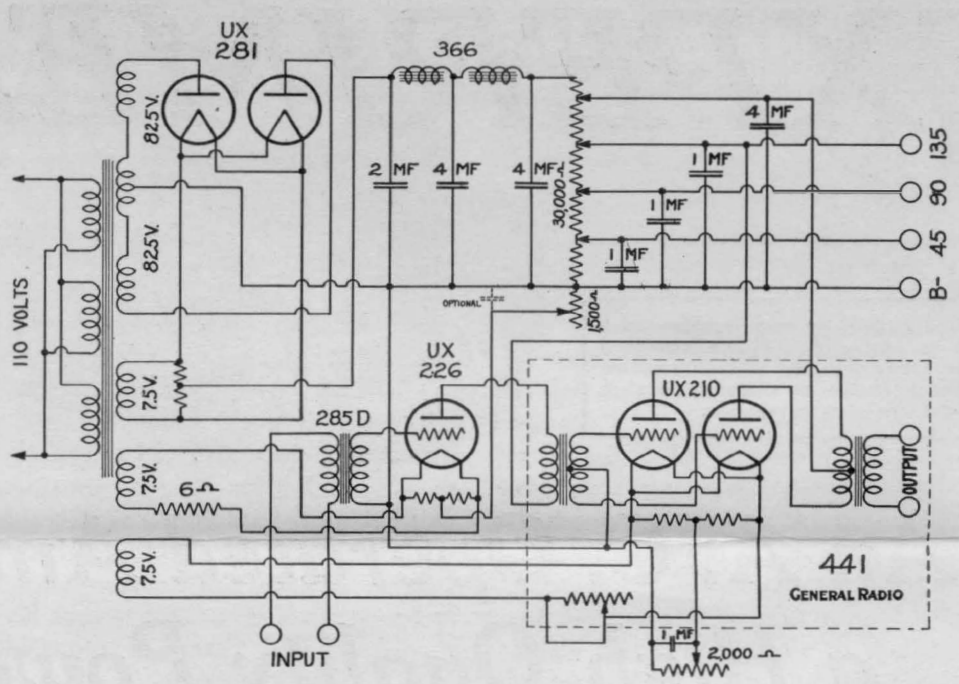


Figure 2
Schematic Wiring Diagram of AC Power Pack

LIST OF PARTS

3 General Radio Type 365 Transformers.

1 General Radio Type 366 Choke.

1 General Radio Type 441 Push-Pull Amplifier (completely wired).

2 General Radio Type 446 Resistance Units.

1 General Radio Type 285 D Transformer.

3 General Radio Type 349 Sockets.

2 General Radio Type 439 Centre Tapped Resistance Units.

1 General Radio 6 Ohm Resistance Strip capable of carrying one Ampere.

1 2000-volt 2mfd. Condenser.

3 1000-volt 4mfd. Condensers.

3 500-volt 1 mfd. Condensers.

1 1mfd Condenser.

1 Variable Resistance 2000 ohms.

1 Baseboard 12 x 20.

Misc. wire screws, bolts, etc.

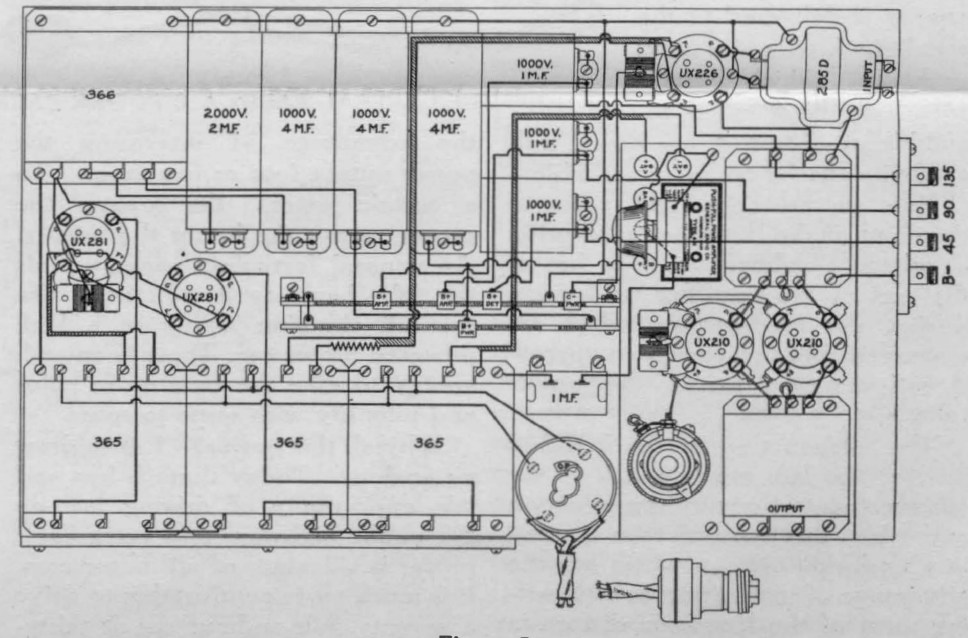


Figure 3
Pictorial Diagram of the General Radio Power Pack

THE SYNCHRONOMETER

By H. W. LAMSON, Engineering Department

THE SYNCHRONOMETER WITH THE TYPE 467 SYNCHRONOUS DRIVING FORK

An example of the special equipment which the General Radio laboratories are developing from time to time is to be found in the recently perfected Type 473 Synchronometer.

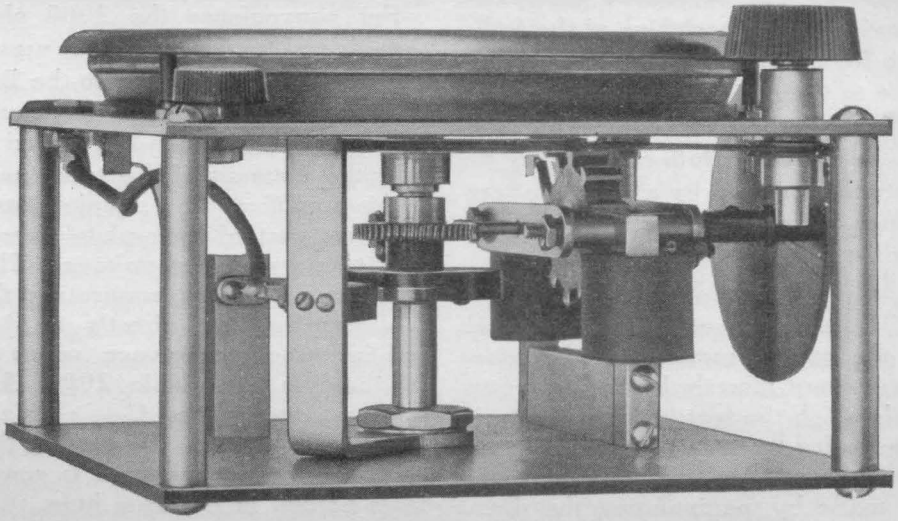
This machine is nothing more than an accurately timed automatic transmitting key which, in the model shown in the illustrations, is designed to close a pair of electrical contacts for a brief interval once in every five seconds. It has, however, a special feature in that, while the duration of contact can be adjusted at will to any value between .05 seconds and .50 seconds, the beginning of the contact interval, or in other words, the "nose" of the signal, always occurs exactly at the zero point on the scale.

The complete outfit comprises two instruments: the Synchronometer proper and the synchronous driving fork. (Type 467).

The Synchronometer carries a black bakelite dial, the circumference of which is graduated into one-second intervals, each second being, in turn, subdivided into twenty spaces. A clock hand, painted white for clear visibility, sweeps over this dial, keeping exact time when the proper adjustments have been made. The shaft carrying this hand is driven at a uniform speed by a small synchronous motor coupled to the shaft through a 50:1 reduction worm drive. The interior view shows the motor and the driving mechanism. The motor has two poles and a ten-tooth rotor, and hence a synchronous speed of 600 revolutions per minute when driven by 100 pulses of current per second. The extremities of the two field coils terminate in a pair of jacks on the upper panel of the instrument.

An insulating disc bearing an annular metallic segment is mounted upon the vertical shaft carrying the clock arm. Two spring contacts press radially against this segment. One of these is mounted in a fixed position which determines the "nose" of the signal. The second brush is mounted upon an arm which may be swung a certain angular distance around the shaft as a center. This brush determines the instant at which the circuit between both brushes through the revolving segment is interrupted and, hence, the duration of the interval of contact. In the front left hand corner of the upper panel will be seen a thumb screw for swinging this arm and clamping it in any desired position. The two brushes are connected to a second pair of jacks mounted upon the top panel whereby this time interval key may be connected into any desired circuit.

A second identical clock hand, known as the index hand, is mounted directly beneath the motor-driven hand. This index hand, which is normally stationary, is carried by a hollow shaft upon which is mounted, directly beneath the panel, a large grooved pulley. In the front right hand corner of the panel is located a hand knob which carries a small pulley beneath the panel. A belt of twine joins these two pulleys. Thus, by manipulating this knob, the index



DETAIL VIEW OF TYPE 473 SYNCHRONOMETER

hand may be set at any desired position on the scale.

The purpose of the index hand is as follows:—Suppose that the automatic signal, transmitted at zero time on the scale, sets in motion a train of mechanisms which, at some later time, produces a second signal, preferably audible in nature. The operator, by setting the index hand under the position of the revolving hand at the instant of the retarded signal, can obviously determine the time required for the operation of the mechanism. If this operation can be repeated a few times at five second intervals, a close determination of the elapsed time may be made. Various applications of a device of this sort will suggest themselves to the experimenter. Obviously a slight change in the design of the instrument will permit considerable variation in the time interval between signals.

The interrupted direct current of 100 pulses per second necessary for driving the synchronous motor is supplied by a 100-cycle electrically driven tuning fork. This is mounted in a separate cabinet which carries also ten No. 6 dry cells furnishing six volts for energizing the magnet of the fork and nine volts for operating the motor. Milliammeters are provided for measuring these two currents and a rheostat for controlling the current to the fork magnet. The fork draws about 20 milliamperes and the motor about 200 milliamperes. An adjustable contact is provided upon each tine of the fork, one for interrupting the magnet current to maintain the fork vibrations and the other for controlling the motor current. Both circuits may be opened or closed by a single battery switch. A twin conductor cord fitted with a plug on the synchronometer end joins the two instruments.

The accuracy of the time interval of the synchronometer is, of course, determined directly by the precision with which the frequency of the fork is adjusted to 100 cycles per second. Small changes in fork frequency can be made by manipulating the rheostat in the driving circuit, while greater changes are accomplished by the adjustment of two counterweights mounted near the outer extremities of the fork tines. A check upon this timing can, of course, be made by comparing the synchronometer with a stop watch. However, if accurately regulated 60 cycle lighting current is available the following procedure is simpler and more rapid. The shaft of the motor protrudes through the right hand side of the cabinet and carries a disc painted black with 12 narrow white segments uniformly spaced around it. When this disc is illuminated by a lighting source supplied with 60 cycle alternating current the spoked pattern will appear stationary if the speed of the motor is exactly 600 R.P.M. If the pattern, on the other hand, appears to advance in the direction of disc rotation, the speed of the motor, and hence the frequency of the fork, is too high and vice versa.

A small knurled handle is attached outside of this disc. This is twirled between the thumb and forefinger to start the motor, which may readily be brought up to synchronous speed by observing the disc pattern in 60-cycle light or by watching the pulses of the needle on the milliammeter reading the motor current.

Equipment of this sort is made to special order. Our engineering staff will be glad to consult with any of our readers who have need of such apparatus.

(Continued from page 2, column 1)

For convenience the 2000 ohm variable resistor is mounted by means of a metal bracket directly to the B— Binding Post of the Type 441 Push-Pull Amplifier. When AC is used to light the filament of the tubes used in this amplifier it is a simple matter to utilize part of their plate current to obtain a grid bias voltage. This is accomplished by connecting the C— Binding Post directly to B— and inserting a resistance, which in this case is a variable 2000 ohm resistor between the C— and the B— Binding Posts. By passing this resistance by a condenser is sometimes helpful in reducing hum.

The filament of the Rectifier tubes together with those of the Amplifier tubes are lighted from the low voltage secondaries of the type 365 Transformers. In the case of the UX-226 tube a fixed resistance of 6 ohms capable of carrying at least 1 ampere is inserted in one of the filament leads underneath the baseboard.

To operate this device it is simply necessary to connect the output of the detector tube or a phonograph magnetic pick-up to the primary of the type 285 D Transformer. The reproducer is connected to the terminals marked output on the type 441 Push-pull Amplifier. If it is desired, the push-pull stage alone may be used by connecting the output of another amplifier directly to the input terminals of the push-pull amplifier.

Under normal operating conditions the tubes, especially the 2UX-281 rectifying tube and the 2UX-210 together with the resistance unit, should get decidedly warm. If the plate of the 2UX-210 Amplifying tube should get red after a period of use it is an indication that the grid bias voltage used is improper and the biasing resistance should be adjusted until this condition disappears. It is almost a positive indication that one or more filter condensers are defective if the plate of the rectifier tube turns red.

Under operating conditions, with the primary of the type 285 D Transformer open, a hum should be heard in the reproducer. This, however, should almost disappear when the two input terminals are shortened or a reasonable load placed on them. In an AC operated device of this sort it is extremely important that the plate and grid voltages of the amplifying tubes be adjusted properly as this helps materially in reducing hum; also the cases of the various parts should be grounded to B—. When using a phonograph magnetic pick-up with this device it is sometimes helpful in removing needle scratch to shunt the input terminals by a fixed condenser. The proper value can only be determined after experimentation, but will usually be around .01 mfd.