RADIO DESIGN

HANDBOOK OF CONSTRUCTION FOR STUDENTS & SET BUILDERS

Pilotone Electric Receiver — Television — Audio Frequency Transformers—Power Amplifiers — Modern Power Supply Units— Hail to the Graf Zeppelin—The Radio Beacon

The SG-105 Screen Grid Regenerative Receiver
Six Tube TRF Receiver with ABC Power Supply

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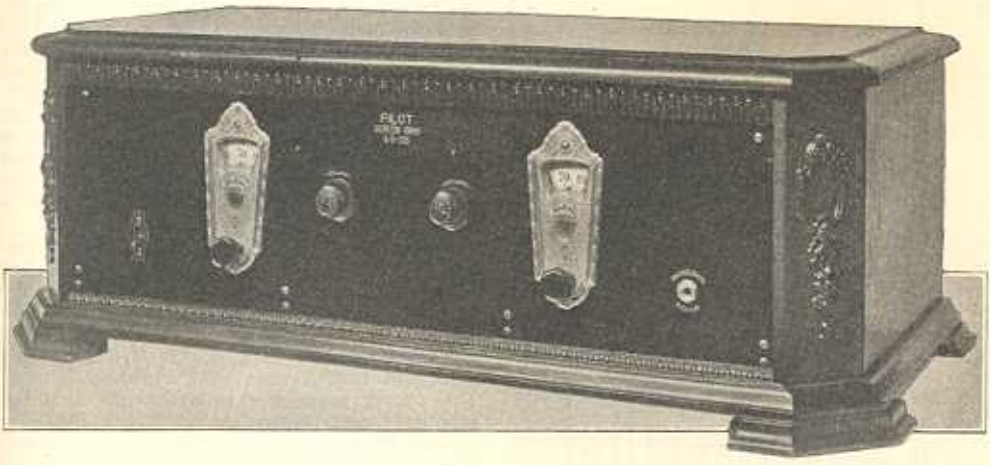

THE PILOT SG-105 SCREEN GRID REGENERATIVE RECEIVER

By JOHN GELOSO
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THE meetings of the Institute of Radio Engineers in New York City provides in addition to its technical lectures and discussions an opportunity for the technical men of the industry to get away from their laboratories and to meet one another during the hours previous, to gathering at the Engineering Societies Building.

If one could take a census of various New York restaurants and hotels, on the evening of an Institute meeting, they would find groups of engineers and executives enthusiastically discussing, across dinner tables, the ways and means and problems of the industry, and sometimes solving some of them.

I had the pleasure recently of attending one of these "get-together" dinners just before a particularly interesting lecture was delivered before the Institute. At the table with me was the president of a large radio manufacturing company, his chief engineer and in addition a consulting radio engineer whose name is known and respected throughout the industry.

Our round table conversation centered around screen grid tubes, and the various circuits using these tubes recommended and published up to that time.

I shall not attempt to tell you the long details of our various opinions, but only my own conception which I stated to these men rather emphatically and with which they were in reasonable agreement.

It was my feeling that, as a general fact, screen grid tubes are all right, but my experience had indicated that the majority of troubles met with in using screen grid tubes had in the past been due to the design of circuits not particularly suited to the tubes themselves.

As soon as the tubes themselves were available, many experimenters used them in circuits, whereby three or four screen grid tubes were used as radio frequency amplifiers, and in both America and Europe efforts were made, and circuits were published, describing the use of screen grid tubes not only as radio frequency amplifiers, but also as detector tubes and as audio frequency amplifier tubes.

Manufacturers, in addition to the experimenters, attempted to capitalize on circuits employing the tubes, and did not hesitate to recommend two, three or four screen grid tubes in a given circuit.

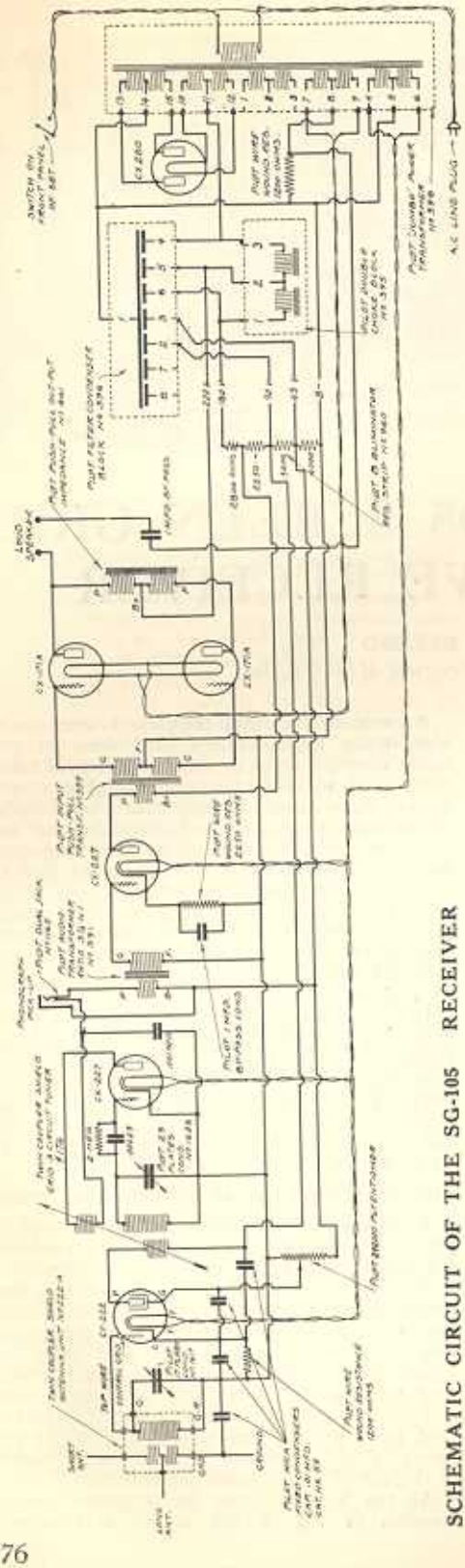
In my opinion, one or two stages of radio frequency amplification in a circuit designed around the screen grid tube provides even more than the necessary selectivity and sensitivity required, and eliminates immediately any necessity for using a large number of tubes, with the possible disadvantage of added complications, both mechanically and electrically.

THE SG-105 USES AN AC SCREEN GRID TUBE.

To prove my contentions, to myself and to others, I designed the Pilot SG-105 all-electric five-tube screen grid regenerative receiver.

This receiver, after several weeks' test and actual use, has proven to me that the opinion that I stated to my friends was a reasonable one, and that opinion was "that a properly designed receiver circuit utilizing a single screen grid tube, would incorporate advantages over and beyond receivers then employing screen grid tubes and to such a degree that the receiver would represent a basic improvement in the art of radio broadcast reception.

As can be seen from the schematic circuit diagram of Fig. 1, the circuit arrangement



SCHEMATIC CIRCUIT OF THE SG-105 RECEIVER

of the receiver is as follows: The antenna is inductively coupled to the grid circuit of the a. c. screen grid tube. The output of the screen grid tube is coupled by a screen grid three circuit tuner providing inductive regenerative control feeding into a UY-227 detector tube. A phonograph jack is provided in the plate circuit of the detector tube, so that the audio frequency amplifier portion of the receiver may be used in combination with a phonograph and phonograph pick-up.

Transformer audio frequency coupling is employed between the detector tube and the first UY-227 audio amplifier tube, the gain ratio being 3½ to 1. The plate circuit of the UY-227 is coupled to two UX-171A tubes in push-pull arrangement, using a Pilot No. 399 input push-pull transformer, and a No. 401 push-pull output impedance to couple the amplifier circuit to the loudspeaker.

The Pilot No. 398 "jumbo" power transformer supplies 2½ volts filament current to the a. c. screen grid tube, the detector tube, and to the first audio frequency amplifier tube. Separate secondary transformer windings supply 5 volts to the filaments of the two UX-171 push-pull amplifier tubes and to the UX-280 full wave rectifier tube.

This same transformer also, of course, supplies the plate voltages of 90 volts to the screen grid tube, 45 volts to the detector tube, 135 volts to the first audio frequency amplifier tube, and 220 volts to each of the two push-pull amplifier tubes. Of the 220 volts supplied to the UX-171 tubes, 180 volts is actually on the plates of the tubes, 40 volts being utilized for the grid bias voltages.

Volume control is provided for by varying the voltage on the screen grid of the UY-222 tube, a Pilot 200,000 ohm potentiometer being connected between the B minus (—) and the 45 volt terminal on the No. 960 fixed resistor.

The grid bias voltage of 1½ volts for the screen grid tube is obtained by taking the voltage drop across a 1200 ohm fixed resistor connected between the cathode and the grid, the resistor being effectively by-passed by a .01 mfd. fixed condenser.

The detector tube input circuit includes a .00025 mfd. grid condenser shunted by a two megohm grid leak.

The first audio frequency amplifier tube has a grid bias voltage of approximately 9 volts, obtained by taking a voltage drop across a 2250 ohm fixed resistor connected between the grid and the cathrode of the tube. This resistor is also shunted by a one mfd. condenser to effectively by-pass audio frequency currents.

The two UX-171 push-pull amplifier tubes have approximately 40 volts grid bias on each grid. This voltage is obtained by the voltage drop across a 1,200 ohm resistor connected to the center tap of the five volt "jumbo" transformer secondary winding.

Particular care has been taken to by-pass all radio frequencies around impedances that would otherwise tend to decrease the total radio frequency gain of the circuit, reduce over all fidelity by the cutting of side bands or allowing radio frequency currents to circulate in the high voltage or filament power supply circuits.

I wish to point out in particular at this time that the actual arrangement of the connection wires in the SG-105 receiver has been studied very carefully and only after several receivers were wired, was a circuit arrangement arrived at, that eliminated to the last degree all possibility of radio frequency feedback in various portions of the circuit, caused by circuit loops, length of radio frequency leads or the susceptibility of the circuit to a. c. "hum" pick-up.

PARTS REQUIRED FOR CONSTRUCTION

The complete list of all parts necessary for the construction of the SG-105 receiver (incorporating, of course, the ABC power supply) is as follows:

1 SG-105 Front Panel.
1 SG-105 Sub-panel.
1 1623 Variable Air Condenser.
1 1617 Variable Aid Condenser.
1 222-A Twin Coupler Shield Grid Ant. Coil.
1 174 Shield Grid Three Circuit Tuner.
2 1282 Illuminated Vernier Dials.
1 1165 Midget Jack.
1 42-W Bakelite Toggle Switch.
1 938 Pilot 200,000 Ohm Potentiometer.
1 398 ABC "Jumbo" Power Transformer.
1 381 Giant Audio Transformer.
1 399 Push-pull Input Transformer.
1 401 Push-pull Output Impedance.
1 396 "Jumbo" Filter Condenser Pack.
2 801 By-pass Condensers.
1 53 Mica Condenser.
1 51 Grid Condenser with grid leak and clips.
4 59 Mica Condensers.
1 395 "Jumbo" Double Choke.
1 960 Fixed Resistor.
1 959 Fixed Resistor.
2 956 Fixed Resistor.
3 216 Sub-panel Sockets.
4 217 Sub-panel Sockets.
4 35 Sub-panel Brackets.
1 each Binding Posts, Ant., Gnd., Short Ant., L. S. + L. S. —.
744 Miscellaneous Hardware.
1 BP-108 Blue Print.

ASSEMBLY INSTRUCTIONS

It is best in assembling the receiver to first mount all parts on the 23" by 7" bakelite sub-panel.

The position of these parts looking down on the top of the receiver is indicated by the drawing of Fig. 2, and the photograph Fig. 3. Looking from the receiver front it will be seen that above the sub-panel and at the rear left hand end of the sub-base panel is mounted the No. 398 power transformer, No. 396 filter condenser block, and the No. 395 double choke coil. Then going toward the right, comes the No. 401 output push-pull impedance, two tube sockets, and the No. 399 input push-pull transformer, and then another socket.

The grid condenser and leak, the No. 960 resistor strip, four other sockets, five binding posts, and the No. 381 audio transformer is also mounted on the top of the sub-base panel. Looking from the receiver front, the socket on the extreme left at the front is for the UX-280 full wave rectifier tube, while the socket just back of the volume control potentiometer and to the right of the left hand variable condenser is for the Twin Coupler screen grid antenna circuit tuning coil.

Fig. 4 is a bottom view line drawing of the receiver sub-base panel, the same view being shown photographically in Fig. 5 and shows that under the sub-panel is mounted the fixed by-pass condensers and the three fixed resistors for the grid bias circuits.

Looking at the receiver front panel as shown by the illustration at the heading of this article (which shows the receiver mounted in a cabinet), we see that the "on" and "off" switch is mounted at the lower left hand corner of the panel and the phonograph pick-up jack in the lower right hand corner.

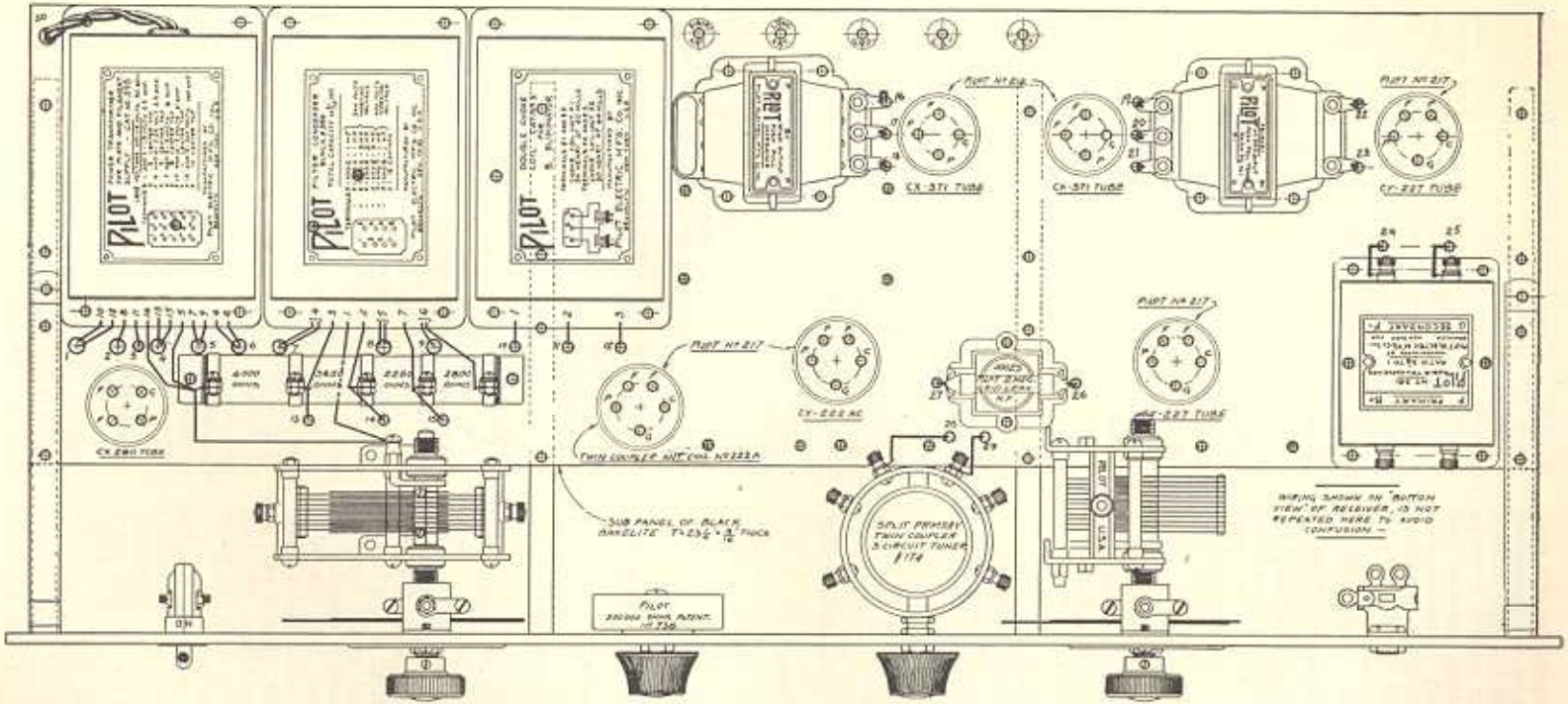
Between the two vernier dial controls are mounted two additional knobs, the one on the left being a volume control (the 200,000 ohm potentiometer), the one on the right being the distance (or the regeneration) control. The photograph referred to illustrates the SG-105 receiver mounted in a Corbett cabinet, making a very fine appearance. All of the parts which are shown in this front panel illustration are, of course, mounted directly on the front panel as is evident by the drawings of Fig. 2 and Figs. 4 and the photographs of Fig. 3 and Fig. 5.

It is best to mount all of the parts underneath the sub-panel first, for some of the resistors and fixed condensers screw heads and nuts will be underneath the "jumbo" power transformer, filter condenser, and choke coils when these units are assembled in place on top of the sub-base panel.

After assembling, all parts on the sub-base panel, wire up the filament circuit connections to all tubes, twisting the wires to reduce possible a. c. current "hum" pick-up. I must again emphasize the necessity of keeping all wires in exactly the positions shown on the drawings and photographs shown here, and in detail on the full assembly and wiring blueprint No. BP-105. After the sub-base panel has been wired complete, the front panel can be attached to the sub-base panel by screwing the front panel up against the ends of the four No. 35 bakelite panel brackets, and in addition by the two nickel-plated bracket supports at each end of the receiver.

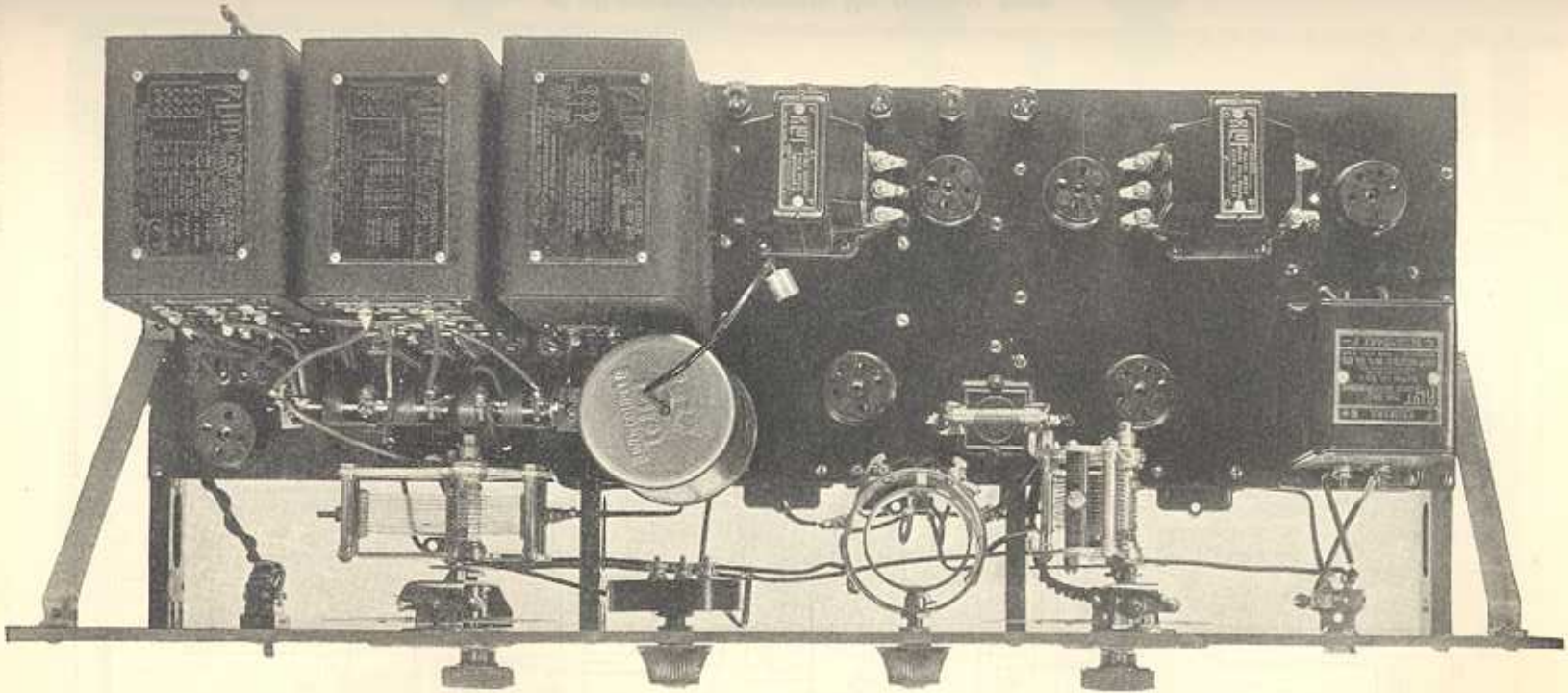
The wiring for the vernier dial lamps, although not shown in the drawings of Fis. 2 and 4 or on the schematic wiring diagram of Fig. 1, should be connected in parallel with the UX-171A five-volt filament circuit (preferably at the No. 398 power transformer terminals Nos. 1 and 9). In wiring the No. 398, power transformer, No. 396 condenser block and No. 395 choke coils, it will be noted that all terminals are numbered and that this numbering is likewise shown in the schematic and picture diagrams and on the large blueprint. Check this wiring over several times to make certain that you have all leads connected to their correct terminals and properly soldered.

I do not know that I have ever read an article telling how to construct a radio receiver, without pointing out with emphasis the necessity of using care in soldering. The two points that are important, are the use of a hot iron and of absolutely no flux or acid. Use only a resin-core solder.



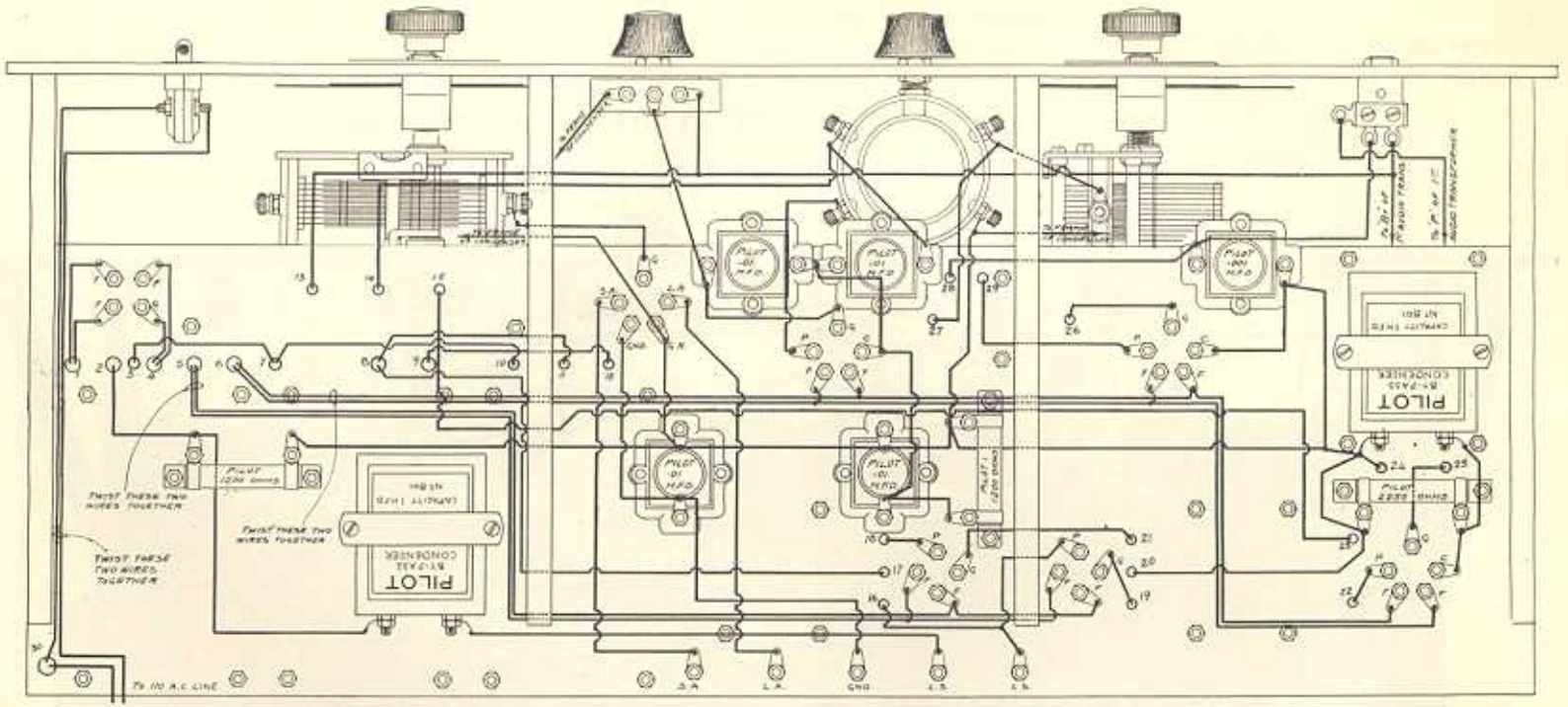
TOP ASSEMBLY AND WIRING DIAGRAM OF THE SG-105.

Fig. 2. Line drawing of the SG-105 receiver showing exact position of parts and wiring on top of the sub-base panel as well as all parts mounted on the rear of the front panel. Assembly of all parts on the rear of the front panel as well as brackets and braces for fastening the sub-base panel to the front panel is clearly illustrated.



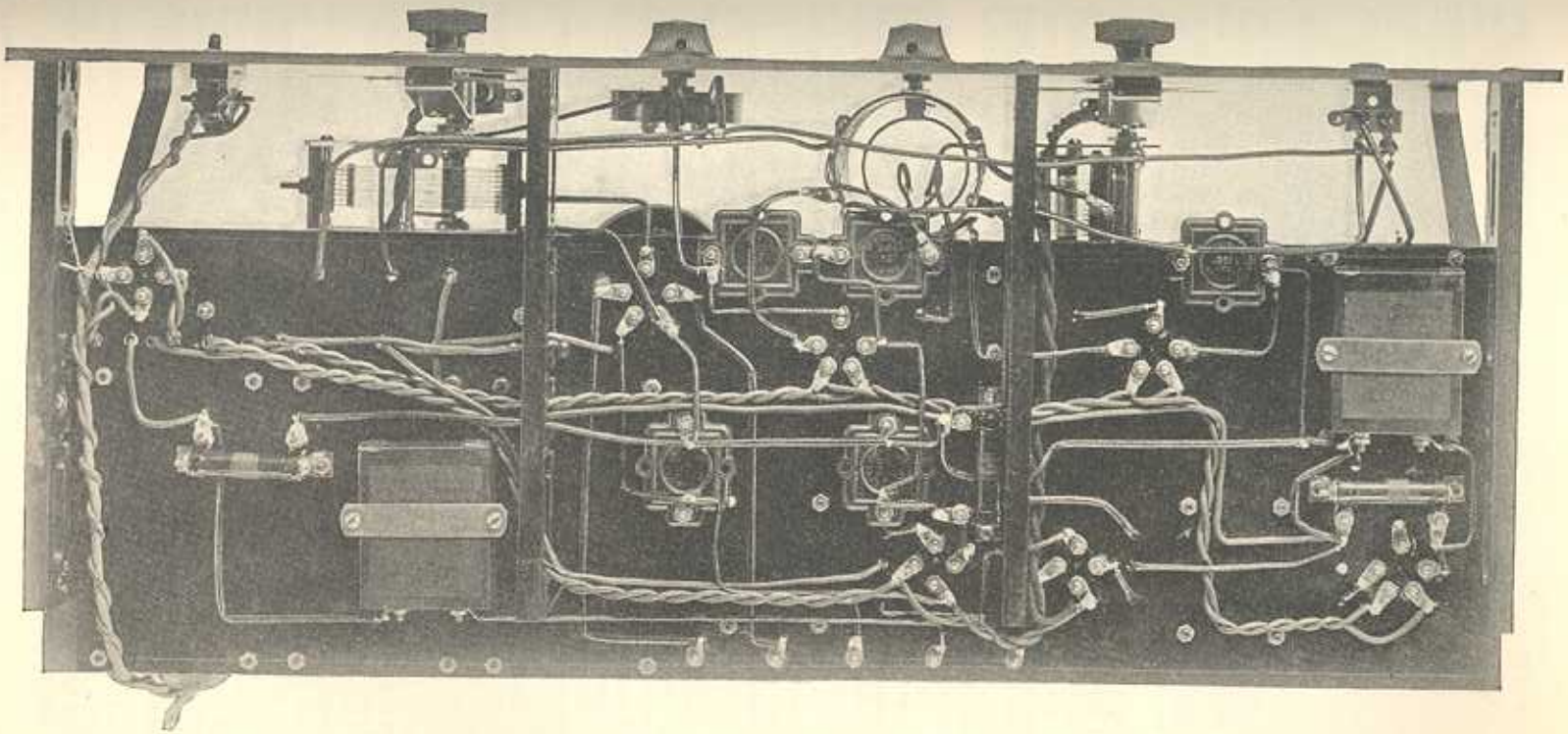
PHOTOGRAPH OF TOP OF ASSEMBLED SG-105 RECEIVER

Fig. 3. This photograph clearly shows the clean-cut appearance of the assembled and wired receiver. The use of the Pilot No. 398 power transformer, No. 395 choke coil, and the No. 396 filter condenser block, assembled at the left rear of the sub-base panel provides complete ABC power supply.



LINE DRAWING OF BOTTOM VIEW OF SG-105 RECEIVER

Fig. 4. This drawing should be studied very carefully before wiring the assembled receiver, for it shows in detail the location of all wiring underneath the sub-base panel.



PHOTOGRAPH OF BOTTOM OF SUB-BASE PANEL OF THE COMPLETED SG-105 RECEIVER

Fig. 5. This photograph illustrates the same view shown by the line drawing of Fig. 4 and clearly shows the details of all wiring. Note the twisted leads connecting all alternating current filament supply circuits.

TUBES REQUIRED

When you have finished wiring your receiver you are ready for the first test, and to every one who has ever assembled and wired a receiver for themselves, this is the moment that never lacks its thrill and its feeling of satisfaction in the "I have made a beautiful job of that receiver and I am proud of it." When you are all ready for the first test you will need the following tubes:

1 UY-222 a. c. screen grid tube
2 UY-227 a. c. tubes
2 UX-171A a. c. tubes
1 UX-280 full wave rectifier tube.

Fig. 2, in addition to the schematic diagram of Fig. 1, shows the proper sockets for each tube.

With the on-and-off switch at the extreme lower left hand end of the receiver panel in its "off" position and with the attachment plug attached to the 110 volt 60 cycle lighting circuit, we are ready to see "what happens."

Snap the on-and-off switch to the "on" position and if you have done a good wiring job and made all connections properly, all tubes of the receiver will light up without any attendant "fire-works."

Everything so god so far, and we can snap "off" the switch for a moment and attach the antenna and ground leads as well as the loudspeaker to the binding posts at the rear of the sub-panel, and set the distance knob or regeneration control so that the rotating coil is at right angles to the vertical coil or in position of minimum regeneration. Set the volume control as far as it will go toward the left.

Snap on the switch "on" again and after giving the tubes several minutes to heat up, slowly rotate the two vernier condenser dials throughout the broadcast range.

When you pick up a signal, tune it in carefully by rotating the vernier dial knobs slowly and for increased volume turn the potentiometer knob "volume" control to the right, as desired. For receiving distant stations or for selecting one station from another (through atmospheric disturbances, "man-made static" or because of interference between broadcasting stations themselves) adjust the regeneration or "distance" control knob so that the maximum signal strength with the desired quality is obtained without the set actually oscillating. The regeneration control will be found to be reasonably smooth in operation over the entire broadcast range, the signal strength increasing as more and more regeneration is added to the circuit, up until just previous to the time the set actually oscillates. Obviously care should be taken in adjusting the regeneration control, for with excess regeneration or with the set actually oscillating distortion will be introduced by the cutting of the side bands of the received signal.

The SG-105 receiver will be found to operate very satisfactory with the usual antenna available and in particular because of the sensitivity of the receiver due to the use of the screen grid stage of tuned radio frequency amplification. A shorter antenna than usual or one having a length of only 40 or 50 feet may be used with fine results as regards reception of even distant stations, and, of course, the shorter antenna wire gives the receiver increased ability to separate one station from another when they are operating in nearly the same frequency channels.

THE SG-105 HAS A PHONOGRAPH PICK-UP JACK

Seemingly, the phonograph pick-up jack has taken the place of the now obsolete phone jack, and well it may be. Those of you who have phonographs either of today's design or of the vintage of ten years or so ago can obtain very fine phonograph record reproduction, using the new electrical cut records, a magnetic pronograph pick-up and the SG-105 receiver.

In the radio broadcasting studio the artist's voice or the music of an orchestra is converted into electrical energy and radiated into space to be received in your home with your SG-105 receiver. The receiver converts the electrical energy back into sound energy.

In the phonograph recording studio the artistry of the performer is recorded on a sound record as mechanical energy. When you bring that record into your home and play it on your usual phonograph you transform that mechanical sound record back into sound. When you play that same record on your phonograph which is equipped with an electrical pick-up device, the sound energy of the record is directly transformed back into electric energy. By plugging the pick-up connection leads into the phonograph pick-up jack on the front panel of your SG-105 receiver you use the audio frequency amplifier portion of the receiver to amplify the electrical energy from the pick-up and listen to the reproduced sound record through your regular radio loudspeaker.

I AM SURE THAT YOU WILL BE PLEASED WITH THE SG-105

Because I believe that the SG-105 receiver uses a screen grid tube at its optimum operating efficiency in combination with a circuit which allows high gain radio frequency amplification, extremely good selectivity and high quality over-all reproduction of speech and music, I am sure that you, too, will be pleased with its performance.

Certainly, we chaps who build our own receivers and amplifiers and who are able to utilize "last-minute-proven" circuit arrangements long before the regular manufacturers of factory-built receivers can use them—we should be in the forefront of radio design and be able to demonstrate the results of our work to our friends and make the truthful statement, that "This set that I have just finished represents the last word in radio."

I am sure, too, that after your friends have "listened-in" on your SG-105 and found out how little the parts cost, that they will also become SG-105 builders and enthusiasts.