THE UNICONTROL 5-BAND TRANSMITTER

by
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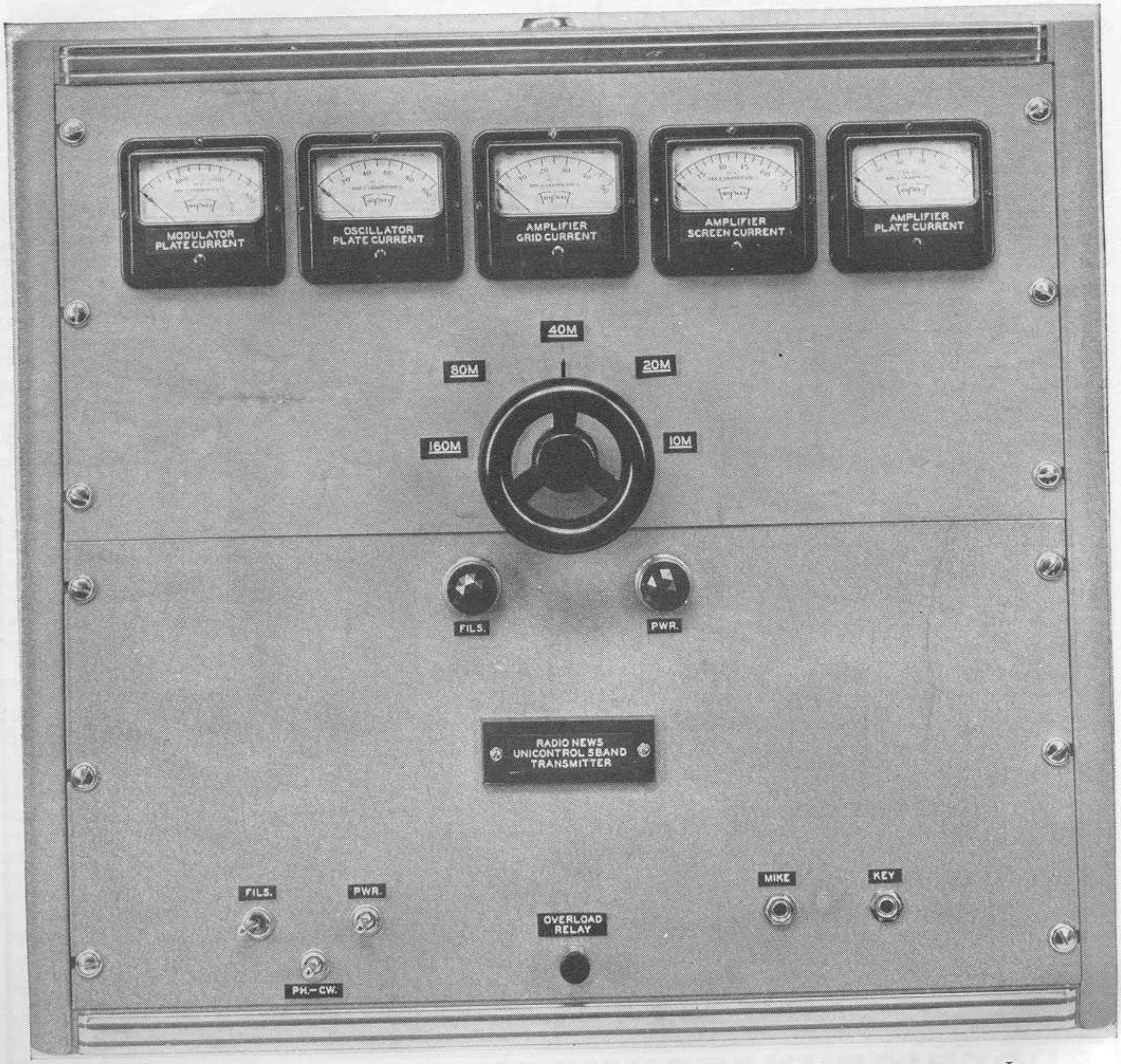
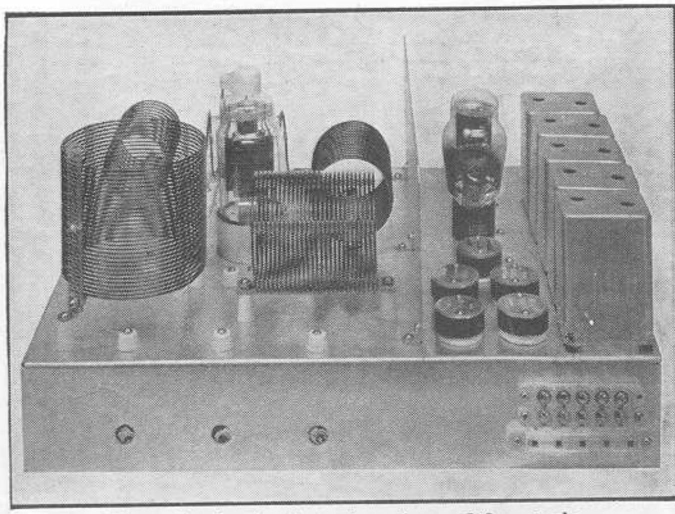
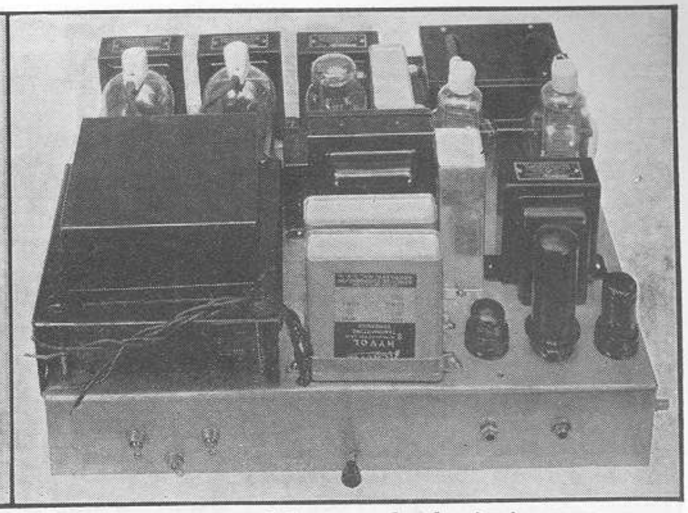
The Streamlined Version of the Ham Transmitter of 1940, featuring 5-band switching and full automatic tuning.



Designed 100% around RCA tubes, only a single control is used to switch from 160 through 10 meters. It is a "safety rig," being crystal controlled on all 5 bands, plus 200 watts output. That is 1940's transmitter!



The r.f. chassis featuring 5 amplifier tanks to the left and 5 separate xtal tanks, right.



The power-modulator-speech chassis is compacted to the 'nth degree, and 100% safe, too.

OF all phases of amateur radio, one of the most fascinating is the design of amateur transmitting equipment. This design, starting with "breadboard" and table-mounted units in about 1912 has gradually progressed through various stages to the cabinet-contained rack and panel rig of today.

At the inception of the radio amateur hobby, the ham very often led his commercial brother in the design of equipment, but more lately the amateur has apparently branched out into a division of his own, while his commercial brother has proceeded straight along the path toward a goal of compactness and ruggedness.

One has only to compare a hundred assorted "ham" transmitters with a hundred equally assorted commercial transmitters to see the wide differences that exist in the engineering minds of each of these two followers of the art. It is only natural therefore that when the authors were thinking of designing a rig for 1940, they should attempt to compact to a greater degree than had been attempted before.

There were many considerations which led to this idea. In the first place, the present ham family is more often than not housed in a small apartment where a 6' rig standing on the floor takes up a lot of space.

The choice of such a size unit immediately limited the amount of power which would be available. However, it was planned to put the greatest amount of output on the air possible, from a unit housed in the smallest amount of space conducive at the same time of rugged and trouble-free construction. If the rig was "table-mounted," it would be best that plug-in coils be eliminated.

According to the tube manual, the RCA 828 would operate and produce an output of 200 watts from an input of 270 watts. This is good efficiency. The loss of the 50 watts output which we accepted in choosing the RCA 828 was more than overbalanced by the advantages which were offered. These were, that the tube required very little driving power, it was an extremely well-shielded tube internally, and it presented little, if any, trouble in the matter of mechanical layout.

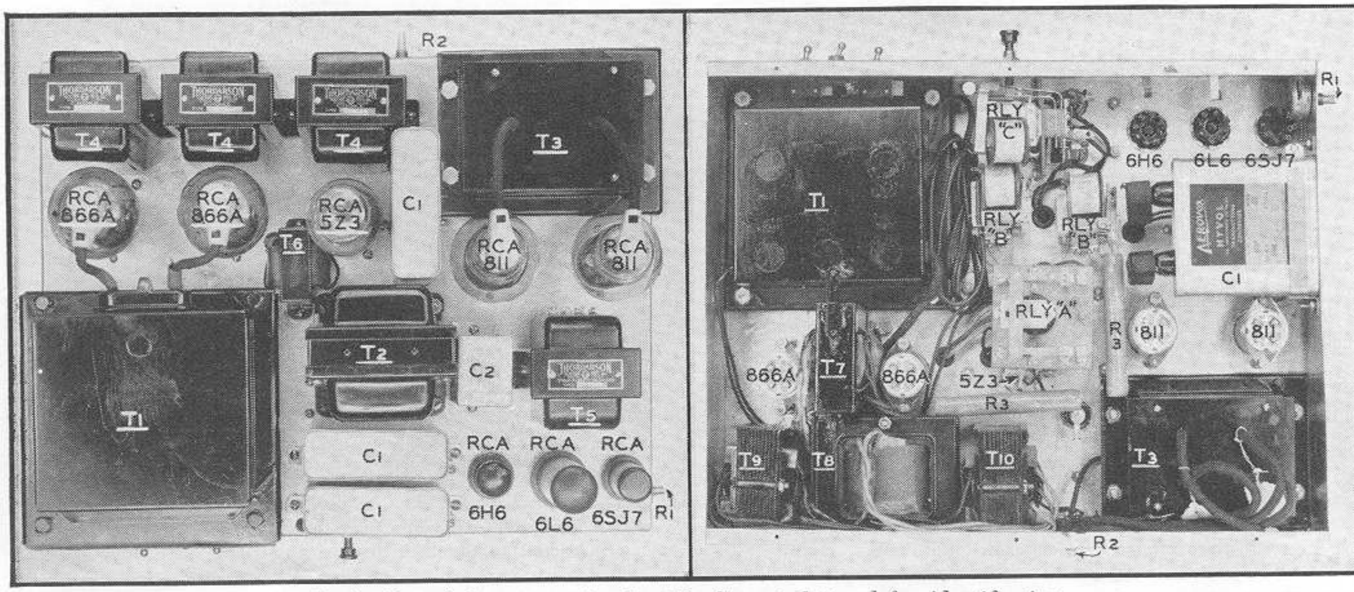
The speech equipment was simple to design since we wished to make use of the new RCA 811 Class B modulators, which would easily furnish the necessary 150 watts of audio which were required to modulate the plate and screen of the 828. Simplicity was desired as well as ruggedness and therefore only two tubes were used in this speech equipment. This setup limits hum pick-up and also makes wiring and assembling easier. We chose the RCA 6SJ7 as a speech input tube because it will operate from a crystal microphone very well, and a 6L6 Class A driver. In order to realize the fullest amount of *output* from our rig, we decided to use speech compression. By the use of an RCA 6H6 tube as a "compressor tube," we would be able to maintain a modulation level in the neighborhood of 80%.

The 828 tube should be run with a minimum of 1200 volts and a maximum of 1500 volts on the plate for efficient operation, and we found that the 811's would also operate at 1500 volts. The question then was whether we should use one or two power supplies. In looking over the manufacturers' specified sizes for 1500 volt plate transformers, the answer was immediately apparent. We would have to get by with one plate transformer. Especially good regulation was necessary since the Class B end of the high voltage would be varying from 30 ma. idling current to 200 ma. on peaks, while the Class C r.f. stage would be running a steady 180 ma. input. The average Class B current is only 100 ma. so the high voltage power supply would be required to furnish 180 ma. for the r.f. stage plus 100 ma. average current for the Class B modulators, making a total of 280 ma.

The choice now came to the size of the transmitter cabinet. We found that the average amateur loud speaker is approximately 8", while receivers varied from 8" to 10" in height and in width from 16" to 21". The average size of the average ham receiver would approximate a 19" rack and panel job by 17½" in height. This was to be the complete size of our transmitter and it was to be housed in a Par-Metal DL1713 DeLuxe cabinet to match that which housed the receiver.

The layout of the transformers was now begun. This was accomplished by cutting a piece of paper the exact size of the chassis, namely 17" x 13", and the various transmitter components which were to be mounted on, and underneath, that particular power chassis were laid out on the paper so as to get all of them into the space required and, at the same time, effect as short leads as possible between each unit. The result of this design and engineering research can be readily seen in the photograph. Please note that the power transformer and modulation transformer are laid on their side, "half-shell" style. This was found to be necessary since if the power transformer stood upright, or the modulation transformer stood upright, the overall height of the transformer plus that of the chassis would prohibit its being used behind an 8¾" panel. For the same reason we had to sink the RCA 866A rectifier tubes as well as the RCA 811 modulators.

Attention is called to the three 200 ma. chokes which are used in this transmitter. Here again commercial practices were resorted to. The choice of these three chokes came about as follows. Ordinarily, if a single power supply is required to deliver power *both* to the modulators and to the Class C r.f. stage, single chokes are used in the filtering legs and the voltage lead is split at the output side of the filter. This requires the use of chokes which will pass the combined current of the modulators and the Class C r.f. stage. Such a choke would be too large to use in this particular type of transmitter. *By splitting the input to the filter system so that each leg only carries the current required by that leg,* namely—one leg carries the current required by the modulators



Both sides of the power chassis with all parts lettered for identification.

and the other leg carries the current required by the Class C r.f. stage, smaller chokes can be used, at the same time maintaining equal filtering characteristics. In this case we were able to use 200 ma. chokes where ordinarily we would have had to have planned the use of a 350, or even a 400, ma. choke.

Considering that the receiver manufacturers have long used ganged switches for band-switching, the authors saw no reason why the same procedure could not be readily adapted to a transmitter. Certain difficulties arose. It was necessary that the switches carry the 1500 volts required in the final stage. Such a switch is that which is manufactured by the Shallcross Company, and known as its *type 532*. There are three of these switches in the transmitter. One for the exciter, one for the final r.f. stage and one for the antenna circuit. These three switches are ganged together by means of gears and chains. These are obtainable from any clock store and are the type generally used in "grandfather clocks." All of the switches excepting one have their detents removed so that only one switch is actually dragging against the chain. This is coupled to the *Coto* wheel found on the outside of the panel, directly through an insulating coupling. By rotating this wheel, all three switches alike are moved through their eleven points (although only every other point is used, giving five positions).

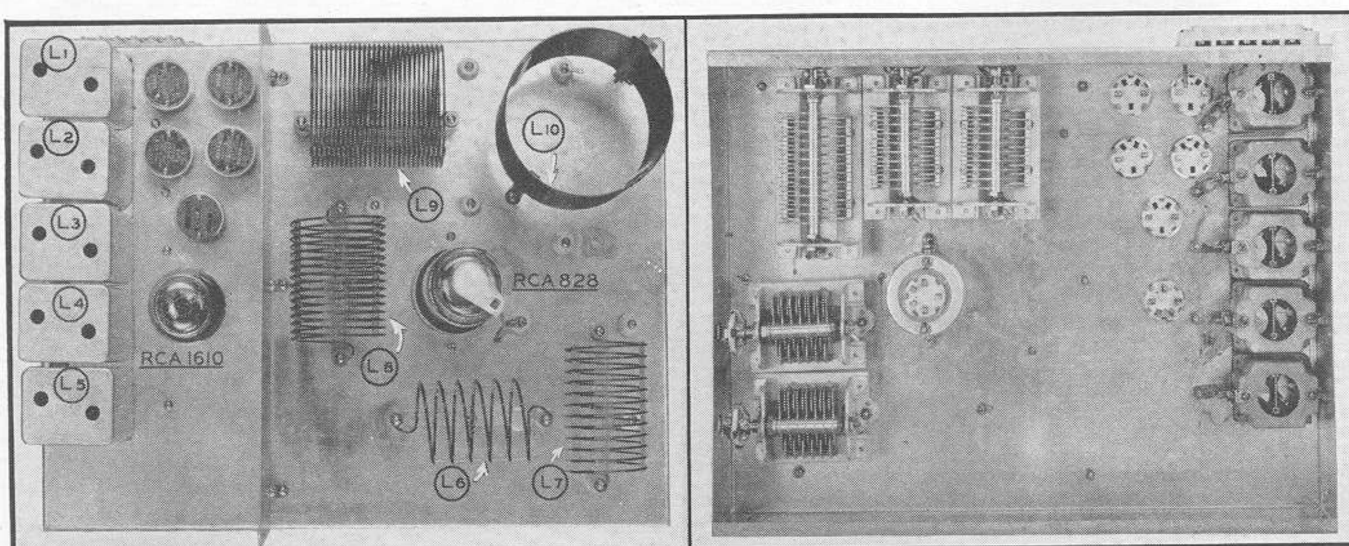
The antenna circuit is designed for a single wire feed and is fed directly from the tank through a blocking condenser. There is an extra section of the switch left over so that a different type of feed may be used if desired. With the "chain gang" switches and the extremely compact power supply, the authors found they had achieved something which more closely resembled the commercial transmitters of the present day and age.

Since the design included a pre-tuned exciter tank and pre-tuned final amplifier tanks, and since there is generally not any necessity for changing the level of the gain, especially with automatic modulation compression, it was decided not to bring out any of the tuning controls to the front of the panel, with the exception of the band-switch *Coto* wheel. This enabled the authors to create a *"uni-control"* transmitter. The sole adjustments necessary *after the transmitter has been tuned* is that of switching from band to band.

In actual test, such switchings are accomplished more rapidly than the receiving party can tune his receiver. Howsoever, some tuning adjustments were necessary, and in order to facilitate these, the tuning condensers' shafts in the final r.f. stage are "brought out," slotted, so that they may be tuned with a screw driver through holes in the *side* and *rear* of the cabinet. The same is also true of the gain control which may be reached with a screw driver in a similar fashion from the side. The compression control is in the rear since when it is once set it need not be again touched. Full information on the tuning and the construction of the r.f. section will be later included.

Before attempting construction of

(*Pse QSY to page* 63)



The r.f. chassis showing the location of the parts, which are lettered.

fact that ECO units work at half the output frequency, thus minimizing tuning interaction.

The Hallicrafters Model SX24 "Defiant" has remarkable freedom from oscillator drift, and has a fully calibrated bandspread dial in the 10, 20, 40 and 80-meter bands.

The tuning stability eliminates the need for a warming up period. This is achieved through the use of temperature compensated capacity so designed as accurately to offset the frequency variations which normally take place as the tube warms up, and also the slower variations contributed by the coil as it warms up. In addition to this, a unique oscillator circuit, in which the plate is tuned and the tickler is in the grid circuit, provides independence of line voltage variations so that oscillator drift at 20-meters amounts to only 30 cycles per volt change in the line, says the manufacturer.

Band-spreading is of the electrical type so that any small part of any one of the four tuning ranges can be spread over the entire 360-degree rotation of the band-spread dial.

The receiver has a separate frequency calibration for each of the ham bands from 10 to 80 meters inclusive which permit accurate adjustment of 1 kc. at 20 meters and approximately 5 kc. at 10 meters.

The built-in and illuminated signal-strength meter is calibrated in "S" units and decibels.

The automatic noise limiter is extremely effective in minimizing interference from car ignition systems and other similar types of noise. It functions through the valve action of the diode which permits noise pulses to be by-passed to ground.

The 9-tube line-up includes: 6SK7-r.f., 6K8-oscillator and mixer, 6SK7's in two i.f. stages, 6SQ7 as detector-first audio-a.v.c., 6H6-automatic noise limiter, 6F6-power output, 76-b.f.o. and 80 rectifier. —30—

Unicontrol Transmitter
(*Continued from page 9*)

the transmitter, the builder should acquire *all* the necessary parts that he will need. This is true because so very many alterations and "conversions" will have to be made to enable the manufacturers' parts to fit into the small space allotted. Unless such "conversions" are made, the whole purpose of the transmitter fails, and the unit becomes "just another ham rig," and not the compact commercial-looking, table-mounting transmitter which the authors designed. So with all the components at hand the "changes" can be started.

Take first the power transformer. It is to be mounted "half-shell" style to conserve height as mentioned above. To convert it remove the four bolts that hold the shell to the windings, and also remove the ceramic insulators from the *secondary,* or high-voltage, side of the shell. Remove all bolts from the leads. Next solder a heavy lead to each of the primary leads found in the transformer, and heavy insulated leads to the short secondary leads. These are to end in *Millen* tube caps of isolantite. With a file or a hack-saw remove the mounting lips of the shell. Place the *secondary* leads through the ceramic insulator which formerly was the *primary* input side. This now becomes your secondary, or rectifier tube leads. In the former secondary side of the shell, drill three ½" holes in the former top. Insert rubber grommets. You will bring out your heavily insulated primary leads through these insulated holes *after* you have placed the transformer in position but *before* you bolt it down. The center-tap lead is brought over the core and inside the shell through to the primary side so that the ground lead will eventually appear on the under chassis side of the transformer. The lead will be brought through the one remaining hole which you have previously drilled in the "old" primary side. As you finish the "conversion" you will find the rectifier leads coming through the ceramic insulator of the former primary side, while the center-tap and the primary leads come through the holes you have drilled in the former primary side. The transformer is, of course, turned over before being re-inserted into its shell and bolted to the chassis in half-shell mounted style. The illustrations will help in visualizing the "conversion." After the power transformer has been converted, it may be mounted in the large hole previously cut in the chassis.

Next the modulation transformer is to be converted. When this will have been finished, the other transformers will not have to be opened, only minor shell alterations will have to be effected. So the modulation transformer presents the last big "conversion." Remove the shell from the transformer by filing the four corner lugs which hold the bakelite insert to the shell. Force the bakelite out of the transformer shell, and the transformer should come apart easily. Caution: Do not unsolder the leads before removing the bakelite piece and opening the transformer, or else you may lose track of the numbers assigned to the leads and be unable to hook the transformer up in proper sequence. Having removed the transformer from its shell, file or hack-saw off the mounting lips. Fashion two ¼" bakelite pieces to cover the holes in the transformer shell where the other bakelite piece was set. Make your ¼" bakelite of such a size that it covers the whole side of the transformer, and do not attempt to *insert* it under the shell itself. Drill four holes in the corners of the bakelite to mount it on the shell, and in one piece drill two evenly spaced ⅜" holes for the leads to the RCA 811 plates, and in the other drill five ⅜" holes evenly spaced for the output under chassis leads. Connect up the transformer as listed in the parts list under the circuit diagram, and solder heavily insulated leads to the proper ends, so that you will have two leads on one side for the plates of the RCA 811's (input) and five for the 4 leads (output) and the center tap on the other side. Bring the center tap lead over to the output side in the same manner as you did with the power transformer. After the bakelite pieces have been bolted to the transformer shells, the transformer can be mounted "half-shell" style in the hole cut for it, the ends put into position and the unit bolted down. Here, again, the illustration will serve to help in visualizing the "conversion."

All flanges are removed from the 5 v. fil. transformer to make mounting more convenient for the position selected. Two spade lugs are soldered to the *Aerovox* filter condenser that mounts above the chassis and the terminals are underslung through cutouts in the chassis. Angle brackets are added to the 6.3 volt filament transformer so that it may be mounted on the rear edge of the chassis as shown.

When parts are wired close together, the importance of using sufficient insulation becomes more and more exact. Automotive ignition cable makes excellent leads for high-voltage work and Consolidated Wire type 4027 was used. These leads are used wherever any voltage in excess of 500 is used. Filament leads are covered with thick walled spaghetti tubing, not because the voltage is dangerous, but as a safeguard against breakdown where sharp bends must be made in the wiring.

All of the high-voltage filter condensers are connected in such a manner as to permit each lead to be soldered as close to the terminal as possible and the units are further equipped with *Sprague* "Lifeguards" that slip over each terminal. Inasmuch as the highest potential in the transmitter is the discharge surge when the load is removed from the filters, this precaution is desirable.

All relays in the schematic diagram are shown in the *c. w. position.* When phone operation is used, the relays are closed and apply plate potential to the proper circuits.

A push-to-talk relay is provided which adds greatly to the operating ease of the transmitter. Most microphone manufacturers include units which are equipped with push switches for this type of operation, but these are not of sufficient current-carrying capacity to allow control of the circuits and therefore it becomes necessary to utilize additional contacts, such as are provided by the relay.

A *Guardian* overload relay offers protection to the transmitting tubes if the output tank should become detuned from resonance. The resistor across the relay coil is adjustable, and may be set so that the contacts will open at about 200 M.A. This unit may be seen mounted on the front edge of the chassis with the reset knob protruding within easy reach of the operator.

The large *Ward-Leonard* relay shown mounted underneath the chassis controls the high-voltage circuits. Originally it is an antenna relay, here used as a D.P.D.T. relay. The micalex insulation offers ample insulation to the voltage used. Details of connecting the relays are clearly shown and will present no difficulty to the constructor.

The tube lineup of the speech amplifier is as follows: RCA 6SJ7 microphone amplifier, RCA 6L6 driver, RCA 6H6 rectifier for the compression circuit, and push-pull RCA 811 Class B modulators. The suppressor grid of the 6SJ7 is used as a control grid. Rectified audio is fed into this grid in such a manner as actually to control the gain of the tube, and consequently, the amount of audio that may be applied to the 6L6 driver grid.

A conventional audio gain control is provided at the input for the microphone. Audio filtering is provided by R10 and R15 in conjunction with C10 and C30. The input grid leads must be carefully shielded to eliminate hum pickup in the high-gain stage.

A pair of RCA 811's are used in Class B as modulators. In order to reduce the number of power supply parts, in order to achieve compactness, we elected to use a common power supply for both the final amplifier and the modulators, as described above.

In addition, fixed-bias is taken from the center tap of the plate transformer. The potential applied to the grid will depend upon the voltage drop across R20. This should be adjusted so that 100 volts negative potential is applied to the grid of the 828. Be sure to watch the polarity of condenser C39 and connect as indicated.

Bias to the 811 modulators is furnished by two 4½ volt C batteries, as this is more practical than taking voltage from a bias resistor. In order to operate the modulators at the same potential as the class C amplifier, bias is used to limit the idling current to a safe value.

Further effective performance may be had by eliminating the screen dropping resistor to the 828 screen. Both the screen and the plate are modulated and the only difference from the conventional method is to divide the secondary of the modulation transformer into two separate channels, applying correct voltage to each winding. The full 1400 to 1500 volts are applied to the 828 plate, while the screen receives 400 volts from the low-voltage plate supply.

The modulation transformer used provides an accurate impedance match to both the screen and plate of the 828 when connected as specified in the parts list. The amount of current through the secondary is less than by using the usual method of a dropping resistor and permits a smaller unit to be used. Instructions for converting this transformer have been given previously.

One thing is certain, the rig cannot be "thrown" together. It will require painstaking effort and close attention to details. As you wire, remember the use to which the particular wire you are working on, will be put. If it is a high-voltage lead, treat it as such. Use the best possible parts obtainable, especially in the hardware and ceramic departments. This rig is going to be really compact and there will be trouble in servicing it, should something break down *due to carelessness,* or cheapness of components. Follow the illustrations carefully. The wiring has been omitted from these because the placing of the parts is that much more clear. Tie your wires down in the best approved "Western Electric" manner. The authors used much of the parts that are manufactured by *James Millen,* since they seemed to fit the situation better.

Next month the description will be limited to the construction of the r.f. chassis, the band-switching mechanism, and tuning procedure.

If *all* the instructions are carefully followed, there is not the slightest doubt but that the builder will possess a "commercial" rig, with all that that name implies. —30—