

NTX-30 Transmitter

General Description: The National NTX-30 is an extremely flexible crystal-controlled transmitter having an RF output of 30 watts on the 10-, 20-, 40- and 80-meter amateur bands. It is complete and self-contained for c.w. operation, and terminals are provided for connecting an external modulator for phone use.

The output stage, which consists of two 6L6's connected in parallel, is operated at 300 volts, and the normal power input under load is approximately 60 watts. The 30-watt output rating is, therefore, very conservative, and if the output circuit is properly loaded, maximum RF power will be as much as 35 or 40 watts. Excitation to the final amplifier is supplied by any one of the four 6L6 tubes. Three of these tubes are employed as doublers following a crystal-controlled oscillator which normally operates in the 3.5- to 4-Mc. band. The doublers will, therefore, provide excitation in the 7-, 14- and 28-Mc. bands, and the desired excitation frequency is selected and is automatically applied to the final amplifier by means of a low-loss push-button type switch. This arrangement will be discussed more in detail under "Circuit Description."

Frequency Control: The crystal oscillator is a conventional circuit wherein the crystal current does not normally exceed a few milliamperes. Under such conditions, there is no possibility of injuring the crystals themselves, but as a further safeguard a 2-volt 60-ma. pilot light is connected in series with the crystal holder. Normally, this lamp does not light, but if for any reason the crystal current should become excessively high, the lamp will burn out before the crystal could become overheated.

A special National type 4-in-1 crystal holder is supplied as standard equipment. This unit is plugged in horizontally on the front panel, so that the crystal selector switch is in the same position as the other panel controls. Any crystal holder which is built to fit in a five-prong tube socket can, if the operator desires, be used in place of the 4-in-1 holder, and the arrangement of the circuit is such that a simple tuned circuit can be plugged into the crystal socket if a self-excited oscillator is desired. Such an oscillator will, however, be subject to slight changes in frequency with variation of line voltage since the circuit is of the tuned-plate-tuned-grid type.

Band Selection: As outlined above, three 6L6 doubler stages follow the crystal oscillator. The outputs of these doublers are on 40, 20 and 10 meters. By simply switching the grid circuit of the final amplifier to the proper tank circuit in the exciter line, and by plugging in the proper output coil, the transmitter, as a whole, may be put on

any desired frequency depending, of course, upon the frequency of the crystals.

The tank condenser of the final amplifier is tuned from the front panel by means of a type "0" dial; it is not necessary to retune the various doubler stages when changing to different frequencies within any of the amateur bands.

Metering: A dual range, illuminated meter, used in conjunction with a five-position switch, serves to check the plate current and excitation of all stages. The meter itself has a 1-ma. movement and is connected through suitable multiplier resistors to any of the cathode circuits. The multipliers are chosen so that the full scale deflection of the meter is 100 ma. when it is connected to the crystal oscillator, or to any of the doublers; when it is connected to the final amplifier cathode circuit, full scale reading is 500 ma.

The meter switch positions are numbered from 1 to 5 corresponding with the oscillator, first, second and third doublers and final amplifier, respectively. It should be noted that measurement of cathode potential does not provide a direct reading of plate current, since the current in the cathode circuit is a combination of control grid, screen and plate currents. Of these, control grid current is comparatively small, but the screen current may, under certain conditions, be quite large, and it so happens that, in general, screen current will decrease with increasing plate current. For instance, when the final tank circuit is tuned to resonance, unloaded, the plate current is minimum, but at the same time screen current will be maximum. When the output circuit is loaded, as it would be in normal operation, plate current is comparatively high, while the screen current drops to a minimum value. These facts are mentioned only because the experienced operator may expect to find a greater "dip" in current than actually occurs when any tank circuits are tuned to resonance.

The cathode potential method of measurement has, however, several important advantages; if, for instance, a short should occur in any of the plate circuits, the meter will not be harmed. Incidentally, the cathode resistors have a very definite stabilizing effect and protect the various tubes against overload when excitation is removed.

Keying: Two key jacks are provided; one in the cathode circuit of the crystal oscillator and one in the cathode circuit of the final amplifier. Keying the final will provide the cleanest signal and is recommended for this reason. Where break operation is desired, it is necessary to key the crystal oscillator, and the panel control of oscillator tuning will be found very convenient in

obtaining the exact adjustment necessary to eliminate keying chirps. The operator should remember that it is quite impossible to obtain good oscillator keying in any transmitter if the crystal is the least bit sluggish, or if the holder is improperly adjusted.

Power Supply: The NTX-30 is designed to operate on line voltages between 105 and 125 at frequencies of either 50 or 60 cycles. Even at a line voltage of 100 volts an RF output of 30 watts is still available. The total power input at 115 volts is about 240 watts. Special models of the NTX-30 are available for 220 volts 50- to 60-cycle operation, but 25-cycle models cannot be supplied nor can the transmitter be supplied for operation from DC line supplies.

Two switches are provided; one is the AC line switch, while the other is connected in the rectifier output and is used to disconnect all plate voltages while allowing the heaters of all tubes to remain turned on. This is the stand-by switch and it is wired to a terminal panel at the rear of the cabinet marked BSW. This terminal panel provides a convenient means of connecting a relay, as may be required in any particular installation.

The B-supply circuits deliver 500 ma. at 300 volts, and are quite conventional except for the use of parallel rectifier tubes, which are required to rectify the comparatively high current. 600-volt oil impregnated condensers are used in a two section filter, which supplies the oscillator and doubler stages. The final amplifier, which requires less filtering, is connected at the junction of the two chokes. It may be of interest to point out that in the event of the failure of one rectifier tube, the remaining tube is still capable of operating the transmitter even though it will be considerably overloaded. Such operation is not recommended, of course, but may be used in case of emergency.

The primary circuit of the power transformer is fitted with a type 3AG fuse having a rating of five amperes. It is mounted underneath the chassis.

Circuit Description

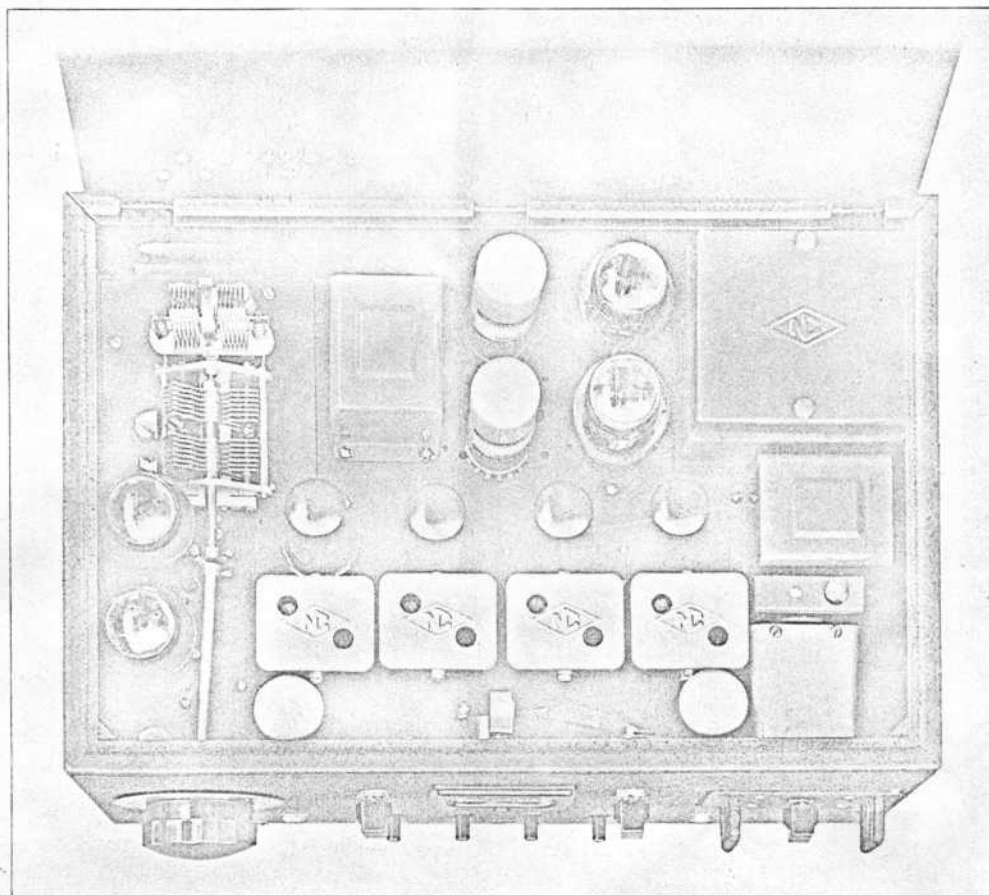
Much of the material which might properly be presented here has been covered in the previous section, and it remains, therefore, to comment upon the unusual design features with which the reader may not be familiar.

The Exciter: As previously indicated, the fundamental circuit of the NTX-30 is quite conventional. The method of band-switching is unique, however, and may be described briefly as follows: Reference to the circuit diagram will show a four-section push-button switch. Each section of this switch has two positions and all sections are inter-connected mechanically by an automatic tripping mechanism. For instance, suppose the 20-meter button is pushed in to provide 20-meter excitation to the final amplifier, inspection

of the diagram will show that excitation to the 10-meter doubler is now disconnected, the compensation condenser C-24 being switched in. The grid circuit of the output tubes is connected to a tap at the proper point on the 20-meter tank coil. Suppose that it is now desired to shift to the 40-meter band, it is only necessary to push the 40-meter button. When this is done, the 20-meter button will be automatically released, disconnecting the final amplifier excitation lead from the 20-meter tank. The 40-meter button will connect 40-meter excitation to the final and will, at the same time, disconnect the grid of the 20-meter doubler. In order to compensate for the detuning effect caused by the decrease in circuit capacity when the doubler grid is removed, compensating condenser C-23 is switched in. The 40-meter tank circuit will, therefore, remain in tune and will supply the correct amount of excitation to the final amplifier.

Possibly the reader has wondered about fixed tuning in the various doubler stages, and its effect upon output when changing frequency within the limits of any band. Actually, no such difficulty arises since panel controls are provided for the two critical circuits, i.e., the crystal oscillator and final amplifier output tanks. The 6L6 doublers do not require precise adjustment of excitation and since they are normally somewhat over-excited the tuning of the various circuits is not at all fussy. There is only one precaution that should be observed: the 10-meter doubler plate circuit should be tuned to within 500 kc. of the operating frequency. For instance, if this circuit is tuned to 29 Mc. the operating frequency should be between 28.5 and 29.5 Mc.; if the deviation is greater than this, there will be a slight drop in the output of the final amplifier.

Final Amplifier: There are several points of interest in connection with the final amplifier, which, as previously stated, consists of two 6L6G tubes connected in parallel. The parallel arrangement was chosen in preference to push-pull for a number of reasons. To begin with, only half of the excitation voltage is required and, furthermore, the excitation can be obtained directly from the various exciter plate circuits with no intermediate link circuits or grid tuning required. The most important point, however, is that the parallel connected tubes have comparatively low plate impedance, making it possible to maintain constant output from 80 to 10 meters, in spite of unavoidable losses which would normally decrease output considerably at the high frequencies. These losses tend to reduce the impedance of the final tank circuit and would, in the case of a push-pull amplifier, impair plate circuit efficiency. The parallel tubes, on the other hand, are much less critical in regard to the tank circuit into which they operate, and the output will, therefore, remain essentially the same over the entire range.



The amateur is apt to regard parallel operation of tubes with disfavor because his experience has shown such a circuit to have tendencies toward parasitic oscillation. It is not difficult, however, to eliminate these spurious oscillations, and in the NTX-30 complete stability is obtained by simply connecting two very small chokes close to the two plate terminals of the 6L6G tubes. They are indicated in the circuit diagram as L_7 and L_8 .

Output Coupling: Each of the plug-in coils used in the final amplifier is provided with a semi-adjustable pick-up coil, designed primarily for coupling the final amplifier to a 72-ohm transmission line. The pick-up coil can be adjusted to provide varying degrees of coupling as may be required for any particular antenna or feeder system. The same coil can, of course, be used for a link pick-up where the NTX-30 is used as a driver for a high power final amplifier.

If the NTX-30 is to be used with a Zepp antenna, the conventional variable series condensers must be connected in the feeders. In the installations where the antenna feeders are of high

impedance, or where voltage feed is used, it will be necessary to employ a pi-section matching network. For complete data on various types of antennae, coupling systems, etc., the reader is referred to the A.R.R.L. Handbook.

Operating and Alignment Instructions

The Exciter Section: Tank circuits and compensators in the exciter section of the NTX-30 are aligned in the laboratory before shipment, but it is quite possible that the alignment may require checking, particularly in the case of the 10-meter doubler tank, which, as stated above, should be tuned to within 500 kc. of the operating frequency. The complete alignment procedure is, therefore, given below and may be accomplished without difficulty if the instructions are carefully followed.

Looking at the NTX-30 from the front, each tank shield in the exciter line will be seen to have two adjustment holes; of these, the ones on the left-hand side of each shield are the main tank condensers, while those on the right are the com-

pensators described above, except in the case of the 10-meter doubler where both trimmers are in parallel and act as tank condensers.

First turn on the AC switch and allow the rectifier tubes to heat for ten or fifteen seconds before turning on the B-supply switch. Push the 10-meter button and set the meter switch at No. 1, and with the desired 80-meter crystal connected in the oscillator, adjust the crystal tuning control on the front panel for a dip in current. In normal operation, the off-resonance current will be in the neighborhood of 45 to 50 ma. and the meter will dip down to about 30 ma. when the crystal is oscillating. Turn the meter switch to position No. 2 and tune the 40-meter tank condenser for minimum meter reading. Off-resonance current will be 60 or 70 ma., while the current at resonance is from 30 to 40 ma. Proceed to the next tank, switching the meter to position No. 3, and tune it to resonance in the same manner; then check the 10-meter tank with the meter in the No. 4 position. Now push the 20-meter selector-switch button and set the 20-meter compensating condenser for minimum reading, the meter switch being in the No. 3 position. Proceed to the next lower frequency range by pushing the 40-meter button and set the 40-meter compensator for minimum reading of the meter with meter switch in position No. 2. Repeating this operation on the 80-meter range with the meter in the No. 1 position will complete the alignment.

The adjusting screws of the various tank condensers are at B+ potential so reasonable care must be taken not to short the screw driver against the shield can. Such a short will not, however, harm the meter, since it is connected in the cathode circuit.

When the NTX-30 is to be used on several different frequencies, it is best, of course (although not especially important), to align the various circuits to the middle frequency of the group. As stated previously, however, the tuning of the 20- and 40-meter tanks is not at all fussy as far as excitation of the final amplifier is concerned, and if the crystal frequencies cover a wide range, it is best to favor those circuit adjustments which give correct alignment on the principal 10-meter frequency.

Neutralization: The design of the final amplifier is such that when it is neutralized on one frequency it remains neutralized at all other frequencies in any of the amateur bands. Naturally, this makes neutralization simple, and the recommended procedure is as follows: Push the 10-meter selector switch to provide excitation to the final at that frequency; plug-in the 10-meter coil and remove the wire connecting the modulation input terminals at the rear of the chassis; connect a 2-volt 60-ma. dial lamp (as used in 2-volt battery receivers) directly across the antenna terminals. The coupling coil should be set to provide maximum coupling. Carefully tuning the final

tank circuit to resonance at about 25 to 30 on the dial should not show any indication of light in the 2-volt lamp. If it does, the neutralizing condenser, which is located just to the left of the split stator tank condenser, should be adjusted with a screw driver made of insulating material. When finally set, the adjusting screw should be locked in place by means of the lock nut which screws down against the molded end piece of the neutralizing condenser. The adjustment which gives correct neutralization is quite critical and it is necessary to set the screw to within $\frac{1}{4}$ of a turn. Care should be taken when locking the screw in its final position as the action of the lock nut tends to reduce the capacity slightly.

The 2-volt lamp, when used in the manner outlined above, constitutes a very sensitive indicator and through its use the final stage can be neutralized very accurately. As a matter of fact, the lamp is very apt to burn out if the final stage is exactly tuned to resonance at any time when the neutralizing condenser is incorrectly adjusted. In order to avoid this possibility, the final tank circuit should be tuned towards the point of resonance slowly (from either side), the neutralizing condenser being adjusted as may be required to keep the indicator lamp from lighting.

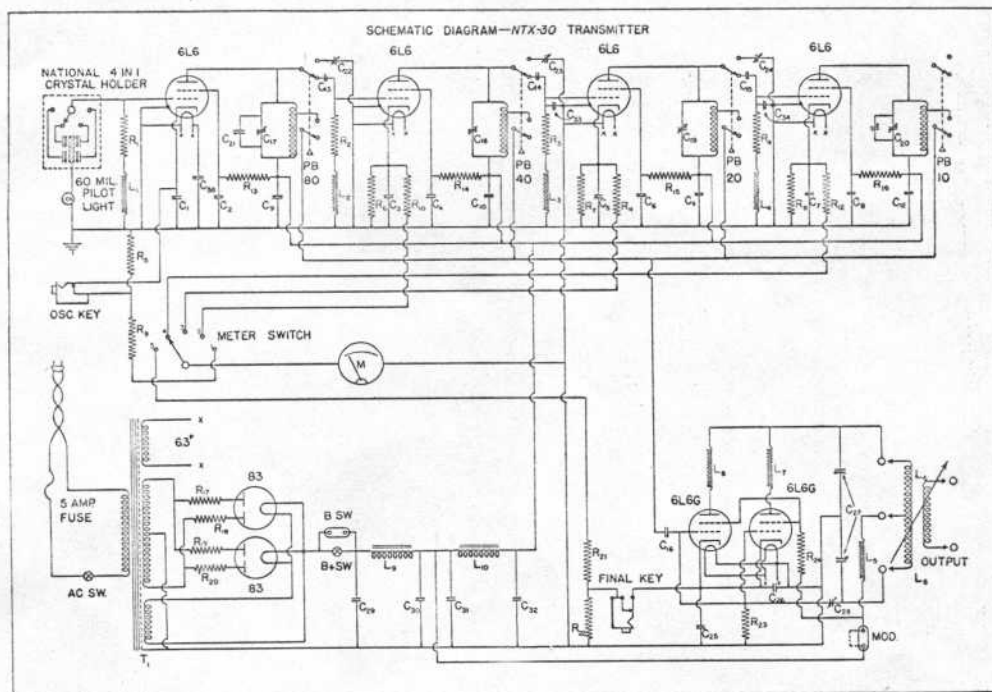
In common with other circuit adjustments of a permanent nature, the neutralizing condenser is set at the factory to correctly neutralize the particular tubes which are furnished with the transmitter.

Final Amplifier Tuning: After the final amplifier is properly neutralized, B-supply voltage may be applied to the plate and screen circuits by replacing the bridge wire connecting the two modulation supply terminals. The various amateur bands will be found at the approximate dial readings listed below:

80 meters	65-70
40 "	55-60
20 "	40-45
10 "	25-30

The plate current drawn by the final stage will vary with the band in use and will, in general, be considerably higher on 10 and 20 meters than it is on 40 and 80 meters. The meter reading will be made with the switch in position No. 5. When the final tank circuit is off-resonance, the final plate and screen currents on 10 and 20 meters will be around 320 ma., and when the circuit is tuned to resonance, as indicated by minimum meter reading, the current will be about 190 ma. Corresponding readings for 40 and 80 meters are 220 ma. off-resonance, and 60 ma. at resonance. When fully loaded and delivering from 30 to 40 watts of RF power, the meter will read about 290 ma. on the 10- and 20-meter bands, and about 190 ma. on 40 and 80 meters.

There is one more point which should be mentioned concerning tuning of the final amplifier. When the 80-meter coil is plugged in, it will be



PARTS LIST

- R_1 to R_4 , inclusive — 50,000-ohm, 2-watt
 R_5 to R_8 , inclusive — 300-ohm, 2-watt
 R_9 to R_{12} , inclusive — 30,000-ohm, $\frac{1}{2}$ -watt
 R_{13} — 20,000-ohm, 2-watt
 R_{23} and R_{14} to R_{16} , inclusive — 7500-ohm, 10-watt
 R_{17} to R_{20} , inclusive — 30-ohm, 2-watt
 R_{21} — 5000-ohm, $\frac{1}{2}$ -watt
 R_{22} — 10-ohm, 2-watt
 R_{24} — 2500-ohm, 10-watt
 C_1 to C_5 , inclusive C_{25} and C_{35} — .01-mfd., 400-volt
 C_9 to C_{12} , inclusive — .003-mfd. mica
 C_{13} to C_{15} , inclusive — .001-mfd. mica
 C_{16} — .00025-mfd. mica
 C_{17} to C_{20} — 25-mmfd. tank condensers of FXT'S
 C_{21} — "Crystal tuning" National STE60
 C_{22} to C_{24} , inclusive — 15-mmfd. compensators of FXT'S
 C_{26} — .001-mfd. mica
 C_{27} — Final tank condenser National TMC-150D
 C_{28} — Neutralizing condenser National NC-600
 C_{29} to C_{32} , inclusive — 4-mfd., 600-volt (oil)
 C_{33} , C_{34} — 10-mmfd. mica
 L_1 to L_4 , inclusive — National R-100 RF Chokes
 L_5 — National R-200 RF Choke
 L_6 — National AR-16S Tank Coils
 L_7 , L_8 — Parasitic Chokes
 L_9 , L_{10} — National Filter Chokes (Special)
PB — National Push Switch ACS-4

possible to tune it to 40 meters by setting the dial at about 10, and considerable output is available even though the amplifier is, in this case, acting as a doubler. Such operation is not recommended, however, since the tuned circuit has a high ratio of inductance to capacity which will result in excessive harmonic radiation. It may also be possible to tune the 40-meter tank coil to 20 meters in a manner similar to that outlined above, but here again the L/C ratio cannot provide adequate harmonic suppression.

Antenna Coupling: The output pick-up coil is designed primarily to match a 72-ohm untuned transmission line. For further data on this subject refer to the last paragraph under "Circuit Description."

In general, the output coupling coil should be adjusted to fully load the final amplifier, this condition being indicated when the meter reading is about nine-tenths of the "off resonance" value. The output coupling coil should be set to provide the correct loading condition by bending the mounting leads and, when once adjusted, need not be changed unless some alteration is made in the antenna system. It is obviously impossible to give exact directions for adjusting and tuning all of the various types of antennae to which the NTX-30 may be connected, and it will be necessary for the operator to do a certain amount of experimental work in order to obtain maximum antenna power. The operator should realize that

the performance of the transmitter depends largely upon the efficiency of the antenna system, and it is well worthwhile, therefore, to take considerable pains to see that all parts of the radiating system are working efficiently.

Phone Operation: The final amplifier of the NTX-30 may be modulated for 'phone operation and suitable terminals are provided at the rear of the chassis for connecting the modulator. Reference to the circuit diagram will show that these terminals are connected in series with the B-supply to both plate and screen circuits, and both circuits will, therefore, be modulated. This system of modulating the final is very satisfactory and an oscilloscope will show negligible distortion up to 100% modulation.

When the final amplifier is fully loaded, about 30 watts of audio power will be required to modulate the carrier completely.

The load impedance of the Class C amplifier, looking into the modulation terminals, will vary with the current drawn by the plate and screen circuits, and the modulator must of course be designed to work efficiently into the Class C load. The 10- and 20-meter impedance is approximately 1000 ohms, while on 40 and 80 meters it is about 1500 ohms. These values are somewhat lower than those ordinarily encountered in a Class C amplifier, but the actual impedance is unimportant as long as the modulator tubes are properly loaded.

National NSM Modulator

General Description: The NSM Modulator is a complete speech amplifier and modulator unit having a maximum undistorted output of 35 watts. It is designed primarily to be used in conjunction with the NTX-30 Transmitter, but can, of course, be used with other transmitters and, to this end, has been fitted with suitable switches, terminal panels, etc., as well as other features which will be described in detail in the following pages.

Nine tubes are employed as follows:

Input Amplifier	6C6
Voltage Amplifier and Compressor Control	6D6
Phase Inverter and Driver	6F8G
Power Output (2)	6L6G
Compressor Rectifier	6X5
Meter Amplifier	6C5
Rectifier	83
Voltage Regulator	VR150

Although the fundamental circuit is quite conventional, there are a number of unusual features which merit a complete description and while this booklet is intended as an instruction manual, it is felt that the operator of the NSM will appreciate information concerning the design and operation of this equipment.

Frequency Characteristic: The normal frequency characteristic of the NSM has been selected to favor the particular characteristics of voice transmission. This subject has been covered thoroughly in the various periodicals devoted to amateur transmitters so that in this booklet it will only be said that the frequency characteristic of the NSM is down 10 db. at 25 cycles, 6 db. at 50 cycles and is flat within 2 db. between 100 and 10,000 cycles.

A four-position tone control is provided which may be used as follows:

In position No. 4, the normal characteristic, as outlined above, is obtained.

In position No. 3, the high frequency response is attenuated in such a way that the gain at 5000 cycles is down 10 db.

In position No. 2, low frequency response is attenuated in such a way that the gain is down 10 db. at 100 cycles.

In position No. 1, both high and low frequencies are attenuated.

Position No. 2 will be found particularly useful when the operator is attempting to work through bad interference, since the effective or "intelligibility modulation" may be increased about 8 db. without actually exceeding 100% modulation.

Input Circuits: Two input circuits are provided. A high gain circuit starts at the micro-

phone jack on the front panel and from this point the overall gain to the modulator output is 140 db. Full output is obtainable with an input of about one-half of one millivolt at the microphone jack. This amplification is sufficient for any conventional low level microphone and it will be seldom necessary to fully advance the gain control.

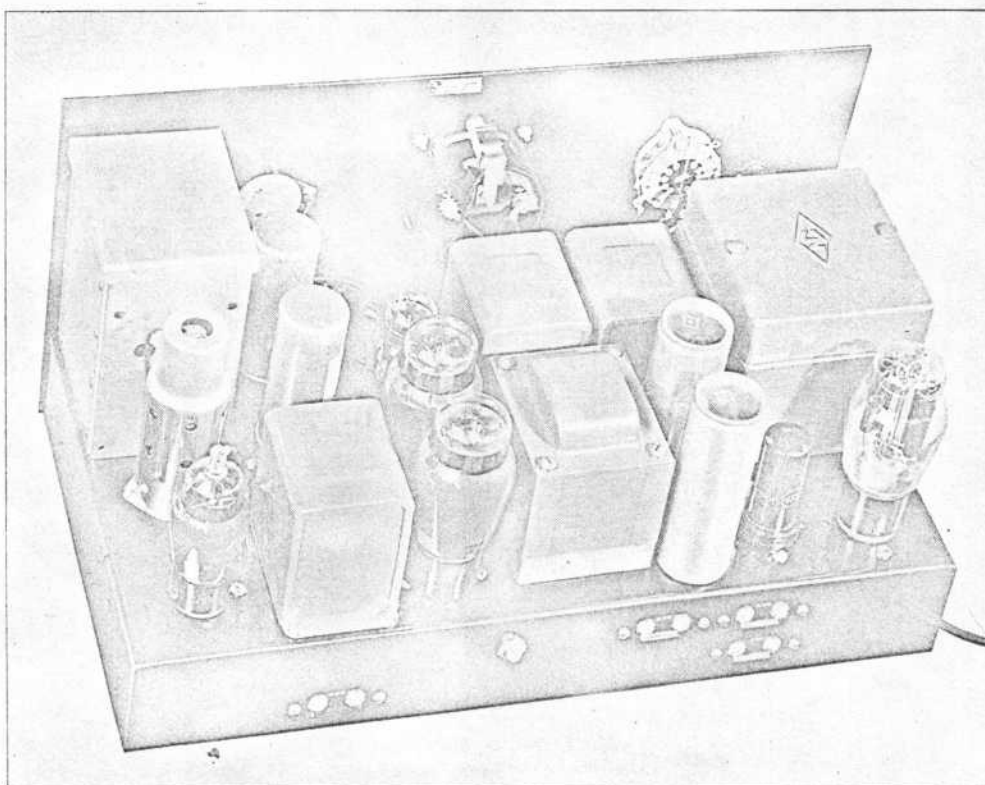
A relatively low gain input circuit (90 db. gain) is brought out to terminals at the left-hand side of the chassis, as viewed from the rear. This channel may be used in conjunction with sound equipment having fairly high level, such as would be obtained from a carbon microphone or a phonograph pick-up.

Both input circuits utilize the same audio gain control or fader. The gain control is located just to the right of the meter on the front panel and is of such design that with the pointer in the vertical position both channels are dead. As the control is rotated counter-clockwise from the central position, the amplification of the low gain channel increases and, conversely, when the control is rotated clockwise from mid-position, the amplification of the high gain channel increases.

Output Circuit: The output of the 6L6G's is brought to a terminal panel at the upper right-hand side of the chassis at the rear. The impedance of the load circuit should be in the neighborhood of 1400 ohms and the NTX-30 may, therefore, be connected directly as covered under "Installation and Operation."

The output transformer is designed to carry the full current drawn by both plate and screen circuits of the Class C amplifier and, as indicated above, will deliver 35 watts under these conditions. In certain applications where the NSM is to be used with a transmitter having markedly different characteristics than those of the NTX-30, or in Public Address work, etc., it may be advisable to connect directly to the plates of the 6L6G's, either directly or through a special coupling transformer. In such cases, the maximum undistorted output will be about 45 watts. The output transformer must, however, be carefully designed and have excellent power efficiency or a large percentage of available power will be lost. The standard 1400-ohm transformer furnished has a power efficiency of about 81%; in other words, the loss is less than 1 db.

Volume Compression: It is doubtful if the average amateur operator realizes that it is practically impossible to operate his transmitter within the limits of 90% and 100% modulation. In order to fulfill this requirement, it would be necessary for him to talk at a uniform level which would not vary more than about one-half of 1 db.



Obviously, this cannot be done and since it is usually necessary to maintain modulation at an average level of at least 80% or 90%, in order to cope with interference and heterodynes, it is no wonder that the majority of phones are considerably over-modulated most of the time. The practical solution to the over-modulation problem lies either in an accurate indicating device, or in volume compression.

Of course, the Federal Communications Commission requires some form of modulation indicator but even though it is used conscientiously, continuous vigilance on the part of the operator is required and the mere fact that an indicator is in use is no assurance that 100% modulation will not be exceeded during a QSO when the operator is trying to think of several things at the same time. The volume compressor, on the other hand, works automatically and will maintain a uniformly high percentage of modulation, even though the output of the microphone varies over a range of about 8 to 1. Study of the NSM diagram will show how the volume compressor works.

The high end of the modulation transformer secondary is connected to the cathode of the 6X5 rectifier, the plate circuit of which is

grounded through a resistance of 100,000 ohms shunted with a 10-mfd. condenser. The plate end of this network is connected through a suitable filter to the control grid of the 6D6 amplifier tube. It should be noted that the rectifier cathode is supplied with a higher audio voltage than that connected to the Class C amplifier. Inasmuch as the tap on the transformer secondary is connected directly to the Class C amplifier, modulation voltage which is sufficient to produce about 90% modulation will, at the same time, produce enough excess voltage, in that portion of the secondary winding connected to the rectifier cathode, to cause rectification of negative audio peaks. At modulation percentages over 90, the carrier envelope during the negative portion of the cycle is very close to zero since, by definition, 100% modulation occurs when the peak modulator voltage equals the DC supply voltage of the Class C amplifier. Obviously, the extra turns on the modulation transformer secondary will couple an additional modulator voltage to the 6X5 rectifier and as soon as the cathode becomes negative, with respect to ground, current flows in the plate circuit and the resulting voltage drop is impressed upon the grid of the 6D6. This voltage cuts down the amplification of the tube in such a

way that the output of the modulator is held essentially constant and it is practically impossible, therefore, to operate the Class C amplifier beyond its modulation capability of 100%.

This type of compressor "takes hold" very quickly; in other words, the volume compressor action is almost instantaneous. The action continues, however, until the condenser in the plate circuit of the rectifier discharges through the 100,000-ohm load resistance. Since this action is relatively slow, there is no audio degeneration or distortion in the audio cycle and the compressor simply rides along on the modulation peaks.

Inasmuch as the compressor is a voltage actuated device, it will work exactly as outlined above on any transmitter provided, of course, that the standard modulation transformer is used.

The volume compression meter employs a special scale and reads directly the decrease in overall gain of the speech amplifier when the compressor is in operation. For instance, assume that a given input from the microphone is just sufficient to produce 90% modulation. At this level there will be no compressor action and the meter will read zero. If, however, the input to the amplifier is increased by 6 db., for example, compressor action starts and cuts down the gain of the amplifier by almost exactly 6 db. so that output and percentage modulation remain about the same as before. The meter will now read 6 db. When it is remembered that a 6 db. increase means a power change of 400% and that this increase would result in 180% modulation (if the modulator tubes could handle it), it is evident that the 17 db. range of the compression meter is ample and in use the meter seldom reads over 10 db.

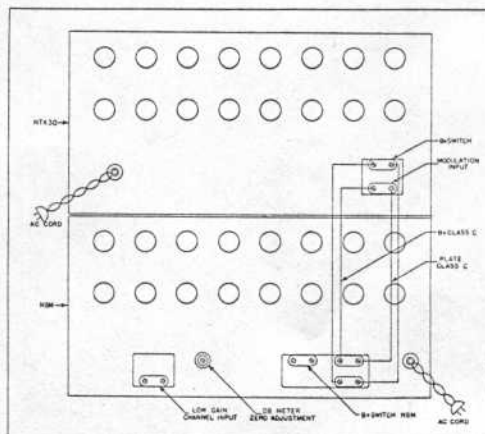
Phase Inverter: Another unusual feature of the NSM is the manner in which the 6F8G is used as a phase inverter. Referring again to the circuit diagram, it will be seen that the upper triode has a voltage divider network connected between the plate and B+ with the grid of the lower triode fed from a tap. This part of the circuit is quite conventional but a self-balancing effect is obtained by connecting a resistor between the plate of the lower triode and the tap which feeds its grid. Briefly, the action is as follows: The resistor network of the upper triode supplies the grid of the lower unit with more audio voltage than is actually needed to obtain balanced output. This excess voltage is, of course, amplified by the lower triode and appears in its plate circuit. Since the plate resistor previously mentioned is connected to the grid excitation tap and since a portion of the total resistance (between B+ and the grid tap) is common to both grid and plate circuits, there will be a bucking action which will equalize the excess grid voltage and will keep the circuit as a whole very closely balanced. The self-balancing action is very desirable since it will

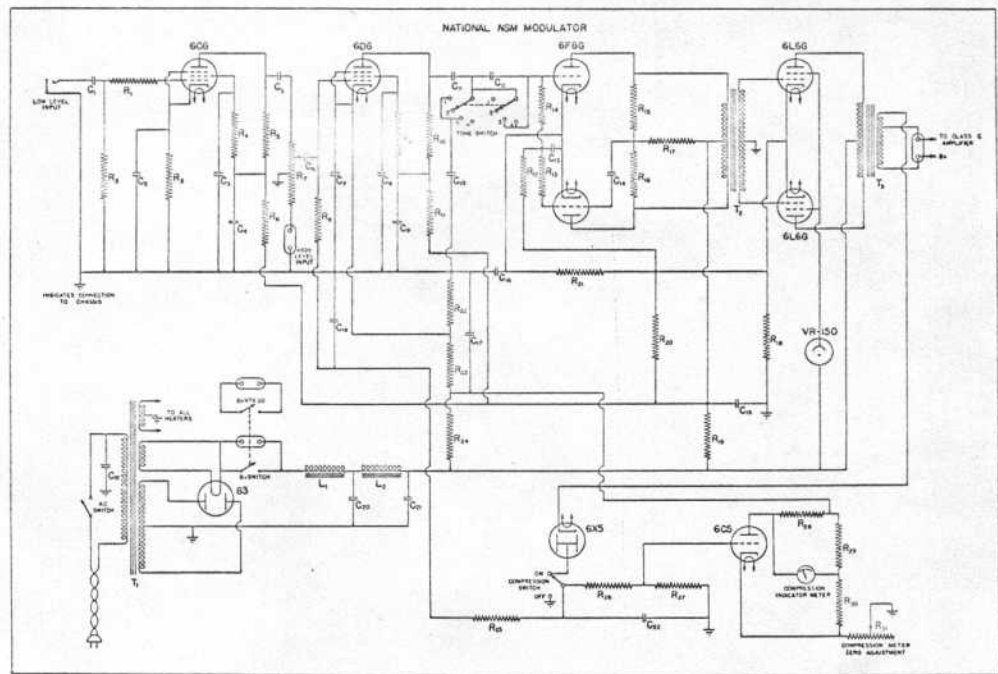
accurately compensate for any slight differences between the two triode sections of the 6F8G tube and will assure good push-pull action, correct balance in the transformer primary, etc., with negligible distortion.

Installation and Operation: The accompanying sketch shows the recommended interconnections between the NSM and the NTX-30. It will be seen that only four leads are required, two for the modulator output and two for the B+ switch circuit of the NTX-30. The B+ switch of the NSM is a double-pole single-throw type and, when wired as shown, will control both the R.F. and modulator power supplies simultaneously. An additional B switch panel is also provided and is connected in parallel with the NSM B+ switch for those installations where it is desired to employ a relay associated with the controls of the receiver. This panel will not, however, be used ordinarily with the NTX-30.

When connecting the two units, it is very important that the modulator output terminals be correctly wired to the corresponding terminals of the Class C amplifier. If they are not, or if polarity is reversed, the volume compressor will be inoperative. If there is any doubt on this point, the wiring of both units should be checked in accordance with the circuit diagram.

After the two units are wired together with the R.F. portion of the transmitter properly adjusted, the modulator AC switch should be turned on and the tubes allowed to warm up for about one minute. The B switch may now be turned on and with the audio gain control off (in mid-position), the compressor switch should be turned on and the compression meter reading checked. If the meter does not read zero, it will be necessary to adjust the compensating resistor located on the back of the chassis. This adjustment is of the semi-permanent type and is made with a screwdriver. When once set it need not be readjusted except at infrequent intervals, as the 6C5 tube changes its characteristics. The micro-





RESISTOR AND CONDENSER LIST

R ₁	50,000 ohms	1/2 watt	R ₂₈	2,500 ohms	1/2 watt
R ₂	5 megohm	1/2 watt	R ₂₉	350 ohms	1/2 watt
R ₃	1,000 ohms	1/2 watt	R ₃₀	20,000 ohms	2 watts
R ₄	1 megohm	1/2 watt	R ₃₁	1,000 ohms	wire-wound rheostat
R ₅	250,000 ohms	1/2 watt	C ₁	.1 mfd.	400 volt tubular
R ₆	100,000 ohms	1/2 watt	C ₂	25 mfd.	25 volt electrolytic
R ₇	1 megohm tapped Fader		C ₃	.25 mfd.	400 volt tubular
R ₈	500,000 ohms	1/2 watt	C ₄	8 mfd.	450 volt electrolytic
R ₉	1 megohm	1/2 watt	C ₅	.1 mfd.	400 volt tubular
R ₁₀	250,000 ohms	1/2 watt	C ₆	.1 mfd.	400 volt tubular
R ₁₁	40,000 ohms	1/2 watt	C ₇	25 mfd.	25 volt electrolytic
R ₁₂	250,000 ohms	1/2 watt	C ₈	.25 mfd.	400 volt tubular
R ₁₃	500,000 ohms	1/2 watt	C ₉	8 mfd.	450 volt electrolytic
R ₁₄	500,000 ohms	1/2 watt	C ₁₀	.005 mfd.	400 volt tubular
R ₁₅	50,000 ohms	1/2 watt	C ₁₁	.025 mfd.	400 volt tubular
R ₁₆	50,000 ohms	1/2 watt	C ₁₂	.001 mfd.	mica
R ₁₇	20,000 ohms	1/2 watt	C ₁₃	.1 mfd.	400 volt tubular
R ₁₈	155 ohms	4 watts	C ₁₄	.1 mfd.	400 volt tubular
R ₁₉	5,300 ohms	5 watts	C ₁₅	24 mfd.	450 volt electrolytic
R ₂₀	20,000 ohms	2 watts	C ₁₆	10 mfd.	50 volt electrolytic
R ₂₁	430 ohms	1/2 watt	C ₁₇	8 mfd.	450 volt electrolytic
R ₂₂	140 ohms	1/2 watt	C ₁₈	.1 mfd.	400 volt tubular
R ₂₃	15,000 ohms	3 watts	C ₁₉	.1 mfd.	400 volt tubular
R ₂₄	15,000 ohms	5 watts	C ₂₀	4 mfd.	600 volt oil
R ₂₅	250,000 ohms	1/2 watt	C ₂₁	4 mfd.	600 volt oil
R ₂₆	80,000 ohms	1/2 watt	C ₂₂	10 mfd.	50 volt electrolytic
R ₂₇	20,000 ohms	1/2 watt			

phone may now be plugged in and the volume control advanced to the right. The operator must, of course, adjust the gain control to provide sufficient sensitivity but it should not be advanced to the point where the compression meter reads over 6 on the ordinary peaks encountered in voice modulation.

Do not try to operate the transmitter with the meter reading above mid-scale, as such operation may cause over-modulation even though the compressor control circuits are capable of holding the modulator output uniform within a few per-

cent. It must be remembered that the carrier is modulated over 90% as soon as the compression meter starts to read and that an increase in the modulator output voltage of only 10% (approximately .5 db.) will produce over-modulation with distortion and side-band splatter.

If the NSM is used for Public Address work, or any similar application not directly associated with the modulation of the Class C amplifier of a transmitter, the compressor switch should always be turned off; otherwise the amplifier circuits cannot function properly.