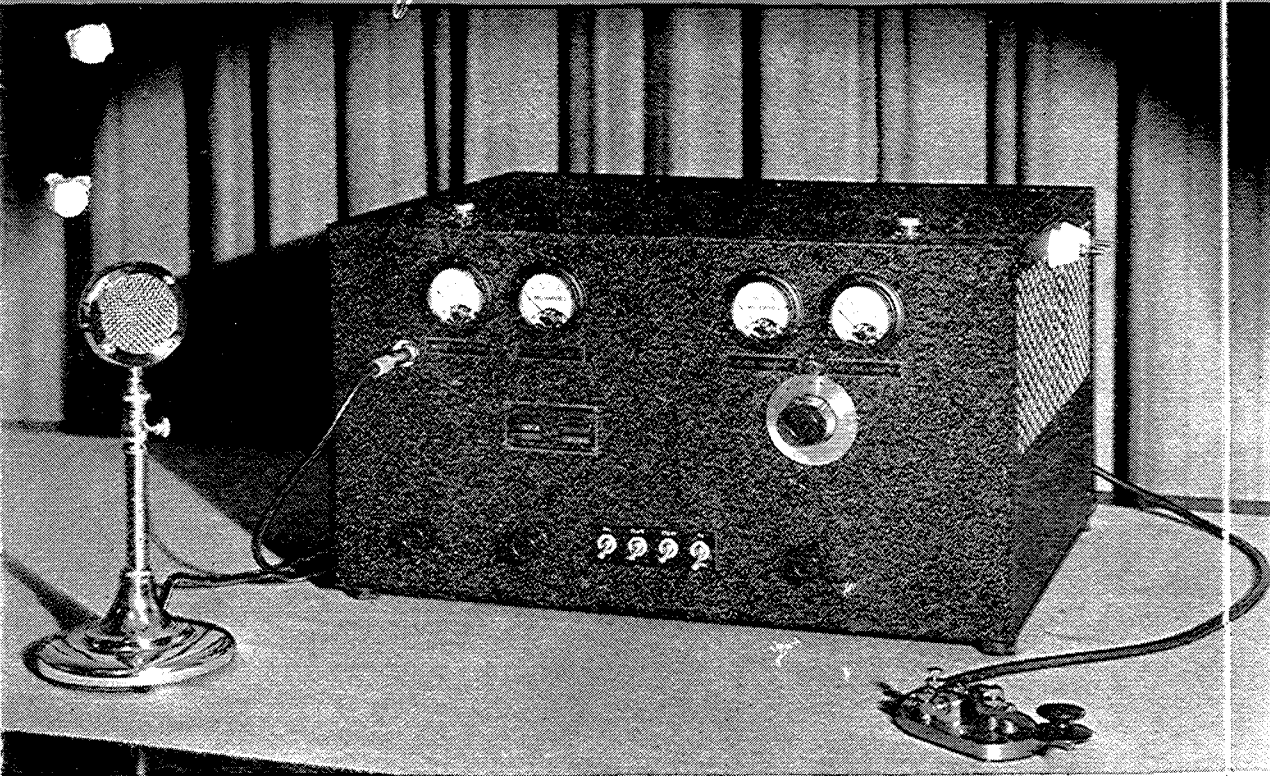


Culminating a Year of Research—the 45A



THE 45A is the newest small-sized transmitter. Collins Radio Company engineers have been working steadily to increase the power, improve the efficiency and afford more reliable performance in a low cost transmitter. The 45A embodies the remarkable results of this work. Compact and serviceable in size, it has a man-sized output—40 watts telephone and 125 watts telegraph.

The

**COLLINS
SIGNAL**



The last issue of the SIGNAL was printed in July, 1934. Not a publishing house, Collins Radio Company has limited its activities since that time to its prescribed field—design and manufacture of transmitting apparatus. However, so many requests have been received from engineers, amateurs, broadcasters and college libraries for more issues of the SIGNAL, that it has been decided to resume publication.

It is our hope to make an interesting and accurate presentation of the technical phases of our products and of their use. A monthly schedule may not be adhered to, but issues will be printed whenever suitable material is available, and time can be taken from routine duties for its preparation. This issue and the next will be devoted to catalog descriptions of new apparatus. We can also include technical reports on such subjects as transmission lines, antennas, transformers, and amplifier operation. May we be guided by your suggestions?

ARTHUR A. COLLINS



S E P T E M B E R
1 9 3 5

COLLINS SIGNAL

PUBLISHED BY

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA, U. S. A.

The 45A Transmitter

THE COLLINS RADIO COMPANY has had an excellent opportunity to determine what features are most desirable in a general purpose, small sized transmitter. Requirements of amateurs, commercial organizations, governments, etc., have been studied during the past several years and hundreds of transmitters of various types have been built. At first, it did not seem possible to meet, in a single model, the needs of every kind of user, but an extensive engineering development program was undertaken to see what could be accomplished. The 45A transmitter was designed as a result of this work and it was found possible to incorporate features which make it desirable for almost every kind of service.

The first design factor to be considered by the transmitter engineer is the amount of power to be delivered by the set to the antenna. A radiophone output of 30 to 50 watts was decided upon as the maximum which could be obtained in a general purpose transmitter without exceeding limitations of cost, size and power consumption. The rated output of the 45A is 40 watts telephone, 125 watts telegraph. On tests, these sets show actual outputs of 50 watts telephone, 160 watts telegraph, with excellent over-all efficiencies. The type of modulation employed permits the full tube and power supply capacity to be used effectively on both telegraph and telephone, and, accordingly, the telegraph output is very unusual for a transmitter of this size.

Its extreme compactness permits the 45A to be "installed" by merely placing it on the operating table beside the usual communications-type receiver, where it occupies only slightly more space than the latter. Every component is self-contained except the microphone, the telegraph key and the leads to the 110 volt outlet and the antenna. The control switches are on the transmitter panel at the operator's finger tips. The

cabinet construction of the 45A is adapted from aircraft transmitter design, and circuit components are located systematically to assure efficient operation and complete freedom from interaction. Perforations in the sides, rear and bottom provide adequate ventilation and give a pleasing appearance similar to that of high-power transmitters. The tubes and frequency shift units are inserted through the hinged top, which is fitted with a power interlock to remove high voltages when the top is opened. The cabinet is fitted with special heavy rubber feet which protect the surface on which the transmitter rests. These feet may be replaced with aircraft-type vibration-damping mountings when the transmitter is installed in a motor car or truck. The cabinet itself is constructed of first grade auto-body steel, which is heavily copper plated as a protection against corrosion in tropical climates or on shipboard and to give good electrical conductivity. The plated metal is finished on the outside with crystalline baked enamel and on the inside with aluminum lacquer.

One of the most interesting features of the 45A is the new unit type frequency shift which allows the set to be operated instantly on any predetermined frequency up to 30 megacycles. The frequency shift unit consists of a small aluminum case containing not only the pre-tuned excitation tank circuits but also the crystal for each frequency on which it is desired to operate. This unit and the output tank coil are plugged into the transmitter through the hinged top, one frequency shift unit and one output tank coil being used for each frequency. The only tuning controls on the panel are the grid and plate condensers in the final amplifier, and their calibrated positions are shown on a card attached to the top of the frequency shift unit. The operation of changing from one frequency to another occupies less than 10 seconds, including the time required to set the

two tuning condensers. The frequency shift unit is normally tuned and locked at the factory, although the user may change crystals and adjust the excitation tank circuits while the frequency shift unit is in the set. However, the frequency shift units are low in cost, and for convenience it is desirable to have a separate unit for each crystal so that the excitation tuning may be locked.

A considerable amount of time has been spent in the design of this method of changing frequencies. An alternative arrangement which was tried and discarded involved the use of a panel control to change from one band to another. This system was not adopted because only three or four bands could be covered, and it was not possible to add new channels after the set was placed in use. The unit type frequency shift system allows the set to be used on any number of bands on any frequency whatever between 1.5 megacycles and 30 megacycles, and, in fact, frequency shift units can be supplied on special order for frequencies as low as 600 kilocycles. All of the advantages of plug-in coils are obtained without the annoyance incident to inserting a multitude of coils and crystals and retuning all of their circuits whenever the frequency is changed.

Amateurs who are primarily interested in CW operation can obtain the frequency shift units fitted with a type 294 Variable Air-gap Holder so arranged that the air gap can be readily adjusted to vary the frequency over a range of several kilocycles. This makes it possible to move the frequency of the transmitter to avoid an interfering signal. This method of adjusting frequency is also very useful on the 14 mc. phone band during conditions of severe interference.

The radio frequency tube lineup is very interesting and bears consideration in connection with the frequency shift method just described. The Collins C-100 oscillator tube was developed specifically for use in crystal controlled transmitters. This tube has a special type of control element which reduces the crystal current and contributes toward very per-

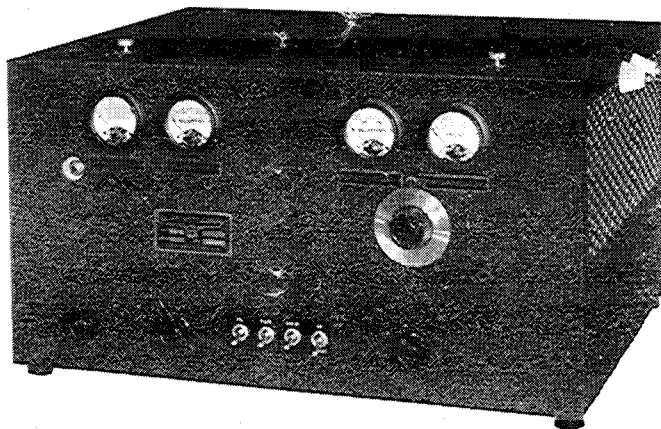
● **45A Continued**

sistent and stable oscillation. The C-100 oscillator may be keyed during telegraph operation so that full break-in reception is possible. Difficulties with erratic starting of oscillation, common with other types of tubes, are avoided. The succeeding r-f stages use a 46, an RK-23, a C-830B and a C-211D in the order named. The 46 is a frequency doubler and is automatically connected in the circuit only when required to reach the higher frequencies. The RK-23 pentode is operated as a straight buffer on all frequencies. This tube and its associated circuits are carefully shielded so that the oscillator is completely isolated from the output section of the transmitter on all frequencies. The power level at the output of the RK-23 buffer is approximately 12 watts, and the final amplifier is excited directly from this stage on the lower frequencies. The C-830B is a special power doubler tube which is automatically connected in the circuit following the RK-23 on the higher frequency bands. This tube is designed to give high efficiency as a doubler, and when it is used it delivers 15 to 18 watts of r-f excitation power to the final amplifier. Thus, while it has been usual for the excitation power to fall off on the higher frequencies

where it is most needed, in the 45A the available excitation actually increases with frequency. The final stage uses the C-211D, which is a tube especially designed for use as a high frequency class C amplifier, or as a control grid modulated amplifier. The C-211D is characterized by a 150 watt dissipation graphite anode, low interelectrode capacity, high filament emission and a plate connection on top of the envelope. The C-211D is similar to the 211 only in that it has the same base, mu and Rp. The operating conditions of this tube in the 45A transmitter are established according to the criteria for high efficiency and high output set up by W. L. Everitt.*

A new Collins' development, low-loss inductive neutralization, is employed in the 45A transmitter. It has been well

known that the usual neutralizing windings and neutralizing condensers associated with triode amplifiers introduce circuit losses which reduce the over-all efficiency of a transmitter. The new inductive neutralization eliminates the additional circuit elements necessary with ordinary types of neutralization and allows a triode amplifier to be operated with the same circuit efficiency and convenience as a shield grid amplifier. At the same time, the disadvantages of shield grid tubes, such as high tube cost and low tube efficiency, are avoided. Inductive neutralization can be considered as a very significant contribution to the transmitter art, and will probably find extensive use in other Collins models in the future.



The improved system of control grid modulation as developed by the Collins Radio Company has been applied to the 45A transmitter.* Serious consideration was given to other types of efficiency modulation, such as suppressor modulation, before control grid modulation was finally adopted. The only advantage which suppressor modulation would have, as applied to the 45A transmitter, would be the elimination of neutralization circuits and, of course, the new inductive neutralization system gains the same advantage for the C-211D triode. Control grid modulation with the C-211D in actual comparative tests showed superiority over suppressor modulation from the standpoint of higher plate efficiency, higher power output, lower total power consumption, lower harmonic distortion,

increased modulation capability, and greater uniformity of adjustment.

In addition to a full complement of instruments, the 45A is equipped with a modulation indicator calibrated both in per cent modulation and in decibels. This instrument gives a constant indication of the average level of modulation during transmission. The meter is not connected in the speech input circuit after the manner of ordinary level indicators, but is arranged to show the actual audio frequency variation in the r-f output. Therefore, if for any reason the transmitter is not adjusted so that full output and full modulation can be obtained, the modulation indicator will indicate only the actual degree of modulation, and a constant check of the modulation capability is possible. Another instrument on the transmitter gives an instant indication whenever any modulation peak exceeds 100 per cent, so that the equipment can be operated at all times in accordance with the new regulations of the Federal Communications Commission.

The speech amplifier in the 45A transmitter is of new design, with the new high fidelity Collins transformers. These transformers have a new coil and core structure, which not only eliminates inductive pickup from external magnetic fields but also provides an extended frequency range. This type of transformer was developed for use in low-level broadcast studio circuits, and although the construction is considerably more expensive than that of ordinary transformers, its use was felt to be justified in the 45A since reduction of noise and increase in fidelity are always helpful in increasing intelligibility under adverse conditions. Also, the operator of an amateur station always gets considerable satisfaction from knowing that his voice is being reproduced at the receiving station in a clear and lifelike manner. The speech amplifier has two stages employing 57 tubes connected as triodes and a 2A3 as an output stage. The latest diaphragm type crystal microphone is used with the 45A, the jack for the shielded microphone plug being conveniently located on the transmitter panel. A gain control knob is also on the

*W. L. Everitt—"Optimum Operating Condition for Class C Amplifiers," Proc. I.R.E., Vol. 22, No. 2, Feb., 1934, pp. 152-176.

*Control Grid Modulation; Wirkler & Collins, QST March, 1935.

● 45A Continued

panel, so that the system can be readily adjusted for proper modulation.

Two separate power supplies furnish the necessary d-c voltages to the various tubes in the 45A. The low voltage power supply delivers 300 ma. at 350 volts to the speech amplifier and excitation tubes, and provides the telegraph and telephone bias voltages for the final amplifier. The high voltage power supply delivers a maximum current of 250 ma. at 1250 volts to the output tube. A separate transformer heats the filaments of the 866's, the C-830B and the C-211D so that these tubes may be turned on before the high voltage is applied. A time delay relay is not ordinarily furnished with the transmitter, because it was felt that most users would prefer to exercise the necessary caution with respect to heating the filaments before applying the high voltage, rather than pay the additional price necessary for a reliable time delay relay. Space is available for mounting such a relay on special order. Great care has been taken in designing the power supply circuits to assure reliable operation. The temperature rise of the transformers is held well within the standards adopted by the Underwriters Laboratory. The filter condensers are of an improved oil impregnated type, with a voltage rating approximately twice the normal voltages. All of the resistors are operated at approximately 50% of their rated dissipation. Wire wound resistors are of the vitreous enamel rather than the cement coated type because of their superior performance in tropical climates. Both the high and low voltage filter circuits have constants considerably larger than ordinarily employed in transmitters of this type and, as a result, the carrier is extremely quiet.

The Collins multi-band antenna was developed for use with the 45A transmitter in order that a single radiating system can be erected which will be effective over as wide a range of operating frequencies as the transmitter itself. The output system in the transmitter consists of an adjustable r-f transformer built as an integral part of the output coil for each frequency. The secondary of this r-f transformer is adjusted for the proper loading on each frequency, and these adjustments are not disturbed when changing from one band to an-

other. The output line current is read on an instrument on the panel. While the multi-band antenna will ordinarily give the best results with the 45A transmitter, other types of antennas having small reactance at the transmitter terminals may be used if desired.

**45A TRANSMITTER
CONDENSED SPECIFICATIONS**

POWER OUTPUT: 40 watts telephone —125 watts telegraph.

FREQUENCY RANGE: 1500 kc. to 30,000 kc. Unless otherwise specified, quotations include frequency units for one band only.

RADIO FREQUENCY TUBES: 1—C-100 oscillator, 1—46 first amplifier, 1—RK-23 second amplifier, 1—C-830B third amplifier, and 1—C-211D output amplifier.

AUDIO FREQUENCY AMPLIFIER: 1—57 input (triode connection), 1—57 interstage (triode connection) and 1—2A3 power amplifier. The gain of the amplifier is 60 db. The input transmission level is minus 35 db, designed for a crystal microphone. The frequency response is essentially uniform from 40 to 10,000 cycles within plus or minus 1.5 db.

MODULATION: Control grid. Modulation capability, 100%.

AMPLITUDE DISTORTION: 10% maximum at 90% modulation.

POWER SUPPLY: The supply voltage is 110-115 v. 60 cycle a-c. The supply line current is 6.5 amperes for telegraph and 4.9 amperes for telephone operation at a power factor of 87%. Two power supply units are included. The low voltage supply employs 2 83V and a separate 2 section filter. The high voltage supply uses 2—866 mercury vapor rectifiers with a two section choke-input filter network. Heating elements may be supplied at extra cost for the envelopes of the 866's to permit operation of the transmitter at zero temperatures.

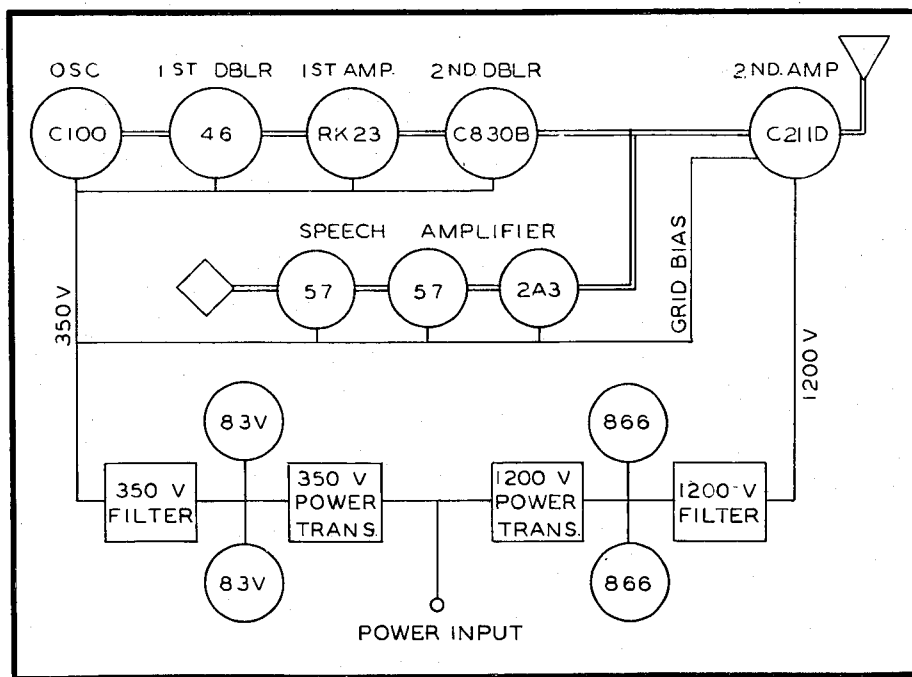
NOISE LEVEL: Approximately 55 db below output level.

DIMENSIONS: 21½" wide, 18" deep and 12" high.

WEIGHT: 130 pounds.

CABINET: Steel. Black crinkle finish outside. Satin aluminum finish inside. Sides and back are perforated to permit adequate circulation of air.

CONSTRUCTIONAL DETAILS: Transformers are oversize, as are also condensers, chokes and resistors. An unusually high degree of mechanical refinement has been accomplished in the construction of the transmitter, making the unit very compact as well as efficient electrically.



BLOCK DIAGRAM OF THE 45A TRANSMITTER

The

202-A TRANSMITTER

PRECISE design methods applied to class B and class C amplifiers have made it possible to build a relatively high powered radiophone transmitter using tubes of only moderate plate dissipation. The new criteria indicate the value of high filament emission and of insulation for high plate voltages, and the improved efficiency eliminates the need for large heat dissipating capability. Several types of tubes meeting these requirements are now available, and the Collins Radio Company has developed the 202A Transmitter to exploit their possibilities.

The power rating of the 202A transmitter may be stated most generally by saying that it is designed to operate with a final amplifier plate input of one kilowatt with complete high level modulation. This one kilowatt input rating is determined by the ratings of the power supply and modulation system. The minimum plate circuit efficiency is 65 per cent at 15 mc. and the efficiency rises to approximately 80 per cent on the lower frequencies so that the r-f output varies between 650 and 800 watts. U. S. amateur regulations specify a maximum plate input of one kilowatt without regard to plate efficiency so that the 202A is adapted to full power amateur operation. Arrangement is also made to reduce the plate input to 666 or 833 watts when the transmitter is used for commercial service under a 400 or 500 watt license based on the indirect method of output rating. An understanding of the 202A's design can best be obtained by immediate reference to its constructional details.

Filament transformers and sockets in the 202A are interchangeable so that two or three groups of r-f tubes may be used. One arrangement consists of a C100 oscillator, an RK25 first amplifier, an RK20 second amplifier and two C200 class C final amplifiers. In this case the audio drivers are four 2A3's and the class B modulators are two C200's. An alternative combination substitutes 150T's in the class C and class B stages. The 150T's are similar in characteristics to the C200's except that the filament voltage is 5 instead of 10, and the anode

material is tantalum instead of graphite.

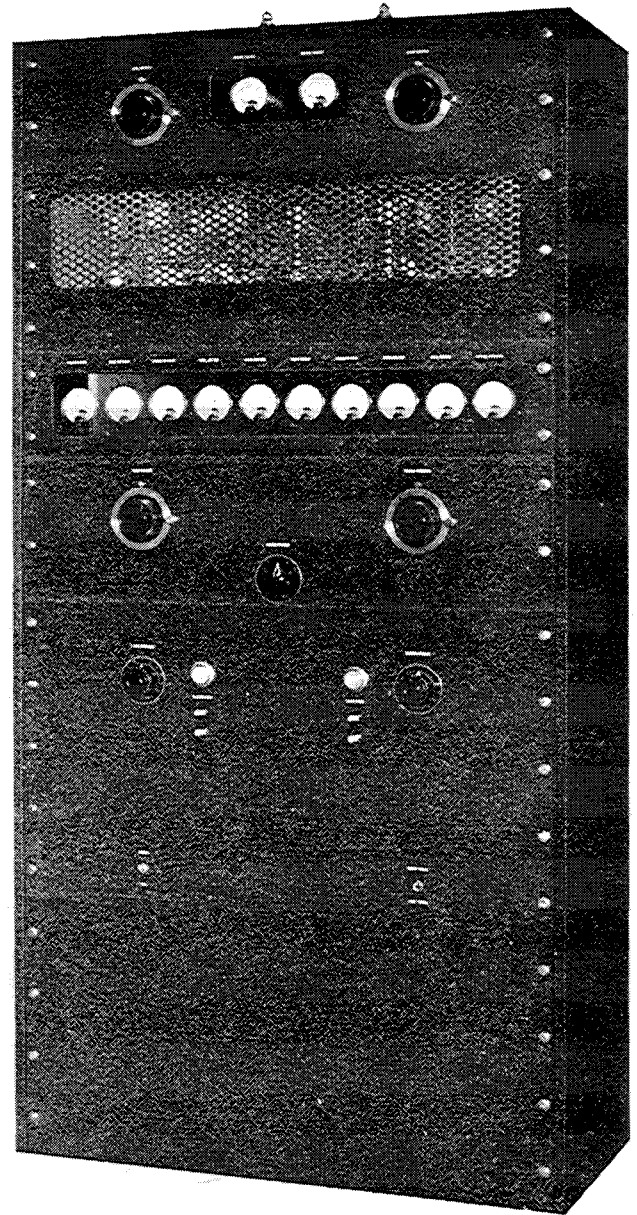
The high voltage power supply has two 872 mercury vapor rectifiers connected with transformer and filter components to deliver 1.0 ampere at 2500 volts. The three low voltage rectifier-filter systems each use a 5Z3 high vacuum rectifier to furnish plate voltage to the oscillator, first amplifier and the audio drivers and to furnish bias voltage to the class B and class C stages.

The apparatus is arranged in the most compact manner consistent with good electrical placement. The plate and modulation transformers are located on the bottom deck with the 872 rectifiers and the filament transformers. The second section carries the high voltage filter reactors, capacitors and the relay control equipment. The third deck mounts the oscillator, first amplifier stage of the r-f channel and the audio drivers with the associated power supplies. Suitable shielding prevents interaction between r-f, a-f and power circuits. The fourth or upper deck accommodates the class B modulators, the second r-f amplifier and the final r-f amplifier. The deck type of construction was adopted in the interests of neatness and accessibility. Each deck except the lower one may be pulled out on its side rails for inspection by loosening the ceramic insulated terminals on its rear edge. The cabling between decks is carried in the sides of the cabinet where it is made accessible by removing the side covers.

Maintenance of the very high plate efficiency of which the 202A is capable

requires each stage to be operated at exact conditions of supply voltage and current. A complete check on these relations is possible by means of the ten instruments mounted on a glass-protected instrument panel which is located at a convenient height for observation from the operator's desk, as well as from a standing position, when one is tuning the transmitter. The line current instruments are on a separate, protected panel near the top of the cabinet.

Devices to afford safeguards for the operator, and to protect the apparatus, have been given very careful study in connection with the 202A. The four rear doors are fitted with interlocks which



FRONT VIEW

The 202-A TRANSMITTER

PRECISE design methods applied to class B and class C amplifiers have made it possible to build a relatively high powered radiophone transmitter using tubes of only moderate plate dissipation. The new criteria indicate the value of high filament emission and of insulation for high plate voltages, and the improved efficiency eliminates the need for large heat dissipating capability. Several types of tubes meeting these requirements are now available, and the Collins Radio Company has developed the 202A Transmitter to exploit their possibilities.

The power rating of the 202A transmitter may be stated most generally by saying that it is designed to operate with a final amplifier plate input of one kilowatt with complete high level modulation. This one kilowatt input rating is determined by the ratings of the power supply and modulation system. The minimum plate circuit efficiency is 65 per cent at 15 mc. and the efficiency rises to approximately 80 per cent on the lower frequencies so that the r-f output varies between 650 and 800 watts. U. S. amateur regulations specify a maximum plate input of one kilowatt without regard to plate efficiency so that the 202A is adapted to full power amateur operation. Arrangement is also made to reduce the plate input to 666 or 833 watts when the transmitter is used for commercial service under a 400 or 500 watt license based on the indirect method of output rating. An understanding of the 202A's design can best be obtained by immediate reference to its constructional details.

Filament transformers and sockets in the 202A are interchangeable so that two or three groups of r-f tubes may be used. One arrangement consists of a C100 oscillator, an RK25 first amplifier, an RK20 second amplifier and two C200 class C final amplifiers. In this case the audio drivers are four 2A3's and the class B modulators are two C200's. An alternative combination substitutes 150T's in the class C and class B stages. The 150T's are similar in characteristics to the C200's except that the filament voltage is 5 instead of 10, and the anode

material is tantalum instead of graphite.

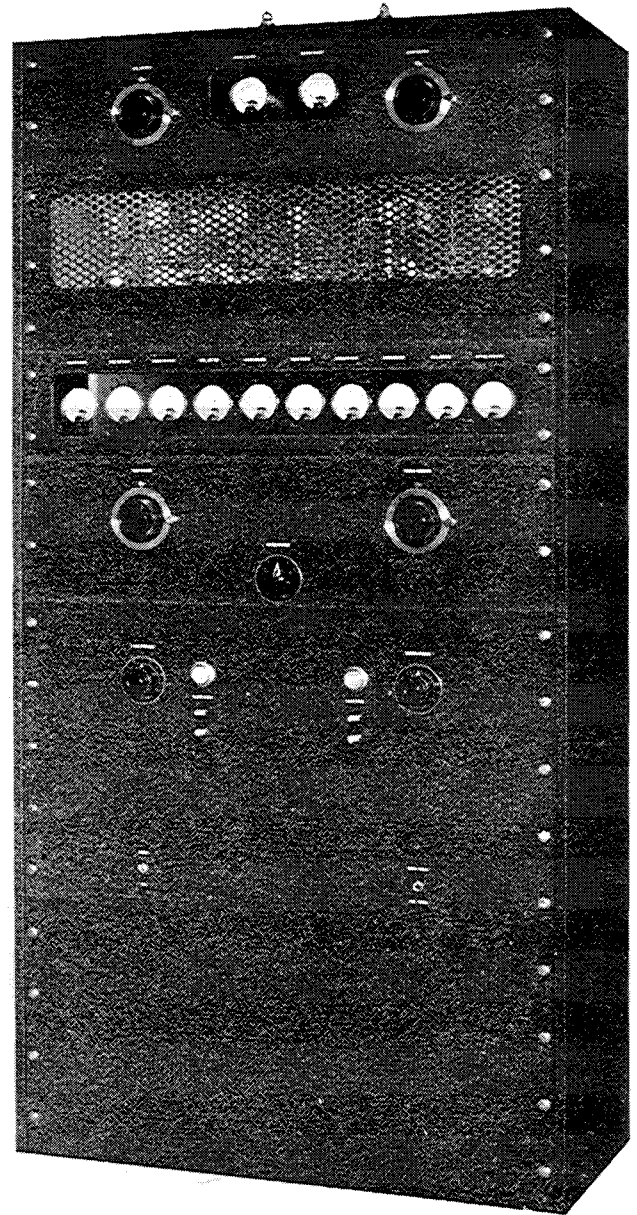
The high voltage power supply has two 872 mercury vapor rectifiers connected with transformer and filter components to deliver 1.0 ampere at 2500 volts. The three low voltage rectifier-filter systems each use a 5Z3 high vacuum rectifier to furnish plate voltage to the oscillator, first amplifier and the audio drivers and to furnish bias voltage to the class B and class C stages.

The apparatus is arranged in the most compact manner consistent with good electrical placement. The plate and modulation transformers are located on the bottom deck with the 872 rectifiers and the filament transformers. The second section carries the high voltage filter reactors, capacitors and the relay control equipment. The third deck mounts the oscillator, first amplifier stage of the r-f channel and the audio drivers with the associated power supplies. Suitable shielding prevents interaction between r-f, a-f and power circuits. The fourth or upper deck accommodates the class B modulators, the second r-f amplifier and the final r-f amplifier. The deck type of construction was adopted in the interests of neatness and accessibility. Each deck except the lower one may be pulled out on its side rails for inspection by loosening the ceramic insulated terminals on its rear edge. The cabling between decks is carried in the sides of the cabinet where it is made accessible by removing the side covers.

Maintenance of the very high plate efficiency of which the 202A is capable

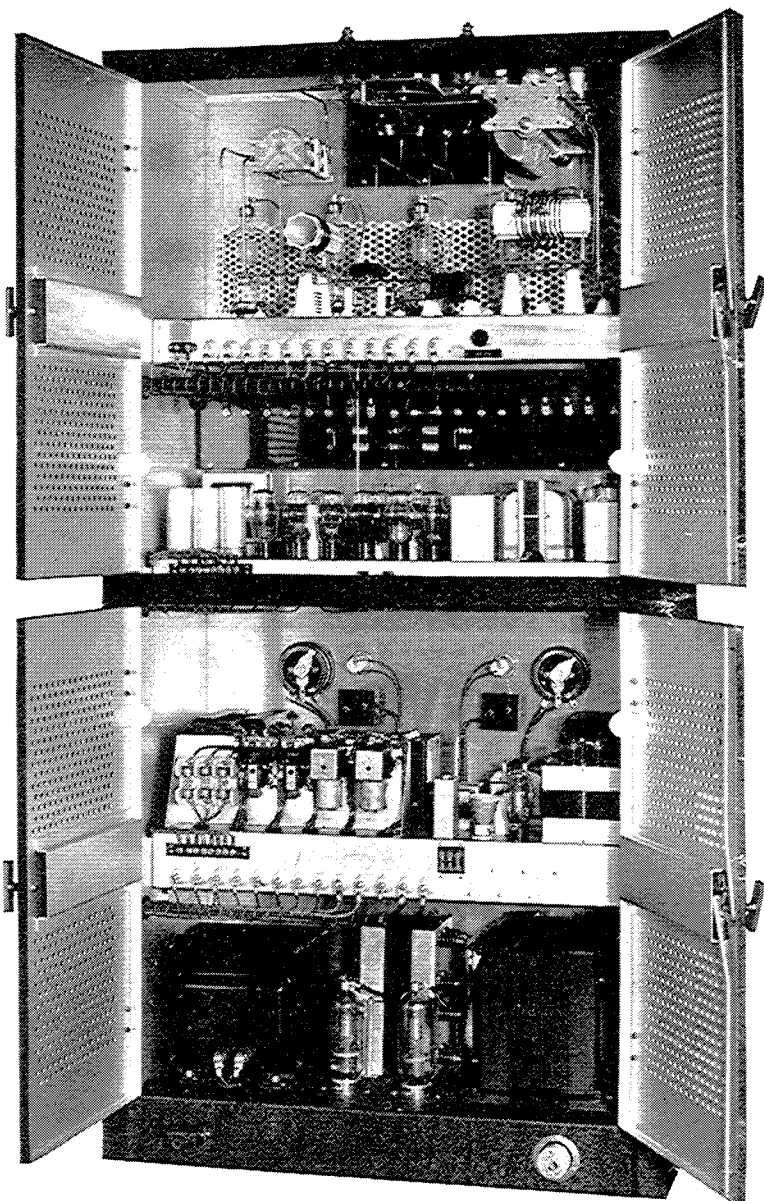
requires each stage to be operated at exact conditions of supply voltage and current. A complete check on these relations is possible by means of the ten instruments mounted on a glass-protected instrument panel which is located at a convenient height for observation from the operator's desk, as well as from a standing position, when one is tuning the transmitter. The line current instruments are on a separate, protected panel near the top of the cabinet.

Devices to afford safeguards for the operator, and to protect the apparatus, have been given very careful study in connection with the 202A. The four rear doors are fitted with interlocks which



FRONT VIEW

● **202-A Transmitter**



REAR VIEW

automatically remove dangerous voltages when the doors are opened. The panel is entirely dead-front. Since the final amplifier tubes operate at high efficiencies and are supplied with power from a small regulation filter system, they would burn up quickly if the efficiency were reduced to zero by detuning the output circuits or by failure of bias voltage. This difficulty is overcome by the use of sensitive overcurrent relays in the plate circuit, which trip if the normal plate current is exceeded, and by under-voltage relays in the bias circuits. Fur-

ther protection during tuning is afforded by a low power switch on the panel which cuts in a current-limiting resistor in the plate circuit while the operator adjusts the tank circuits to resonance. In addition to these devices a fuse block is inserted in the primary supply circuit, and additional fuses protect each of the smaller power transformers.

Power to the 202A is controlled by push-buttons on the panel which energize contactors in the high and low voltage circuits. After the transmitter has been adjusted to the desired frequency, control may be transferred to the operator's position where a push-to-talk key may be used to place the carrier on the air. Several arrangements for shifting from telephone to telegraph, either manually or by relays, can be supplied on special order.

The first four 202A transmitters manufactured have been supplied to amateurs. Mr. George C. Cannon, owner of station W2BSD, completed the first installation, and during the first week of operation established radiophone contacts with England, France, Norway, Costa Rica, Cuba, Dominica Republic, Brazil, Ireland, Scotland, and Mexico. In

all cases a very strong, clear signal was reported, even under adverse conditions, indicating that a transmitter of this size is suitable for long distance amateur communication. The 202A will appeal to many other amateurs, but possibly its most extensive applications will be for government communication work and for short wave broadcasting. At present two 202A's are being installed by the State of Iowa Police Network for state-wide coverage, a type of service for which the 202A is well adapted.

202A SPECIFICATIONS

POWER OUTPUT:

650 to 800 watts telegraph and telephone. Rating for commercial service, 500 w.

FREQUENCY RANGE:

1.5 mc. to 15 mc., at reduced power to 30 mc.

AUDIO RESPONSE:

Uniform from 60 to 8000 c.p.s within plus or minus 2 db. Distortion less than 8 per cent at 95 per cent modulation.

CARRIER NOISE:

50 decibels below average modulation level.

DIMENSIONS:

72 in. high, 34 in. wide, 14 in. deep.

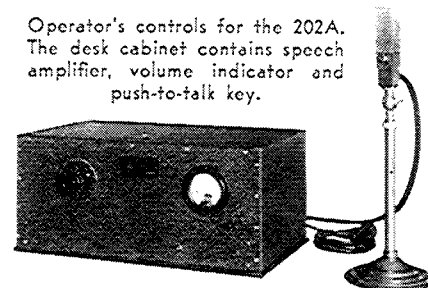
NET WEIGHT:

913 pounds.

POWER REQUIREMENT:

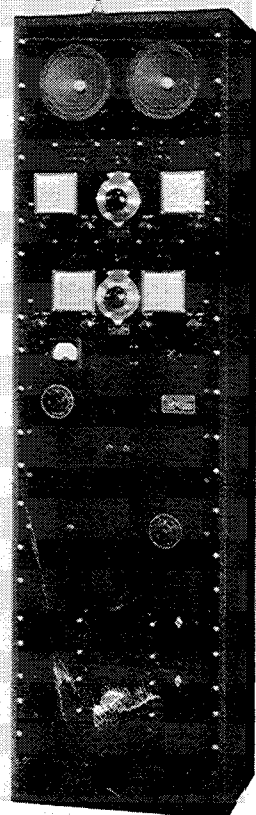
3.8 kva. maximum at 110/220 v. 60 cycle, single phase.

Operator's controls for the 202A. The desk cabinet contains speech amplifier, volume indicator and push-to-talk key.



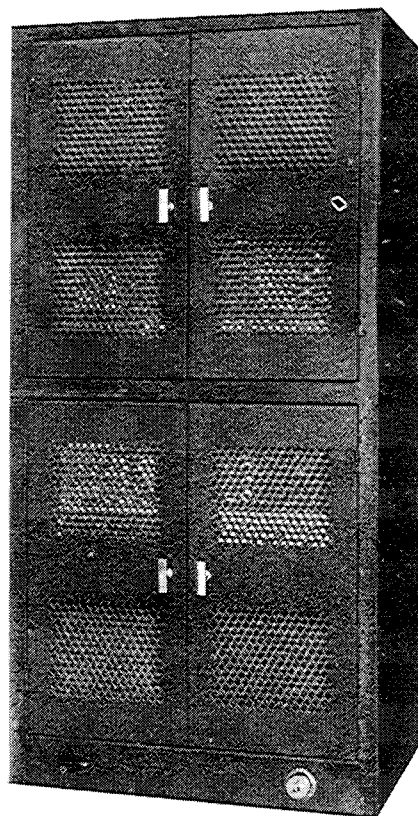
● **202-A Transmitter**

The Iowa State Police transmitter installations are of particular interest as an example of the most modern type of police radio equipment. The 202A Transmitters are arranged to work at a power of either 400 or 500 watts in connection with vertical radiators on 1682 kc. Tower matching units are located at the base of the radiators and energy is carried from the transmitter to the matching



broadcast. When the operator's key is closed the receivers are disconnected and the transmitter is fully modulated with a 500 cycle tone for a period of five seconds. When the tone modulation ceases the speech circuit is automatically connected and a pilot light indicates to the operator that the broadcast may be started. Electronic timing is used to control the duration of the warning signal and an adjustment is provided so that the duration may be varied between one-half second and thirty seconds. The frequency of the warning tone may also be set at any value between 250 and 2500 cycles so that each station may be given a distinguishing note if desired.

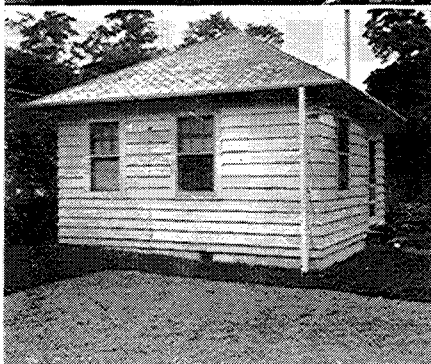
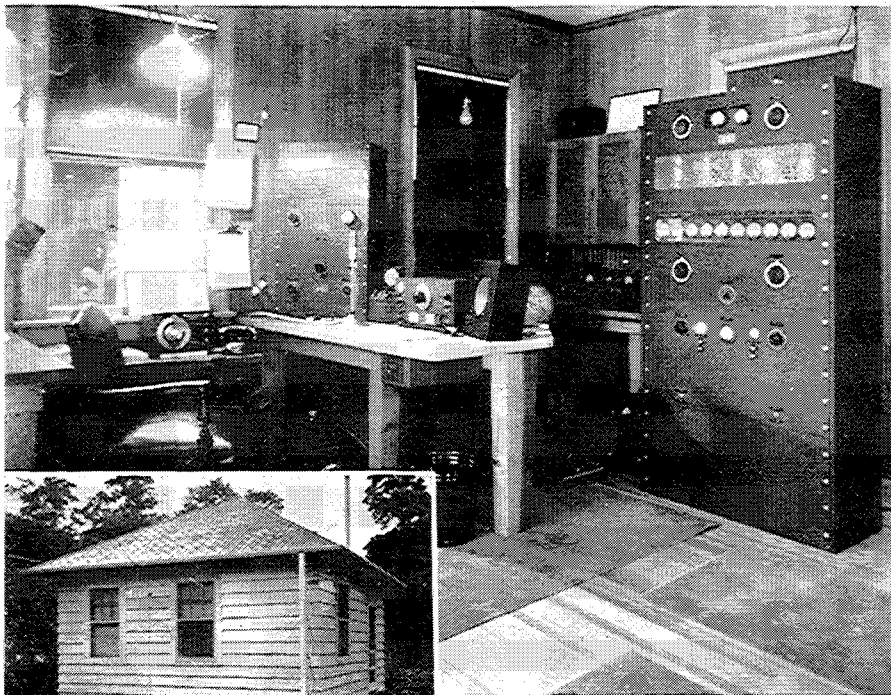
The two receivers on the control bay are normally adjusted to receive broadcasts from other stations in the State network and from police transmitters in certain cities throughout the state. At the present time Collins 150C transmitters are in service at police headquarters in Cedar Rapids and Davenport. It is contemplated that other cities in the state will make installations in the future and co-ordinate their activities with the state law enforcement system by radio.



REAR VIEW—Closed

unit through a new type of concentric transmission line. The convenience with which this transmission line can be installed permits the radiating system to be located in the most desirable position and permits the transmitting equipment to be installed in existing office space assigned for this purpose.

A control bay of the type illustrated above is installed with each transmitter. In addition to the 7C speech amplifier the control bay contains a type 8C Signal Frequency Oscillator, modulation indicators, control keys and two communication-type Superheterodyne receivers with their associated power supplies and speakers. The signal frequency oscillator is arranged to transmit a warning tone automatically before each



W2BSD, New Rochelle, New York. The first radiophone station of Mr. Cannon, the owner, was built in 1916 and was operated at that time by Cannon and DeForest to broadcast the first scheduled programs in this country.