

THE *New* PORTABLE TAPE RECORDER

. . . with studio performance

By

W. E. STEWART

Audio Engineering Section

Engineering Products Department

General Description

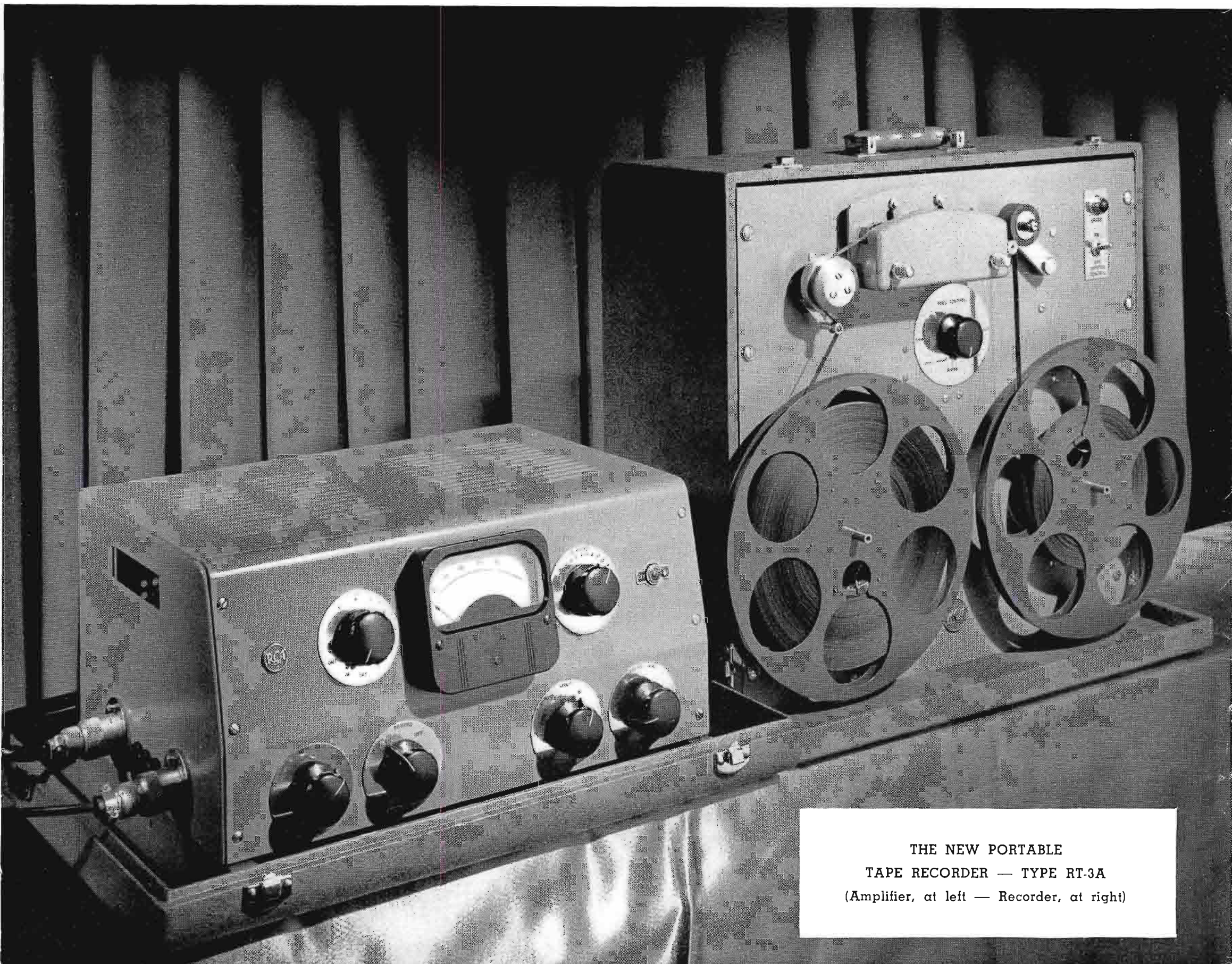
The new RT-3A portable magnetic tape recorder is designed to fulfill the broadcasters' needs for a lightweight, low cost recorder with true studio quality. Incorporating a smooth, two-speed, synchronous motor drive, the RT-3A is well suited for recording programs at remote points with

the same high fidelity that is possible in the studio. The advantages of simplicity and ease of recording, long playing, easy editing are equally desirable for all applications. The RT-3A is a complete recording system consisting of an amplifier unit and recording unit plus necessary interconnecting cables. The amplifier unit *includes a recording amplifier, playback amplifier and "erase" and bias oscillator.*

The recorder proper includes motor board, capstan drive, magnetic recording head plus all necessary controls which are front-panel mounted for easy access. Two recording speeds (15 in./sec. and 7.5

in./sec.) are provided. With the tape speed set for 15 in./sec. the reels hold sufficient tape for 33 minutes of continuous recording with 15 KC response, and by the simple flip of a switch it is possible to change the tape speed to 7.5 inches-per-second (with 7 KC response) which provides sufficient tape for over an hour of recording. The speed-control switch also automatically applies the proper compensation for both response positions.

The reel shafts are of the proper size to accommodate RMA proposed standard reels which are in use on many recorders today, as well as the regular larger reel.



THE NEW PORTABLE
TAPE RECORDER — TYPE RT-3A
(Amplifier, at left — Recorder, at right)

With this smaller "RMA" reel, there will be room for a half hour recording at 7.5 inches-per-second tape speed.

THE AMPLIFIER UNIT

Recording Amplifier

The entire RT-3A amplifier is contained in a separate carrying case which also has room for the connecting cords, reels, etc. Cannon quick-disconnect plugs and receptacles are used. The recording amplifier circuit has sufficient gain to operate directly from a microphone input. Impedances and levels are correct for matching the new BN-2A Remote Amplifier, or the OP-7 Mixer Preamplifier, if more input channels are required. Also line terminals and a pad are built in the amplifier so that recordings may be taken directly from a 600-ohm line, when desired.

An input gain control is provided at the grid of the first tube, and three stages of amplification using 1620 and 6J7 tubes are provided with feedback applied to reduce distortion. It is not possible to express amplifier operation strictly in the usual terms of gain, since the input is normally measured in volts and the output in current supplied to the recorder head. Using a constant voltage input to the amplifier, the output current to the recorder head follows the characteristics shown in Fig. 4. The motor-selector switch changes speed and amplifier recording characteristic simultaneously, so that it is not necessary for the operator to give any thought to the proper compensation curves.

Although there has not yet been a standard recording curve recommended by the NAB, the curves in Fig. 4 are based on extensive laboratory work and represent favorable conditions for the usual broadcast program material. Other compensation curves may be obtained by the change of a few simple R-C components.

The tube cathode currents may be observed with the VU meter furnished by simply throwing a meter switch. The VU meter can also be switched to the recording circuit for measuring recording levels.

FIG. 2 (at right). Both units (recorder and amplifier) are easily portable for use on remote recordings. Recorder is being carried in operator's right hand—amplifier in his left hand.



FIG. 3 (below). The RT-3A amplifier unit with top cover removed to illustrate accessibility of all parts and tubes. Note that only high-quality broadcast type components are used throughout.

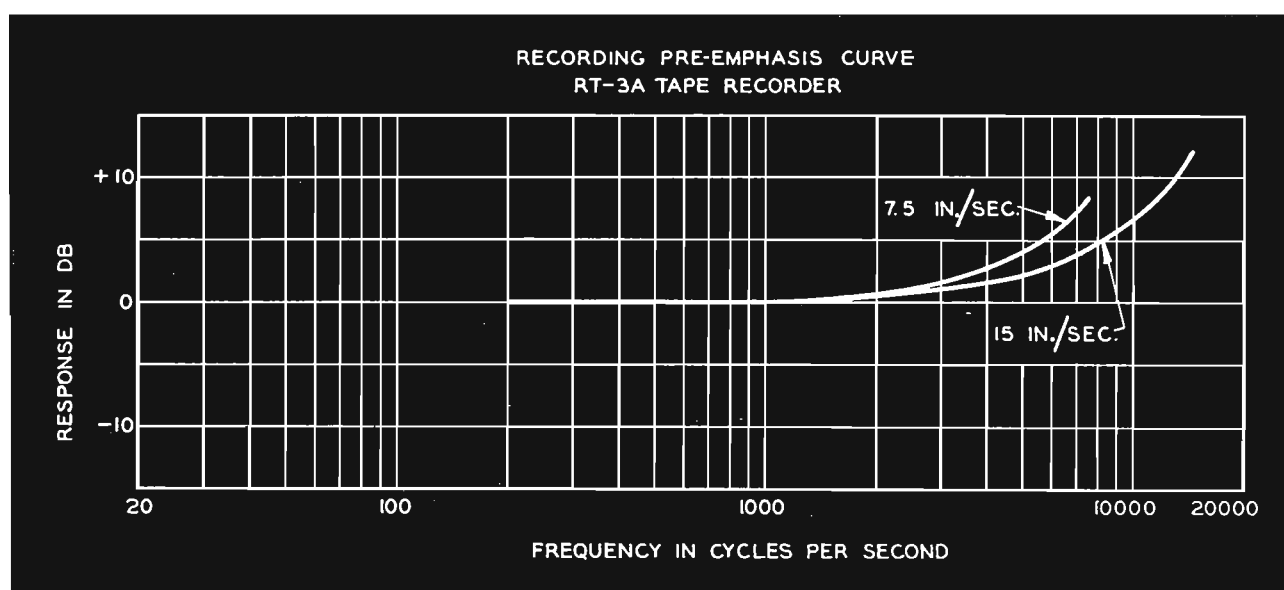


FIG. 4 (at right). Recording pre-emphasis curves for 7.5 inches per second and 15 inches per second tape speeds.

"Erase" and "Bias" Oscillator

A single oscillator circuit supplies both "erase" and "bias" voltages. The oscillator frequency is set at approximately 100 KC so that it is well above all audio frequen-

cies. "Erase" and "bias" voltages are independently adjustable and can also be checked with the VU meter.

A calibration potentiometer is provided so the bias setting may be accurately

adjusted and "zeroed" with the VU meter. The calibrated scale makes it easy to observe the exact original setting, in the event it is found desirable to make a later recheck. However, these adjustments normally remain quite stable and seldom require change. With the "Record" knob in "Off" position, the recording head and the output of the recording amplifier are short-circuited and the plate power supply is disconnected from the oscillator and recording amplifier. Thus, accidental erasing or recording is not probable. A pilot light on the recorder panel is operated by the "erase" current and gives a positive indication that the controls are in the position for recording.

Playback Amplifier

The need for "blind" recording by the operator is eliminated through the unique design of the RT-3A amplifier unit. It incorporates a separate playback and recording amplifier, thus enabling recording and simultaneous monitoring of the recorded program—which assures the operator that all equipment is functioning properly.

The playback amplifier circuit consists of three stages of amplification (type 1620 and 6J7 tubes are used). Compensation to obtain the proper response from the pickup head is provided in the feedback circuit of the first stage, and is changed automatically by the "speed-selector" switch. Like the recording characteristic, it is easily altered by a simple change of R-C components. A gain control is employed between the 1st and 2nd stages and amplification is sufficient to feed a line level of +18 dbm. The front-panel VU meter can be "switched-in" to meter the cathode currents, or measure the output level across the line. Suitable binding posts are provided for line connections and a headphone jack for monitoring.

THE RECORDER UNIT

Synchronous, Two-speed Motor

A unique mechanical arrangement using a single motor provides convenient functioning of the recorder without sacrificing compactness and portability.

Recorder design includes a hysteresis type synchronous motor with two windings so that the speed may be changed from 3600 to 1800 rpm by the speed selector knob on the amplifier front panel. It is this design feature which makes possible instant change of speed and compensation simultaneously and eliminates mechanical speed change devices.

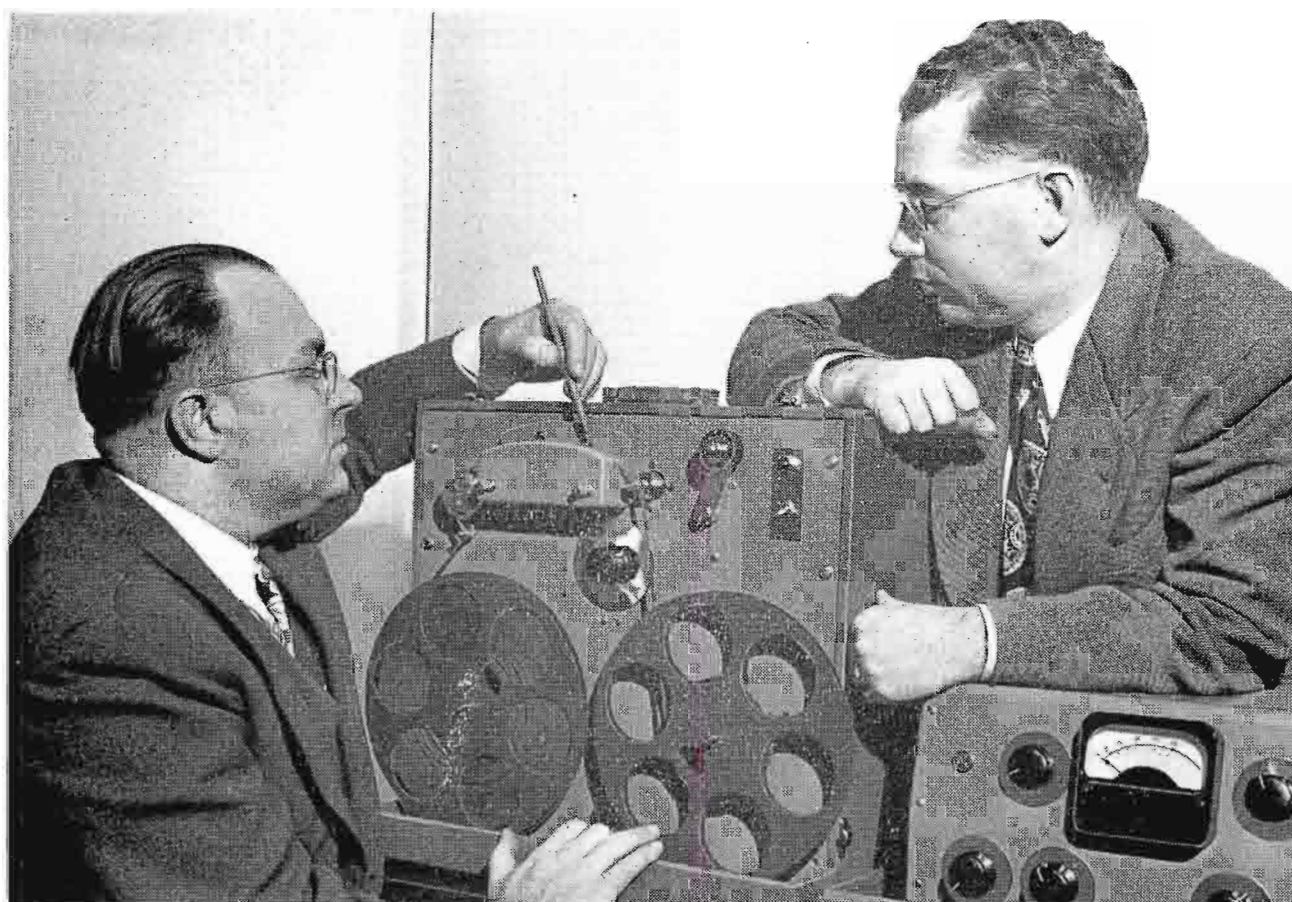


FIG. 5 (above). W. E. Stewart, RCA Broadcast Audio engineer, points out features of plug-in recorder head assembly to W. L. Babcock of Broadcast Equipment Sales.

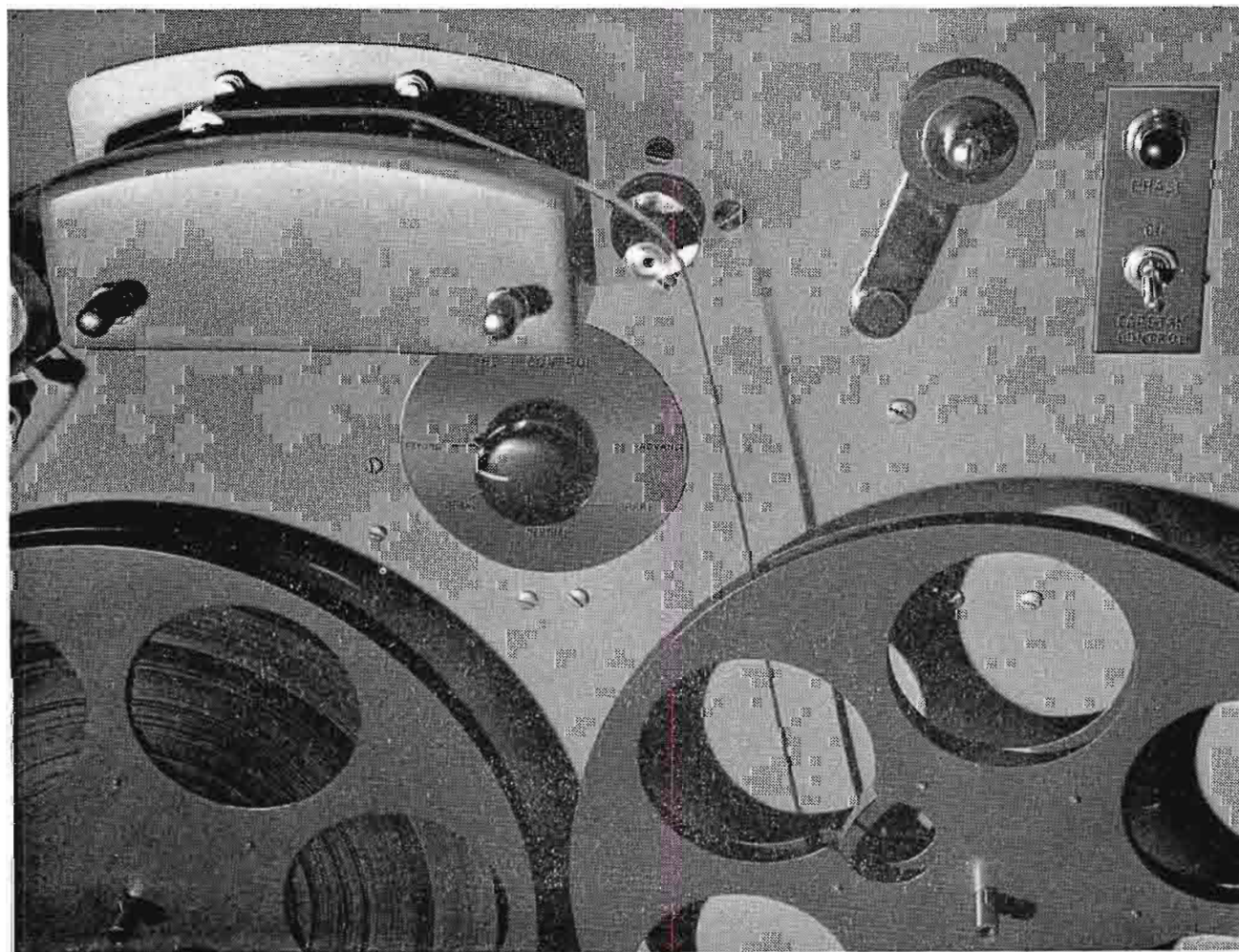


FIG. 6 (above). In this closeup view of the recorder, the stabilizer is partially visible at extreme left—with recorder head assembly adjacent, and capstan drive at right-hand end of head assembly. Note that pressure roller (in upper right of photo) is raised for a fast rewind operation.

Automatic Torque Adjustments

The motor maintains proper torque on both the "supply" and "take-up" reels through a horizontal belt and friction drum arrangement in which the drums float on the belt, and the weight of the tape on the reels applies essentially constant tension to the tape. Normal tape tension of the RT-3A is such that head wear is extremely slow and long life is realized. A knob near the center of the front panel will lift either reel off the belt and depress the opposite reel in order to provide a fast "forward" or "reverse" wind. The same adjustment knob is used to lift the pressure roller off the capstan drive during these operations. Braking positions are provided to avoid snarling the tape at the end of a fast winding operation. It is not necessary to operate the capstan control during rewind operations, since a cam switch automatically energizes the motor. In the neutral position of the rewind knob, the motor is turned "off," and the mechanism is ready for operation (at recording speeds) from the capstan control. "Rewind" of the entire reel of tape can be completed in less than three minutes.

The use of two-sided reels mounted in a vertical position avoids possibility of accidents in which tape might become tangled due to unskilled winding or accidental misalignment. It also reduces the possibility of an idle reel unwinding several turns when the tension is slack; such as might otherwise occur when a loaded reel is placed on the hub, but not yet threaded.

Stabilizer

The stabilizer is an inertia device which smooths out tape-tension variations coming from the supply reel. It is a ball bearing arrangement in which all rotating parts are held to very close tolerances in order to give the smoothest possible action, and avoid irregularities due to eccentricities. A fly wheel on the rear end of the shaft provides the necessary inertia.

Capstan Drive

Capstan drive is accomplished through another belt coupled to a heavy fly wheel on the rear of the capstan shaft. A ball bearing carries the weight of the fly wheel, while a sleeve bearing at the tape end assures smooth tape drive. Comparatively slow shaft speeds allow the capstan to be large enough to minimize the effects of eccentricity.

Quick Threading of Tape

The tape path leads from the "supply" reel on the left of the recorder unit through a stabilizer (see Figs. 6 and 7) to the recording heads, then over the capstan drive to the "takeup" reel. This arrangement makes tape threading a simple process which may be completed within a few seconds. During threading, the recorder rewind-knob is placed in the neutral position with the capstan roller up—and capstan switch "Off". After positioning the

reels, threading consists of simply placing the tape over the stabilizer, recorder head assembly, and capstan. The capstan pressure roller is then lowered on the tape, and the equipment is ready for recording.

Recorder Head Assembly

The magnetic recorder head assembly is one of the most important items in the machine, since it is the point at which erasing, recording, and reproducing take place.

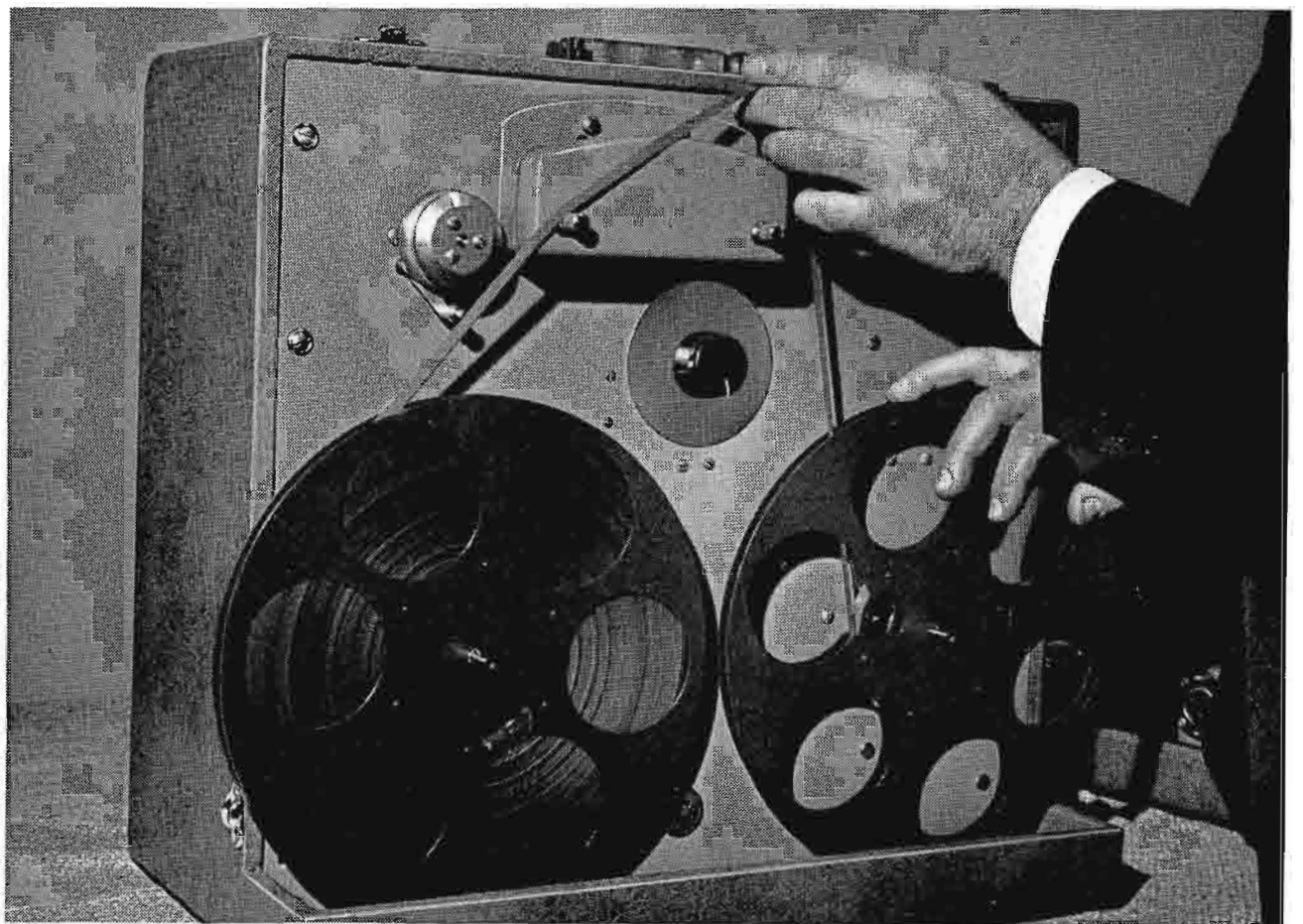


FIG. 7 (above). Threading is quickly and easily accomplished in a matter of a few seconds. Operator simply lifts tape with forefingers over the capstan, recorder heads and stabilizer in one operation.



FIG. 8 (at right). The single 3-unit plug-in head assembly is simple to remove as illustrated here. High grade, silver-plated, self-ejector type connectors insure positive contact and easy removal.

The 3-unit head assembly is a convenient, compact plug-in arrangement. Two thumb screws loosen the entire assembly and ejector springs force the contacts apart, so that no pulling or prying of the head assembly is necessary. Carefully placed positioning pads assure exact re-alignment when the assembly is replaced. Under the outer cover, which serves as a magnetic shield, are the three heads which are mechanically similar, however, they differ in important details.

The "erase" head is on the extreme left where the tape travels over it first. A 100 KC signal from the amplifier supplies this head with erasing current. An adjustment for this current is readily accessible in the amplifier and erase current

can also be checked by the VU meter on the amplifier and the pilot light on the recorder. This current adjustment is not critical, nor is the adjustment of the magnetic gap in the core, or the azimuth alignment. The "erase" head is shielded with copper to reduce external fields from the 100 KC signal. The winding is low impedance and a wide gap is used for efficient erasing.

The "record" head is in the middle of the recorder head assembly. It serves the important function of placing the program on the tape. The edge of the gap in the magnetic core must be a straight line, so that the recording is always placed properly on the tape. It is also important that the core gap be exactly at right angles to

the motion of the tape. (This is further explained in a paragraph below.) The program from the recording amplifier is applied to the recording head through a matching transformer (high frequencies are somewhat pre-emphasized, see Fig. 4). "Bias" current from the 100 KC oscillator is supplied in series with the secondary of the transformers. The VU meter on the amplifier may be used to check the bias current and the program level.

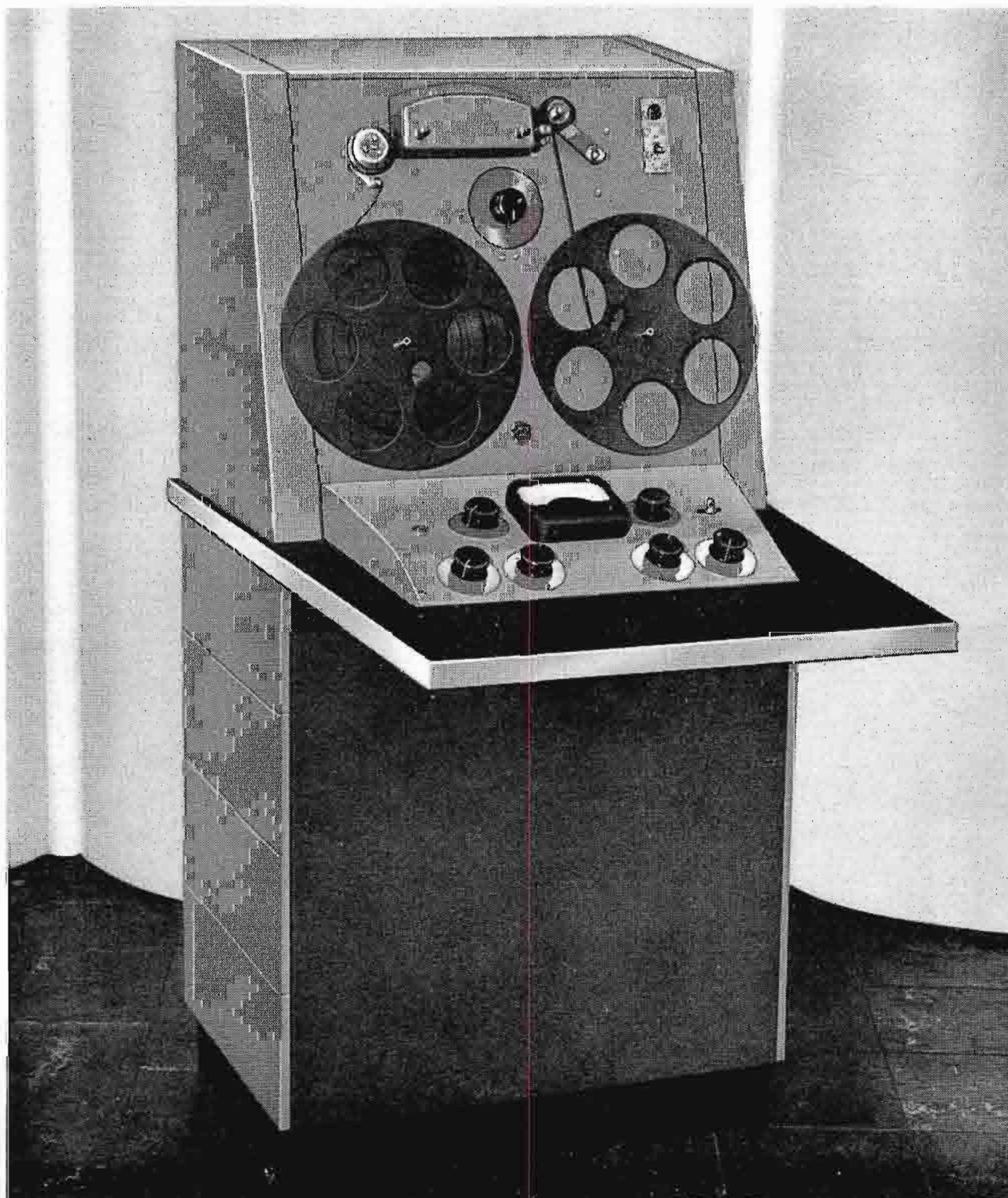
The "Reproduce" head is similar to the "record" head since each has a balanced winding and a mu-metal shield to avoid possibilities of crosstalk or stray fields. Each head has a single screw adjustment to assure alignment of the core gap exactly at right angles to the tape motion. These adjustments are under the outer cover or shield to avoid inadvertent operation during regular recording conditions. Tape is arranged to give full contact with the heads even under very light tape tension. Operation of the reel-control knob raises the tape from the heads during fast winding operations—and intermediate positions permit a gradual lowering of the tape. Thus, it moves lightly over the "reproduce" head and cueing operations are facilitated.

With a 15,000 cycle tone on a tape moving at 15 inches per second, one full wavelength of the recorded signal will be only .001 inch long. If the gap in the magnetic head, across which the signal is produced, is .001 inch wide then it would span just one wavelength of the recorded signal and no signal would be reproduced. This is the so-called "cancellation frequency," well known in sound-film, and magnetic-wire and tape recording. It is obviously necessary to use a gap shorter than this, preferably one which is less than half a wavelength (.0005 inch). This gap must be perfectly straight and smooth, and for this reason tolerances in the micro-inch region are employed in the design of the "record" and "reproduce" heads. Lapping techniques, similar to those used in optical work have been developed by RCA for application in the RT-3A magnetic heads. In addition, these parts are assembled with the same care and precision as that employed in producing microphones such as the KB-2C and the famous 44-BX.

The Recording Tape

The RT-3A tape recorder is designed to accept and use any of the standard quarter-inch magnetic tapes now on the market. The frequency-response compensation curves are adjusted for a high quality tape which is available from RCA.

FIG. 9 (below). The studio model, RT-4A recorder as it will be supplied in a desk type console. Recorder and amplifier are "built-in" with extra desk-top space provided. Below the desk top, space is available for mounting additional amplifiers.



Several points concerning good recording practice with tape are included here. Over-modulation in recording on tape should be avoided since it results in at least three undesirable effects: (1) It increases distortion, (2) It causes poor erasure so that the next program will have more noise in the background, (3) It causes the signal to "soak" through from one layer to another in storage so that a "crosstalk" effect may appear in the program with time. It has also been found that storage in warm or hot places increases the tendency of the program to "soak" through.

Where storage of program masters or recordings for indefinite long periods are involved, it may be more economical and desirable to employ standard disc recorders for this purpose. However, for simplicity and ease of recording, hi-fidelity, long playing, or ease of editing, magnetic tape holds many advantages. It is also economically desirable where the program is recorded, reproduced and the tape is then ready for another program.

Console Studio Model (RT-4A)

The RCA Tape Recorder will also be available to the broadcaster in a modified version (see RT-4A, Fig. 9) for studio use which retains all design features of the portable model. It will be suitable for installing in the control room, adjacent to the studio console or turntables.

The motor board will be similar in most details to the portable version. It will employ connector sockets on the rear identical to those used in the RCA plug-in amplifier line. The studio unit is planned so that it may be mounted in a standard 19 inch audio equipment rack, or in a special desk console provided for it.

The amplifier will also be similar to the portable version, but rearranged for plug-in or standard RCA type BR-2A shelves. It will also easily mount without any change in the special desk console, with all controls conveniently arranged just below the recorder in a nearly horizontal plane with a work shelf in front of the controls.

There will be adequate room and standard mounting brackets available in the base of the console for at least one shelf of amplifiers. It is anticipated that a limiter amplifier may be desirable for some record-

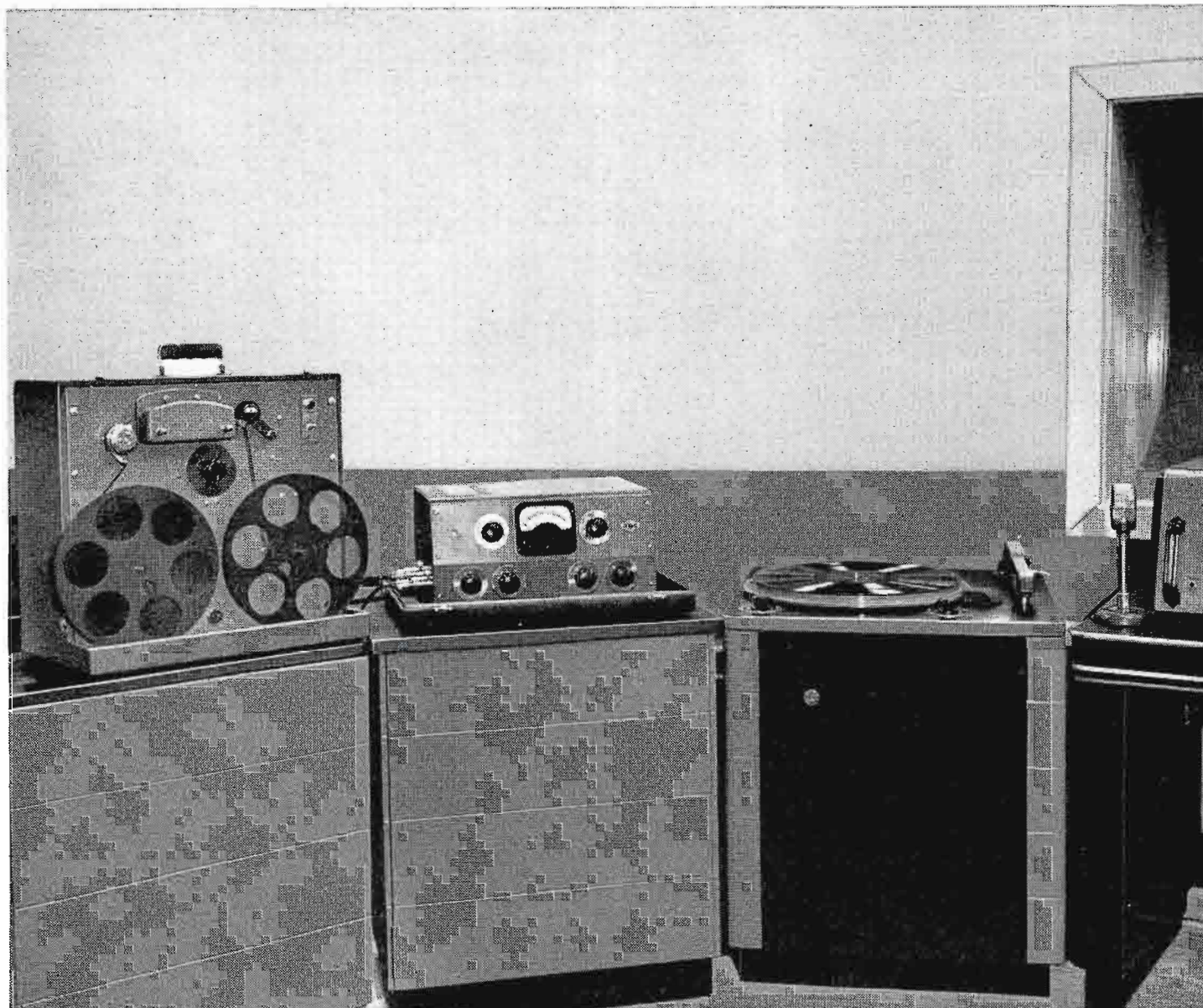


FIG. 10 (above). Typical recording setup in the control room with RT-3A recorder shown at left, amplifier center, and turntable and console at extreme right.



FIG. 11 (above). In this view, the operator at the console is "playing back" and putting the recorded program on the air. Note that amplifier controls, turntable and console may all be easily reached from the operator's position.



FIG. 12 (above). Here, a program originating in the studio is recorded in the control room with the RT-3A recorder. Note that cable lengths and connections permit use of various arrangements of the recorder and amplifier.

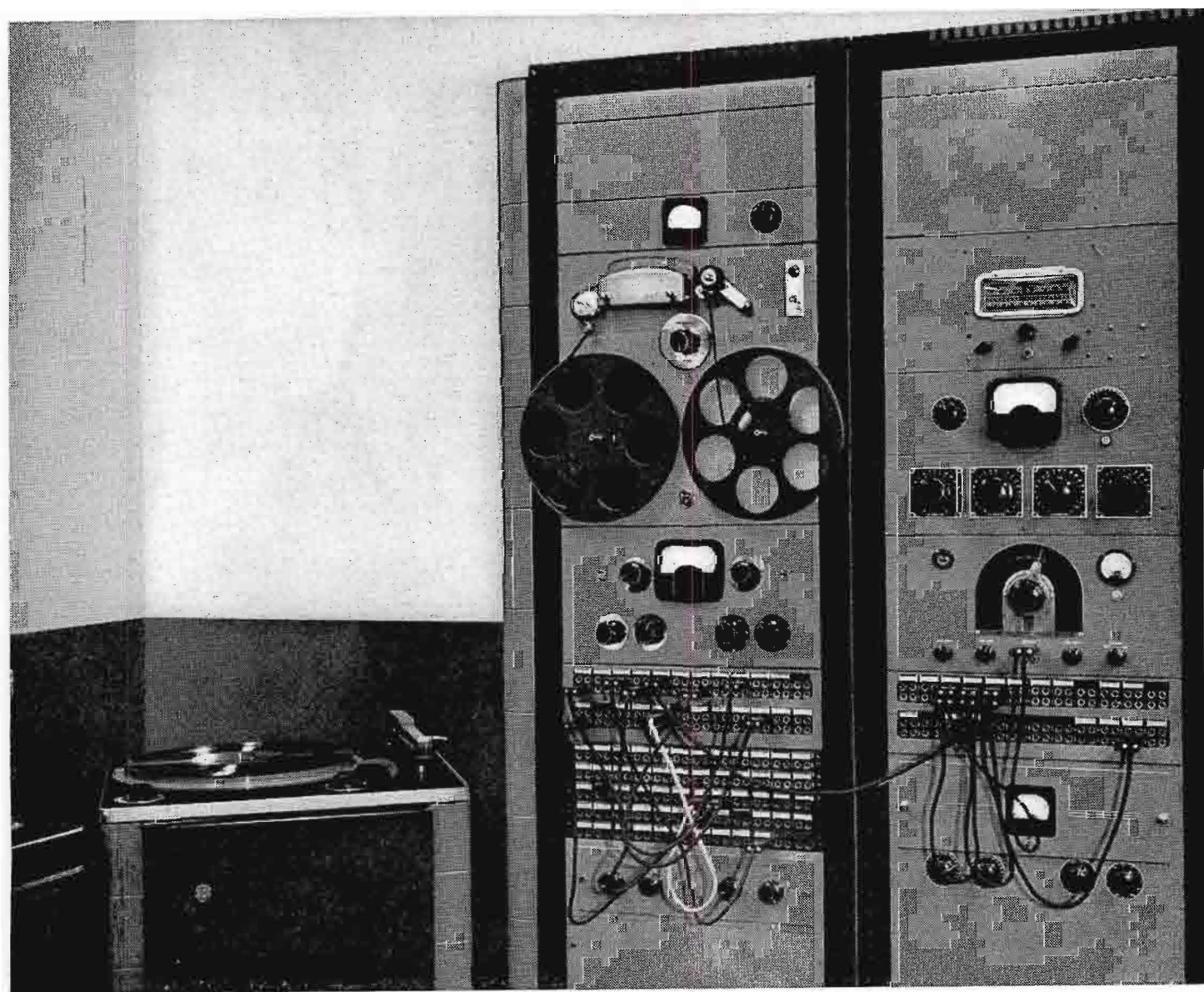


FIG. 13 (above). Closeup of typical control room setup where RT-5A is rack-mounted in a standard BR-84 series audio equipment rack. Recording is easily handled by operator at the console (a remote control switch at console starts and stops recordings).

ing applications, or a BA-4C for monitoring in other cases. This arrangement may be easily handled by a single operator from his position at the studio control desk. Remote starting and stopping may be easily incorporated.

Similar equipment in a rack equipment mounting (see RT-5A, Fig. 13) may be desirable for small or crowded studio control rooms. The tape can be loaded and cued at the rack, then started from the control desk with a remote control switch.

Tape Recorder Systems

The RT-3A recorder, as illustrated in the various photos included, is employed efficiently in the broadcaster's studio, studio control room or at remote locations, as desired. The RT-3A lends itself well (in addition to remote or regular program assignments) to system layouts where more elaborate recording jobs must be done. Fig. 14 shows a simple system that will give continuous "record" or "reproduce". In this setup two RT-3A recorders are used and either machine may be recording while the other is playing back. Only the simple addition of the switches shown would be required, since the RT-3A equipment includes necessary amplifiers, meters and headphone cueing facilities.

The diagram of Fig. 15 illustrates a slightly more elaborate setup in which two sets of switches are used. In this arrangement, the proper impedance matching should be obtained. If the input lines are terminated externally, nothing more is required, since line input positions are bridging on the RT-3A design. Either or both recorders may operate from input lines singly or simultaneously. When recording long programs, this permits the recording of some overlap. It also makes possible the duplicate recording of an important program, when desirable.

The output circuit is similarly connected and a matching pad should be used if the two recorders are to be played back simultaneously over the same line (for example, where two sound effects are mixed). A cue circuit is shown which could be used as a second outgoing line, or connected to an amplifier and loudspeaker for cueing.

An additional feature which may be incorporated in the above systems is the use

of a suitable limiting amplifier such as the RCA 86-B. This will permit a higher average level to be safely recorded on the tape, and at the same time avoid effects of overmodulation.

In addition to the above recording arrangements, there are many other possible combinations which might expand into the use of additional RT-3A recorders for the simultaneous recording of several programs. RCA engineers are ready and equipped to assist in the design and layout of special tape recording systems to meet particular requirements.

Performance

The RT-3A professional tape recorder will provide the broadcaster with an essentially flat frequency response from 50 to 15,000 cycles, when recording at a speed of 15 inches per second. (See performance curve of Fig. 16.) In addition to its excellent frequency response, the RT-3A is designed to assure a low level of noise, wow and flutter. A list of the general electrical and mechanical performance characteristics of the RT-3A recorder is given below.

Summary of Performance Characteristics

The RCA Broadcast Portable Tape Recorder, Type RT-3A, will have the following general technical characteristics *when used with the proper tape*:

INPUT: Microphone level, 150/250 ohms or bridging from 600 ohm line. Gain control on recording amplifier. VU meter to check recording level.

OUTPUT: Maximum +18 dbm at 150/600 ohms. Gain control on playback amplifier. VU meter can be used to check output level.

MONITORING: The output (playback) amplifier is entirely separate from the recording amplifier so the program on the tape may be checked by headphone while recording.

TAPE SPEED: 15 inches per second, or 7½ inches per second. Speed may be selected by a switch on the amplifier which also changes the amplifier's compensation curves.

TAPE WIDTH: ¼ inch.

PLAYING TIME: 33 minutes at 15 inches per second.

66 minutes at 7.5 inches per second.

REWIND TIME: Approximately 3 minutes in either direction.

FREQUENCY RESPONSE: 50 to 15,000 cycles at 15 inches per second in accordance with NAB.

50 to 7,000 cycles at 7.5 inches per second in accordance with NAB.

SIGNAL-TO-NOISE: Better than a 50 db ratio on the tape (below peak recording level).

45 db or better for the playback amplifier (below peak recording level).

WOW AND FLUTTER: 0.2% RMS at 15 inches per second.

0.3% RMS at 7.5 inches per second.

METERING: All tubes, erase and bias voltages, recording and output levels may be checked with the standard VU meter.

MAGNETIC HEADS: Single, plug-in assembly with erase, record, and playback heads.

MECHANICAL: The amplifier case has room for the reels and connecting cord. It is 15 inches high, 21 inches long, 10¾ inches deep and weighs 49 pounds.

Recorder case is 19⅞ inches long, 18⅜ inches high, and 11⅞ inches deep. Weight, 44 pounds.

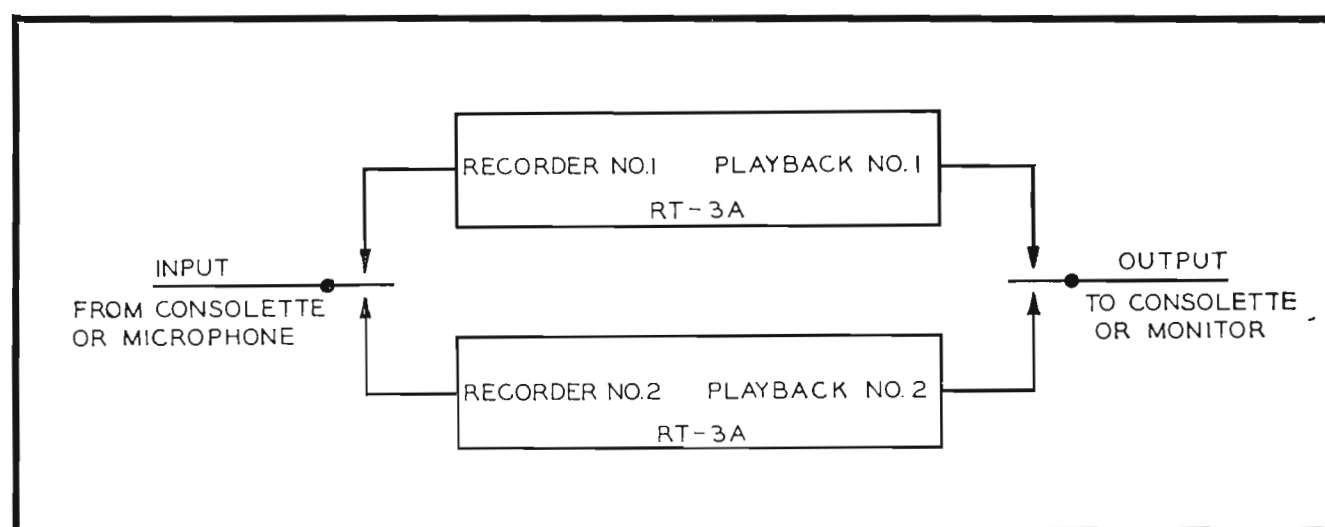


FIG. 14 (above). Systems setup for two RT-3A recorders which provide continuous "record" or "reproduce" (either machine may record while other plays back).

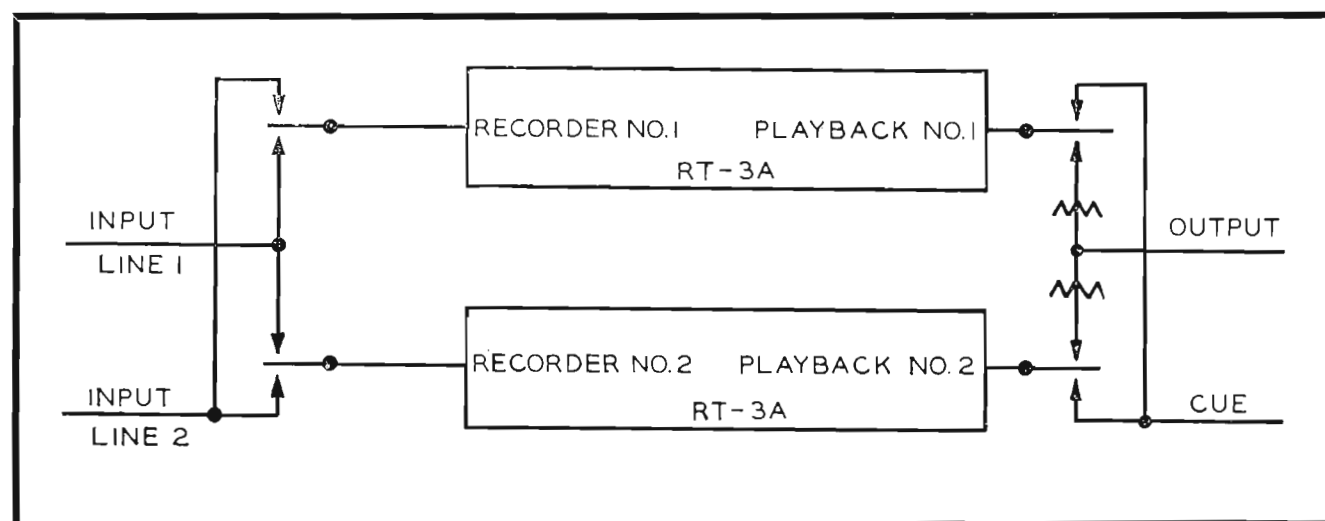


FIG. 15 (above). Setup of two RT-3A recorders with extra switches provided to permit operation from input lines singly or simultaneously, as desired.

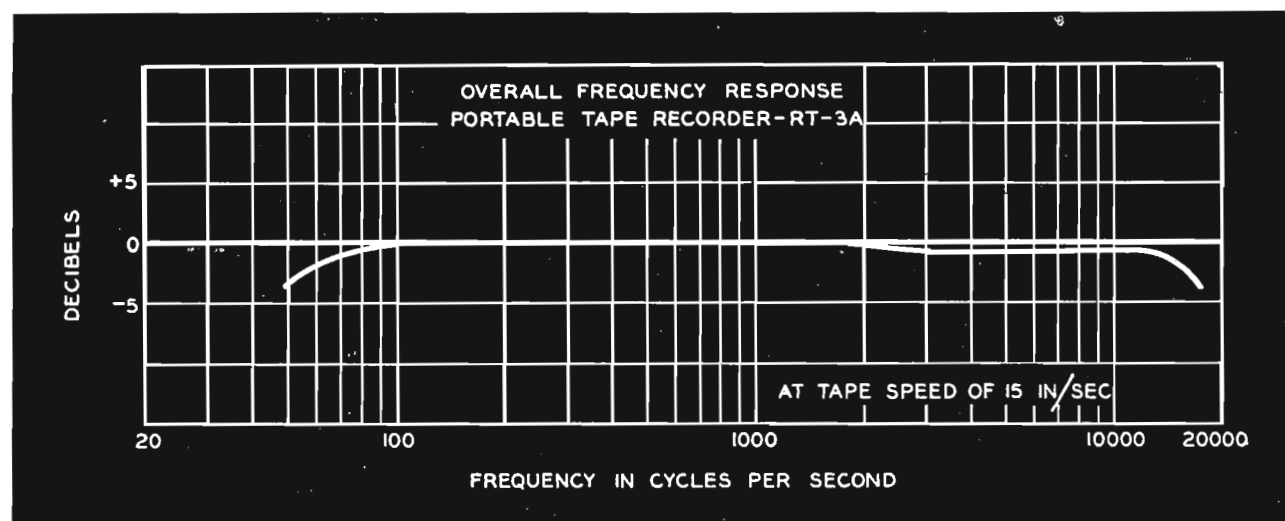


FIG. 16 (above). Frequency response of the RT-3A recorder is essentially flat from 50 to 15,000 cycles, as shown above.