Jan. 11, 1949. E. L. BAULCH 2,458,550

TRAINER FOR ENABLING THE GIVING OF RADIO INSTRUCTION

Filed Dec. 9, 1944 4 Sheets-Sheet 1

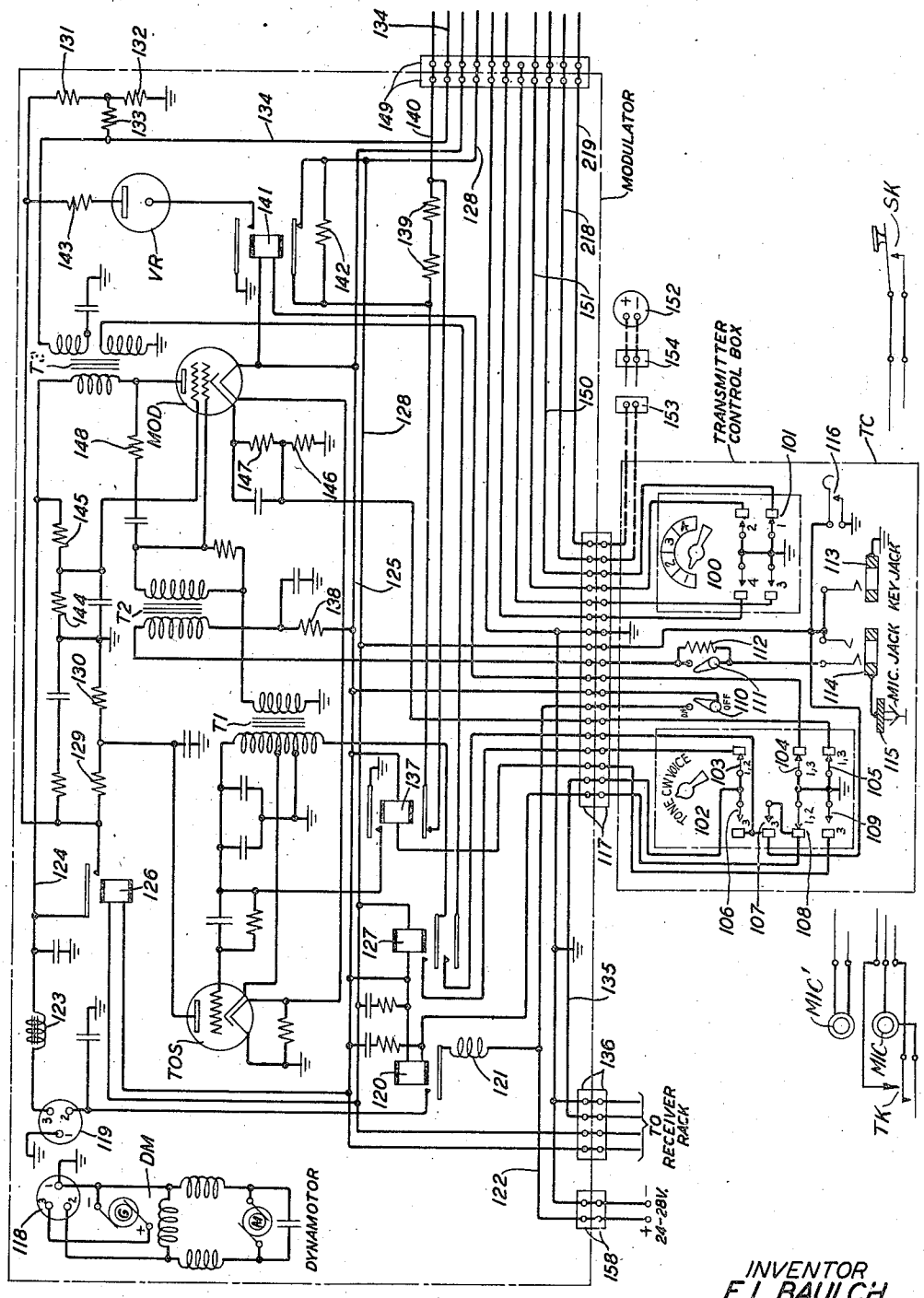

FIG. 1

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Filed Dec. 9, 1944 4 Sheets-Sheet 2

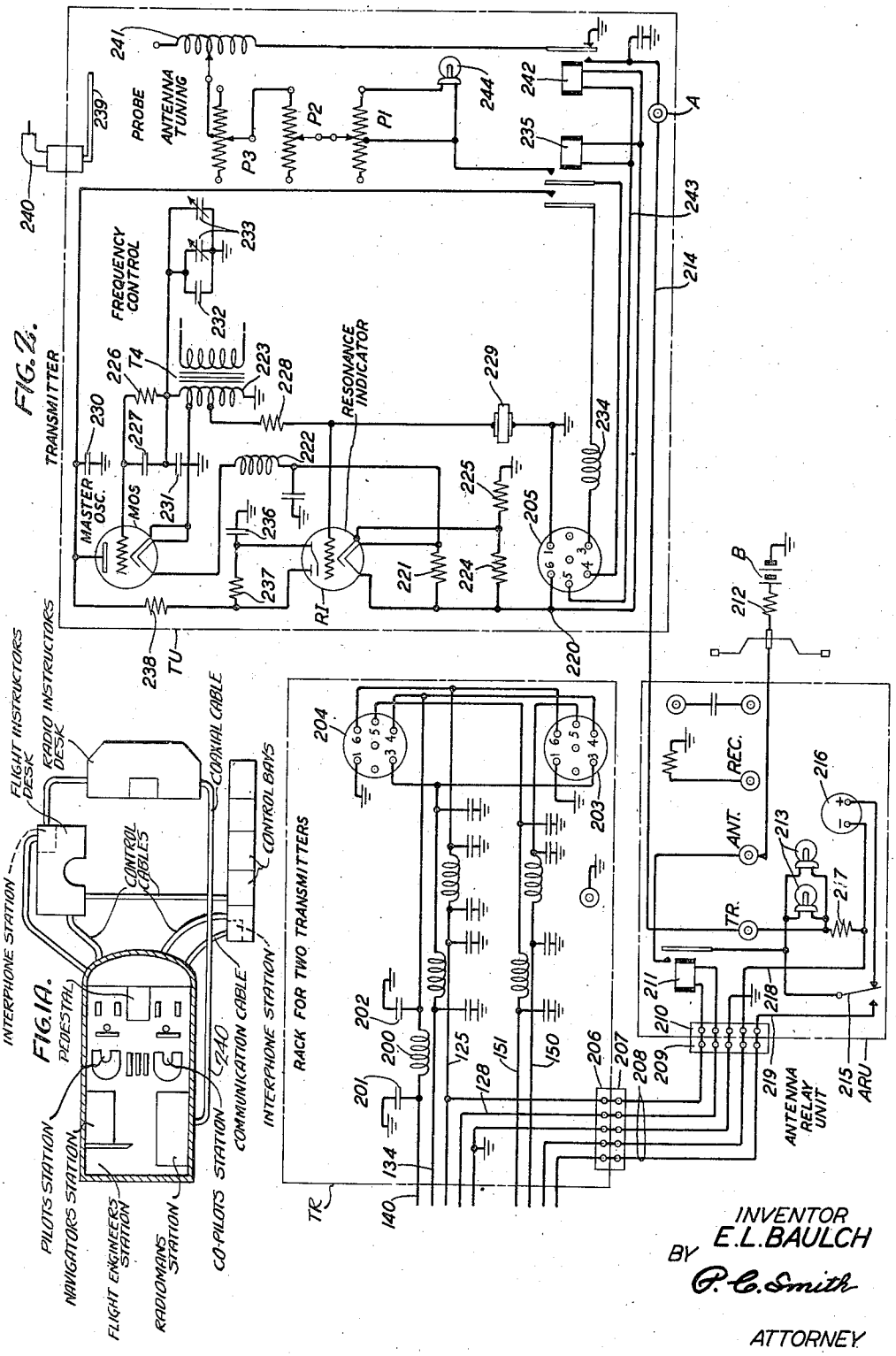

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FIG. 3

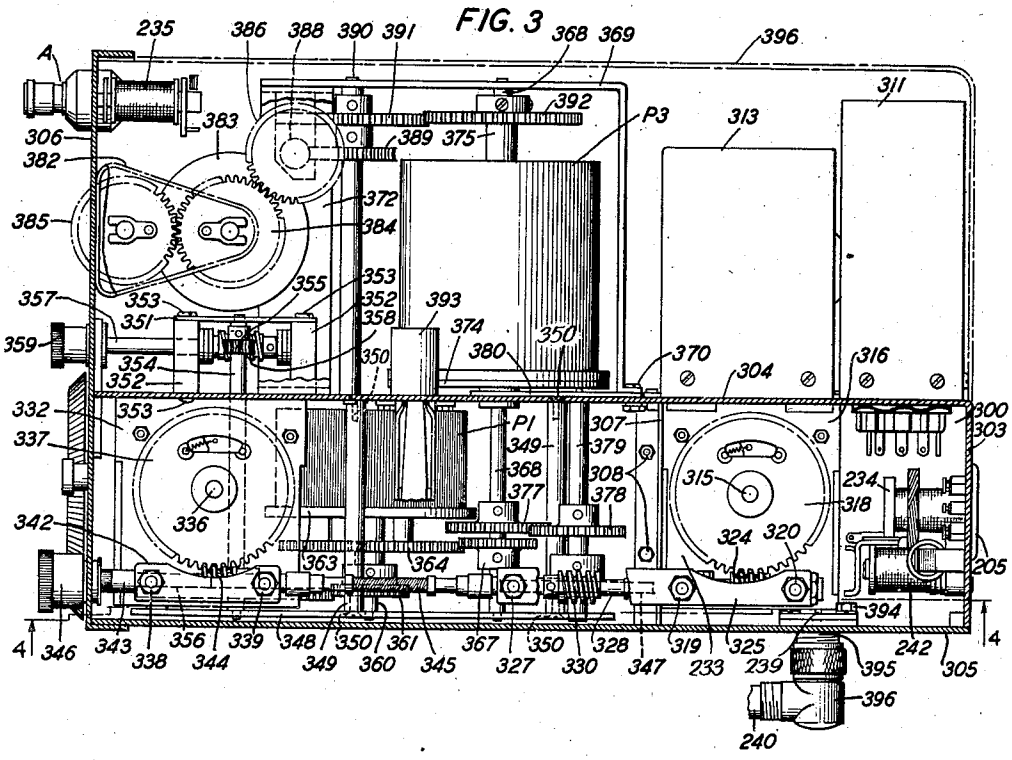

FIG. 4

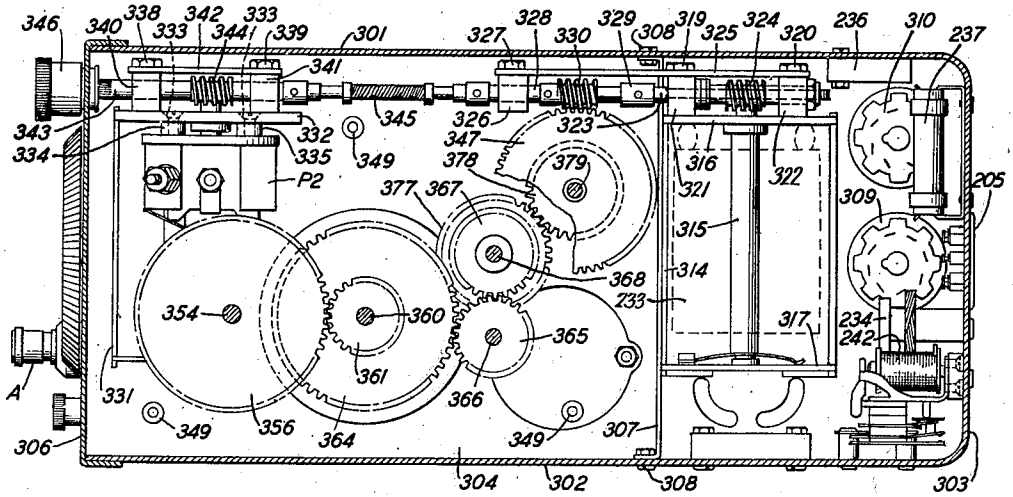

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FIG. 5

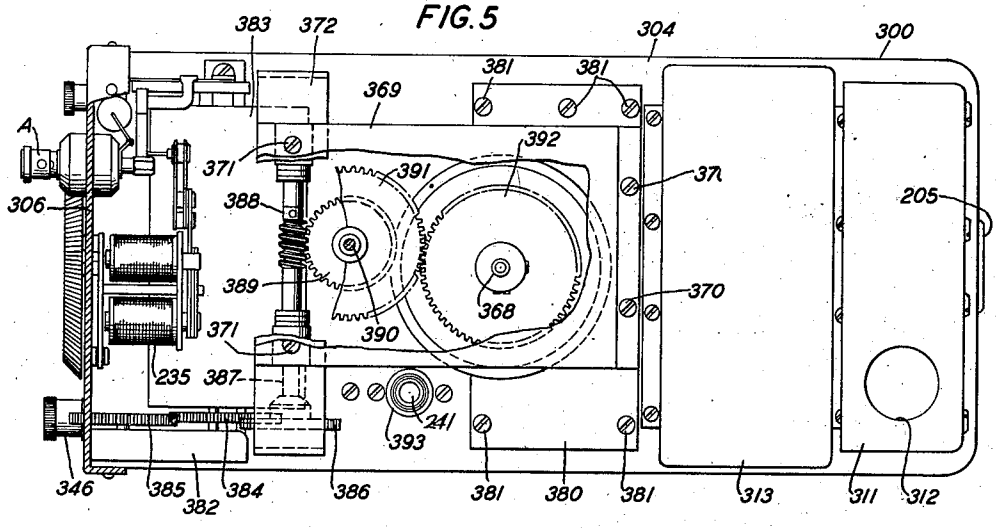
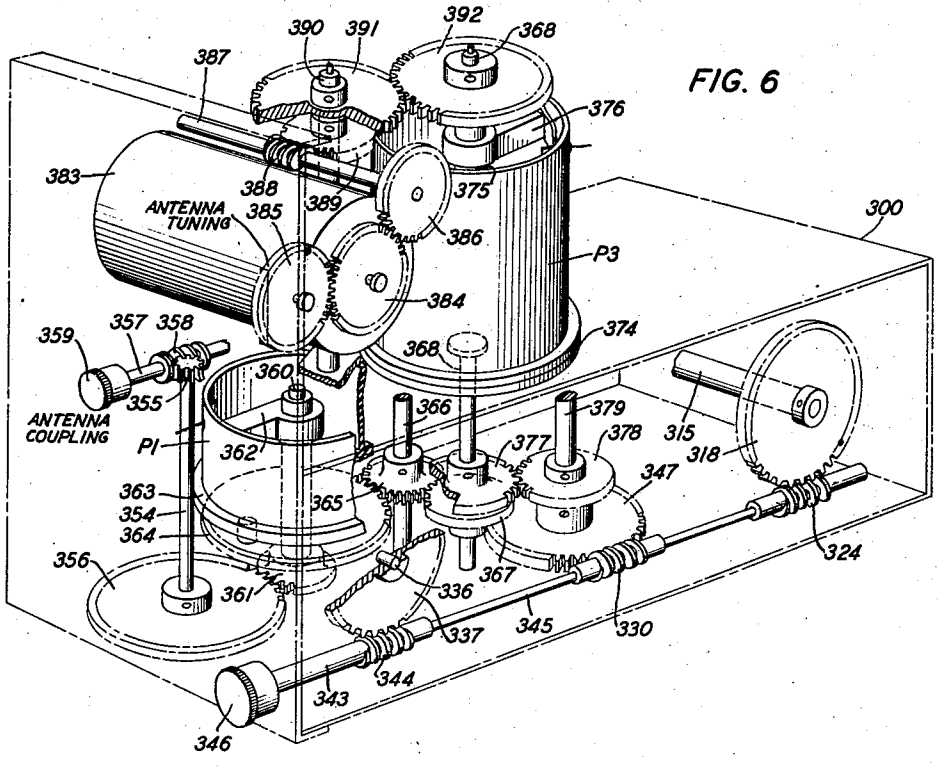


FIG. 6



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2,458,550

UNITED STATES PATENT OFFICE

2,458,550

TRAINER FOR ENABLING THE GIVING OF RADIO INSTRUCTION

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Application December 9, 1944, Serial No. 567,446

10 Claims. (Cl. 35—14)

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This invention relates to a radio transmitter and more particularly to the modification of a transmitter whereby it may be used in the training of airplane crew members in the proper tuning and handling of a regular radio transmitter.

There are many instances where radio transmitting and receiving equipments are very important adjuncts and where therefore it is essential that radiomen be trained to handle them efficiently under all operating conditions. One such instance, for example, is on airplanes. Modern airplanes, and particularly those used in combat service, are each equipped with an interphone system if the airplane is of sufficient size to require a crew for its operation, with one or more radio receivers which may be tuned to receive intrasquadron messages or messages from distant bases and with one or more radio transmitters which may be tuned to transmit messages to other airplanes of the same squadron or to more distant bases.

For training an airplane crew to handle this equipment and to best coordinate their endeavors involving the use of such equipment, it is proposed to provide radio instruction equipment in connection with an airplane crew trainer which has been developed for giving flight training to an airplane crew. This radio instruction equipment comprises the communication equipment which would be installed as regular equipment on an airplane of the type which the crew trainer is designed to simulate, and a radio instructor's desk at which radio receiving, radio transmitting and monitoring equipment is provided to enable the instructor to transmit such messages and instructions for reception in the trainer as might be transmitted from another airplane or from a distant base, for enabling the instructor to receive messages transmitted from transmitters in the trainer, and for enabling the instructor to monitor on conversations carried on over the interphone system of the trainer and to monitor on the operation of the receivers and to some extent on the transmitters of the trainer. A system of this type is disclosed in the copending application of A. Ludwig, Serial No. 567,445, filed December 9, 1944.

The present invention is more particularly concerned with the modification of a transmitter of the type ordinarily used in an airplane for short distance transmission. Since it is not desirable for training purposes to radiate power from the transmitter, the transmitter unit is not connected to a radiating antenna but is shielded and a probe is positioned within the shield, which probe is

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connected by a coaxial cable with the instructor's desk where it may be connected to a radio receiver. Since little power is required for transmission over the short coaxial cable to the instructor's desk, the power amplifier equipment is removed from the transmitter and a direct current circuit embodying three potentiometers, operable from the regular tuning controls of the transmitter, is installed. The antenna relay unit which functions with the transmitter is also modified so that the antenna current indicator of the antenna relay unit is operable by direct current in simulation of its usual response to the tuning of the transmitter. The master oscillator of the transmitter and the resonance indicator of the transmitter are retained.

The antenna relay unit is modified by omitting the antenna coupling loop and the radio frequency thermocouple which ordinarily would control the antenna current indicator to indicate the antenna load and in place thereof lamps are provided which are connectable in parallel with the indicator and in series with the potentiometer circuits of the transmitter to provide a resistance temperature coefficient which permits the indicator to operate on a similar resonance curve and to operate with approximately the same degree of damping as when the indicator is deflected on the output of a thermocouple.

For operation with the transmitter the modulator unit which would ordinarily be used with the transmitter is employed but with the addition of filter capacitances to reduce the clicks which are received by the radio transmitter at the instructor's desk when operating the transmitter and by the addition of two relays one of which provides for the simulated operation of the voltage regulator tube and modulator and the other relay for switching resistances into the tuning circuit to change the indication given by the antenna current meter with the operation of the tone-CW-voice control of the modulator.

The jack box at the rear of the transmitter rack has been modified to include a radio frequency filter in each of the leads which pass from the transmitter to the cables connected to the transmitter rack to prevent the radiation of radio frequency from such leads.

For a clearer understanding of the invention and the mode of its operation reference may be had to the following detailed description when read in connection with the accompanying drawings in which:

Fig. 1A discloses schematically a flight trainer simulating the fuselage of an airplane, a flight

instructor's desk, a radio instructor's desk, the control bays in which the control apparatus of the trainer is installed, and control and communication cables interconnecting the trainer, the control bays and the instructors' desks;

Figs. 1 and 2 taken together show the complete circuit of a radio transmitter modified in accordance with the invention, Fig. 1 showing in the upper portion thereof the modulator unit and in the lower portion thereof the transmitter control box, and Fig. 2 showing in the upper left portion thereof the transmitter rack including the filter circuits, in the lower left portion thereof the antenna relay unit and in the right portion thereof the transmitter unit;

Fig. 3 shows a side elevation view of the transmitter unit, the side of the shielding casing having been cut away;

Fig. 4 is a cross-sectional view of the transmitter unit taken along section line 4—4 of Fig. 3;

Fig. 5 is a top elevation view with portions broken away to better disclose some of the operating elements of the transmitter; and

Fig. 6 is an isometric view of the potentiometers of the modified transmitter and the gearing by which such potentiometers are controlled from the tuning controls of the transmitter.

The transmitter control box shown in the dot-dash rectangle TC in the lower portion of Fig. 1 is installed on the pilot's pedestal in the trainer and is provided with a transmitter selector switch 100 having four selection positions for enabling the selection of any one of four transmitters. When the switch lever is moved to any one of the four indicated selection positions, one of the switches shown immediately below the lever is closed. For example, with the lever positioned as shown to select transmitter No. 1 the switch 101 is closed as shown. The switch 102 controls the choice of emission and has three selection positions indicated as "Tone," "CW" or continuous wave and "Voice." When the switch lever is in the No. 1 or "Tone" position, the switch contacts 103, 104, 105 and 108 are closed, when the switch lever is in the No. 2 or "CW" position switch contacts 103 and 108 are closed and when the switch lever is in the No. 3 or "Voice" position switch contacts 104, 105, 106, 107 and 109 are closed as is indicated by the small numerals 1, 2, and 3 appearing adjacent such switch contacts.

The control box is also provided with a power-on switch 110 which controls the connection of direct current to the heater bus bar of the transmitter for supplying operating current to the relays and tube filaments in the circuits of the modulator, transmitter and antenna relay unit of the transmitter. A second switch 111 is also provided for controlling the connection of a 510-ohm resistance 112 in series with the microphone circuit to adapt the circuit for the use of a low resistance microphone.

Two jacks are provided into one of which, 113, an outside signaling key SK may be plugged and into the other of which, 114, a microphone may be plugged. If a microphone, such as MIC, equipped with a talk key TK is plugged into jack 114, then the sleeve of the jack is connected to ground by tightening the knurled nut 115. The nut 115 is disclosed as in the tightened position which would be used with the microphone MIC. If, however, the microphone MIC', not equipped with a talk key, is plugged into the jack 114, then the nut 115 is loosened and the ground connection to the sleeve of jack 114 is omitted, and to talk, the built-in key 116 or the signaling key plugged into jack 113 must be used.

The transmitter control box is connected to the modulator shown in the dot-dash rectangle of Fig. 1, labeled "Modulator," by a cable terminating at each end in a multiconnection plug, the plug on one end of the cable being insertable into a jack on the control box and the plug on the other end of the cable being insertable into a jack mounted on the modulator casing. For simplicity of illustration this interconnection has been shown schematically as a single plug and jack connection 117.

The modulator is provided with three tubes, a tone oscillator tube TOS, a modulator tube MOD and a voltage regulator tube VR. For providing plate potential for the tubes of the modulator unit and for the tubes of the transmitter unit the usual dynamotor unit DM is provided which is connected through the coupling plug 118 and coupling jack 119. This unit comprises a direct current motor M which is driven from the 24 to 28-volt source of the trainer connected to the modulator over the plug and jack connection 158 and a direct current generator G capable of generating a direct current potential suitable for the operation of the tubes of the modulator and transmitter. The dynamotor unit is caused to operate whenever the dynamotor relay 120 is operated, the circuit for motor M extending from ground over the No. 1 contacts of plug 118 and jack 119, through the motor armature, thence over the No. 2 contacts of the plug 118 and jack 119, over contacts of relay 120 and through choke coil 121 to the positive power supply lead 122. The output of the generator G is applied over the No. 3 contacts of plug 118 and jack 119 and through the choke coil 123 to the high potential positive bus bar 124. The relay 120 is operated when the power-on switch 110 of the control box TC is operated to the on position and when the emission selector switch 102 of the control box is in its No. 1 or No. 2 position for either "Tone" or "CW" transmission, over a circuit which may be traced from the battery bus bar 122 over the switch 110 to the heater bus bar 125 in the modulator, thence through the winding of relay 120 and over switch contacts 108 of the selector switch 102 to ground. If, however, the switch 102 is in its No. 3 position for "Voice" emission the circuit traced to the bus bar 125 and through the winding of relay 120 extends over the switch contacts 107 and thence to ground over contacts of the key 116 or contacts of the key plugged into key jack 113 each time that either one of these keys is operated to talk.

When a key is operated for talking or for either "Tone" or "CW" code transmission, a circuit is established upon each closure of the key contacts from battery bus bar 125, through the windings of relays 126 and 127 in parallel and thence to ground applied to the keying conductor 128 over contacts of the operated key. Relay 126 upon operating connects high positive potential from bus bar 124 through the potential divider comprising resistances 129 and 130 to ground, whereby anode potential is applied from the junction point between these resistances to the anode of tone oscillator tube TOS. Relay 126 also applies potential from bus bar 124 through the potential divider comprising resistances 131 and 132 to ground, whereby anode potential is supplied from the junction point between these resistances through resistance 133 to conductor 134 for supplying anode potential to the anode of the master

oscillator tube MOS of the transmitter unit of Fig. 2 as will be later described.

Relay 127 upon operating connects the lower section of the primary winding of transformer T1 over its inner contacts and the contacts 103 of the emission selector switch 102, conductor 135 and contacts of the jack and plug connector 136 over which the modulator is connected by cable to the receiver rack in the trainer, whereby when the switch 102 is set into either the "Tone" or "CW" position for code transmission, a side-tone of the transmitted signal may be picked up by the radio receiver of the trainer and heard by the pilot. Relay 127 also connects the lower right secondary winding of output transformer T3 over its outer contacts and the contacts 106 of switch 102, conductor 135 and thence to the receiver whereby when the switch 102 is set into its "Voice" position a side-tone of the transmitted voice modulated signal may be picked up by the receiver.

Relay 137 is continuously operated when the emission selector switch 102 is set into its No. 3 or "Voice" position over a circuit extending from battery on bus bar 125, through the winding of relay 137 and over the contacts 109 of switch 102 to ground. Relay 137 when operated is effective to establish a shunt over its upper contacts of the oscillator tube TOS to prevent the tube from oscillating should the key 116 or the key plugged into the key jack 113 be closed to enable talking, if the microphone plugged into jack 114 is not provided with a talk key. In addition, relay 137 removes a shunt from resistance 139 whereby the resistance ground established from conductor 128 upon each operation of a key to talk, to conductor 140 extending to the transmitter unit is increased for a purpose to be later described.

Relay 141 is continuously operated when the emission selector switch 102 is set into either its No. 1 "Tone" or No. 3 "Voice" position over a circuit extending from battery on the bus bar 125 through the winding of relay 141 and over contacts 104 of switch 102 to ground. Relay 141 when operated, at its lower contacts removes a shunt from resistance 142 whereby the resistance ground applied from conductor 128 upon each operation of the key for tone transmission, to conductor 140 is further increased for a purpose to be later described. At its upper contacts relay 141 connects the tube VR through resistance 143 across the potential divider including resistances 131 and 132 whereupon tube VR glows in simulation of the operation of the tube which usually regulates the anode potential applied over conductor 134 to the master oscillator tube MOS of the transmitter unit.

Filament heating current for the tubes TOS and MOD is supplied from battery bus bar 125 serially through such filaments to ground. Anode potential is supplied to the anode of modulator tube MOD from the high potential positive bus bar 124 through the primary winding of output transformer T3 and potential is applied to the screen grid of tube MOD from the junction point between resistances 144 and 145 of the potential divider comprising these resistances, which potential divider is connected between the bus bar 124 and ground. When the tone oscillator TOS is operating, that is, on "Tone" and "CW" emission, the output of the oscillator tube is impressed upon the secondary winding of transformer T1 and applied to the control grid of the modulator tube MOD. When the emission selector switch 102 is set for "Voice" emission, at which time the tone oscillator TOS is not operating, modulating

potential is applied to the control grid of modulator tube MOD from the secondary winding of transformer T2 the primary winding of which is connected in a circuit from battery bus bar 125 through resistance 138, through such primary winding, through resistance 112 if the switch 111 is open, through the microphone plugged into jack 114, thence either over the talk key associated with the microphone to ground over the sleeve of jack 114 and the ground connection made by the operation of the knurled nut 115, or if the microphone has no associated talk key, over the ring of jack 114 to ground over the contacts of either key 116 or to ground over the contacts of the key plugged into keying jack 113 when either of such keys is operated to talk.

When the tube MOD is required for modulation, that is, when the emission selector key 102 is in either the "Tone" or the "Voice" position, tube MOD is rendered effective by the shunting of the 51,000-ohm resistance 146 in the circuit between the cathode of tube MOD and ground. This shunt is established from the junction point between resistances 146 and 147 and over the contacts 105 of the selector switch 102 to ground. On CW emission or when the master oscillator tube MOS of the transmitter is being operated in accordance with a keyed code, modulation is not required and although the tone oscillator tube TOS also responds in synchronism with the master oscillator tube MOS, its operation is not effective due to the blocking resistance 148 which is interposed in the circuit extending through the secondary windings of transformers T1 and T2 and through the primary winding of transformer T3.

The output of modulator tube MOD is impressed upon the secondary windings of transformer T3 from the lower one of which a side-tone is impressed upon the radio receivers of the trainer as previously described and from the upper one of which a modulated signal potential is impressed upon conductor 134 and thence as presently described upon the anode of the master oscillator tube MOS of the transmitter unit.

The modulator is connected over a cable of conductors with the transmitter rack TR of Fig. 2 upon which two transmitters may be mounted. Each end of the cable is provided with a plug one of which is insertable in a jack in the modulator and the other of which is insertable in a jack on the transmitter rack. For simplification of the disclosure this interconnection has been indicated schematically as a single plug and jack connection 149.

Mounted on the rear of the rack on which two transmitter units are supported is a casing designated TR having five shielded compartments through each of which one of the lead wires incoming from the modulator unit and extending to the transmitter unit passes and terminates in a terminal of each of two multiterminal plugs. Each of the leads has a filter interposed therein. Such leads are the heater battery lead 125, the anode battery supply and modulated signal input lead 134, the direct current tuning lead 140 and two of the transmitter selection leads 150 and 151 extending from the transmitter selection switch 100 of the transmitter control box TC.

These filters each comprise an inductance coil connected in series with the lead, such as the coil 200 connected in series with lead 140, and two condensers, such as 201 and 202, connecting the respective ends of the inductance coil to ground. These filters are provided for the purpose of pre-

venting the radiation of high frequency energy from the leads which interconnect the modulator and the transmitter.

As previously stated, each of these leads terminates in the terminals of two plugs 203 and 204, one allocated to one of the two transmitter units and the other allocated to the other of the two transmitter units. Only one of the transmitter units is disclosed in Fig. 2, being indicated by the apparatus disclosed within the dot-dash rectangle labeled TU. This transmitter unit is assumed to be the No. 1 unit and is connectable to the modulator unit by the insertion of the multiterminal connection plug 203 of the casing TR into the jack 205. The other transmitter is similar to the transmitter TU but would be tuned to a different carrier frequency. This other transmitter would be provided with a jack corresponding to jack 205 into which the plug 204 of the casing TR would be inserted.

The casing TR is provided with an additional plug schematically shown at 206 into which one plug 207 of a cable 208 is inserted and over which cable control leads are extended to the antenna relay unit ARU. For connection with the jack 210 of the relay unit the cable 208 is provided with a plug 209.

The antenna relay unit is provided with a relay 211, the terminals of the winding of which are connected to the heater battery lead 125 and to the keying lead 128 and is therefore operable each time a key is operated in the transmitter control box TC for talking or for tone or CW code emission to connect battery B connected through resistance 212 to the antenna binding post ANT, over its contacts through the lamp resistances 213, to the transmitter binding post TR and thence by conductor 214 to the antenna binding post A of the transmitter unit TU. When the switch 215 is in its right or "local" position, the antenna current indicator 216 is bridged in series with resistance 217 across the lamp resistances 213. A remotely located antenna current indicator 152 may, if desired, be bridged across the resistances 213 when the switch 215 is in its left or "remote" position over conductors 218 and 219 extending through the cable 208, over contacts of the plug and jack connections 149 and 117 and contacts of jack 153 and plug 154.

The transmitter unit TU is equipped with a master oscillator tube MOS and a resonance indicator tube RI. The usual power amplifier equipment has been eliminated from the transmitter since for training purposes only a low output is required. The filaments of the tubes RI and MOS are heated by current conducted over the heater lead 125, over the No. 6 terminals of plug 203, and jack 205, over conductor 220, through resistance 221 and the filament of tube RI in parallel, through the tertiary winding 222 of transformer T4, through the filament of tube MOS and the primary winding 223 of transformer T4 to ground. Current also flows from conductor 220 through the resistances 224 and 225 of a potential divider to ground and potential at the junction point of the potential divider is supplied to the cathode of tube RI.

The cathode of the oscillator tube MOS derives potential from a tap near the upper end of the primary winding of transformer T4 and the grid of this tube is connected through resistance 226, bridged by condenser 227, to the upper terminal of the primary winding of transformer T4. The lower portion of the primary winding of the transformer is bridged by resistance 228 connected in series with the control crystal 229. The anode of tube MOS is connected through condenser 230 to the grounded terminal of the primary winding of the transformer and the fixed tuning condensers 231 and 232 and an adjustable tuning condenser 233 are bridged around the primary winding of transformer T4 and between the grid and the anode of tube MOS. Anode potential is applied to the anode of tube MOS from lead 134 over the No. 3 contacts of plug 203 and jack 205, through inductance coil 234 and over the outer contacts of relay 235 when such relay is operated. When the filament of tube MOS is heated and anode potential is thus applied, the tube oscillates at a frequency determined by the tuning imposed by the tuning condensers 231, 232 and 233. The carrier frequency emitted by the tube may be adjusted to a frequency of 2.1 to 3 megacycles through the adjustment of the condenser 233 by the frequency control knob of the transmitter.

The anodes of the resonance indicator RI are connected by a condenser-resistance network comprising the condenser 236 and resistances 237 and 238 to the anode of tube MOS and the grid of tube RI is connected through resistance 228 and a portion of the primary winding of transformer T4 and through resistance 226 to the grid of tube MOS. The resonance indicator tube RI functions to produce a narrowed shadow condition when the oscillator is tuned to the frequency of the checking crystal 229. A tube of this type is disclosed in Patent No. 2,051,189, granted August 18, 1931, to H. N. Wagner.

The secondary winding of the output transformer T4, which would ordinarily be coupled to the input of a power amplifier stage, is left unconnected and a probe 239 is positioned within the shielded casing of the transmitter which picks up the modulated or unmodulated output of the oscillator tube MOS and transmits it over a coaxial cable 240 to a radio receiver at the instructor's desk as shown schematically in Fig. 1A. On CW transmission, the oscillator tube is caused to start and stop in accordance with a keyed code signal under the control of the keying relay 126 of the modulator and as on this type of emission, no modulation is effective, the tube MOS emits the carrier frequency in accordance with the keyed code signal. On tone modulated emission, the oscillator tube MOS is also caused to start and stop in accordance with a keyed code signal under the control of the keying relay 126, but the tone oscillator tube TOS and modulator tube MOD also function and the anode potential applied to the anode of master oscillator tube MOS is modulated by the 1,000 cycle tone emitted by the oscillator tube TOS. On voice modulated emission, the oscillator tube MOS is caused to start and stop in accordance with the operation of the talk key at the transmitter control box but the tone oscillator tube TOS is prevented from oscillating by ground connected over contact 109 of switch 102 which causes the operation of relay 137, relay 137 upon operating connecting ground over its upper contacts to the grid of tube TOS.

The tuning controls, comprising a frequency control, an antenna inductance control and an antenna coupling control, are retained in the transmitter together with the antenna tuning inductance 241 and the gearing by which it is associated with the antenna tuning control wheel. Two relays 235 and 242 are also provided which are operable in parallel in a circuit from the heating battery lead 125, extending over contacts of

plug 203 and jack 205 to conductor 220, thence through the windings of such relays, over conductor 243, over the No. 5 contacts of jack 205 in plug 203, conductor 150 and over contacts of the plug and jack connection 117 to ground over contacts 101 of the transmitter selector switch 100 of the transmitter control box, which selector is assumed to be set in position 1 to select the No. 1 transmitter.

Relay 235, upon operating, closes the circuit previously traced over which anode potential and modulated signal potential are applied to the anode of the master oscillator tube MOS and at its inner contacts closes a direct current tuning circuit which has been added to control the antenna current indicator in simulation of its operation in response to the tuning of the transmitter when power amplifier equipment is used. The direct current tuning circuit may be traced from ground applied to keying conductor 128 in response to the operation of a signaling key or a talk key at the transmitter control box, over the back contacts of relays 137 and 141 to conductor 140, or from conductor 128 through resistances 139 and over the back contact of relay 141 to conductor 140 if relay 137 is operated, or from conductor 128 through resistances 139 and 142 to conductor 140 if relays 137 and 141 are both operated, thence over the No. 4 contacts of plug 203 and jack 205, over the inner contacts of relay 235, through potentiometers P1, P2 and P3, through the antenna tuning inductance 241, over the front contact of relay 242 to antenna terminal A connected by conductor 214 to terminal TR of the antenna relay unit, through the resistance lamps 213 and the front contact of relay 211, also operated in response to keying to the terminal ANT. and thence through resistance 212 to battery B and ground.

The antenna current indicator 216 being connected through resistance 217 over the right contacts of switch 215 and bridging the resistance lamps 213, will operate to give an indication of the current flowing over the circuit just traced. This indication will vary in accordance with whether the resistances 139 and 142 are all omitted as when neither relay 137 or 141 is operated on CW emission, with whether the resistance 142 is included as when relay 141 is operated on tone emission, with whether the resistances 139 and 141 are included as when relay 137 and 141 are both operated on voice emission, and in accordance with the operation of the potentiometers P1, P2, P3 and the antenna tuning inductance 241 of the transmitter.

For any one of the three types of signaling emission, indicated in the direct current tuning circuit extending through the antenna relay unit by the inclusion of neither one of the resistances 139 and 142, by the inclusion of resistance 139 and by the inclusion of all resistances 139 and 142, the antenna current indicator 216 will produce a maximum reading when the tuning controls have been operated to positions in which a regular transmitter would produce its maximum antenna loading for the particular type of signal emission for which the transmitter is being tuned. In a regular transmitter, the antenna current indicator is controlled by a thermocouple which is associated by a coupling loop with the antenna of the transmitter so that the load on the antenna is effective to heat the thermocouple and to thus control the indicator. In the present case since no transmitter antenna emission is present, the direct current tuning circuit simulates such emission, the resistance lamps 213 providing a resistance temperature coefficient which permits the antenna current indicator 216 to operate on a resonance curve similar to that upon which it usually operates under thermocouple control and with the same degree of damping.

The manner in which the potentiometers P1, P2 and P3 are controlled by the tuning controls of the transmitter may best be understood by reference to Figs. 3 to 6, inclusive, of the drawing. The transmitter unit has a casing 300 comprising side walls 301, 302 and 303, a top wall 304 and a removable bottom closure plate 305. The front of the casing is closed by the panel 306 and the casing is divided into a front and a rear compartment by the transverse partition 307, the vertical edges of which are bent to form flanges which are secured to the side walls 301 and 302 by the bolts 308.

Secured to and extending through the rear end of the top wall 304 of the casing are three sockets in which checking crystal 229, the oscillator tube MOS and the resonance indicator tube R4 as disclosed in Fig. 2 are mounted. Two of these sockets are indicated 309 and 310. These tubes and the crystal are enclosed in a removable shield 311. This shield is provided with a sight hole 312, as shown in Fig. 5, directly above the resonance indicator tube through which the tube may be viewed when the frequency output of the transmitter is being adjusted. Mounted on the top wall of the casing adjacent to the tubes is the output transformer T4, disclosed in Fig. 2, which is enclosed in a removable shield 313.

Mounted within the casing on the rear wall 303 thereof, is the connection jack 205, inductance coil 234 and relay 242. The antenna binding post A is insulatedly mounted in the front panel 306 and the relay 235 is mounted on the inside of the panel 306.

Mounted within the rear compartment of the casing 300 is the condenser indicated as 233 in Fig. 2, the frame 314 of which is secured by bolts to the underside of the top wall 304 of the casing. To simplify the drawing the plates of the condenser have been indicated by the dotted lines. The shaft 315 of the condenser is journaled in the end members 316 and 317 of the frame and has a worm gear 318 mounted on the rear end thereof outside the end member 316. Secured to the end member 316 by screws 319 and 320 are two journal blocks 321 and 322 in which the shaft 323 is journaled. Secured to the shaft between the journal blocks and meshed with the gear 318 is a driving worm 324 by which the movable plates of the condenser may be adjusted. Secured to the outer faces of the journal blocks 321 and 322 by the screws 319 and 320 is a journal supporting plate 325 to the end of which a third journal block 326 is secured by the screw 327. Journaled in the block 326 is a shaft 328, the rear end of which is connected to the shaft 323 by the coupling 329 and which shaft has a worm 330 mounted thereon between the journal block 326 and the coupling 329.

The frame 331 of a second condenser, ordinarily used in the transmitter for tuning the amplifier stage, is mounted within the front compartment of the casing 300 just back of the front panel 306. This frame is secured by bolts to the underside of the top wall 304 of the casing and has one side wall and the condenser plates removed to provide mounting space for gearing by which the brush of potentiometer P1 is driven

as will later be described. Secured to the end member 332 of the condenser frame by screws 333, and spaced therefrom by spacers 334 and 335 is the potentiometer P2, the shaft 336 of which extends through the member 332 and has a worm gear 337 secured to the outer end thereof. Secured to the end member 332 by screws 338 and 339 are two bearing blocks 340 and 341, the outer ends of which are interconnected by the strap 342 which strap is secured thereto by the screws 338 and 339. Journaled within the bearing blocks 340 and 341 is a shaft 343 on which is secured the worm 344 meshed with the worm gear 337.

The shaft 343 is aligned with the shafts 328 and 323 and is connected with them through the flexible coupling shaft. The flexible coupling enables the shafts 328 and 323 to be turned by the shaft 343 even though the alignment of the shafts is not exact. Secured to the forward end of shaft 343 and on the outer face of the panel 306, is a knob 346 by which the shafts 343, 345, 328 and 323 and the worms 344, 330 and 324 secured thereto may be turned to rotate the worm gear 337, the worm gear 347 and the worm gear 318.

Positioned within the forward compartment of the casing 300 and adjacent and parallel to the removable bottom closure plate 305 is a journal plate 348. This plate is spaced from the wall 304 of the casing 300 by the spacing posts 349, the ends of which are secured to wall 304 and to the journal plate 348 by screws 350. Positioned about the top wall 304 of the casing 300 near the front panel 306 is a journal plate 351 which is spaced from the wall 304 by the journal blocks 352, the ends of which are secured to the wall 304 and to the journal plate 351 by the screws 353.

Journaled in the lower journal plate 348 and in the upper journal plate 351 and extending freely through a hole in the top wall 304 of the casing 300 is a vertical shaft 354 having a worm gear 355 secured thereto near the upper end thereof and having a gear 356 secured at the lower end thereof. Journaled in the journal blocks 352 is a horizontal shaft 357 on which and located between the journal blocks 352 a worm 358 is secured for meshing with the worm gear 355. The shaft 357 carries on the forward end thereof and located outside the panel plate 306, a knob 359 which in the unmodified transmitter is used for controlling the antenna coupling.

Journaled in the lower journal plate 348 and in the top wall 304 of casing 300 is a shaft 360 upon the lower end of which is secured the gear 361 in mesh with the gear 356 as best disclosed in Fig. 6 and, to the upper end of which is secured the slider arm 362 of potentiometer P1. The winding spool of potentiometer P1 has its mounting flange 363 secured to the gear 364, which gear is freely rotatable with respect to the shaft 360 but is rotatable by the idler gear 365 mounted on the shaft 366. The shaft 366 is also journaled at its lower end in the journal plate 348 and at its upper end in the top wall 304 of the casing 300.

The gear 365 meshes with the gear 367 which is secured to the shaft 368. Shaft 368 is journaled at its lower end in the journal plate 348, extends freely through an opening in the top wall 304 of casing 300 and is journaled at its upper end in the horizontal arm of the bracket 369. The bracket 369 is L-shaped, the vertical arm of which serves to space the horizontal arm

from the top wall 304 of the casing and is secured to such top wall by the bolts 370. The forward end of the horizontal arm of the bracket 369 is supported by and secured by screws 371 to the base of a U-shaped bracket 372, the ends of the arms of which are secured by bolts to the upper wall 304 of the casing 300.

Secured to the shaft 368 immediately above the top wall 304 of the casing 300, is a disc 374 to which is secured the mounting flange of the winding spool of potentiometer P3 whereby the potentiometer winding is rotatable by the shaft 368. The shaft 368 further extends through the sleeve 375 and is rotatable with respect thereto. Near its upper end the slider arm 376 of potentiometer P3 is secured. Shaft 368 also has secured thereto a gear 377 which meshes with the gear 378 mounted on the shaft 379.

The shaft 379 is journaled at its lower end in the journal plate 348 and is journaled at its upper end in the journal plate 380 which is secured by screw 381 to the upper surface of the top wall 304 of the casing 300. The shaft 379 also has secured thereto the worm gear 347 previously referred to which is meshed with the worm 330. Thus when the frequency control knob 346 is turned, the worm 330 rotates worm gear 347 and through the gears 378 and 377 rotates the winding of potentiometer P3 and also through the gears 367, 365 and 364 rotates the winding of potentiometer P1.

Secured to the rear face of the front panel 306 is a U-shaped bracket 382 in the rearwardly extending arms of which is rotatably mounted a drum 383 of insulating material on which is wound the antenna inductance coil 241. The usual follower slider engages with the coil, being schematically illustrated in Fig. 2. Secured to the shaft on which the drum is mounted is a gear 384 which meshes with a toothed control wheel 385, the wheel 385 being journaled on a stud shaft secured to one arm of the bracket 382 and protruding through a slot in the panel 306 whereby it may be engaged by the fingers of the radio man to rotate the drum 383. In mesh with the gear 384 is a gear 386 secured to the horizontal shaft 387. The shaft 387 is journaled in the vertical arms of the inverted C-shaped bracket 372, the lower inturned ends of the arms of which are secured to the top wall 304 of the casing 300. The shaft has secured thereto the worm 388.

The worm 388 meshes with the worm gear 389 mounted on the vertical shaft 390. Shaft 390 is journaled at its lower end in the top wall 304 of the casing 300 and at its upper end in the horizontal arm of the bracket 369. Also secured to shaft 390 is the gear 391 which meshes with gear 392 secured to the sleeve 375, to which the slider arm 376 of potentiometer P3 is secured. Thus when the control wheel 385 is operated to adjust the antenna inductance 241 by the rotation of the drum 383, the brush of potentiometer P3 is also rotated through the medium of gears 384, 386, 388, 389, 391 and 392.

Secured to the top wall 304 of the casing 300 adjacent to the winding of potentiometer P3 is a lamp socket 393 in which a switchboard lamp 244 is mounted. The winding of each potentiometer P1 and P3 has a center tap, as best disclosed in Fig. 2. The terminals of the lamp socket 393 are connected to the center tap and to one end of the winding of potentiometer P1 so that the resistance of lamp 244 is in shunt with one-half

of the winding of the potentiometer as disclosed in Fig. 2.

The bottom closure plate 305 of the casing 300 has insulatedly connected thereto by screws 394 a coaxial thimble 395 to which the elbow fitting 396 in which the coaxial cable 240 terminates is secured. The thimble 395 terminates on the inside of the casing 300 in a probe 239, illustrated schematically in Fig. 2, which lies parallel to the closure plate 305.

The apparatus disclosed in Fig. 3 above the top wall 304 of the casing 300 is enclosed in a casing 396 illustrated by the dotted lines, this casing having been omitted to better disclose the apparatus. This upper casing may be secured to the lower casing in any suitable manner.

Referring to Fig. 2, it will be noted that the sliders of potentiometers P1 and P2 are connected together, that one terminal of the winding of potentiometer P2 is connected to the slider of potentiometer P3 and that the center tap of the winding of potentiometer P3 is connected to the slider of the antenna tuning inductance coil 241. The slider of potentiometer P2 being responsive through gears 344 and 337 to the frequency control knob 346, the reading of the antenna current indicator 216 is made to depend upon the choice of transmission frequency selected. Since the winding of potentiometer P3 is also turned by the gears 330, 347, 378 and 377 in response to the operation of the frequency control knob 346, the antenna inductance tuning point is shifted with a variation in frequency and since the winding of potentiometer P1 is also turned by the gears 330, 347, 378, 377, 367, 365 and 364, in response to the operation of the frequency control knob 346, the setting of the antenna loading control is shifted depending upon the frequency selected. The slider of the potentiometer P3 being geared to the antenna inductance control wheel 385 through the gears 384, 386, 388, 389, 391 and 392, the slider may be set directly on the center tap of the winding of potentiometer P3 to indicate the resonance point of the antenna indicator. The slider of the potentiometer P1 may be set on the center tap point of the winding of such potentiometer through the gears 358, 355, 356 and 361 under the control of the antenna coupling control knob 359 to provide a maximum reading of the antenna current indicator 216 with a condition of maximum loading.

As these potentiometers are turned so that the sliders 362 and 376 do not rest on center tap points of the windings of potentiometers P1 and P3, the antenna current indicator indicates less than peak current, thus simulating the current readings which result when an actual radio transmitter is tuned to appproach the resonance point or point of maximum antenna coupling. The connection of the lamp resistance 244 in parallel with one-half of the winding of potentiometer P1 provides an unsymmetrical decrease in the antenna current when the antenna coupling control is turned to move the slider of potentiometer P1 to the right or left of the center tap position.

While the invention has been described in connection with a transmitter particularly adapted for use in training equipment for training the operating crew of an airplane, it will be obvious that the invention is equally applicable to other training purposes.

The transmitter is, as disclosed schematically in Fig. 1A, connected with a radio instructor's desk over a coaxial cable 240 so that the instructor is able to determine from a radio receiver which he has tuned to receive on the allocated wavelength if the crew man in the trainer has correctly set the transmitter to transmit on the proper wavelength and with the proper type of emission. The equipment at the instructor's desk is fully disclosed in the Ludwig application hereinbefore referred to. The transmitter of the present invention also enables the crew man to operate the transmitter to secure a response of the antenna current indicator to indicate the proper antenna load for the type of emission selected.

What is claimed is:

1. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, tuning controls, an antenna current indicator, a source of current, and potentiometers operable by said controls for deriving a potential from said source and for applying it to said indicator whereby said indicator is operated in simulation of its usual operation in accordance with antenna loading in response to the actual tuning of the amplifier equipment of a regular radio transmitter.

2. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with keyed code signals, means for modulating said frequency in accordance with keyed code signals, means for modulating said frequency in accordance with voice signals, means for selecting the type of emission to be used, tuning controls, an antenna current indicator, a source of current, means for deriving a potential from said source which varies in accordance with which of the frequency control or modulation means is selected for use, and potentiometers operable by said tuning controls for modifying said derived potential and for applying said modified potential to said indicator whereby said indicator is operated in simulation of its usual operation in accordance with the antenna loading for the selected type of emission in response to the actual tuning of the amplifier equipment of a regular radio transmitter.

3. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for selectively determining whether said frequency shall be controlled in accordance with keyed code signals, shall be modulated in accordance with keyed code signals or shall be modulated in accordance with voice signals, tuning controls, an antenna current indicator, a source of direct current, means controlled by said frequency control selector for deriving a potential from said source which varies in accordance with the type of frequency control selected, and potentiometers operable by said tuning controls for modifying said derived potential and for applying said modified potential to said indicator whereby said indicator is operated in simulation of its usual operation in accordance with the antenna loading for the selected type of emission in response to the actual tuning of the amplifier equipment of a regular radio transmitter.

4. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for selectively determining whether said frequency shall be controlled in accordance with keyed code signals, shall be

modulated in accordance with keyed code signals, or shall be modulated in accordance with voice signals, tuning controls, an antenna current indicator, a source of direct current, a series of resistances, means controlled by said frequency control selector for selectively associating said resistances with said source of current for deriving a potential from said source which varies in accordance with the type of frequency control selected, and potentiometers operable by said tuning controls for modifying said derived potential and for applying said modified potential to said indicator whereby said indicator is operated in simulation of its usual operation in accordance with the antenna loading for the selected type of emission in response to the control of the tuning of the amplifier equipment of a regular radio transmitter.

5. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, tuning controls, a source of current, a lamp resistance, an antenna current indicator in bridge of said resistance, and potentiometers operable by said tuning controls for deriving a potential from said source and for impressing it upon said resistance, whereby said indicator is operated on a similar resonance curve and with approximately the same degree of damping as it would in operating in accordance with antenna loading in response to the actual tuning of the amplifier equipment of a regular radio transmitter.

6. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, tuning controls, a coaxial system, a probe for picking up said carrier frequency and for applying it to said coaxial system, an antenna current indicator, a source of current, and potentiometers operable by said tuning controls for deriving a potential from said source and for applying it to said indicator, whereby said indicator is operated in simulation of its usual operation in accordance with antenna loading in response to the actual tuning of the amplifier equipment of a regular transmitter.

7. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, a control for determining the frequency to be generated, a control for varying the inductance of the antenna circuit, a control for varying the antenna coupling, an antenna current indicator, a source of current, and potentiometers operable by said controls for deriving a potential from said source and for applying it to said indicator whereby said indicator is operated in simulation of its usual operation in accordance with the antenna loading in response to the actual tuning of the amplifier equipment of a regular radio transmitter by said controls.

8. In a device for simulating the operation of a radio transmitter, an oscillator, for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, a control for determining the frequency to be generated, a control for varying the inductance of the antenna circuit, a control for varying the antenna coupling, an antenna current indicator, a source of current, a first potentiometer the winding of which is rotatable by said frequency control and whose slider is operable by said antenna coupling control, a second potentiometer whose slider is operable by said frequency control, and a third potentiometer whose winding is rotatable by said frequency control and whose slider is operable by said antenna inductance control, said potentiometers being jointly effective to derive a potential from said source and to apply it to said indicator whereby said indicator is operated in simulation of its usual operation in accordance with the antenna loading in response to the actual tuning of the amplifier equipment of a regular radio transmitter by said controls.

9. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, a control for determining the frequency to be generated, a control for varying the inductance of the antenna circuit, a control for varying the antenna coupling, an antenna current indicator, a source of current, a first potentiometer whose center-tapped winding is rotatable by said frequency control and whose slider is operable by said antenna coupling control, a second potentiometer whose slider is electrically connected to the slider of said first potentiometer and is rotatable by said frequency control, and a third potentiometer whose center-tapped winding is rotatable by said frequency control and whose slider is electrically connected with one terminal of the winding of said second potentiometer and is operable by said antenna inductance control, said potentiometers being jointly effective to derive a potential from said source and to apply it to said indicator whereby said indicator is caused to produce a maximum deflection for the frequency selected when the sliders of said first and third potentiometers are at the center tap positions of their windings in simulation of the usual operation of said indicator in accordance with the antenna loading in response to the actual tuning of the amplifier equipment of a regular radio transmitter by said controls.

10. In a device for simulating the operation of a radio transmitter, an oscillator for generating a carrier frequency, means for controlling said frequency in accordance with signals which it is desired to transmit, a control for determining the frequency to be generated, a control for varying the inductance of the antenna circuit, a control for varying the antenna coupling, an antenna current indicator, a source of current, a first potentiometer whose center-tapped winding is rotatable by said frequency control and whose slider is operable by said antenna coupling control, a second potentiometer whose slider is electrically connected with the slider of said first potentiometer and is operable by said frequency control, a third potentiometer whose center-tapped winding is rotatable by said frequency control and whose slider is electrically connected with one terminal of the winding of said second potentiometer and is operable by said antenna inductance control, and a lamp resistance in shunt of one half of the winding of said first potentiometer whereby said potentiometer produces an unsymmetrical response when its slider is positioned on opposite sides of the center-tap position of said winding, said potentiometers being jointly effective to derive a potential from said source and to apply it to said indicator whereby said indicator is caused to produce a maximum deflection for

the frequency selected when the sliders of said first and third potentiometers are at the center-tap positions of their windings in simulation of the usual operation of said indicator in accordance with the antenna loading in response to the actual tuning of the amplifier equipment of a regular radio transmitter by said controls.

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