RADIO TELEPHONE MONITORING SYSTEM

Filed May 19, 1936 3 Sheets-Sheet 1

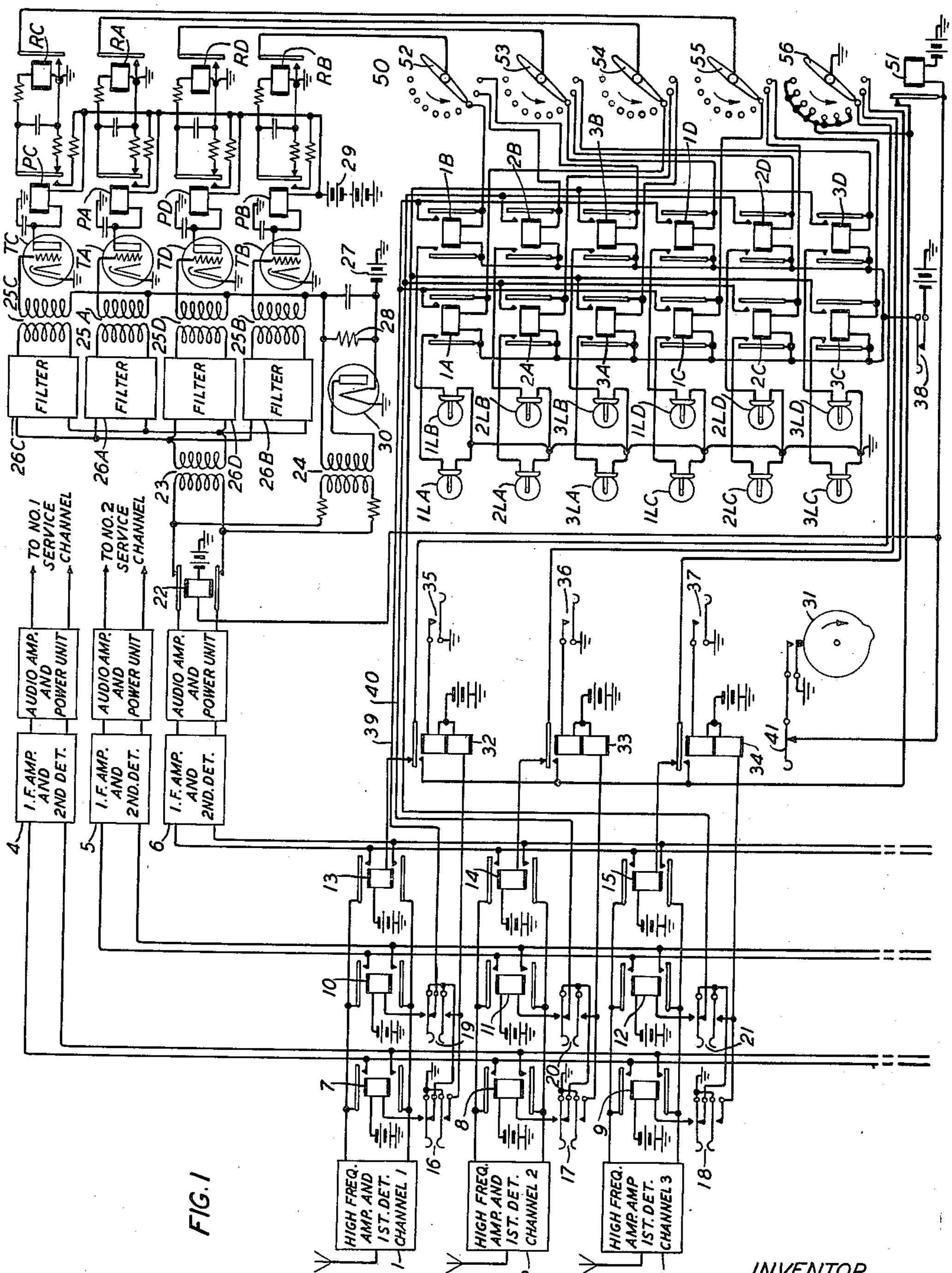

FIG. 1

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Sept. 21, 1937. H. M. PRUDEN 2,093,847

RADIO TELEPHONE MONITORING SYSTEM

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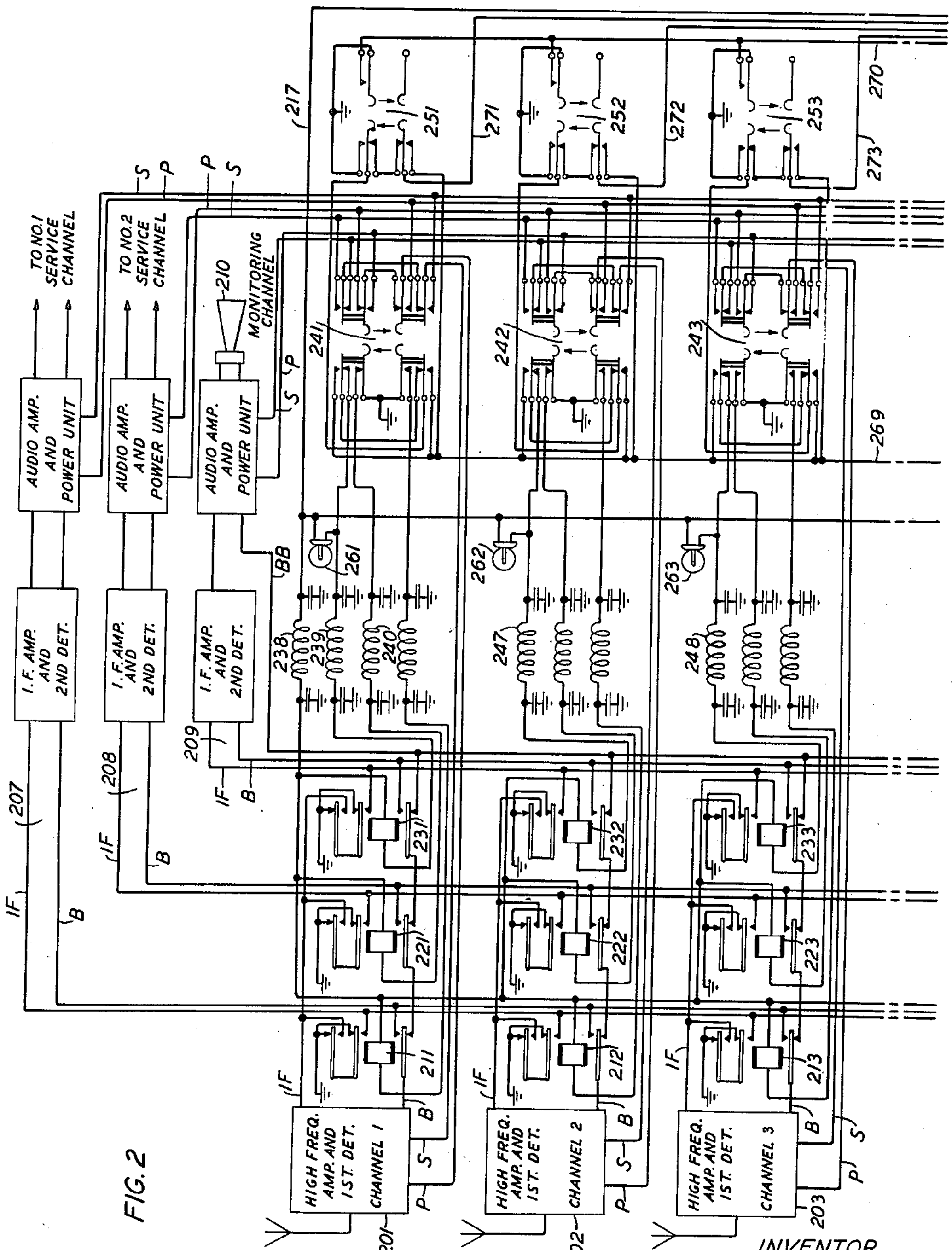

FIG. 2

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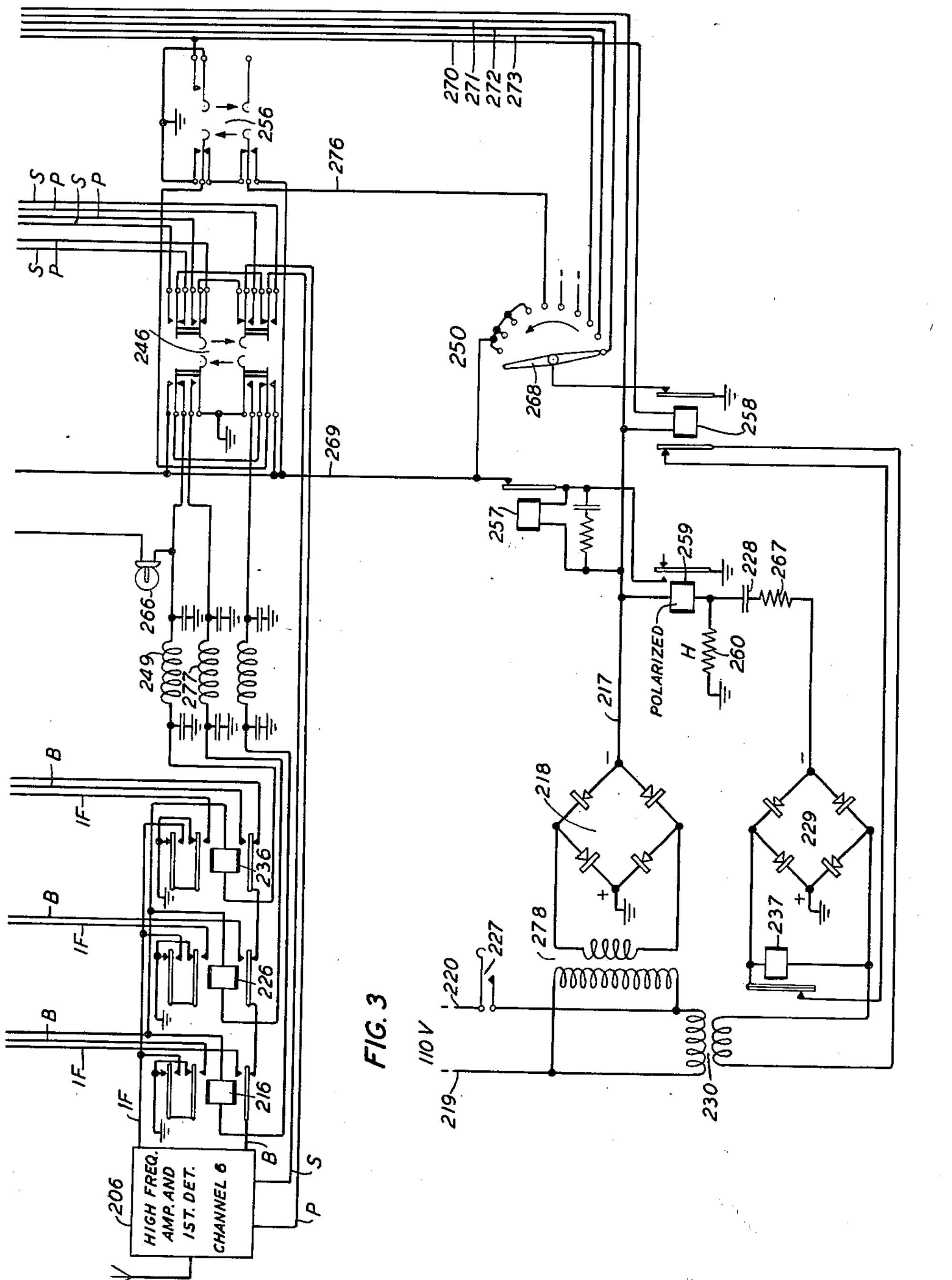

FIG. 3

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UNITED STATES PATENT OFFICE

2,093,847

RADIO TELEPHONE MONITORING SYSTEM

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12 Claims. (Cl. 250—20)

This invention relates to radio telephone circuits and more particularly to facilities for enabling monitoring to be accomplished on a plurality of radio telephone receiving channels which are used on a shared time basis.

In some instances it is desirable to use one receiver for monitoring on any one of a plurality of receiving channels each served by a different directive receiving antenna. One of these channels may be arranged, for example, to receive on one frequency band from two or more transmitting stations, a second channel may be arranged to receive on another frequency band from two or more transmitting stations, a third channel may be arranged to receive on another frequency band from two or more transmitting stations and other channels to receive on other frequency bands from one or more transmitting stations. Where the directivity of the antennae is sufficiently defined and the stations transmitting are operating on different frequencies, no great difficulty is encountered in determining which station is being received. However, where reception is required over several antennae, as in the case assumed, from several transmitting stations operating on the same frequency band, the antennae may not be sufficiently directive to determine definitely which of such stations is transmitting. It is therefore the object of the present invention to provide a monitoring system for enabling an accurate determination of the source of incoming radio reception.

The manner in which this object may be attained is disclosed herein. It is to be understood, however, that the disclosure is only illustrative of two embodiments of the invention and that other equivalent circuits and apparatus might be employed without departing from the scope of the invention as defined in the appended claims.

In accordance with the present invention provision is made for monitoring by a single receiver on any one of a plurality of receiving channels, each associated with a receiving antenna. Each receiving channel comprises high frequency amplifier and first detector panels tuned to receive on a particular high frequency carrier band from one or more transmitting stations. The carrier band transmitted from different stations may be modulated by tone signals of relatively low frequency by means of which each transmitting station may be distinctively identified. Thus, for example, four stations transmitting on the same carrier frequency band could be identified by four modulating tone frequencies of 600, 1050, 1500 and 1950 cycles, respectively.

In accordance with one embodiment of the invention three intermediate frequency receiving channels are provided two of which are used for service connections and the third for monitoring purposes. Three groups of switching relays are provided for connecting any one of a plurality of high frequency receiving channels to any one of the three intermediate frequency channels. The output of the intermediate frequency monitoring channel is connected through a transformer to a plurality of signaling frequency filters each arranged to pass a different signaling tone frequency and also through an untuned transformer to a diode tube. The output of each filter is connected to a detector tube in the plate circuit of which a relay is connected. The electrodes of the diode tube are connected to the grid biasing circuit of the several detector tubes. When the monitoring channel is connected to any high frequency receiving channel, the tone signal superimposed on the carrier for identifying a particular transmitting station will be passed by the signaling frequency filter which is tuned to respond thereto thereby operating the relay of the detector tube associated with that filter and thereby identifying the particular transmitting station. Should there be a noise or static disturbance on the high frequency channel, the diode tube will function to increase the negative bias on the grids of the detector tubes to desensitize them so that they will not respond.

A normally operating step-by-step selector switch is provided for successively operating the relays of the group which connects the high frequency channels to the intermediate frequency monitoring channel, whereby the high frequency channels may be monitored on in rotation for identifying to the monitor the particular high frequency channel which is connected at any time for monitoring and for identifying the particular transmitting station, reception from which is being received over that channel. A plurality of signal lamps is provided which are selectively controlled by the plate relays of the signaling frequency detector tubes over wipers of the selector switch.

Keys are also provided for enabling the monitor to cause the selector switch to automatically pass by any high frequency channel upon which monitoring at the time is not desired. A bank of keys is also associated with each intermediate frequency service channel by means of which the monitor may operate the relays for associating any high frequency channel on which incoming signals have been detected by the monitoring channel, as indicated by a lighted signal lamp, with an intermediate frequency channel for a service connection.

In some instances individual station identification may not be required and therefore the tuned filters, detectors and signaling equipment may be eliminated and a monitoring loud-speaker used in lieu thereof as disclosed in a second embodiment of the invention. In this embodiment of the invention, the same provision is made for connecting the high frequency channels in rotation to an intermediate frequency monitoring channel and for connecting any high frequency channel to an intermediate frequency service channel for service connections. Signal lamps are provided for indicating to the monitor which of the high frequency channels is being monitored on at any instant. The output of the intermediate frequency monitoring channel is connected to a loud-speaker by means of which the monitor may determine when an incoming call is being received on any high frequency channel which is at the time connected for monitoring. A bank of keys is provided, one for each high frequency channel for enabling the monitor to switch any high frequency channel upon which an incoming call has been detected to one or the other intermediate frequency service channel and to thereby cause the selector switch to pass by such channel during its rotation. A second bank of keys is also provided, one for each high frequency channel for enabling the monitor to hold the high frequency channel connected to the monitoring channel or to cause the selector switch to pass by such channel during its rotation.

It is believed that a clearer understanding of the invention and its mode of operation may be obtained from a consideration of the following detailed description taken in connection with the accompanying drawings of which:

Fig. 1 discloses one embodiment of the invention arranged for successively monitoring on any one of a plurality of high frequency receiving channels and for the automatic detection and identification of any one of a plurality of transmitting stations reception from which may be received over the receiving channel being monitored on;

Figs. 2 and 3 taken together with Fig. 3 placed beneath Fig. 2 show a second embodiment of the invention from which the apparatus for the automatic detection and identification of transmitting stations has been omitted, Fig. 1 showing the high frequency receiving channels, the intermediate frequency receiving channels and certain switching equipment and Fig. 2 showing a further high frequency receiving channel, the switching equipment associated therewith, and a selector switch whereby the high frequency receiving channels are switched in rotation to the intermediate frequency monitoring channel.

Referring first to the embodiment of the invention disclosed in Fig. 1, it will be assumed that monitoring on three high frequency receiving channels is required and that reception from any one of four transmitting stations may be incoming on any one of these receiving channels. The high frequency receiving channels are schematically illustrated by the boxes 1, 2 and 3 and each comprises a receiving antenna system, a high frequency amplifier panel and a first detector panel. Three intermediate frequency receiving channels are provided as indicated by the boxes 4, 5 and 6, each comprising an intermediate frequency amplifier, second detector, an audio frequency amplifier and power unit. Two of these intermediate frequency channels 4 and 5 are connected on their output sides to service channels and the third channel 6 is connected on its output side to a tone signal detection circuit.

A group of switching relays 7, 8 and 9 is provided for connecting the input circuits of intermediate frequency channel 4 with the output circuit of any one of the high frequency receiving channels 1, 2 or 3. A second group of switching relays 10, 11 and 12, is provided for connecting the input circuit of intermediate frequency channel 5 with the output circuit of channel 1, 2 or 3 and a third group of switching relays 13, 14 and 15 is provided for connecting the input circuit of intermediate frequency monitoring channel 6 with the output circuit of channel 1, 2 or 3. The operation of relays 7 to 12, inclusive, are controlled by keys 16 to 21, inclusive, individual respectively thereto and relays 13, 14 and 15 are operated in rotation under the control of the step-by-step selector switch 50 in a manner to be hereinafter described.

The output of the audio frequency amplifier of the intermediate frequency monitoring channel 6 is connected over the back contacts of relay 22 in parallel to the primary windings of transformers 23 and 24. The secondary winding of transformer 23 is connected in parallel to the primary windings of four transformers 25A, 25B, 25C and 25D which are respectively tuned by filter circuits 26A, 26B, 26C and 26D. If it be assumed that four signaling frequencies of 1950, 1500 1050 and 600 cycles are employed for station identification, these filters would be designed to tune the transformers to these frequencies; filter 26C tuning transformer 25C to frequency C of 1950 cycles, filter 26A tuning transformer 25A to frequency A of 1500 cycles, filter 26D tuning transformer 25D to frequency D of 1050 cycles, and filter 26B tuning transformer 25B to frequency B of 600 cycles.

The secondaries of transformers 25C, 25A, 25D and 25B are connected respectively to the grids of detector tubes TC, TA, TD and TB, negative biasing potential being applied therethrough to the grids of these tubes from the battery 27, through resistance 28. The plate of each detector tube is connected through the winding of a plate relay to the positive terminal of plate battery 29, the plate of tube TC being connected through the winding of relay PC, the plate of tube TA being connected through the winding of relay PA, the plate of tube TD being connected through the winding of relay PD and the plate of tube TB being connected through the winding of relay PB. Each of the plate relays upon operating controls the operation of a secondary relay, relay PD for example controlling the operation of relay RD over an obvious circuit.

Although units comprising filter tuned transformers, detector tubes and relays controlled thereby have been disclosed for selective response to four different signaling frequencies, it is to be understood that additional units may be supplied if more than four stations are arranged to transmit on the same carrier frequency to be recevied over the same high frequency receiving channel.

The secondary of untuned transformer 24 is connected across the elements of the diode tube

30 and its output is adjusted to be approximately twenty decibels less than that of any of the tuned transformers. The output of the diode tube 30 is used to control the grid bias of all of the detector tubes TC, TA, TD and TB since if the noise or static level is high the effect of the diode tube will be to produce a direct current voltage drop across resistance 28 and thereby raise the negative bias on the grids of the tubes and thus serve as a noise desensitizer. The system is thus capable of operating through extraordinary noise conditions and is practically free from false operation on either voice or noise currents.

For connecting the high frequency receiving channels in rotation to the monitoring channel 6 and for placing channel signal lamps successively under the control of the signal detection circuit, a rotary step-by-step selector switch 50 is provided. This switch is actuated step-by-step by its stepping magnet 51 under the control of interrupter 31 to advance its wipers over their respective arcuate banks of terminals. Under the assumption that the system is designed to function in response to four different signaling frequencies four wipers 52 to 55, inclusive, are provided which are connected with contacts of relays RA, RB, RC and RD responsive respectively to the four signaling frequencies A, B, C and D. The three equipped terminals of the arc associated with wiper 54 are connected to the windings of relays 1A, 2A and 3A which control the circuits of signal lamps 1LA, 2LA and 3LA. The equipped terminals of the arc associated with wiper 52 are connected to the windings of relays 1B, 2B and 3B which control the circuits of lamps 1LB, 2LB and 3LB. The equipped terminals of the arc associated with wiper 55 are connected to the windings of relays 1C, 2C and 3C which control the circuits of lamps 1LC, 2LC and 3LC and the equipped terminals of the arc associated with wiper 53 are connected to the windings of relays 1D, 2D and 3D which control the circuits of lamps 1LD, 2LD and 3LD.

In the designation of these relays and lamps, the prefix numeral indicates the high frequency receiving channel to which they are allocated and the suffix letter indicates the signaling frequency and thus a particular transmitting station, reception from which may be received over that channel. Thus the relays 1A, 1B, 1C and 1D and the lamps 1LA, 1LB, 1LC and 1LD form one group allocated to the No. 1 receiving channel for identifying respectively four stations employing the modulating signaling frequencies A, B, C and D. Should it be found necessary to identify more channels, other groups of relays and lamps would be added, the relays being controlled over other terminals of the arcs of switch 50. Also should it be found necessary to identify more than four stations on any channel, additional detector units each comprising a filter tuned to another signaling frequency, detector tube and relays such as PA and RA would be provided as previously stated and an additional wiper would be added to the switch 50 for each such unit and other relays and lamps such as 1A and 1LA would be added to each group of relays and lamps in the indicator.

Under the assumption that monitoring is required on but three high frequency receiving channels, three terminals of the arc with which wiper 56 cooperates are connected over back contacts of the skip channel relays 32, 33 and 34 to the windings of switching relays 13, 14 and 15 so that as the switch 50 advances, these switching relays are operated in rotation to successively connect the three high frequency channels 1, 2 and 3 with the monitoring channel 6. The remaining terminals of this switch arc are strapped together to cause the switch to pass over them quickly. Should other high frequency receiving channels be added, the switching relays thereof corresponding to relay 13 would be controlled over terminals of the arc associated with wiper 56.

Keys 35, 36 and 37 are provided for operating the skip channel relays 32, 33 and 34 when for any reason it becomes desirable to omit monitoring on any high frequency channel for causing the selector switch 50 to pass by that channel without causing its connection to the monitoring channel 6.

Having now described the apparatus disclosed in Fig. 1, the mode of its operation will now be discussed. It will be assumed that the selector switch 50 is standing in the position disclosed and that therefore the circuit of switching relay 13 is established from battery, winding of relay 13, back contact of relay 32, the terminal on which wiper 56 is temporarily standing to ground. Relay 13 therefore operates and connects the output circuit of high frequency receiving channel 1 to the input circuit of the monitoring channel 6. It will now be assumed that reception is received in the monitoring channel from a transmitting station which is identified by the modulating signaling frequency A and that therefore the output of the monitoring channel 6 is applied over the back contacts of relay 22 through the transformer 23 and is passed by transformer 25A, tuned by filter 26A to the input of detector tube TA. The detector tube TA will therefore respond, operating its plate relay PA and in turn relay RA. Since this particular signaling frequency A cannot pass the tuned filters 26B, 26C and 26D no other tube will respond and the relays controlled thereby will not operate. With relay RA operated, a circuit is closed from ground over its contacts wiper 54 and the terminal with which it is engaged, winding of relay 1A to battery over the normally closed contacts of release key 38. Relay 1A now operates locking in a circuit from battery over the contacts of key 38, winding and right front contact of relay 1A, conductor 39, normal contacts of keys 19 and 16, to ground and closing a circuit for lamp 1LA, extending from battery over the contacts of key 38, left front contact of relay 1A, lamp 1LA to ground or if desired to ground through an auxiliary signaling device not shown. The lighting of lamp 1LA indicates to the monitor that the reception from a station identified by signaling frequency A is being received over the receiving channel 1. The monitor may now connect the high frequency channel 1 to a free intermediate frequency service channel 4 or 5. If channel 4 is free, he will operate key 16 thereby operating switching relay 7 to connect the channel 1 to channel 4. The operation of key 16 also opens the locking circuit of relay 1A which will then release and extinguish lamp 1LA as soon as the switch 50 advances another step, and closes an obvious circuit through the lower winding of skip channel relay 32 to prevent monitoring on channel 1 as long as it is connected for a service connection.

When the interrupter 31 next closes its contact, a circuit is established from ground thereover, normally closed contacts of stop key 41, winding of stepping magnet 51 to battery, whereby the wipers of switch 50 are advanced one step, and a circuit is closed in parallel therewith through the winding of relay 22. Relay 22 upon operating opens the output circuit of the monitoring channel 6 during the time that the switch is advancing to its next monitoring position. When wiper 54 leaves the terminal on which it was resting, relay 1A releases if either key 16 or 19 has been operated and causes lamp 1LA to become extinguished.

It will now be assumed that a station identified by the signaling frequency C is transmitting and reception therefrom is being received over high frequency channel 2. A circuit is now established from ground over wiper 56 and the terminal with which it is now engaged, back contact of relay 33, winding of switching relay 14, thereby connecting channel 2 with the monitoring channel 6. Relay 22 having now released, the output of channel 6 is connected through transformer 23 to the tuned transformers 25A, 25B, 25C and 25D and since the signaling reception incoming over channels 2 and 6 is modulated with frequency C, the tuned transformer 25C passes this frequency causing the detector tube TC to function, and operate relays PC and RC. With relay RC operated a circuit is established over its contacts, wiper 55 and the terminal with which it is engaged, winding of relay 2C to battery over the contacts of key 38.

Relay 2C operates locking over its right front contact, conductor 40, normal contacts of keys 20 and 17 to ground and closing the circuit of lamp 2LC. The lighting of lamp 2LC apprises the monitor that reception from a station identified by the signaling frequency C is being received over channel 2. The monitor may now complete a service connection from channel 2 to intermediate frequency service channel 5, for example, by operating switching relay 11 through the operation of key 20. The operation of key 20 also establishes an obvious circuit through the lower winding of skip relay 33 which operates to prevent monitoring on channel 2 so long as it is connected for a service connection and opens the locking circuit of relay 2C.

When the interrupter 31 again closes its contacts, relay 22 is again operated and switch 50 advances its wipers another step. In its advanced position, switching relay 15 is operated over wiper 56 to connect channel 3 to the monitoring channel 6 and the relays 3A, 3B, 3C and 3D are connected over wipers 54, 52, 55 and 53, respectively, to the contacts of relays RA, RB, RC and RD preparatory to registering the identification of any station, reception from which may be incoming over channel 3.

On the next closure of the contacts of interrupter 31, the switch 50 is advanced another step whereupon a self-interrupting circuit is established from ground over wiper 56 strapped terminals of the arc with which it is associated, interrupter contacts and winding of stepping magnet 51 to battery whereby the switch is quickly advanced into the position in which the first channel 1 is again monitored. If the previously established service connection from channel 1 over channel 4 is still effective, relay 32 will be operated and the switch 50 will at once be quickly advanced one step by a circuit established from ground over wiper 56, front contact of relay 32, interrupter contacts and winding of stepping magnet 51 to battery and no circuit for switching relay 13 will be established. In a similar manner if the service connection from channel 1 over channel 5 is still effective, relay 33 will be operated and switch 50 will be advanced immediately into a position for monitoring on channel 3 without establishing any monitoring connection from channel 2 to the monitoring channel.

Monitoring on any high frequency channel may be skipped at the option of the monitor by operating one of the keys 35, 36 or 37 individual to these channels. For example, the operation of key 37 causes the operation of relay 34 which is effective to open the operating circuit of switching relay 15 thus preventing the connection of channel 3 to the monitoring channel 6 and prepares a circuit for causing switch 50 to quickly pass by this channel when it is advanced to the position in which this channel would normally be monitored. Should the monitor desire to stop the switch at any time, he may do so by operating the key 41. The key 38 when operated will restore any operated indicator relay and extinguish the lamp whose circuit is controlled thereby.

Consideration will now be given to the further embodiment of the invention disclosed in Figs. 2 and 3 which is similar to that disclosed in Fig. 1 except that the specific identification of the particular station transmitting is not made but only an identification of each high frequency channel as it is being monitored upon. In these figures, it is assumed that six high frequency receiving channels 201, 202, 203—206 are equipped, provision being possible for the further expansion of the system to monitor on four additional channels. Should an ultimate of twenty-two channels be required, the step-by-step selector switch 250 could be replaced by a larger switch having twenty-two terminals in its arc rather than ten as disclosed.

Three intermediate frequency channels 207, 208 and 209 are provided each comprising an intermediate frequency amplifier, second detector, audio frequency amplifier and power unit as indicated by the boxes. Two of these channels 207 and 208 are connected on their output sides to service channels and the third or monitoring channel 209 is connected on its output side to a monitoring device such as the loud-speaker 210.

Associated with each high frequency channel are three switching relays and two three-position keys. The switching relays associated with each channel are effective when operated to connect the output circuit of the particular channel with the input circuit of any one of the three intermediate frequency channels 207, 208 or 209. For example, relay 211 when operated connects channel 201 to service channel 207; relay 221 when operated connects channel 201 to service channel 208; and relay 231 when operated connects channel 201 to the monitoring channel 209. Similarly relay 212 is effective to connect channel 202 to service channel 207, relay 222 is effective to connect channel 202 to service channel 208 and relay 232 is effective to connect channel 202 to monitoring channel 209.

One key associated with each channel controls the operation of two of the switching relays to connect the channel with either one of the two service channels and to connect the screen grid and plate conductors of the high frequency channel to the power unit of the service channel to which it becomes connected. The second key associated with each channel controls the operation of the third switching relay to connect the channel with the monitoring channel and to provide for the skipping of the channel in the manner to be later described. For example, key 241 when operated to its lower position establishes the operating circuit of switching relay 211 and connects the screen grid conductor S and plate conductor P for channel 201 to the screen grid and plate supply leads S and P extending from the power unit of the service channel 207. When key 241 is operated to its upper position, it establishes the operating circuit of switching relay 221 and connects the screen grid and plate conductors S and P of channel 201 to the screen grid and plate supply conductors S and P extending from the power unit of service channel 208. When key 251 is operated to its upper position, it establishes the operating circuit of switching relay 231 and closes a circuit for relay 258 to arrest the operation of selector switch 250 and when operated to its lower position establishes a circuit to cause the selector switch 250 to pass by channel 201 in its routine operation as will be later described. The keys associated with the other high frequency channels perform similar functions as will be obvious from an inspection of the drawings.

The selector switch 250, having a stepping magnet 257, is provided for operating the switching relays 231, 232, 233—236 in rotation to successively connect the high frequency channels 201, 202, 203—206 to the monitoring channel 209. The lamps 261, 262, 263—266 are also lighted in succession by the step-by-step advance of the selector switch to indicate to the monitor which channel is at any instant connected to the monitoring channel.

Direct current for operating the switching relays, lamps, selector switch and selector switch control relays 258 and 259 is supplied to the negative bus-bar 217 by the full-wave rectifier 218, for example of the copper oxide type, which is fed from the alternating current commercial power lines 219 and 220 through the control key 227 and the transformer 278. To insure that the selector switch 250 will step quickly from position to position and pause for a predetermined interval in each position, the polarized stepping relay 259 is provided, the operation of which is controlled by the charging and discharging of condenser 228. The charging and discharging of condenser 228 is controlled by the full-wave rectifier 229 which may also be of the copper oxide type and which is fed from the power lines 219 and 220 through the transformer 230 under the control of the self-interrupting heat coil relay 237.

To guard against the transfer of extraneous operating frequencies, generated in the operating circuit, to the high frequency channels, filters such as 238 to 240, 247 to 249, etc. each comprising a series inductance and two grounded condensers are provided. The filter 238 is connected between the negative bus-bar 217 and one terminal of each of the switching relays and the other filters are connected between the other terminals of the switching relays and the positive bus-bar or ground.

Having now described the apparatus of the monitoring system disclosed in Figs. 2 and 3, the manner in which it functions will now be discussed. To start the operation of the circuit, the key 227 is operated thereby applying power from the supply mains 219 and 220 through the step-down transformer 278 to the input junctions of the rectifier 218 and to the primary winding of transformer 230. The alternating current applied to rectifier 218 is rectified thereby to apply negative 24-volt direct current potential over one of its output junctions to bus-bar 217 and to apply positive potential to its other grounded output junction. This direct current will thereupon flow from the positive junction of the rectifier through high resistance 260 and the winding of polarized relay 259 to the negative junction but relay 259 will not operate to close its front contact since it is biased by this current against its back contact. With the heat coil relay 237 unenergized and the bi-metallic contact element controlled thereby cold and engaging its back contact, the application of alternating current to the primary winding of step-down transformer 230, induces current in the secondary winding thereof which is bridged across the input junctions of rectifier 229 over the left back contact of relay 258 and the back contact of heat coil relay 237. The winding of heat coil relay 237, also bridged across the input terminals, become energized to heat its bi-metallic contact element and a direct current potential of approximately 14-volts is produced across the output terminals of the rectifier 229.

With 14-volts negative potential applied from rectifier 229 through resistance 267, to one side of condenser 228 and negative potential of 24-volts applied through the winding of relay 259 to the other terminal condenser 228, the condenser charges through the winding of relay 259 and since the charging current now flowing through the winding of polarized relay 259 will overcome the biasing current supplied to the winding of this relay from the rectifier 218, relay 259 will thereupon immediately operate its armature to its front contact to close the operating circuit of stepping magnet 257. This circuit may be traced from bus-bar 217 through the winding of magnet 257 to ground at the front contact of relay 259. After an interval determined by the capacitance of condenser 228 and the value of resistance 267 condenser 228 will become fully charged and charging current will cease to flow through the winding of relay 259. The biasing circuit of relay 259 will thereupon become effective to operate the relay to open the circuit of magnet 257. Magnet 257 thereupon quickly advances wiper 268 of switch 250 one step.

When the winding of heat coil relay 237 has been energized for an interval, and its bi-metallic element has become sufficiently heated it will open its normally closed contact thereby disrupting the input circuit of the rectifier 229. With no potential across its output terminals the charge on condenser 228 now leaks off through resistance 267 and through the rectifier 229 to ground. The circuit through the winding of heat coil relay 237 being opened, its bi-metallic now cools and after an interval recloses the input circuit of rectifier 229. This cycle of operations will now be repeated so long as switch 227 is maintained closed causing switch 250 to step its wiper 268 quickly from terminal to terminal with a pause on each terminal determined by the operating time of the heat coil relay 237 and the charging time of condenser 228.

It will be assumed that at the time switch 227 was closed, the wiper 268 was standing on the No. 1 terminal of its arc. With all of the channel keys in their normal positions a circuit is now established from the negative bus-bar 217 through filter 238, winding of switching relay 231, filter 239 and in parallel therewith through signal lamp 261 over the left normal contacts of key 241 to the left normal contacts of key 251, conductor 271, terminal and wiper 268 of switch 250 to ground at the right back contact of relay 258. Relay 231 operates and lamp 261 lights.

Relay 231 upon operating opens its upper back contacts thereby removing ground from its upper active contacts which ground normally shields the relay contacts against the leakage of high frequency energy across them, establishes over its upper front contacts the continuity of the intermediate frequency conductor IF, between the output of high frequency channel 201 and the input of the intermediate frequency monitoring channel 209, establishes over its lower front contact and the lower back contacts of switching relays 211 and 221, the continuity of the biasing conductor B between the output of channel 201 and the input of monitoring channel 209, and at its lower back contact intercepts the connection between the biasing conductor B and the blocking bias conductor BB over which the receiving channel 201 was blocked against operation by blocking bias supplied from the power unit of the monitoring channel 209.

With the blocking bias removed and screen grid and plate potentials supplied over supply conductors S and P and the right normal contacts of key 241 from the power unit of the monitoring channel to the high frequency channel 201, this high frequency channel is in condition for reception. If then reception is received, such reception will be transmitted to the monitoring channel 209 and be made manifest by a signaling tone or voice in the loud-speaker 210.

The monitor hearing the tone or voice reception and noting the lighted lamp 261, is apprised of the fact that reception is being received over the first high frequency channel 201. He will then operate key 241 to either its upper or lower position dependent upon the availability of an intermediate frequency service channel. It will be assumed that service channel No. 1 is available and that the key is operated to its lower position, thereby opening at its lower left normal contact the previously traced circuit of relay 231. Relay 231 upon releasing disconnects channel 201 from the monitoring channel 209. At its inner lower left alternate contact, key 241 establishes the operating circuit of switching relay 211 which may be traced from bus-bar 217 through filter 238, winding of relay 211, filter 240, contacts of key 241 to ground. Relay 211 upon operating functions in the same manner as relay 231 to establish the continuity of conductors IF and B between the output of channel 201 and the input of intermediate frequency channel 207 whereby a service connection is established to the No. 1 service channel. At its lower right contacts key 241 transfers the screen grid and plate potential supply conductors S and P of channel 201 from the power unit of the monitoring channel 209 to the power unit of the intermediate frequency service channel 207. At its outer lower left contact key 241 also establishes a circuit for immediately advancing the selector switch 250 to its next position for monitoring on the second high frequency channel 202. This circuit may be traced from bus-bar 217, winding and interrupter contacts of stepping magnet 257, conductor 269, lower left alternate contacts of key 241, left normal contacts of key 251, conductor 271, terminal and wiper 268 of switch 250 to ground at the back contact of relay 258.

With switch 250 now in position 2 a circuit is established from bus-bar 217, filter 238, winding of switching relay 232, filter 247, and in parallel therewith through lamp 262, left normal contacts of key 242, left normal contacts of key 252, conductor 272, No. 2 terminal and wiper 268 of switch 250 to ground at the back contact of relay 258. Relay 232 operates and lamp 262 lights. Relay 232 upon operating functions in the same manner as relay 231 to establish the continuity of conductors IF and B between the output of channel 202 and the input of the monitoring channel 209 and to remove blocking bias normally applied from the power unit of the monitoring channel over conductor BB and the lower back contact of relay 232 to the biasing conductor B of channel 202.

With the blocking bias removed and the screen grid and plate potentials supplied over supply conductors S and P and the right normal contacts of key 242 from the power unit of the monitoring channel to the high frequency channel 202, this high frequency channel is conditioned for reception. The lamp 262 being lighted the monitor is apprised of the fact that the monitoring channel is associated with the second high frequency channel 202. It will be assumed that the monitor is not certain from the operation of the loudspeaker 210 whether reception is in fact being received over channel 202 and wishes to make a longer test than would be possible during the interval that the selector 250 normally pauses in any of its monitoring positions. The monitor will therefore operate key 252 to its upper position thereby establishing a holding circuit for switching relay 232 to maintain channel 202 connected with the monitoring channel. This circuit may be traced from bus-bar 217 through filter 238, winding of relay 232, filter 247, left normal contacts of key 242, upper left alternate contacts of key 252 to ground. Lamp 262 is also maintained lighted over a parallel branch of this circuit. At its upper right contacts key 252 establishes a circuit from ground over conductor 270 through the winding of relay 258 to the bus-bar 217. Relay 258 opens the current supply circuit through the rectifier 229 and relay 237 to stop the further operation of the selector switch and removes ground from wiper 268 to insure against the operation of the switching relay 233 and the lighting of the lamp 263 of the next channel should switch 250 be advanced another step.

The monitor may now wait for a sufficient time to convince him as to the presence of reception on channel 202. It will be assumed that he hears no signaling tone or voice reception from the loudspeaker 210 and therefore restores key 252 to its normal position thereby releasing relay 258. The selector switch circuits are now conditioned for operation and in due course switch 250 advances its wiper 268 to the next position. Wiper 268 upon leaving its No. 2 terminal opens the operating circuits of switching relay 232 and lamp 262 and since the holding circuits for this relay and lamp have been opened by the restoration of key 252, relay 232 releases to disconnect channel 202 from the monitoring channel 209 and lamp 262 becomes extinguished. When wiper 268 engages its No. 3 terminal a circuit is completed from bus-bar 217 through filter 238, winding of switching relay 233, filter 248 and in parallel through lamp 263, left normal contacts of keys 243 and 253, conductor 273, wiper 268 to ground at the back contact of relay 258. Relay 233 now operates to connect channel 203 to the monitoring channel and lamp 263 lights to apprise the monitor that such monitoring connection has been established. In a similar manner the fourth and fifth high frequency channels, not shown, are connected with the monitoring channel as the selector switch advances through its fourth and fifth positions. It will be assumed that upon the association of each of these channels with the monitoring channel, no reception is indicated by the loud-speaker 210.

When switch 250 reaches its sixth position, a circuit is established from bus-bar 217 through filter 238, winding of switching relay 236, filter 249, and in parallel through lamp 266, left normal contacts of keys 246 and 256, conductor 276, wiper 268 to ground at the back contact of relay 258. Relay 236 now operates to connect the No. 6 channel 206 to the monitoring channel and lamp 266 lights. It will now be assumed that a signaling tone or voice reception is produced by the loud-speaker 210. The monitor hearing this tone or voice reception and noting that lamp 266 is lighted is apprised of the fact that the reception is being received on channel 206 and will proceed to connect channel 206 with a free intermediate frequency service channel. If channel 208 is available he will operate key 246 to its upper position thereby opening at its upper left normal contacts the previously traced circuit of relay 236. Relay 236 upon releasing disconnects channel 206 from the monitoring channel 209. At its inner upper left alternate contacts, key 246 establishes an operating circuit for switching relay 226 which may be traced from bus-bar 217 through filter 228, winding of relay 226, filter 277, contacts of key 246 to ground. Relay 226 upon operating establishes the continuity of conductors IF and B between the output of channel 206 and the input of intermediate frequency channel 208 whereby a service connection is established to the No. 2 service channel. At its upper right contacts, key 246 transfers the screen grid and plate potential supply conductors S and P of channel 206 from the power unit of the monitoring channel 209 to the power unit of the service channel 208. At its outer upper left contact, key 246 also establishes a circuit for immediately advancing the sequence switch 250 to its next position. This circuit may be traced from bus-bar 217, winding and interrupter contacts of stepping magnet 257, conductor 269, upper left alternate and lower left normal contacts of key 246, left normal contacts of key 256, conductor 276, wiper 268, to ground at the back contact of relay 258.

Since only six of the possible ten high frequency channels have been equipped, as soon as wiper 268 advances to its seventh terminal position it is immediately advanced to its first terminal position, over a circuit extending from bus-bar 217, winding and interrupter contacts of stepping magnet 257, strapped terminals and wiper 268 of switch 250, to ground at the back contact of relay 258. With the wiper 268 now positioned on the first terminals of its arc, monitoring on the first high frequency channel now proceeds. If the first channel is still connected with the No. 1 service channel and key 241 is still operated to its lower position, switch 250 will pass by this channel quickly without operating the switching relay 231 as the circuit of this switching relay will be open at the lower left normal contacts of key 241. The circuit by which the switch 250 is advanced into position 2 may be traced from bus-bar 217, winding and interrupter contacts of magnet 257, conductor 269, lower left alternate contacts of key 241, left normal contacts of key 251, conductor 271, wiper 268, to ground at the back contact of relay 258.

The switch 250 then proceeds in the manner previously described to connect the high frequency channels to the monitoring channel in rotation so long as the key 227 is operated.

Should it be desirable to skip monitoring on any channel at any time, the monitor may do so by operating the second key associated with that channel to its lower position. For example, should the key 251 of the first channel 201 be so operated, when the switch 250 reaches its first position in which monitoring on that channel would ordinarily be made, a circuit is established for immediately advancing the switch to its second monitoring position which circuit may be traced from bus-bar 217, winding and interrupter contacts of stepping magnet 257, conductor 269, lower left alternate contacts of key 251, conductor 271, first position terminal and wiper 268 of switch 250 to ground at the back contact of relay 258.

What is claimed is:

1. In a signaling system, a plurality of high frequency receiving channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, switching means for connecting said high frequency channels in rotation to said monitoring channel, and manually operated switching means for connecting any one of said high frequency channels to any one of said intermediate frequency service channels.

2. In a signaling system, a plurality of high frequency receiving channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allotted respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel, and manually operable means for controlling the relays of the other groups to connect any one of said high frequency channels to any one of said intermediate frequency service channels.

3. In a signaling system, a plurality of high frequency receiving channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allotted respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, a signal associated with each high frequency channel, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel and to successively operate said signals to indicate when each high frequency channel is associated with said monitoring channel, and manually operatable means for controlling the relays of the other groups to connect any one of said high frequency channels to any one of said intermediate frequency service channels.

4. In a signaling system, a plurality of high frequency receiving channels over which different signaling frequencies identifying different transmitting stations may be received, a plurality of intermediate frequency channels, certain of which are used for completing service connections

and one of which serves as a monitoring channel, a plurality of responsive devices connected to the output of said monitoring channel, each of said devices being responsive to a different signaling frequency, a plurality of banks of signal lamps, each bank of lamps being allotted to one of said high frequency channels, switching means for successively connecting each of said high frequency channels to the input of said monitoring channel and for simultaneously rendering the allotted banks of lamps subject to the control of said responsive devices, and manually operated switching means for connecting any one of said high frequency channels to any one of said intermediate frequency service channels.

5. In a signaling system, a plurality of high frequency channels over which different signaling frequencies identifying different transmitting stations may be received, an intermediate frequency channel, a plurality of transformers associated with the output circuit of said intermediate frequency channel, each tuned to be responsive to a different signaling frequency, a detector tube in the output circuit of each of said transformers, a relay associated with the output circuit of each of said tubes and responsive only to the reception of a particular signaling frequency, a plurality of indicators allotted respectively to said high frequency channels and each comprising a group of relays and lamps controlled thereby, the relays of each of said indicators being selectively responsive to said first relays, and means for successively associating each of said high frequency channels with the input of said intermediate frequency channel and for simultaneously rendering the groups of relays of said indicators successively subject to the control of said first relays.

6. In a signaling system, a high frequency channel over which different signaling frequencies identifying different transmitting stations may be received, an intermediate frequency channel associable therewith, a plurality of transformers associated with the output circuit of said intermediate frequency channel, one of said transformers being untuned and the others of said transformers being tuned to be responsive respectively to different signaling frequencies, a detector tube in the output circuit of each of said tuned transformers, a relay associated with the output circuit of each of said tubes, each of said relays being rendered responsive only to the reception of a particular signaling frequency, a tube in the output circuit of said untuned transformer and effective to increase the bias on the grids of said detector tubes in response to static disturbances or voice frequency currents, and signal lamps selectively responsive to said relays for indicating the identity of the transmitting stations.

7. In a signaling system, a plurality of high frequency receiving channels, an intermediate frequency monitoring channel, a switching relay and a key allotted to each of said high frequency channels, a selector switch, operating circuits for said relays successively established during the advance of said switch whereby said relays are controlled to connect said high frequency channels in rotation to said monitoring channel, and means controlled by the key associated with any one of said high frequency channels to open the circuit of the corresponding switching relay and to cause said switch to pass by such channel without effecting its connection to said monitoring channel.

8. In a signaling system, a plurality of high frequency receiving channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allocated respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel, a key individual to each relay of said other groups for controlling said relays to connect any one of said high frequency channels to any one of said service channels, a skip monitoring relay associated with each high frequency channel and operative when said channel is associated with any one of said service channels, each of said latter relays when operated being effective to cause said switching means to pass by the channel with which it is associated without causing the connection thereof to said monitoring channel.

9. In a signaling system, a plurality of high frequency receiving channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allocated respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel, a key individual to each relay of said other groups for controlling said relays to connect any one of said high frequency channels to any one of said service channels, and means controlled by the operation of any one of said keys to cause said switching means to pass by the high frequency channel with which said operated key is associated without causing the connection of said channel with said monitoring channel.

10. In a signaling system, a plurality of high frequency receiving channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allocated respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel, and a key individual to each relay for controlling said relays to connect any one of said high frequency channels to any one of said intermediate frequency channels.

11. In a signaling system, a plurality of high frequency channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allocated respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel, a key individual to each re-

lay of said other groups for controlling said relays to connect any one of said high frequency channels to any one of said service channels, and a key individual to each relay of said one group for controlling said relays to connect any one of said high frequency channels to said monitoring channel independent of said switching means.

12. In a signaling system, a plurality of high frequency channels, a plurality of intermediate frequency channels, certain of which are used for completing service connections and one of which serves as a monitoring channel, a plurality of groups of switching relays, said groups of relays being allocated respectively to said intermediate frequency channels and each comprising as many relays as there are high frequency channels, automatic switching means for operating the relays of one group in rotation to successively connect said high frequency channels to said monitoring channel, a key individual to each relay of said other groups for controlling said relays to connect any one of said high frequency channels to any one of said service channels, a key individual to each relay of said one group for controlling said relays to connect any one of said high frequency channels to said monitoring channel independent of said switching means, and means controlled by any one of said keys for causing said switching means to pass by the channel with which the operated key is associated.

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