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RADIO SWITCHING SYSTEM

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1. The present invention relates to remote control or remote switching systems, and particularly, to such a system used for the control of a plurality of radio transmitters and receivers from a number of control stations. A telephone handset and dial are provided at each control point, and the radio transmitters and receivers are coupled together in pairs or units, with a transmitter and a receiver in each unit. These radio transmitters and receivers would ordinarily, in the application envisaged, be located at some central point, together with the switching equipment and one or more attendants as required.

Another object of the invention is the provision of a flexible system of control whereby any one of a large number of such transmitter-receiver units may be selected from any control station, connected to the telephone of such station for two-way communication, and adjusted remotely to the desired wave length or frequency channel.

Another object of the invention is to provide the attendant or attendants with similar means of control, but incorporating special facilities not available to the regular control stations.

Still another object of the invention is the provision of intercommunication service between the control and attendant stations, and, if desired, connections with an automatic telephone switchboard.

One feature of the invention is the division of the radio transmitter-receiver units into two groups, with the units of one group controllable from the regular control stations through the wipers of a dial controlled stepping switch, while the units in the second group, whose frequencies are set in advance, are selected by means of quick select relays in the stepping switch, operated directly from a multi-point contact switch at the control station, which is set by hand to select the unit desired.

Another feature of the invention is the use of a separate dial-controlled stepping switch for each control station and each attendant station, with the radio units of both groups connected to the banks of all stepping switches, but the units of the second group made artificially busy in the banks of the control station stepping switches.

A further feature of the invention is the use of special arrangements in the attendant station stepping switches whereby the units of either group can be seized and operated by the attendant station even if already in use.

Another feature of the invention is the employment of a quick means of cross connection of units, as by means of patch cords, whereby any unit can be transferred from one group to another by a simple operation.

Other objects and features of the invention will be apparent from the description to follow and the accompanying drawings which illustrate one form of the said invention. It will be of course understood that numerous modifications may be made in the arrangement shown without departing from the spirit and scope of the invention.

With reference to the drawings, Figure 1 shows a portion of a control station and a portion of the associated stepping switch. Figure 2, which goes to the right of Figure 1, shows a number of control relays and patching jacks normally associated with a given transmitter-receiver unit, and Figure 3, which goes to the right of Figure 2, shows a part of the frequency selecting equipment required for each unit. The radio equipment proper has not been shown, since its exact form is not material to the invention. Figure 4, which goes below Figure 1, shows another portion of the control station equipment and another part of the associated stepping switch. Figure 5, which goes to the right of Figure 4, shows the equipment at the attendant station for handling incoming calls to the attendant, together with an alternative impulse receiving arrangement for the frequency selecting equipment of the radio units.

In connection with Figure 1, the control station equipment is shown at the left, behind the broken line 48, and comprises a telephone, a dial 17, and a telegraph keying jack 19 for sending Morse code if desired. The telephone is preferably of the handset type, with a press-to-talk button 16 in the handle and a side-tone circuit so the speaker can hear the sound of his own voice and thus know his instrument is working. A loudspeaker, not shown, is also indicated as being connected to this telephone, through back contacts of the press-to-talk switch.

The stepping switch is a two motion switch having vertical and rotary movements, such as commonly employed in automatic telephone systems. The vertical magnet 121 may be seen in the lower central part of Figure 1, the rotary magnet 132 at the lower right and the release magnet 104 at the lower left. A talking circuit is shown in the upper part of Figure 1 and the wipers and bank contacts at the extreme right. Eleven relays are also shown in this figure, including a pulsing relay 100, a release relay 105, a vertical transfer relay 110, a battery feed line relay 115, a busy relay 120, a differential line relay 130, a switching relay 140, rotary transfer
relays 150 and 155, a cut-off relay 160, and a rotary interrupter relay 165. The attendant station has a switch similar to that used for control stations except for a special over-ride conductor 118, and special connections to the pulsing and test bank contacts such as indicated at 192A, 194A and 197A. It may or may not be provided with quick select equipment.

In Figure 2, the talking circuit and the four control relays normally associated with a particular receiver-transmitter unit are shown connected to a particular set of bank contacts in the switch. This talking circuit and the various other circuits controlled by these relays are connected to the associated radio unit through the patching jacks shown on the right of the relays. By plugging patching cords into these jacks, in case of trouble for example, the normally associated unit can be quickly disconnected and a different unit connected up in its place, the various jack contacts being opened upon the insertion of the plugs of the patching cord into the jacks, and the circuits connected straight through. At the lower left of Figure 2 is indicated another set of patching jacks for connecting the required radio units to the quick select circuits of the stepping switches. The talking circuit of each unit is multiplied to several jacks in the upper row, while the quick select circuits of the different stepping switches are connected individually to the jacks of the lower row. This permits several control stations to come in on the same unit over this path at the same time. When a patch cord such as 214 is plugged into an upper jack such as 215, a busy lamp such as 213 is lighted, and busying relay 210 is operated. The other control relays are a cutoff relay 220, a hold relay 230, and a talk-listen relay 240.

In Figure 3, the rectangular 313 and 353 represent a radio receiver and a radio transmitter making up a single radio unit. Identical channel selecting circuits, comprising four relays and a ten point stepping switch commonly known in automatic telephone practice as a minor switch, are indicated in schematic form in each rectangle. Relays 310 and 350 are pulsing relays, relays 320 and 390 are wiper guarding relays, relays 330, 340, 370 and 380 are pulse absorbing relays, and the minor switches are indicated under the brackets 315 and 355. Four leads are shown going to the receiver from the switching and control equipment: namely, a pair of incoming speech leads 330 and 390 terminating in the receiver output transformer 314, a pulsing conductor 302, and a locking conductor 303, which is required only when the channels to be selected exceed ten. Similarly, six leads go to the transmitter from the switching and control equipment: a pair of outgoing speech leads 330 and 391 terminating in the transmitter input transformer 334, a pulsing conductor 307, a locking conductor 308, which goes to a keying relay, and a switch talk conductor 309, whose function is to prepare the transmitter to handle speech. The radio circuits themselves are not shown, since they form no part of the invention.

In Figure 4, the control station quick-select hand switch is shown at the left, behind the broken line 50. Each of the two contact arms of this switch is connected to a pair of combination relays 400 and 410, and 420 and 430, the relays of each pair being wired in series with each other and in shunt with oppositely poled dry disc rectifiers. The other side of each pair of relays is taken to a grounded source of alternating current such as the transformer 408. The contacts of the quick select switch are connected to direct ground, to ground through a dry disc rectifier such as 25 poled to pass positive half cycles of current, to ground through a dry disc rectifier such as 26 poled to pass negative half cycles of current, or are simply left open. Thus, for different settings of the contact arms, which are arranged to move together as a unit, the relays 400 to 430 and their dependent or slave relays 440 to 490 are operated in different combinations to make the required selection. Direct ground on a contact arm, for example, will cause alternating current to pass through the relays of the associated pair of relays, causing them both to operate, whereas an absence of ground will cause neither to operate. Positive half cycles of current on the other hand, through rectifier disc 25, will cause the first relay of the associated pair to operate, and negative half cycles through rectifier disc 26 will cause the second relay only, to operate, by the bucking and shunting effect of the disc associated therewith.

A total of fifteen relay combinations and fifteen selections are made possible with the equipment indicated. It will be apparent however, that by the use of additional relays and a gang switch with more contact arms and more contacts, or by using a bank of keys or push buttons instead of a contact switch, this number could be increased materially. The complete list of combinations used herein is shown in the following table:

<table>
<thead>
<tr>
<th>Switch Position</th>
<th>Relays Operated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>400, 410, 420, 430</td>
</tr>
<tr>
<td>2</td>
<td>400, 410, 420</td>
</tr>
<tr>
<td>3</td>
<td>400, 410, 430</td>
</tr>
<tr>
<td>4</td>
<td>400, 410, 430</td>
</tr>
<tr>
<td>5</td>
<td>400, 410</td>
</tr>
<tr>
<td>6</td>
<td>400, 420</td>
</tr>
<tr>
<td>7</td>
<td>400, 430</td>
</tr>
<tr>
<td>8</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>9</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>10</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>11</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>12</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>13</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>14</td>
<td>400, 430, 420</td>
</tr>
<tr>
<td>15</td>
<td>400, 430, 420</td>
</tr>
</tbody>
</table>

In Figure 5, the equipment at the left is the intercommunicating equipment required at the attendant station. The upper portion is for calls made through the banks of the stepping switches, and the lower portion for calls made by way of the quick select relays. Separate repeating bells 555 and 556 are employed, together with separate signal buzzers 512 and 532, separate signal lamps 513 and 553, and separate battery feed relays 510 and 550. The attendant's telephone, not shown, may be connected to either circuit through the answering key 54. This could be the same phone used by the attendant for radio calls, but it is assumed here to be a separate instrument. In the case of several attendant stations, a quick select circuit could be assigned to each, thus reducing the number of circuits available for radio selections over this path, or a single quick select circuit could be made available for calling the head attendant, with the other attendant stations accessible only through the banks of the stepping switch.

On the right hand side of Figure 5 is shown the alternative pulse receiving arrangement already.
entitled, for controlling the channel selecting[justification]
  performance of the radio unit. In case it is de-
  cided to replace the channel setting minor
  switches at the end of each call, upon release of
  the connection, a circuit such as this is necessary.

1. The channel select circuit of Figure 3, the
  minor switches remain in the last operated po-
  sition until the next call, when they release at the
tart of the new channel selecting operation, as will
  be explained.

2. In Figure 5, relays 520 and 560 are the pulsing
  relays, relays 530 and 570 are release
  relays, and relays 540 and 580 are wiper
  relays guarding relays. The minor switches, which are
  identical with those of Figure 3, are indicated by
  the numbers 523 and 566. The same leads are
  required to these circuits also, as for those of
  Figure 3 but the pulse lead to the transmitter
  is connected therein to ground rather than to the
  pulsing relay, which is now in multiple with the
  transmitted line.

Both types of channel selecting circuits may be used if desired, in the same
installation.

Control station call to first group

In the operation of the system, an operator at
a control station, in order to initiate a radio call through
a radiotube of the first group, removes the hand-
set from the telephone, thereby causing the
common switch 16 to close its contacts. This
causes pulsing relay 160 to operate from ground
at the common switch, by way of the impulse
spring 15, and the conductor 32. Relay 100 upon
operating, closes make contacts 101 and 102, but
without effect at the moment, and at make con-
acts 103 closes an obvious circuit to release relay
105 which operates. Release relay 105 upon
operating, closes make contacts 106 and 107, but
without immediate effect; at break contacts 107
disconnects ground from the release circuit now
open at vertical off normal springs 144; at make
contacts 109 prepares a local pulsing circuit; and
at make contacts 108 closes a circuit to the lower
wheeling of vertical transfer relay 110, by way of
the normally closed vertical off-normal springs
117.

Transfer relay 110 upon operating, at make
contacts 113 prepares the vertical magnet stopping
and at make contacts 112 connects starting ground to the tone
start conductor 119 which leads to a dial-and-busy-tone unit, not
shown, as commonly used in small automatic
telephone exchanges. This tone unit, which may be nothing more than a buzzer relay
and a pair of interrupter relays, along with a
transformer or a choke coil, thereupon starts
and connects a steady tone to the tone-tube con-
ductor 123 whence it passes through the closed
break contacts 163 and the closed make contacts
111 to the talking conductor 34, through the
receiver 14 and condenser 15 of the calling tele-
phone, and back over talking conductor 33 to
grounded battery through the upper wheeling of
relay 115. This tone serves as notice to the call-
ing station that the equipment is ready for dial-
ing. Interrupted tone is also connected to the
busy tone conductor 128 by the tone unit at this
time, but this is without effect, due to the open
make contacts 121 on the busy relay.

The operator at the control station, upon hear-
ing the dial tone, operates the dial twice to select
the desired radio transmitter-receiver unit. On
the first pull of the dial, as soon as the dial moves
off normal, the shunt springs, which are the
upper three springs on the dial, close and connect
ground to both of the talking or line conductors
30 and 31. The ground on the lower conductor
31 shuts the lower windings of relays 115 and
130, while the ground on the upper conductor
energizes the upper windings of these relays, and
causes them to operate in series. Both of these
relays operate and close their make contacts 116
and 131, but without effect at this time.

The dial 17 upon being released, returns to
normal and at its impulse springs 19 interrupts
the circuit of the operated pulsing relay 100 the
digit dialled. The pulsing relay 100 follows these dial
pulses and reverses the position of its contacts
a corresponding number of times. Contacts 101
and 102 are still without effect, due to the open
make contacts 144 and 146 on the switching relay.

Break contacts 103 of relay 100, however, repeat
the dial pulses by way of make contacts 105 and
113 to the vertical magnet 127 and the upper
wheeling of relay 110 which are now connected
in parallel. The vertical magnet operates inter-
mittently in response and at each operation raises
the switch shaft and wipers one step until they
are opposite the desired level of bank contacts.

At the first step, the vertical off normal springs
117 shift position and open the operate circuit
to the lower wheeling of relay 110 which is now
held through its upper winding. The circuits of
relays 105 and 110 are opened and closed inter-
mittently during the pulsing, but these relays
remain operated during these momentary inter-
ruptions, due to having been made slow to release
by the use of copper sleeves over their core.

When the dial reaches its normal position
again, the dial shunt springs open, and release
relays 115 and 130, and the impulse springs close
and remain closed, thereby holding relay 105.

Transfer relay 110 after a short delay now
releases, and at break-make contacts 113 discon-
nects the now open pulsing circuit from the verti-
cal magnet 127 and connects it to the rotary
magnet 132. Relay 110 also at make contacts 111
disconnects the dial tone from the line and at
make contacts 112 removes ground from the tone
start conductor, whereupon the tone equipment
will stop operating, provided of course that the
tone start lead is not grounded at this time from
some other switch.

Upon the second operation of the dial, the
movement of the dial off normal again closes the
dial shunts, which again causes relays 115 and
130 to operate in series over their upper wind-
ings. Upon the release of the dial, impulse
springs 19 again interrupt the circuit of relay 100
intermittently, and this relay follows the pulses
as before. Upon the first release of relay 100 at
the start of the second series of impulses, a cir-
cuit is closed to the rotary magnet 132 as fol-
loows: ground at break contacts 103, make contacts
109, break contacts 113, break contacts 125, 148
and 167, and the winding of magnet 132 to nega-
tive battery. A branch of this circuit also passes
through the winding of rotary transfer relay 150.
Relay 150 and the rotary magnet thereupon
both operate. Relay 150, at break contacts 151
disables the circuit of the interrupter relay 165, at
make contacts 152 closes a shunt around break
contacts 126 and 143 to prevent interference with
the pulsing by the busy and switching relays, and
at make contacts 122 closes an obvious circuit
to rotary transfer relay 155, which also operates.

Transfer relay 155 upon operating closes make
springs 158, but without effect, and at break-
make contacts 157 momentarily disables the oper-
ate circuit of the switching relay 140 and pre-
pares a circuit for the busy relay 120. The rotary magnet now operates intermittently in response to the pulses, and at each operation rotates the wipers into the selected level in the switch bank until the bank contacts of the selected radio unit, such as the contacts 130 etc. shown in Figure 1, are reached. Transfer relay 130 remains operated during the pulse interruptions, since it is made slow to release through the use of a copper sleeve over the core.

At the end of the second digit, pulsing relay 105 remains operated as before, and relays 115 and 130 again release, without effect. Transfer relay 150 also releases, after a short delay, and opens the circuit of transfer relay 155 which also releases, after a still further short delay, since it also is made slow to release. Assuming that the called unit is not in use, and is not otherwise made busy, test contact 190 in the switch bank will have negative battery on it, through the upper winding of the hold relay 230. Upon the release of rotary transfer relay 155, the closing of break contacts 155 completes a circuit for the operation of switching relay 140 in series with relay 230 as follows: ground at make contacts 105, break contacts 125, upper winding of relay 140, break contacts 165, test wiper 165, test contact 104, conductor 202, busying key 236, break contacts 211, and the upper winding of relay 230 to battery. Relay 230 upon operating, extends ground from make contacts 231 and 232 through the patching jacks to the hold conductors 305 and 306. Relay 140 upon operating, at make contacts 147 locks to ground at make contacts 107, and at break contacts 148 disables the pulsing circuit to rotary magnet 132.

Swinging relay 140 also at make contacts 141 and 142 extends the talking circuit from the calling control station to the receiver of the selected radio unit. This circuit is from the line conductors 30 and 31, through the repeating coil 135, make contacts 141 and 142; break contacts 161 and 162, switch wipers 167 and 169, bank contacts 158 and 150, conductors 200 and 201, through the repeating coil 235, break contacts 241 and 242, the upper patching jacks, and conductors 300 and 301 to the output transformer 314 in the receiver 313. Relay 140 also, at break contacts 143 disconnects the busy tone circuit, at make contacts 141 and 145 prepares circuits for the unit pulsing relays 310 and 350, and at make contacts 146 connects direct ground to the test wiper 133, to make the called unit busy to the other control stations.

The operator at the calling control station now dials the third or channel selecting digit. When the dial moves off normal, relays 115 and 130 again operate in series over their upper windings as before. This time, the operation of relay 115 is still without immediate effect, but relay 130 upon operating closes separate pulsing circuits to relays 310 and 350. The circuit to relay 310 is from ground at make contacts 131, through make contacts 102; make contacts 165, wiper 161, bank contact 195, conductor 202; break contacts 241, the upper patching jack, conductor 302, and the winding of relay 350 to battery. The circuit for relay 350 is from the same ground at make contacts 121, through make contacts 101 and 144, break contacts of the normal post springs 149, wiper 165, bank contacts 167, conductor 206, break contacts 242, fourth or bottom patching jack, conductor 307, and the winding of relay 350 to battery. Relays 310 and 350 both operate over these circuits, and at make contacts 311 and 351 close obvious circuits to the release relays 32 and 360 which also operate and cause the change selecting switches to release from their last operated position. The release circuits are from the ground at the make contacts 321 and 361 through break contacts 345 and 382, and the closed off-normal springs of each switch to the respective release magnets. Upon the closure of these circuits, both minor switches release immediately, and upon complete restoration to normal, open their off-normal springs.

When the dial is let go, pulsing relay 105 in Figure 1 follows the interruptions of the impulse springs 19 exactly as before, but with different results. The pulsing springs 105 of this relay, for example, are now without effect, since the local pulsing circuit to the vertical magnet 127 is now open at make contacts 113, and the circuit to the rotary magnet 132 is likewise open at break contacts 142. Pulsing springs 105 and 120 however, are now fully effective, and at each interruption open the circuits of the energized pulsing relays 310 and 350 in Figure 3, which pulse accordingly.

At the first release of relays 310 and 350, the pulse absorbing relays 320 and 370 both operate from grounds at the make contacts 321 and 371 through break contacts 322 and 325. Relays 330 and 375 at make contacts 332 and 372 lock operated, and at make contacts 331 and 371 prepare circuits for the pulse absorbing relays 330 and 375.

Upon the re-operation of relays 310 and 350 therefore, at the end of the first impulse, ground through make contacts 311 and 351 in addition to re-energizing relays 320 and 370 which being slow to release, remain operated during the pulse, also passes through make contacts 331 and 371 to the upper windings of relays 340 and 350 which operate. These relays upon operating, at make contacts 343 and 382 lock to the grounds at make contacts 321 and 331, and at make contacts 341 and 381 prepare the circuits of the rotary or stepping magnets.

Upon each subsequent release of the relays 310 and 350, therefore, during the remainder of the pulses, the rotary magnets operate and step the wipers across the banks. Since the first pulse has been absorbed to provide time for the release, as just described; the number of steps taken at this point will be one less than the digit dialed. When the dial reaches normal however, the shut spring opens and relays 115 and 130 release. Relay 105 is of course again in the operated position at this time. Upon the release of relay 130 make contacts 131 open and remove ground from pulsing contacts 131 and 102 and hence from relays 310 and 350. Relays 310 and 350 thereupon release, and at break make contacts 311 and 351 open the circuit of release relays 320 and 380, and close circuits to the rotary magnets by way of closed make contacts 341 and 381. The rotary magnets then upon operate and advance the wipers one additional step. Relays 320 and 380 then release after a short delay due to their slow release characteristics, and at make contacts 321 and 381 open the locking circuits of the pulse absorbing relays which likewise restore and release the rotary magnets. Relays 320 and 380 also at break contacts 322 and 382, and break contacts 323 and 383 close the wiper circuits to the selected tuning elements, such as fixed condensers of various values, in the associated radio receiver and transmitter.

To talk, the operator at the control station
first operates the press to talk key 10. This disconnects the loud-speaker amplifier, and connects the telephone transmitter 13 directly across the line or talking conductors 39 and 31. This closes a direct current circuit over both conductors 39 and 31 as follows: ground through the lower winding of the battery feed relay 115, lower winding of the differential relay 110, lower left hand winding of repeating coil 138, conductor 39, lower winding of the telephone induction coil, and the upper winding of relays 139 and 140 to battery. Relay 115 operates over this circuit, but differential relay 13 does not, due to the fact that its windings are now energized in opposition. A circuit is therefore closed through make contacts 116, releasing the operation of the talkin relay 240. This circuit is as follows: ground through break contacts 31, make contacts 116, and both right hand windings of repeating coil 138 in parallel, make contacts 141 and 142, break contacts 161 and 162, switch windings contact conductors 200 and 201, both left hand windings in parallel of repeating coil 235, and the winding of relay 230 to battery. This is the well known simplex method of control, and does not disturb the balance of the talking circuit, nor interfere with conversation.

Relay 240 upon operating, at break-make contacts 241 and 242 disconnects the speech circuit from the radio receiver and connects it to the radio transmitter input transformer, by way of the third matching condenser and contacts 348 and 358. Relay 240 also, at make contacts 243 extends ground to the switch-talk conductor 309 by way of the lower matching jack. This operates a relay (not shown) in the transmitter which prepares it for speech in a well known manner. The operator now proceeds with the conversation, releasing key 10 and relay 240 as may be necessary, to listen to incoming speech.

To send Morse code, the operator plugs a telegraph key into the keying jack 10, if this has not already been done, and proceeds to tap out the code. Upon each closing of the telegraph key, a keying relay (not shown) in the transmitter is operated over the following circuit: ground at the key jack, through the telegraph key, over conductor 38, make springs 147A, wiper 159, bank contact 198, conductor 298, the lower matching jack and conductor 308 to the keying relay which automatically puts the code on the air. The press to talk key is left normal whenever the telegraph key is used.

If instead of being idle, the called radio unit is in use, or is otherwise made busy, ground instead of battery will be on test contact 184. When therefore, test wiper 193 comes to rest on this contact, at the end of the rotary movement of the switch, this busy ground, which may come through the test wiper of another switch, or also from the make contacts 211 on the buzzing relay 210, or from the buzzy key 235, will cause busy relay 120 in the switch to operate, by way of the wiper 198, and make contacts 157 on the rotary transfer relay. Relay 120 upon operating at make contacts 151, at make contacts 123 prepares a locking circuit for itself, at break contacts 125 opens the operate circuit of switching relay 140, at make contacts 124 prepares the automatic rotary circuit which is not required in this instance, and at break contacts 125 opens the regular pulsing circuit to the rotary magnet. Finally relay 120 at make contacts 121 connects busy tone to the line conductor 31 from conductor 123, by way of break contacts 156 and 143. This busy tone passes through the receiver 14 of the calling telephone where it is audible to the operator, and then through condenser 15, conductor 39 and 31, upper windings of relays 139 and 141 to battery and ground. The calling station must then hang up and try again later.

Control station call to second group

To initiate a radio call through a radio unit of the second group of units, the control station operator must, as previously indicated, use the quick select switch. Assuming for example, that the transmitter-receiver unit indicated in the drawings has been placed in the second group by plugging the patching cord 214 into the patching jack 215, make contacts 216 in the jack 215 will be closed, and therefore the associated lamp 213 will be lit, and the busying relay 210 will be operated. Relay 210, at its break-make contacts 211, will disconnect the upper winding of relay 230 from test condenser 263, and will connect ground to this conductor instead. This will make the associated radio unit busy in the banks of the stepping switches of all of the control stations, and prevent its seizure therefrom by dialing.

To make a call through this unit therefore, the operator at the control station has merely to remove the handset, thus operating relays 160, 165 and 110, and set the quick select switch on its first contact. With the contact arms 21 and 26 on the first contacts, an alternating current circuit is closed through both pairs of relays associated therewith, and all of these relays operate. Considering the upper pair of relays 400 and 410 for example, the positive half cycles of current, if they may be assumed to be moving from left to right, will be opposed by rectifier disc 408 and must pass through the relay 400, but they will be shunted around relay 410 by the rectifier disc 413 which is poled in the opposite direction to disc 403. Similarly, the negative half cycles of current will be opposed by disc 413 and thus forced through relay 410 but will be shunted around relay 400 by disc 403. Both relays will therefore operate over the circuit extending from ground at the first contact, through contact arm 27, conductor 34, relays 408 and 411, and the secondary of the alternating current source transformer to ground. The operation of the lower pair is similar.

The quick select relays 400, 410, 420 and 430 upon operating, at their upper make contacts connect ground to conductor 456 and to cut-off relay 160 which operates. Relay 166 upon operating, at break contacts 161 and 162 opens the switch talking circuit to wipers 157 and 159, and at break contacts 163 opens the dial tone circuit, which was closed upon the operation of relay 119. The quick select relays also, at their make contacts 302, 412, 422 and 432 close direct current circuits to their dependent or slave relays 440, 450, 460, 470 and 480. These latter relays are employed because of the fact that the heavy spring loads involved would be too much for the controlling alternating current relays 400 to 430.

Relays 440, 450, 460, 470 and 480 upon operating, complete a speech circuit from the calling control station direct to the selected radio unit independently of the wipers of the stepping switch associated with the said control station. This circuit is from the control station telephone, over conductors 39 and 31, through the left hand
make contacts 157 to busy relay 120, which will cut off all battery feed relay 1, cut off the switching relay, and connect busy tone to the calling line in the usual manner.

If the attendant telephone is idle however, test wiper 193 will encounter only negative battery through resistor 501 on the test contact. Busy relay 120 therefore will not operate. The moment when transfer relays 150 and 155 restore after the second digit, switching relay 140 operates from this same battery, by way of break contacts 157 and 123 to the ground at make contacts 106. Switching relay 140 upon operating, at make contacts 141 and 142 extends the calling circuit through to the repeating coil 505, at break contacts 143 opens the busy tone circuit, at make contacts 146 connects direct ground to the test wiper, at make contacts 147 locks to ground from make contacts 107.

To signal the attendant, the control station operator will now close the press to talk switch momentarily. This will again complete a direct current loop circuit over conductors 30 and 31, through the transmitter 13 and make contacts 10, for the operation of the busy relay 115. Relay 130, being again energized operate. Now press the number 2, not operate, and ground from break contacts 116, passing through make contacts 116, causes the operation of signal buzzer 512 and the lighting of signal lamp 513, by way of both right hand windings of repeating coil 138 in parallel, through contacts 141 and 142, 161 and 162, wipers 187 and 189, bank contacts 500 and 501, conductors 503 and 504, left hand windings of repeating coil 505 in parallel, and break contacts 511.

When the attendant answers, by removing the receiver or handset from the intercommunication telephone, not shown, a circuit is closed over conductors 514 and 515, through back contacts of the answering key 534 and the right hand windings of repeating coil to battery feed relay 510. Relay 510 operates over this circuit to cut off the signals and at the same time furnishes calling battery to the called telephone. The calling control station operator again operates the press to talk key each time he speaks, in order to connect talking battery from relay 115 to his telephone transmitter.

To call the attendant telephone of Figure 5 by means of the quick select switch, the control station operator, after removing the handset, will set the quick select switch on its #15 contacts. On the removal of the handset, relays 100, 105 and 110 will operate in the usual way, and on the positioning of the quick select switch, contact arm 27 will encounter an open contact so that relays 406 and 410 will remain normal, but contact arm 28 will encounter negative pulsations of current through the rectifier 425, which will cause the operation of relay 430 and its associated relays 470 and 480. Relay 430 also at make contacts 431 will pass ground to cut-off relay 160 which will accordingly operate to cut off the dial tone and disconnect wipers 181 and 189. The speech circuit now extends from the right side of repeating coil 128 through the left side of repeating coil 588, by way of conductors 453 and 454, break contacts 442 and 443, 452 and 454, 464 and 466, make contacts 478 and 488, and conductors 489 and 490 to the left side of repeating coil 508.

To signal the attendant, the control station operator will operate the press to talk key momentarily as before, to operate battery feed relay 115. This again connects ground from break

Control station call to attendant

Assuming a single attendant station, and assuming likewise that the intercommunicating telephone associated with this attendant station is connected to the first contacts of the tenth level in the line banks or speech banks of the control station switches, the control station may communicate with the attendant over this phone by removing the handset in the usual manner and placing it "01" circuit.

Upon the removal of the handset and the closing of cradle switch contacts 16, relays 100, 105 and 110 operate in the manner already described, and on the dialing of the first digit, the vertical magnet 127 responds to the pulsations of contacts 103 and elevates the wipers to the tenth level.

The normal post springs 149 will operate as the wipers reach the tenth level but without effect. Transfer relay 110 then restores, and transfers the pulsing circuit to the rotary magnet 132. The rotary magnet therefore responds to the second digit in the usual manner, and steps the wipers one step into the banks, of which there are six, or one for each wiper. Relays 150 and 155 operate as before, during the rotary stepping. In this position line wipers 187 and 189 are connected to the left side of repeating coil 505 in Figure 5, by way of bank contacts 500 and 501 and conductors 503 and 504, while test wiper 193 is connected to negative battery by way of bank contact 502, conductor 506, and resettor 507. The other wipers are now standing on contacts which are vacant, except perhaps for the bank multiple from the corresponding contacts of the other control switches. Relays 115 and 120 operate as before each time the dial goes off normal and restore after each digit, without effect.

If the attendant telephone is already in use, by a call from another control station, test wiper 193 will encounter direct ground from the other switch on the test contact on which it is standing, which ground will pass immediately through windings of the repeating coil 138 and condenser 139, by induction to the right hand side of the repeating coil 138, conductors 493 and 494, make contacts 442 and 443, 452 and 453, 463 and 464, 473 and 491, conductors 496 and 497, patching jacks and cord, conductors 217 and 216, left hand windings of repeating coil 235, by induction to the right hand windings of the repeating coil, break contacts 240 and 242, the upper patching jacks, and conductors 300 and 301 to the receiver output transformer 314. The channel selecting equipment is not affected, and pulsing relays 310 and 350 remain normal. To talk, the operator has only to operate the press to talk switch in the usual way. This connects up battery feed relay 115 which operates and at the same time provides current for the telephone transmitter. Differential relay 130 remains unoperated as before and at break contacts 131 connects ground to the center point of repeating coil 138 by way of make contacts 116. This ground passes over the conductors 493 and 494 in parallel, and over the new talking circuit to the talk-listen relay 240, which operates to ground the switch talk conductor 300, and transfer the talking circuit from the radio receiver 313 to the transmitter 355. It can then be transferred back and forth by releasing and repressing the talk key, as long as desired. If another control station operator wishes to come in on this connection, he may do so by setting up his quick select switch also on its first contacts. He cannot do so by dialing however.
contacts 131 to the center point of the repeating coil 138. This ground thereupon passes over both sides of the just traced speech circuit in parallel to the center point of the repeating coil 508, and hence through break contacts 561 to the buzzer 552 and the signal lamp 553. The buzzer buzzes and the lamp lights in response, as a signal to the attendant, who answers by removing the handset and operating key 544 down. This causes the operation of the battery feed relay 560 to cut off the signals, and completes the talking circuit between the two telephones as before.

In case a number of attendant station inter-communicating telephones are provided, they will be connected to successive contacts in the tenth level of the control switches, starting with the first contact. In order to provide automatic hunting of an idle telephone, it is necessary also, to start the test contact 562 of each such attendant telephone, except the last, to the corresponding "extra" test contact, corresponding to bank contact 157.

If now an operator at a control station dials "0" to call an attendant, and the first attendant being idle, the operation is exactly as described for a single telephone. If however, the first telephone is busy, the switch will continue to rotate in search of an idle telephone, and will give a busy signal only in case all of the telephones connected to the tenth level are busy.

The action briefly is as follows:

When the control operator dials "0," after removing the handset and listening for dial tone, the vertical magnet 127 again raises the wipers of the switch to the tenth level, which upon the switch shall again cause the operation of the normal post springs 149, thereby connecting wiper 196 to the open make contacts 124 on the busy relay, to prepare the automatic rotary operation. Now when the operator dials the second digit "1," transfer relays 155 and 150 operate, and the rotary magnet 132 steps the wipers into the banks one step.

If the first telephone is busy, ground on the test contact thereof in the banks, will be passed to the busy relay 126 by way of test wiper 193 and end make contacts 124. The busy relay 120 will then operate, will open the switching relay circuit, open the pulsing circuit to the rotary magnet, and prepare the automatic rotary circuit, at make contacts 124. Then, when transfer relay 150 restores, shortly after the cessation of the rotary pulsing, and before transfer relay 155 can release, a circuit is completed for the operation of the interrupter relay 156 as follows:

ground from the test contact in the bank, through the strap connecting it to the associated extra test contact, wiper 155, make contacts of the normal post springs 149, make contacts 124, break contacts 151, make contacts 158, break contacts 133, and the winding of relay 165 to battery.

Interrupter relay 156 upon operating over this circuit, at make contacts 166 locks to ground from make contacts 166, and at make contacts 167 closes an obvious circuit to the rotary magnet 132, which operates and steps the wipers on to the next contacts. A branch of this same circuit also passes through the break contacts 152 to transfer relay 155 and prevents this relay from releasing. The operation of rotary magnet 132 opens break contacts 133, releasing relay 155.

Relay 155 in turn, opens the circuit to the rotary magnet which releases, and to relay 156 which however being slow to release remains operated for an instant. If the next bank contact is also busy, wiper 195 will still encounter ground, and interrupter relay 165 will again operate, re-energizing relay 165 and re-operating the rotary magnet.

If all of the attendant phones are busy, relay 165 and magnet 132 will continue to operate alternately in this manner at high speed until the last contacts of the group are reached, which as previously stated, have no strapping between the test and extra test contacts. The extra test wiper 196 will therefore encounter an open contact, and the stepping will stop. Test wiper 193 however, will still encounter ground, thus maintaining busy relay 120 operated, and when transfer relay 155 releases after a slight delay, the lower contacts of the break-make-before-break springs 157 of this relay will complete a looking circuit for relay 120, by way of make springs 123 and 108. At the same time break contacts 155 close to complete the busy tone circuit.

If the last attendant phone or any intermediate phone is idle however, there will be only negative battery through a resistor such as 507 on its test contact. The rotary stepping will therefore stop at that point, and the telephone busy relay 120 will release. Transfer relay 155 will also release after the usual short delay, and switching relay 140 will immediately operate and lock and switch the talking circuit through to the wipers 183 and 185, whereupon the attendant may be signalled in the manner previously described.

Call from attendant stations

The two motion switches associated with the attendant stations are identical with those associated with the regular control stations except for use of a special "override" conductor 118 leading from the attendant station to the lower winding of the switching relay 140, and special wiring to the bank contacts associated with the pulsing and test wipers 191, 193 and 195, as indicated by the dotted conductors 204, 205 and 207, leading to bank contacts 192A, 195A and 197A.

The automatic rotary feature may also be omitted from these switches, though it may be retained to avoid the use of two different kinds of switches. An override button is provided at each attendant station, by means of which ground may be connected to conductor 118 when desired.

To initiate a call through a radio unit of the first group of units, the attendant removes the handset from the control telephone at the attendant station and on hearing the dial tone, dials the required two digits to select the desired unit, and then dials the third digit to select the channel, just as for a call from a regular control station. The operation of the switch in response to the first two digits dialled is also the same as described for calls from a regular control station.

Assuming that the called radio unit is the one shown in Figure 3 of the drawings, at the end of the rotary pulsing, wipers 187 and 186 will be on bank contacts 188 and 189, wipers 191, 193 and 197 will be on bank contacts 192A, 194A and 197A, and wiper 195 will be on bank contact 195. If this unit is idle, battery through the winding of cutoff relay 120 and the lower winding of hold relay 230 will be on test contact 194A. When therefore, transfer relay 150 and 155 release, shortly after the last rotary impulse, a circuit will be closed for switching relay 140 in series with relays 220 and 235 as follows: ground through make contacts 106, break contacts 125,
upper winding of relay 160, upper break contacts of the break-make-before break springs 151, test wiper 163, test contact 184A, conductor 206, and the windings of relays 220 and 223 in parallel to negative battery. Relays 140, 220 and 223 all operate over this circuit.

Switching relay 140 upon operating, at make contacts 141 and 142, switches the talking circuit through to bank contacts 158 and 159, at make contacts 144 extends the transmitter channel-select pulsing circuit through to wiper 156 and bank contact 157A, and at make contacts 145 extends the receiver channel-select pulsing circuit through to wiper 151 and bank contact 152A. Relay 140 also at make contacts 146 extends direct ground to wiper 153 and bank contact 144.

The other functions of the switching relay are as explained in previous sections. Cutoff relay 220 upon operating, at make contacts 221 and 222 extends the channel-select pulsing circuits through to the pulsing conductors 202 and 203 and the associated pulsing relays 310 and 359. Relay 220 also, at break contacts 221 and 222 disconnects conductors 202 and 203 from these circuits. Both relay 333 upon operating, extends holding ground to the hold conductors 323 and 325 in the usual manner.

When the attendant now dials the third digit, relays 165 and 166 operate from the shunt springs as usual, as soon as the dial moves off normal, and relay 165 at make contacts 131 connects ground simultaneously to both of the aforementioned channel-select pulsing circuits to relays 310 and 359. Both of these relays thereupon operate immediately to release the channel select switches in the manner previously described. When the dial is released, the resulting impulses drive the minor switches to a new position as before, in accordance with the digit dialed. When the dial again reaches normal following the last pulse, relays 115 and 130 release as before, and relay 126 again removes ground from make contacts 101 and 192 and hence from the channel-select pulsing circuits. Relays 310 and 359 and their associated relays then restore just as previously explained, and the minor switches advance break contacts to the final step to compensate for the absorbed initial pulse. The talking circuit is switched from receiver to transmitter in the usual way by operating the talk-listen relay 340 over the speech circuit.

If the called unit is already in use from another attendant station at the time this call is attempted, ground from the other switch will be on test contact 195A and as soon as test wiper 183 lands on this contact busy relay 130 will operate and give the busy signal, and on the release of transfer relay 165 will lock through the lower break contacts of springs 157. The switching relay 140 is at the same time prevented from operating, by the open break contacts of the break-make springs 123. If the second attendant wishes to cut in on the connection, he may so at any time, by operating his override button. This connects ground to conductor 115 and to the lower winding of the switching relay 140 which operates and locks, cuts off the busy signal, and extends the speech and pulsing circuits to the busy unit. The second attendant may either listen or talk on this connection, or both, and may if desired, release and re-position the minor switches of the said radio unit. The first attendant may of course, do likewise.

If the called unit is in use by a regular control station, it will be busy to other control stations, but not to the attendant stations, because of the fact that a busying ground on bank contact 191 is not communicated to bank contact 194A in the attendant's switch. For this reason the attendant's switch would cut through immediately or such a call, from the battery on conductor 206 and the use of the override button would not be required. Cutoff relay 220 would operate to extend the pulsing circuits from the attendant and cut off the pulsing circuits from the control switch. The attendant station may now release and reset the channel select switches of the selected unit without interference from the control station.

If the attendant wishes to make a radio call through the unit of the second group, the operation is similar. Busying relay 240 of the called unit will be operated to ground the associated test contact, such as 145, but this will not affect the corresponding test contact in the bank of the attendant's switch. For this reason, when an attendant station calls such a unit, it is again switched through immediately, and may if desired change the channel select of such unit at will merely by dialing the required third digit.

Alternative pulsing scheme

When the alternative pulsing scheme of Figure 5 is used, the pulsing relays of the receiver and transmitter channel selecting equipment are multiplexed together as indicated in Figure 5 and connected to the upper pulsing conductor associated with the lower pulsing conductor being connected to ground at the transmitter channel selecting equipment.

Now when a selector switch extends a connection to this channel selecting equipment and the associated radio receiver and transmitter, the operation of the switching relay 140 following the dialing of the second digit, immediately causes the operation of the pulsing relays 520 and 560. The circuit for these relays is as follows: ground from the radio transmitter on conductor 317, the lower pulsing jacks, break contacts on the make before break springs 222, conductor 266, bank contact 197, wiper 192, break contacts of the normal post springs 440, make contacts 144, wiper 145, bank contact 192, conductor 262, break contacts of the make before break springs 221, through the second pulsing jacks, conductor 302, and the windings of relays 520 and 560 in parallel.

Pulsing relays 520 and 560 upon operating, close obvious circuits to release relays 530 and 575 which also operate to open the release circuits and prepare the stepping circuit. Now when the channel selecting digit is dialed, each release of pulsing relay 100 causes a corresponding release of pulsing relays 520 and 560, through the interruptions of make contacts 101 and 402. The slow release wiper-guard relays 540 and 580 operate on the first pulse and release shortly after the last pulse to keep the wipers open during the stepping. The rotary magnet operates on the first pulse and on each successive pulse, in parallel with the wiper guard relays. The release relays being also swung relays are not outwardly affected by the pulsing. At the termination of the call, when the connection is released, pulsing relays 520 and 560 also release. The release relays, due to their slow release qualities, remain operated for an instant, permitting the wiper guard relays and the rotary magnets to be again momentarily energized.
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medialement thereafter however the release relays restore and at their break contacts close circuits to the release magnets which operate and restore the wipers to their normal position. As each switch reaches normal, its off normal springs open and open the release circuit.

It will be apparent that the two motion stepping switches herein described may also be utilized to extend calls to an automatic telephone switchboard such as a PAX, provided only that such automatic switchboard pass ground back to the base of the pulsing wiper when seized from such switch. Thus for conductors would be required to the automatic switchboard instead of the more usual three conductors.

What is claimed is:

1. In a remote control system, a first and a second control station, a first and a second selector switch associated respectively with said control stations in the order named, a plurality of multi-channel radio units each including a radio transmitter and receiver, channel selecting devices associated with each said radio unit, a pulse repeating circuit in each said selector switch, an impulsing device at each said control station for operating the associated selector switch to select any one of said multi-channel units, means in said first selector switch to extend the associated pulse repeating circuit to such selected unit if it is free and to prevent such extension if said selected unit is in use, means in said second selector switch to extend the associated pulse repeating circuit to such selected unit whether it is in use or not, and means to repeat further impulses from said impulsing devices over said extended pulse repeating circuits to position the channel selecting devices of said selected unit.

2. In a switching system, a first and a second control station, a first and a second selector switch associated respectively with said control stations, a plurality of multi-channel radio units each including a radio receiver and a radio transmitter, a channel selecting device associated with each said transmitter and each said receiver, a pulse repeating circuit in each said selector switch, a speech circuit from each said control station to its associated selector switch, an impulsing device at each said control station for operating the associated selector switch to select any one of said multi-channel units, means in said first selector switch to then extend the associated speech and pulse repeating circuits to such selected unit if it is not in use, means in said second selector to extend the associated speech and pulse repeating circuits to such selected unit regardless of its condition of use, means to repeat further impulses from said impulsing devices over said extended pulse repeating circuits to the channel selecting devices of such selected units for operating such devices, and means responsive to the selection of any one of said units to disable the pulse repeating circuits from said first selector switch to prevent interference.

3. In a switching system, a control station, a control selector switch associated therewith, an attendant selector associated therewith, a plurality of multi-channel radio units, a radio receiver and a radio transmitter in each said unit, channel selecting devices associated with each said unit, a speech circuit and a pulse repeating circuit associated with each said selector, an impulsing device at said control station for operating the associated selector to select any one of said radio units or said attendant station, means responsive to the selection of an idle one of said units by said control selector to extend the associated speech and pulse repeating circuits to said idle unit, means responsive to the selection of a busy one of said units by said control selector for preventing the extension of the associated speech and pulse repeating circuits to said busy unit and for giving a busy signal to the calling control station, an impulsing device at said attendant station for operating the associated selector to select any one of said units, means responsive to the selection of any one of said units by said attendant selector to extend the associated speech and pulse repeating circuit to such unit even when busy, means to repeat further impulses over the said extended pulse repeating circuits to operate the channel selecting device of the selected unit, and means responsive to the selection of the attendant station by said control switch to extend the associated speech circuit to said attendant station if idle, for purposes of intercommunication.

4. In a radio switching system, a control station, a two-motion switch associated with said control station, a plurality of attendant stations accessible to said control switch, a two-motion switch associated with each said attendant station, a plurality of multi-channel radio units associated with said switch, a radio receiver and a radio transmitter in each said unit, channel selecting devices associated with each said unit, a speech circuit and a pulse repeating circuit in each said switch, an impulsing device at said control station for transmitting impulses to the associated two motion switch to cause said switch to select any one of said radio units or one of said attendant stations, means responsive to the selection of an idle one of said radio units by said control switch and pulse repeating circuits to extend the associated speech and pulse repeating circuits to said idle unit, an impulsing device at each of said attendant stations for transmitting impulses to the associated two motion switch to cause said switch to select any one of said radio units, means responsive to the selection of any one of said units by said attendant switch and pulse repeating circuits to extend the associated speech and pulse repeating circuit to said selected unit even if said selected unit is busy, means to repeat further impulses from said impulsing devices over such last mentioned extended pulse repeating circuit to the channel selecting devices of such selected unit for operating and positioning said last named devices, means responsive to the selection of an idle attendant station by said control switch to extend the associated speech circuit to said idle attendant station, means responsive to the selection of a busy attendant station by said control switch to cause said switch to rotate automatically in search of an idle attendant station, and means to stop said rotation and give a busy signal to the calling station in case all of said attendant stations are busy.

5. In a radio telephone switching system, a first control station, a first stepwise switching mechanism associated therewith, a second control station, a second stepwise switching mechanism associated therewith, a first group of radio units, a second group of radio units, a radio receiver and a radio transmitter in each of said units, a speech circuit extending from each said control station to its associated stepwise switching mechanism, impulsing means at said first control station to operate said first stepwise switching mechanism to select any one of said radio units, means to therewith extend the associated speech circuit to the receiver...
of said selected unit only in case said selected unit is in the first group and is idle, impulsing means at said second control station for operating said second stepping switch to select any one of said radio units, means to thereupon extend the associated speech circuit to the receiver of said selected unit regardless of the group involved and of the condition of use of said selected unit, a relay associated with each said unit, and means for operating such relay at will from the calling control station over such extended speech circuit to transfer the extended speech circuit from the receiver to the transmitter of the selected unit.

6. In a radio switching system, a first control station, a second control station, a first and a second two-motion selector switch associated respectively with said stations, a first and a second group of radio units, a radio receiver and a radio transmitter in each of said units; a pulsing circuit, a speech circuit and a telegraph circuit extending from each said control station to its associated selector switch; impulsing means at each said station for operating the associated switch over the associated pulsing circuit to select any one of said radio units; means responsive to such selection by said first selector switch to extend the associated speech circuit to the receiver of the selected unit and the associated telegraph circuit to the transmitter thereof provided such selected unit is both in the first group and is idle; means responsive to such selection by said second selector switch, for extending the associated speech circuit to the receiver and the associated telegraph circuit to the transmitter of the selected unit, regardless of the group involved and regardless of the busy condition of such selected unit, a relay associated with each said unit; a circuit means controlled from the calling control station over the extended speech circuit for operating said relay to transfer said extended speech circuit to the transmitter of the selected unit and to condition said transmitter for the transmission of speech and control means at said stations to permit the subsequent release and re-operation of said relay over said circuit means as required during the connection.

7. In a radio switching system, a control station, a selector switch; wipers on said switch; a speech circuit and a pulsing circuit extending between said control station and said switch, a first group of radio units accessible to said wipers, a second group of radio units accessible to said wipers but made artificially busy thereto, an impulsing device at said control station for operating said switch over said pulsing circuit to select any one of said radio units, means responsive to the selection of an idle unit in said first group by said wipers to extend said speech circuit through said wipers to such selected unit, a multiple-pulse-hand operated switch at said control station, means controlled by positioning said multiple-pulse-hand switch operating said second switch circuit from said control station direct to any one of said units in said second group independently of said wipers, a radio receiver and a radio transmitter in each radio unit, means controllable from said control station over either of said extended speech circuits for switching said speech circuit back and forth between the receiver and transmitter of the unit involved, and a cross connecting arrangement for quickly transferring any of the units of said second group to said first group and removing the busy condition therefrom.

8. In a radio switching system, a first control station, a second control station, a first and a second two-motion selector switch associated respectively with said stations, a first and a second group of radio units, a radio receiver and a radio transmitter in each of said units; a pulsing circuit, a speech circuit and a telegraph circuit extending between each said control station and its associated selector switch, wipers on each said selector switch, a first and a second group of radio units, a radio receiver and a radio transmitter in each of said units, an impulsing device at each said control station for operating the associated selector switch over the associated pulsing circuit to select any one of said transmitters, means in said first switch responsive to the selection thereof by an idle unit in said first group to extend the associated speech circuit through the wipers of said first switch to such selected unit, means in said second switch responsive to the selection thereof by any unit in either of said groups to extend the associated speech circuit through the wipers of said second switch to such selected unit even if busy, a quick select circuit for said first selector switch, a manually operated multiple-pulse-hand switch at said first control station for operating said quick select circuit to extend the speech circuit of said first control station to any unit of said second group independently of the wipers of said first selector switch, and means in said first selector switch to extend the speech circuit of said first control station to said second control station, either through the wipers of said first switch; or through said quick select circuit.

9. In a remote control system, a first control station, a second control station, a first stepping switch associated with said first station, a second stepping switch associated with said second station, a speech circuit associated with each said control station, wipers on each said stepping switch, a first and a second group of radio units, a radio receiver and a radio transmitter in each of said units, an impulsing device at each said control station for operating the associated stepping switch to select any one of said radio units, means in said first stepping switch responsive only to the selection of an idle unit, the wipers of said first stepping switch to such selected unit, the receiver and transmitter of said selected unit as required for radio communication, a quick select hand operated switch at said control station, quick select relays for said last mentioned switch, and means controlled by said quick select switch for operating said relays in various combinations to extend said speech circuit directly to any one of said units in said second group independently of the wipers of said selector switch.

10. In a radio switching system, a control station, a selector switch; wipers on said switch; a speech circuit and a pulsing circuit extending between said control station and said switch, a first group of radio units accessible to said wipers, a second group of radio units accessible to said wipers, means controllable over said speech circuit for switching said speech circuit back and forth between the receiver and transmitter of said selected unit as required for radio communication, a quick select hand operated switch at said control station, quick select relays for said last mentioned switch, and means controlled by said quick select switch for operating said relays in various combinations to extend said speech circuit directly to any one of said units in said second group independently of the wipers of said first switch to such selected unit, means in said second switch responsive to the selection.
thereby of any unit regardless of the group involved and regardless of the condition of use of such unit to extend the speech circuit of said second station through the wipers of said second switch to the selected unit, a quick select relay circuit in said first switch, a manually operated multi-point contact switch at said first control station for operating said relay circuit to select any radio unit in said second group and extend the speech circuit of said first station thereto independently of the wipers of said first stepping for extending speech circuits to switch such circuit back and forth between the receiver and transmitter of the selected unit as required, means to extend the speech circuit of said first control station to said second control station through the wipers of said second control station to said second control station through said quick select circuit, and means to signal said second station over each of said two last named extended speech circuits.

11. In a remote control system, a first group of control stations, a second group of control stations, a selector switch and a speech circuit associated with each of said control stations, wipers on said switches, a first group of radio transmitter and receiver units, a second group of radio transmitter and receiver units, impulse responsive means for extending the speech circuit of any one of said first group of stations through the wipers of the associated selector switch to any idle radio unit in said first group of units but not to a unit in said second group of units, impulse responsive means for extending the speech circuit of any one of said second group of stations through the wipers of the associated selector switch to any idle radio unit in either group of units and for extending such speech circuits to any busy radio unit in either group of control stations but not if in use by one of said second group of control stations, and other means for extending the speech circuit of any one of said second group of control stations through the wipers of the associated selector switch, if desired, to any busy radio unit in either group in use by another control station in said second group of stations.

12. In a remote control system, a radio transmitter and a radio receiver, a control station, an impulse dial at said control station, a two-motion selector switch, a pulsing relay and a local pulsing circuit in said two-motion switch operated in response to impulses from said impulse dial to cause said selector to seize said radio transmitter and receiver, separate pulse repeating circuits extended to said transmitter and receiver in response to the seizure of said transmitter and receiver by said two motion switch, means in said two motion switch including separate pairs of pulse repeating contacts on said pulsing relay for repeating further impulses from said impulse dial over both of or to either of said repeating circuits simultaneously and means for energizing such circuits during such further pulsing only while said dial is off normal.

13. In a remote control system, a first and a second radio transmitter and receiver unit, an impulse dial, a two-motion selector switch, a pulsing relay and said switch operated in response to impulses from said dial to cause said selector switch to seize either of said transmitter and receiver units depending on the number dialed, a pulse repeating circuit comprising two conductors extended to either of said transmitter and receiver units in response to the seizure thereof by said selector switch, a first and a second impulse receiving set associated respectively with said transmitter and receiver units, means responsive to the seizure of said first transmitter and receiver unit to cause further impulses from said dial to be repeated by said pulsing relay to said first impulse receiving set over both conductors of said pulse repeating circuit simultaneously and for energizing the conductors of said pulse repeating circuit during such further impulses only while said dial is off normal, and means responsive to the seizure of said second transmitter and receiver unit to cause such further impulses to be repeated by said pulsing relay to said second impulse receiving set over only one conductor of said pulse repeating circuit and for energizing said one conductor immediately upon the seizure of said second transmitter and receiver units by said selector switch.

14. In a remote control system, a plurality of control stations, a two-motion selector switch associated with each said control station; an impulse circuit, a speech circuit, and a telegraph circuit extending from each said control station to its associated two-motion switch; impulse repeating circuits in said switches, a plurality of multi-channel radio units, a radio transmitter and a radio receiver in each of said units, a channel selecting device associated with each said transmitter and each said receiver, an impulse device at each said control station for operating the associated two motion switch over said impulse circuit to select any one of said multi-channel units, means for extending said speech and telegraph circuits and at least one of said impulse repeating circuits to said selected unit if it is idle and to prevent such extension if said selected unit is in use, and means to repeat further impulses from said impulse device over said extended impulse repeating circuits or circuits to position the channel selecting devices of said selected multi-channel unit simultaneously.

15. In a radio switching system, a plurality of control stations, a control switch associated with each said control station, an attendant station, an attendant switch associated therewith, a talking circuit between each of said stations and its associated switch, an impulse device at each said station, a pulse repeating circuit in each said switch, a plurality of multi-channel radio units, a radio transmitter and a radio receiver in each of said units, a channel selecting switch associated with each said transmitter and each said receiver, means to pass impulses from the impulse device at any one of said stations to the associated switch and thereby operate said switch to select any desired one of said radio units, means responsive to the selection of a free unit by an operated control switch to extend the associated talking and pulse repeating circuits to said free unit, means for repeating further impulses from the impulse device at the associated control station over said extended pulse repeating circuit to the channel selecting switches of said selected unit to position said switches, means responsive to the selection of a busy unit by said operated control switch for preventing such extension of said talking and pulse repeating circuits and for giving a busy signal to the associated control station, means responsive to the selection of any one of said units by an operated attendant switch to extend the associated talking and pulse repeating circuits to such selected unit.
whether free or not, means for repeating further impulses from the impulsing device at the associated attendant station, over said extended pulse repeating circuit, to the channel selecting switches, of said selected unit to position said switches, and means whereby any one of said control switches may be operated by its associated impulsing device to extend the associated talking circuit from the associated control station to said attendant station.

16. In a remote control system, a control station, a plurality of radio units, a radio transmitter and a radio receiver in each of said units, a pair of relays connected in series, a second pair of relays connected in shunt with each of said relays, the rectifier discs of each pair of relays being also connected in series with each other but poled oppositely with respect to each other, an alternating current source connected to each pair of relays, a multi-point hand operated switch having different positions for operating said relays, in different combinations from said alternating current source to select any one of said radio units, a speech circuit, means operated by such operated relay combination for extending said speech circuit from said control station to such selected radio unit, and means controlled over said extended speech circuit for switching said speech circuit back and forth at will between the receiver and transmitter of said selected unit as required for two way radio communication.

17. In a remote control system, a plurality of radio units for two way radio communication, a control station, a speech circuit associated with said control station, a pair of relays connected in series, a rectifier disc connected in shunt with each of said relays and poled oppositely with respect to each other, another pair of relays arranged similarly, an alternating current source, terminals for said source, connections from one of said terminals to one side of each of said pairs of relays, a hand operated switch at said control station having a plurality of positions, contact arms on said switch connected individually to the other side of each of said pairs of relays; other rectifier discs, a plurality of contacts for each of said contact arms, some of said contacts being connected to the other terminal of said source directly, some of said contacts being connected to said other terminal through differently poled ones of said other rectifier discs, and others of said contacts being left open, said contact connections being made in such a way that for each position of said switch various of said relays are operated in different combinations; and means controlled by said operated combinations of relays for extending said speech initiated from said control station to any desired one of said radio units as determined by the setting of said switch contact arms on said contacts.

18. In a remote control system, a radio transmitter and a radio receiver, impulse responsive relays and stepping switches associated with said transmitter and receiver, a control station, an impulse dial at said control station, a two motion selector switch operated in response to preliminary trains of impulses from said dial to seize said transmitter and receiver and the associated impulse responsive relays, pulse repeating circuits extended to said impulse responsive relays in response to the seizure thereof by said two motion switch, a pulsing relay for said switch, special pulse repeating contacts on said relay for repeating subsequent impulses to said impulse responsive relays over said extended pulse repeating circuits for operating and positioning said stepping switches which remain at the set position until release of the connection, means for energizing said pulse repeating circuits when said dial is moved off normal to initiate further impulses, said stepping switches being released from their previously operated position responsive to such energization, the first of such further impulses being absorbed by said impulse responsive relays to increase the time available for such release, and means for de-energizing said pulse repeating circuits when said dial again reaches normal for causing said impulse responsive relays to pass an additional impulse to said stepping switches.

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