

Oct. 17, 1961

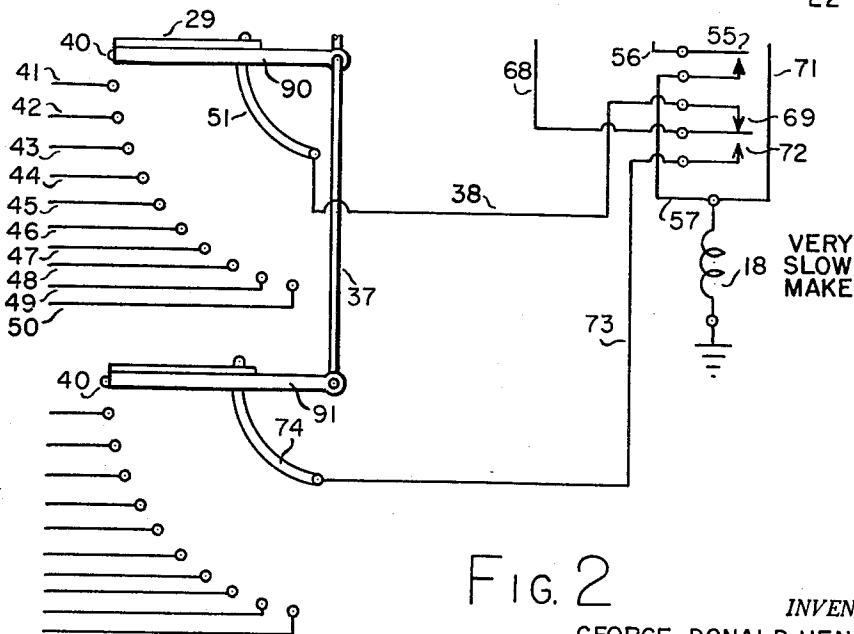
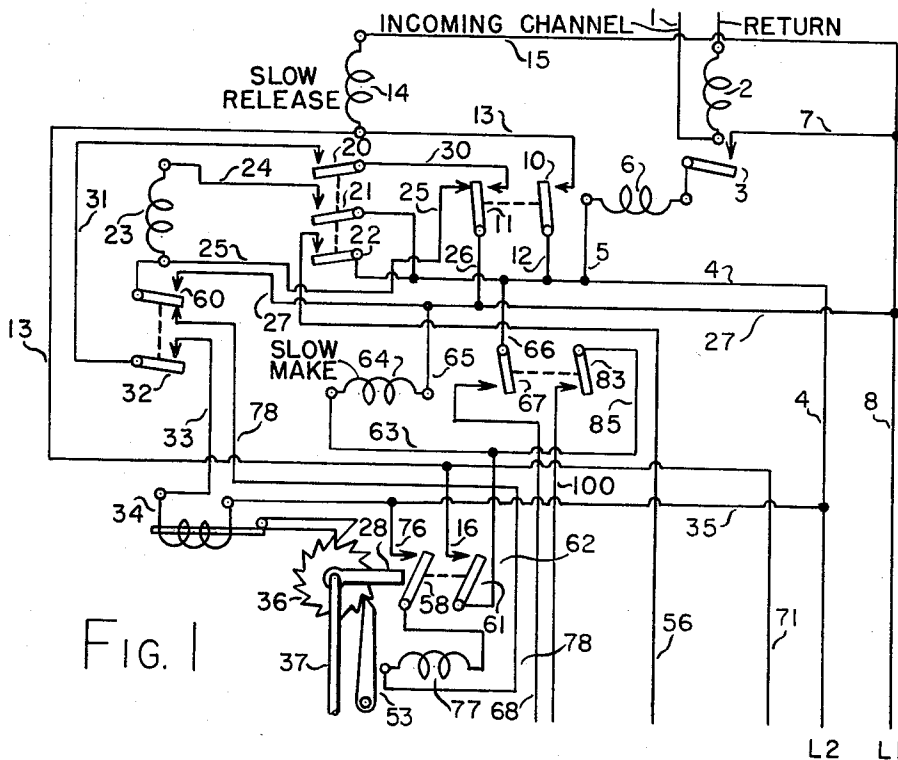
G. D. HENDRICKS

3,005,188

ELECTRIC CHANNEL SELECTORS

Original Filed Dec. 6, 1954

3 Sheets-Sheet 1



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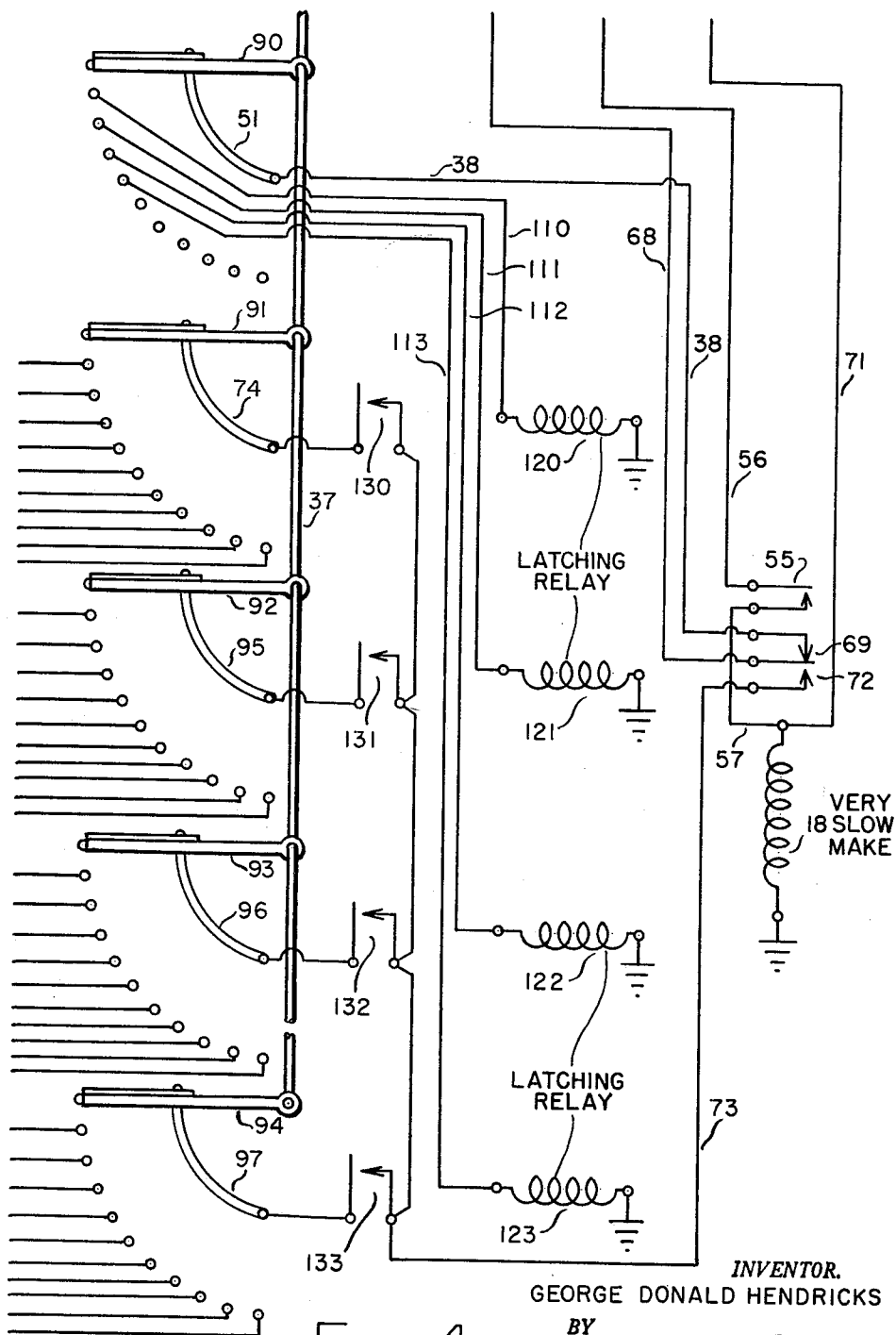
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3 Sheets-Sheet 2



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FIG. 4

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3 Sheets-Sheet 3

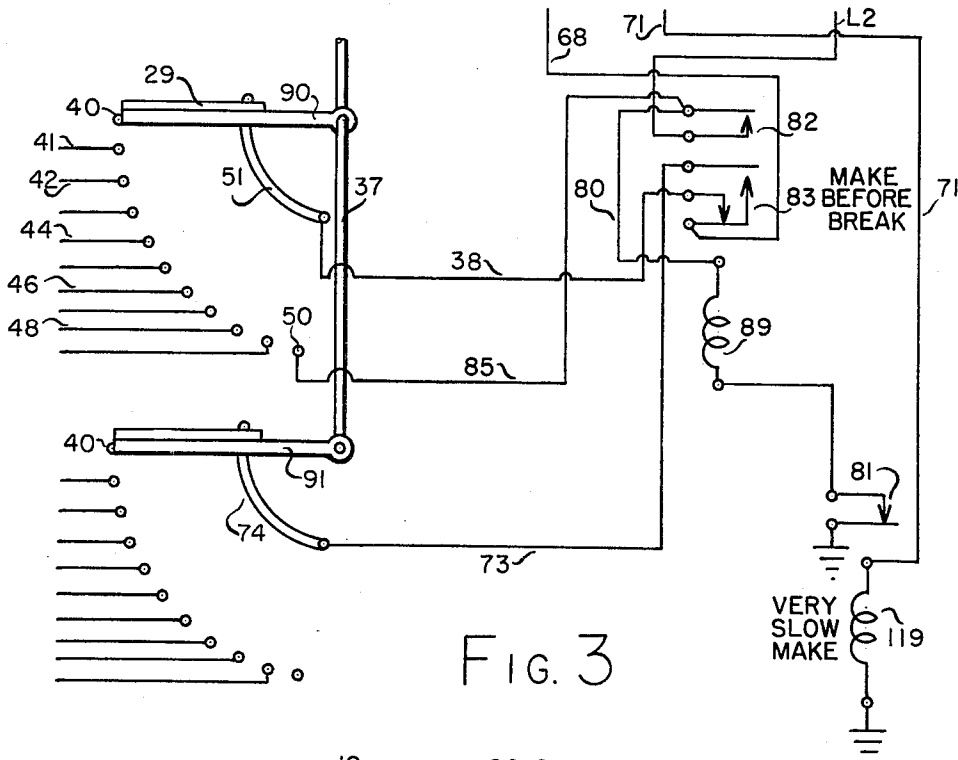


FIG. 3

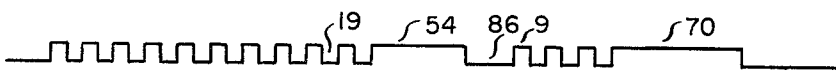


FIG. 8

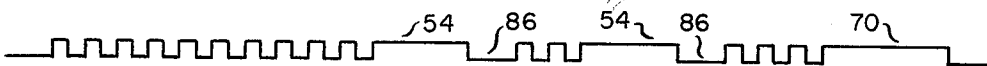


FIG. 9



FIG. 10

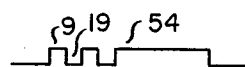


FIG. 7



FIG. 6

FIG. 5

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3,005,188

ELECTRIC CHANNEL SELECTORS

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Continuation of application Ser. No. 473,080, Dec. 6, 1954. This application Feb. 18, 1960, Ser. No. 9,653 19 Claims. (Cl. 340—167)

The invention relates to devices which respond to signal impulses of short, intermediate, and long duration separated by intervals of short or long duration to select and place current on one of a number of outgoing channels.

This is a continuation of my United States patent application Serial No. 473,080, filed December 6, 1954, now abandoned.

In particular, the invention relates to a preconditioning circuit and a transfer circuit for use with a standard multibank step switch to first select the proper bank and then select and place current on the proper contact and load circuit connected thereto.

An important feature of one form of the invention is its ability to select a sequence of contacts on the second bank of the step switch upon receipt of a sequence of groups of impulses. After a given contact is selected and had current placed on it for a short interval, the step switch is reset. Another contact may then be selected and have current placed on it upon the receipt of a new sequence of impulses. The number of additional impulses required is equal to the number of pulses normally required less the number of contacts on the first bank. This reduces impulsing time and wear on the instrument. Emergency functions may be assigned to the higher numbered contacts and may be selected rapidly even while a normal function is in the process of selection. The higher numbered function supercedes the lower number function.

Another feature of one form of the invention is its ability to select a contact on the second bank of a step switch without impulsing through the contacts on the first bank. This, too, saves impulsing time and wear on the equipment.

Another form of the invention employs a ten bank step switch and a transfer device. A first group of short impulses selects the bank to be effective; a pulse of intermediate duration latches in the transfer device for the selected bank; a second group of short impulses selects a contact on the effective bank, and a long pulse energizes an outgoing circuit connected to the effective contact. Thus, the device preselects a bank and then selects a contact on that bank.

Such devices, herein referred to as channel selectors, may be used in connection with a single channel leading from a central station to a distant location. At the distant location the channel selector is adapted to allow the single channel to cause current to be placed on any one of a number of local channels. Each of these local channels may lead to a different instrument, machine, or signal which is to be connected to the central station to receive current.

The current thus transmitted may be used to supply power to the local channel, or to close a local circuit feeding current into the channel. The single channel may be a physical conductor or a radio channel.

Devices are known in which an arm is stepped along a path of travel, contacting a different local channel at each step. Usually the arm rotates about an axis and the contacts are arranged along an arc. This limits the maximum number of local channels that can be served to the number of contacts that can be placed on the arc.

The invention herein described is designed to expand

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the usefulness of the device shown in United States Patent 2,832,060, granted April 22, 1958, to G. Donald Hendricks, Frank Arthur Pearson, and George Leland Rambo, entitled Replacement of a Plurality of Channels by a Single Channel. In Patent 2,832,060 a seven contact step switch is shown connected to a local traffic signal controller. Six functions within the local controller may be remotely controlled from a central station using the device shown in the above named patent. Increased popularity of this form of single channel control led to its widespread usage. With widespread usage more and more functions were desired to be controlled. Thus, the apparatus shown herein was invented to permit as many as 100 functions to be remotely controlled over a single radio or wire channel.

As a further illustration, the device increases the usefulness of the decoder and responder system shown in United States Patent 2,826,752, granted March 11, 1958 to G. Donald Hendricks, Frank Arthur Pearson, and George Leland Rambo, entitled Systems Permitting Response by Only Selected Units of Those Connected to a Single Channel. In Patent 2,826,752 a ten contact step switch is shown connected ahead of a responder of the type shown in Patent 2,832,060 named above. The responder is shown connected to a local traffic signal controller through six conductors. When a large number of local controller functions are to be controlled from a master controller, a multibank step switch of the type shown in the present application may be employed.

It will be obvious that the maximum number of local channels from which selection can be made is limited by the number of teeth on the ratchet wheel and the number of local channel terminals that can be crowded onto the step switch. If the device is to be compact and electro-mechanically re-set, experience indicates that the practical number of local channels that can be served is limited to about thirty. For simplicity of illustration, the step switches shown in the drawings have ten contacts per bank.

By contrast, in the invention the number of local channels may exceed the number of contacts that can be contacted by a single arm rotating through a pre-determined arc.

Channel selectors having an arm and a maximum of ten steps are widely used in the telephone and electrical industry and referred to as 'minor switches'. Herein they will be referred to as step switches.

The invention provides a channel selector incorporating such a step switch having two or more banks or levels and associated circuitry which permits selecting any one of a large number of local channels, perhaps as many as a hundred. The invention also includes the latch relay and/or transfer relay that connect the single channel to the arm that leads to the selected deck at the proper time and, after the termination of the signals, change the connections and reset the selector to its initial position.

A feature of the step switch is the provision of a number of superimposed arcs on separate decks with a separate arm for making the contacts on each arc. In response to signals received from the central station over the single channel, the ratchet relay steps all the arms over their arcs.

The invention may take any one of several forms, depending on the number of local channels which the selector is to serve.

The first form of the invention is adaptable to a circuit selector having only two decks. The proper deck is selected at the beginning of the coding signal and the device is automatically re-set at the end of the signal.

The second form of the invention is also adaptable to a circuit selector having only two decks. It is particularly

adapted for use in systems where several local channels terminating on the same deck are to be selected in sequence.

The third form of the invention is adapted to serve a large number of decks.

All of these forms of the invention have many common elements: the relays that respond to the signals coming over the single channel and supply local current to actuate the various devices; the means for rejecting certain types of signals; the means for stepping the arms forward; the means for placing current on the proper arm at the proper time; and the means for returning the arms to their initial position when the proper local channel has been energized.

The object of the invention is to provide an electric channel selector having a plurality of arms with means to move all the arms into a position where one of these arms contacts the desired local channel, then connecting only that arm to a source of current.

Another object is to provide such an electric channel selector which will respond to a current of uniform intensity whose flow is interrupted at intervals in a manner to give a series of pulses coming in over a single channel from a distant source.

Another object is to provide such an electric channel selector which will in response to short pulses move the arms to a desired position and in response to a long pulse that follows place current on the proper arm.

Another object is to provide a circuit for use with a multibank step switch which permits successive higher channels to be called upon receipt of additional impulses.

Another object is to provide a circuit for use with a multibank step switch which permits any channel on the second bank to be selected without stepping through all the contacts on the first bank.

Another object is to provide a circuit for use with a two bank step switch which permits selection of any contact on a first bank when a transfer device is not conditioned and permits selection of any contact on a second bank when the transfer device is preconditioned by a long pulse preceding the short pulses.

Another object is to provide a preconditioning circuit and a transfer circuit for use with a multibank step switch which permits the selection of one of a plurality of banks by a first group of impulses and the selection of a contact on the selected bank by a second group of impulses.

Other objects will be evident from the description.

The elements common to all three forms of the invention will be described first. Then the circuits closed by these common elements that lead to the elements distinctive of each form of the invention will be traced.

FIGURE 1 shows diagrammatically these elements common to all three forms of the invention.

FIGURE 2 shows those elements in diagrammatic form which, associated with the elements shown in FIGURE 1, constitute the first form of the invention.

FIGURE 3 shows diagrammatically those elements which, associated with the elements in FIGURE 1, constitute the second form of the invention.

FIGURE 4 shows diagrammatically those elements which, associated with the elements in FIGURE 1, constitute the third form of the invention.

FIGURE 5 shows one type of signal that is used in connection with the first form of the invention shown in FIGURES 1 and 2.

FIGURE 6 shows another type of signal that is also used in connection with the first form of the invention.

FIGURE 7 shows one type of signal used in connection with the second form of the invention shown in FIGURES 1 and 3.

FIGURES 8 and 9 show other types of signals used in connection with the second form of the invention shown in FIGURES 1 and 3.

FIGURE 10 shows one type of signal used in connection

with the third form of the invention shown in FIGURES 1 and 4.

The elements common to all three forms of the invention shown in FIGURE 1 will first be described.

The numeral 2 indicates a key relay actuated by a single channel 1.

The single channel may consist of one wire leading to a grounded key relay or it may consist of a pair of wires, one being the return wire. This key relay actuates a switch 3 that allows current to flow from a local power source L2 over line 4, line 5, relay 6, switch 3, line 7, line 8 to L1.

Relay 6 in turn closes switches 10, 11.

The sole function of key relay 2 and relay 6 is to substitute current from a local L2 source that may be stronger than that received over the single channel for the actuation of the devices to be described.

Switch 10, when closed, will do three things.

Switch 10 will feed current over line 4, line 12, switch 10, line 13 to a slow-release relay 14, line 15, line 8, and back to L1. Relay 14 therefore closes at once.

Switch 10 will also feed current over line 13 to line 16 leading to the normally open switch 61.

Switch 10 will also feed current over line 13 to line 71 leading to FIGURES 2, 3, 4.

If the signal coming over single channel 1 is of the type shown in FIGURE 5, consisting of a series of short pulses followed by a long pulse, on the arrival of the first short pulse switches 3, 10, 11 all close and slow-release relay 14 closes but very slow-make relays 18 in FIGURES 2 and 4 and very slow-make relay 119 in FIGURE 3 connected to line 71 do not close.

Slow release relay 14 closes switches 20, 21, 22. With switch 21 closed, current becomes available to the relay 23.

When switch 21 closes a circuit starting at L2 extends over line 4, switch 21, line 24, relay 23, line 25, switch 11, line 27, line 8, to L1. Switch 11 opens this circuit during the receipt of the first conditioning pulse thus preventing relay 23 from closing during the arrival of the first pulse.

Whenever current on single channel 1 is interrupted switches 3, 10, and 11 open, allowing switch 11 to again assume the position shown in the drawing.

This first pulse 9, FIGURES 5, 7, 10, which does not actuate any of the devices in FIGURES 2, 3, 4, is referred to as a conditioning pulse. Its function is to place the various relays in condition to allow succeeding pulses to act upon the devices in FIGURES 2, 3, 4 to move the arms in a manner to be described. Another function of this circuitry is to allow a single pulse of a particular type to be used to pass through the elements of FIGURE 1 without moving the arms referred to since only the second and subsequent pulses move the arms.

In a traffic signal control system to which the invention has been applied, this single pulse is known as a resynchronizing pulse and is employed to keep the local traffic signal controllers in step with the master controller. The resynchronizing pulse is normally discontinued during the transmission of stepping pulses.

Thus, on the arrival of the first short pulse, switches 3, 11, 21 all move from the position shown. When the pulse ceases, switch 21 controlled by a slow-release relay 14 remains closed and switches 3 and 11 again assume the positions shown. Current now flows from L2, line 4, switch 21, line 24, relay 23, line 25, switch 11, line 26, line 27, line 8 to L1.

When relay 23 closes switch 60, a holding circuit is established around switch 11 directly to L1 over lines 27 and 8. The complete circuit includes L2, line 4, switch 21, line 24, relay 23, switch 60, line 27, line 8 and L1.

Thus the first or conditioning short pulse 9 is used to close slow-release relay 14. The first interval 19, FIGURES 5, 7, between the first, or conditioning pulse and the next pulse is used to close relay 23. Relays 14,

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and 23 remain closed during the entire time the pulsed signal shown in FIGURE 5 is sent.

Each pulse after the first will again close switches 3, 10, 11 and this will cause current to flow from L2, line 4, line 35, stepping relay 34, line 33, switch 32, line 31, switch 20, line 30, switch 11, line 26, line 27, line 8 to L1.

Thus on arrival of each of the pulses after the first, the stepping relay 34 moves the ratchet wheel 36 forward one step in a counter clockwise direction. A spring not shown here but of the type shown in the Hendricks et al. Patent 2,826,752 referred to above, tends to turn the shaft in a clockwise direction.

The ratchet wheel 36 is mounted on a shaft 37 which extends into FIGURES 2, 3, 4 and also carries a short arm 28.

A pawl 53 holds the ratchet wheel in the position to which it has been advanced by the stepping relay.

When the long pulse 54 in FIGURE 5 comes along, current on line 33 steps the ratchet wheel 36 one step just as the short pulses did. But this long pulse also flows over lines 13 and 71 in FIGURE 1 to line 71 in FIGURES 2, 3, 4 where the long pulse acts on devices that do not respond to the short pulses.

Switches 58, 61 normally held open by arm 28 are closed as soon as ratchet wheel 36 moves from its initial position. Each time switch 10 closes and places current on line 13, line 16, a circuit is established over switch 61, line 62, line 63, slow-make relay 64, line 65, line 27, line 8 and L1.

However, as relay 64 is slow-make and does not respond to short pulses 9 it will not close until long pulse 54 comes. Relay 64 supplies current from L2 over line 4, line 66, switch 67, line 68 to line 68 in FIGURES 2, 3, 4.

A short interval after the entire signal has been sent slow-release relay 14 opens, opening switches 20, 21, 22. Switch 22 thus cuts off the power from line 56, extending to FIGURES 2, 4. Opening switch 21 opens relay 23. When switch 60 opens, current flows from L2, line 35, line 76, over switch 58, relay 77, line 78, switch 60, line 25, switch 11, line 26, line 27 to line 8 and L1. Relay 77 now draws holding pawl 53 away from ratchet wheel 36 allowing the spring, not shown, to return the ratchet wheel 36 and the shaft 37, and all the arms carried by the shaft, to their initial position.

In the first form of the invention illustrated by FIGURE 2 taken in connection with FIGURE 1 just described, the shaft 37 extending from FIGURE 1 to FIGURE 2 carries two arms 90, 91.

Each arm, such as 90, carries a contact bar 29 that normally rests on a contact such as 40 and as the ratchet wheel 36 is stepped along the contact bar 29 successively rests on the various contacts 41-50 which form the terminals of local circuits.

The contact bar 29 also rests on an arc 51 that can be supplied with current from line 38.

Line 71 coming from FIGURE 1 leads to a very slow-make relay 18 that does not respond either to the short pulses or to long pulses but only to very long pulses 70, FIGURES 6, 8, 9, 10.

Throughout this specification, reference is made to slow-make relays and very slow-make relays. The time for the closing of a slow-make or the closing of a very slow-make relay may differ in the various forms or applications of the invention. It is important, however, that the short pulses do not last long enough to close either a slow-make or a very slow-make relay. Pulses of intermediate duration must last long enough to close the slow-make relay but not the very slow-make relay. Long pulses must last long enough to close the very slow-make relay. The slow-make relay may require a pulse lasting one second to close; the very slow-make relay may require a long pulse lasting one and a half second. Relay 64 is a slow-make relay and relay 18 in FIGURES

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2 and 4 and relay 119 in FIGURE 3 are very slow-make relays.

Optimum results have been achieved when the short pulse is a square wave one-twentieth of a second in duration, the short pause is one-twentieth of a second, and the long pause is one-fourth of a second. The pulse of intermediate duration may be slightly more than one second and the pulse of long duration may be slightly more than one and one-half seconds. It will be understood that the invention is not limited to these particular pulse or pause durations.

Line 68 coming from FIGURE 1 receives current only after slow-make relay 64 closes. Line 68 leads to switch 69 which feeds the current to line 38 and thence to arc 51 and arm 90.

When a signal of the type shown in FIGURE 5, designed to place current on one of the local channels 41-50 is sent, the first short pulse 9 conditions the apparatus in FIGURE 1 in the manner described so that each succeeding short pulse steps the shaft 37, and with it arms 90 and 91. If, by way of illustration, local channel 45 is desired, the series of short and long pulses shown in FIGURE 5 is sent. Four short pulses follow pulse 9 and the arm 90 is stepped to contact 44. Then the long pulse 54 follows. This long pulse, as already explained, does several things. First it steps the arm 90 one more step to contact 45. Then, after the lapse of about a second, the slow-make relay 64 closes and places current on line 68. This current flows over the connections already described over line 38, arc 51, contact bar 29 to local channel 45.

It should be noted that although arm 91 is in contact with some local channel no current flows over line 73 to the contact bar on arm 91, and also that very slow-make relay 18 does not act.

Thus, with a pulsed signal of the type shown in FIGURE 5 any one of the local channels 41-50 on the upper tier may be energized.

If the local channel to be energized is on the lower deck, a signal of the type shown in FIGURE 6 is sent. This has an initial pulse 70 that is extra long. This pulse, coming over the single channel 1 will close switch 3, energize relay 6, close switches 10 and 11, and energize slow-release relay 14 which closes switches 20, 21, 22. Relay 23 will not be energized during this long pulse because switches 11 and 60 are open; but current will flow from L2 over line 4, line 12, switch 10, line 13, line 71 to line 71 in FIGURE 2. This extra long pulse will close very slow-make relay 18 in FIGURE 2.

When relay 18 closes it will close switch 55. Current flowing from L2 over line 4, switch 22, and line 56 in FIGURE 1 leading to line 56 and switch 55 in FIGURE 2 will hold very slow-make relay 18 energized as long as the slow-release relay 14 is energized.

When the very slow-make relay 18 is held closed, switch 69 is opened and switch 72 is held closed.

The short pulses in FIGURE 6 that follow the initial extra long pulse and the final long pulse 54, all function as already described. Only this time, since the switch 72 is closed and switch 69 is open, current flows from line 68 to line 73 and arc 74 to arm 91.

It has been shown that by the use of the signals shown in FIGURES 5 or 6 in connection with the apparatus shown in FIGURES 1 and 2 an incoming single channel may be connected to any one of the terminals on two decks. Normally that connection, terminating shortly after the signal of FIGURES 5 or 6 ceases, will accomplish a desired result in that local channel. Often some switches, not shown, are closed, and these switches may continue to supply current from a local source to the selected channel.

Proceeding to the second form of the invention which comprises the elements and circuits shown in FIGURES 1 and 3 taken together, if the local channel sought is on the upper deck in FIGURE 3 a signal of the type shown in FIGURE 7 is sent. The signal shown in FIG-

FIGURE 7 is similar to that shown in FIGURE 5 already described and is sent to relay 2 in FIGURE 1. The first short pulse 9 conditions the circuits in FIGURE 1 as already described and the succeeding short pulses turn the shaft 37 extending into FIGURE 3 as described.

When the long pulse 54 shown in FIGURE 7 is applied to incoming channel in FIGURE 1 the slow-make relay 64 closes and current is now supplied over line 68 leading out of FIGURE 1 to switch 83 in FIGURE 3 which in its unactuated position connects line 68 to line 38 and in its actuated position connects line 68 to line 73. Since switch 83 is at this time in its unactuated position, current flows over line 38 to arc 51 and over contact bar 29 to one of the contacts 41-50 on the upper deck as before. If the long pulse 54 comes before the arm has reached contact 49, current is supplied to one of the local channels on the upper tier.

If the signal is of the type shown in FIGURE 8 with enough short pulses to carry the arm to contact 49, then the long pulse 54 will move the arm to contact 50 which, in this form of the invention, does not connect to a local channel but connects with line 85. The long pulse then feeds current over line 85 and line 80 to a relay 89 and then over a normally closed switch 81 to ground. Relay 89 closes switch 82 and switch 83 shifts the connection of line 68 from line 38 to line 73. Switch 82 supplied L2 current to line 80 and relay 89, holding relay 89 closed after the current coming over line 85 ceases.

A pause 86 in the signal shown in FIGURE 8 that is somewhat longer than the normal pause 19 between the succession of short pulses, follows long pulse 54 and serves to allow all switches, other than those controlled by relay 89, to assume their original position.

During this pause 86 arms 90, 91 and ratchet wheel 36 assume their original position. Arms 90, 91 are now in the position as shown in FIGURE 3. The net result of the first movement of the arms is therefore merely to lock the relay 89 in closed position.

A conditioning pulse 9, followed by short pulses allows the arms 90, 91 to again be stepped forward a distance determined by the number of pulses. Then an extra long pulse 70 follows. This closes slow-make relay 64 in FIGURE 1 which supplies current in the manner described in conjunction with FIGURE 3 over line 68 which is directed over closed switch 83 to line 73, arc 74 and over contact bar 29 on arm 91 to the desired contact terminal of a local channel on the second tier.

As the extra long pulse continues, current flowing over line 71 from FIGURE 1 closes very slow-make relay 119 and opens switch 81 in FIGURE 3 which opens relay 89 by interrupting its holding circuit.

When the holding circuit for relay 89 is broken at switch 82 and the signal ceases, the various relays in FIGURE 1 open and the arms 90, 91 are carried back to their initial position.

One of the advantages of this second form of the invention is that it permits connecting the incoming single channel to a number of local channels on the second deck in succession without going through the first deck by using a signal such as shown in FIGURE 9.

It will be noted that this signal is similar to that shown in FIGURE 8 having the same initial short pulses, the long pulse 54 that selects the second deck, the long pause 86, then short pulses to move the arms to the proper local channel on the second deck. But, instead of the extra long pulse 70, a long pulse 54 follows and then another long pause 86 to move the arms back to the initial position. Then more short pulses follow to move the arms to the second desired single channel on that deck. Then follows another long pulse 54, no shown, if there is to be still another local channel to be selected on that deck, but if no further local channel on that deck is to be selected an extra long pulse 70 follows.

The third form of the invention will be understood by reference to FIGURES 1 and 4.

This form permits an unlimited number of local channels to be placed on any number of decks. This form of the invention is adaptable to a much larger number of local channels than the two preceding forms.

One of the features of this form of the invention is that the arms make only two sweeps to connect the single channel to any local channel and do not pass through each preceding deck as in the second form of the invention.

The uppermost arm 90, on the first sweep, selects the deck on which the desired contact is located. The arms 90-94 then return to their original position and when, on the second sweep of the arms, the arm on the selected deck reaches the desired local channel terminal, current is placed only on that arm.

Referring to FIGURES 1 and 4, the shaft 37 carried in addition to the arms 90, 91 described in the preceding forms of the invention any desired number of additional arms such as 92, 93, 94.

Each of these arms has a number of contacts and each arm can be fed current at the proper time by its arc 51, 74, 95, 96, 97.

Arm 90 and the upper deck is used solely to select on the first sweep of the arm 90 the particular deck in which the desired local channel terminates. Each contact on the remaining decks is the terminal of a local channel.

The type of signal used in connection with this form of the invention is shown in FIGURE 10.

The first conditioning pulse 9 shown in FIGURE 10 sets the various relays in FIGURE 1 in the manner described so that succeeding pulses will cause the ratchet wheel 36 to be moved to turn shaft 37 and to move arms 90, 91, 92, 93, 94. When the long pulse 54 comes, the relay 64 in FIGURE 1 closes and supplies current over line 68 to switch 69 and line 38 leading to arc 51. This places current on one of the lines 110, 111, 112, 113 and each of these lines leads to one of relays 120, 121, 122, 123, respectively. This long pulse also supplies current over line 13 and line 71 in FIGURE 1 to line 71 in FIGURE 4 which leads to very slow-make relay 18. However, this relay does not close in response to a mere long pulse as it requires an extra long pulse to close.

When current flowed to one of the relays 120, 121, 122, 123 that relay locked itself and closed one of the switches 130, 131, 132, 133. These relays form a group that is of the type shown in United States Patent 2,798,917, granted to G. Donald Hendricks and George Leland Rambo on July 7, 1957. When any one relay in the group is closed, it latches itself closed and remains closed after the current ceases. In latching one relay in this group any other relay in the group that was previously latched is released.

The long pause 86 in FIGURE 10 now opens all the relays except this latched relay and the arms return to their initial position.

The extra long pulse 70 that now follows does two things. It conditions the relays in FIGURE 1 and it supplies current over line 13 and line 71 in FIGURE 1 to line 71 in FIGURE 4 for a period long enough to close very slow-make relay 18.

It should be noted that as the arms on shaft 37 returned to their initial position, switch 61 was opened and therefore the extra long pulse 70 cannot supply current to close slow-make relay 64.

Since the relays in FIGURE 1 are still conditioned, switch 22 is closed and current from line L2 is supplied to line 56 that leads to switch 55 that is now closed by relay 18. This supplies a holding circuit through line 57 to relay 18.

The short pulses in signal following the very long pulse 70, FIGURE 10, act in the manner already described in connection with the signals shown in FIGURE 5, and step the arms to the position where one arm is one position short of the desired local channel. The

long pulse 54 in FIGURE 10 now moves the arm into position to contact the desired local channel and through slow-make relay 64 in FIGURE 1 supplies current to line 68 leading to FIGURE 4.

When relay 18 was energized and held through its own holding circuit, switch 69 was opened and switch 72 closed so that this current flows over line 73 and whichever one of the switches 130 to 133 that has been held closed by its latched relay to the proper one of the arcs 74, 95, 96, 97 to the proper arm and over that to the desired local channel.

A short time after the signal is completed, slow release relay 14 shown in FIGURE 1 opens and this causes the circuit that places holding current on line 56 for relay 18 to restore relay 18 to its initial off position.

It should be noted in connection with the device of FIGURE 4, that if several local channels that chance to be on the same deck are to be contacted successively, even though a long time intervenes, the whole operation need not be repeated. This is true because the previously selected latch relay remains mechanically latched until released by the energization of a different latch relay.

Thus if a signal has been sent and the third deck selected in the manner described above and the signal completed by sending long pulse 54, it is possible, even after the lapse of a long time, to select another channel in the same deck by sending a signal similar to that in FIGURE 10 but beginning with extra long pulse 70.

This will step the arms in response to the short pulses to the position desired and then the long pulse 54 will send current over whichever of the switches 130-133 is still locked.

In this way any number of local channels on the same deck may be selected without sending the entire signal shown in FIGURE 10 after the selection of any local channel on that deck.

All three forms of the invention use signals consisting of pulses of uniform sign and intensity wherein each signal is composed of pulses of not more than three lengths with controlled pauses between pulses of not more than two lengths. The system employs four types of relays—instantaneously responsive; normal-make and slow release; slow-make and normal release; and very slow-make and normal release.

The slow release and slow-make relays employed in one preferred form of the invention operate in the following times:

Slow release relay 14 operates substantially immediately upon application of potential and releases one-fourth to one-third second after removal of potential.

Slow make relay 64 operates after potential has been applied for approximately one second and releases substantially immediately upon removal of potential.

Very slow make relays 18 and 119 operate after potential has been applied for approximately one and one-half seconds and release substantially immediately upon removal of potential.

Make before break relay 89 closes its contacts and makes the circuit between lines 68 and 73 before it opens its contacts and breaks the circuit between lines 68 and 38.

The stepping switches common in the telephone industry to which reference has been made in column 2, line 46, frequently have two decks such as shown in FIGURES 2 and 3 with a shaft 37 and arms 90 and 91 and lines 38, 73 leading respectively to arcs 51, 74. However, lines 38 and 73 simply are the two wires of some circuit that are thus connected to one of the ten contact pairs.

Such a step switch can be connected in the manner herein shown in the first and the second form of the invention to make the larger number of contacts. A step switch of the type shown in the third form of the invention can be connected thusly to provide contact to many more circuits than the switch was designed for.

The type of pulsing equipment employed at the master station for stepping the local devices shown herein is not shown in the present patent application but is illustrated in FIGURE 4 of United States Patent 2,832,060 referred to above. A telephone type dialing mechanism may be used to obtain the short pulses and pauses. Slow release relays of the type illustrated in the present application may be employed in a circuit to obtain pulses of intermediate or long duration and pauses of long duration. The circuit is not shown herein because it may be devised by one skilled in the art.

It is evident that the pulses referred to herein may be timed interruptions in potential rather than timed applications of potential. That is, the interconnecting channel may be normally energized when the function is not being changed. The interconnecting channel would then be deenergized for varying intervals to operate the invention. The only change required in the apparatus would be in the key relay 2. Its contacts 3 would be chosen normally closed. Thus, while key relay 2 is normally energized its contacts would remain open. When key relay 2 is deenergized its contacts 3 would close and apply local power to relay coil 6.

The resynchronizing pulse referred to above would then be a resynchronizing pause or interruption. Resynchronizing power would be applied to the interconnecting circuit or channel during approximately 97% of the traffic signal cycle. The power would be interrupted during approximately 3% of the cycle to permit the local controllers to start in synchronism with the master. This would constitute fail safe operation; when resynchronizing power is lost, the local controllers would operate independently of the master. Thus, they would not stall and disrupt traffic flow.

I claim:

1. A circuit for use in conjunction with a step switch having a plurality of contact banks and arms rotatable thereover and a transfer circuit for selecting one of said arms all operated by electric pulses of equal magnitude and polarity and variable as to number and duration for switching local power to one of a number of outgoing channels; including in combination, an incoming single channel, an external source of electric signals connected thereto; a preconditioning circuit comprised of a key relay connected to said channel, a source of local power, a second relay energized from local power through contacts on said key relay, a slow release relay energized from local power through first contacts on said second relay, said slow release relay having contacts closed for a short time after said second relay is deenergized, a fourth relay energized from local power through said contacts on said slow release relay and through back contacts on said second relay which are closed when said second relay is deenergized, holding contacts on said fourth relay maintaining said fourth relay energized while said slow release relay contacts remain closed, said fourth relay thereby preconditioned by a single incoming pulse; a step switch having contact banks and arms rotatable thereover, a solenoid on said step switch co-operative with a ratchet mechanism thereon for stepping said arms over said contacts, said solenoid energized from local power through contacts on said fourth relay during each incoming pulse after the first, hold contacts on said step switch closed after the first step, a slow make relay energized from local power through said hold contacts during an incoming signal and making near the end of a long incoming signal, a transfer circuit including contacts on said slow make relay connecting local power to one of said step switch arms, a plurality of outgoing channels one connected to each contact on said contact banks, said long signal being sufficiently longer than the make time of said slow make relay to cause local power to flow to the outgoing channels contacted by said one arm.

2. A circuit as in claim 1, including a very slow make

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relay, a transfer circuit including contacts on said slow make relay and said very slow make relay and said arms, a very long incoming signal being sufficiently long to close said very slow make relay and cause local power to flow to the outgoing channel connected to the contact contacted by an arm other than said one arm; a release solenoid on said step switch adapted to return said arms to initial position when energized from local power through back contacts on said fourth relay when same is deenergized by said slow release relay.

3. A circuit as in claim 1 permitting selection of succeeding contacts on the second bank without repeating rotation through the first bank, including a make before break relay, a circuit including the last contact on said first bank in series with the coil of said make before break relay to connect same to local power through a contact on said slow make relay, said long signal incoming after a plurality of short pulses equal in number to said contacts on said bank serving to energize said make before break relay, a holding contact on said relay, a pause in incoming signal serving to reset said step switch arms to zero, succeeding short pulses serving to step said step switch arms, a very slow make relay, said very slow make relay energized from local power through said contacts on said second relay near the end of a very long incoming signal, a release contact in said last named holding circuit opened thereby; a release solenoid on said step switch adapted to return said arms to zero energized from local power through back contacts on said fourth relay when same is deenergized by said slow release relay.

4. A circuit as in claim 1 permitting selection of a contact on one of a large number of banks, including a transfer circuit including contacts on said slow make relay connecting local power to the first of said step switch arms, a plurality of latch circuits each one connected to one contact on the first bank of contacts on said step switch, said latch circuit latching when energized near the end of said long incoming signal and unlatching any other latched circuit, said step switch reset to zero upon release of said slow release relay by a long pause in said incoming signal; a second plurality of incoming signal pulses preconditioning said fourth relay and stepping said step switch arms, a very slow make relay energized from local power through said contacts on said second relay, contacts on said very slow make relay in said transfer circuit connecting local power through contacts on said latch relay to its corresponding step switch arm, a plurality of outgoing channels each one connected to one contact on said step switch, one of said contacts energized from local power through said transfer circuit near the end of a very long incoming signal; said step switch again reset to zero upon release of said slow release relay by a long pause in said incoming signal.

5. An electromechanical switching device operated by electric pulses of equal magnitude and polarity and variable as to number and duration for switching local power to one of a number of outgoing channels, including in combination, a single incoming channel, a source of local power, a key relay connected across said incoming channel; a preconditioning circuit consisting of a second relay energized by local power through contacts on said key relay, a slow release relay energized by local power through contacts on said second relay, a fourth relay energized by local power through contacts on said slow release relay and by back contacts on said second relay, and a holding circuit on said fourth relay; an electromechanical step switch energized by local power through contacts on said fourth relay, said slow release relay, and said second relay and stepped one step for each incoming pulse after the first; hold contacts on said step switch closed after the first step, a slow make relay energized by local power through said hold contacts, contacts on said slow make relay closed after a long incoming pulse; a plurality of contact banks on said step switch, a plurality of wiper

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arms one for each bank and rotatable thereover, a self-holding transfer circuit connected to apply local power to one or another of said arms through contacts on said slow make relay; a very slow make relay energized by local power through said contacts on said second relay connected to switch local power to one or another of said arms; a holding circuit on said very slow make relay including contacts on said slow release relay; and a release coil on said step switch energized from local power through back contacts on said fourth relay.

6. A circuit for use in conjunction with a step switch having a plurality of contact banks and arms rotatable thereover and a transfer circuit for selecting one or another of said arms, including in combination, an incoming single channel, a distant source of electric signals connected thereto, a preconditioning circuit comprised of a key relay connected to said channel, a source of local power, a second relay energized from local power through contacts on said key relay, a slow release relay energized from local power through first contacts on said second relay, said slow release relay having contacts closed for a short time after said second relay is deenergized, a fourth relay energized from local power through said contacts on said slow release relay and through back contacts on said second relay which are closed when said second relay is deenergized, holding contacts on said fourth relay maintaining said fourth relay energized while said slow release relay contacts remain closed, said fourth relay thereby preconditioned by a single incoming pulse; a solenoid on said step switch cooperative with a ratchet mechanism thereon for stepping said arms over said contacts, said solenoid energized from local power through contacts on said fourth relay during each incoming pulse after the first; hold contacts on said step switch closed after the first step, a slow make relay energized from local power through said hold contacts after a long incoming signal, a circuit including contacts on said slow make relay connecting local power to one of said step switch arms, a plurality of outgoing channels one connected to each contact on said contact banks, said long signal being sufficiently longer than the make time of said slow make relay to cause local power to flow to the outgoing channel contacted by said one arm; a very slow make relay, a transfer circuit including contacts on said slow make relay and said very slow make relay and said arms, a very long incoming signal being sufficiently long to close said very slow make relay and cause local power to flow to the outgoing channel connected to the contact contacted by an arm other than said one arm; a release solenoid on said step switch adapted to return said arms to their initial position energized from local power through back contacts on said fourth relay when same is deenergized by said slow release relay.

7. A circuit for use with a step switch having first and second contact banks and arms rotatable thereover permitting selection of succeeding contacts on the second bank without rotation through the first bank, including in combination, an incoming single channel, an external source of electric signals connected thereto; a preconditioning circuit comprised of a key relay connected to said channel, a source of local power, a second relay energized from local power through contacts on said key relay, a slow release relay energized from local power through first contacts on said second relay, said slow release relay having contacts closed for a short time after said second relay is deenergized, a fourth relay energized from local power through said contacts on said slow release relay and through back contacts on said second relay which are closed when said second relay is deenergized, holding contacts on said fourth relay maintaining said fourth relay energized while said slow release relay contacts remain closed, said fourth relay thereby preconditioned by a single incoming pulse; a solenoid on said step switch cooperative with a ratchet mechanism thereon for stepping said arms over said contacts, said solenoid energized from

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local power through contacts on said fourth relay during each incoming pulse after the first, hold contacts on said step switch closed after the first step, a slow make relay energized from local power through said hold contacts after a long incoming signal, a circuit including contacts on said slow make relay connecting local power to one of said step switch arms, a plurality of outgoing channels one connected to each contact on said contact banks, said long signal being sufficiently longer than the make time of said slow make relay to cause local power to flow to the outgoing channel contacted by said one arm; a make before break relay, a circuit including the last contact on said first bank in series with the coil of said make before break relay to connect same to local power through a contact on said slow make relay, said long signal incoming after a plurality of short pulses equal in number to said contacts on said bank serving to energize said make before break relay, a holding contact on said relay, a pause in incoming signal serving to reset said step switch arms to zero, succeeding short pulses serving to step said step switch arms, a very slow make relay energized from local power through said contacts on said second relay near the end of a very long incoming signal, a release contact in said last named holding circuit opened thereby; and a release solenoid on said step switch adapted to return said arms to their initial position when energized from local power through back contacts on said fourth relay when same is deenergized by said slow release relay.

8. A circuit for use with a step switch having a plurality of contact banks and arms rotatable thereover permitting selection of a contact on any of the banks, including in combination, an external source of electric signals, a single channel between said external source and said circuit, a preconditioning circuit comprised of a key relay connected to said channel, a source of local power, a second relay energized from local power through contacts on said key relay, a slow release relay energized from local power through first contacts on said second relay, said slow release relay having contacts closed for a short time after said second relay is deenergized, a fourth relay energized from local power through said contacts on said slow release relay and through back contacts on said second relay, holding contacts on said fourth relay effective while said slow release relay contacts remain closed, said fourth relay thereby preconditioned by one incoming signal pulse, a solenoid on said step switch cooperative with a ratchet mechanism on said step switch for stepping said arms over said contacts, said solenoid energized from local power through contacts on said fourth relay during each incoming pulse after the first; hold contacts on said step switch closed after the first step, a slow make relay energized from local power through said hold contacts near the end of a long incoming signal, a transfer circuit including contacts on said slow make relay connecting local power to the first of said step switch arms, a plurality of latch circuits each controlled by a solenoid connected to a contact on the first bank of contacts on said step switch, one of said latch circuits latching when its solenoid is energized near the end of said long incoming signal and unlatching any other latched circuit, said step switch reset to initial position upon release of said slow release relay by a long pause in said incoming signal; a second plurality of incoming signal pulses preconditioning said fourth relay and stepping said step switch arms, a very slow make relay energized from local power through said contacts on said second relay, contacts on said very slow make relay in said transfer circuit connecting local power through contacts on the latched relay to its corresponding step switch arm, a plurality of outgoing channels each one connected to one contact on said step switch banks, one of said contacts energized from local power through said transfer circuit near the end of a very long incoming signal; said step switch again reset to initial position upon release of said slow release relay by a long pause in said incoming signal.

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9. A circuit non-responsive to static or a sole pulse for use in conjunction with an electromechanical switching device, comprising, a single incoming channel connected to said circuit, a step-by-step electromechanical step switch which has two decks of contacts and a wiper arm for each deck and electromechanical stepping means to step said arms along said contacts, a plurality of local channels each connected individually to said contacts, relay apparatus responsive to a succession of current pulses of short duration arriving over said single incoming channel to cause said electromechanical stepping means to move said arms forward step by step, one step for each current pulse after the first current pulse, time delay relay apparatus responsive only to current pulses of long duration to preselect one of said arms contacting the deck on which a desired local channel terminates, and relay means responsive to a current pulse of intermediate length coming after the arms have been stepped to the contact immediately ahead of the desired contact to step said step switch arms one additional step and to supply current to the pre-selected one of said arms and thence to the desired contact and the local channel connected thereto.

10. An electric channel selector for use with a step switch having at least two banks of contacts and a wiper arm for each bank adapted to contact each of the contacts on the bank with which each is associated in succession, and thereby energize an outgoing channel connected to each contact, including in combination, pulse responsive apparatus responsive to all but the first of a number of successive short pulses of equal polarity and potential received over a single channel to pulse the step switch wiper arms one step for each pulse after the first, apparatus responsive only to a long first pulse to preselect a particular wiper arm for subsequent energization, and apparatus responsive to a pulse of intermediate duration following said short pulses adapted to energize the preselected arm and thus the preselected contact and outgoing channel connected thereto.

11. Apparatus responsive only to a plurality of alternating current impulses of given potential received over a single incoming channel, including, a circuit having slow release means responsive to impulses for preconditioning a portion of said circuit for receiving and passing impulses after the first when the impulses occur before the release time of said slow release means, multibank step switch means connected to be responsive to impulses from the incoming channel through said slow release circuit at the termination of the first impulse and stepped at the termination of the second and subsequent impulses, said step switch means having first and second wiper arm portions and auxiliary switch means, slow make circuit means connected to the incoming channel through said auxiliary switch means on said step switch means which is closed after said step switch means has stepped one step and which is responsive to an impulse of intermediate duration to place current on said first wiper arm portion of said step switch means, and very slow make transfer means connected to the incoming channel during all impulses and responsive to an impulse of long duration to remove current from said first wiper arm portion of said step switch means and place current on said second wiper arm portion of said step switch means.

12. Apparatus responsive only to impulses of common potential received over a single channel, including, a first relay connected to be responsive to impulses of potential received over said channel and having a set of transfer contacts and a pair of contacts, a source of A.C. potential, a slow release relay energized from said A.C. source through said contacts on said first relay, contacts on said slow release relay and means to maintain said contacts transferred for a short time after said relay is deenergized, a third relay energized through a circuit including said transfer contacts on said first relay and said contacts on said slow release relay, said third relay energized through said circuit only while said slow release relay is maintained

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transferred and said first relay is deenergized, a multibank step switch having a wiper arm for each bank and solenoid operated electromechanical means for stepping each wiper arm over the contacts on each bank, a plurality of controlled lines each terminating on individual contacts on said step switch, said step switch solenoid energized through a circuit including said A.C. source and contacts on said third relay and said contacts on said first relay while said third relay is energized and said first relay is deenergized, said electromechanical means adapted to step said wiper arms when said solenoid is operated when said last mentioned circuit is operative when said first relay is again energized, at least one circuit transfer means connected to one of said contacts on said step switch, and a circuit for energizing said transfer means, said circuit including contacts on said first relay closed when said first relay is energized, contacts on said slow release relay closed after said slow release relay has operated, contacts on said third relay closed when said third relay is energized, and one of said wiper arms.

13. A circuit for use with a step switch having a plurality of contact banks and wiper arms for each bank and electromechanical means for stepping said wiper arms over said contacts, the improvement comprising a circuit including a transfer relay energized when an interconnecting circuit is energized, an interconnecting circuit from a remote point, a source of local power, a slow release relay energized from local power when said transfer relay is deenergized and having contacts which transfer when said slow release relay is energized and which remain transferred for a short interval after said slow release relay is deenergized, a conditioning relay energized when said transfer relay is deenergized and while said slow release relay remains transferred, said conditioning relay having contacts which apply local power through contacts on said transfer relay to said electromechanical means, said conditioning relay having also contacts which apply local power to said wiper arms through contacts on said slow release relay and contacts on said transfer relay, and a plurality of transfer devices each having energizing means connectable to individual contacts on one of said plurality of contact banks on said step switch, and a plurality of outgoing control circuits individually terminated at remaining contacts on said step switch.

14. A circuit for use in conjunction with a step switch having a plurality of contact banks and arms rotatable thereover and at least one transfer device selectable by at least one of said arms all operated by electric signals of equal magnitude and variable as to number and duration for switching local power to one of a number of outgoing channels; including in combination, an incoming single channel, an external source of electric signals connected thereto; a preconditioning circuit connected to said channel and including a first relay having an actuated and an unactuated position, a source of local power, a slow release relay energized from local power through contacts on said first relay when said first relay changes position, a third relay energized from local power through first contacts on said slow release relay and contacts on said first relay when said first relay again changes position, said preconditioning circuit thereby preconditioned for a short time after a single incoming signal; a step switch having contact banks and arms rotatable thereover, a solenoid on said step switch cooperative with a ratchet mechanism thereon for stepping said arms over said contacts, said solenoid energized from local power through contacts on said first relay and said third relay, said step switch arms stepped one step for each incoming signal after the first, homing contacts on said step switch closed after the first step, a plurality of outgoing channels one connected to each contact on said contact banks, at least one transfer device connected to a plurality of contacts on said contact banks, circuit means within said preconditioning circuit effective after an incoming signal of medium duration to cause local power to flow to the outgoing

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channel contacted by one of said arms, and back contacts on said third relay effective after a signal of long duration to cause local power to flow to said homing contacts on said step switch and adapted to return said arms to an initial position.

15. An electromechanical switching device operated by electric pulses of equal magnitude and polarity and variable as to number and duration for switching local power to an outgoing channel, including in combination, a single incoming channel, a source of local power, a preconditioning circuit consisting of a key relay connected across said incoming channel, a second relay energized by local power through back contacts on said key relay, and a third relay energized by local power through contacts on said first and second relays; an electromechanical step switch energized by local power through contacts on said key relay and said third relay and stepped one step for each pause in incoming signal after the first; homing contacts on said step switch closed after the first step; a plurality of contact banks on said step switch, a plurality of wiper arms one for each bank and rotatable thereover, a plurality of transfer devices each one connected to apply local power to a different one of said wiper arms and thence to a different one of said outgoing channels, each of said transfer devices connected to and energized through a different one of said plurality of contacts on one of said step switch banks, and a release coil on said step switch energized from local power through said homing contacts and contacts on said third relay.

16. A device for remotely selecting one of a number of output circuits, said device responsive in one manner to pulses of approximately $\frac{1}{20}$ second duration separated by pauses of approximately $\frac{1}{20}$ second and responsive in another manner to a pulse of longer duration, an incoming line, a slow release relay connected to said incoming line and adapted to hold its output circuit closed longer than $\frac{1}{20}$ second, a step switch having stepping means connected to said output circuit and adapted to be energized and stepped thereby after each pulse after the first pulse received over said incoming line, a plurality of output circuits, said step switch having a plurality of contacts each one connected to one of said output circuits, a slow make device responsive only to a pulse of longer duration and connected through said step switch to said output circuits and adapted to place current on the remotely selected output circuit.

17. An electric channel selector for use with a step switch having a plurality of banks of contacts and a wiper arm for each bank adapted to contact each of the contacts on the banks in succession, including in combination, apparatus responsive to all but the first of a number of successive short pulses of equal polarity and potential received over a single channel for pulsing the step switch wiper arms one step for each pulse after the first, apparatus responsive to a pulse of longer duration following said shorter pulses adapted to energize the arms and thus the preselected contact and outgoing channel connected thereto.

18. Apparatus responsive to alternating current impulses of given potential received over a single incoming channel, including, a circuit having slow release means responsive to impulses for preconditioning a portion of said circuit for receiving and passing impulses after the first when the impulses occur before the release time of said slow release means, multi-bank step switch means connected to the incoming channel through said slow release circuit and responsive to impulses received there-through and stepped at the second and subsequent impulses, said step switch means including wiper arm portions and auxiliary switch means, circuit means including said auxiliary switch means connected to the incoming channel through the first named circuit means and closed after said step switch has stepped one step and responsive to an impulse of intermediate duration to place cur-

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rent on said wiper arm portions of said step switch means, transfer means connected to be responsive to impulses from the incoming channel and responsive to an impulse of long duration to remove current from one of said wiper arm portions and place current on another of said wiper arm portions, and a plurality of output circuits connected to said contacts on said step switch means through said wiper arm portions and said transfer means.

19. A device responsive only to a plurality of impulses of various lengths for selecting a particular one of the plurality of circuits in one of a plurality of banks of circuits and placing current thereon, comprising circuit means adapted to prevent the device from responding to a single pulse, circuit means responsive only to short pulses and intervening pauses after the first pulse and pause, for selecting a particular bank of circuits, circuit

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means responsive only to a long pulse transmitted after said short pulses for energizing a latch device connected to the selected bank of circuits, said circuit means which is responsive only to short pulses also responsive to further impulses for selecting a particular circuit in the selected bank, and circuit means responsive to an extra long pulse following the circuit selecting pulses for placing current on the selected circuit.

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