

Nov. 29, 1949

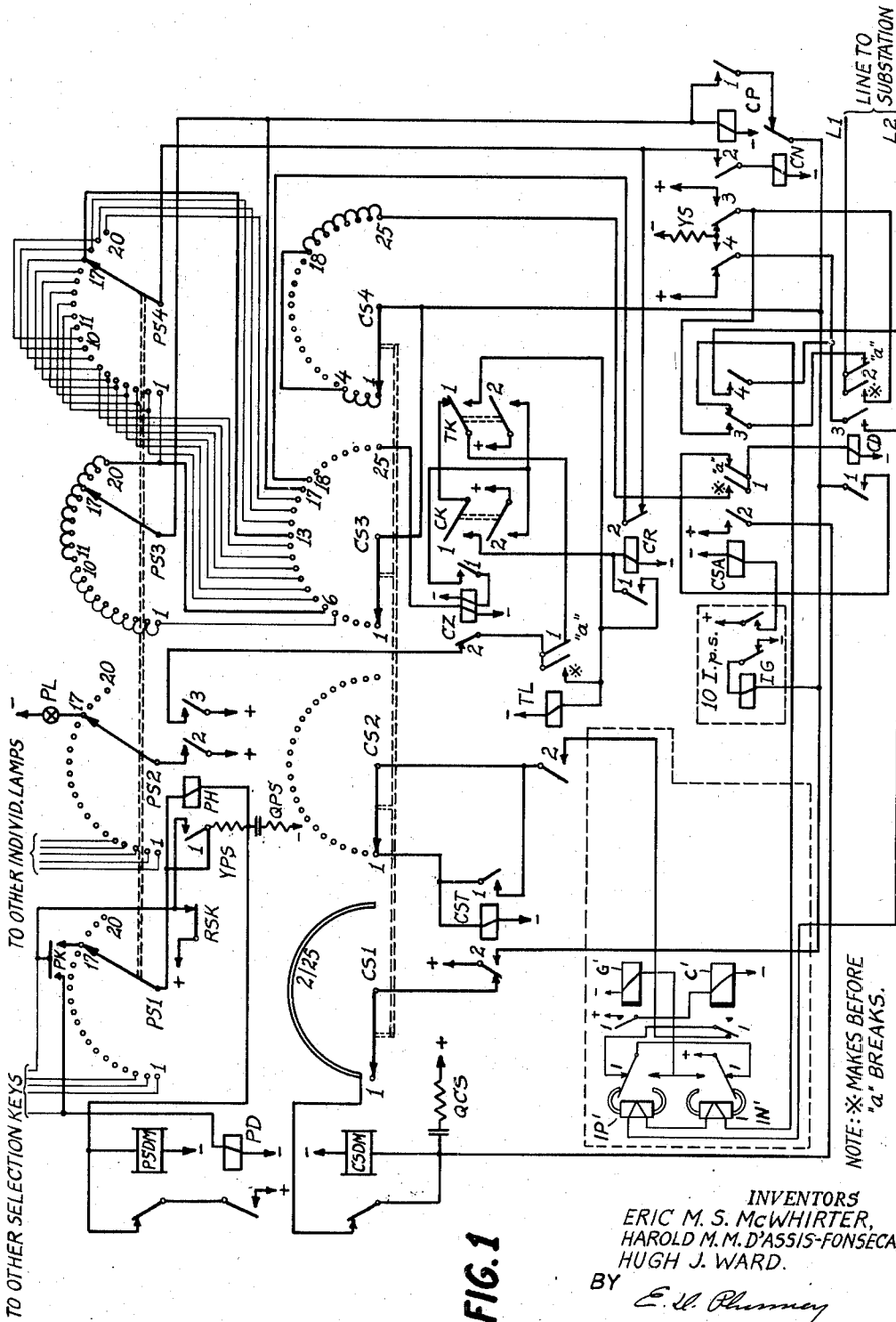
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2,489,306

ELECTRIC SIGNALING TRANSMITTER

Filed Aug. 27, 1945

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

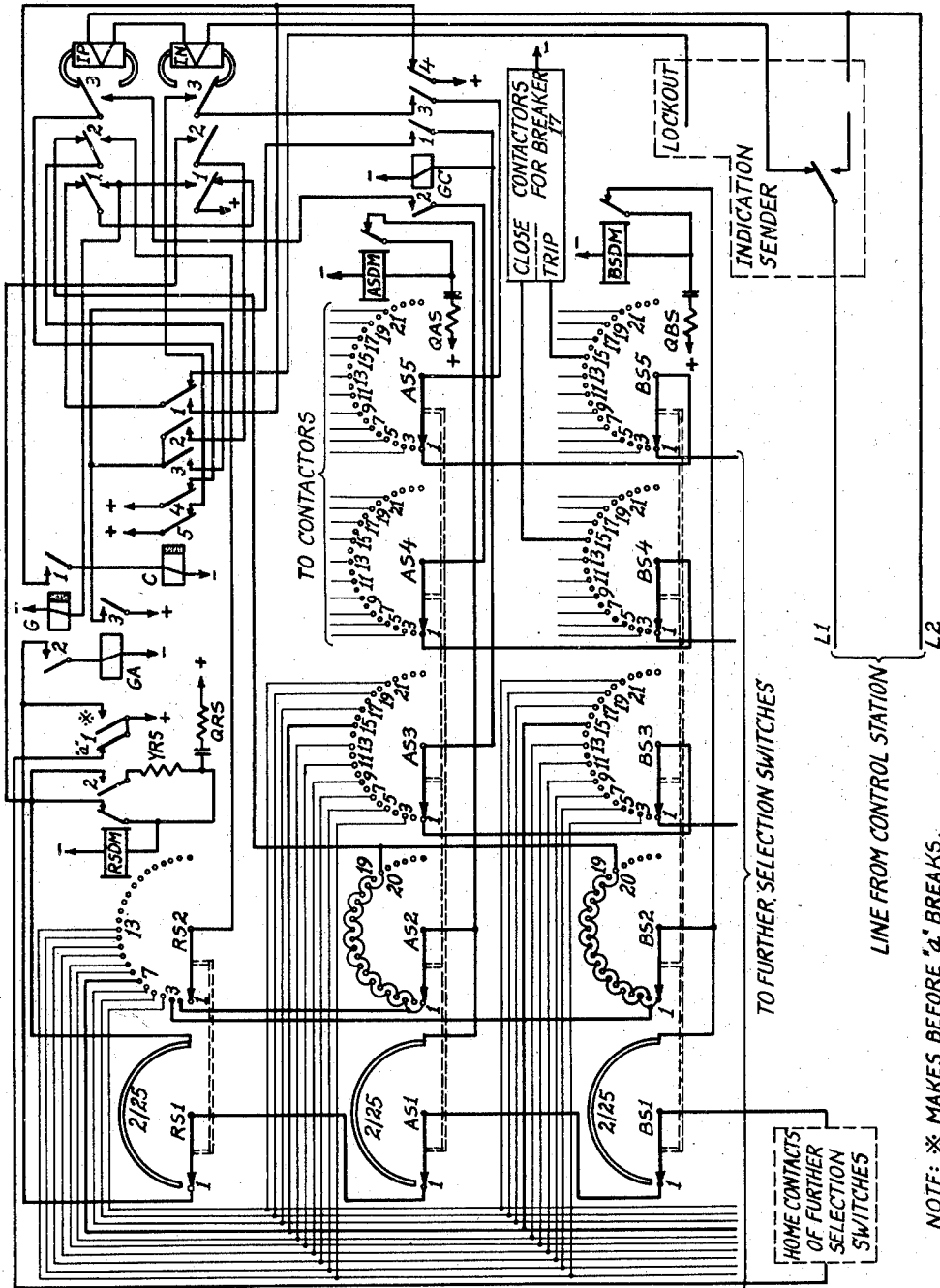


FIG. 2

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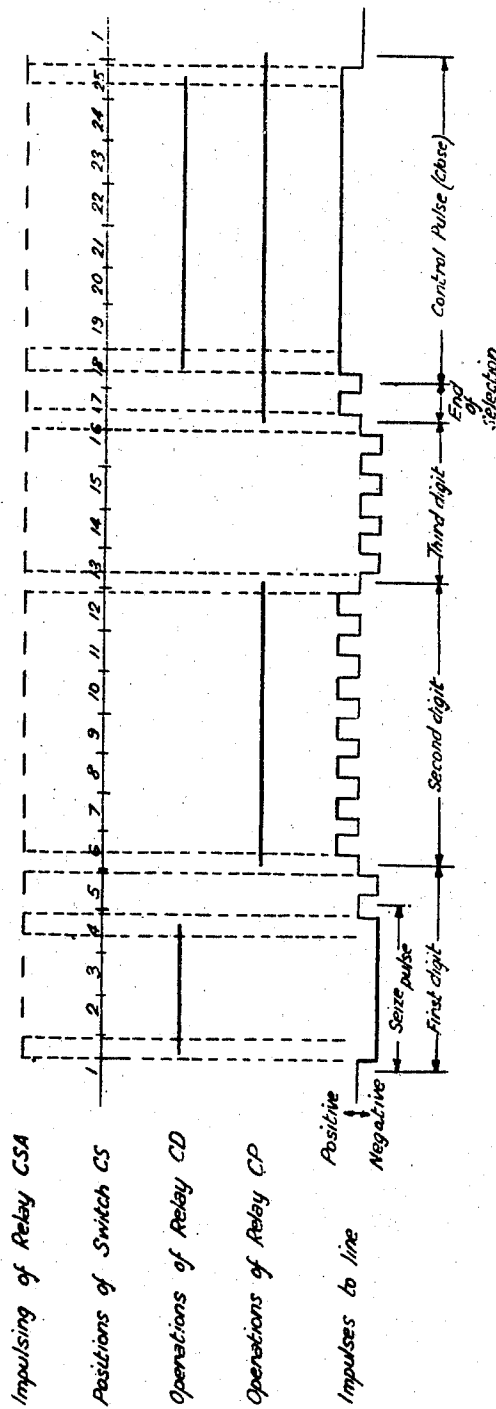
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ELECTRIC SIGNALING TRANSMITTER

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3 Sheets-Sheet 3

FIG. 3.



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ELECTRIC SIGNALING TRANSMITTER

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Standard Electric Corporation, New York, N. Y.,
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Section 1, Public Law 690, August 8, 1946
Patent expires July 26, 1964

4 Claims. (Cl. 177-380)

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This invention relates to electric signalling sys-
tems in which signalling is effected by means of
impulse trains.

It is an object of the invention to reduce the
time required for the transmission of a plurality
of impulse trains by eliminating the usual inter-
digital pause that serves to distinguish one train
from the next.

More particularly, it is an object of this inven-
tion to provide means at a control station for
transmitting to a controlled station a plurality of
digital impulse trains of alternate polarity, repre-
sentative of a desired selective indication, the
impulses being preferably arranged according to
a constant total code consisting, say, of three
digits. These digital impulses may be succeeded,
according to a further feature of the invention,
by an "end of selections" impulse of predeter-
mined polarity, followed by a control pulse of pro-
longed duration, enabling a further selection to
be made depending on whether the control pulse
is positive or negative.

Additional features and objects will subse-
quently appear.

The following description relates to the accom-
panying drawings in which:

Fig. 1 is the relevant circuit at the control
station in a remote control and supervisory sys-
tem;

Fig. 2 is the relevant circuit at the substation
in said system; and

Fig. 3 is a time-chart explaining the genera-
tion of a signal in the control station circuit.

GENERAL

The equipment to be described provides for the
selection by the operator at the control station of
a particular piece of apparatus, say a circuit-
breaker, at the substation, and for the control of
the apparatus selected, say by way of closing or
tripping a circuit-breaker. Corresponding to
each piece of apparatus in the substation there
is provided at the control station a selection key
PK, a selection indicator lamp PL, and an indi-
vidual position in the banks of a selection switch
PS. When the operator depresses a selection
key PK, the appropriate contact is marked in
bank PS! of the switch PS, and the switch PS
is made to hunt for the contact as marked.
When the switch PS finds the marked contact

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and stops on it, the individual lamp PL lights up.
Then when the operator desires to effect the con-
trol of the selected apparatus, assuming that it
is a circuit breaker and, therefore, is to be either
closed or tripped, he presses either the close key
CK or the trip key TK, so that under the control
of a send switch CS there is sent out to line L1,
L2, a train of impulses of which the earlier part
is distinctive of the particular circuit-breaker,
being determined by the setting of switch PS, and
of which the later part is distinctive of the con-
trol operation desired, being determined by key
CK or TK. The selection signal consists of a
constant number of impulses broken up into
three digits. For convenience in what follows
it will be assumed that the selected circuit-breaker
is that which occupies position No. 17 on switch
PS, and that its three-digit constant-total selec-
tion code is 2-7-4.

In the particular embodiment shown and de-
scribed, use is made of a code having a constant
total of 13 and consisting of three digits, permit-
ting the remote control of twenty different pieces
of apparatus. As will be more fully explained
hereinafter, the circuit breakers at the substation
are divided into two groups of ten units each, the
first digit of the code indicating the group and
the second the unit selected. The third or com-
plementary digit merely serves as a check on the
correctness of the code received. The following
table will illustrate this relationship:

Position of Selection Switch	Selection Code		
1	1	1	11
2	1	2	10
3	1	3	9
4	1	4	8
5	1	5	7
6	1	6	6
7	1	7	5
8	1	8	4
9	1	9	3
10	1	10	2
11	2	1	10
12	2	2	9
13	2	3	8
14	2	4	7
15	2	5	6
16	2	6	5
17	2	7	4
18	2	8	3
19	2	9	2
20	2	10	1

The sending of the signal to line is controlled by the repeated operation and release of relay CSA under the control of an impulsing circuit IG. In Fig. 3 there has been shown by means of a time chart the impulsing of relay CSA and immediately below this is indicated the successive stepping of the send switch CS dependent upon each release of CSA. The impulses may be long or short, positive or negative (positive pulse means positive to L1, negative to L2). For the sending of a long pulse, relay CD is operated; for a positive pulse relay CP is operated.

The composition of the signal sent to line is shown at the bottom of Fig. 3.

The first digit "2" is sent as two negative pulses, the first of these two being long so as to serve also as a seizure or calling signal at the substation. The second digit, which follows straight on without an inter-digit pulse, is differentiated from the first by its polarity, the seven impulses being positive. The third digit, again, is differentiated by the fact that its four impulses are negative. There then follows a single positive pulse indicating end of selection; and finally there is the long control or marking out pulse which causes the selected circuit-breaker to be operated. This control pulse is positive for "breaker close" and negative for "breaker trip."

At the substation, negative pulses are received on relay IN and positive pulses on relay IP. The negative trains, that is the first and third digits, are applied to switch RS, which is thus stepped round to a first position in response to the first digit (i. e. position No. 3 in response to digit "2"), and to a second position in response to the third digit (i. e. position No. 7 in response to digit "4") following digit "2"). According to what said first position is, some one of the switches AS, BS, is selected for the reception of the positive train that constitutes the second digit. Thus at the end of the three-digit selection train one of the switches AS, BS, has been selected and has been set to a position distinctive of a certain circuit breaker. The long control pulse then causes energisation of the appropriate contactor.

DETAILED DESCRIPTION

At the control station

The selection switch PS, previously referred to, is shown in Fig. 1 as a rotary switch of the non-homing type comprising the four banks PS1, PS2, PS3 and PS4 as well as a driving magnet PSDM. Each bank is formed by a selected number of contacts of which only the first twenty are shown. The send switch CS, shown as comprising four banks CS1, CS2, CS3 and CS4 as well as a driving magnet CSDM, is a rotary homing-type selector switch having twenty-five contacts in each bank, shown for convenience in a semi-circular array. It will be understood, however, that in practice the step between contact 25 and home contact 1 is similar to that between any other pair of adjacent bank contacts.

QPS and QCS indicate the spark quenching circuits for driving magnets PSDM and CSDM, respectively. RSK is a restoring key assumed to be closed at the beginning of a selecting operation.

The symbols + and - designate positive and negative terminals which may be those of a common battery, not shown. In the following analysis of energizing circuits for the various relays, specific mention of these terminals has been omitted.

Preparing a circuit breaker selection

The control operator presses a certain selection key PK particular to a certain breaker, and common relay PD operates: RSK, PK, PD; selection switch PS steps in response to its driving magnet front contact of PD, armature and winding of magnet PSDM until it finds the contact (No. 17) marked by PK in its bank PS1, when it stops; the magnet being held energised: RSK, PK, contact PS1(17), wiper PS1, resistor YPS, magnet PSDM. Relay PH operates: RSK, PK, contact PS1(17) and wiper PS1, PH, PS; and locks: RSK, front contact (1) of PH, PH, PS. Individual lamp PL lights: front contact PH(2), wiper PS2 and contact PS2(17), PL, indicating that the switch PS stands on that outlet. The operator releases key PK, and relay PD releases.

Sending a selection and control signal

The operator presses close key CK, and relay CR operates: front contact PH(3), back contact cz(2), back contact TL(1), normal contact TK(1), CK(1) closed, CR; followed by relay TL: same as above through CK(1), front contact CR(1), TL, -; both CR and TL locking: front contact PH(3), back contact CS(2), front contact TL(1), etc. (Note that the fact of TL having operated renders any further key manipulation ineffective.)

First digit—two impulses—negative polarity

Relay CST operates: lock-out wire, front contact TL(2), wiper CS2 and contact CS2(1), CST. Relay CSA operates impulsively, over an obvious circuit in response to the impulses generated by the 10 i. p. s. generating circuit IG: front contact CST(2), IG. Switch CS steps once for each impulse: front contact CSA(2), magnet CSDM; relay CD operates on the first operation of CSA: front contact CST(2), wiper CS4 and contact CS4(1), front contact CSA(1), CD; and remains operative over a holding circuit, which includes its own front contact (1) and, alternately, the back contact (1) of CSA or front contact (1) of the latter in series with bank contacts 1 to 3, and wiper CS4, until switch CS reaches position 4, when it releases upon operation of relay CSA. Thus a long negative seize pulse is sent to line, having a duration of 350 milliseconds, i. e. for 300 m. s. over front contacts (2) and (3) of CD, and for the last 50 m. s. over front contacts (3) and (4) of CSA. Switch CS steps to position 5 on the fourth release of relay CSA. A short negative pulse is sent to line when relay CSA operates for the first time, being of normal length because CD is not energized.

Second digit—seven impulses—positive polarity

At the end of the second impulse as above described, switch CS steps to position 6 (note with respect to this position that there is a strapping between contacts CS3(6) and PS3(17)). Relay CP operates: front contact CST(2), wiper CS3 and contact CS3(3), contact PS3(17) and wiper PS3, CP, and locks: front contact CST(2), back contact of CN, front contact (1) and winding of CP; thus reversing the polarity of the feed to the line L1, L2: front contacts (3) and (4) of CP. The following impulses, seven in all, are therefore of positive polarity, until switch CS reaches position 13 (again be it noted that there is a strapping between contacts CS3(13) and PS4(17)). Relay CN operates: front contact CST(2), wiper CS3, and contact CS3(13), contact PS4(17) and wiper PS4, front contact CP(2), CN, and relay

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CP releases: at back contact of CN; also CN releases, so that:

Third digit—four impulses—negative polarity

The line-signalling feed is restored to negative polarity. Impulse-sending continues until switch CS reaches position 17, where:

End-of-selection—single impulse—positive polarity

Relay CP again operates and locks, so that the impulse sent in this position is positive, and serves to mark the end of the selection code.

Control—single pulse—long

Throughout the movement of switch CS in positions 18 to 24, relay CD is operated and locked thus smothering the impulsing to line at contacts (3) and (4) of relay CSA, and giving one long pulse of 750 milliseconds duration—eight make-periods with seven intervening break-periods. This is the "marketing out" or control pulse, and is of positive polarity: CR and CP are operated, CN is de-energized.

Release

Switch CS steps to position 25: relay CZ operates: front contact CST(2), wiper CS3 and contact CS3 (25), CZ. Relays TL and CR release: at back contact CZ(2). Relay CST releases: at contact TL(2), restoring the sending circuit to normal. CS steps to position 1: back contact CST(2), wiper CS1 and off-normal contacts CS1(2/25), armature and winding of magnet CSDM. Relay CZ also releases, unless CK is still depressed; in that case CZ remains up and ensures no repetition of the sending until the key is released and for a second time depressed. Key RSK is depressed, relay PH releases, and the selection circuit is restored to normal, extinguishing lamp PL.

Alternative control signal

Had it been "circuit breaker trip" instead of "circuit breaker close," the operator would have pressed key TK instead of CK. Then only relay TL would have operated, instead of TL and CR; relay CN would have operated in position 18; front contact CST (2), CS3 wiper and CS3 contact (18), back contact CR(2), front contact CP(2), CN; so that relay CP would not have remained energized in positions 18 to 25; and the long single control pulse would have been of negative instead of positive polarity.

OPERATION AT THE SUBSTATION

For a complete understanding of the invention, reference is now had to Fig. 2 where the indication receiving mechanism of the controlled station has been illustrated.

Switch RS, which determines the decade or group of the circuit-breaker selected, is shown as comprising two contact banks, RS1 and RS2, and a driving magnet RSDM. The unit selection switches AS and RS each comprise five contact banks, AS1 to AS5 and BS1 to BS5 respectively, and individual driving magnets ASDM and BSDM. Switches RS, AS and BS are of the 25-position homing type and the remarks made in connection with send switch CS (Fig. 1) apply thereto. QRS, QAS and QBS are respective quenching circuits. IN and IP are polarized relays. C and G are slow-acting relays.

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Seize pulse

Relay IN operates; relay G operates over front contact (1) of IN, and remains up throughout impulsing; front contact IN(1) or IP(1), G; relay C operates: back contact GC(4), front contact G(1), C; relay GA operates: front contact G(2), and home-contacts and wipers of all switches in series, and locks: front contacts GA(1) and G(2).

Polarity discrimination

Relays IN and IP respond to the negative and positive pulses, respectively. Switch RS counts negative impulse trains, switch AS or switch BS (according to the setting of RS) counts the positive impulse train.

First digit two impulses—negative polarity

Switch magnet RSDM energizes: front contacts GA(3), C(2), IN(2), armature and winding RSDM; the latter remains operated, because its armature is shunted by front contact GA(2) in series with resistor YRS. Magnet RSDM deenergizes: at the end of the impulse, and switch RS steps to position 2. Similarly on the second impulse, switch RS steps to position 3.

Second digit—seven impulses—positive polarity

Relay IP operates: switch magnet BSDM energizes: front contacts GA(3), C(3), IP(2), wiper RS2 and contact RS2(3), contact BS2(1) and wiper BS2, armature and winding of driving magnet BSDM; and with self-interruption steps to position 2. Relay IP releases: switch magnet BSDM energizes, over a circuit which includes the front contacts GA(3) and C(3), back contact IP(2), contact BS2(2) and wiper BS2, self-interrupts, and steps to position 3. Thus for each incoming positive impulse, switch BS takes two steps, coming to rest after the seventh impulse in position 15.

Third digit—four impulses—negative polarity

These impulses are repeated by relay IN to switch RS, which is thus stepped to position 7. (To check the correctness of the code received, each of the ten individual contacts 4 through 13 on the RS2 bank is connected in multiple to a corresponding individual contact of bank 3 on all unit selection switches. Note that a strapping exists between contact RS2(7) and contacts AS3(15) and BS3(15) in parallel.)

Single pulse—end of selection—positive polarity

Relay GC operates: front contacts GA(3), C(3), IP(2), wiper RS2 and contact RS2(7), contact BS3(15) and wiper BS3, contact AS3(1) and wiper AS3, GC, and locks: front contacts GA(3), GC(1), GC. (The operating circuit of relay C is now opened at back contact GC(4), but relay C continues to hold over back contacts (1) of IN and IP until a long pulse outlasts its slow-release time.)

Control pulse—long—positive polarity for "breaker close"

Relay IP operates for 750 milliseconds. Relay C releases. Appropriate close contactor is energized: back contact C(4), front contacts IP(3), GC(2), wiper AS4 and contact AS4(1), wiper BS4 and contact BS4(15). At the end of the long pulse: relay IP releases. Relay G slow-releases. Relay GA releases. Relay GC releases. All the selector switches drive home: over back contact GA(1), each via its No. 1 bank and the normal of the previous switch.

Alternative-control pulse negative for "breaker trip"

Relay IN operates and relay C releases. The appropriate trip contactor is energised: back contact C(5), front contacts IN(3), GC(3), wiper AS5 and contact AS5(1), wiper BS5 and contact BS5(15), etc. In the table below there is given a compilation of the positions which switches RS, AS and BS occupy upon reception of each selection code, and the order number of the circuit breaker energized thereby. The latter agrees, of course, with the corresponding position of the selection switch PS at the control station as listed in the table given in the description of Fig. 1.

Selection Code	Position of Switch			Circuit Breaker
	RS	AS	BS	
1 1 11	13	3	1	1
1 2 10	12	5	1	2
1 3 9	11	7	1	3
1 4 8	10	9	1	4
1 5 7	9	11	1	5
1 6 6	8	13	1	6
1 7 5	7	15	1	7
1 8 4	6	17	1	8
1 9 3	5	19	1	9
1 10 2	4	21	1	10
2 1 10	13	1	3	11
2 2 9	12	1	5	12
2 3 8	11	1	7	13
2 4 7	10	1	9	14
2 5 6	9	1	11	15
2 6 5	8	1	13	16
2 7 4	7	1	15	17
2 8 3	6	1	17	18
2 9 2	5	1	19	19
2 10 1	4	1	21	20

NOTES

Extensibility

The system is extensible to control any number of switchgear units, each selection switch AS, BS, etc. serving ten such units. In the circuit shown, selection switch AS is used for the ten codes having initial digit 1, BS for the ten codes having initial digit 2, and so on. For each additional selection switch (10 codes) the constant total of the code is increased by one, and the RS positions shown in column 2 of the foregoing table also increase by one, corresponding changes being made at the control station.

When the system is to be thus extended, it will be necessary to continue the leads from the RS2 bank, wiper BS4, and home contacts BS3, BS4 and BS5 as indicated in Fig. 2. It will be understood, however, that the total check multiple which now includes the leads from contacts 4 through 13 on the RS2 bank will have to be reconnected to a different series of contacts on that bank, consistent with the number of selection switches that have been added. For instance, if two additional unit selection switches are to be used, contacts RS2(4) and RS2(5) will be connected to be odd terminals of bank 2 of the respective new switches and the total check multiple will then comprise the series of contacts from RS2(6) through RS2(15). The conductor which interconnects the even-numbered contacts of the AS2 and BS2 banks will also be extended to the additional selection switches.

The provision of more than two ten-unit selection switches will have the further effect of shortening the marking out or control pulse, at the end of the signal, unless the changes at the control station include an increase in the total number of contacts on send switch CS.

If the coding system is to be extended, other

switches similar to PS may be introduced in which the strapping, as shown on the contacts of PS3, may be arranged for other first digit numbers as necessary, and as outlined above with respect to switches RS and BS.

System guard

It will be noted that, as RS is stepped only by the first and third digits of the code, its final position is fixed by the sum of these two digits, or, in other words the constant total minus the second digit. Thus there is a definite position of RS corresponding to the position of the selection switch in use, which is fixed by the second digit.

This interrelation of the switches is shown in columns 2, 3 and 4 of the above table and is used as a check on the correctness of the received code.

Contact spacing

The advantages of the method of stepping the selection switches AS, BS etc., so that they take two steps for each complete received impulse, lies in the spacing between outlets which results. Odd bank terminals only are used so that the chance of a short circuit occurring between two adjacent "close" contactors, say, is considerably reduced as there is a dead terminal between them.

Lockout

On signalling systems using a single channel over which signals may be transmitted in either direction but not simultaneously in both directions, provision must be made to prevent a sender from interfering with received signals. This provision is illustrated in the accompanying drawings. At the control station the indication receiver is shown in sufficient detail, to enable a proper understanding of same. The receiver in Fig. 1 comprises a pair of polarized relays IP' and IN', similar to relays IP and IN of Fig. 2. The armature of relay IN' is connected to a positive source and applies a potential to relay G' either over the front contact of IN' or the back contact of IN', armature of relay IP' and back contact of IP'. Contact G'1 connects positive voltage to relay C'. The armature of relay C' is connected to the front contact of relay IP' and delivers a positive potential to relay CST over TL2, wiper arm CS2, relay CST, negative. Relays IN' and IP' are serially connected and are placed across the line connecting the control station with the substations over L2, IN', IP', csa3, back, cd2, back, L1. Thus, when relay C' is energized, starting positive potential to relay CST is prevented until the final release of IN' or IP', thereby effectively locking out the sender shown in Fig. 1. At the substation the indication sender is also shown in block form, its starting circuit being via the wire labelled "lockout," and is in all respects identical in structure and function with the sender shown in detail in Fig. 1. From the moment relay IN operates on the seize pulse to the final release of IN or IP after marking-out relay C having released during this period, positive is disconnected from the lockout wire so that the sender cannot start.

On the other hand, it will be seen from Fig. 1 that the connection from L1 to the indication receiver leads over the back contacts CD(2) and CSA(3). Even if CD is not energized, the indication receiver will remain inoperative during impulse transmission since contact CSA(3) will not remain closed for sufficiently long periods to permit energization, by the seize pulse, of the slow-acting receiving relay corresponding to relay G of

Fig. 2. An analogous arrangement is provided for the indication sender of Fig. 2, shown in the form of a switch in series with wire L1.

What is claimed is:

1. An electric signalling system for designating any one of a plurality of units to be operated, each of which units is identifiable by a separate three digit code number, comprising a first multi-bank-switch having preselectable contacts representative of respective pieces of apparatus to be controlled, a second multi-bank switch having a normal and a plurality of off-normal contacts, a transmission line, and means for applying to said transmission line a series of impulse trains of divers polarities and duration characteristic of the position of said first switch, said means including an impulse generator, a manually closable starting circuit for said generator, means for stepping said second switch in synchronism with said generator, means under the control of said generator for repeatedly applying a signalling potential to said line, a relay for reversing the polarity of said signalling potential, and applying a pulse of longer duration than the preceding ones and an energizing circuit for said relay which includes a wiper and off-normal contact of said second switch and a wiper and preselected contact of said first switch.

2. A system as set forth in claim 1, wherein said first means further comprise a relay for restoring the polarity of said signalling potential, and an energizing circuit for said restoring relay which includes a wiper and off-normal contact of said second switch and a wiper and preselected contact of said first switch.

3. A system as set forth in claim 1, wherein said first means further comprise a relay for restoring the polarity of said signalling potential, and wherein said starting circuit includes a pair of alternatively operable keys, one of said keys being adapted to inactivate one of the said relays in a predetermined off-normal position of said second switch.

4. A system as set forth in claim 1, wherein the means for applying a signalling potential to the transmission line include an interrupter contact operable in synchronism with said impulse generator, and wherein means is provided for bridging said interrupter contact in certain positions of said second switch.

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