

Jan. 7, 1947.

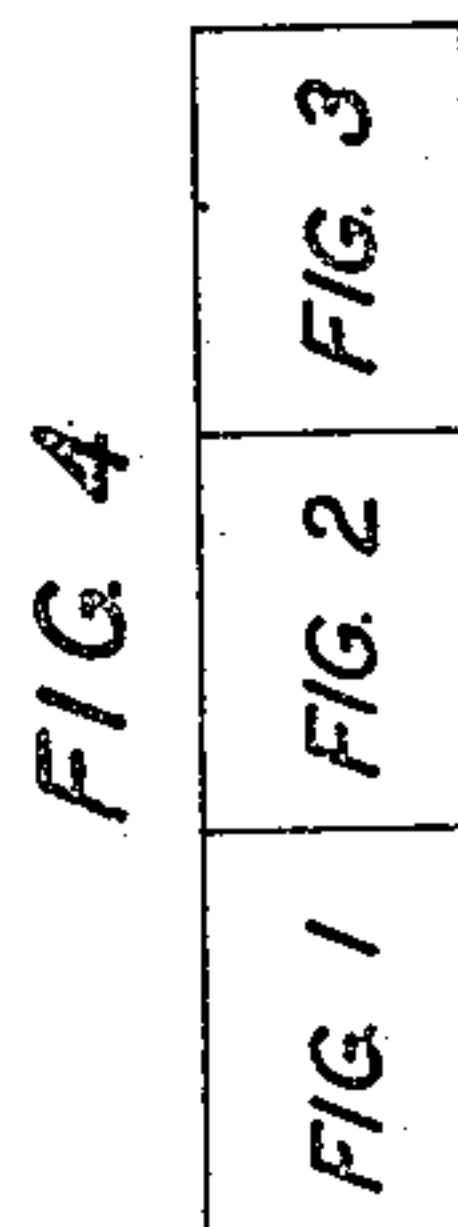
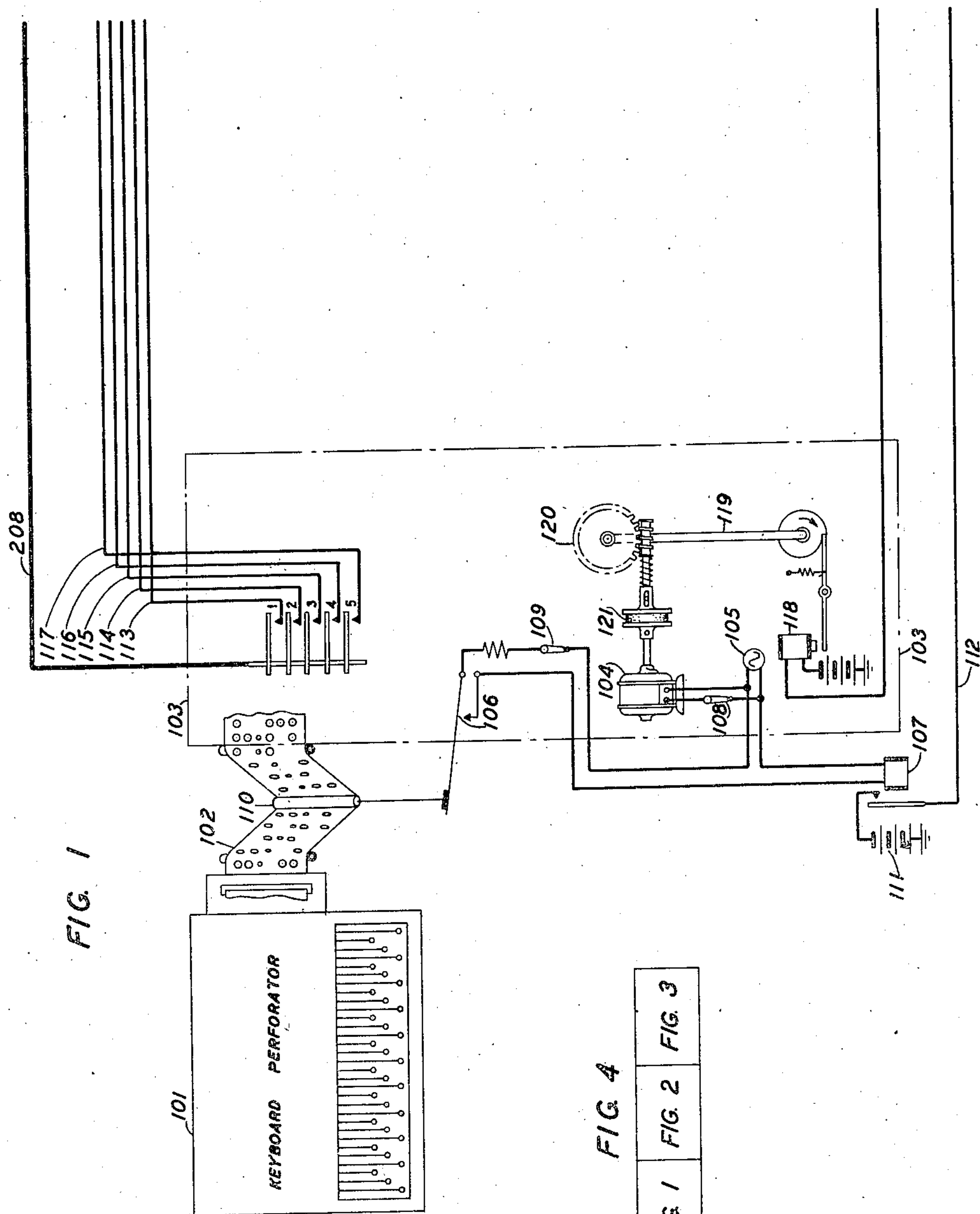
W. R. YOUNG, JR

2,413,741

TELEGRAPH SWITCHING SYSTEM

Filed Nov. 19, 1942

5 Sheets-Sheet 1



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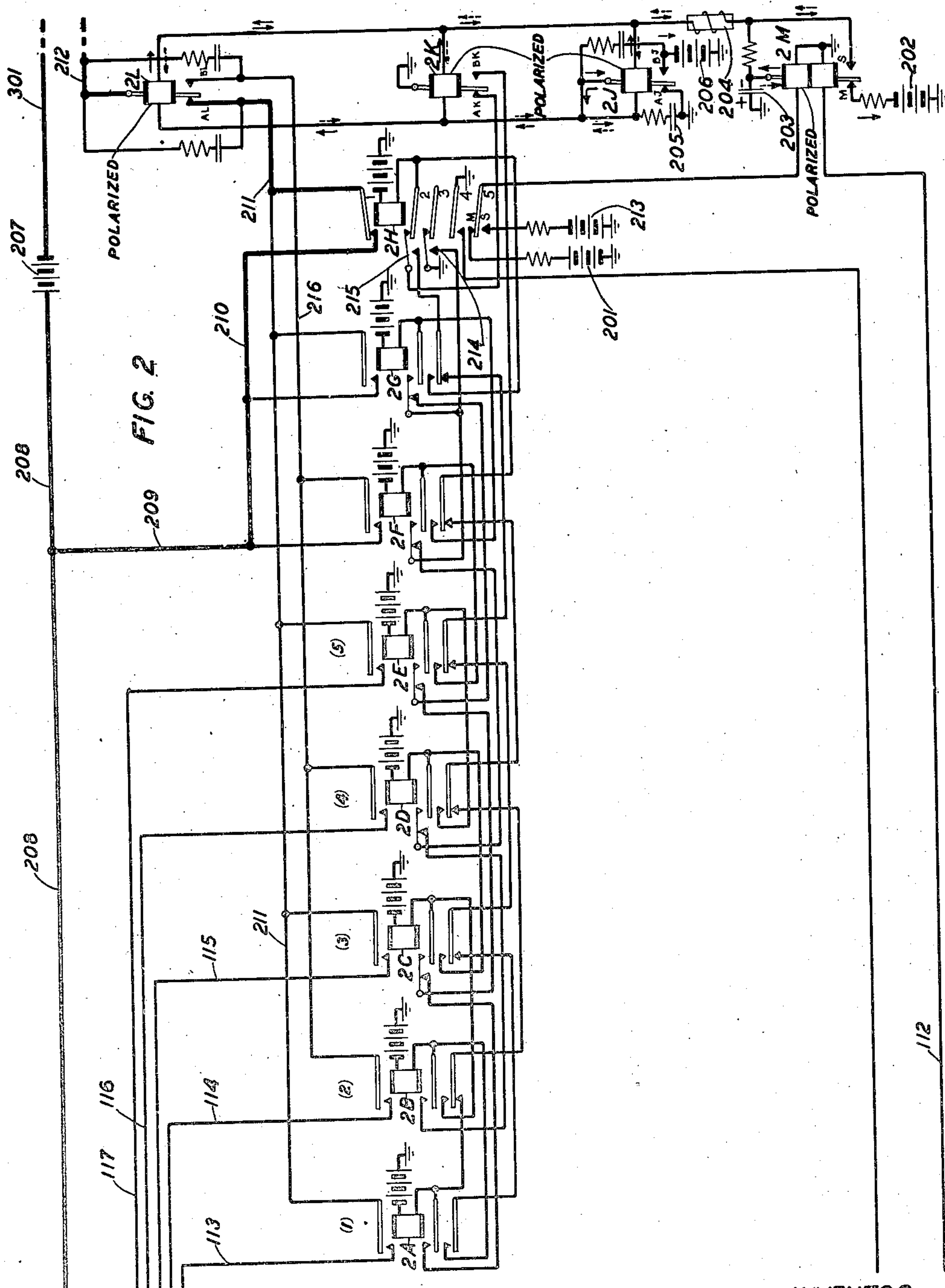
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TELEGRAPH SWITCHING SYSTEM

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5 Sheets-Sheet 2



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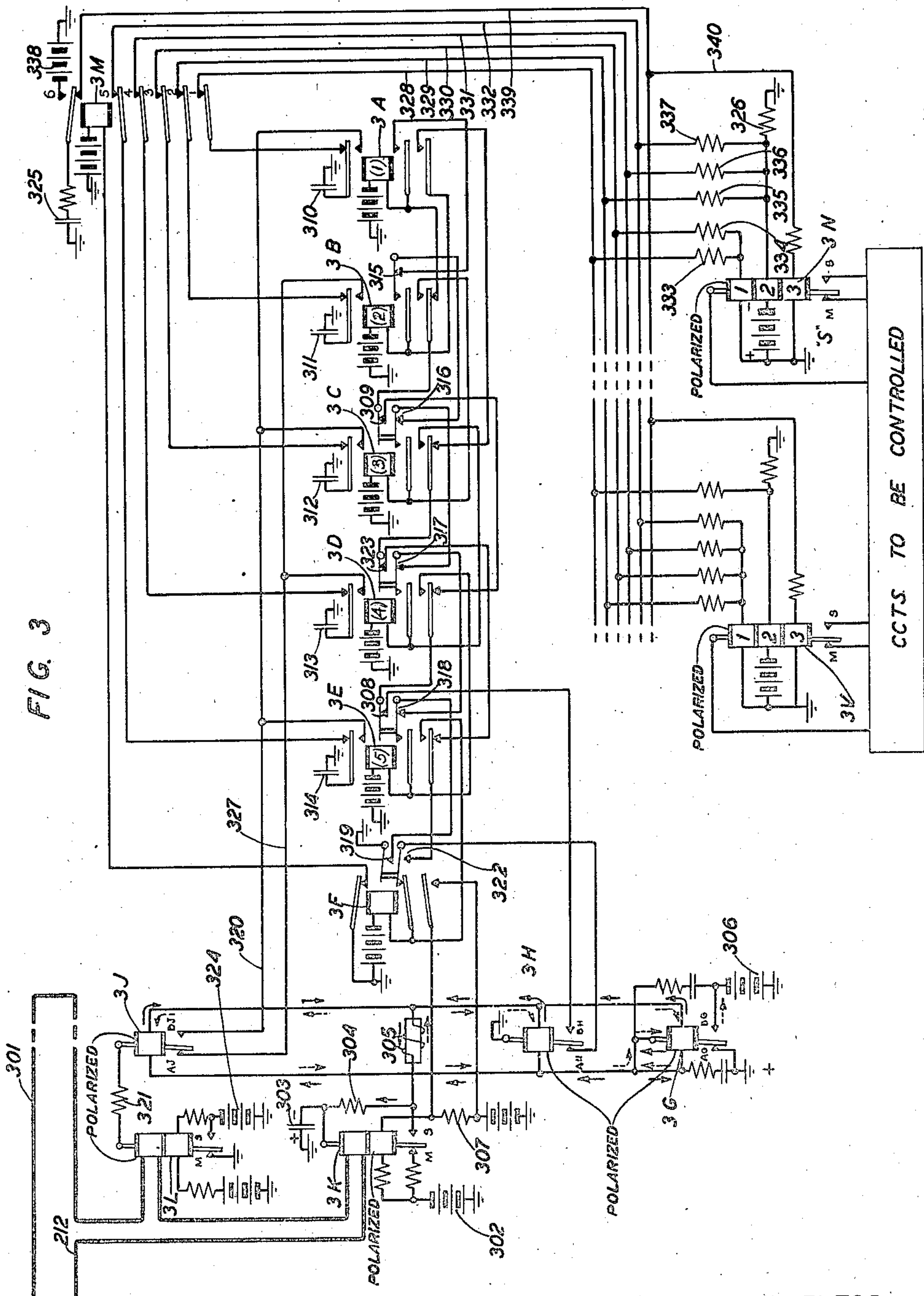
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TELEGRAPH SWITCHING SYSTEM

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5 Sheets-Sheet 3



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TELEGRAPH SWITCHING SYSTEM

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5 Sheets-Sheet 4

FIG 5
SENDING END

(1-S) CODE PULSES:
SIGNAL "S" TO BE
SENT

INSTANT OF
CIRCUIT STARTING
IMPULSE

(2-S) AMP-TURNS
IN (2M)

(3-S) CONTACTS
OF (2M)

(4-S) CURRENT IN
(2J), (2K) & (2L)
REFINING PROCESS

(5-S) CONTACTS OF
(2J), (2K) & (2L)

(6-S) RELAY
OPERATION
ROUGH
SCANNING
PROCESS

(7-S) TRANS. LOOP
CLOSED
OPEN

(7 ¹ -S) PARTIAL PATH FOR LOOP CLOSURE	* 2L ON AL	2L ON BL	2L ON AL	2L ON BL	2L ON AL	2L ON BL	2L ON AL	2L ON BL	2L ON AL
(7 ² -S) REMAINDER OF PATH FOR CLOSURE	** 2H CONT.		2A CONT.	2B CONT.	2C CONT.	2D CONT.	2E CONT.	2F CONT.	2G THEN 2H CONT.
(7 ³ -S) PLACE AT WHICH LOOP PATH IS OPEN	NONE	2L ON AL	NONE	TAPE-PIN CONT. 2	NONE	TAPE-PIN CONT. 4	TAPE-PIN CONT. 5	NONE	NONE

* ARMATURE OF RELAY 2L ON CONTACT AL. ** UPPER ARMATURE OF RELAY 2H ON CONTACT.
*** TAPE-PIN CONT. 1 = CONTACT NO. 1 OF PERFORATOR TRANSMITTER 103

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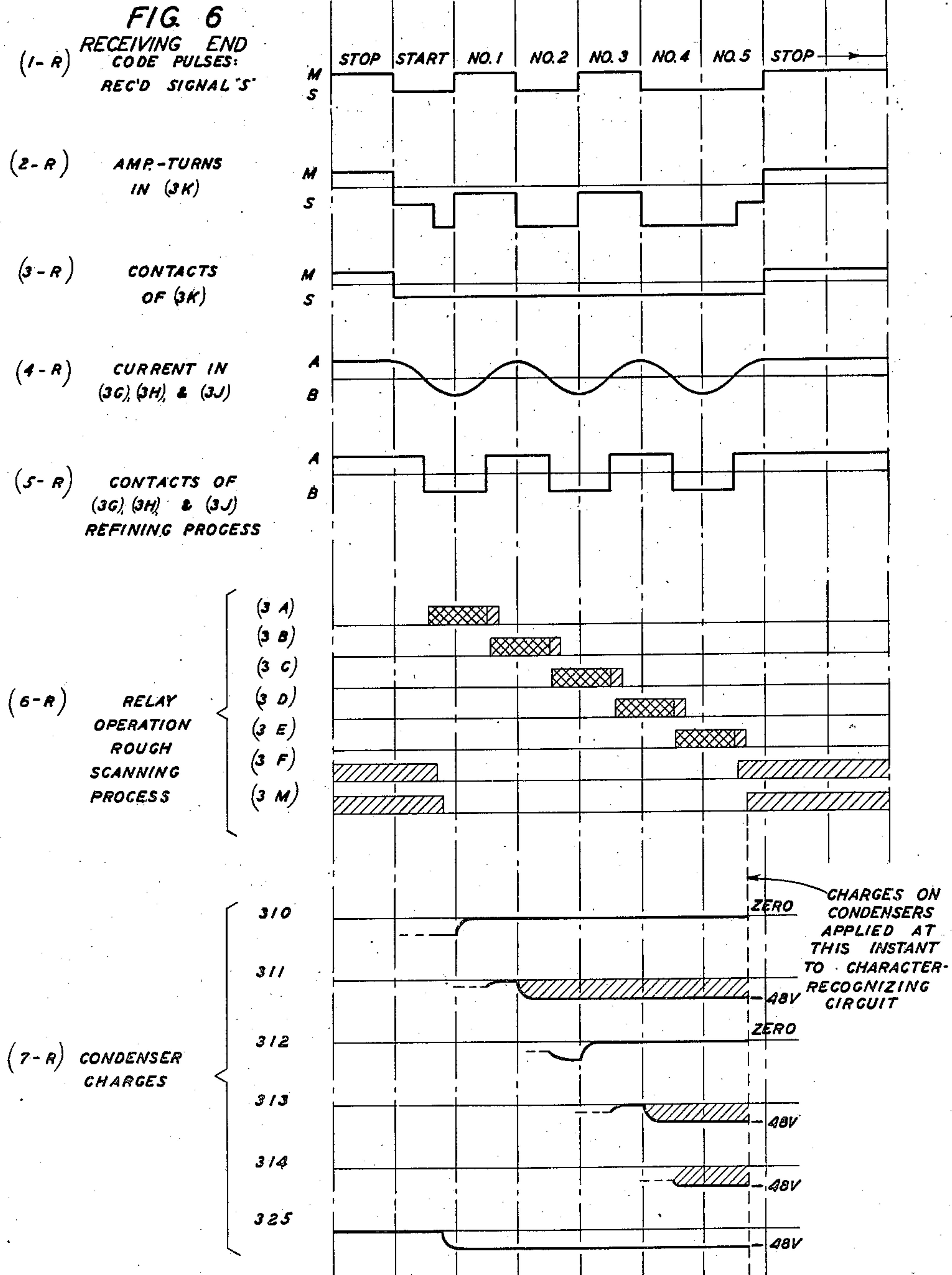
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TELEGRAPH SWITCHING SYSTEM

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5 Sheets-Sheet 5



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2,413,741

TELEGRAPH SWITCHING SYSTEM

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Application November 19, 1942, Serial No. 466,127

7 Claims. (Cl. 178—70)

1

This invention relates to distributor systems in which a succession of groups of impulses including a start impulse, code conditions, each of which may be of one or the other of two kinds such as marking and spacing, and a stop pulse are distributed and accurately formed and timed without the use of rotary or power driven machinery.

An object of the invention is to substitute relay systems for motor or otherwise driven rotating elements, such as rotary distributors, for scanning and correcting the shape of transmitted and/or received permutation code signals.

As embodiments of the present invention, two exemplary forms of circuit arrangements are disclosed; using similar principles for sending or receiving device permutation code or teletypewriter signals. These units are disclosed by way of illustration at the sending and receiving termini of a channel of transmission.

The sending unit is designed to generate, shape, time and transmit teletypewriter signals in which the code pulses of each character signal are determined by simultaneously set combinations of code conditions such as might be set up by a teletypewriter keyboard or tape feeler pins of a tape transmitter, or relays, etc.

The receiving unit is designed to receive teletypewriter signals consisting of code combinations of impulses arriving in time sequence, distribute and start the code pulses for selective recognition of a particular code combination to control the operation of a particular device or relay, or combination of relays. The device or relay thus controlled may control a director circuit for selecting, testing or conditioning a line or channel or may be extended through fanning-out relays such as disclosed in a patent to Krecek 2,368,666, dated February 6, 1945, or used to control transmitters or receivers as in patent to Krecek et al., 2,366,733, dated January 9, 1945, or it may constitute the ultimate element to be selected. In each of these units the desired results are accomplished without the use of brush type or cam type rotating distributors.

A feature of the invention is (1) a sending unit suitable for transmission from group settings of code contacts such as may be set by a keyboard, tape-feeler-pass, relays etc., and (2) a receiving unit to receive and distribute permutation code signals remotely transmitted from teletypewriter tape or keyboard and make selections under control thereof.

Another feature is the provision of a circuit arrangement wherein there is a continual readiness

2

to send and/or receive, and no wear is occasioned during the idle, or waiting, periods.

Another feature is the economy effected in the use of relays in place of rotary distributors.

Another feature is the use of scanning operation in both units and the dividing of such operation in each case into two parts, namely, a rough scanning process and a refining process.

The foregoing objects, features and operation for the specific embodiments of the invention, the novel features of which are specifically pointed out in claims appended hereto, may be more fully understood from the following description when read with reference to the attached drawings in which:

Figs. 1 and 2 show the sending unit at the originating end of a teletypewriter switching system; Fig. 3 shows the receiving unit at the terminating end of a teletypewriter switching system; Fig. 4 shows the relative arrangement of Figs. 1, 2 and 3;

Fig. 5 illustrates by a series of curves the principles of operation of the sending unit; and Fig. 6 illustrates by a series of curves, the principles of operation of the circuit of the receiving unit.

The use of reference characters shown on Figs. 1, 2 and 3 have been kept to a rigid plan. Thus all relays shown in each of Figs. 2 and 3 have reference characters consisting of numerals and letters, the numerals shown are prefixes corresponding to the figure in which the particular relay is located. All other parts of the circuit are designated by numerals only, for instance, those parts of Fig. 1 are designated with numerals between 100 and 199, those of Fig. 2 are designated with numerals between 200 and 299, etc., wherein the hundreds digit designates the figure in which the particular part is found.

Sending unit, Figs. 1 and 2

The system shown in the drawings is arranged for transmitting permutation code signals from a tape transmitter at the sending station to an arrangement at a receiving station. Especially designed devices employing substantially the same principles are employed at opposite ends of the transmission circuit. However, it is not necessary that these devices be provided at opposite ends of a single transmission circuit. It may be preferable to provide a system wherein a specially designed device is used at one end only of the transmission circuit.

In the drawings of the present application, there is shown for illustrative purposes only, a

teletypewriter system having a specially designed device at each end of a transmission circuit.

The medium for transmitting permutation code signals in the illustrated embodiment of the invention consists of a keyboard perforator 101, perforated tape 102 and a tape transmitter 103. The tape transmitter is driven by motor 104 which receives its operating current from alternating current source 105. When there is a sufficient supply of tape perforated for message sending purposes, contacts 106 are closed and maintained energized the operating circuit for relay 107 from source 105. Manually operated switches 108 and 109 are provided to open, as desired, the operating circuit for motor 104 and the operating circuit of relay 107, respectively. During transmission by the keyboard transmitter, contacts 106 are closed, motor 104 is operating and relay 107 is in its operated position unless the supply of perforated tape is depleted at which time tape 102 becomes taut and thereby raises arm 110 to open contacts 106. When contacts 106 open transmission stops until sufficient the perforated tape accumulates to permit contacts 106 to close. A suitable device for automatically opening contacts 106 is disclosed in Dixon's United States Patent 1,192,171, issued July 25, 1916. Electromagnet means comprising a relay, such as that designated 19 in the Dixon patent, may be employed to advance the perforated tape in transmitter 103 and therefore avoid the use of motor 104, another rotary element.

The signal pulses transmitted from tape transmitter 103 must be sent consecutively and accurately, with reference to their length and square-topped wave shape before transmission over the outgoing circuit. This is accomplished by two simultaneously operated processes, one referred to herein as a rough scanning process which employs relay 2A, 2B, 2C, 2D, 2E, 2F, 2G and 2H and the other, the refining process which employs, in the main, relay 2L, 2J, and 2K of an oscillating circuit. The rough scanning produces signal pulses of approximately equal lengths and the refining process signals of exactly equal unit lengths.

In the idle condition, relay 2H is operated by its locking circuit which is traceable from grounded battery, through the winding, No. 2 armature and front contact of relay 2H, left-hand contact AK and armature of relay 2K, to ground. Relay 2H, in its operated position, provides a current for holding relay 2M normally operated in a circuit traceable from grounded positive 48-volt battery 201, front contact and armature No. 5 of relay 2H, through the upper winding of relay 2M, to ground. Relay 2M, in its normally operated position, holds itself in readiness to produce oscillations, the circuit being traceable from grounded negative 48-volt battery 202, left-hand, or marking, contact and armature of relay 2M, condenser 203, to ground.

At the beginning of a transmission period, switches 108 and 109 are operated to the positions shown and as soon as sufficient tape is perforated at perforator 101 the slack thereby produced in tape 102 permits the closure of contacts 106. Relay 107 operates to close a circuit that may be traced from grounded negative 48-volt battery 111, conductor 112, through the lower winding of relay 2M, to ground, and relay 2M operates to its right-hand, or spacing, contact. Relay 2M, upon operating to its spacing position, causes condenser 203 to discharge in a circuit traceable over the armature and right-hand, or spacing, contact of

relay 2M, retardation coil 204, through the windings, in parallel, of relays 2J, 2K and 2L, armature and left-hand contact AJ of relay 2J, to ground. The armatures of relays 2J, 2K and 2L, simultaneously operate to contacts BJ, BK and BL, respectively. As soon as the charging current of condenser 203 becomes zero and then reverses, relays 2J, 2K and 2L return to their respective original positions, namely, with their armatures in engagement with contacts AJ, AK and AL, respectively by means of another circuit traceable from grounded negative 48-volt battery 206, contact BJ and armature of relay 2J, through the windings, in parallel, of relays 2J, 2K and 2L, retardation coil 204, right-hand, or spacing, contact and armatures of relay 2M, condenser 203, to ground. Condenser 203 is charged to a potential having a value approximating that of grounded negative 48-volt battery 206 which is of the same voltage as that of grounded negative battery 202. Relay 2J, returning to its contact AJ, closes a circuit hereinbefore traced, for again discharging condenser 203, and the armatures of relays 2J, 2K and 2L again operate to their contacts BJ, BK and BL, respectively, after the discharge current becomes zero and reverses. This oscillation continues in the manner hereinbefore described because of the excitation furnished by the appropriate operation of the armature of relay 2J between contacts AJ and BJ.

The normally closed signaling circuit, or loop, is traced from the positive pole of battery 207, conductors 208, 209 and 210, contact and upper armature of relay 2H, conductor 211, contact AL and armature of relay 2L, conductor 212, through the upper windings, in series, of relays 3K and 3L, conductor 301, to the negative pole of battery 207. A quarter of a cycle after the start of the oscillations, the closure of the signaling circuit is opened by the operation of relay 2L to a position wherein the relay armature engages contact BL. The open condition of the signaling circuit is maintained for the duration of a unit pulse to send a "start," or "spacing," pulse to the receiving station.

Also, at this time relay 2K operates to contact BK and thereby unlocks relay 2H which now releases. Relay 2H, upon releasing, closes a circuit traceable from grounded negative 48-volt battery 213, through the upper winding of relay 2M and thereby reverses the current flowing in this upper winding to maintain relay 2M in its spacing position for the duration of the code combination for the character or function signal that is being transmitted over the signaling circuit. Also, relay 2H, upon releasing, closes at its No. 4 armature and contact an operating circuit for relay 113 which operates and thereby permits cam shaft 119 to rotate under the influence of friction clutch 121 to start the tape transmitter 103 operating, retract the sensing pins, step the tape and operate the sensing pins to sense the next code combination punched in the tape.

Relay 2K, upon operating to its contact BK, had also closed an operating circuit for relay 2A, the circuit being traceable from ground at the armature and contact BK of relay 2K, outer lower armature and back contact of each of relays 2F, 2D and 2B, in turn, through the winding of relay 2A, to grounded battery and relay 2A operates. Relay 2A, upon operating, locks in a circuit traceable over its inner lower armature and contact, make-before-break contacts of each of relays 2C, 2E and 2G, in turn, to ground at the normally open make-before-break contact 214.

5

Relay 2K, upon operating back to contact AK in its course of oscillating, closes an operating circuit for relay 2B, the circuit being traceable from ground at contact AK of relay 2K, make-before-break contact 215, outer lower armature and back contact of each of relays 2G, 2E and 2C, in turn, outer lower armature and front contact of relay 2A, through the winding of relay 2B, to grounded battery, and relay 2B operates thereby opening the operating circuit for relay 2A which, however, remains in its operated condition due to its locking circuit.

Relay 2B, upon operating, locks over a part of the locking circuit used for relay 2A which was hereinbefore traced.

Relay 2K, upon operating again to contact BK due to its oscillating circuit, closes an operating circuit for relay 2C which operates, the operating circuit being similar to that of relay 2A except that it now extends over the outer lower armature and front contact of relay 2B, through the winding of relay 2C. Relay 2C, upon operating, locks over part of the locking circuit used for relays 2A and 2B, except that the inner lower armature and front contact of relay 2C is now included. Also, relay 2C, upon operating, opens at its inner lower armature and contact, the locking circuit for relay 2A which now releases.

Likewise, relays 2D, 2E, 2F and 2G, in turn, are operated and locked in their operated positions during the operation of the oscillating circuit, and each relay except relay G, in turn, is released when its second succeeding relay is operated, for example, relay A releases when relay 2C operates, relay 2B releases when relay 2D operates, etc. Relay G, upon operating, locks in its operated condition over a circuit directly traceable to ground at contact 214 of relay 2H in its released position, and its locking circuit is opened when relay 2H operates at the end of each character signal.

Assume that the first character signal transmitted is the letter "S," then the corresponding pulses in permutation code are marking, spacing, marking, spacing and spacing for the selective pulses, the "start" pulse as hereinbefore stated being spacing and the "stop" pulse being marking. Accordingly, contacts 1 and 3 of tape transmitter 103 are closed and contacts 2, 4 and 5 are open. To go back to the time that the "start," or spacing, pulse is transmitted over the signaling circuit, the path prepared thereby over which the first selective pulse which is marking is transmitted, finds relay 2L operated to its contact AL, relay 2H released, relay 2A operated and contacts No. 1 of the tape transmitter 103 closed in accordance with the permutation code combination for letter "S." The circuit for transmitting the first, or marking, pulse, which is now completed, extends from the positive pole of battery 207, conductor 208, No. 1 contact of tape transmitter 103, conductor 113, contact and upper armature of relay 2A, conductor 211, contact AL and armature of relay 2L, conductor 212, through the upper windings, in series, of relays 3K and 3L, conductor 301, to the negative pole of battery 207. The first pulse is therefore transmitted at the correct instant by the operation of the armature of relay 2L to contact AL, and the completed circuit is then opened at the correct moment by the return of the relay armature to contact BL.

In the meantime relay 2B has operated and inasmuch as contact No. 2 of tape transmitter 103 is open in this permutation code combination and relay 2H is released, the second selective, or

6

spacing, pulse is transmitted over the signaling circuit at the time that the armature of relay 2L is in engagement with the contact BL.

The oscillating circuit in its course of operating, next moves the armature of relay 2L back to its contact AL and inasmuch as contact No. 3 of the tape transmitter is closed and relay 2C is operated at this time, the signal circuit is closed as hereinbefore traced except that it now extends over contact No. 3 of the tape transmitter, conductor 115, contact and armature of relay 2C to conductor 211. A marking pulse is therefore transmitted to the receiving station.

The next operation of the oscillating circuit moves the armature of relay 2L into engagement with the contacts BL and inasmuch as contact No. 4 of the tape transmitter is open and relay 2H is released, an open pulse, that is a spacing pulse is transmitted over the signal circuit.

Likewise contact No. 5 of the tape transmitter is open and relay 2H is released as the oscillating circuit again moved the armature of relay 2L back to contact AL and an open pulse, that is, a spacing pulse, is transmitted to the receiving circuit.

When relay 2L operates to move its armature into engagement with contact BL, to terminate the transmission of the selective pulses, relay 2F is in an operated position and the signaling circuit is again closed and now includes conductors 208 and 209, contacts and armature of relay 2F, and contact BL and armature of relay 2L to send the "stop," or marking, pulse. When relay 2L moves its armature back to contact AL and relay 2G is in its operated position, the signaling circuit is maintained closed to maintain the "stop" pulse as marking. The circuit now includes conductors 209 and 210, contact and upper armature of relay 2G, conductor 211 and contact AL in engagement with the armature of relay 2L.

Relay 2K which operates in synchronism with relay 2L in the oscillating circuit, moves its armature into engagement with contact AK at the same time that relay 2L moves its armature into engagement with contact AL and a circuit is therefore closed extending from ground at the armature and contact AK of relay 2K, make-before-break contacts 215, outer lower armature and front contact of relay 2G, through the winding of relay 2H, to grounded battery. Relay 2H again operates and locks in its operated position in a circuit traceable over its No. 2 armature and contact to ground at contact AK and armature of relay 2K. Relay 2H, upon operating, also transfers its armature No. 5 from its back contact to its front contact and thereby reversing the current flow in the upper winding of relay 2M. This causes relay 2M to operate to its left-hand, or marking, position, if the current in the lower winding of relay 2M has become zero because of open contacts at relay 107. Relay 2M, in its marking position, stops the oscillating circuit and restores the transmitting arrangement to its normal, or idle, condition in readiness to send a new signal character. If relay 2M has remained in its spacing position the oscillating circuit continues and the sending of the next character or function code combination automatically begins.

Fig. 5

The operation of the sending unit shown in Figs. 1 and 2 can best be understood by reference to the curves shown in Fig. 5. Curve 1—S shows

the start-stop permutation code signal combination representing the letter "S" which is assumed herein as being the first signal prepared on the perforated tape for transmission by the tape transmitter 103. The "stop" and "start" signals are, as usual, shown to be marking and spacing respectively, and the five selective pulses of the signal combination are shown marking, spacing, marking, spacing and spacing. At the instant relay 107 operates spacing current begins to flow in the lower winding of relay 2M from grounded negative 48-volt battery 111 and this current is in opposition to the marking current normally flowing in the upper winding of relay 2M from grounded positive 48-volt battery 201. The spacing current in the lower winding is of sufficient magnitude to overcome the marking current in the upper winding and thereby causes relay 2M to move its armature to its spacing contact. Relay 2M, upon operating, as hereinbefore stated, starts the oscillating circuit and the normally operated relay 2H thereby releases. Relay 2H, upon releasing, disconnects grounded positive 48-volt battery 201 and connects in its place grounded negative 48-volt battery 213 to the upper winding of relay 2M. The current flowing in the upper winding of relay 2M, due to the release of relay 2H is now in the same direction as that in the lower winding and relay 2M is held in its spacing position for the duration of transmission of the signal combination. The currents flowing in the windings of relay 2M indicated in curve 2—S give rise to ampere-turns around the armature which are indicated in curve 2—S. The solid lines represent the case in which the operating circuit for relay 107 is opened, either at contacts 106 or switch 109, during transmission of a character, while the dotted lines represent the case where such circuit remains closed.

Curve 3—S shows the position of the armature of relay 2M with respect to its associated spacing and marking contacts during the time that current is flowing in either or both of the relay windings.

Curve 4—S shows the nature of the current flowing in the winding of relay 2J, 2K and 2L of the oscillating circuit during the interval beginning with the closure of the armature of relay 2M with its spacing contact and ending with the reoperation of relay 2H, immediately upon the completion of the transmission of the signal combination. The alternate charge and discharge of condenser 203 causes an alternating current as indicated in curve 4—S to flow through the windings, in parallel, of relays 2J, 2K and 2L, the cycles recurring in regular intervals.

Curve 5—S shows the positions of the armatures of relays 2J, 2K and 2L relative to their respective "A" and "B" contacts during the time condenser 203 is charging and discharging in regular intervals. The relays operate simultaneously and therefore their armatures will be on corresponding contacts at the same instant.

Curve 6—S shows the duration of the operation of each of relays 2A, 2B, 2C, 2D, 2E, 2F and 2G during the time that a signal combination is being transmitted. Relay 2H which is normally operated, is in a released condition during transmission of each signal combination. These relays perform, as hereinbefore stated, the rough scanning of the signal combination being transmitted and the refining process is performed by relay 2L as part of the oscillating circuit. The cross-hatched section of each block representing

the duration of operation of relays 2A, 2B, 2C, 2D, 2E, 2F and 2G is that part of the pulse that is actually transmitted over the signaling circuit by the operating armature of relay 2L. The signal combination as impressed on the signal circuit is a wave having pulses of uniform length and squared-topped shape as shown in curve 7—S.

The condition of the signal circuit for each pulse of a signal combination transmitted is represented by curve 7¹—S, 7²—S and 7³—S. Normally, relays 2H and 2L are held in the positions shown and therefore during the "stop" interval of a signal combination, the armature No. 1 of relay 2H is in engagement with its contact, and the armature of relay 2L is held in engagement with its contact AL. The signaling circuit, when idle, is closed as indicated in the "stop" section of curves 7¹—S, 7²—S, 7³—S, and extends as hereinbefore traced from the positive pole of battery 207, conductors 208, 209 and 210, contact and armature No. 1 of relay 2H, conductor 211, contact AL and armature of relay 2L, conductor 212, through the windings, in series, of relays 3K and 3L, and back over conductor 301 to the negative pole of battery 207 as indicated in the first, or "stop," section of curves 7¹—S, 7²—S and 7³—S.

During the "start" pulse interval as indicated in the second or, "start," section of curves 7¹—S, 7²—S and 7³—S, the signaling circuit is in a spacing condition because the armature of relay 2L is in engagement with its contact BL and its contact AL is open.

During the first selective pulse interval as indicated in the third section, designated No. 1, of curve 7¹—S, 7²—S, and 7³—S, the armature of relay 2L is on its contact AL, the upper armature of relay 2A is closed to its contact and contact No. 1 of tape transmitter 103 is closed to place the signaling circuit in a marking condition. The circuit now extends from the positive pole of battery 207, conductor 208, contact No. 1 of tape transmitter 103, conductor 113, contact and upper armature of relay 2A, conductor 211, contact AL and armature of relay 2L, conductor 212, back over conductor 301, to the negative pole of battery 207.

During the second selective pulse interval as indicated in the fourth section, designated No. 2, of curve 7¹—S, 7²—S, and 7³—S, the armature of relay 2L is on its contact BL, the upper armature and contact of relay 2B are closed, but contact No. 2 of tape transmitter 103 is open, to place the signaling circuit in a spacing condition.

During the third selective pulse interval as indicated in the fifth section, designated No. 3, of curve 7¹—S, 7²—S and 7³—S, the armature of relay 2L is in engagement with the contact AL, the upper armature and contacts of relay 2C are closed and contact No. 3 of tape transmitter 103 is closed, to place the signaling circuit in a marking condition. The circuit at this time extends from the positive pole of battery 207, conductor 208, contact No. 3 of tape transmitter 103, conductor 115, upper armature and contact of relay 3C, conductor 211, contact AL and armature of relay 2L, over the loop and back to the negative pole of battery 207.

During the fourth selective pulse interval indicated in the sixth section, designated No. 4, of curves 7¹—S, 7²—S and 7³—S, the armature of relay 2L is in engagement with its contact BL, the upper armature and contact of relay 2D, are closed, but the No. 4 contact of tape transmitter

103 is open to place the signaling circuit in a spacing condition.

During the fifth selective pulse interval indicated in the seventh section, designated No. 5, of curves 7¹-S, 7²-S and 7³-S, the armature of relay 2L is in engagement with the contacts AL, the upper armature and contacts of relay 2E are closed, but contact No. 5 of tape transmitter 103 is open to maintain the signaling circuit in a spacing condition.

During the first part of the "stop" pulse interval indicated in the "stop" section of curves 7¹-S, 7²-S and 7³-S, the armature of relay 2L is in engagement with contact BL, and the upper armature and contact of relay 2F are closed, to place the signaling circuit in a marking condition. The signaling circuit is traceable from the positive pole of battery 207, conductors 208 and 209, upper armature and contact of relay 2F, conductor 216, contact BL and armature of relay 2L over the loop and back to the negative pole of battery 207.

When the armature of relay 2L operates to contact AL the "stop" pulse is continued through this contact and the upper armature and contact of relay 2G, until relay 2H operates and relay 2G releases, whereupon the upper armature and contact of relay 2H maintain the loop closure.

Until the "start" of another signal combination is transmitted the "stop" pulse is maintained as indicated in the next section of curves 7¹-S, 7²-S and 7³-S. The armature of relay 2L is held in engagement with contact AL, and the upper armature and contact of relay 2H are closed to maintain the signaling circuit in a marking condition. The signal circuit is now traceable from the positive pole of battery 207, conductors 208, 209 and 210, contact and upper armature of relay 2H, contact AL and armature of relay 2L, over the loop and back to the negative pole of battery 207.

Receiving unit, Fig. 3

The signal pulses during transmission over a long circuit are subject to considerable attenuation and therefore correcting processes, similar to those employed at the sending end, are used at the receiving station. At the receiving station, the rough scanning process employs relays 3A, 3B, 3C, 3D, 3E and 3F and the oscillating circuit which performs the refining process comprises relays 3J, 3H and 3G. Relays 3L and 3K are provided to receive the signal pulses incoming over the loop, or signal, circuit.

In the idle condition, that is, in the "stop," or continuous marking, interval preceding a character, or permutation code, signal, relay 3F is operated and locked in its operated position by current in a circuit traceable from grounded battery, through the winding, inner lower armature and contact of relay 3F, left-hand contact AH and armature of relay 3H to ground. Although the biasing current in the lower winding of each of relays 3L and 3K is spacing, the armatures of the respective relays are held on their left-hand, or marking, contacts, by the marking current in the loop, or signaling circuit. Relay 3K, in its marking condition, holds in readiness a path for starting the oscillating circuit, the path being traceable from grounded 48-volt negative battery 302, marking contact and armature of relay 3K, condenser 303, to ground. Condenser 303 is therefore held charged to a potential approximating the potential of battery 302 when the receiving circuit is in its idle condition.

In response to the start, or spacing, pulse of an incoming permutation code signal, the armatures of relays 3L and 3K operate to their respectively associated right hand, or spacing, contacts and thereby start the simultaneous performance of both the rough scanning and the refining process. Relay 3K, upon operating to its spacing position, closes a circuit for discharging condenser 303, the circuit being traceable from ground, condenser 303, resistance 304, retardation coil 305, through the windings, in parallel, of relays 3J, 3H and 3G, armature and left-hand contact AG of relay 3G to ground. The discharging current causes the armatures of relays 3J, 3H and 3G to simultaneously operate to contacts BJ, BH and BG, respectively.

As soon as the charging current of condenser 303 becomes zero and then reverses, relays 3J, 3H and 3G return to their respective original positions, namely, contacts AJ, AH and AG, respectively, by means of a current circuit traceable from grounded negative 48-volt battery 306, contact BG and armature of relay 3G, through the windings, in parallel, of relays 3J, 3H and 3G, retardation coil 305, right-hand, or spacing, contact and armature of relay 3K, condenser 303 to ground. Condenser 303 again charges to a potential approximating that of grounded negative battery 306 which is of the same voltage as that of grounded negative battery 302. Relay 3G, upon returning to its contact AG in response to the charging current flowing from battery 306, closes a circuit hereinbefore traced for again discharging the condenser 303 to cause the armatures of relays 3J, 3H and 3G to again operate to contacts BJ, BH and BK, respectively. This oscillation continues in the manner hereinbefore described because of the excitation furnished by the appropriate operation of the armature of relay 2J between its contacts AJ and BJ.

As soon as the armature of relay 3H leaves its contact AH at the start of an incoming permutation code signal received over the signaling circuit, the locking circuit for relay 3F is opened to release relay 3F. Relay 3F, upon releasing, closes at its outer lower armature and contact a shunt path around resistance 307 whereby the biasing current flowing through the lower winding of relay 3K is increased to hold the armature of relay 3K in engagement with its right-hand, or spacing, contact for the duration of the incoming five selective pulses of the permutation code signal.

As soon as the armature of relay 3H engages its contact BH, in the middle of the "start" pulse of the incoming permutation code signal, relay 3A operates in a circuit traceable from ground at the armature of contact BH of relay 3H, make-before-break contact 308 of relay 3E, outer lower armature and back contact of relay 3D, make-before-break contact 309 of relay 3C, outer lower armature and back contact of relay 3B, through the winding of relay 3A, to grounded battery. Relay 3A, upon operating, (1) closes at its upper armature and front contact a circuit for charging condenser 310, (2) locks itself at its inner lower armature and front contact in a circuit which extends over the make-before-break contacts 315, 316, 317 and 318, in turn, of relays 3B, 3C, 3D and 3E, respectively, closed contacts 319 of relay 3F, to ground, and (3) prepares at its outer lower armature and contact an operating circuit for relay 3B which operates as hereinbefore described when the armature of relay 3H returns to its AH contact during the

second cycle of oscillations for each signal combination.

The circuit for charging condenser 310 may be traced over the upper armature and front contact of relay 3A, conductor 320, contact BJ and the armature of relay 3J, resistance 321, armature and right-hand, or spacing, contact of relay 3L, to grounded negative 48-volt battery 324, and condenser 310 thereby assumes a potential approximating that of grounded battery 324. Relay 3L is arranged, as hereinbefore stated, to follow the pulses of the permutation code signals incoming over the signaling circuit. During the first half of the first selective pulse of the incoming permutation code signal, condenser 310 will acquire a voltage representative of the marking or spacing nature of this pulse in the signal received.

Inasmuch as letter "S" is hereinbefore selected to be the permutation code signal transmitted from the sending station, the first selective pulse after the "start" pulse, is marking and the armature of relay 3L is on its left-hand, or marking, contact. Therefore the charge impressed by the first selective pulse on condenser 310 is of zero value. In the middle of the first selective pulse further change in potential on condenser 310 is prevented by the opening of the charging circuit when the armature of relay 3J returns to its contact AJ.

Relay 3H, upon operating in the oscillating circuit, causes its armature to engage contacts AH and BH alternately at regular intervals. Relay 3H, upon moving its armature to its contact BH, operates relay 3A as hereinbefore stated, and upon causing its armature to return to contact AH closes an operating circuit for relay 2B, the circuit being traceable from ground at the armature and contact AH of relay H, contact 322, outer lower armature and back contact of relay 3E, make-before-break contact 323, outer lower armature and back contact of relay 3C, front contact and armature of relay 3A, through the winding of relay 3B, to grounded battery. Relay 3B operates and locks in its operated position over its inner lower armature and front contact and part of the locking circuit for relay 3A hereinbefore described.

Relay 3H, upon moving its armature to contact BH for the second time, closes an operating circuit for relay 3C, the circuit being traceable from ground on the armature and contact BH of relay 3H, make-before-break contact 308, outer lower armature and back contact of relay 3D, make-before-break contact 309, outer lower armature and front contact of relay 3B, through the winding of relay 3C, to grounded battery. Relay 3C operates and locks over its inner lower armature and front contact and part of the locking path for relay 3A.

Relay 3H, upon returning its armature to contact AH for the second time, closes an operating circuit for relay 3D, which circuit may be traced from ground on the armature and contact AH of relay 3H, contacts 322, outer lower armature and back contact of relay 3E, make-before-break contact 323, outer lower armature and front contact of relay 3C, through the winding of relay 3D, to grounded battery. Relay 3D operates and locks up in a circuit traceable over its inner lower armature and front contact and part of the locking path for relay 3A.

Relay 3H, upon operating its armature to its contact BH for the second time, closes an operating circuit for relay 3E, the circuit being traceable from ground at the armature and contact BH

of relay 3H, make-before-break contact 308, outer lower armature and front contact of relay 3D, through the winding of relay 3E, to grounded battery. Relay 3E operates and locks in a circuit traceable over its inner lower armature and front contact as part of the locking path of relay 3A.

Relay 3H, upon returning its armature to its contact AH for the third and last time of the group of five selective pulses representing the incoming signal for letter "S," closes a circuit for reoperating relay 3F to its normally operated position to await the next incoming signal combination. The operating circuit for relay 3F may be traced from ground at the armature and contact AH of relay 3H, closed contact 322, outer lower armature and front contact of relay 3E, through the winding of relay 3F, to grounded battery. Relay 3F operates and locks up over its inner lower armature and contact to ground at contact AH and the armature of relay 3A. The locking circuit for each of relays 3A, 3B, 3C, 3D and 3E is maintained closed only until the next succeeding relay is operated, for example, relay 3A is locked in its operated position until relay 3B operates, likewise, 3B until relay 3C operates and so on until relay 3F operates and locks in its operated position. Relay 3F, upon operating, closes at its upper armature and contact an operating circuit for relay 3M which operates to complete means for selecting the character-recognizing equipment as will be hereinafter described. Relay 3F remains operated until another signal is received over the signaling circuit.

The operation of relays 3B to 3E in conjunction with the operation of relay 3J and positioning of relay 3L by incoming code pulses causes charges to be stored on condensers 311 to 314, respectively, the initial magnitudes of the charges being either zero or approximately the full negative value determined by the voltage of grounded negative 48-volt battery 324. These stored charges are respectively determined by the nature of the five selective pulses constituting the incoming permutation code signal. Charging of each of these condensers is interrupted in the middle of the pulse which each condenser represents, by the operation of the armature of relay 3J between contacts AJ and BJ.

Shortly after the middle, viz., at the end of the fifth pulse, charges on the code storing condensers 310 to 314 and on condenser 325 are applied by the operation of relay 3M, which operates in response to the operation of relay 3F, to the winding of a character-recognizing circuit. The character-recognizing circuit may take a variety of forms, for example, the code storing condensers in cooperation with the resistances of various values, may cause in such character-recognizing circuit the operation of code storing relays, such as relays 3N, 3V, etc., which, in turn, may operate a set of so-called "fanning relays" shown and described in Krecek Patent No. 2,368,666, supra.

With the illustration selected herein, relays 3N and 3V, respectively operate in response to different permutation code signals received over the signaling circuit, that is, relay 3N is operated for one letter, say letter "S," and relay 3V for another letter. Each of these relays together with each of several other relays that may be used, is connected so as to operate only when the desired character, or letter, is electrically stored in the code storing condensers. Relay 3N may be assumed to respond to the signal combination corresponding in a commonly used code to letter "S"

in which case the selecting voltages furnished by condensers 310 to 314 over armatures 1 to 5, respectively, of relay 3M are zero, -48 volts, zero, -48 volts, and -48 volts. The selecting voltages correspond to the five selective pulses for letter "S," the pulses received from signaling circuit being, as hereinbefore stated, marking, spacing, marking, spacing and spacing.

Returning to the operation when the permutation code signal corresponding to letter "S" is received and relay 3L responds first to the "start" pulse of the signal combination and then to the first selective pulse which is marking. When relay 3L responds to the first selective pulse, its armature returns to the position shown. The armature of relay 3J is at this time in engagement with its contact BJ and a circuit is closed from ground on the left-hand, or marking, contact and armature of relay 3L, resistance 321, armature and contact BJ of relay 3J, conductor 320, front contact and armature of relay 3A, condenser 310 to ground, to store a zero potential on condenser 310.

When relay 3L responds to the second selective pulse, its armature operates to its right-hand, or spacing, contact, the armature of relay 3J at this time being in engagement with its contact AJ and a circuit is closed to store a -48 volt potential on condenser 311, the circuit being traceable from grounded -48 volt battery 324, spacing contact and armature of relay 3L, resistance 321, armature and contact AJ of relay 3J, conductor 327, front contact and upper armature of relay 3B, condenser 311 to ground.

When relay 3L responds to the third selective pulse, its armature operates to its left-hand, or marking, contact. The armature of relay 3J at this time is in engagement with its contact BJ and a circuit is thereby closed from ground at the marking contact and armature of relay 3L, resistance 321, armature and contact BJ of relay 3J, conductor 320, front contact and upper armature of relay 3C, condenser 312 to ground to store a zero potential on condenser 312.

When relay 3L responds to the fourth selective pulse, its armature again operates to its spacing contact. The armature of relay 3J at this time is in engagement with contact AJ and a circuit is thereby closed from grounded -48 volt battery 324 at the spacing contact and armature of relay 3L, resistance 321, armature and contact AJ of relay 3J, conductor 327, front contact and upper armature of relay 3D, condenser 313 to ground to store a -48 volt potential on condenser 313.

When relay 3L responds to the fifth and last selective pulse its armature remains on its spacing contact. The armature of relay 3J at this time is in engagement with contact BJ and a circuit is thereby closed from grounded -48 volt battery 324 at the spacing contact and armature of relay 3L, resistance 321, armature and contact BJ of relay 3J, conductor 320, front contact and upper winding of relay 3E, condenser 314, to ground, to store a -48 volt potential on condenser 314.

Relays 3A, 3B, 3C, 3D and 3E release, in turn, as hereinbefore described so that the upper armatures thereof are moved into engagement with the respective back contacts. Relay 3M operates in response to the operation of relay 3F and the stored potentials on condensers 310 to 314 are impressed through armatures Nos. 1 to 5 of relay 3M, on conductors 328 to 332, respectively. Conductors 328 to 332 may be multiplied, as shown, to relays 3N and 3V and as many other relays as may be used depending on the number of

combinations of resistances, such as resistances 333 to 337, that may be employed.

Relay 3N which is assumed to be responsive to the transmission of the permutation code signal combination corresponding to the letter "S," as hereinbefore stated, is normally held in the position shown by current flowing in a circuit extending from grounded -48 volt battery through the relay No. 2 winding, resistance 326 to ground. Conductors 328 and 330 are connected through resistances 333 and 334, respectively, to a path extending through winding No. 1 of relay N to ground, and conductors 329, 331 and 332 are connected through resistances 335, 336 and 337, respectively, to a path extending through a resistance 326 to ground. Therefore no current flows through the windings of relay 3N as a result of the stored potentials on condensers 310 to 314. However, when relay 3M was in released position during the time that the permutation code signal corresponding to letter "S" was being received, condenser 325 was charged to a potential approximating the -48 volt potential from grounded battery 338 and the relay, upon operating, impresses this stored potential on a circuit extending over armature No. 6 and front contact of relay 3M, conductors 339 and 340, through the No. 3 winding of relay 3N and to ground. Relay 3N momentarily operates to start the desired function controlled thereby, the current flowing through winding No. 3 of relay 3N being of such direction and magnitude to overcome the biasing current in winding No. 2.

Fig. 6

The operation of the receiving unit shown in Fig. 3 can best be understood by reference to the curves shown in Fig. 6.

Curve 1R shows the start-stop permutation code signal representing letter "S" that is assumed to be received over the signaling circuit and then through the upper windings, in series, of relays 3K and 3L. As hereinbefore stated, the "stop" and "start" pulses are marking and spacing, respectively, and the five selective pulses of the signal combination are marking, spacing, marking, spacing and spacing. Relays 3L and 3K are normally in position shown, that is, in their marking positions under the influence of the "stop" pulse current flowing in their upper windings. Accordingly, during the idle interval of the receiving unit, condenser 303 is charged to a potential approximating that of grounded negative 48-volt battery 302, and relays 3F and 3M are operated to the positions shown, relay 3F under the control of its locking circuit which extends to ground at contact AH and armature of relay 3H, and relay 3M also under control of relay 3H.

Curve 2R shows the inductive action of the currents flowing in the windings of relay 3K during the reception of a signal combination. As soon as the "start," or spacing pulse is received by relays 3L and 3K, the armatures of both relays move to their respective spacing positions under the influence of the biasing currents flowing in their lower windings. Relay 3K is maintained in a spacing position for the duration of the reception of a signal combination even though some of the selective pulses of the signal combination received in the upper winding of relay 3K may be marking, as will be hereinafter described.

Curve 3R shows the operation, or position, of the armature of relay 3K relative to its marking and spacing contacts, it being noted that the armature remains on its spacing contact in response to the incoming "start" pulse and the

five selecting pulses, that is, for the duration of the signal combination regardless of the polarity or nature of each individual selective pulse. Relay 3K, upon operating, to its spacing contact, closes a discharging circuit for condenser 303 which may be traced from ground, condenser 303, armature and spacing contact of relay 3K, retardation coil 305, through the windings, in parallel, of relays 3J, 3H and 3G, armature and contacts AG of relay 3G to ground. The discharge of condenser 303 operates the armatures of relays 3J, 3H and 3G to their respectively associated contacts, BJ, BH and BG. Relay 3H, upon leaving its contacts AH, opens the locking circuit of relay 3F which releases. Relay 3F, upon releasing, effects at its upper armature and contact the release of relay 3M and at its outer lower armature and contact the closure of a circuit for shunting resistance 307 from the biasing circuit of relay 3K. Relay 3K receives in its lower winding, when resistance 307 is shunted, a biasing current of sufficient magnitude to maintain its armature on its right-hand, or spacing contact, thereby producing the effect of holding the relay in a spacing condition for the duration of reception of the signal combination to which reference was hereinbefore made. As soon as the armature of relay 3G engages its contacts BG, condenser 303 again charges to a negative potential of approximately 48 volts in a circuit traceable from grounded negative battery 306, contact BG and armature of relay 3G, through the windings in parallel, of relays 3J, 3H and 3G, retardation coil 305, right-hand, or spacing contact and armature of relay 3K, condenser 303 to ground.

Curve 4R shows the nature of the current flowing in the windings, in parallel, of relays 3J, 3H and 3K of the oscillating circuit during each oscillating interval beginning with the first closure of the armature of relay 3K with its spacing contact and ending with the reoperation of relay 3F immediately after the completion of the reception of a signal combination. The cycles of the current due to the alternate charging and discharging of condenser 303 recur in regular intervals.

Curve 5R shows the curve produced as the armature of relays 3J, 3H and 3G engage their respective "A" and "B" contacts during the time condenser 303 is charging and discharging in regular intervals. The relays operate simultaneously and therefore their armatures will be on corresponding contacts at the same instant.

Curve 6R shows the duration of the operation of each of relays 3A, 3B, 3C, 3D and 3E during the time that a signal combination is being received. Relays 3F and 3M which are normally operated, as hereinbefore stated, are in a release condition during the reception of these signal combinations. These relays perform, as hereinbefore stated, the rough scanning process of the incoming signal combination and the refining process is performed by relays 3J, 3H and 3G as part of the oscillating circuit. The cross-hatched section of each block representing the duration of operation of each of relays 3A, 3B, 3C, 3D and 3E is the actual length of the corresponding pulse of the selective pulses that are transmitted at the sending end of the signaling circuit, but each is reproduced with respect to its corresponding pulse received by relays 3K and 3L, to show a lag due to the time for energization and operation of relay 3K and the relays of the oscillating circuit.

Curve 7R shows the potential charge stored on

each condenser 310, 311, 312, 313, 314 and 325 during the time that the signal combination is being received. Each of relays 3A, 3B, 3C, 3D and 3E is in readiness to discharge the charge on its associated condenser at the time relay 3M reoperates in response to the reoperation of relay 3F, and these charges are simultaneously impressed over character-recognizing circuit paths respectively including resistances 333, 334, 335, 336 and 337. In response to a received signal combination corresponding to letter "S" the potential on each of condensers 310 and 312 will be zero and that on each of condensers 311, 313, 314 and 325 will be negative 48 volts. The potential on condenser 325 is negative 48 volts for each and every signal combination received. For a signal combination of letter "S," the charge on condenser 325 only is effective to operate the desired relay, such as relay 3N. Should any one or more of the paths respectively controlled by relays 3A, 3B, 3C, 3D and 3E carry current, relay 3N would not have operated, inasmuch as its operation was not desired, but another relay, such as relay 3V, would have responded.

If the character received over the signal circuit had not been "S," current would have momentarily flowed in one or more of resistances 333 to 337 which are preferably of different values and these currents would have been of such direction and magnitude as to prevent the operation of relay 3N.

The scanning operation is completed at about the middle of the fifth selective pulse of the received permutation code signal. The operation of relay 3F restores the biasing current in the lower winding of relay 3K to normal. If the fifth selective pulse is marking, relay 3K returns to its marking contact M, immediately. If the pulse is spacing, relay 3K returns to its marking contact M at the beginning of the stop pulse. The return of the armature of relay 3K to its marking contact M stops the oscillating circuit and prepares it for restarting upon the receipt of the next incoming permutation code signal.

It is not necessary to limit this circuit to sending open and closed signals. For example, minor alterations would permit it to apply to the outgoing line alternate positive and negative battery or alternate battery and ground.

Two rotary stepping selector switches may be used to perform the rough scanning of relays 2A, 2B, 2C, 2D, 2E, 2F, 2G and 2H at the sending station. One selector switch operated from the BK contact of relay 2K can perform the function of relays 2A, 2C, 2D and 2G, and another selector switch operated from contact AK of relay 2K can perform the functions of relays 2B, 2D, 2F and 2H.

What is claimed is:

1. In a distributor, a start element, a chain of stepping relays, a timed vibrating element, conductive means to which code pulses representing marking and spacing conditions are to be delivered sequentially, a source of pulses to be distributed, a pulse refining or timing relay, means whereby the start element initiates the operation of the vibrating element, means whereby the refining relay follows the vibrating element, means whereby the vibrating element controls the stepping of the chain of stepping relays, and paths closed in succession to said conductive means, each said path including a closed path over a contact from a source determined as marking or spacing by a code condition and including a

contact of a stepping relay and a contact of said refining relay.

2. In a distributor system, a start element, a chain of stepping relays, a timed vibrating element, a device for setting up permutated marking and spacing conditions for controlling pulses to be delivered sequentially to a transmission conductor, a pulse refining or timing relay, means whereby the start element initiates the operation of the vibrating element, means operable incident to the start of operation of the vibrating element to transmit a start pulse to said conductor preceding the pulses to be distributed, means whereby the refining relay follows the vibrating element, means whereby the vibrating element controls the stepping of the chain of stepping relays and paths closed in succession to said transmission conductor, each said path including a closed path over a contact from a source determined as marking or spacing by said device and including a contact of a stepping relay and a contact of said refining relay.

3. In an arrangement according to claim 2, means operable incident to and following the transmission of the last code pulse of a code group to said transmission conductor to restore said transmission conductor to marking condition.

4. A distributor for distributing a group of mixed marking and spacing conditions comprising a chain of stepping relays and a refining relay, a conductor to which said conditions are to be distributed, means for closing in series a plurality of paths one for each element of said group of conditions each of which paths includes a contact of a different stepping relay and a contact of said refining relay.

5. Means for distributing groups of code pulses of the start-stop type in which each group includes a start pulse and a sequence of mixed marking and spacing conditions, comprising an element for receiving said conditions from an incoming line, start means, a vibratory timing element, a refining element and a relay chain in

which the start pulse initiates the operation of said vibratory timing element and controls the stepping chain and in which means are provided to cause the refining element to follow the vibratory element, also including devices in number equal to the number of code conditions, means whereby each such device is successively included in a path over a contact of a stepping element and a contact of said refining element.

6. A selective system operable by permutation codes in which each code element may comprise either of two conditions and the total number of code elements in a group is n , comprising n capacity elements and a maximum number of 2^n elements to be selectively controlled, means for distributing a code group of n conditions to said capacity elements to charge them individually according to the nature of the individual code element conditions, means for discharging said capacity elements simultaneously to said elements to be controlled and conductive connections to said controlled elements whereby one thereof may be operated or conditioned selectively out of the entire group upon each discharging operation.

7. In a relay distributor system, a vibratory relay, a start relay, a refining relay, a relay chain, means whereby the vibratory relay controls the start relay and the refining relay, means whereby the start relay initiates operation of the relay chain, means for closing in succession paths including contacts of the refining relay and successively closed paths over the contacts of the relays of the relay chain, selector means comprising a series of storage elements equal to a given number n , a maximum of 2^n elements to be controlled, interconnecting means between said storage elements and elements to be controlled whereby simultaneous discharge of all said elements through said elements to be controlled selectively operates one of the entire number thereof.

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