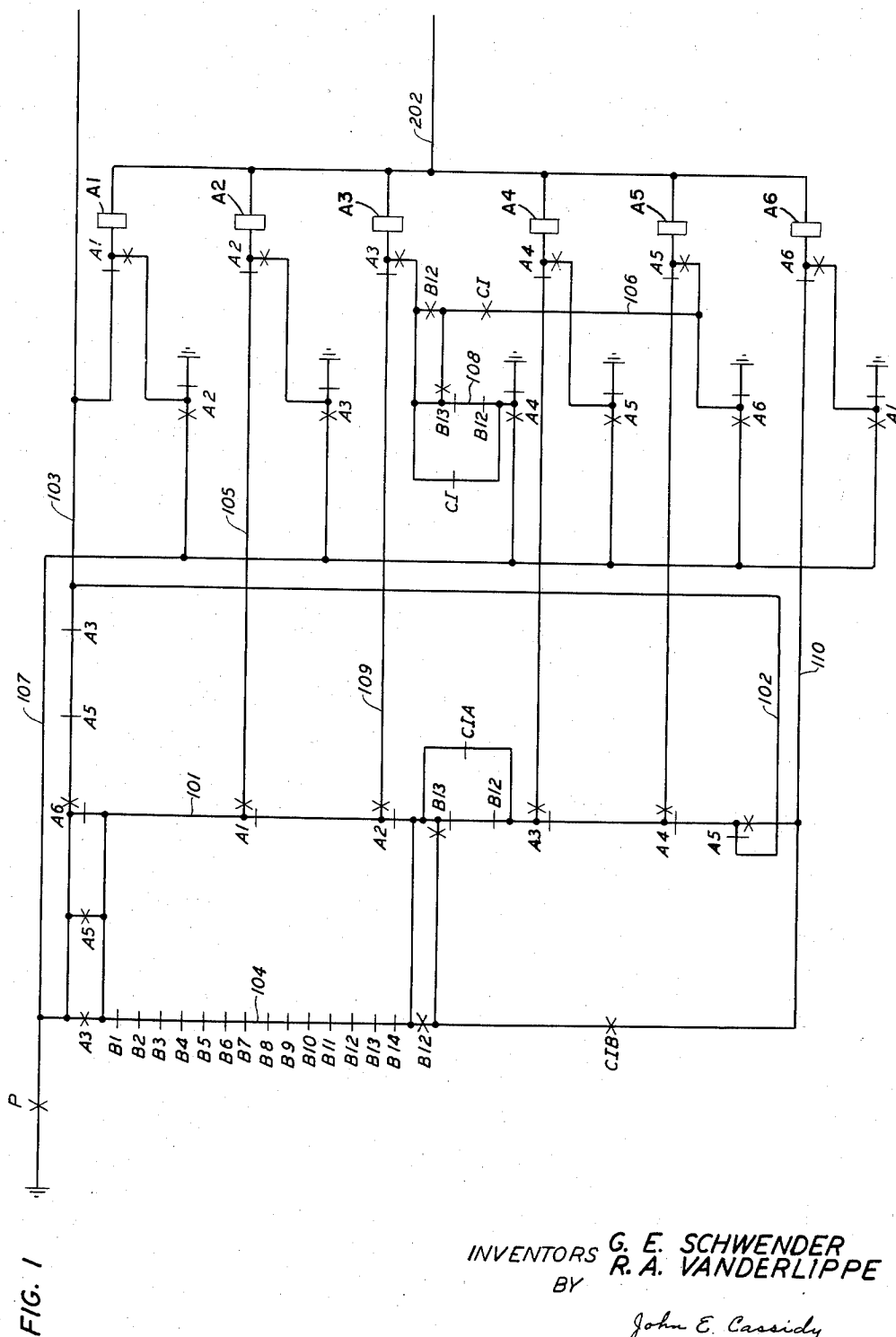


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CODE SIGNAL PROGRAMMER

CODE SIGNAL PROGRAMMER

5 Sheets-Sheet 1



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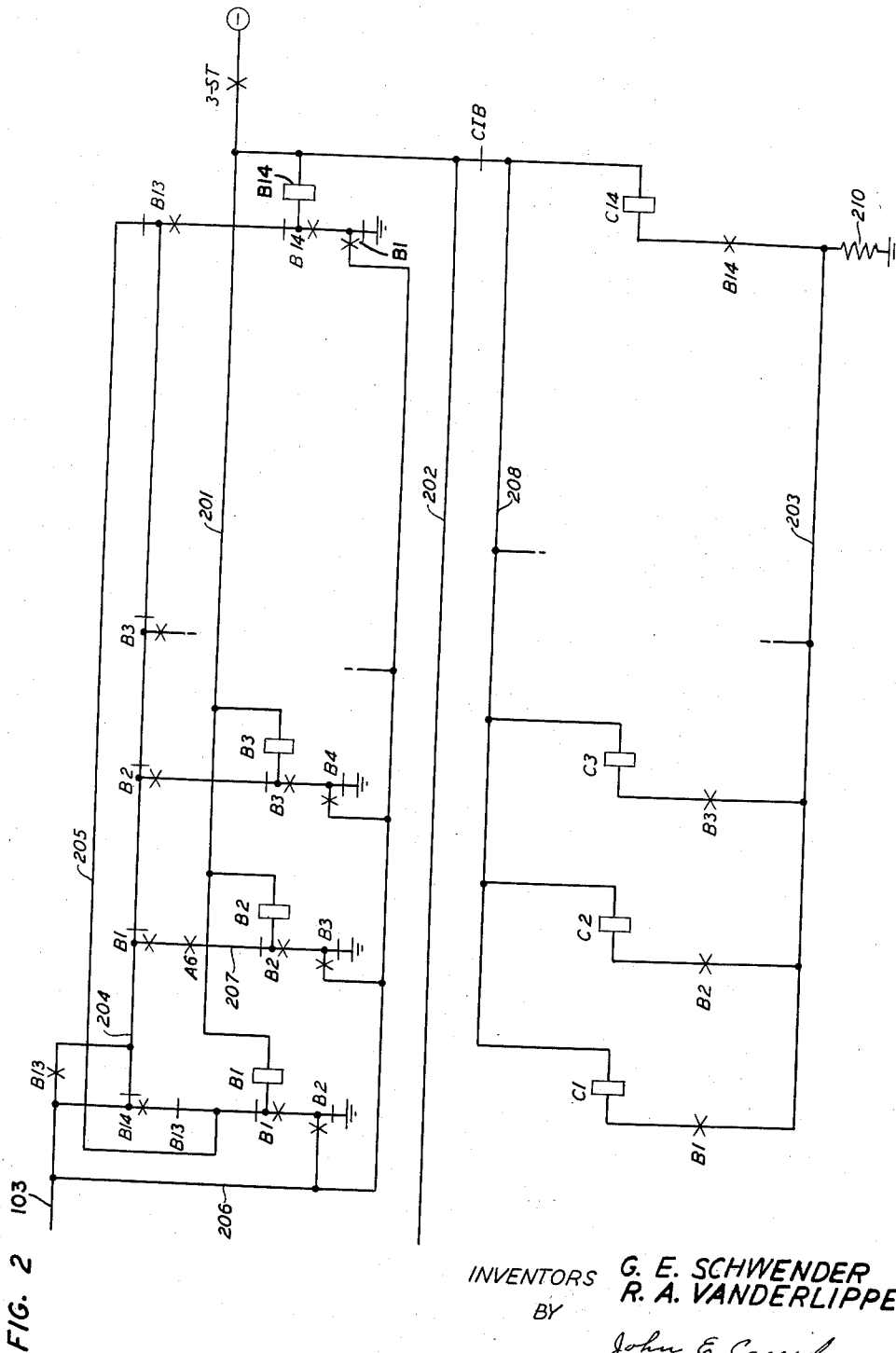
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CODE SIGNAL PROGRAMMER

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5 Sheets-Sheet 2



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5 Sheets-Sheet 3

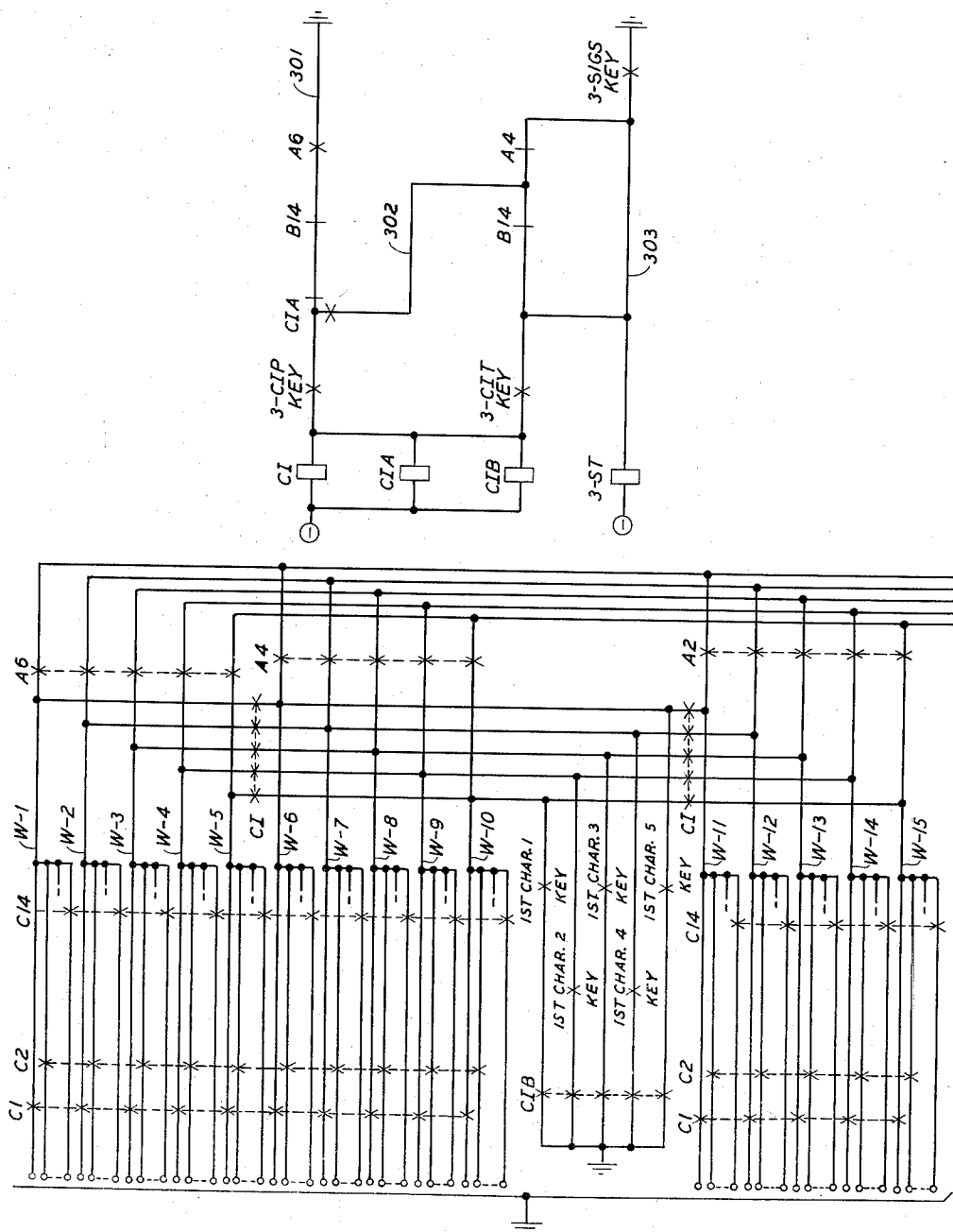


FIG. 3

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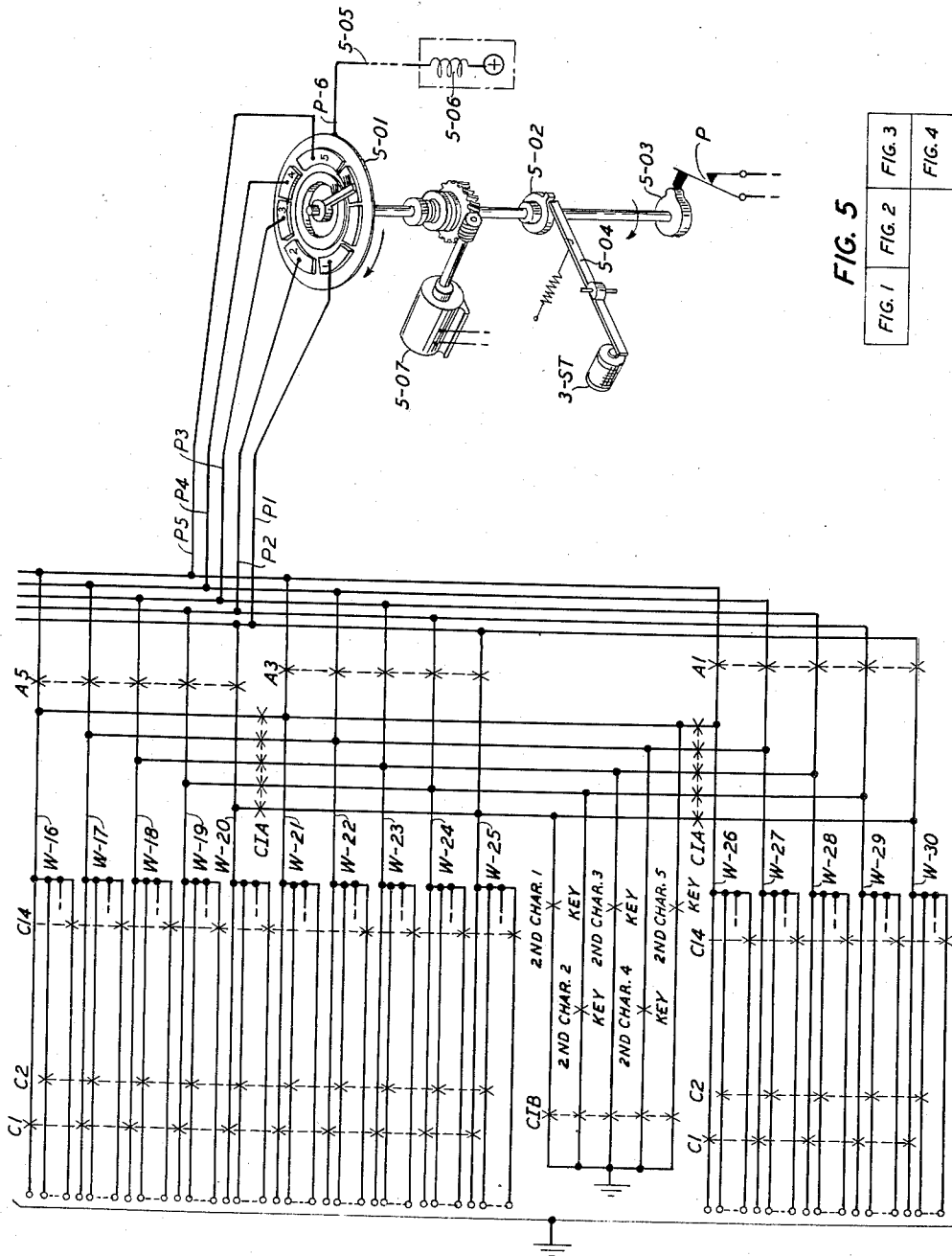


FIG. 4

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FIG. 5

FIG. 1	FIG. 2	FIG. 3	FIG. 4
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Jan. 17, 1961

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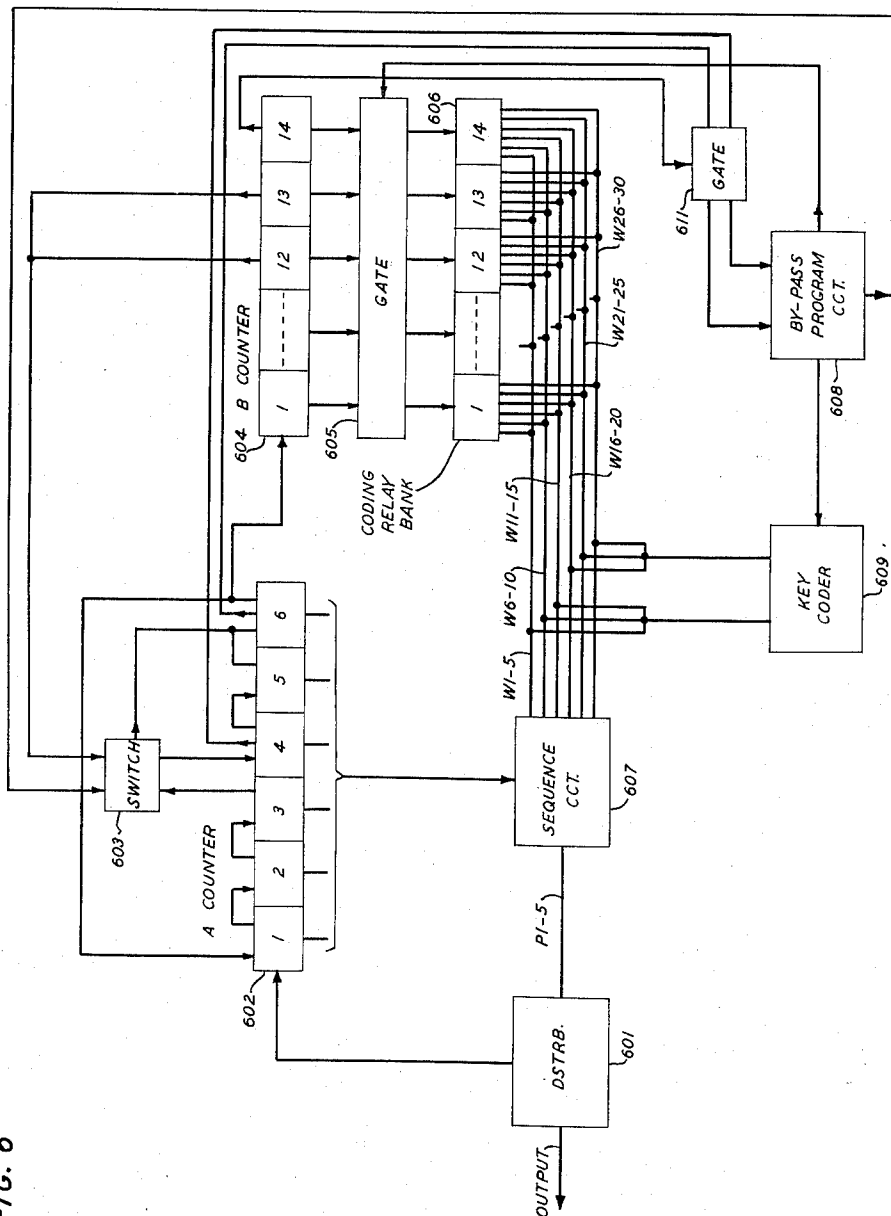
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CODE SIGNAL PROGRAMMER

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FIG. 6



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2,968,694

CODE SIGNAL PROGRAMMER

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Filed June 25, 1957, Ser. No. 667,871

8 Claims. (Cl. 178—53.1)

This invention relates to code signal programming arrangements and more particularly to circuitry for the generation of repetitive sequences of permutation code signal combinations.

A primary object of this invention is to provide a circuit arrangement for applying repetitive sequences of permutation code signal combinations defining teletypewriter characters to a distributor for use, for instance, in the maintenance and testing of telegraph transmission systems.

Another object of this invention is to provide programming circuitry for rapidly intermixing predetermined sequences of related and unrelated digital code signal intelligence.

One further object of this invention is to provide circuitry for the generation of signal intelligence which is capable of making rapid changes in the nature, format, and quantity of intelligence generated.

One feature of this invention is the interconnection of a multiplicity of counting rings in cascade, in a manner which provides a total count less than the product of the number of stages in the individual counting rings for use, for instance, when the generation of a smaller number of combinations than the maximum possible is desirable.

Another feature of this invention is counting ring switching means for intermixing digital code sequences at specific points in the counting cycle.

An additional feature of this invention is common pulse recycling means for effecting the recycling of one counting ring while simultaneously registering a single count on a second ring utilizing a common activating pulse to accomplish both operations.

In the preferred embodiment of this invention, the principal components thereof, comprising a six-step relay counting chain, a fourteen-step relay counting chain, and a bank of multiple coded relays, are arranged to apply a predetermined sequence of teletypewriter characters in five element digital code to a "start-stop" teletypewriter distributor. During each transmitting cycle of the teletypewriter distributor, a stepping pulse is applied to the counting rings in a particularly timed relation to assure that the previous coding is properly registered on the distributor and will not be interfered with by the succeeding registration resulting from a new pulse applied to the counting circuitry.

A first relay counting ring of six steps is interconnected with a second relay counting ring of fourteen steps and the operating contacts associated with these counting relays control the operation of the relays in the multiple coding bank so that with each count of the fourteen-step relay chain a new coding relay in the multiple coding relay bank is selected and with each step of the six-step counting relay chain a character permutatively established on the output leads from the multiple coding relay bank by the selected coding relay is applied to the distributor.

When the circuit is energized, the teletypewriter distrib-

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utor begins to operate and battery is applied to the counting and coding relays. During each cycle of the teletypewriter distributor, a pulse is applied to the counting rings. The counting rings are composed of identical single-count circuits, each requiring one relay per count. Normally only one relay in each ring is operated except during an initial starting of the counting cycle and during transfer of the counting process from one stage to the next. In order to permit recycling of the counting rings, the first stages thereof differ slightly from the other stages. In addition, the path for the pulse which steps the relays of the fourteen-step ring is bridged to the operating path of the first relay of the six-step ring, thereby to effect a single stepping of the fourteen-step ring for each cycle of the six-step ring. Consequently, when a cycle of the fourteen-step ring is completed the six-step ring will have cycled fourteen times, therefore, a total of eighty-four five digit teletypewriter characters will have been applied to the distributor.

Additional circuitry is also provided to enable the bypassing of certain of the steps in the six-step cycle chain at particular steps of the fourteen-step chain. When this by-pass circuitry is utilized, the combinational count of the two relay chains, or the number of teletypewriter characters established on the distributor input leads, is less than the numerical product of the stepping relays in the two rings.

Normally the multiple coding relays are selected sequentially by the fourteen-step relay chain and the connection of the coded teletypewriter characters thus selected to the teletypewriter distributor is controlled by the successive operation of the relays of the six-step chain. In this manner a combination of signals representing a teletypewriter test message pattern may be repetitively applied to the teletypewriter distributor until the circuit is deenergized.

The operation of a relay in the multiple coding bank applies a predetermined pattern of grounds to a 30-wire multiple circuit arrangement which is divided into six groups of five leads, each for connection to groups of make contacts associated with each of the relays of the six-step chain. An optional coding arrangement is also provided in this invention. To select the optional arrangement, a key is depressed which effects deenergization of the multiple relay coding bank and switches control of the pattern of grounds applied by the contacts of the relays of the six-step chain on the distributor to two five-key switch sets. Thus, two five-digit code characters may be established by manual setting of the switches and repetitively applied to the distributor by the contacts of the cycling six-step counting chain. It is also possible by using the programming circuitry mentioned hereinbefore to intermix the sending of two-character and sentence signal sequences during particular cycles of the six-step counting chain, and to reduce the number of characters sent in a complete sequence to a total which is compatible with page-type teletypewriters.

Although the application of this invention will be described with relation to a teletypewriter segmental distributor, it is to be understood that the digital code generating and programming features of this invention may be applied to any type of distributor, data processing or other utilization circuitry requiring a digital code input.

The invention will be more clearly understood from a consideration of the following description, to be read in connection with the drawings in which: Figs. 1 through 4 when arranged as shown in Fig. 5 show, in detached contact schematic representation, the interrelation of counting rings A and B with the multiple relay coding bank C, and the control circuits for applying a predetermined sequence of teletypewriter characters in five element digital codes to a start-stop teletypewriter segmental dis-

tributor; and Fig. 6 shows, in block form, the manner in which the apparatus and circuits cooperate.

In the drawings the relay contacts are shown detached from the relay windings. The relay windings are given letter designations and the associated contacts are also identified by the same letter designations. Contacts which are closed when the relay is deenergized, known as "break" contacts, are represented by a single short line perpendicular to the lines representing the connecting conductors, while contacts which are closed when the relay is operated, known as "make" contacts, are represented by a cross or X crossing the connecting conductors. A "make" and a "break" contact, associated with the same relay, connected together and in close proximity represent a continuity or "make before break" set of contacts. Similarly, contacts of keys, etc., which are normally closed are represented by a line perpendicular to the conductor line and normally open contacts closed by the operation of the key, etc., are represented by a cross intersecting the conductor line.

Referring now to Fig. 6, a code distributor generally indicated by block 601 is shown. Distributor 601, which is well known in the art, functions to transmit teletypewriter characters to an output circuit in accordance with signals coded on the distributor by distributor leads P1-5. The signal output of distributor 601 may be utilized, for example, for the testing of telegraph receiving devices.

Distributor leads P1-5 comprise a set of five leads which are extendible by way of sequence circuit 607 to corresponding sets of leads in wire multiple W1 to W30. Wire multiple W1 to W30 comprises six sets of five leads identified in Fig. 6 as leads W1-5, W6-10, W11-15, W16-20, W21-25 and W26-30. The manner in which distributor leads P1-5 are extended to each set of five leads in multiple W1-30 and the manner in which multiple leads W1-30 are coded with signals are described hereinafter.

When distributor 601 concludes the transmission of a teletypewriter character, the auxiliary contact, not shown, of the distributor applies a pulse to A counter 602. Counter 602 comprises a six-stage relay counting ring. The operation of each relay in counter 602 functions to extend the distributor pulsing lead to the next successive relay stage, as shown in Fig. 6, whereby counter 602 continuously steps in response to the distributor pulses. It is noted that when the third stage of counter 602 is operated, the distributor pulsing lead is extended to the fourth stage by way of switch 603. The operation of switch 603 will be described hereinafter. It is also noted that when the sixth stage of counter 602 is operated, the distributor pulsing lead is extended to B counter 604 in addition to the first stage of counter 602.

Counter 604 comprises a 14-stage relay ring counter wherein each stage is successively operated in substantially the same manner as counter 602. Since the distributor pulsing lead is extended to counter 604 only when the sixth stage of counter 602 is operated, counter 604 is stepped once for each complete cycle of counter 602. Accordingly, counter 602 will cycle 14 times for each cycle of counter 604 whereby 84 steps or counts are obtained.

Associated with each stage of counter 604 is a relay of coding relay bank 606. The operation of each stage of counter 604 operates the associated relay of bank 606 by way of normally enabled gate 605. Each relay of bank 606, when operated, functions to code the thirty leads of multiple W1-30 with predetermined character signal elements.

Returning now to counter 602, the operation of the relays in the counter instructs sequence circuit 607 to sequentially extend each set of five leads in multiple W1-30 to distributor leads P1-5. Accordingly, during the first cycle of counter 602, wherein the first stage of counter 604 is operated, leads W1-30 are coded by the

first relay in bank 606 and a sequential one of the above-described sets of leads in multiple W1-30 is extended to distributor leads P1-5 for each pulsing of counter 602. Similarly, during each succeeding cycle of counter 602, a subsequent relay in bank 606 codes leads W1-30 and the above-described sets of leads are sequentially applied to distributor leads P1-5. Thus, for a complete cycle of counter 604, a test message of 84 predetermined characters is transmitted by distributor 601.

When the device to be tested is a teletypewriter page printer, it may be desirable to send only two test characters. Furthermore, since a page line can accommodate 72 characters in certain well-known page printers, it is desirable to limit the test message to 72 characters.

Key coder 609 comprises an arrangement which includes character keys for conditioning a first three sets of leads in multiple W1-30 with a first character and a second three sets of leads with a second character. To activate or operate key coder 609, by-pass program circuit 608 is provided.

By-pass program circuit 608 includes a program key, not shown in Fig. 6 but shown and identified relative to the detailed description of the circuit in Fig. 3 as key 3-CIP. Assuming key 3-CIP is operated, by-pass program circuit 608 is prepared for subsequent activation. During the first cycle of counter 602, the first five characters are transmitted by distributor 601 in the same manner as previously described. At the conclusion of the transmission of the fifth character, the sixth stage of counter 602 is operated as previously described. The operation of the sixth stage applies a signal to gate 611 and with the fourteenth stage of counter 604 unoperated, the signal is gated by way of gate 611 to the by-pass program circuit 608 thereby activating circuit 608. The activation of circuit 608 permits key coder 609 to code multiple W1-30. Circuit 608 also disables gate 605 whereby coding relay bank 606 is precluded from coding multiple W1-30. In addition, program circuit 608, when activated, prepares by-pass switch 603 for subsequent operation.

With gate 605 disabled and key coder 609 operated, the sixth character coded on leads P1-5, and thus on distributor 601, is the character coded on the set of leads associated with stage 6 of counter 602 by key coder 609. Similarly, the characters coded on distributor 601 during the second through eleventh cycle of counter 602 are determined by key coder 609.

When the twelfth cycle of counter 602 is initiated, the twelfth stage of counter 604 operates, thereby operating by-pass switch 603 which was previously conditioned by program circuit 608. The operation of switch 603 functions to transfer the distributor pulsing lead path extended by the operation of the third stage from the fourth stage of counter 602 to the sixth stage. Accordingly, during the twelfth cycle of counter 602, the first three stages successively operate followed by the operation of the sixth stage whereby the fourth and fifth stages are by-passed. Similarly, during the thirteenth cycle of counter 602, the operated thirteenth stage of counter 604 operates switch 603 to by-pass stages 4 and 5 of counter 602. Accordingly, four characters are by-passed or eliminated during the twelfth and thirteenth cycles of counter 602.

During the fourteenth cycle of counter 602, the fourteenth stage of counter 604 operates whereby, when the fourth stage of counter 602 operates, a signal is gated by way of gate 611 to the by-pass program circuit 608, deactivating circuit 608. Since this occurs at the conclusion of the third character in the fourteenth cycle, the next successive three characters will be determined by the fourteenth relay in bank 606.

It is thus seen that key coder 609 and by-pass circuit 608 function to code the first five characters and the last three characters of the test message on distributor 601

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in the conventional manner and, in addition, code the intermediate characters on distributor 601 in accordance with key coder 609. Furthermore, although there are normally 76 characters in the intermediate sequence, program circuit 608 in cooperation with by-pass switch 603 eliminates four of the characters whereby the intermediate sequence comprises 72 characters.

Therefore, when a page printer is being tested, the first five and last three characters of the test message are arranged to provide nonprinting-nonspacing functions. Accordingly, the intermediate 72 characters provided may all be printing characters and can be accommodated on one 72 space page printer line.

Program circuit 608 is also provided with a test key, not shown in Fig. 6 but hereinafter disclosed and shown in Fig. 3 relative to the detailed description of the circuit as key 3-CIT. Key 3-CIT is furnished to provide an arrangement whereby a continuous test message comprising the printing characters established by key coder 609 may be produced. The operation of key 3-CIT permanently activates program circuit 608 whereby gate 605 is disabled and key coder 609 is operated. Thus, a continuous test message of characters provided by key coder 609 is obtained. Since program circuit 608 is activated, the two steps of counter 602 during the twelfth and thirteenth cycles are by-passed as previously described. Accordingly, the operation of test key 3-CIT provides a test message comprising 80 printing characters.

Referring now to Figs. 1 through 4, when test signals are not required and the circuit is disabled, the starting relay 3-ST of Fig. 3 is released, the negative battery of Fig. 2 is removed from the windings of the A, B, and C relays by the open make contact of released relay 3-ST and the distributor of Fig. 4 is blocked and prevented from rotating by lever 5-04. Thus, relays A1 through A6, B1 through B14 and C1 through C14 are released and the starting key 3-SIGS make contact of Fig. 3 is open.

When test signals are required, the 3-SIGS key is depressed and its make contact in conductor 303 closes to apply operating ground to the winding of starting relay 3-ST. Relay 3-ST, upon operating, closes its associated make contact in Fig. 2 to apply negative battery over conductors 201 and 202 to the windings of counting relays A1 to A6 and B1 to B14 and code relays C1 to C14. In addition the energized magnet armature of relay 3-ST, shown in representation in Fig. 4, frees distributor 5-01, which is normally driven by motor 5-07 through a friction clutch, by removing latching lever 5-04 from engagement with cam 5-02 on the distributor shaft and accordingly the distributor will continue to rotate until relay 3-ST is later released.

The pulsing ground output of distributor 5-01 appearing on lead P6 may be applied over transmission conductor 5-05 and through selector magnet 5-06 to battery as shown in the dotted rectangle work circuit of Fig. 4 or to any of the teletypewriter start-stop pulse utilization circuits which are well known in the art.

During the first rotation of the distributor, relays A1 to A6, B1 to B14 and C1 to C14 remain released; thus the coding applied to the distributor is that in which no segmental element is grounded. This is a "blank" signal in one commonly used teletypewriter code.

As the distributor brush leaves segmental element 5, make contacts P, Fig. 5, close for a predetermined interval of time, such as 30 milliseconds, and then reopen as the distributor continues to rotate.

In Fig. 1 the closure of make contact P applies ground to the operating path of relays A1 and B1. The operating path for relay A1 extends from ground, through make contact P, a break contact with the continuity contacts of released relay A6, over conductor 101, through a closed break contact of the continuity contacts of each of released relays A1 and A2, the break contact of relay

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CIA or, in shunt thereto, the break contact of the continuity contacts of relay B13 and the break contact of relay B12, the break contacts of the continuity contacts of relays A3, A4 and A5, over conductors 102 and 103, through a closed break contact of the continuity contacts of relay A1, through the winding of relay A1, over conductor 202 and through a closed make contact of relay 3-ST to negative battery and relay A1 locks to ground by way of the now closed make contact of its continuity contact combination A1 and a closed break contact of a continuity contact combination of relay A2. This ground pulse is also applied to the winding of relay B1 over a parallel path extending from conductor 103, through a break contact of the continuity contacts of relay B14 over conductor 204 comprising closed break contacts of the continuity contacts of released relays B1 through B13 of which the break contacts of relays B4 through B12 are not shown, conductor 205, through a closed break contact of the continuity contacts of released relay B1, the winding of relay B1, over conductor 201, and through the closed break contact of operated relay 3-ST to negative battery and relay B1 locks to ground by way of the make contact of its continuity contacts and the break contact of contacts B2. The operation of relay B1 effects operation of relay C1. This latter operating path is traced from negative battery through closed make contact 3-ST and break contact C1B, over conductor 208, the windings of relay C1, closed make contact of operated relay B1, and over conductor 203 and through resistor 210 to ground. Thus, the first or starting cycle of the distributor results in operation of counting relays A1 and B1 and coding relay C1.

Referring to Figs. 3 and 4, sets of make contacts associated with operated relay C1, each indicated by a broken line extending from a make contact designated C1, are closed to apply a predetermined pattern of grounds to the 30-wire multiple bank W1 through W30 shown in Figs. 3 and 4. As indicated, ground may be connected as desired to the make contacts of the coding relays C1 to C14 which, when operated, apply ground to the leads of the 30-wire multiple to correspond to any particular group of code combinations. The 30-wire multiple is divided into six groups of five leads, each connected to groups of normally opened make contacts associated with relays A1 to A6. When a relay in the group A1 to A6 operates, its make contacts in Figs. 3 and 4 apply the grounds established by the contacts of relay C1 to leads P1 through P5 and thereover to the segments on the face of distributor 5-01. Since relays A1 and C1 are operated, a path is therefore extended from leads P1 through P5 to the above-mentioned terminals connectable to ground by way of the make contacts of relay A1, Fig. 4, multiples W-26 through W-30, respectively, and the make contacts of relay C1. Thus, the character coded on distributor 5-01 is determined by the grounded ones of the above-mentioned terminals that extend to multiples W-26 through W-30 by way of make contacts C1. Distributor 5-01 comprises an outer ring having seven spaced conducting segments insulated from an inner continuous conducting ring. The seven segments consist of a stop segment followed by a start segment and five character forming segments. The rotatable arm has two interconnecting brushes which bridge these segments successively as the arm rotates to the inner continuous ring. The inner continuous ring is connected through a working circuit to battery. As the outer brush engages each segment of the outer ring a closed or open circuit condition is produced, dependent upon whether or not the path through the relay contacts in Figs. 3 and 4 to ground is open as closed.

The first or starting grounding pulse was applied via make contact P at a time when both relays A1 and A6 were released. However, in the normal counting cycle when the recycling pulse is applied to relay A1 after the

A relays have completed a count and bridged to relays B1 through B14, relay A6 as the preceding relay in the chain will be operated. This pulse is applied by way of make contact P, make contact A6 and break contacts A5 and A3 to conductor 103 and then to the winding of relay A1 and to the B counting relays, as previously described.

Under the starting condition, operated relay A1 prepares a path for subsequent operation of relay A2 by closing the make contact of the continuity contacts of relay A1 in conductor 105 and transfers the operating ground for relay A1 to a holding ground, through the closed make contact of contacts A2 and the break contact of the continuity contacts of released relay A2. As relay A6 is unoperated when the first or starting pulse is applied, the break contact in conductor 101 associated with relay A6 will remain closed and immediately upon operation of relay A1 a path is complete from ground, through make contact P, a closed break contact of the continuity contacts of relay A6, over conductor 101, through closed make contact of the continuity contacts of operated relay A1, over conductor 105, through the break contact of contacts A2, the winding of relay A2, conductors 202 and a closed make contact of relay 3-ST to negative battery, thereby to operate relay A2. The closure time of make contact P and the operating times of relays A1 and A2 are such that relay A2 operates immediately upon operation of relay A1 in response to the initial starting grounding pulse and locks to ground by way of the make contact of its continuity contacts and the break contact of contacts A3. Relay A2 upon operating will transfer the holding path for relay A1 from direct ground to ground applied through closed make contact P, conductor 107 and the make contact of contacts A2. Consequently, when make contact P opens to terminate the grounding pulse, relay A1 will release and relay A2 will remain operated. It is pointed out that whenever make contact P opens to terminate a grounding pulse, the A relay ring will return to the normal counting condition under which one relay and only one relay remains operated.

As explained hereinbefore, the operating path for relay B1 in the B ring is in parallel with the operating path for relay A1. This path was previously traced over conductor 101 which is broken by the opening of contacts associated with operated relays A1 and A2. However, conductor 104 comprising closed break contacts of released relays B1 through B14 is in shunt with the break contacts of contacts A1 and A2 in conductor 101 which open on operation of relays A1 and A2. Therefore, until relay B1 or others of the B ring operate, this supplemental shunting path will assure a bridging of the grounding pulse to the B ring. As counting progresses after the starting interval, one of the relays B1 through B14 will always be operated. Therefore, the supplementary shunting path of conductor 104 will not interfere with the normal counting function as it will be opened by one of the break contacts associated with relays of the B chain.

Near the end of the second cycle of rotation of the distributor, a second closure of the make contact P will occur and a grounding pulse will be applied through make contact P, a closed break contact of the continuity contacts of relay A6 over conductor 101 through closed break contact of contacts A1, make contact of the continuity contacts of relay A2, over conductor 109, through a closed break contact of the continuity contacts of relay A3 released, through the winding of relay A3, over conductor 202 and a closed make contact of relay 3-ST to negative battery. At the time this pulse is applied, relay A2, as previously described, is operated and locked over a holding path through a closed break contact of released relay A3. Upon the operation of relay A3, the holding path for relay A2 is transferred via the make contact of contacts A3 to conductor 107 and

through make contact P to ground. Accordingly, relay A2 will release upon the opening of contacts P which will terminate the grounding pulse. The make contacts of relay A3 in Fig. 4 apply the grounding pattern established in the multiple coding bank on multiples W-21 through W-25 by operated relay C1 to leads P1 through P5 to code the distributor face. Relay A3 in operating functions similarly to relay A2 by transferring the holding path of relay A2 to the pulsing make contact P, preparing a circuit for the operation of relay A4 on the next pulse, and transferring its operating path from the P make contact to ground through a closed make contact of its continuity contacts and a break contact of the continuity contacts of released relay A4. The function of the remaining circuitry associated with relay A3 comprising contacts of relays C1, B12 and B13 will be discussed in detail hereinafter.

The counting transfer operation as described with relation to relays A1 through A3 is identical for all relays of the A chain and all relays of the B chain, as the counting rings comprising relays A1 to A6 and B1 to B14 are identical basic single-count circuits each requiring one relay per count. During the normal counting operation only one relay in each ring is operated except during the initial starting operation discussed hereinbefore and during the transfer of the count from one stage to the next as discussed with relation to relays A2 and A3. With each successive pulse a new code combination will be applied through leads P1, P2, P3, P4, and P5, of Figs. 3 and 4, to the distributor segments in accordance with the grounding established by the make contacts of relay C1.

For the last count of the A relays, with relays A5 operated and A6 released, the closure of make contact P will apply a grounding pulse over conductor 101, as previously described, and through the closed make contact of the continuity contacts of operated relay A5, over conductor 110, through the closed break contacts of the contacts of released relay A6, through the winding of relay A6 and closed make contact of relay 3-ST to negative battery operating relay A6. Relay A6, upon operating, transfers the holding path of operated relay A5 to conductor 107 and accordingly relay A5 will not release until the P make contact opens. Make contacts of relays A3 and A5 are bridged across a break contact of relay A6, in conductor 101, and when relay A6 is operated and relay A5 is operated simultaneously, the make contact of relay A5 will shunt the break contact of relay A6, to keep the operating path for relay A6 intact and to provide sufficient time for relay A6 to transfer its operating path from conductor 101 and the P make contact to a holding ground through the closed break contact of the continuity contacts of released relay A1. If this bridging path comprising a make contact of either relays A3 or A5 were not provided, relay A6 would be self-interrupting. The make contact of relay A3 performs the same function as the make contact of relay A5, just described, when relays A4 and A5 are by-passed in the counting chain, as is described hereinafter.

When relay A6 has operated and extended the coding on multiples W1 through W5 to leads P1 through P5, the next rotation of the distributor will apply a grounding pulse for recycling the A ring and for effecting a single stepping of the B ring, which is stepped only upon energization of relay A1. This recycling grounding pulse will be applied through the closed make contact of the contacts of relay A6 operated and break contacts of relays A3 and A5 released to lead 103 and then via the break contact of contacts A1 and the winding of released relay A1 and through lead 202 and the make contact of relay 3-ST to negative battery. A parallel branch of this circuit extends through conductor 103, closed break contacts of the continuity contacts of released relay B14, over conductor 204, through

closed make contact of the contacts of operated relay B1, make contact A6, to the winding of released relay B2 via conductor 207 and the break contact of contacts B2. Therefore, relay B2 is energized as well as relay A1. Relay B1, held operated by way of the make contact of its continuity contacts and the break contact of contacts B2 throughout the first cycle of the A ring, remains operated by way of the make contact of contacts B2 and conductor 206 to conductor 103 until make contact P opens, as the transfer of counts between relays of the B ring is identical to that described with relation to the A ring, with the exception that a transfer in the B ring takes place only once for each of the six transfers in the A ring.

Relay B2, upon operating, closes an operating path for relay C2 which will operate to close contacts in the multiple coding bank of Figs. 3 and 4 to establish a new grounding code pattern on the contacts of relays A1 to A6. When make contact P opens at the end of the recycling pulse, relay B1 will release to cause the corresponding release of relay C1. Another cycle of counting of relays A1 and A6 will now occur. However, the coding applied by their associated contacts in Figs. 3 and 4 to leads P1 through P5 will be that established by the make contacts associated with relay C2.

Similarly continuous recycling of the A ring will cause relays B3 through B14 to be operated successively one for each cycle and relays C3 through C14, respectively, to be operated simultaneously therewith. In this manner a pattern of grounds corresponding to six teletypewriter characters is applied, character by character, to leads P1 through P5, as the A ring goes through six counts, and as each six-count cycle of the A ring is accompanied by a step in the B ring, and the operation of another C relay, with the release of the one previously operated, fourteen groups of six teletypewriter characters each are presented to distributor 5-01 in fourteen cycles of the A counting ring. This sequence of 84 teletypewriter characters will be repeated indefinitely until relay 3-ST is released to block the distributor and remove negative battery from the winding of the A, B, and C relays.

Although the foregoing description relates to the programming of teletypewriter characters, it is not to be interpreted as a limitation, as any type of digital code information could be programmed by the grounding of the contacts on the multiple wire coding bank. However, if the invention is applied to telegraph testing, not more than 72 characters which require lateral movement of the page teletypewriter carriage should be used in order to prevent an accumulation of characters at the end of a line of page teletypewriter printing. Consequently, the test sentence must contain twelve coded combinations which control the teletypewriter to perform what are termed functions, such as "carriage return," "line-feed," "letters(shift)" or "figures(shift)" unless by-pass circuitry explained hereinafter is used to reduce the total count to less than 84. These particular functional combinations do not cause the teletypewriter to move laterally from left to right, as do printing and spacing combinations.

A reduction of the total count to less than 84 characters may be accomplished by the utilization of a by-pass circuit in ring A which will effect the skipping of certain steps in that ring. Referring to Fig. 1, and assuming that relays CI, CIA, and CIB are operated, the operation of relay B12 or B13 in the cycle of the B ring will transfer the holding circuit of relay A3 which normally extends from ground through closed break contact of the continuity contacts of released relay A4, break contact CI and make contact of the contacts of relay A3 to a circuit which may be traced from ground through a closed break contact of the contacts of released relay A6, over conductor 106 and through closed make contacts of relay CI and B12 or B13, and closed make contacts of operated relay A3, by opening the

normal holding path at the break contacts of operated relay B12 or B13 in conductor 108 and the break contact of operated relay CI. In addition, the path to ground over conductor 101, which would normally operate relay A4 after operation of relay A3, is open at the break contacts of operated relays CIA, B12 or B13 and is diverted through a closed make contact of operated relay B13 or B12, through a closed make contact of operated relay CIB and over conductor 110 and break contact of contacts A6 to the winding of relay A6. Therefore relay A6 is energized by the grounding pulse normally applied to relay A4 and the counts associated with relays A4 and A5 are eliminated. Consequently under these conditions only four pulsed operations of make contact P are required to complete a count cycle in the A ring and as the elimination of two counts is accomplished at two particular steps of the B chain associated with relays B12 and B13, the total count is reduced from 84 to 80. However, when relays CI, CIA and CIB are released, a continuous program of 84 counts is resumed.

With reference to Figs. 3 and 4, an alternate type of coding may be applied through the coding matrix to leads P1 through P5. Ground may be applied to these leads independent of the make contacts of relays C1 through relay C14 by means of make contacts associated with two sets of keys, each set having five make contacts, one of which is identified as the 1ST CHAR 1 to 1ST CHAR 5 (first character one to first character five) key in Fig. 3, and the other of which is identified as the 2ND CHAR 1 to 2ND CHAR 5 (second character one to second character five) key in Fig. 4. For instance, in Fig. 4 the second character set of keys may be depressed selectively to allow their associated contacts to apply a pattern of grounds to the leads P1 through P5 by way of make contacts A1, A3 or A5 and representative of a particular permutation code character for testing purposes. Similarly the set of keys associated with the first character bank of Fig. 3 may be depressed in a permutation code combination for application to leads P1 through P5 via make contacts A2, A4 or A6. Normally open make contacts of relay CIB are interposed between ground and the contacts of the character key sets 1 and 2 and therefore relay CIB must be operated before the character coding can be applied to the face of distributor 5-01 over leads P1 through P5.

The circuit is conditioned to repeat a two-character code sequence by operation of key 3-CIP or key 3-CIT in Fig. 3. When key 3-CIP is depressed its make contact in conductor 301 closes to prepare an operating path for relays CI, CIA, and CIB. This operating path extends from negative battery through the windings of these relays in parallel through a closed make contact of operated key 3-CIP, a closed break contact of the continuity contacts of unoperated relay CIA, a closed break contact of released relay B14 and a closed make contact of operated relay A6, and over conductor 301 to ground. Thus, after the depression of key 3-CIP an operating path for relays CI, CIA, and CIB will be completed upon the first coincidence of the operated condition of relay A6 and the released condition of relay B14. However, when key 3-CIT is depressed the closure of its associated contact completes a path from ground through the closed make contact of the starting key 3-SIGS, over conductor 303, through the closed make contact of key 3-CIT and through the winding of relays CI, CIA, and CIB in parallel to negative battery, thereby operating these latter relays. Thus, on depression of key 3-CIT, relays CI, CIA, and CIB are operated immediately whereas if key 3-CIP is depressed these relays are conditioned to operate upon the first coincidence of the conditions described in the foregoing.

The functions of operated relays CI, CIA, and CIB will now be described.

Referring to Fig. 1, the operation of relay CI closes its

associated make contact in conductor 106, thereby partially preparing counting ring A for by-passing steps 4 and 5, as previously described, whenever relay B12 or B13 is operated, by transferring the holding path for relay A3 from ground through the break closed contact of released relay A4 to ground through the break contact of relay A6, over a path extending from closed make contact of operated relay A3, through closed make contact of operated relay B12 or B13, make closed contact of operated relay CI, over conductor 106 and through closed break contact of released relay A6. The operation of relay CI also removes the shunt across the break contacts on relays B12 and B13 in conductor 108 to open the normal holding path for relay A3. The operation of relay CIA opens its break contact in the shunting path across break contacts of relays B12 and B13 in conductor 101, thereby preparing ring A for by-passing counts 4 and 5 whenever relay B12 or B13 is operated. The removal of this shunt permits the operation of relay B12 or B13 to open the circuit of conductor 101 and to transfer the grounding pulse circuit from the operating paths of relays A4 and A5 to the operating path of relay A6 so that a grounding pulse incoming over conductor 101 will be coupled through closed make contacts of either relay B12 or B13 and make contacts CIB to conductor 110 and the operating winding of relay A6 as previously described.

Referring to Fig. 2, the break contact associated with operated relay CIB is opened, removing the negative battery applied over conductor 208 to the coding relays C1 to C14, inclusive. Therefore, as counting rings A and B go through their cycles, the operations of the B relays will not energize their associated coding C relays and accordingly test sentence coding will not be applied by the make contacts of the C relays to leads P1 through P5.

With reference to Figs. 3 and 4, the operation of relay CIB applies ground to the contacts associated with the first and second character keys. In Fig. 3, make contacts associated with operated relay CI close to apply the coding leads associated with make contacts of relays A2, A4 and A6 to the leads associated with contacts of the first set of character keys, to permit the pattern of ground established by these keys to be applied to leads P1 through P5 when the make contacts associated with relays A2, A4 or A6 close during the counting cycle of the A relay chain. In Fig. 4 the operation of relay CIA closes its associated make contacts to connect the leads associated with the contacts of the second set of character keys to the leads associated with make contacts of counting relays A1, A3, and A5. Accordingly, as relays A1, A3, and A5 close their make contacts during the normal counting cycle of the A chain, the coding established by the second set of character keys will be applied to leads P1 through P5 and thence to the face of distributor 5-01. Consequently with relays CI, CIA, and CIB operated, the coding established by the operation of keys in the second character group is applied to contacts of relays A1, A3, and A5 and the coding established by operations of keys in the first character group is applied to contacts of relays A2, A4, and A6. As the multiple coding relays C1 to C14 are prevented from operating, the test sentence coding is not applied and the coding applied to the distributor 5-01 over leads P1 through P5 will alternate between the characters established at the first and second sets of character keys.

With key 3-CIT depressed this repetition of two-character sequences will continue indefinitely until the 3-SIGS key is released. However, if the alternate key 3-CIP is depressed, relays CI, CIA, and CIB are not energized until that point in the counting cycle at which the coincidence of the conditions of relay A6 operated and relay B14 released occurs. When this happens, operated relay CIA transfers the grounding path for relays CI, CIA, and CIB from conductor 301 to a holding

ground circuit extending over make contact CIA, conductor 302, through closed break contacts of either relay A4 released or B14 released and through the closed make contact of depressed start key 3-SIGS. This locking path for relays CI, CIA, and CIB extending over conductor 302 is opened when relays A4 and B14 are simultaneously operated. When this occurs relays CI, CIA, and CIB release to restore the circuit to the test sentence condition and the last three characters of the test sentence hereinbefore suggested to be of a nonspacing nature, such as letters, are transmitted. Relays CI, CIA, and CIB will not be reoperated by ground over conductor 301 until the coincidence of the conditions of relay B14 released and relay A6 operated occurs or until the last three and the following first five characters of the test sentence have been distributed corresponding to the number of steps between the coincidental operation of relays B14 and A4 and the coincidental operation of relays B1 and A6.

Key 3-CIT, which permits unlimited repetitive sequences of the two-character codes, is utilized when the number of characters received by the utilization equipment is inconsequential such as in the case of a teletypewriter tape perforator receiver. However, key 3-CIP is utilized when a page printing teletypewriter receiver having a limitation of a 72-space line of copy is connected to the output of distributor 5-01. It is to comply with this limitation of page printing teletypewriters that two counts on the A cycle are eliminated during the intervals that relays B12 and B13 are operated, as previously described, as the number of counts occurring between the initiation of the two character code sequence and the termination thereof by a transfer to sentence coding is 76 which exceeds the 72-space line limitation of a page printing teletypewriter.

Since, as hereinbefore described, the first five and the last three characters of the test sentence coding are intermixed with the repetitive sequence of 72 characters when key 3-CIP is utilized, these eight characters of the test sentence must be nonspacing functions. In the preferred embodiment, the last three characters of the test sentence coding are "letters(shift)" and the first five characters of the test sentence coding are "letters(shift)," "carriage-return," "carriage-return," "line-feed," and "letters." Consequently each line of page copy begins at the left margin of the page and is separated by one line from the preceding sequence.

Although a particular embodiment of the invention has been disclosed herein and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiment but is capable of modification and rearrangement without departing from the spirit of the invention, within the scope of the appending claims.

What is claimed is:

1. In a coding system, a pulse source, a plurality of series of relays operable by pulses from said source, means for transferring successive pulses to successive relays throughout each of said series, means operatively interconnecting the operating path of a particular one of the relays of one series to the operating circuit of a succeeding series to cause the pulsing of said succeeding series simultaneously with the pulsing of said particular relay in said one series, and means controllable by relays of said succeeding series for transferring successive pulses applied to said one series to nonsuccessive relays of said one series.

2. In a coding system, a pulse source, a first and second series of relays operable by pulses from said source, means for transferring successive pulses to successive relays throughout each of said series, means operatively interconnecting the operating path of a particular one of the relays of said first series to the operating circuit of said second series to cause the pulsing of said second series simultaneously with the pulsing of said particular

relay in said first series, an output circuit, a plurality of coding instrumentalities each selected by one of the relays of said second series for operable connection to said output circuit in accordance with the successive pulsing of relays in said first series, other coding instrumentalities for operable connection to said output circuit in accordance with the successive pulsing of relays in said first series, and means operatively associated with said first and second relay series for controlling the connection of said instrumentalities to said output circuit during the successive pulsing of said first series.

3. In a code programming system, a pulse source, a first and second series of relays, means for transferring successive pulses to successive relays throughout each of said series, means operably connecting said first relay series to said pulse source to receive individual pulses from said pulse source and adapted to cause repetitious cycle of said first relay series, means interconnecting the operating path of a particular one of the relays of said first relay series and the operating circuit of said second relay series to cause the pulsing of said second relay series simultaneously with the pulsing of said particular one relay, and by-pass means operably associated with said first series of relays and controllable by said second series of relays for transferring successive pulses to non-successive relays in said first series.

4. A system in accordance with claim 3 wherein said by-pass means are only effective at particular ones of the successive steps of said second series and said pulse source comprises means controllable by a distributor adapted to transmit telegraph signals for generating a pulse once in each cycle of said distributor.

5. In a code programming system, a pulse source, a first and second series of relays, means for transferring successive pulses to successive relays throughout the series, means operably connecting said first relay series to said pulse source to receive individual pulses from said pulse source, means operatively interconnecting the operating path of the first relay of said first relay series with the operating circuit of said second relay series to enable a pulsing energization of said first relay of the first series at the initiation of a cycle thereof and to also cause energization of a relay in said second series, by-pass means operatively associated with the operating paths of certain relays of the first series and certain of the relays of the second series to cause skipping of said certain relays of said first series during cycles when said certain relays of said second series are energized, an output circuit, a signal coding relay individual to and operable by each of the relays of said second series for coding a plurality of code combinations, and means including the relays of said first series for applying to said output circuit in succession the code combinations coded by an operated one of said coding relays.

6. A code generator comprising a pulse source, a first and second relay counting ring circuit operably responsive to pulses from said source, means responsive to the operation of each of said relays in said first ring for extending the output of said pulse source to the next successive one of said relays, means effective when a specific one of said relays in said first ring is operated for extending the output of said pulse source to said second ring, means effective when a selected one of said relays in said first ring and a selected one of said relays

in said second ring are simultaneously operated for transferring the output of said pulse source from said next successive relay in said first ring to a subsequent one of said relays in said first ring, a set of output leads, a set of coding leads associated with each of said relays in said first ring, normally disabled coding means for coding said sets of coding leads with signals, other coding means responsive to the operation of each of said relays in said second ring for coding said sets of coding leads with signals, means responsive to the operation of each of said relays in said first ring for extending said set of output leads to said associated one of said sets of coding leads, and switching means controlled by predetermined relays in said first and second rings for enabling said coding means and disabling said other coding means.

7. A code generator comprising a code distributor, a first and second relay counting ring circuit operably responsive to pulses, a pulse source controlled by said distributor for applying pulses to said first ring, means responsive to the operation of each of said relays in said first ring for extending the output of said pulse source to the next successive one of said relays, means effective when a specific one of said relays in said first ring is operated for extending the output of said pulse source to said second ring, means effective when a selected one of said relays in said first ring and a selected one of said relays in said second ring are simultaneously operated for transferring the output of said pulse source from said next successive relay in said first ring to a subsequent one of said relays in said first ring, a set of coding leads associated with each of said relays in said first ring, coding means responsive to the operation of each of said relays in said second ring for coding said sets of coding leads with signals, and means responsive to the operation of each of said relays in said first ring for extending said associated one of said set of coding leads to said distributor.

8. A code generator comprising a first and second relay counting ring circuit operably responsive to pulses, a pulse source for applying pulses to said first ring, means effective when a specific one of said relays in said first ring is operated for extending the output of said pulse source to said second ring, a set of output leads, a set of coding leads associated with each of said relays in said first ring, normally disabled coding means for coding said sets of coding leads with signals, other coding means responsive to the operation of each of said relays in said second ring for coding said sets of coding leads with signals, means responsive to the operation of each of said relays in said first ring for extending said set of output leads to said associated one of said sets of coding leads, and switching means controlled by predetermined relays in said first and second rings for enabling said coding means and disabling said other coding means.

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