Sept. 20, 1960 E. S. ANDERSON ET AL 2,953,778

OFFICE CODE TRANSLATOR

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FIG. 1

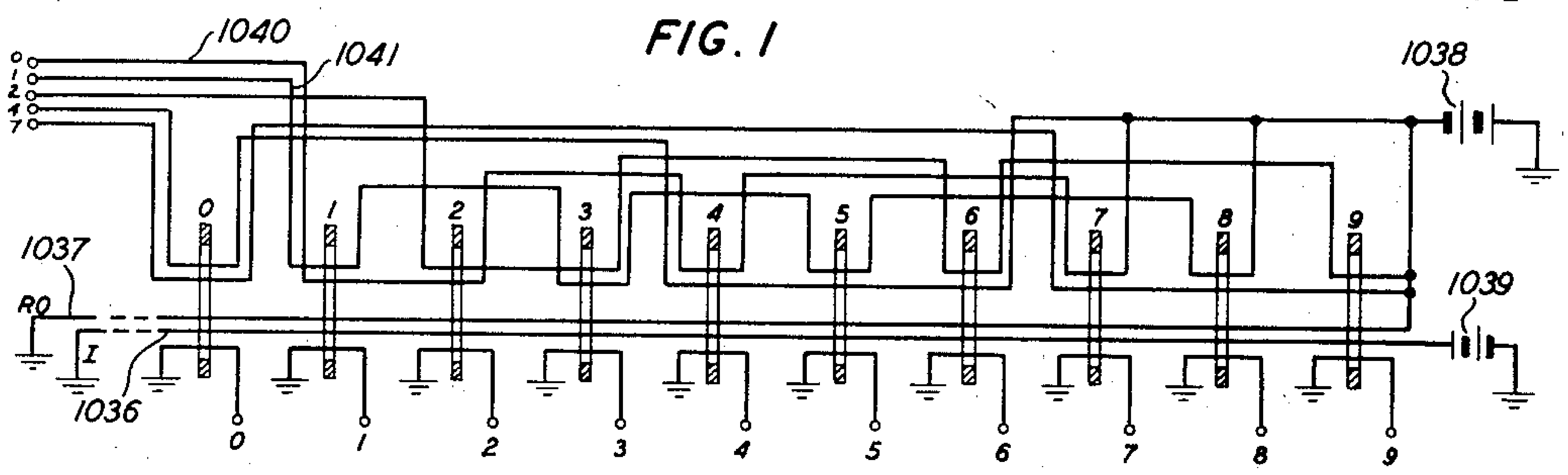

FIG. 2

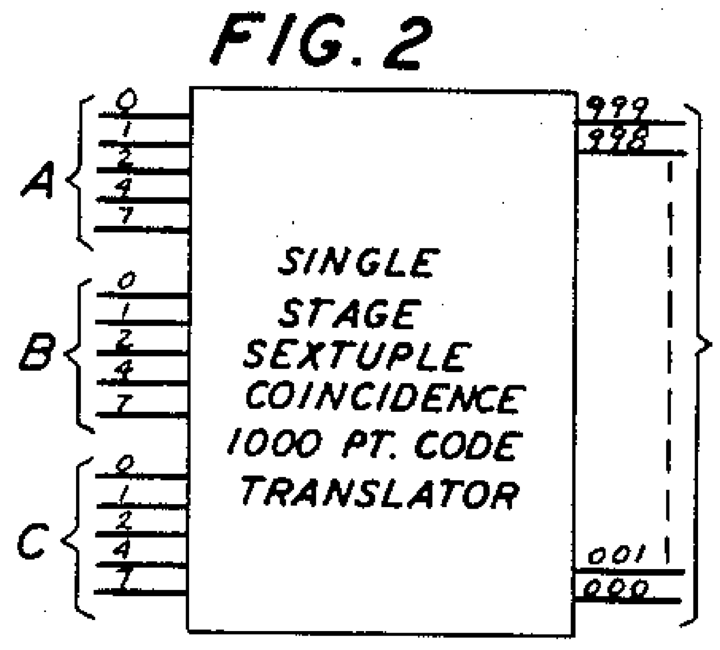

FIG. 3

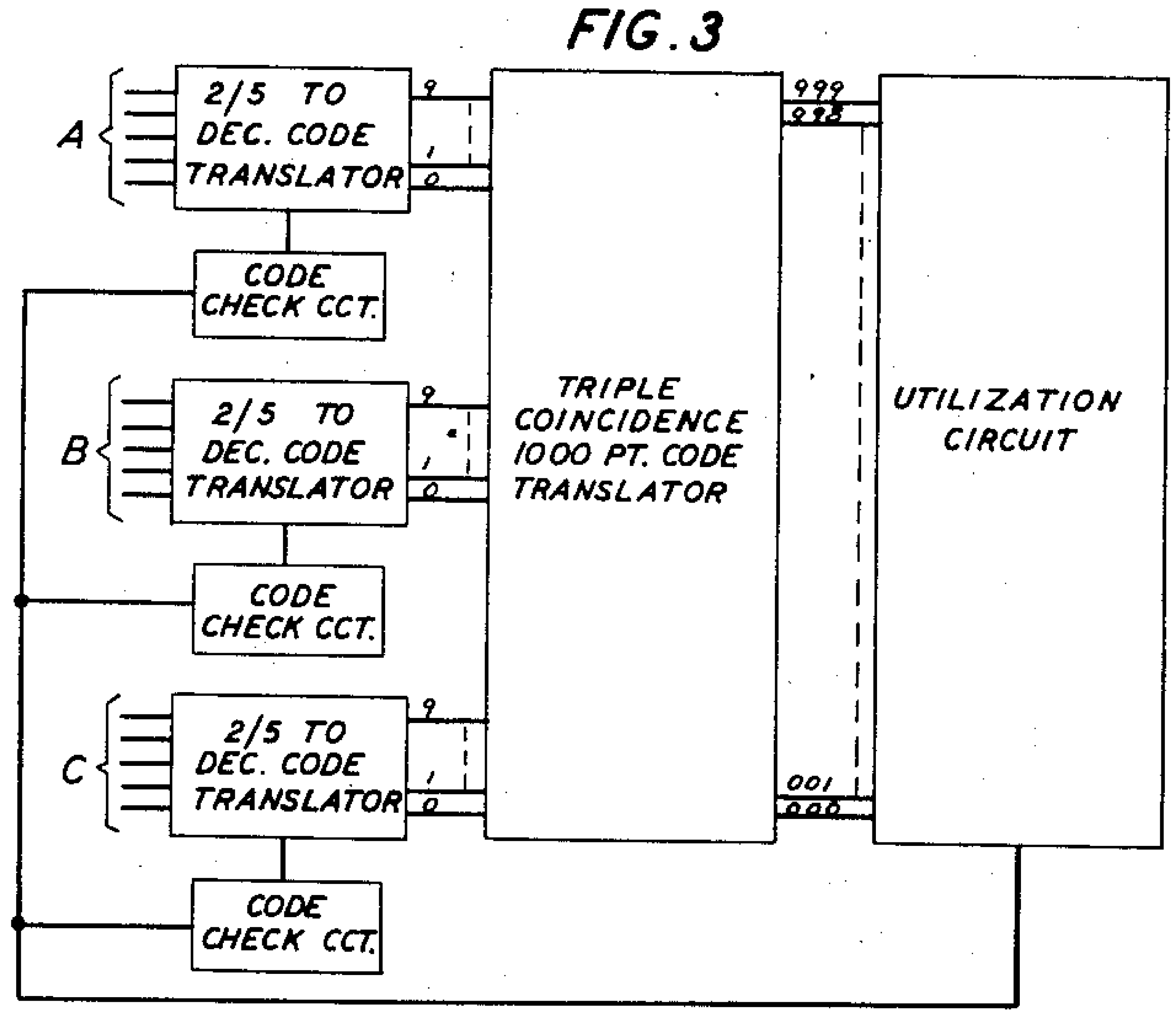

FIG. 4

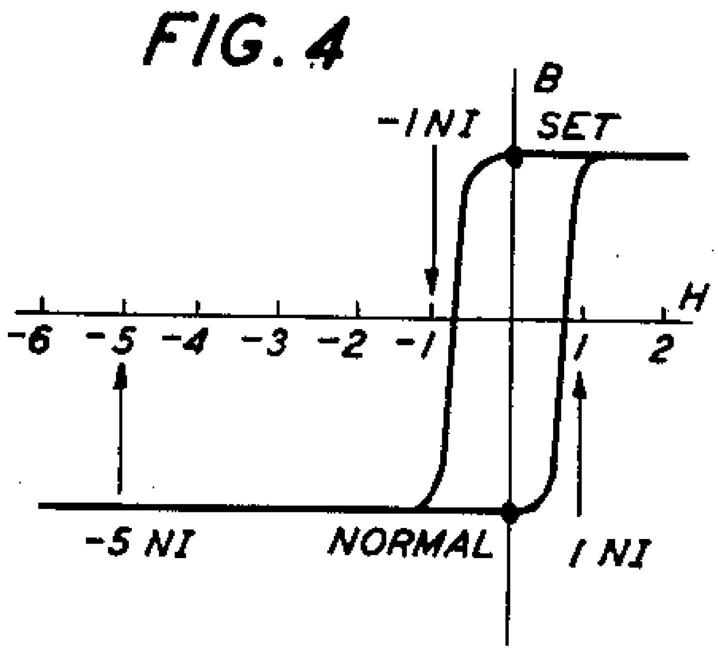

FIG. 5

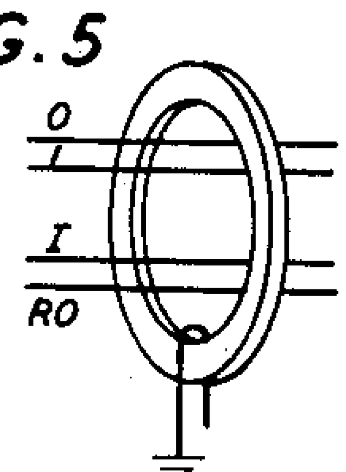

FIG. 6

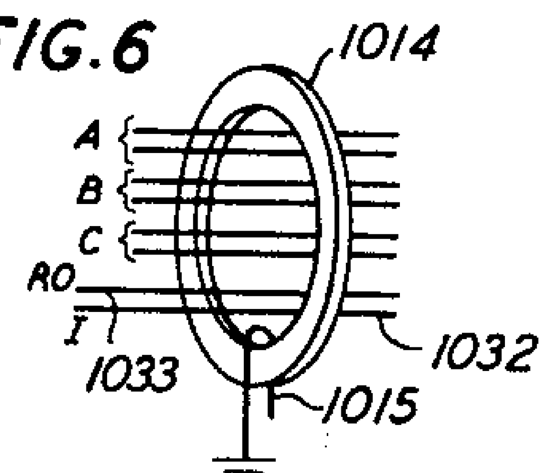

FIG. 7

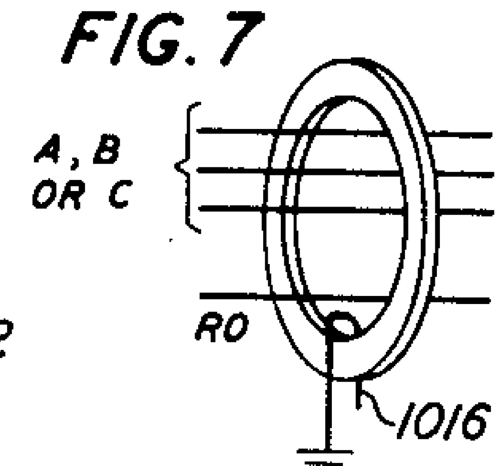

FIG. 8

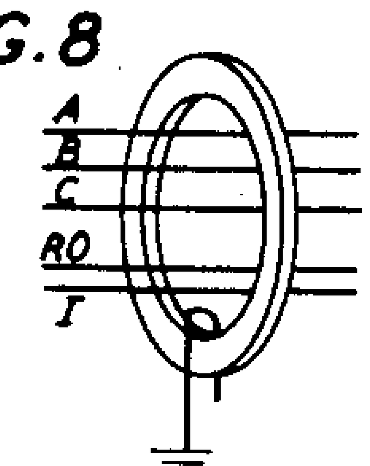

FIG. 12

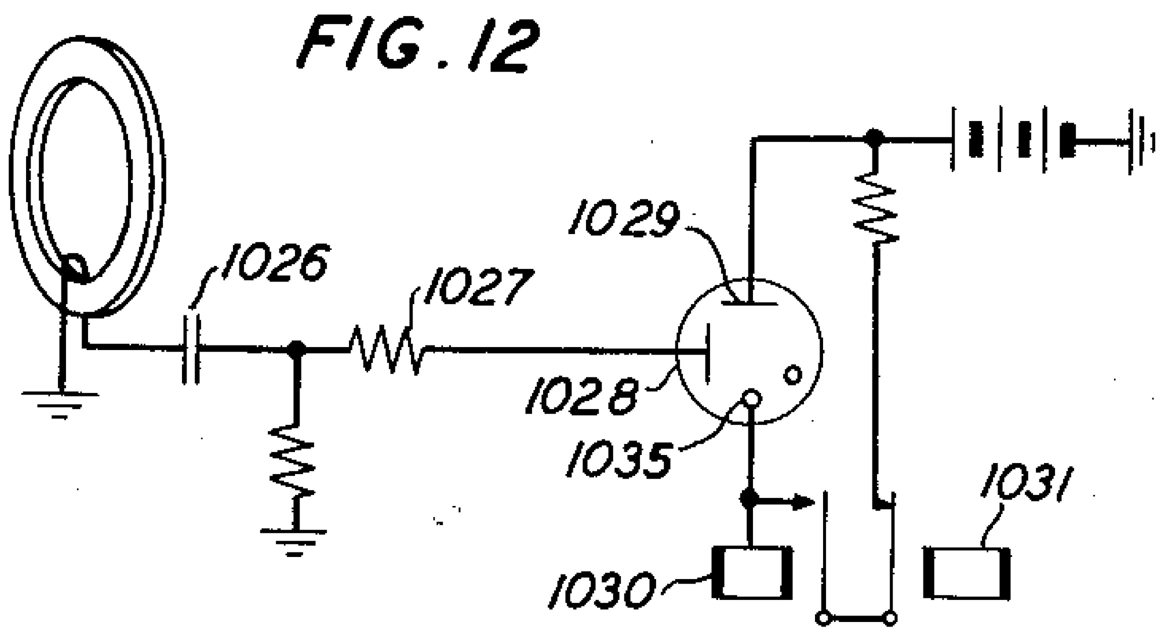

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FIG. 9

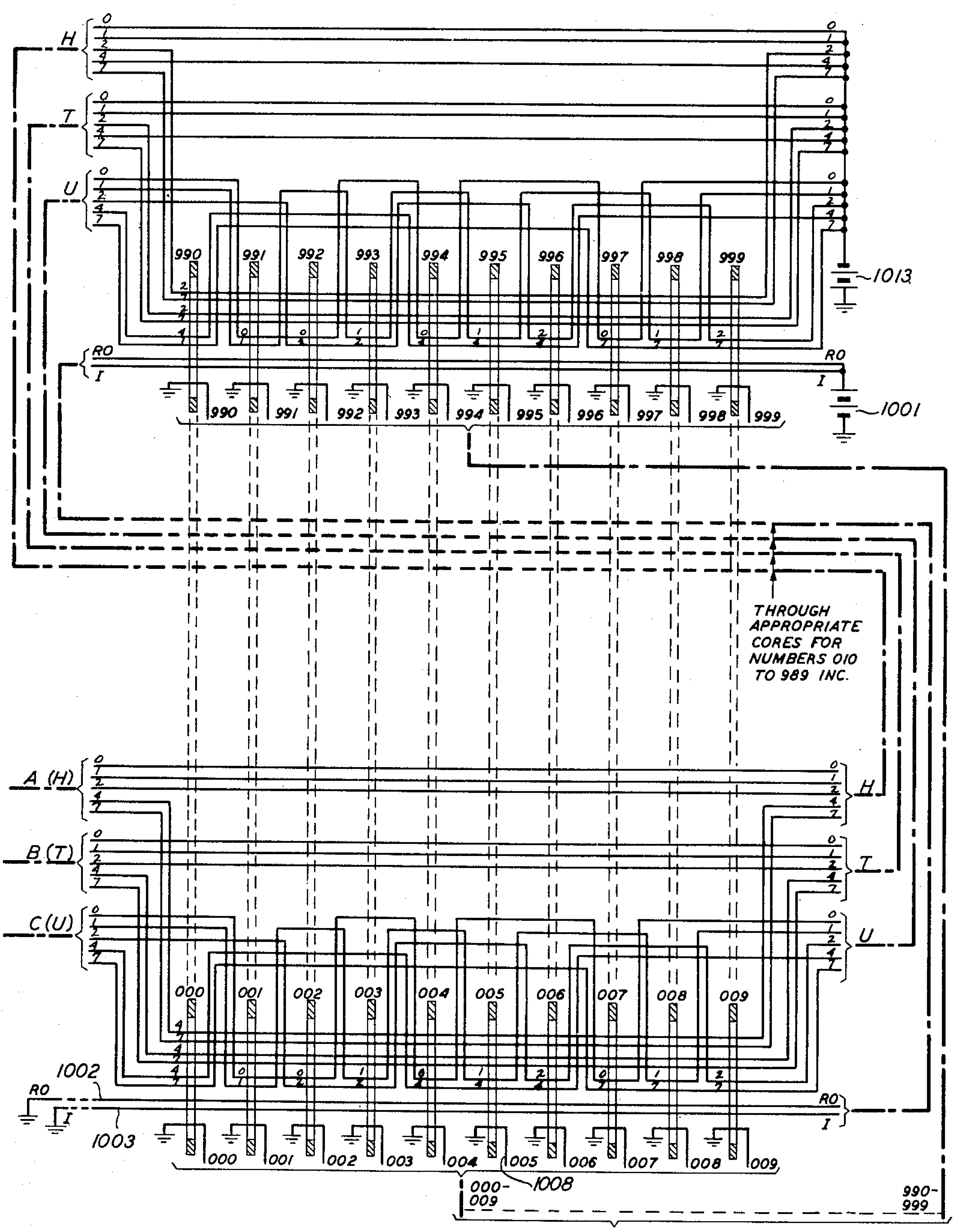

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FIG. 10

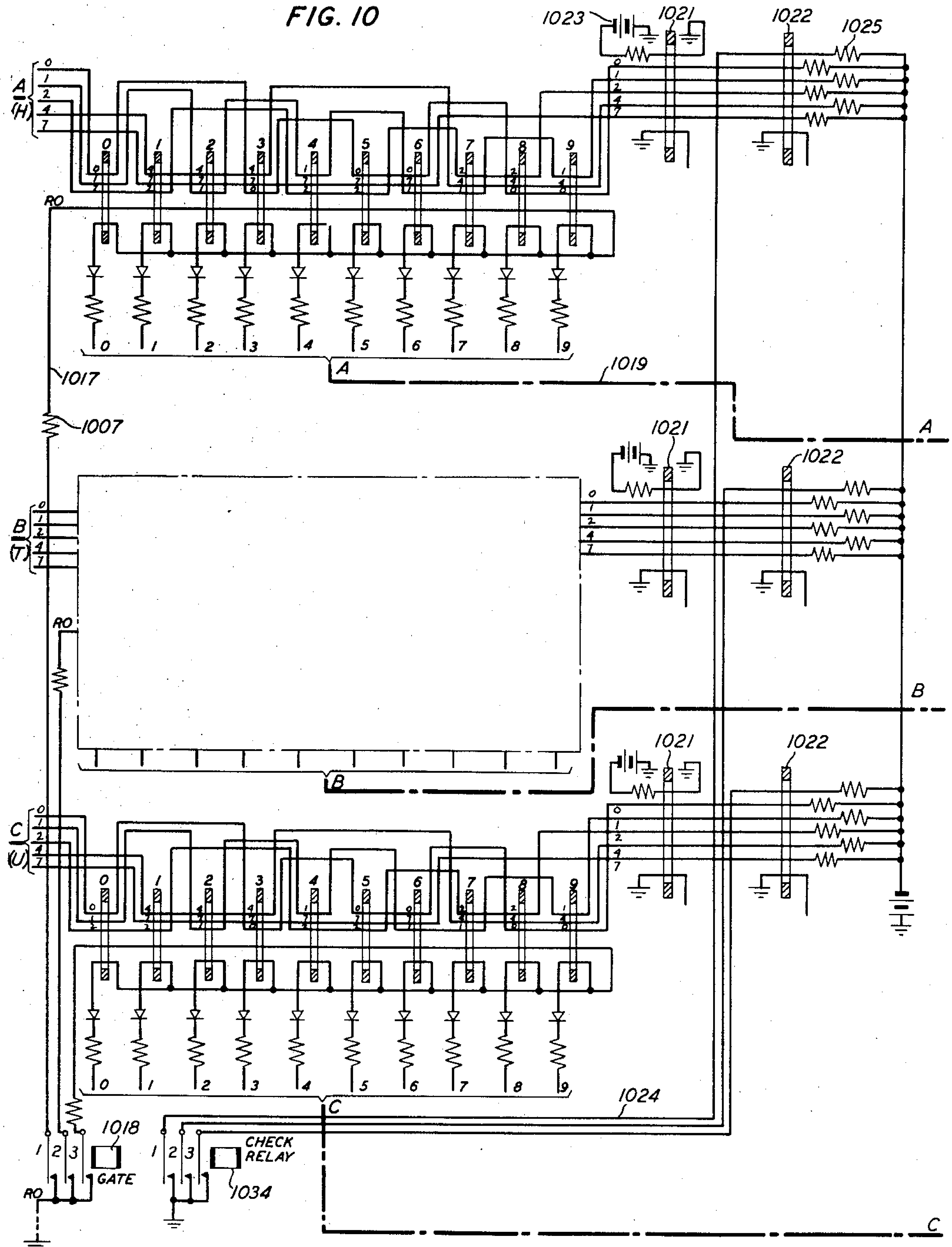

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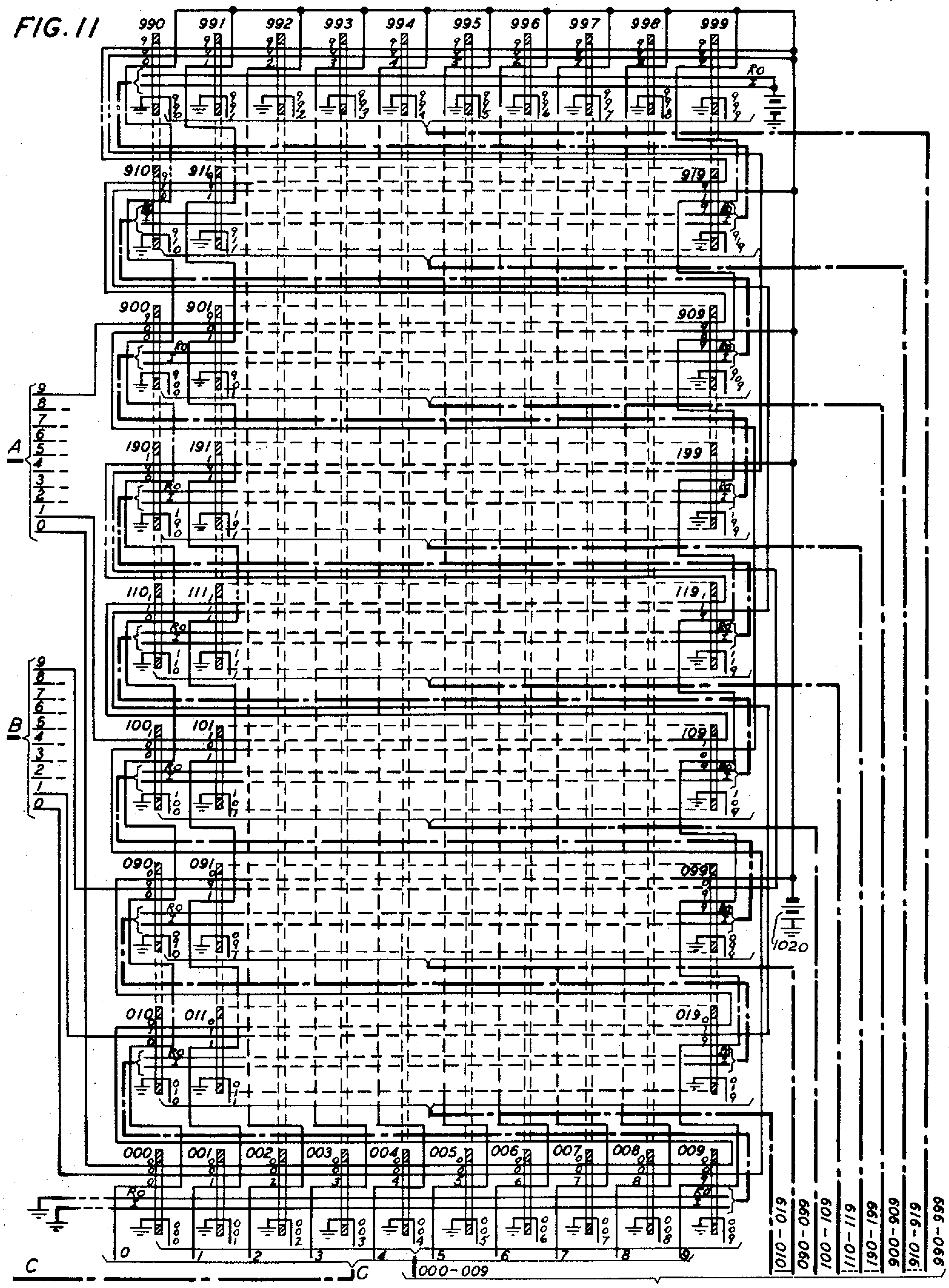
FIG. 11



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United States Patent Office

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OFFICE CODE TRANSLATOR

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Filed Sept. 21, 1956, Ser. No. 611,318

7 Claims. (Cl. 340—347)

This invention relates to code translators and more particularly to such translators in which rectangular hysteresis loop magnetic cores are utilized as the active translating elements.

Over the past several decades, a wide variety of data processing equipment has been developed in which information has been handled in coded form. In certain data processing operations, information can be more expeditiously and economically handled when presented in a code of one type, whereas in other operations it may be advantageous to present the information in a code of a different type. Accordingly, it has been found desirable to translate information from one code to another in a variety of data processing applications.

In complex telephone switching systems, conversion of data from one code to another is often made many times while such data is serving its intended function, and the subject-matter of this invention relates to a translating device which advantageously converts data from one of the well-known telephone switching codes to another.

One basic object of this invention is to improve code translators.

More specifically, an object of this invention is to provide code translating apparatus that is economical, rapid in operation and positive in functioning.

In accordance with one feature of this invention, a plurality of rectangular hyteresis loop magnetic cores are suitably disposed in an array and are each inhibitedly biased in such manner that no core will be switched from its normal magnetic state unless all of its plurality of activating windings are simultaneously energized.

In accordance with another feature of this invention leads from the input terminals are selectively intertwined through the magnetic core array in such manner that any one combination of a predetermined number of leads will be connected to all the activating windings on but one such core.

In accordance with yet another feature of this invention, a read-out lead is passed through each core and is activated during each translating cycle, thereby to switch back to its initial condition any core that may have been changed from its original magnetic state.

In accordance with still another feature of this invention, a winding from each core is individually connected to a separate output terminal, thereby to provide paths over which a change in the magnetic condition of each core may be detected.

The invention and the above noted and other features thereof will be more fully understood from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a schematic diagram of a simple embodiment of the invention;

Fig. 2 is a block diagram of one embodiment of the invention;

Fig. 3 is a block diagram of an alternate embodiment;

Fig. 4 is a B–H diagram showing the rectangular hysteresis loop of a representative core;

Fig. 5 sets forth in detail the arrangement of windings of the cores in Fig. 1;

Fig. 6 depicts similar details relating to the cores in Figs. 2 and 9;

Fig. 7 depicts similar details relating to the two-out-of-five to decimal code translators of Figs. 3 and 10;

Fig. 8 sets forth similar details relating to the triple-coincidence thousand-point code translator of Figs. 3 and 11;

Fig. 9 is a schematic diagram of the embodiment of Fig. 2;

Fig. 10 is a schematic diagram of the A, B and C two-out-of-five to decimal code translators shown in Fig. 3;

Fig. 11 is a schematic diagram of the triple-coincidence thousand-point code translator of Fig. 3; and

Fig. 12 is a schematic diagram of a representative type of apparatus that is effective to respond to magnetic core output pulses.

Now referring to Fig. 1, it will be noted that a two-out-of-five to one-out-of-ten code translator is therein depicted diagrammatically. Information may be presented to the translator in the well-known two-out-of-five code in which form it is introduced into the translator by grounding two of the five input terminals. A corresponding one of the ten output terminals will be activated by an electrical signal derived from one of the ten magnetic cores in the manner now to be described.

All magnetic materials possess a characteristic known as hysteresis. According to this characteristic, the magnitude of magnetic flux induced within the material by a given magnetomotive force may be different depending upon whether the magnetomotive force has been most recently increased or decreased. In certain types of magnetic materials, this difference is substantially negligible, whereas in others it may be of considerable magnitude. Rectangular hysteresis loop cores fall within the latter category, and as can be seen from the curves of Fig. 4, may be in either of their two extreme states while coerced with certain values of magnetomotive force. For example, a core, if set, i.e., magnetically saturated at the upper limit (Fig. 4), will remain in the set condition while the coercive force H is varied from one-half to zero, and if normal, i.e., magnetically saturated at the lower limit (Fig. 4), will likewise remain in the normal state while the coercive force is varied from zero to one-half. This property, i.e., hysteresis, has been advantageously utilized in a variety of applications in which cores are used as memory devices. In the embodiment of Fig. 1, the cores are biased at the—1 NI point and therefore will not be changed to the set state until a positive coercive force of approximately 2 NI is applied.

In telephone switching apparatus one of the most widely utilized codes is that identified by the name "two-out-of-five." According to this code, each digit 0 through 9 is represented by two-out-of-five conditions, the five conditions for sake of convenience being denominated 0, 1, 2, 4 and 7. The following table sets forth decimal numbers and their code equivalents.

Decimal number:	Two-out-of-five equivalent
0	4 and 7
1	0 and 1
2	0 and 2
3	1 and 2
4	0 and 4
5	1 and 4
6	2 and 4
7	0 and 7
8	1 and 7
9	2 and 7

Referring again to Fig. 1, it will be noted that there are depicted therein ten magnetic cores numbered 0–9, five input terminals numbered 0, 1, 2, 4 and 7, five leads connected to the input terminals and selectively threaded through the cores, ten output terminals numbered 0–9, one biasing lead **1036** (I), one read-out lead **1037** (RO), a source of activating potential **1038** and a source of biasing potential **1039**. As hereinbefore stated, grounding of any pair of input terminals is effective to switch one and only one of the cores from its normal state to its set state, the particular core thus affected being representative in decimal code of the information represented by the pair of grounded input terminals.

In Fig. 5 there is depicted in detail a representative one of the cores of Fig. 1. Four leads are shown passing through the core, the four being as follows: a conductor denominated 0 which is connected to the No. 0 input terminal (Fig. 1); a conductor denominated **1** which is connected to the No. 1 input terminal (Fig. 1); a biasing lead denominated I; and a read-out lead denominated RO. In addition, there is an output winding which is provided for sensing changes in the core magnetic state. The core is biased at the −1 NI point (Fig. 4) by current that flows in the bias lead. Each of the two input leads 0 and 1, when energized, induces a magnetomotive force of +1 NI; and the read-out lead, when energized, induces a magnetomotive force of −2 NI.

Returning now to Fig. 1, any pair of the input terminals may be selected and grounded. If, for example, terminals 0 and 1 are those chosen, it will be apparent that two paths will be extended from ground through certain of the cores to the source of activating potential **1038**. The first path may be traced from ground (not shown) through terminal 0 and thence over conductor **1040** through magnetic cores 1, 2, 4 and 7 to the source of potential **1038**. The other path may be traced from ground (not shown) through terminal 1 and thence over conductor **1041** through magnetic cores 1, 3, 5 and 8 to source of potential **1038**. It is especially significant that of the cores traversed by leads **1040 and 1041, only** magnetic core 1 is traversed by both, although the leads individually traverse cores 1, 2, 3, 4, 5, 7 and 8. Since the current that flows in each of the grounded input leads induces a positive magnetomotive force of 1 NI, it is apparent that only in magnetic core 1 will the input leads induce a total magnetomotive force of +2 NI, and that therefore only core 1 will be switched from its normal to its set remanent state.

The selected core will remain in the set remanent state until either the selected terminals are disconnected from ground or until the read-out lead **1037** is energized. In the event the input leads are disconnected, the resultant magnetomotive force will revert to −1 NI (the bias force alone), and the core will be changed from the set to the normal magnetic state (Fig. 4). If, instead, the read-out lead is activated, the magnetomotive force of −2 NI induced by current flowing therethrough will change the resultant force from +1 NI to −1 NI, thereby switching the core back to the normal state. Either of these alternative methods may be effectively utilized to reset a switched core to its normal state.

The aforementioned changes in magnetic flux within the selected core are effective to induce two pulses in the output winding thereof. The first of these pulses is induced by the change in flux that occurs when the core is switched from the normal to the set state, whereas the other is induced by the change in flux that occurs when the core is switched back to normal. These two pulses are of different polarity and may be utilized to operate any one of the devices well-known in the art such as the device of Fig. 12 which is fully explained below.

It is now apparent that the grounding of any pair of input terminals will result in the switching of a corresponding one of the magnetic cores, and it will therefore be noted that the circuits of Fig. 1 are effective to translate information from the two-out-of-five to decimal code.

Now referring to Fig. 2, it will be noted that a single stage sextuple-coincidence translator is therein depicted in block diagram form. Information may be presented to the translator in the well-known two-out-of-five code according to which A, B and C digit information (corresponding to hundreds, tens and units, respectively) is introduced by grounding a total of six leads, two being grounded in each of the three groups of five. A corresponding one of the 1000 output terminals will be activated by an electrical signal derived from a magnetic core in the manner hereinafter described.

In Fig. 9, the schematic diagram of the embodiment of Fig. 2, twenty rectangular hysteresis loop cores are shown together with representations of 980 others. In addition, there are shown fifteen input leads segregated into three groups of five each; one read-out lead **1002** (RO), one biasing lead **1003** (I), 1000 output leads numbered 000–999, and suitable sources of bias and activating potentials **1001** and **1013**. The three groups of input leads are identified A (H), B (T) and C (U), respectively, the letters A, B and C being well-known telephone switching designations, and the letters H, T and U representing the words "hundreds," "tens" and "units," respectively. These leads are grouped into cables for purposes of clarity in depiction, the cables being represented by heavy dashed lines.

The source of biasing potential **1001** is poled in reverse to the source of activating potential **1013**. In the simple diagram of Fig. 9, as in other figures, the activating, bias and read-out leads are all shown passing through the cores in the same direction in order to add clarity to the diagram, thereby requiring that oppositely poled sources of potential of different magnitudes be provided as hereinafter explained more fully below. However, a single source of potential could be used and the leads oppositely connected to windings of differing numbers of turns to effect the same operative result.

A detailed diagram of a typical one of the 1000 cores of Fig. 9 is shown in Fig. 6 wherein the core is depicted as an annular member **1014** through which are projected two "A" leads, two "B" leads, two "C" leads, one RO (read-out) lead and one I (biasing) lead. An output lead **1015** is wound about the core ring **1014**. Although in practice all of these leads might be wound several times around the core or connected to windings mounted thereon, for purposes of clarity they are depicted in all the figures as passing therethrough to add clarity.

In operation, the core of Fig. 6 is normally biased with a magnetomotive force of −5 NI (see Fig. 4) induced by current flowing through the I lead **1032** from a source (not shown). Each of the six ABC leads will provide a counter magnetomotive force of +1 NI when connected to a source of current (not shown). Accordingly, if all six ABC leads are thus connected, the resultant magnetomotive force induced in the core ring will be +1 NI (−5+6=+1) and the core will be switched from its normal to its set remanent state, thus inducing an electromotive force pulse in the output winding **1015**. However, if fewer than all six of the ABC leads are activated, the resulting magnetomotive force will be 0 or negative and will not change the core magnetic state.

In the event the core of Fig. 6 is switched to its set remanent state, it may be reset to its normal condition either by interrupting the flow of current in the ABC leads (in which event the bias current will be sufficient to switch the core to its original state) or by activating the RO (read-out) lead **1033** with current of bias polarity and 2 NI magnitude. When the core changes from the set to the normal condition, an additional pulse is induced in the output winding **1015**.

Now returning to the embodiment of Fig. 9, it will be noted that the aforementioned RO (read-out) and I (bias) leads pass through each of the thousand cores shown and represented therein, whereas the fifteen ABC input leads are interlaced through the cores in such manner that each core is distinctive according to the combination of six such leads that pass therethrough. Each core is, therefore, representative of the three digit number represented by the two A digit, the two B digit and the two C digit leads that pass therethrough. For example, the core number 000 is traversed by six leads identified 474747. These six leads are representative in the aforementioned two-out-of-five code of the digits 0, 0 and 0, respectively.

Further reference to Fig. 9 discloses that the arrangement of the activating leads follows a characteristic plan according to which each pair of the five A digit leads is passed through 100 consecutively numbered cores. Thus, for example, A digit input leads 4 and 7 pass through cores numbered 000–099, leads 0 and 1 pass through cores numbered 100–199, leads 0 and 2 pass through cores numbered 200–299, leads 1 and 2 pass through cores numbered 300–399, . . . and leads 2 and 7 pass through cores numbered 900–999. Thus, the two A digit leads which represent a given decimal number are passed through the 100 cores whose identifying numbers begin with the represented decimal digit.

The B digit input leads, i.e., the tens leads, are arranged somewhat differently but are nevertheless threaded in pairs through the 100 cores identified by numbers containing the represented second digit. For example, B digit leads 4 and 7 are threaded through the 100 cores numbered 000–009, 100–109, 200–209, 300–309, . . . and 900–909. Similarly, the B digit pairs 0 and 1, 0 and 2, 1 and 2, 0 and 4, 1 and 4, 2 and 4, 0 and 7, 1 and 7, and 2 and 7 are passed through the 100 cores identified with numbers having second digits of 1, 2, 3, 4, 5, 6, 7, 8 and 9 respectively.

The C digit leads, i.e., the units leads, are still differently arranged. These leads are extended in pairs through cores whose last identifying number digit is represented thereby. Thus, for example, C digit leads 4 and 7 are passed through cores numbered 000, 010, 020, 030, 040, . . . 090, 100, 110, 120, . . . 190, 200, . . . 900, 910, 920, . . . and 990.

It should now be apparent that, as hereinbefore stated, each core is not only distinctive with respect to the combination of leads passing therethrough, but that the leads are specifically representative, in one code, of information represented by the identifying designations accorded the cores. In this specific illustrative embodiment, the first code is the well-known two-out-of-five code, and the designations given the cores are decimal numbers from 000 to 999.

In operation, information is presented to the translator by grounding a pair of leads in each of the three groups of A, B and C conductors, thereby switching the one core identified by the selected ABC digit number. If, for example, the A0, B0, and C5 lead pairs are grounded (i.e., A leads 4 and 7, B leads 4 and 7, and C leads 1 and 4), core No. 005 will be switched from its normal to its set remanent state (Fig. 4) and an output pulse will be induced in core 005 output winding **1008**.

The remaining 999 cores will be retained in their normal magnetic states because, as set forth above, all six of the aforementioned leads pass through but one of the cores which, in this illustrative example, is core 005. Although a number of cores within the array are traversed by five of the six selected leads, the resulting magnetomotive force of 0 NI ($-5+5=0$) is insufficient (Fig. 4) to switch them to the set remanent state.

The translator may be reset to its original condition in the manner hereinbefore described, i.e., by either ungrounding the six grounded leads or by activating, i.e., grounding, the read-out lead **1002** through control apparatus (not shown). The flow of current within the

read-out winding induces a magnetomotive force which tends to aid the bias flux and which, added thereto, is of sufficient magnitude to overcome the setting flux, thereby switching the set core back to its normal state. The resulting change in flux induces an additional pulse in the output winding **1008**; and since the polarity of this pulse is opposite to that of the previous pulse, i.e., the pulse induced in response to the setting of the core, it can be differentiated therefrom, if desired, by any one of the polarity-recognizing devices well-known in the art.

Any one of the remaining 999 cores may be similarly switched by grounding the six input leads which are related thereto, and it can therefore be seen that translation of information is effected from a three digit two-out-of-five code to a three digit decimal code.

The thousand output leads of Fig. 9 may be individually connected to pulse-responsive devices similar to the device of Fig. 12 (which will hereinafter be described in detail) or to any one of the many other pulse utilization circuits well-known in the art.

In the apparatus of Fig. 3, translation is effected in two stages. The first stage individually translates three digits from two-out-of-five to decimal code, and the second stage, i.e., the triple coincidence thousand point translator, completes the translation by converting the three separate decimal digits to one corresponding three digit decimal number. The first stage of translation which, as mentioned above, is performed by the circuits of Fig. 10, is accomplished in an identical manner by each of the three two-out-of-five to one-out-of-ten translators depicted therein. Accordingly only the A digit translator will be described in detail.

The three two-out-of-five to decimal code translators of Fig. 3 are depicted schematically in Fig. 10 and are shown to each comprise twelve magnetic cores, ten resistor-asymmetrical current device pairs, suitable sources of activating potential, current limiting resistors, and interconnecting circuitry.

In a manner similar to that in which information is presented to the translator of Fig. 9, information is presented to the translators of Fig. 10 by grounding two leads in each set of five input leads that comprise the A, B and C digit groups. However, the translators of Fig. 10 differ in principle of operation from that of the translator of Fig. 9 in that whereas the selected core in the Fig. 9 array is switched from one state to another and the remaining 999 cores remain in their previous condition, the selected core in each of the three Fig. 10 translators remains unchanged and all of the other cores are switched. Accordingly, it will be noted that the input leads which traverse the cores are those which are numerically unrelated thereto. This characteristic can perhaps be more clearly understood from an examination of the core of Fig. 7 which is representative of each of the thirty translating cores of Fig. 10.

In Fig. 7, it will be noted that the core is traversed by four leads, namely, a read-out lead and three A, B and C digit leads. No biasing lead is provided, and the only remaining conductor shown is the output winding **1016**. It will be apparent, therefore, that activation of any one of the three digit leads will serve to switch the core from one of its two settable states to the other, provided the direction of current within the activated conductor is appropriately poled.

Now returning to Fig. 10, it will be noted that the ten cores of the A digit translator are each similar to the core of Fig. 7 except that lead designations are set forth and connections to the read-out and output windings are shown.

Since activation of any one of the digit leads will serve to switch any core traversed thereby, it is immediately apparent that the two leads related to a given core are intentionally omitted therefrom. For example, neither lead 4 nor lead 7 passes through core 0, whereas one or the other of them passes through each of the remainder.

Similarly, one or the other of leads 0 and 1 passes through all of the cores except core 1. It will therefore be seen that grounding any two of the five A digit input leads (through control apparatus, not shown) will result in the switching of all A digit cores except the one only which representative of the decimal digit number expressed by the two selected leads. After the nine cores in each group have been switched, the digit-representing input leads are ungrounded by the control apparatus and the digit remains registered in the cores until subsequently read out.

The information which has been stored in the cores in the form of a switched condition of all but the selected one may be effectively utilized subsequently by switching the nine set cores back to the normal state. This may be accomplished by completing a path for appropriately poled current through the read-out lead **1017** and will result in a current output pulse only at the one terminal associated with the aforementioned selected unset core in the manner hereinafter set forth.

A gate relay **1018** may be used for control of the read-out phase of translation and, when operated, a path will be completed from ground over the No. 1 contacts thereof to the A stage read-out conductor **1017** through resistor **1007**, and thence serially through all ten of the A stage cores to a common terminal of each of the asymmetrical current device resistor pairs which are associated with the cores. Ten separate paths are provided from this common terminal through the resistor asymmetrical current device pairs, over the A stage cable **1019** and thence through the triple coincidence translator of Fig. 11 to negative battery **1020**.

Gate relay **1018** is operated by any suitable control apparatus (not shown) after the aforementioned nine cores have been switched and after the two grounded input leads have been disconnected. The nine cores are therefore switched back to their normal conditions by the read-out lead current previously mentioned, and a corresponding pulse is induced in each of the nine output windings. Inasmuch as the polarity of these output pulses back-biases the nine connected asymmetrical current devices, no current will flow therethrough during the pulse interval. However, in the output winding of the selected core, no pulse is induced, since no switching occurs, and therefore current will flow from battery **1020** through the triple coincidence translator and thence over the path previously described, through the one resistor-asymmetrical current device pair associated with the selected core, and thence through lead **1017** and common load resistor **1007** to ground at gate relay **1018**. It is therefore seen that an output pulse is conducted only over the one output lead associated with the unswitched core.

Subsequent to the decay of the pulses induced in the output windings, all ten resistor-asymmetrical current device pairs will conduct current of nominal magnitude until the circuit is broken by the deactivation of gate relay **1018**. However, the magnitude of the current thus flowing in each of the ten resistor-asymmetrical current device pairs is substantially less than the magnitude of current which flows through the single selected resistor-asymmetrical current device pair at the time of switching, the reason for this being that the voltage of battery **1020** is redistributed across the common load resistor **1007** (Fig. 10) and the resistor of the single conducting pair during the pulse interval. The triple coincidence translator parameters are selected to discriminate between these magnitudes so as to effectively respond only to the larger.

A separate two-out-of-five code check circuit is provided for each of the three translators of Fig. 10, and each comprises a pair of cores **1021** and **1022**. Core **1021** is permanently biased by current flowing from battery **1023** over the obvious path, and sufficient magnetomotive force is thereby induced to prevent switching of the core unless three or more of the leads 0, 1, 2, 4 and 7 are grounded. Accordingly, a pulse induced in the core output winding denotes a code error which consists of the activation of an excessive number of input leads, i.e., three or more.

Core **1022** recognizes the code error which consists of the activation of an insufficient number of leads. The five input conductors 0, 1, 2, 4 and 7 are poled to retain the core in its normal magnetic state. During the interval in which the input leads are grounded, check relay **1034** is operated by any suitable apparatus (not shown) and a path is completed from ground through the No. 1 contacts thereof and thence over conductor **1024**, through A stage core **1022**, and thence through resistor **1025** to negative battery. Current flowing over this path is poled to switch the core to its set state and is of sufficient magnitude to overcome the opposing magnetomotive force induced by the input leads unless two or more of such input leads have been grounded. Accordingly, core **1022** will be set and a pulse will appear at its output winding terminal only if fewer than two input leads have been grounded. It will thus be apparent that a pulse induced in the output winding of either core **1021** or **1022** evidences a code error and may be used by any one of the devices well-known in the art to prevent further translation or utilization of the processed information (Fig. 3).

Although the two-out-of-five to decimal code translators depicted in Fig. 10 have been explained by way of illustration specifically directed to the translator of the A digit, it will be observed that the two remaining translators, i.e., the B and C digit translators, therein represented are identical to the A digit translator with respect to their structure and mode of operation. Therefore, information which is presented to the three translators by grounding the appropriate pair of input conductors in each of the A, B and C digit groups, is translated into a pulse-activated condition of one of the ten conductors in each of the three output groups. The three output pulses are conducted over individual leads in the A, B and C cables to the correspondingly numbered input conductors of the triple coincidence translator of Fig. 11 in which, as hereinbefore stated, an additional translation function is accomplished whereby the one core which represents the selected A, B and C digit number is activated.

Operation of the translator of Fig. 11 is similar to that of Fig. 9, except that in the latter, information is presented by grounding six conductors, whereas in the former, information is presented by pulsing three conductors with pulses obtained from the two-out-of-five to one-out-of-ten translators. Accordingly, in the representative illustration of Fig. 8, only one A digit, one B digit and one C digit lead are shown traversing the core; and the biasing lead will induce a magnetomotive force of -2 NI instead of -5 NI. The input conductors (Fig. 11) are intertwined through the cores in such manner that all of any selected three will traverse no more than one core, the single core which is traversed thereby being identified with the three digit number corresponding to the selected A, B and C digits. Thus, for example, the A digit lead 0 will traverse each of the cores numbered 000–099. The A digit lead 1 will traverse each of the cores numbered 100–199 . . . and the A digit lead 9 will traverse each of the cores numbered 900–999.

The arrangement of the B digit leads is correspondingly different but follows the same general principle. For example, the B digit lead 0 traverses each core identified with a three digit number having 0 as the middle (i.e., tens) digit. Thus, B digit lead 0 traverses cores numbered 000–009, 100–109, 200-209 . . . and 900–909.

The C digit leads are still differently arranged but again follow the same general principle of arrangement. For example, each C digit lead is laced through the cores which are identified with a three digit number having the represented C digit in the units position. Thus, C digit lead 0 traverses cores numbered 000, 010, 020, 030 . . . 090, 100, 110 . . . 190, 200 . . . 900, 910, 920 . . . 990.

As hereinbefore described with respect to the translator of Fig. 9, each of the thousand cores of Fig. 11 is equipped with an output winding which is individually connected to a terminal (not shown) from which connections may be made to any one of the suitable information-utilizing circuits well known in the art. One type of such known utilization apparatus is depicted in Fig. 12 and comprises a simple gas tube circuit which is fired by the pulse received from an activated core.

The pulse received from a core output winding is passed through direct-current blocking capacitor **1026** and thence through the gas tube load resistor **1027** to the starter electrode of gas tube **1028**, thus providing an instantaneous voltage of magnitude sufficient to cause ionization of the gas and therefore result in a relatively heavy flow of current from the plate **1029** to the cathode **1035** and thence through relay **1030** to ground, thereby operating relay **1030**. The gas tube circuit of Fig. 12 may be subsequently reset by operating the release relay **1031** from any suitable external circuit (not shown).

While we have illustrated our invention by particular embodiments thereof, said invention is not limited in its application to the specific apparatus and particular arrangement therein disclosed. Various applications, modifications and arrangements of the invention will readily occur to those skilled in the art. For example, 10,000 cores could be arranged in an array embodying the principle of Fig. 9, and four decimal digit-representing leads could be utilized to represent one of the 10,000 digits, thereby to effect translation of a four digit number. Additionally, translation could be readily effected between codes other than those herein illustrated. Furthermore, the bias leads could be eliminated if the coercive force induced by each activating lead were made substantially equal to the force required to switch the core divided by the number of such core-traversed leads.

The terms and expressions which we have employed in reference to the invention are used as terms of description and not of limitation, and we have no intention in the use of such terms and expressions of excluding equivalents of the features shown and described or parts thereof, but on the contrary, intend to include therein any and all equivalents, modifications and adaptations which may be employed without departing from the spirit of the invention.

What is claimed is:

1. A code translator comprising a plurality of input terminals representative, in combinations of pairs, of values expressed in a first code, means for activating said terminals in said combinations, magnetic core translating means connected to said input terminals and rendered effective by the activation of said combinations of pairs for translating said values expressed in said first code into corresponding values expressed in a second code, other magnetic core translating means connected to said magnetic core translating means and rendered effective by the translation of said values from said first code to said second code for translating said values in said second code into corresponding values expressed in a third code, and error detecting means connected to said translating means operable on the receipt of values expressed other than in combinations of pairs for rendering said other translating means ineffective.

2. Apparatus according to claim 1 in which said other magnetic core translating means comprises an array having one magnetic core for each value in said third code.

3. Apparatus according to claim 2 in which each magnetic core in said other array is inhibitively biased to one of two stable states.

4. A apparatus according to claim 3 in which each of said magnetic cores is connected to said magnetic core translating means over a plurality of paths selectively representing the identity of said each of said cores in said second code.

5. A code translator circuit comprising first magnetic core translating means for translating values expressed in a first code into corresponding values expressed in a second code, second magnetic core translating means for translating said values in said second code to corresponding values in a third code, means for transferring said values from said first translating means to said second translating means, said transferring means including a read-out winding linking each core of said first translating means, an output winding on each of said cores of said first translating means, said output windings being connected in parallel with each other and all serially connected to said read-out winding, a diode serially connected to each of said output windings, lead means connected to each of said diodes and linking the magnetic cores of said second translating means in accordance with the desired translation between said second and third codes, a source of potential, and means connecting each of said lead means to said potential source whereby said output windings on said first translating means cores, said diodes, and said lead means linking said second translating means cores provide a plurality of parallel paths between said read-out winding and said potential source, said output windings and diodes being arranged so that switching of each of said first translating means cores but one causes induced electromotive forces in each of said cores but said one to reverse-bias said diodes causing output current to flow only in the path including said output winding of said one core and the lead means connected thereto, the current flowing in parallel through all of said output windings and lead means connected thereto on cessation of said induced electromotive forces being insufficient to cause switching of said second translating means cores, and error detecting means connecting to said first translating means and operable on receipt of values expressed in other than said first code.

6. A code translator circuit in accordance with claim 5 wherein said first code is an m-out-of-n code and comprising input windings linking said first translating means magnetic cores such that for any particular value represented by an output from a particular core at least one of said m input leads links every other core of said first translating means but said particular core.

7. A code translator in accordance with claim 6 wherein there are a plurality of said first translating means, said second code being a one-out-of-x code and said third code being a one-out-of-y code, y being considerably larger than x.

References Cited in the file of this patent

UNITED STATES PATENTS

2,550,600	Rehm	Apr. 24, 1951
2,719,773	Karnaugh	Oct. 4, 1955
2,734,182	Rajchman	Feb. 7, 1956
2,769,971	Bashe	Nov. 6, 1956
2,784,049	Mitchell et al.	Mar. 5, 1957