Dec. 14, 1943. F. H. HIBBARD 2,336,543

DIGIT SIGNAL TRANSLATOR

Filed July 31, 1942 3 Sheets-Sheet 1

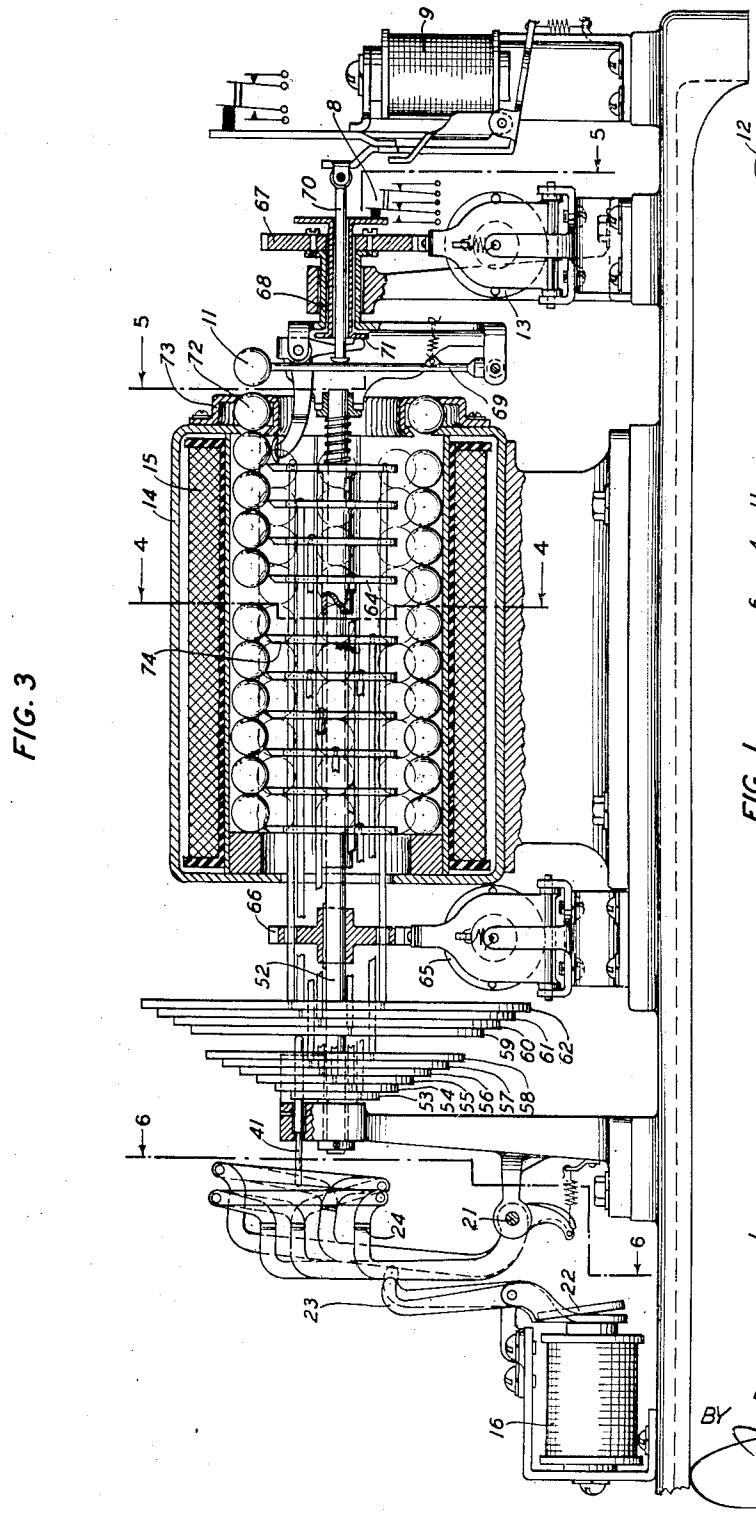

FIG. 3

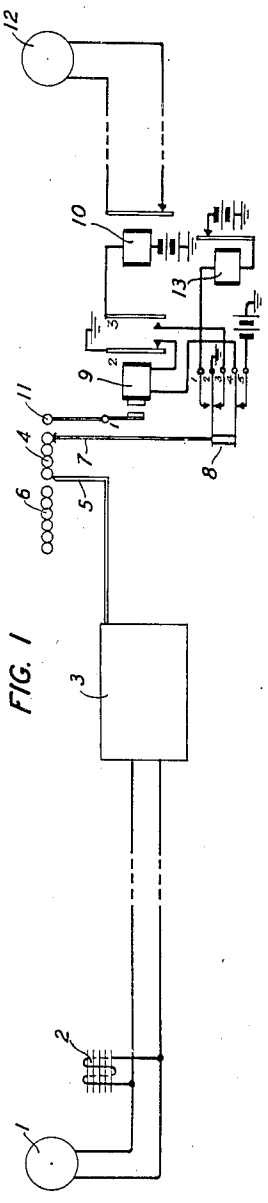

FIG. 1

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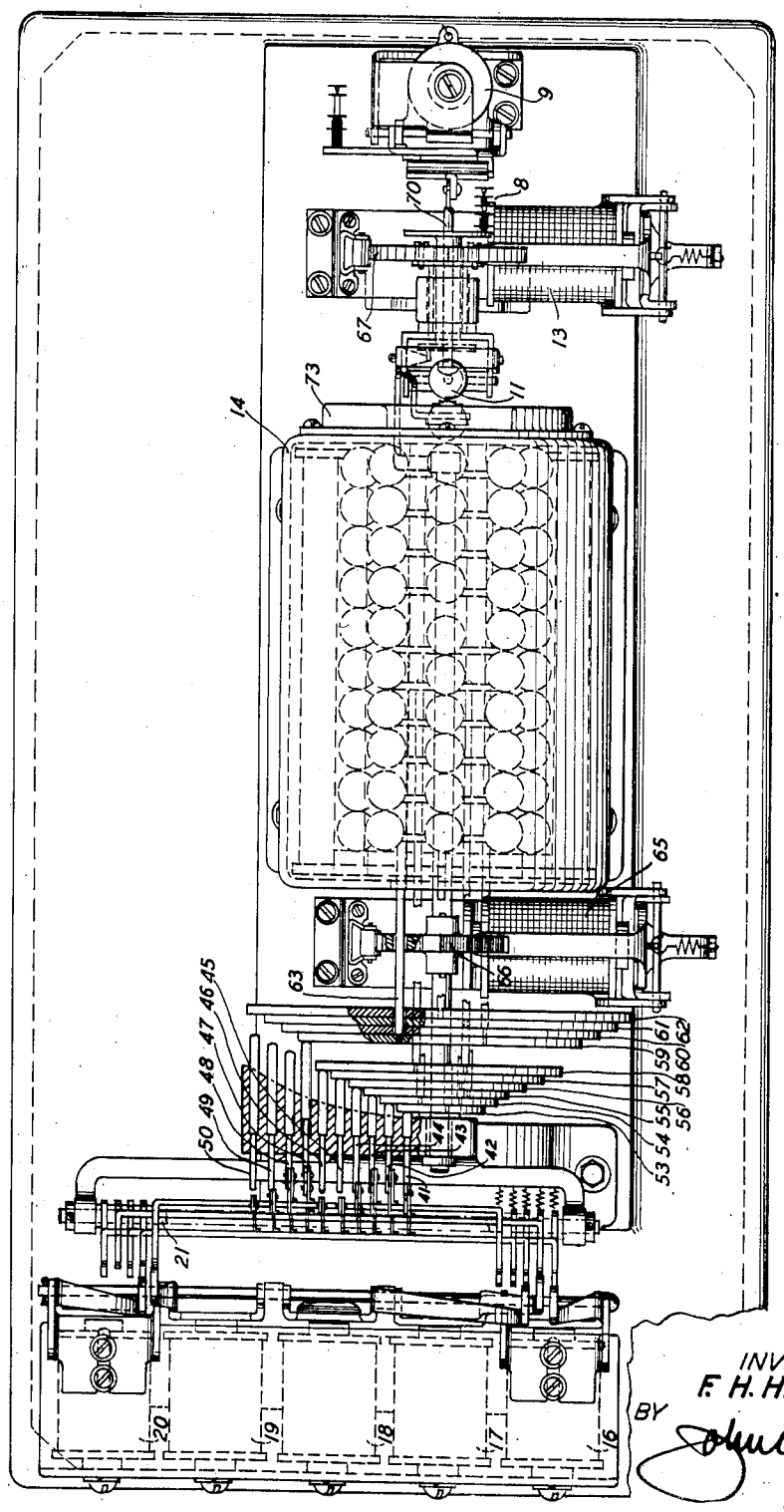

FIG. 2

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FIG. 5

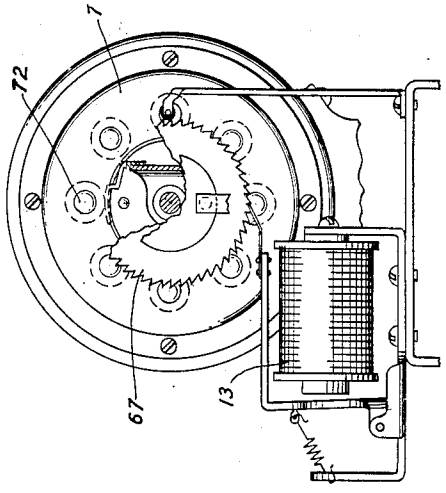


FIG. 7

CODE TABLE

DECODER LEVERS	1	2	3	4	5	6	7	8	9	0
CARRIED ON ARMATURES NOS.	1/4	2/4	4/5	2/5	3/4	1/3	2/3	3/5	1/5	1/2

FIG. 4

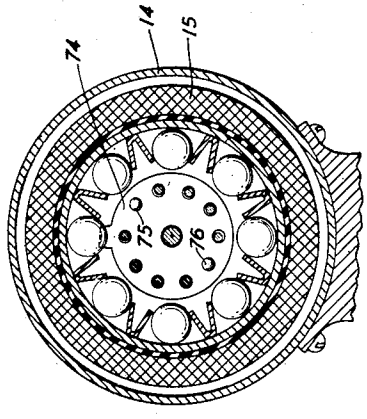
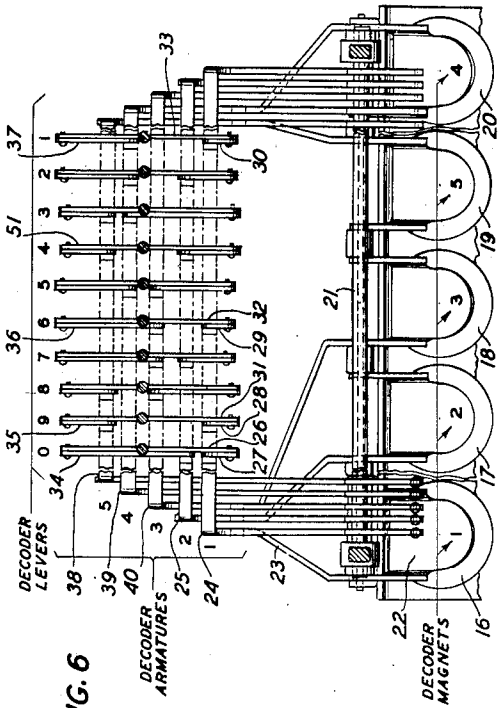


FIG. 6



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Patented Dec. 14, 1943

2,336,543

UNITED STATES PATENT OFFICE

2,336,543

DIGIT SIGNAL TRANSLATOR

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Application July 31, 1942, Serial No. 453,052

7 Claims. (Cl. 177—380)

This invention relates to register senders and particularly to simple and economical devices for registering digital designations by one code and transmitting such designations by another code.

The object of the invention is to provide an improved and simple mechanical structure which will translate digital designations transmitted thereto in the form of a single stroke or operation into a corresponding train of pulses, suitable, by way of example, for transmitting number designations or for setting step-by-step selective switches.

In a copending application, Serial No. 420,536 filed November 26, 1941 in the name of G. R. Stibitz, issued as Patent Number 2,292,489 on August 11, 1942, there is disclosed a counting arrangement in which a series of resilient balls, mounted within the field of a magnet in contact with one another may be moved one at a time still within the field of the magnet by the impact of a similar ball and along the axis of contact of the balls. Such a device is known as a binary impact device since each ball has two positions of rest in each of which it is held stationary by the field of the controlling magnet.

In accordance with this invention a row of resilient steel balls within the field of a magnet are lined up in contact with each other. Means controlled by a selective device separates the train of balls at a selected point so that by thereafter employing a binary impact means the balls thus separated from the others and displaced from their normal positions may be returned thereto one at a time, being counted in the process and an impulse being transmitted for each ball so counted.

A feature of the invention is a register sender which may be set by means controlled by digital designations in one form and which will translate such designation into a train of digital impulses by means of a binary impact device.

The drawings consist of four sheets having seven figures as follows:

Fig. 1 is a schematic circuit diagram showing the fundamental method of operation;

Fig. 2 is a plan view of the translating apparatus;

Fig. 3 is a side view of the same, partly in section;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 1;

Fig. 6 is an end view of the decoding means shown at the left-hand end of Figs. 2 and 3; and

Fig. 7 is a chart showing the combinations of magnet operations to operate the various decoding levers.

The fundamental mode of operation is shown in Fig. 1. A substation 1 is equipped with a transmitter 2 which sends combinations of two frequencies of alternating currents over the line to a receiving apparatus 3. This apparatus in response, let us say, to that combination of frequencies representing the digit 4, divides a row of resilient balls into two groups, one designated 4, of four balls and the other, designated 5 of six balls. The group 4 is moved to the right by the wedge 5, whereupon the end one causes a feeler 7 to move downwardly and operate the contact set 8 so that spring 2 makes contact with spring 3. Thereupon a circuit is closed from ground, armature 2 and back contact of magnet 9, springs 4 and 5 of contact set 8 to battery, thus placing magnet 9 in a self-interrupting circuit. Upon each energization of the magnet 9, a ball 11 is caused to strike the end ball of the group 4. The wedge 5 now having been withdrawn, the balls of group 4 are returned one at a time to the group 6. Upon each energization of the magnet 9 the relay 10 is operated to momentarily open the circuit leading through well-known dial pulse responsive means to establish a connection to a distant station 12. As the last ball of the group 4 is struck and thereby moved to the right, the feeler 7 moves upwardly and operates the contact set 8 to its alternate position. In this position the energizing circuit for magnet 9 is opened and the circuit for relay 10 is opened at spring 3 of the contact set 8. A circuit is now established from ground, springs 2 and 1 of contact set 8, winding of magnet 13, its armature and back contact to battery. Magnet 13 moves the ball 11 and the feeler 7 to another row of balls which has been divided in accordance with the next digit.

It will be understood that other necessary controls are provided, such as means to hold the circuit of magnet 13 open during the idle condition of the apparatus, and so forth. Such means are well known and generally take the form of an off-normal switch, operated when the apparatus is taken for use and is first operated as by the first operation of the wedge 5.

It will further be understood that the magnets 9 and 13 may be adjusted for precise operation so that the pulsing relay 10 will give a properly proportioned open and closed circuit condition. Magnet 13 may be arranged to go through a given number of operations before bringing the

ball 11 and the feeler 7 in association with the next row of balls so that a definite interdigit pause is counted off. It will appear hereinafter that it will take six operations of this magnet to reach the required point so that with precise control of the operation of this magnet a definite and sufficient time interval is provided between digits.

The translating device is shown in Figs. 2 to 6, inclusive. It consists of a barrel-like casing 14 containing an electromagnetic coil 15 and a plurality of trains of resilient balls of magnetic material. Each of these trains of balls is in a straight line race and all are held in physical contact with each other in their left-hand positions normally under magnetic restraint provided by energization of the coil 15. When one train is divided into two sections, the balls of the left-hand section remain in their normal positions still under restraint by the magnetic influence of the coil 15. The balls of the right-hand section will then take up their alternate positions and remain in physical contact with each other under restraint by the coil 15. When the extreme right-hand ball is then struck, the impulse will be communicated through the balls of the right-hand section and the extreme left-hand ball of that section will break away and add itself to the left-hand section of balls and will then remain as the extreme right-hand ball of the left-hand section under the restraint of the coil 15. In this way by a step-by-step process, the balls of the right-hand section are returned to their left-hand or normal positions.

The means for dividing a train of balls into two sections consists of five magnets 16, 17, 18, 19 and 20.

Each magnet has an armature which operates a bail or code bar pivoted on the shaft 21. Thus the magnet 16 has an armature 22 having an arm 23 which bears against one of the legs of bail 24. There being five magnets and five corresponding bails, these are operated in combinations of two, each such combination representing one of the ten digits 1 to 0, inclusive. The chart of Fig. 7 shows the various combinations.

Each combination of two bails operated effectively operates a single decoder lever. Thus the first bail 24 and the second bail 25 effectively operates the decoder lever 26 which corresponds to the digit 0. Each bail has attached to it four links which connect the bail to the corresponding decoder levers. Thus bail 24 has connected to it the links 27, 28, 29 and 30, which are connected to the lower ends of decoder levers 26, 31, 32 and 33, respectively. It may be noted that the upper ends of these decoder levers are connected to links 34, 35, 36 and 37, respectively, which in turn are connected to bails 25, 38, 40 and 39, respectively.

The decoder levers are provided to operate a corresponding ten pins 41 to 50, inclusive. These pins and the corresponding faces of the decoder levers are at some distance from each other in their normal positions. If either the top or the bottom link for a decoder lever is operated, such decoder lever moves toward but does not operate the corresponding pin. It is only when both the top and the bottom links are moved that the pin is operated.

By way of example, it is assumed that the digit 4 has been sent from the calling station. By means well known, the magnets 17 and 19 will thereby have been operated resulting in the operation of bails 25 and 38 whereby the decoder lever 51 is moved by both its top and bottom links with the result that the pin 47 is fully operated. Other decoder levers will be partially operated at this time but no other pin will be operated.

The result of the operation of pin 47 is to divide one train of balls into two groups, one of six balls and one of four balls, as shown in Fig. 3. There is a shaft 52 mounted on the axial line of the barrel-like structure 14. Mounted on this shaft are ten discs 53 to 62, inclusive, each of a different diameter in accordance with the spacing of the pins 41 to 50, inclusive. These discs are movable along the shaft so that, as illustrated, when the pins 47 is fully operated the last four discs 59 to 62 will be moved toward the right by the pressure of pin 47 against the disc 59. Through an assembly of rods, such as the rod 63 (Fig. 2) each disc is connected with another cam disc such as 64 which partakes of the right-hand movement of the disc 59.

In Fig. 4 the right-hand face of disc 74 is shown. This being the fifth cam disc (counting from the right) it is shown with the heads of two rods 75 and 76 riveted thereto for moving such disc, and eight other rods in cross section passing through holes therein for operating the other four discs to the right. It will be understood that twenty rods for operating the ten cam discs pass through holes in the ratchet wheel 66. Each disc 64 has a cam-like projection whereby it may be cooperatively associated with a single train of balls. Thus when the disc 59 is moved toward the right, the disc 64 is also moved toward the right and that train of balls with which the cam-like projection is associated will perform the functions of the wedge 5 (Fig. 1) and will divide the train into two sections. All ten discs, like the disc 64, will have their cam-like projections in the same line so that as the assembly of discs and so forth is rotated about the shaft 52 one train of balls after another will be affected.

A magnet 65, operated in well-known manner at the completion of the registration of each digit, will cooperate with a ratchet wheel 66 and step the assembly of discs into cooperative relationship with the next train of balls. In Fig. 4, eight trains of balls are shown, but any number may be used. The ratchet wheel 66 may have eight teeth so that a single operation of the magnet 65 will cause the proper adjustment of the assembly of discs, or it may have a larger number of teeth so that several operations of the magnet 65 are required as heretofore described in connection with magnet 13.

Magnet 13 cooperates with a ratchet wheel 67 which is secured to a hollow shaft 68 which carries the striker ball 11 mounted on a stem 69 and operated by a rod 70 moved by the magnet 9. The feeler 7 is in the form of a bell crank lever which communicates its movements through a hollow shaft arrangement 71 to the contact set 8. Thus the striker ball 11 and the feeler 7 may be brought into cooperative relationship with each train of balls in succession.

There is an eleventh ball for each train, such as the ball 72, which is trapped in an annular chamber, provided by the element 73, which eleventh ball serves to communicate the impulse imparted thereto by the striker ball 11 to the extreme right-hand ball of a train.

Various other elements such as retractile springs, parts of the framework, pinions, pivots, and so forth, will be readily understood from a casual inspection of the drawings.

What is claimed is:

1. A device comprising a train of resilient balls of magnetic material in a magnetic field, means for selectively dividing such train of balls into two trains in a single operational movement, impact means for returning the balls of one of said trains to the other of said trains one at a time, and means for transmitting an impulse for each ball so returned.

2. A device comprising a train of resilient balls of magnetic material in a magnetic field, means responsive to keyed digital designations for selectively dividing such train of balls into two trains in a single operational movement, impact means for moving the balls of one of said trains to the other of said trains one at a time, and means responsive thereto for transmitting an impulse for each ball so moved.

3. A device comprising a train of resilient balls of magnetic material in a magnetic field, means responsive to coded digital designations for selectively dividing such train of balls into two trains in a single operational movement, a magnet having precisely timed operating characteristics, impact means operated by said magnet for moving the balls of one of said trains to the other of said trains one at a time, and means responsive thereto for transmitting an impulse for each ball so moved.

4. A device comprising a train of resilient balls of magnetic material in a magnetic field, means responsive to coded digital designations for selectively dividing such train of balls into two trains in a single operational movement, a magnet having precisely timed operating characteristics, impact means operated by said magnet for moving the balls of one of said trains to the other of said trains one at a time, means responsive thereto for transmitting an impulse for each ball so moved, and means responsive to the complete restoration of said first train of balls for halting the action of said magnet and terminating the transmission of said impulses.

5. A device for translating coded digital designation signals from a first type in which the elements of the code are sent simultaneously to a second type in which the elements of the code are sent sequentially comprising a train of resilient balls in a magnetic field, means responsive to signals of the said first type for selectively dividing such train of balls into two trains in a single operational movement, impact means for returning the balls of one of said trains to the other of said trains one at a time, and means for transmitting an element of a code of a corresponding signal of said second type for each ball so returned.

6. A device for translating coded digital designation signals from a first type in which the elements of the code are sent simultaneously to a second type in which the elements of the code are sent sequentially comprising a train of resilient balls in a magnetic circuit means responsive to signals of the said first type for selectively dividing said train into two smaller trains and simultaneously moving the balls of one of said smaller trains aside, impact means for returning the balls of said moved train one at a time and means for transmitting an element of a code of a corresponding signal of said second type for each ball so returned.

7. A device for translating coded digital designation signals from a first type in which the elements of the code are sent simultaneously to a second type in which the elements of the code are sent sequentially comprising a plurality of trains of resilient balls in a magnetic circuit, means responsive to signals of the said first type for selectively dividing one of said trains into two smaller trains and simultaneously moving the balls of one of said smaller trains aside, impact means for returning the balls of said moved train one at a time, means for transmitting an element of a code of a corresponding signal of said second type for each ball so returned and means for sequentially bringing each of said first trains of balls into cooperative relationship with said dividing and said impact means.

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