Nov. 3, 1953 A. ABATE 2,658,139

BINARY DECODING SYSTEM

Filed March 29, 1950

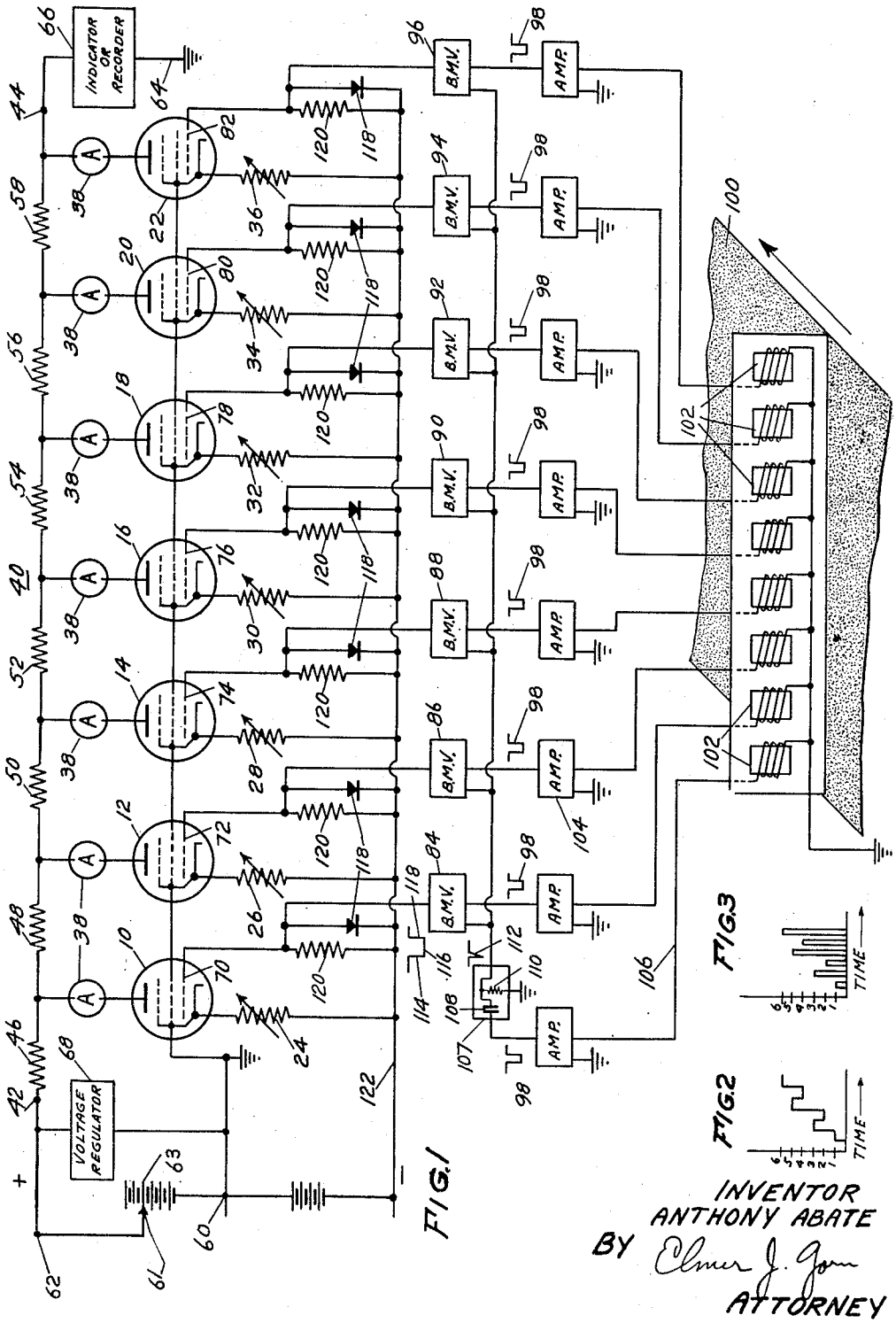


FIG. 1

FIG. 3

FIG. 2

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Patented Nov. 3, 1953

2,658,139

UNITED STATES PATENT OFFICE

2,658,139

BINARY DECODING SYSTEM

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Application March 29, 1950, Serial No. 152,680

5 Claims. (Cl. 250—27)

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This invention relates to decoding of binary digital code information.

In many instances, it is desirable to convert binary coded intelligence to voltage signals whose amplitude determines the converted intelligence. For instance, where original information has been in the nature of varying amplitude voltage signals and has been converted to binary code numbers to take advantage of ease in transmission and storage in this form, it often becomes desirable to reconvert such information to its original form, or to play back the stored information.

Such conversion of binary coded numbers to corresponding voltage signals is achieved by the present invention in a very accurate, rapid and relatively simple manner. Precision resistors are utilized as the standard for reference. These precision resistors are used in conjunction with constant current devices, such as pentode vacuum tubes, whose high plate impedance insures constant current characteristics.

A present embodiment of the invention uses the above in a novel arrangement particularly adapted to the play back of stored information of a seven digit code. In this embodiment the precision resistors are used to establish the voltage levels corresponding to each binary digit. The resistors are connected together to form a resistance string. Seven constant current input channels are used in conjunction with the resistance string. Each of the channels is connected to a point along the string to be hereinafter described. Each of the channels represents a digit in the code. An ammeter and variable resistance are provided in each channel for accurately setting the current flow at the same magnitude in each channel when it is conducting. The various channels are controlled so as to make them conductive and non-conductive depending upon the particular number to be converted to an amplitude voltage signal. Thus channels which are conducting will produce a voltage drop across the resistance string determined by the magnitude of the various resistances, the current flow in each channel and the position of the particular channel along the resistance string. By proportioning the valves of the resistances in the string between the successive channels so that the sum of the resistances, reading from one side of the string to the other, will vary between successive channels as a geometric progression with a ratio of two, voltage drops will occur across the resistance string in equal increments for each succeeding number in the range of numbers covered by the code. For example, in the present instance of a seven digit code, the range of numbers is 0 through 127. By proportioning resistance values as explained above, a particular current value for the digit channels may be found

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which provides for a direct count of one volt per number; thus the number 127 may be directly represented by 127 volts. While such a one volt per number scale is convenient for some applications, other proportions of resistances and channel currents may be used to produce other desirable conversion scales.

In the present embodiment, vacuum tube pentodes maintain a constant current in each of the seven current channels. A digital registering circuit, such as a bistable multivibrator, is connected to the control grid of each pentode in a manner to make the pentode either conductive or completely nonconductive, depending on the code number being represented. A clamping device, as a diode, is arranged between the control grid and cathode of each pentode to insure a constant grid bias when the tube is conducting. The bistable multivibrators providing the register circuits are triggered in accordance with the code number being converted. By their nature, they inherently maintain this code number until cleared by a clearing circuit arangement for a new number to be registered therein.

The foregoing and other advantages, objects and features of the invention will be better understood from the following description taken in connection with the accompanying drawing, wherein:

Fig. 1 is a schematic view of a preferred embodiment of the invention particularly adapted automatically to convert stored binary code numbers to proportional voltage signals;

Fig. 2 is a graph illustrating the voltage output picture of the embodiment in Fig. 1; and

Fig. 3 is a graph illustrating an alternate voltage output picture obtainable from the embodiment in Fig. 1.

Referring to Fig. 1 in more detail, constant current devices, such as constant current pentodes 10, 12, 14, 16, 18, 20 and 22, each may be considered as representing a digit in the binary code. For example, in this instance, by representing a pentode by a 0 when it is conducting and a 1 when it is not conducting, the pentodes will represent numbers in binary code, some of which are as follows:

Pentode							Number Represented
22	20	18	16	14	12	10	
0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1
0	0	0	0	0	1	0	2
0	0	0	0	1	0	0	4
0	1	0	0	0	0	0	32
1	0	1	0	1	0	1	85
1	1	1	1	1	1	1	127

Thus the highest number which may be represented in the present embodiment is 127, in which instance all of the pentodes are nonconductive. By adjusting variable resistances 24, 26, 28, 30, 32, 34 and 36 in the cathode circuits of pentodes 10, 12, 14, 16, 18, 20 and 22, respectively, the current flow in each pentode is set at the same value. The adjustment and subsequent checking are facilitated by providing an ammeter 38 in the plate circuit of each of the pentodes. Values of the resistances in the series resistance string 40 are so proportioned that the sums of the individual resistances, reading from point 42 on one side of the string 40 to the point 44 on the other side of the string 40, follow a geometric progression having a ratio of 2. In the present instance, a one-volt difference between points 42 and 44 of the resistance string 40 for each number in the code is obtained by making the value of resistances 46, 48, 50, 52, 54, 56 and 58 of resistance string 40 1000 ohms, 1000 ohms, 2000 ohms, 4000 ohms, 8000 ohms, 16,000 ohms and 32,000 ohms, respectively, and the constant current value in each of pentodes 10, 12, 14, 16, 18, 20 and 22 one milliampere. Thus the voltage drop between points 42 and 44, when all the pentodes are conducting, will be precisely 127 volts. By referring to the above table to determine those of the pentodes 10, 12, 14, 16, 18, 20 and 22 which are conducting for a given number, it will be seen that those tubes conducting for the given number will produce a voltage between points 42 and 44 equal to the complement of the number. Thus the number 85 represented in the pentodes will produce a one hundred and twenty-seven minus 85 or a forty-two volt differential between points 42 and 44. By initially setting the voltage between points 60 and 62, as by adjusting arm 61 on a variable voltage source as battery 63, at precisely 127 volts, the voltage between points 44 and 64 when all of the pentodes are conducting will be zero. It will be noted from the table above that when all of the pentodes are conducting they represent the number zero. Further, the voltage between points 44 and 64 when all of the pentodes are nonconductive will be 127 volts which corresponds to the number represented by all of the pentodes being nonconductive. In like manner, it is seen from the table above that the voltage at point 44 will vary between zero and 127 with one-volt increments for succeeding numbers represented by the pentodes. Intelligence voltage representing binary numbers in the pentodes at 44 may therefore be read directly or recorded on a suitable indicator or recorder 66. The present embodiment preferably incorporates a voltage regulator 68 at the power source end of the voltage string 40 so as to insure the maintenance of a constant voltage between points 42 and 60 and thereby prevent inaccuracies which might be due to long term power source fluctuations.

The pentodes 10, 12, 14, 16, 18, 20 and 22 are made conductive or completely nonconductive by controlling the potential at control grids 70, 72, 74, 76, 78, 80 and 82, respectively. This is done in the present embodiment by providing register circuits, such as bistable multivibrator circuits 84, 86, 88, 90, 92, 94 and 96, respectively. Triggering pulses 98 are used to trigger those bistable multivibrators corresponding to the coded number desired to be converted to amplitude voltage intelligence. Those multivibrators triggered by a pulse 98 will cause a drop in potential in the corresponding control grid of the pentode sufficient to stop current flow in that pentode. Because of the nature of the bistable multivibrator, this drop in potential is maintained at the corresponding control grid until the particular multivibrator has been again triggered so as to return the potential of the control grid to its conducting state. Triggering pulses 98 in the present embodiment may be provided by any suitable means. One such suitable means is a magnetic recording tape 100 upon which suitable coded numbers have been recorded, as by magnetizing magnetic particles on the tape. These magnetized particles energize cored solenoids 102 as the tape moves in the direction of the arrow. After amplification in suitable amplifiers 104 they appear as triggering pulses 98. It will be noted that, in addition to a solenoid 102 for each of the digits in the code, an eighth cored solenoid leading to line 106 is used. The signal 98 from this eighth solenoid is converted by a pulse forming circuit 107 which may consist of a condenser 108 and resistance 110 into a clearing pulse 112 of short duration which is led to each of the multivibrators 84, 86, 88, 90, 92, 94 and 96 which are thereby triggered so as to insure the removal of any prior number before the registration of a new number from the recording tape 100. Thus, for example, a pulse 98 occurring at the bistable multivibrator 84 in response to a digit signal from the tape 100 will cause a drop in potential in the control grid 70, as shown at 114. This reduced potential will be maintained at the control grid 70, as shown at 116, until cleared by the pulse 112 so as to cause removal of the biasing potential as at 118. The pulse 112 may be timed from the recording strip 100 so that it occurs simultaneously with the pulse 98 or so that it occurs before the pulses 98. If it is made to occur simultaneously with the pulses 98, since it is of shorter duration than the pulses 98, one of the pulses 98 will predominate and will determine the pulse position of the multivibrator. For example, if, for a particular number in one cycle, the pulse 98 occurred at the bistable multivibrator 84 so as to cause a voltage drop 114 at the control grid 70, and for a succeeding number from the recording strip 100 it is necessary that the control grid 70 be maintained at the negative potential, then for the next number another pulse 98 will occur simultaneously with the clearing pulse 112. However, since the clearing pulse 112 is of shorter duration than the pulse 98, any triggering caused by pulse 112 will be retriggered by the pulse 98 so that the control grid 70 will continue to be maintained at the desired negative potential. In this simultaneous pulse system, successive numbers will appear in a continuous curve as in Fig. 2. If the clearing pulses 112 are made to appear before a succeeding number, then the multivibrators will be all triggered to a zero position before the new number arrives. Thus, in each instance, all of the pentodes will be conductive after each number and will thereby cause a zero voltage at point 44 after each number. This will produce a graphical amplitude picture on recorder 66, as shown in Fig. 3.

A clamping device 118, such as a diode, and a leakage resistance 120 are provided between the control grid of each pentode and the negative potential line 122, thereby insuring a constant biasing potential at the control grids of the respective pentodes and minimizing variations in current intensity in the respective channels.

This invention is not limited to the particular details of construction and processes described, as many equivalents will suggest themselves to

those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A circuit for converting binary coded pulses to direct-current voltages comprising: a source of voltage; a plurality of resistors and a voltage-indicating device connected in series across said source of voltage from the higher to the lower potential terminals thereof; said resistors corresponding in number to the number of digits in the code and having consecutive values following a predetermined geometric progression; a plurality of constant current devices, likewise corresponding in number to the number of digits in said code; one of the ends of each of said constant current devices being connected to the lower potential terminal of said source of voltage; the other ends of said constant current devices being successively connected, respectively, to the lower potential ends of said resistors; and means for controlling the conductivity of said constant current devices in accordance with the patterns of said coded pulses.

2. A circuit for converting binary coded pulses to direct-current voltages comprising: a source of voltage; a plurality of resistors and a voltage-indicating device connected in series across said source of voltage from the higher to the lower potential terminals thereof; said resistors corresponding in number to the number of digits in the code and having consecutive values following a geometric progression having a ratio of 2; a plurality of constant current devices, likewise corresponding in number to the number of digits in said code; one of the ends of each of said constant current devices being connected to the lower potential terminal of said source of voltage; the other ends of said constant current devices being successively connected, respectively, to the lower potential ends of said resistors; and means for controlling the conductivity of said constant current devices in accordance with the patterns of said coded pulses.

3. A circuit for converting binary coded pulses to direct-current voltages comprising: a source of voltage; a plurality of resistors and a voltage-indicating device connected in series across said source of voltage from the higher to the lower potential terminals thereof; said resistors corresponding in number to the number of digits in the code and having consecutive values following a predetermined geometric progression; a plurality of electron discharge devices, likewise corresponding in number to the number of digits in said code; the cathodes of said electron discharge devices being connected to the lower potential terminal of said source of voltage; the anodes of said electron discharge devices being successively connected, respectively, to the lower potential ends of said resistors; and means for controlling the conductivity of said electron discharge devices in accordance with the patterns of said coded pulses.

4. A circuit for converting binary coded pulses to direct-current voltages comprising: a source of voltage; a plurality of resistors and a voltage-indicating device connected in series across said source of voltage from the higher to the lower potential terminals thereof; said resistors corresponding in number to the number of digits in the code and having consecutive values following the geometric progression 1—1—2—4—8, etc.; a plurality of electron discharge devices, likewise corresponding in number to the number of digits in said code; the cathodes of said electron discharge devices being connected to the lower potential terminal of said source of voltage; the anodes of said electron discharge devices being successively connected, respectively, to the lower potential ends of said resistors; and means for controlling the conductivity of said electron discharge devices in accordance with the patterns of said coded pulses.

5. A circuit for converting binary coded pulses to direct-current voltages comprising: a source of voltage; a plurality of resistors and a voltage-indicating device connected in series across said source of voltage from the higher to the lower potential terminals thereof; said resistors corresponding in number to the number of digits in the code and having consecutive values following a predetermined geometric progression; a plurality of constant current devices, likewise corresponding in number to the number of digits in said code; one of the ends of each of said constant current devices being connected to the lower potential terminal of said source of voltage; the other ends of said constant current devices being successively connected, respectively, to the lower potential ends of said resistors; means for controlling the conductivity of said constant current devices in accordance with the patterns of said coded pulses; and means for restoring said constant current devices to their initial conditions after each action thereon by said coded pulses.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,608,527	Rainey	Nov. 30, 1926
2,505,029	Carbrey	Apr. 25, 1950
2,514,671	Rack	July 11, 1950
2,581,426	Mason	Jan. 8, 1952