

Jan. 2, 1968

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3,361,920

COMBINATION ANALOG AND DIGITAL DISPLAY DEVICE

Filed Aug. 20, 1965

3 Sheets-Sheet 1

FIG. 1
PRIOR ART

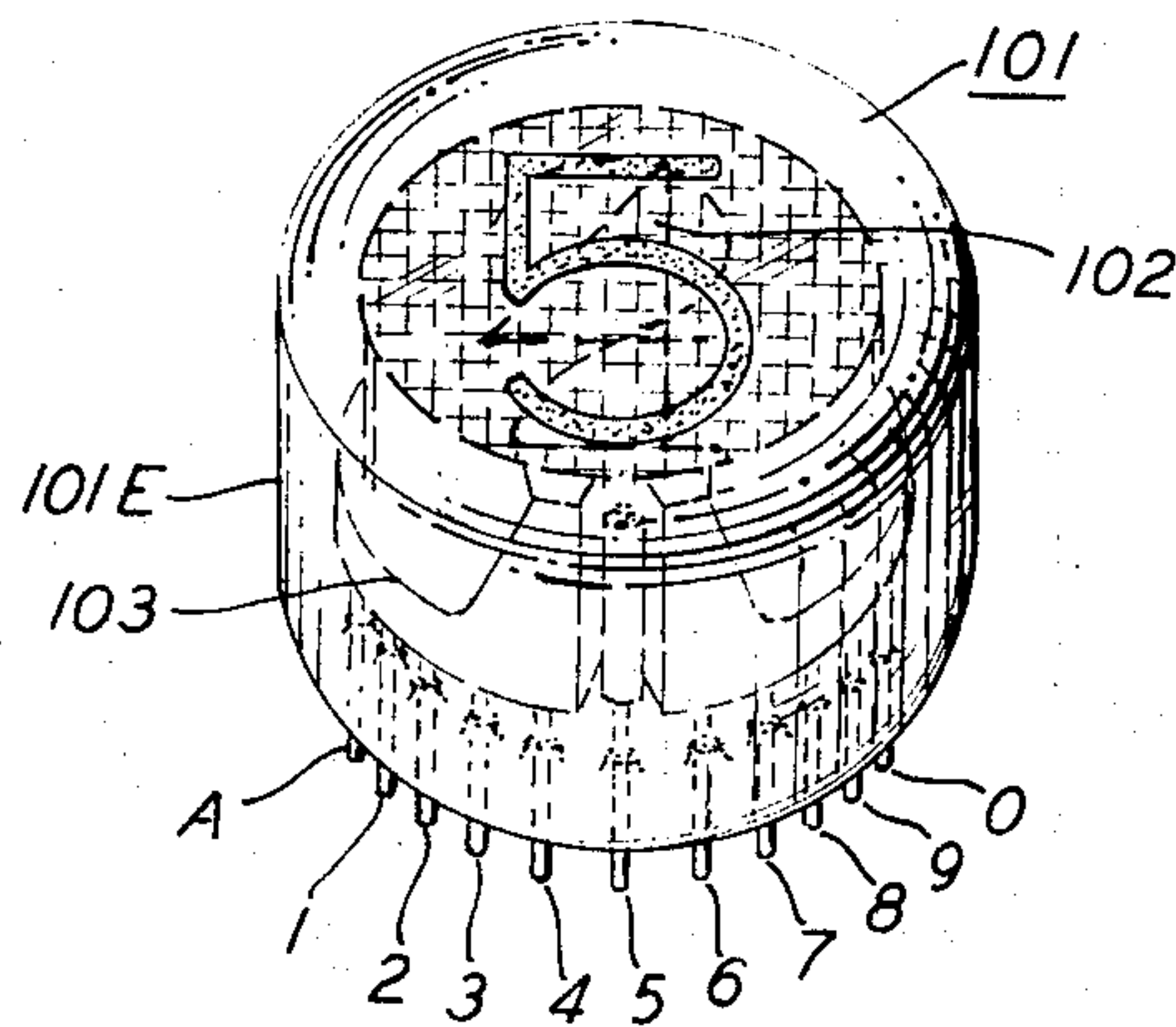
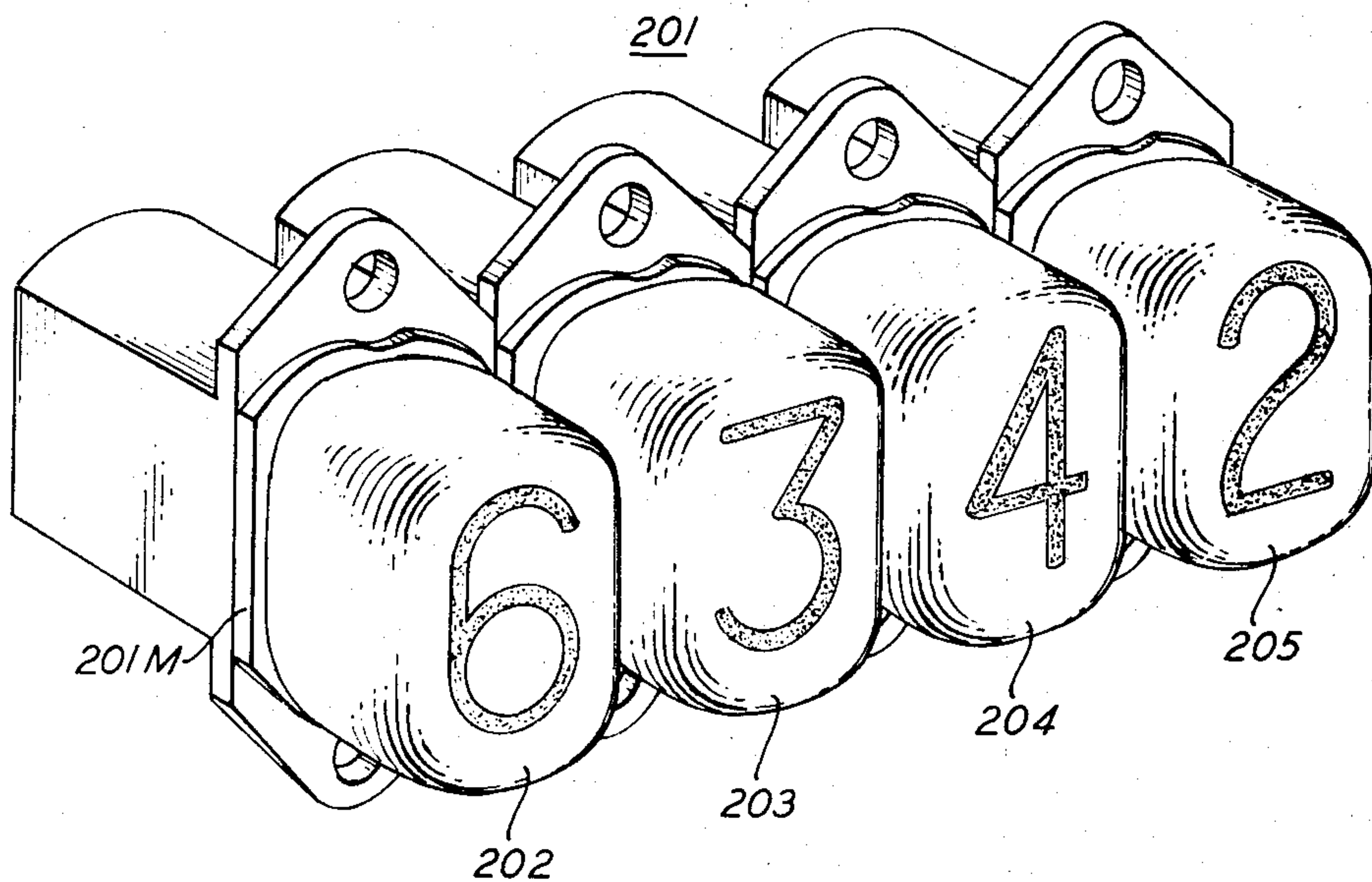


FIG. 2
PRIOR ART



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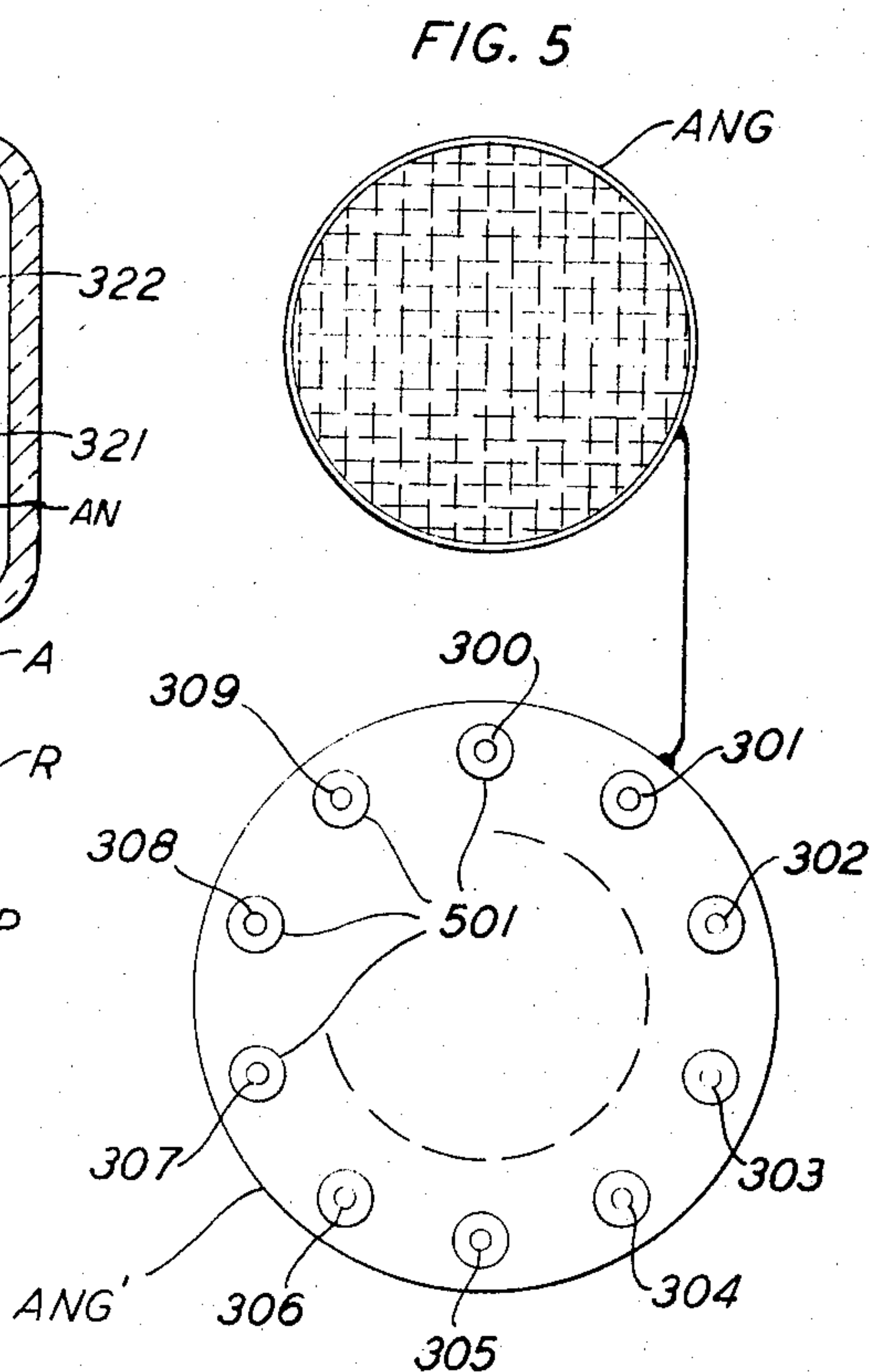
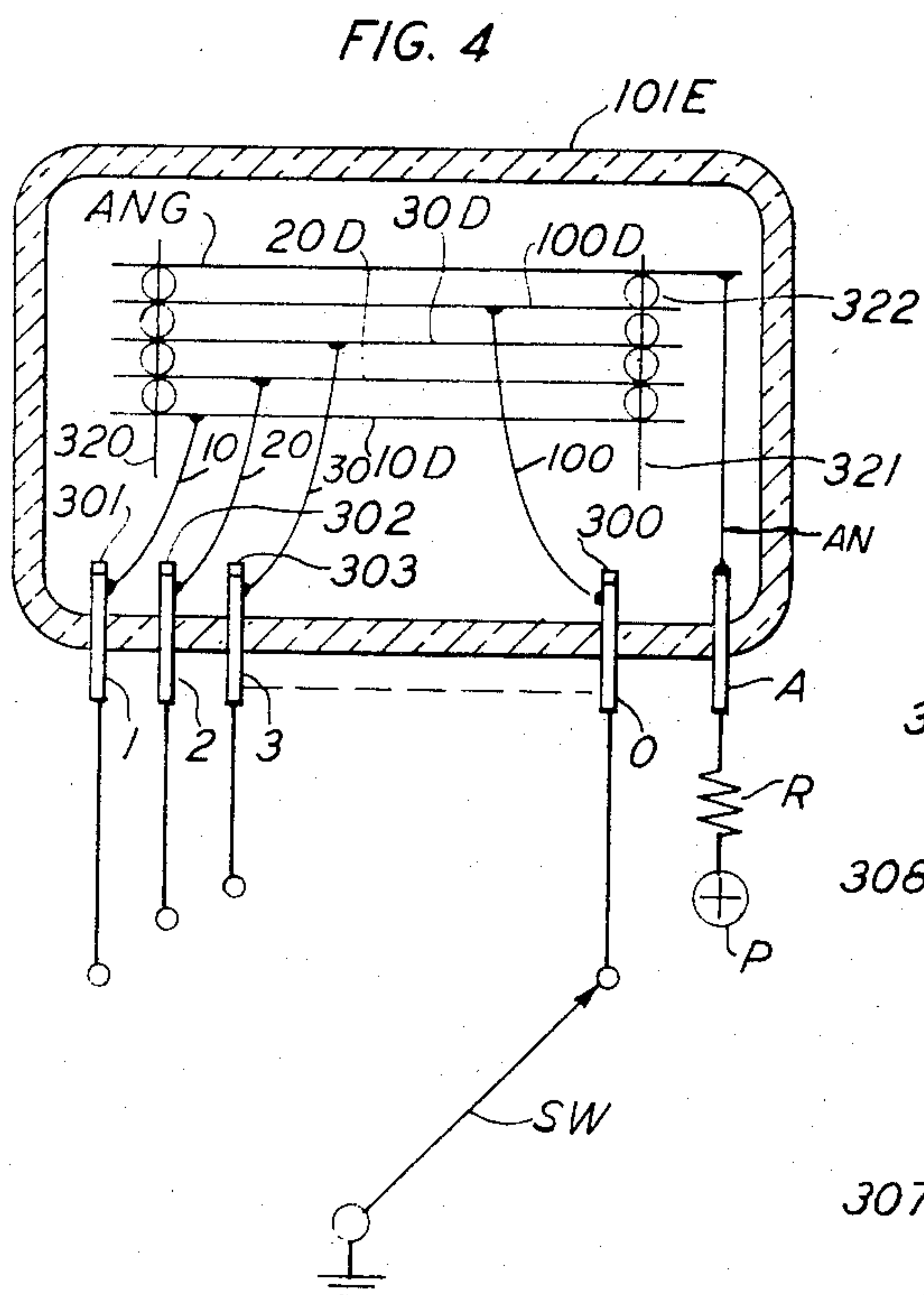
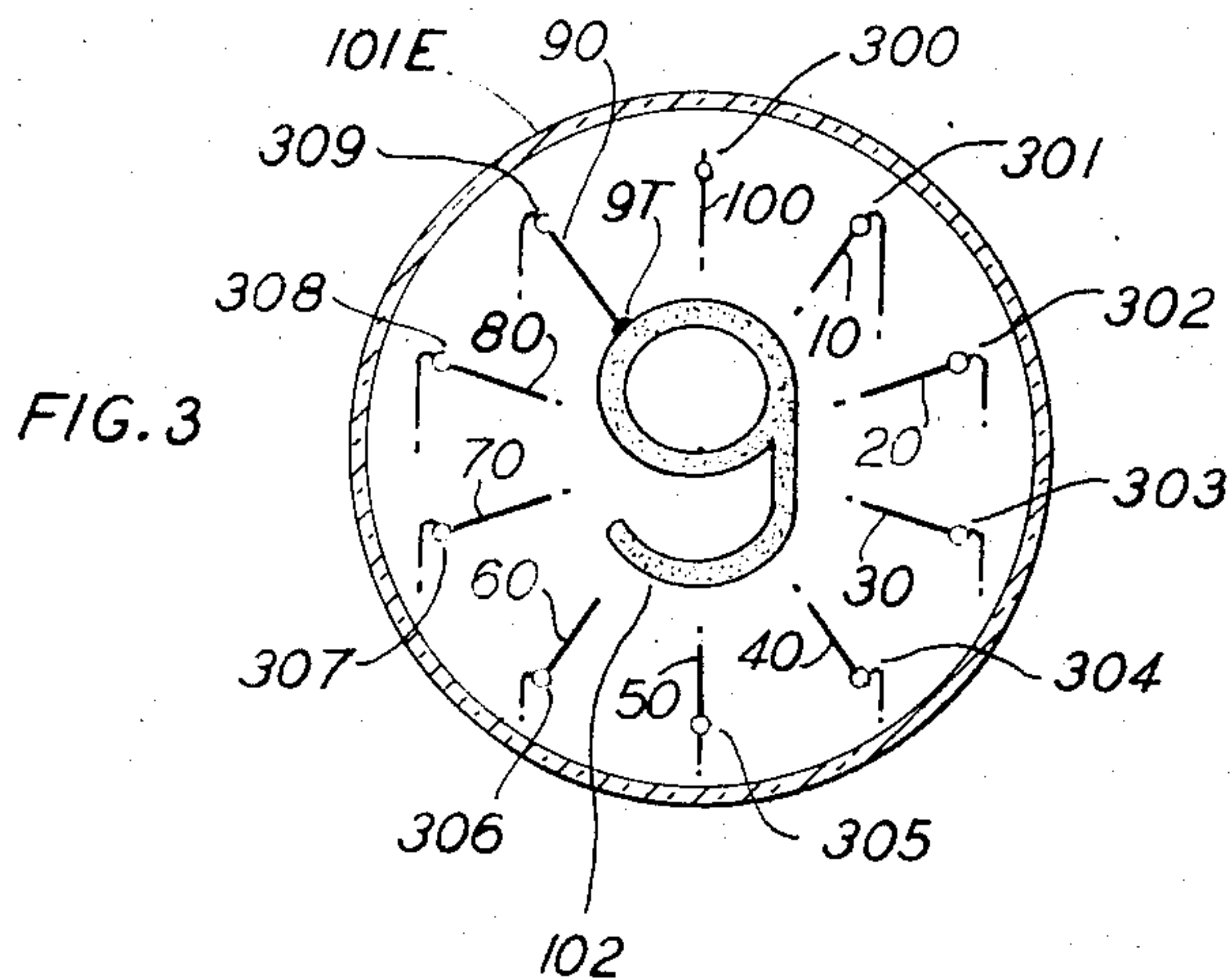
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Filed Aug. 20, 1965

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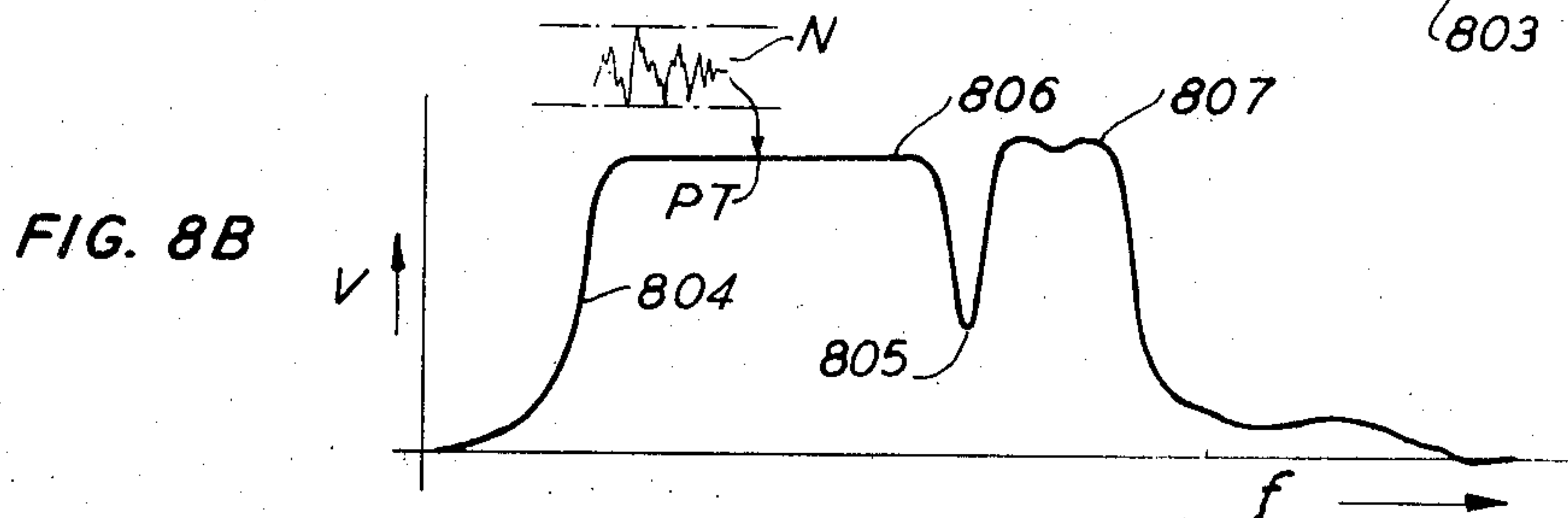
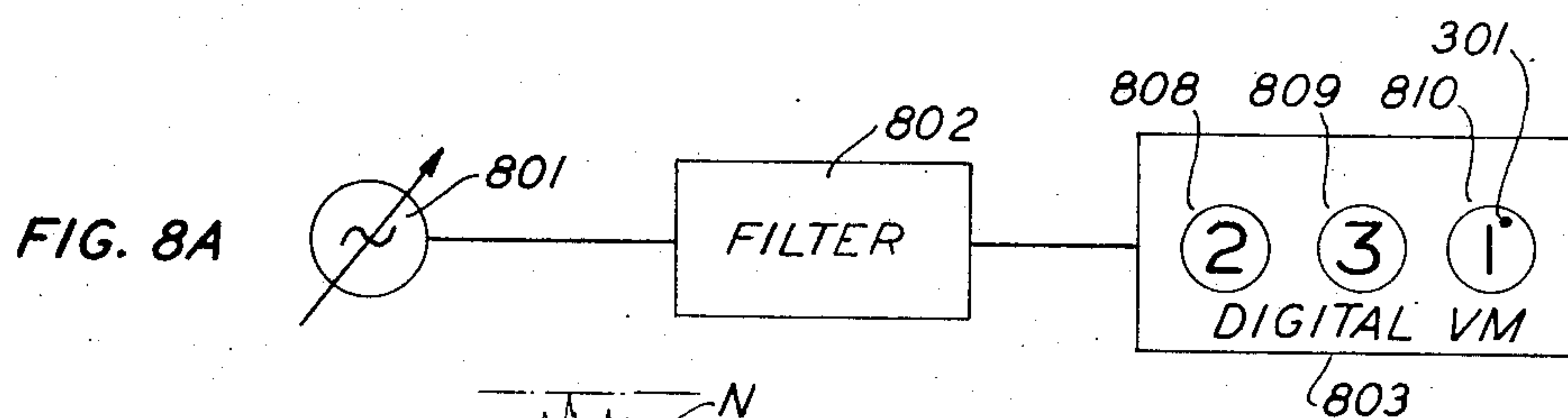
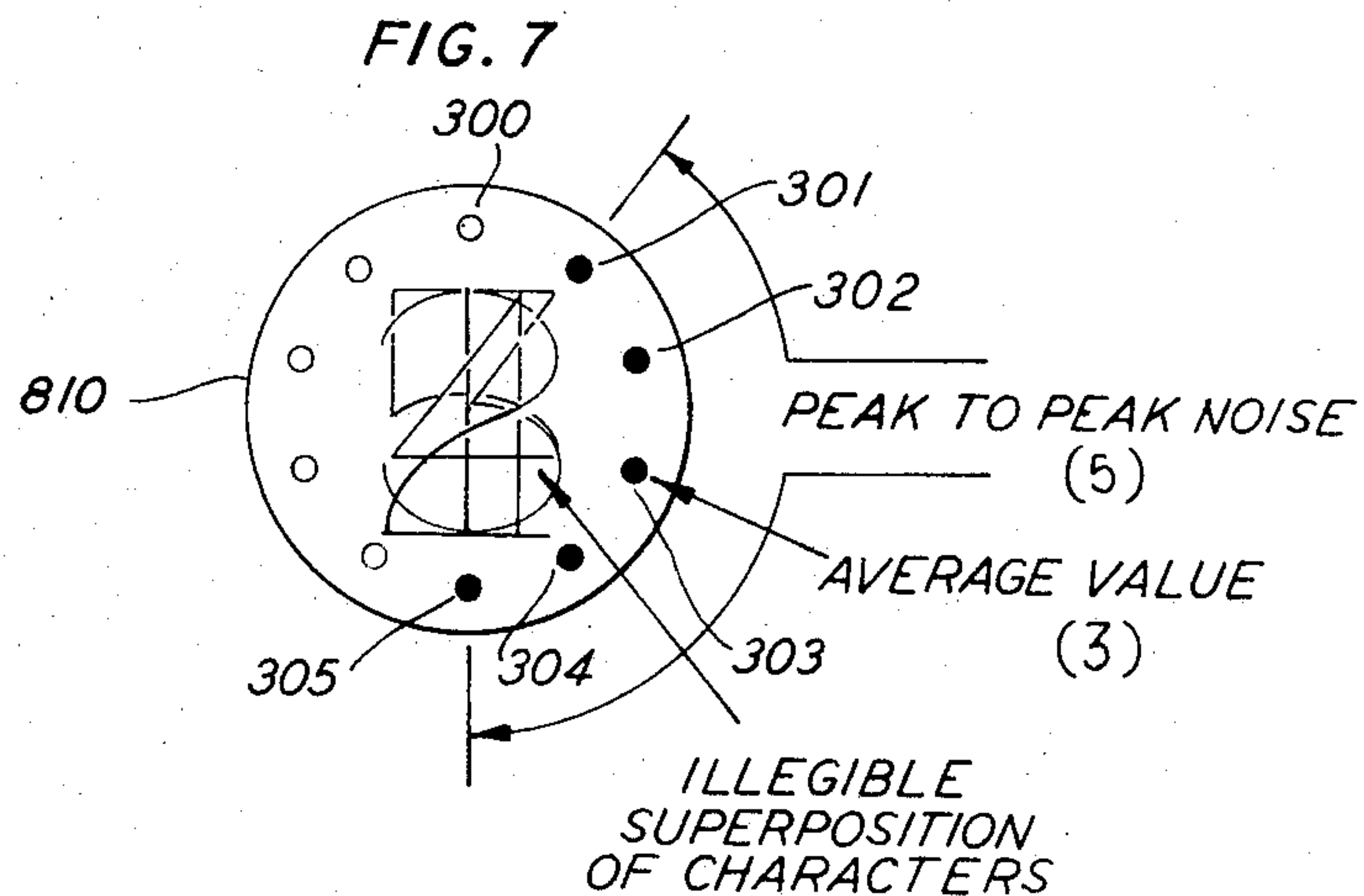
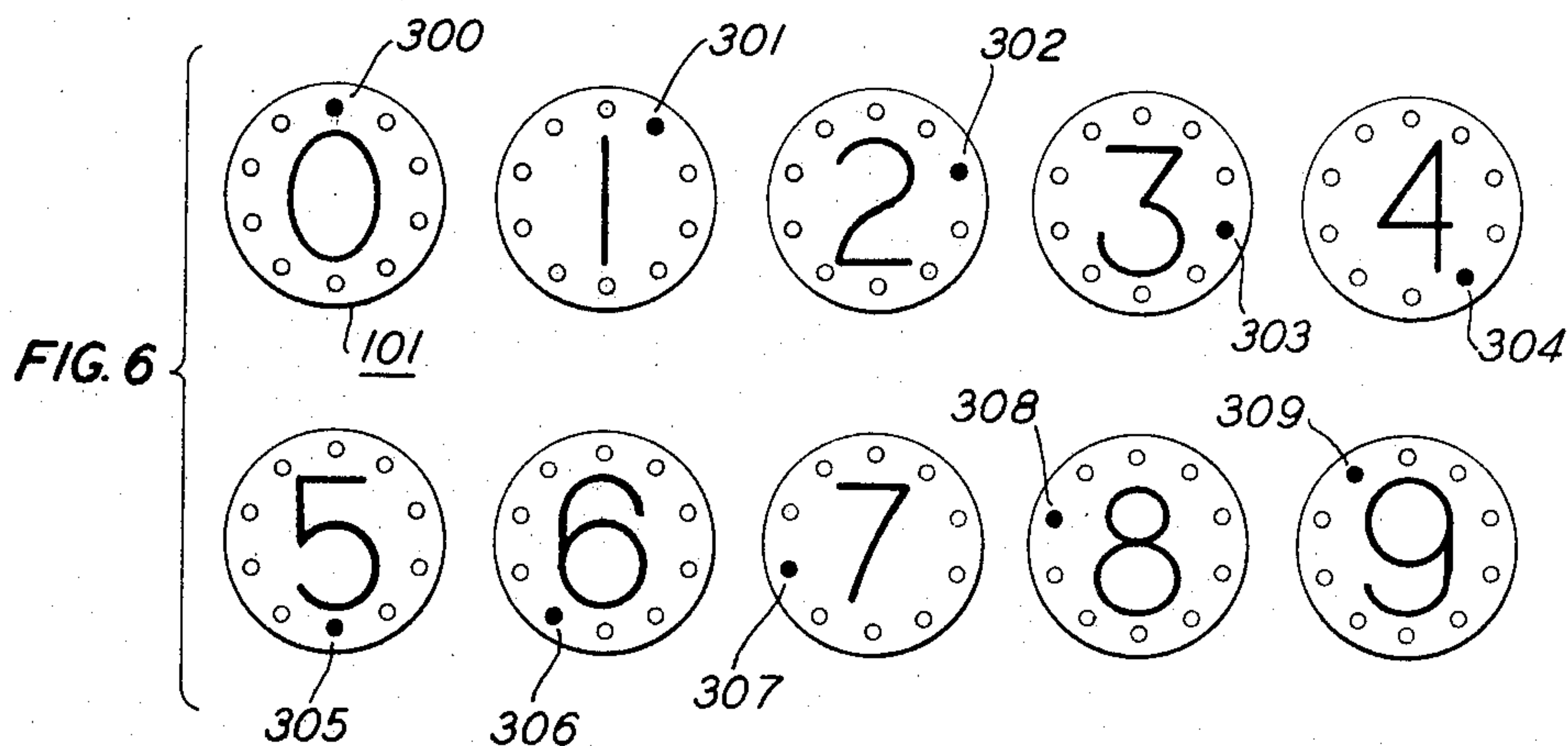
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COMBINATION ANALOG AND DIGITAL DISPLAY DEVICE

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Filed Aug. 20, 1965, Ser. No. 481,226

5 Claims. (Cl. 313-109.5)

ABSTRACT OF THE DISCLOSURE

In a glow discharge display tube each of a plurality of successively illuminable superimposed numerals is connected to a respective one of a plurality of illuminable dots disposed in a ring that surrounds the numerals to provide an instantaneous supplementary visual indication of the numerical direction of change in a changing numerical display.

This invention relates to digital display devices and more particularly to display tubes of the type that includes an array of successively illuminable characters such as Arabic numerals.

Continuing growth in the application of digital registering equipment of the type found in computers and electrical measuring instruments has created a need for increased versatility in associated visual display apparatus. One commonly used digital display device is a tube that encloses a stacked array of successively illuminable indicia such as characters of the alphabet or Arabic numerals. In a typical display arrangement, several tubes of this type may be employed to provide means for displaying a multidigit number with the tube on the right displaying the units digit. As the display number changes, the rate of change of each digit is of course ten times the rate of change of the adjacent digit on the left. With respect to the units digit in particular, the rate of change in a given situation may surpass the level of readability as each digit is viewed only as a very brief light flash. At such speeds, moreover, the direction of change, that is to say either an increase or a decrease, cannot be detected visually from the flashing units indicator, and in certain applications instantaneous recognition of the direction of change by an operator or observer may be a more critical need than the instantaneous recognition of any single digit.

Accordingly, a general object of the invention is to improve digital display devices.

Another object is to increase the information display capabilities of digital display tubes.

A further object is to enable an observer to detect instantaneously the direction of numerical change taking place in a digital display tube irrespective of the readability of the individual digits.

These and other objects are attained in accordance with the principles of the invention in one illustrative embodiment wherein a conventional digital display tube is modified to provide an instantaneous visual indication of the direction of change of a changing numerical display, irrespective of the readability of the individual digit. Specifically, the stack of tube enclosed illuminable digits is surrounded by and interconnected with a ring of illuminable dot indicators so that the illumination of each digit is accompanied by the simultaneous illumination of a corresponding dot. Physically adjacent dots in the ring correspond to numerically adjacent ones of the digits. Accordingly, as the digits change successively in either increasing or decreasing numerical order, a lighted dot appears to move in either a clockwise or counterclockwise direction, respectively, around the flashing digits. The

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time required for the apparent travel of the lighted dot through one complete revolution is greater by a factor of 10 than the elapsed time between the illumination of successive digits. Consequently, direction of change may readily be detected even though the numerical rate of change is too great to permit individual digits to be read.

A feature of the invention is the combination of a sequential, numerical visual display with a visual display indicator showing the direction of change taking place in the numerical display.

A further feature is a digital display tube utilizing an array of stacked successively illuminable numerals surrounded by a ring of successively illuminable dots, adjacent ones of said dots corresponding to numerically adjacent ones of said numerals, the apparent direction of movement of the dots being indicative of the numerical direction of change between successively illuminated ones of the numerals.

The principles of the invention and additional objects and features thereof will be fully apprehended from the following detailed description of an illustrative embodiment and from the drawing in which:

FIG. 1 is a perspective view of a digital display tube in accordance with the prior art;

FIG. 2 is a perspective view of an array of visual digital display tubes in accordance with the prior art;

FIG. 3 is a partial plan view of a digital display tube in accordance with the invention;

FIG. 4 is a schematic circuit diagram of a digital display tube in accordance with the invention;

FIG. 5 is a sketch of a dual anode grid arrangement that may be employed in a tube of the type shown in FIG. 4;

FIG. 6 is a sketch of the face of each of 10 display tubes in accordance with the invention, each illustrating a different displayed indicator;

FIG. 7 is a sketch of a display tube in accordance with the invention illustrating its employment as an average value indicator;

FIG. 8A is a sketch of a display tube in accordance with the invention in use as an indicator for a digital voltmeter; and

FIG. 8B is a voltage-frequency plot of the characteristics of the filter shown in FIG. 8A.

A typical prior art type of digital display tube 101, shown in FIG. 1, is comprised of a glass, gas-filled envelope 101E with an enclosed mounting structure 103, which supports a superimposed array of illuminable digits 102. The digit 5 is shown illuminated. Conventional pin members A and 0 through 9 provide the means for applying signals to illuminate successively each of the digits in array 102.

The conventional combination digital tube display arrangement 201, shown in FIG. 2, includes a mounting means 201M and a row of four digital display tubes 202 through 205, each displaying a different digit of the multidigit number 6342. Tube 202 displays a digit for the thousands decade, tube 203 for the hundreds decade, tube 204 for the tens decade and tube 205 for the units decade. Either tube 101, shown in FIG. 1, or the combination display 201, shown in FIG. 2, is suitable for use in any arrangement requiring visual registration of a digital output provided, however, that the rate of change of the output is sufficiently low to permit each digit, particularly the units digit, to be read before the succeeding digit is illuminated. At higher rates of change, neither the units digit nor the direction of change can be detected visually with any degree of certainty.

FIG. 4 shows the internal circuitry and a portion of the internal structure of a display device such as that shown in FIG. 1, modified, however, to include the features of

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the invention. Pin A is shown connected to a positive voltage source P. A lead AN connects pin A to an anode grid member ANG by way of a resistor R. The anode grid member ANG is positioned above the superimposed array of ten digit grids or filaments, 10D, 20D . . . 100D. Each of the ten digit filaments 10D through 100D comprises a wire or metallic portion formed to represent a respective Arabic numeral. The digit filaments are supported by rod support members 320 and 321, each being insulated from the anode ANG and the ten digit filaments 10D through 100D by sets of the insulating spacers 322. Each of the pins 0 through 9 is connected to a corresponding one of the digit filaments 10D through 100D by a respective one of the leads 10, 20 . . . 100. Means for successively applying a ground to each of the pins 0 through 9 is shown schematically in the form of switch SW. As is known in the art, any suitable switching means may be employed to apply successive grounds to each of the pins 0 through 9 in order to illuminate a corresponding one of the display digits through a glow discharge phenomenon.

Each of the leads 10, 20 . . . 100, shown in FIG. 4, is insulated whereas the number portions or filaments of the digit grids 10D through 100D are noninsulated in order to ensure that a glow discharge occurs only from the digit rather than from the connecting leads or from a portion other than the actual numerical or filament portion of the digit grid. In accordance with the invention, however, as shown in FIG. 3, a small spot of insulation is removed from each of the leads 10, 20 . . . 100, or from an otherwise insulated portion of each digit grid, at a point near envelope 101E so that a ring of noninsulated illuminable spots 300 through 309 is formed around the array of superimposed digits 102. Alternatively, as shown in FIG. 4, insulation may be removed from the top portion of each of the pins 0 through 9 to form the glow discharge spots 300 through 309. Each of the spots 300 through 309, whether a portion of the digit grid, or a portion of the connecting lead, or the top portion of the corresponding tube pin, is connected to a corresponding one of the illuminable numerals by a connecting tab such as tab 9T for the digit 9, as shown in FIG. 3. With the arrangement shown in FIGS. 3 and 4, the illumination of each of the digit filaments 10D, 20D . . . 100D (the digits 0 through 9) is accompanied by the illumination, through glow discharge, of a corresponding one of the spots 300 through 309. The physical and electrical relation of each of the spots 300 through 309 to its corresponding digit is further illustrated by the display tubes of FIG. 6. As shown, spot 300 is illuminated when the digit 0 is illuminated, spot 301 is illuminated when the digit 1 is illuminated and so on through digit 9, the illumination of which is accompanied by the illumination of spot 309.

A slightly modified internal structural arrangement for the tube shown in FIGS. 3 and 4 is shown in FIG. 5. If the plane of the illuminable dots 300 through 309 is substantially removed from the plane of the anode grid ANG, it may be desirable to employ a supplementary anode grid ANG' electrically connected to the grid proper ANG and physically positioned at a lower level in close proximity to the illuminable spots 300 through 309. The supplementary grid ANG' includes a ring of circular apertures 501, each being positioned over a corresponding one of the noninsulated spots 300 through 309 to permit visual display of these spots at the time of spot and digit illumination.

In a display tube in accordance with the invention as described hereinabove, the display of a digit with the base 10 has been assumed. If the number to be displayed is a base other than 10, the number of illuminable spots and the number of digit characters in the center are adjusted accordingly. Although a particular type of display device has been illustrated, almost any type of digital display device which can be modified to produce a ring of

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illuminable spots along with numeric characters may be used in the practice of the invention, the only restriction being that the display be capable of changing rapidly, thus ruling out mechanical mechanisms as well as those projection systems which utilize incandescent bulbs with long time constants.

FIG. 8A illustrates a specific utilization of a display tube constructed in accordance with the invention. A variable oscillator 801 and a digital voltmeter 803 are shown being used to examine the characteristics of a transmission filter network 802. Assume that it is desirable to find and measure the peaks and holes in the voltage-frequency plot of the network's response and also to observe the magnitude of the noise at the output of the network. With a conventional digital display, such an examination would require that the oscillator 801 be swept very slowly to enable the operator to determine when a minimum or maximum point had been reached. It would be necessary to make a mental comparison between each reading of the digital voltmeter and the previous reading in order to determine whether an increase or a decrease had occurred, and, accordingly, it would be essential to present the readings at a sufficiently slow rate for the operator to perform this process. Moreover, only a very rough estimate of noise magnitude could be gained from the rapid transitions that occur in the noise area N shown in the plot in FIG. 8B.

With the digital voltmeter 803 equipped with a units digit display tube 810 in accordance with the invention, it is evident that an apparent clockwise rotation of the spots (such as spot 301) would indicate an increasing voltage magnitude and a counterclockwise rotation a decreasing magnitude. Therefore, at the instant when the direction of apparent rotation of the flashing spots changes, it is evident that a minimum voltage has been passed such as at point 805, for example, if the apparent spot movement shifts from the counterclockwise to the clockwise direction. At this point the oscillator sweep may be stopped and the voltage magnitude read from the displayed digits.

In FIG. 7 the units digit display tube 810 of digital voltmeter 803, FIG. 8A, is shown being used to determine the average value of noise N appearing at a particular point PT on the plot of FIG. 8B. Five of the dots 301 through 305 are alternately being illuminated as the noise N creates a succession of rapid changes in the voltage level. It is evident that the peak-to-peak measurement of noise N is 5 volts and further that the average noise level is 3.

In the illustrative embodiment described herein, a tube in accordance with the invention has been employed to display only the least significant digit in a multidigit number. It is evident, however, that in a particular display, depending upon the rate of change of displayed information, it may be desirable to have more than one or even all of the tubes constructed in accordance with the invention. Such an arrangement would be somewhat analogous to a meter display that includes a succession of meters, each meter having a scale factor differing by ten from that of adjacent meters and each having an infinitely long but continuously repeating scale. A display in accordance with the invention may also be viewed as being characterized by an analog quality that uniquely enhances both the readability and versatility of a rapidly changing display.

It is to be understood that the embodiment described herein is merely illustrative of the principles of the invention. Various modifications thereto may be effected by persons skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A digit display device comprising, in combination, a gaseous discharge tube having a transparent envelope, an array of substantially superimposed digit display characters within said envelope, a ring of display dots within said envelope surrounding said display characters, adjacent ones of said dots corresponding to numerically ad-

jacent ones of said characters, means responsive to successive input signals for illuminating each of said digit display characters and for simultaneously illuminating corresponding ones of said dots, whereby the apparent direction of movement of an illuminated one of said dots corresponds to an ascending or descending numerical direction of successive illuminations of said characters, thereby imparting both digital and analog display characteristics to said device.

2. Apparatus for displaying a changing numerical representation comprising, in combination, a gaseous discharge tube having a transparent envelope, a plurality of substantially superimposed numerical character devices within said envelope successively illuminable in either ascending or descending order, a plurality of dot devices in a ring-like configuration within said envelope surrounding said character devices, adjacent ones of said dot devices being successively illuminable simultaneously with corresponding numerically adjacent ones of said characters, thereby creating an apparent substantially circular movement of an illuminated one of said dot devices in either clockwise or counterclockwise direction as said character devices are successively illuminated in either ascending or descending numerical order, respectively.

3. Digital information display apparatus comprising, in combination, a gaseous discharge tube having a transparent envelope, a first array of numerical indicating devices, a second array of dot indicating devices, said first and second arrays being positioned within said envelope, means responsive to successive electrical input signals indicative of a numerical sequence for illuminating corresponding successive numerically adjacent ones of said devices in said first array and for simultaneously illuminating corresponding successive physically adjacent ones of said devices in said second array, only a single one of said devices in said first array and only a single corresponding one of said devices in said second array being illuminable at any one time, the direction of apparent clockwise or counterclockwise movement of an illuminated one of said dot indicating devices caused by the successive illumination of physically adjacent ones of said dot indicating devices being indicative of the ascending or descending numerical order, respectively, of successively illuminated ones of said numerical indicating devices, whereby said apparatus is enabled to display a combination of both digital and analog information.

4. Combination analog and digital information display apparatus comprising, in combination, a gaseous discharge tube having a transparent envelope, a first array of numerical indicating devices successively and illuminably responsive in either ascending or descending numeri-

cal order to the application of electrical input signals indicative of a numerical sequence; a second array of spot indicating devices arranged in a substantially circular path surrounding said first array, adjacent ones of said last named devices being successively and illuminably responsive in either clockwise or counterclockwise direction to the application of said signals; said first and second arrays being positioned within said envelope, only a single one of said devices in said first array and only a single corresponding one of said devices in said second array being illuminated at any one time, the direction of apparent clockwise or counterclockwise movement of an illuminated one of said dot indicating devices caused by the successive illumination of physically adjacent ones of said last named devices being indicative of the ascending or descending numerical order, respectively, of successively illuminated ones of said numerical indicating devices.

5. Digital information display apparatus comprising, in combination, a plurality of gaseous discharge digit display tubes having transparent envelopes for displaying the respective digits of a multidigit number, each of said tubes comprising a first array of illuminable digit devices, at least one of said tubes having a second array of illuminable dot devices in a substantially circular path surrounding said first array, means responsive to the application of successive electrical signals indicative of a numerical sequence in either ascending or descending numerical order for illuminating a corresponding digit in said first array in each of said tubes, the illuminated digit device in said one tube changing with each successive one of said signals, adjacent ones of said dot devices being successively and illuminably responsive to successive ones of said signals, only a single one of said dot devices and a single one of said digit devices in said one tube being illuminated at any one instant of time, the direction of apparent clockwise or counterclockwise movement of an illuminated one of said dot devices caused by the successive illumination of physically adjacent ones of said dot devices being indicative of the ascending or descending numerical order, respectively, of successively illuminated ones of said digit devices in said one tube.

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P. C. DEMEO, *Assistant Examiner*.