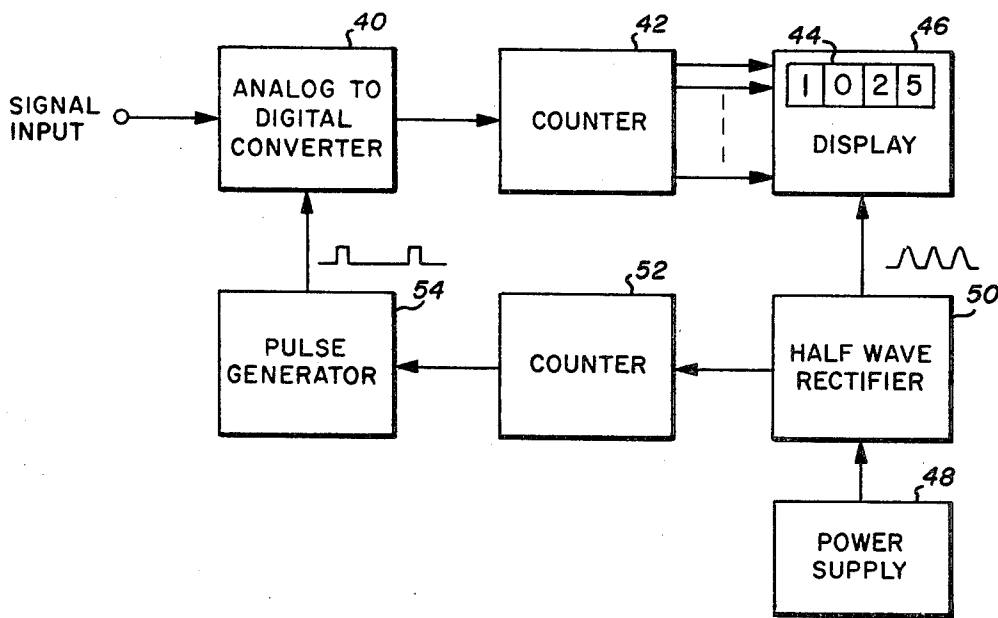


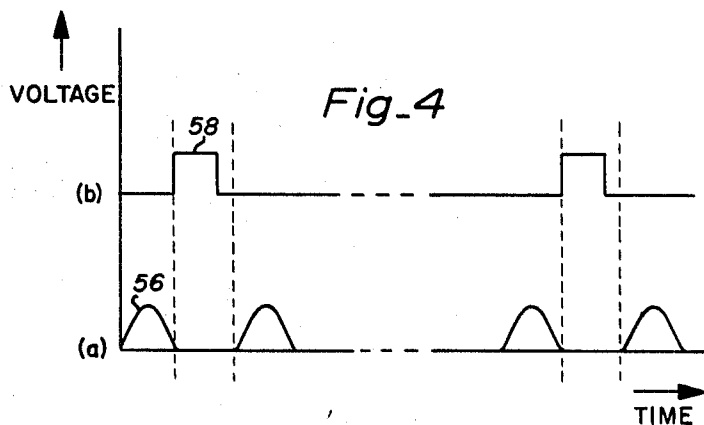
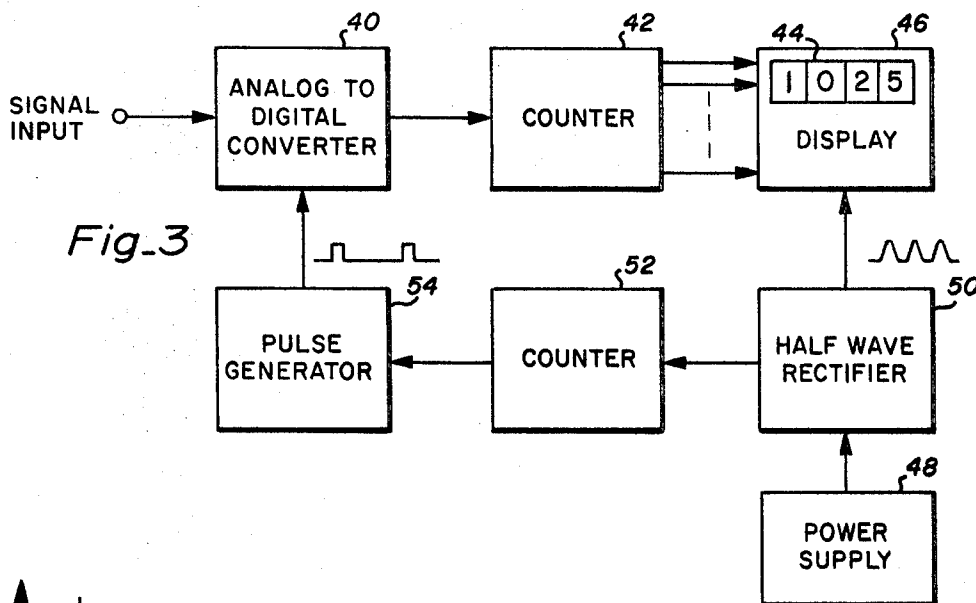
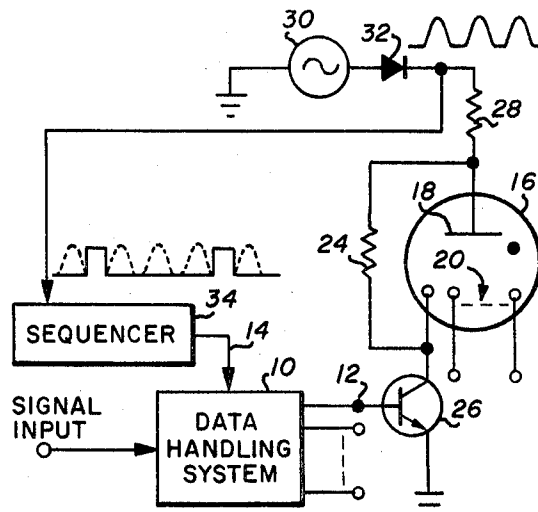
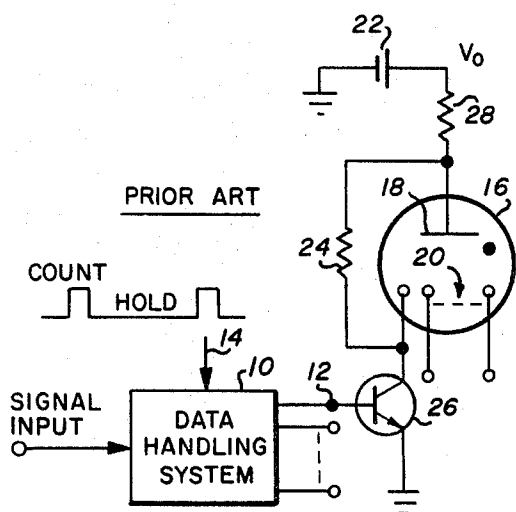
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[56] **References Cited**
UNITED STATES PATENTS
3,171,953 3/1965 Young..... 235/92
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[54] **CHARACTER DISPLAY APPARATUS**
2 Claims, 4 Drawing Figs.
[52] **U.S. Cl.**..... **340/324,**
235/92
[51] **Int. Cl.**..... **G08b 5/00**
[50] **Field of Search**..... **340/324,**
347; 235/92

ABSTRACT: A continuous display digital readout system is disclosed wherein the indicator tubes are periodically inactivated for short periods of time at a rate exceeding the resolution threshold of the human eye, and the data conversion and counting operations are performed during selected ones of these inactivated periods so that no counting flicker is produced in the readout.





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CHARACTER DISPLAY APPARATUS

STATEMENT OF THE INVENTION

The present invention relates in general to character readout apparatus of the type used in analog-to-digital conversion systems, and more particularly, although not limited thereto, to a novel means for providing a continuous visual display of a counter output free of counting flicker without using memory circuit means between the counter and the display unit.

DESCRIPTION OF THE PRIOR ART

In conventional analog-to-digital conversion systems of the type having particular utility as digital voltmeters and the like, an input signal is converted from analog-to-digital form, counted in a binary counting apparatus, and then displayed by a digital readout device.

The digital readout device commonly used in systems of this type includes a plurality of gas discharge numerical indicator tubes commonly referred to as "Nixie" tubes which provide a visual indication in numerical form of the system output. These indicator tubes consist of one anode and 10 cathodes having the physical configuration of the digits 0, 1, 2...9, respectively, all of which are suitably mounted in a glass envelope filled with neon gas at a low pressure. When a potential of a predetermined ignition voltage is applied between the anode and one of the cathodes of the respective tubes a glow in the shape of a numerical digit appears at the cathode, and may be viewed through the end or side of the glass envelope.

In one form of prior art apparatus, each decade of the counter is connected through suitable decoding and switching circuits to one of the indicator tubes. The electronic counter is generally designed to count selected events, and then hold the count result for a short observation period before performing a subsequent count. Since the indicator tubes are directly controlled in response to the counter output, the tubes will attempt to follow the count as well as display the count result after the counting operation is terminated. Thus, during the counting operation a flickering of the indicator tubes is produced which is objectionable to one viewing the readout. Another objectionable feature of this type of system is that finite periods of time are required to establish and display new and successive counts, and, since the observation period may not be reduced below a certain duration without materially increasing the probability that erroneous readings might be taken, the observer must wait after each observation period for a new count to be performed and displayed.

These problems have been eliminated in more elaborate prior art equipment by the insertion of memory circuits between the binaries and the indicators. The function of these memory circuits is to provide a storage means to which the output of the counter can be transferred. The storage means then control the indicator tubes to provide a continuous display of the previous count until a new count is available. Obviously, these improved devices are considerably more complex and expensive even though they do solve the aforementioned problems.

SUMMARY OF THE INVENTION

In accordance with the present invention a means is provided wherein the function of a data storage unit is simulated, thus enabling the construction of a low cost digital readout data conversion system which is not subject to the objectionable indicator flickering present in similar prior art apparatus. This is accomplished by periodically applying a voltage, or conversely, removing a voltage supplied to the anodes of the indicator tubes at a rate above the resolution time of the human eye so that counting transients in the signal input to the indicator tube cathodes during the inactivated periods will not be displayed. The analog-to-digital converter and counting apparatus is then periodically activated for short intervals at any suitable rate, but only during the indicator tube "off" periods.

OBJECTS OF THE INVENTION

It is therefore a principal object of the present invention to provide an analog-to-digital conversion and display apparatus in which the objectionable indicator tube flickering of the prior art devices is eliminated.

Another object of the present invention is to provide a data conversion and indication system which continuously displays the converted signal in digital form without visual distortion caused by the counting operation.

Still another object of the present invention is to provide a data display system wherein the indicia is continuously displayed without the use of a data storage means.

Still other objects and advantages of the present invention will become apparent after a reading of the following description of a preferred embodiment illustrated in the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically illustrates the operation of prior art devices;

FIG. 2 is a schematic representation of the operation of a device in accordance with the present invention;

FIG. 3 is a block diagram representation of a data conversion and display system in accordance with the present invention; and

FIG. 4 is a timing diagram illustrating the operation of the system shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawing, there is shown a schematic illustration of a prior art form of data conversion and display system. For purposes of illustration only one digit indicator is shown. An input signal fed into the data handling system 10 is converted to digital form, and the value thereof is counted to produce an appropriate output signal on one of the output leads 12 at the end of the count. The system is caused to alternately count and then display for a predetermined period by an appropriate control signal provided, as indicated, at 14.

A gas discharge numerical indicator tube 16 is provided for indicating the result of the counting operation performed on the input signal by data system 10. The tube 16 is typically a neon glow tube commonly referred to as a "Nixie" tube, and has an anode 18 and ten cathodes 20 having the configuration of the numerals 0, 1,...9, respectively. A battery 22 is connected to anode 18 for raising the potential of the anode to the ignition voltage V_0 of the tube 16. A plurality of high resistance means 24 of perhaps 1.8 megohms are connected between the anode and each of the cathodes for maintaining the tube in a nonindicating condition when no signal is impressed on one of the cathodes 20.

A plurality of switching means 26 are connected to each of the cathodes 20 for reducing the potential of the cathode to ground when the switch is energized by an output signal from the data system 10. The result is that when one of the cathodes 20 is grounded a difference in potential of approximately V_0 appears between the anode 18 and the particular cathode 20 causing a glow to appear at the cathode in the shape of that particular filament, and that digit may be viewed through the end or side of the tube envelope. A resistor 28 is provided in series between the battery 22 and the anode 18 for limiting the discharge current, and reducing the anode voltage to a value just high enough to sustain the gaseous discharge.

The operation of the prior art device may then be described as follows. When the data system is caused to "count" as illustrated in the drawing, the input signal is converted and the counting operation begins. As the count proceeds, each of the cathodes 20 will be sequentially illuminated until the count is terminated. The last digit of the count will then be "held" and remain illuminated until a new count is begun.

As the cathodes 20 are sequentially illuminated in rapid succession during the counting operations, an objectionable

flickering is observed which until now has only been circumvented by the insertion of complex and expensive memory circuits between the data system 10 and the indicator switching means 26.

In FIG. 2 of the drawing, the novel features and advantages of the present invention are briefly illustrated. As shown, the battery 22 has been replaced by an alternating current power source 30 and a half-wave rectifier means 32 so that the ignition voltage supplied to the anode 18 of the indicator tube 16 is, in effect, pulsed on and off at a rate higher than the resolution rate of the human eye, i.e., greater than 30 Hz. A sequencing means 34, synchronized with the voltage supplied to anode 18, is also provided for initiating counting operations by the system 10 during periods when no voltage is supplied to the anode 18.

The effect then, of this novel system, is to cause the counting operation to take place entirely during certain ones of the tube "off" times and, since only the count result is displayed periodically at a rate unnoticeable to the eye, the objectionable flickering problem is eliminated. Moreover, the problem is solved in a simple and inexpensive manner and without the use of any memory circuits.

Turning now to FIG. 3 of the drawing, a preferred embodiment of a functional data converting and indicating system in accordance with the present invention will be described. This particular system is, for example, suitable for use as a digital voltmeter, but is, of course, not limited to that particular application. In accordance with the invention an input signal is fed to an analog-to-digital converter 40 from which the signal emerges in, for example, time duration form and is supplied to a binary counter 42 which performs a counting operation on the signal. A typical counting unit will include a plurality of decades each comprised of four binary circuits connected together. The number of decades is determined by the number of digits desired in the system readout, and the output of each decade is connected to an indicator tube 44 of display 46 through a suitable decoding circuit.

An alternating power supply 48 is connected through a half-wave rectifier 50 to the anode voltage supply circuit of each indicator tube 44 so as to periodically energize the tubes. Although the frequency of power supply 48 may be of any value greater than 30 Hz., a 60 Hz. power supply has been found to be convenient. As an alternative, a gated DC power supply means may be substituted for alternating power supply 48 and rectifier 50.

An output of half-wave rectifier 50 is also supplied to a frequency counter 52 which operates in a countdown mode to convert the 60 Hz. rectified signal into, for example a 10 pulse-per-second train. This signal is then applied to a pulse generator 54 which produces a series of pulses for triggering the analog-to-digital converter 40 and causing it to make a new conversion.

By referring to the timing diagram of FIG. 4, the operation of the system may be readily understood. In part (a) the half-wave rectified 60 Hz. output 56 of rectifier 50 is illustrated. This is the form of the voltage applied to the anodes of the indicator tubes 44, but, since 60 Hz. is substantially above the resolution threshold of the eye, it appears that the tubes are being continually energized. The same wave form is presented to counter 52, but counter 52 is set to divide by six and produce only a single output signal for each six input half-waves it sees, thus the frequency is reduced to 10 Hz. This 10

Hz. signal is then used to trigger pulse generator 54 which is designed to produce a 10 pulse-per-second train, as shown in part (b), with the duration of each pulse 58 falling within the no-voltage time space following each sixth half-wave 56.

Since the converter 40 and counter 42 are only active for the duration of the pulses 58 and the indicators 44 are rendered nonresponsive to input signals during this period, there will be no flicker apparent on the tubes as the counter 42 performs its counting operation. So long as the count remains the same, the indicators 44 will appear to continuously display the digital result while the system performs 10 complete samplings per second. The output is therefore accurate to one-tenth of a second, and will accurately follow a changing input signal to this degree.

This inventive concept can readily be adapted to any data receiving and display system, and is not limited to an analog-to-digital conversion process. It has equal utility in a digital-to-digital system or, for that matter, any type of system wherein data is converted and visually displayed. Furthermore, the visual display indicia need not be limited to numerical digits, but may take the form of alphabetical letters or other appropriate symbols.

After having read the above disclosure, many alterations and modifications of the invention will be apparent to those of skill in the art, and it is understood that this description of a preferred embodiment is for purposes of illustration only and is in no manner intended to be limiting in any way. Accordingly, I intend that the appended claims be interpreted as covering all modifications which fall within the true spirit and scope of my invention.

What I claim is:

1. A character display apparatus for continuously displaying the output of a data handling system, comprising:

indicator means responsive to the output of said data handling system and operative to display a digital readout thereof, said indicator means including a plurality of gas discharge tube means each having an anode and a plurality of numerically configured cathodes for providing said digital readout;

power supply means coupled to said indicator means and including means for generating a half-wave rectified alternating voltage signal for periodically energizing said indicator means for short periods of time and at a rate substantially imperceptible by the human eye, said means for generating being coupled to the anodes of said tube means whereby said voltage signal alternately supplies an ignition voltage and no voltage thereto;

activating means coupled to said power supply means and synchronized with said voltage signal for activating said data handling system inbetween selected ones of said short periods of time, such that only the end products generated by said data handling system are displayed by said indicator means.

2. A character display apparatus as set forth in claim 1 wherein said activating means includes an activating signal generating means coupled to said power supply means for producing activating signals in synchronism with said voltage signal, said activating signals being generated inbetween said short periods of time and having time durations of less than the intervals between said short periods of time, said signal generating means being coupled to said data handling means for controlling the actuation times thereof.