

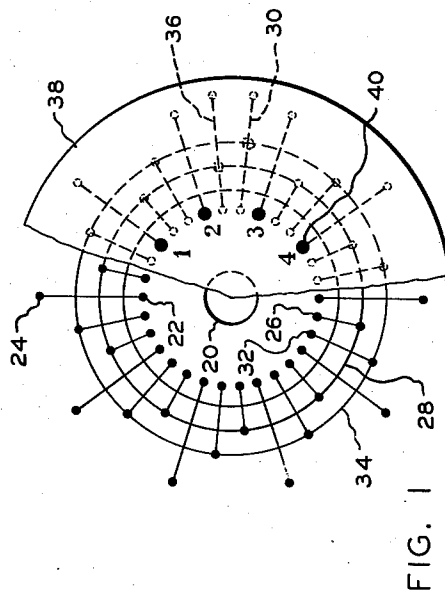
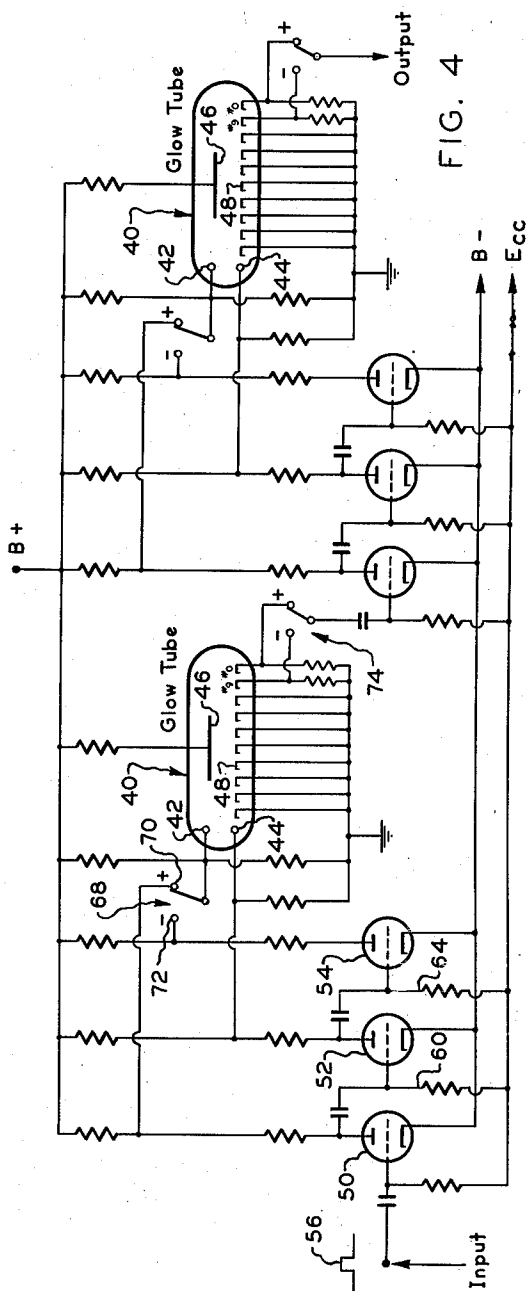
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REVERSIBLE COUNTING TUBE SYSTEM

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REVERSIBLE COUNTING TUBE SYSTEM

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4 Claims. (Cl. 315—84.6)

The present invention relates to counting tubes and, more particularly, to circuitry for imparting digital information to counting tubes of the type comprising a common electrode (e.g. a central anode) and a plurality of sequence electrodes (e.g. a plurality of surrounding cathodes) within a discharge gas. The gas conducts or glows between the common electrode and a selected sequence electrode when a predetermined voltage is supplied. In a typical counting tube, the glow is shifted from one to the other of a pair of adjacent sequence electrodes by a pair of guide electrodes, positioned therebetween, to which a pair of sequential voltage pulses are applied. Although such counting tubes often are bi-directional, that is, capable of being driven forward and backward, they have been used primarily for counting in one direction only, either forward or backward. The present invention concerns the use of such tubes for counting in both directions so that they constitute arithmetic units capable both of adding and subtracting digital information.

The object of the present invention generally is to provide a new driving technique for counting tubes involving the application to adjacent guide electrodes of certain guide pulses selected in a novel manner from a given sequence. Where the guide electrodes are two in number, there may be generated three rather than two sequential guide pulses, of which two are selected in order to govern whether the counting tube is to operate in the forward or the reverse direction. In other words, if the second guide pulse always is applied to the second guide electrode, the choice of either the first or the third guide pulse for application to the first guide electrode will determine the timing of the operation of the first and second guide electrodes.

Other objects of the present invention will in part be obvious and will in part appear hereinafter.

For a complete understanding of the present invention, reference should be had to the following detailed disclosure, taken in connection with the accompanying drawing where:

Figure 1 illustrates an exemplary counting tube useful in accordance with the present invention;

Fig. 2 illustrates representations of two guide pulses of the type conventionally used to drive the counting tube of Fig. 1;

Fig. 3 illustrates representations of three guide pulses used in accordance with the present invention to drive the counting tube of Fig. 1; and

Fig. 4 illustrates an exemplary circuit for driving the counting tube of Fig. 1 in response to input counting pulses representing positive and negative values.

The counting tubes of the illustrated embodiment of the present invention are multi-cathode glow tubes of the type shown in Fig. 1. As shown in Fig. 1, each counting tube includes an anode 20, ten cathodes 22 having independent leads 24, ten first guides 26, all connected through a guide ring 28 to a lead 36, and ten second guides all connected through a second guide ring

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34 to a lead 30. As shown, the cathodes, first guides and second guides are interspersed in cyclic order and are disposed within a hermetic envelope containing an inert gas such as argon, neon, krypton, etc. Under the control of guides 26 and 32, the gas conducts in one of ten restricted regions beneath a dial or bezel 38. Bezel 38 provides translucent positions 40, one of which at any given time is illuminated by a glow generated below it by a discharge between anode 20 and a selected cathode 22.

In a typical case, the first and second guides normally are held at a positive potential (e.g. +60 volts) with respect to the cathodes. Initially a random discharge occurs between anode 20 and some cathode 22. When a pair of overlapping sequenced negative going pulses 23 and 25 (Fig. 2), (designated for convenience by #1 and #2) are applied (e.g. -120 volts), the glow transfers in the following way. When #1 pulse is applied to first guides 26, the discharge region preferentially shifts in a clockwise direction to the adjacent position between anode 20 and the next clockwise first guide 26. At this time, the discharge region does not shift in a counter clockwise direction to first guide 26 because it is too remote from the region already ionized. Similarly, when #2 pulse is applied to the second guides 32 at the moment the previous pulse is terminated, the discharge region preferentially shifts in a clockwise direction to the adjacent position between anode 20 and the next clockwise second guide 32. Similarly, when the #2 pulse is terminated, the discharge region preferentially shifts in a clockwise direction to the adjacent position between anode 20 and the next clockwise cathode 22. In the case of a reversible glow tube, the glow will step in counter clockwise increments when the aforementioned #1 and #2 pulses are applied first to second guides 32 and then to first guides 26.

As shown in Fig. 3, the driving technique of the present invention utilizes three pulses 58, 62 and 66 (designated for convenience by #1, #2 and #3) generated in sequence by any suitable means such as that shown in Figure 4. The #2 pulse always is applied to guide 26. The #1 pulse or the #3 pulse is fed to guide 32 depending upon whether it is desired that the operation be forward or backward. The circuit of Fig. 4 is shown as comprising a plurality of counting tubes 40 having first guides and second guides shown at 42 and 44, respectively. First and second guides 42 and 44 normally are held at a positive voltage so that discharge can occur only between the anode 46 and the cathode 48. The drive circuit for each tube 40 includes three triode stages 50, 52 and 54. Upon receiving a positive input pulse 56, triode stage 50 produces negative rectangular #1 pulse 58. Pulse 58 is differentiated by resistance capacitance coupling 60 to provide a positive input pulse to triode stage 52, the output of which is negative rectangular #2 pulse 62. Pulse 62 is differentiated by resistance capacitance coupling 64 to provide a positive input pulse to triode stage 54, the output of which is negative rectangular #3 pulse 66. Thus, one input pulse 56 produces three negative sequential guide pulses 58, 62 and 66, overlapped as shown in Fig. 3. As indicated, negative pulse 62 is applied by triode stage 52 to second guide electrode 44. Either #1 pulse 58 or #3 pulse 66 is applied to first guide 42 through a switch 68 from either first triode stage 50 or third triode stage 54. Thus the position of switch 68 determines the order in which pulses are applied to first and second guides 42 and 44. If pulses 58 and 62 are applied in that order the glow will move in one direction. If pulses 62 and 66 are applied in that order, the glow will move in the other direction. Specifically, if switch 68 is at position 70, triode stage 50 will apply #1 pulse 58 to first guide

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42 and triode stage 52 will apply #2 pulse 62 to second guide 44, in consequence of which the glow will move in the forward direction. On the other hand, if switch 68 is at position 72, #1 pulse 58 merely will serve to trigger the remaining stages 52 and 54 but will not be applied to first guide 42. Thus, #2 pulse 62 will be applied initially to second guide 44 and #3 pulse 66 will be applied thereafter to first guide 42. In consequence, the glow will move backward. It will be understood that switch 68 may be mechanical for low speed switching or electronic for high speed switching. At the end of a particular count, the counting tubes are reset to zero by a suitable circuit which operates to raise the potential on all cathodes but the zero cathode and therefore to force the glow to return to that position.

For multi-digit arithmetic operation there exists the problems of carry and borrow. A switch 74 similar to switch 68 and controlled in the same way as switch 68, is connected between sequential glow tubes. When an addition is to be effected, output from the unit glow tube is taken from cathode #0 to effect a carry into the next higher digit. When subtraction is to be effected, output is taken from cathode #9 to effect a borrow from the next higher digit.

A typical operation of one of the glow tubes of Fig. 4 may be illustrated in connection with the sequence: $4+3-2=5$.

- (a) Assume glow tube is to be at zero (reset);
- (b) Switch 68 is at position 70 (+);
- (c) Apply four input pulses, glow tube reads 4;
- (d) Switch 68 remains at position 70;
- (e) Apply three input pulses, glow tube reads 7;
- (f) Switch 68 is moved to position 72 (-);
- (g) Apply two input pulses, glow tube reads 5.

Since certain changes may be made in the above described system without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or illustrated in the accompanying drawing shall be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. A system for driving counting tubes, said counting tubes each comprising an anode, a plurality of sequence electrodes, two groups of guide electrodes, and means for producing a sequence of three guide control pulses of which two are capable of shifting in order the discharge at a position between said anode and a first sequence electrode to a position between said anode and a second sequence electrode, a number of said plurality of groups being less than the number of said control

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pulses and means for applying selected ones of said control pulses to said groups, the second of said guide control pulses being applied to one of said two groups of guide electrodes and a selected one of the first and third pulses being applied to the other of said two groups of guide electrodes in order to determine the direction of the shift.

2. The system of claim 1 wherein said means is a circuit including a first electron valve stage for receiving an input pulse and for generating a first output pulse, a second electron valve stage for receiving said first output pulse and for generating a second output pulse and a third electron valve stage for receiving said second output pulse and for generating a third output pulse, said first, second and third output pulses occurring in sequence.

3. A system for driving counting tubes, said counting tubes each comprising an anode and a plurality of sequence electrodes arranged to enable a discharge between said anode and selected sequence electrode of said plurality, two groups of guide electrodes arranged to shift said discharge from one to another sequence electrode when pulsed in sequence, first electron valve means for receiving an input pulse from an information source, second electron valve means for receiving an input pulse from said first electron valve means and third electron valve means for receiving an input pulse from said second electron valve means, means for applying the output of said second electron valve means to one of said two groups of guide electrodes, and means for selectively applying one of the output pulses of said first and third electron valve means to the other of said two groups of guide electrodes, whereby the output pulse applied to said other of said two groups of guide electrodes occurs at a time spaced from the time at which the output pulse of said second of said electron valve means occurs.

4. The system of claim 3 wherein the output of said first electron valve means is capacitively coupled to the input of said second electron valve means and the output of said second electron valve means is capacitively coupled to the input of said third electron valve means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,679,978	Kandiah	June 1, 1954
2,714,179	Thomas et al.	July 26, 1955
2,833,476	Hayes et al.	May 6, 1958
2,872,621	Adams	Feb. 3, 1959
2,881,418	Stephens et al.	Apr. 7, 1959