

July 21, 1959

P. H. ALLEN ET AL

2,896,112

CATHODE RAY TUBE APPARATUS

Original Filed Aug. 20, 1945

3 Sheets-Sheet 1

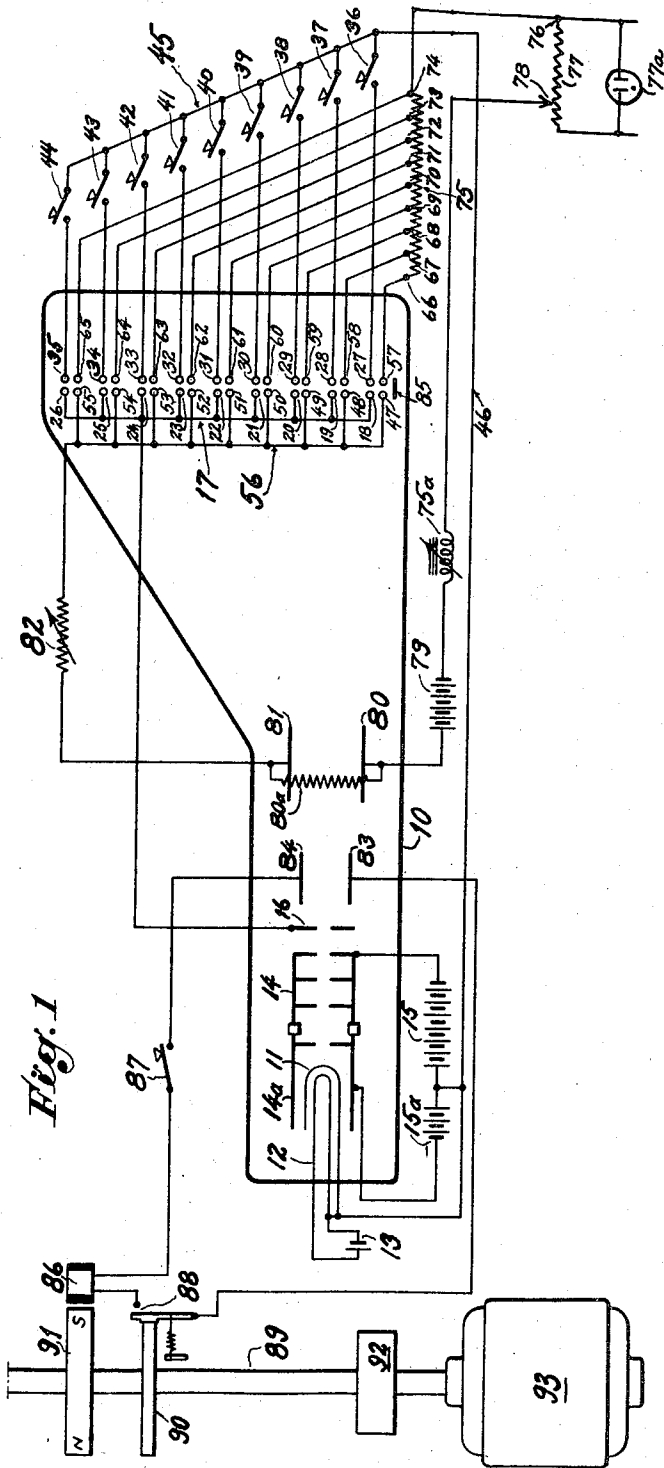


Fig. 1

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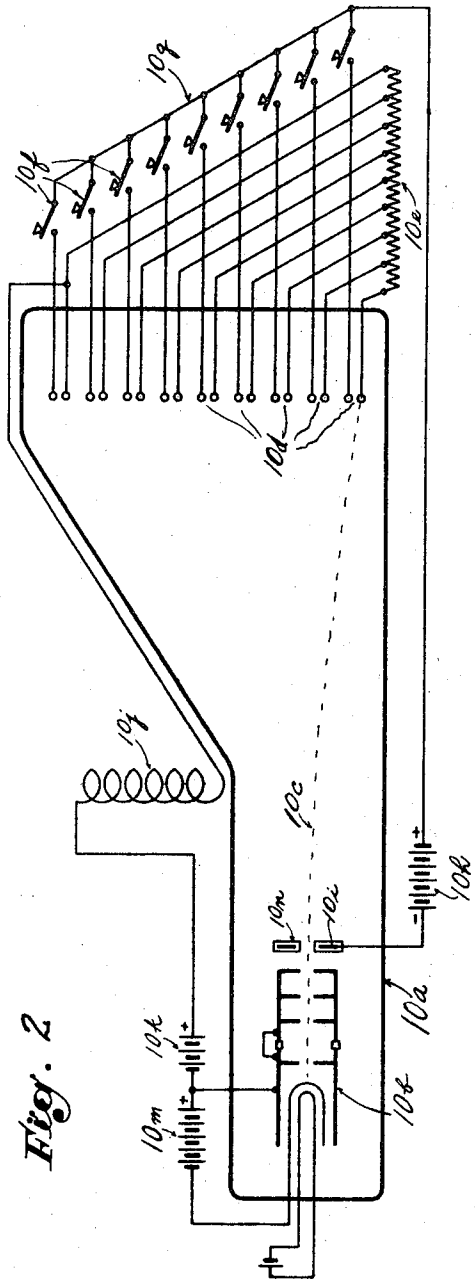


Fig. 2

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2,896,112

## CATHODE RAY TUBE APPARATUS

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Original application August 20, 1945, Serial No. 611,608.

Divided and this application September 30, 1957, Serial No. 687,182

26 Claims. (Cl. 315-21)

This invention relates to cathode ray tube apparatus in general. More particularly, this invention relates to cathode ray tube apparatus in which the beam of the cathode ray tube is controlled automatically to perform certain desired functions.

This application is a division of our application, Serial No. 611,608, filed August 20, 1945.

A general object of the invention is to provide a cathode ray tube circuit which operates in a cyclic fashion to perform the desired functions.

A further object of the invention is to provide a new and rapid electronic selecting mechanism for a register.

Another object of the invention is to provide an improved electrical mechanism selectively operable to provide electrical pulses corresponding to the various integers.

Another object of this invention is to provide a cathode ray tube device employing the cathode ray beam for closing selected circuits in an electrical calculating device.

Still another object of this invention is to provide an electrical apparatus adapted for use in a calculator in which an automatically controlled cathode ray beam is employed for controlling selected circuits.

Still another object of this invention is to provide a cathode ray tube with a target having a plurality of areas adapted to be scanned by the cathode ray beam automatically in a predetermined sequence.

Still another object of this invention is to provide a cathode ray tube with a plurality of contacts adapted to be closed by the cathode ray beam, the aforesaid cathode ray tube being provided with additional contacts connected to selectively extinguish the beam after predetermined ones of the circuit closing contacts have been closed.

Another object of the invention is to provide a cathode ray tube having a series of contacts adapted to be closed by the cathode ray beam in which the closing of one set of contacts energizes the electrostatic or electromagnetic deflecting means of the tube to cause stepping of the beam to the next adjacent set of contacts.

Still another of the invention is to provide a cascade of cathode ray tubes each tube having a series of target contacts adapted to be closed by the cathode ray beam thereof and connected so that the beams of the tubes in the cascade are automatically caused to step across the series of contacts thereof after the operation of the first tube of the cascade is initiated.

Other and further objects of this invention will be apparent to those skilled in the art to which it relates from the following specification and claims.

In accordance with this invention, there is provided a cathode ray tube circuit in which the tube employs a target that is adapted to be scanned in a predetermined manner automatically once the scanning operation is initiated. For the present purpose one or a series of cathode ray beam devices may be connected to produce desired electrical pulses in predetermined groups for use in computing operations and these pulses may be produced

in accordance with values entered into the machine which values determine the number of pulses produced by the cathode ray devices. The cyclic operation of these devices is provided by a cycle initiating mechanism.

These and other features of this invention will be set forth in detail in the following specification and the accompanying drawing in which briefly:

Fig. 1 is a schematic diagram of the circuit of one of the cathode ray tube devices;

Fig. 2 is a schematic diagram of a modified form of cathode ray tube device circuit shown in Fig. 1; and

Fig. 3 is a schematic diagram of an embodiment of this invention employing a series or cascade of cathode ray tube devices.

Referring to Fig. 1 in detail, reference numeral 10 designates an electronic tube of the cathode ray beam type which is employed in conjunction with other related parts as one order of the selection apparatus as disclosed in our application, Serial No. 611,608, filed August 20, 1945, of which this application is a division. The tube 10 is provided with an electron gun employing a cathode 11 which may be of the indirectly heated type, and a filament 12 connected to a battery 13 or other current supply, a control electrode 14a connected to the positive or negative terminal of battery 15a and an anode 14 connected to the positive terminal of the battery 15, the negative terminal of this battery being connected to the cathode 11 and to the positive terminal of battery 15a.

A quenching or de-focusing electrode 16, connected to the contact electrode bus 17, is provided for the purpose of quenching or de-focusing the cathode ray beam transmitted from the electron gun including the cathode 11, control electrode 14a and anode 14, as will be more fully described in further paragraphs of the specification. The contact electrode bus 17 is connected to a plurality of contacts 18 to 26, inclusive, which comprise part of the beam target and which are provided with electron emitting surfaces from which the electron emission is stimulated by bombardment of the cathode ray beam. Associated with these target contacts but slightly spaced therefrom are target contacts 27 to 35, inclusive, respectively, and these latter contacts are connected to the manually operated value keys 36 to 44, inclusive, respectively. One terminal of each of these value keys 36 to 44, inclusive, is connected to the bus 45, as shown, and this bus is in turn connected through the wire 46 to the negative terminal of the battery 15. The cathode ray tube 10 is provided with an additional series of beam target contacts 47 to 55, inclusive, connected to the electrode bus 56 and associated with this latter group of contacts 47 to 55, inclusive, is another group of contacts 57 to 65, inclusive. These contacts 47 to 55, inclusive, are associated with the contacts 57 to 65, inclusive, respectively.

Thus the series of contacts 18 to 26, inclusive, arranged in equally spaced relation opposite the corresponding spaced contacts 27 to 35, inclusive, form nine pairs of selective beam quenching contacts that are employed in controlling the production of a selected number of electrical pulses by the tube 10. Likewise, contacts 47 to 55, inclusive, and 57 to 65, inclusive, also form nine pairs of equally spaced beam controlling contacts that are employed in producing and transmitting the selected number of electrical pulses by effecting automatic stepping of the beam of the tube 10. All of these contacts that are of negative polarity by virtue of batteries 15 and 79, respectively, when the circuits thereof are closed, are provided with electron emitting surfaces giving profuse electron emission under the bombarding stimulus of the cathode ray beam originating at the cathode 11, as will be more fully described hereinafter.

The beam controlling contacts 57 to 65, inclusive, are

respectively connected to the terminals 66 to 74 of the voltage dividing resistor 75. The terminal 74 of this resistor is also connected to the terminal 76 of the potentiometer 77, and the variable contactor 78 of this potentiometer is connected to the positive terminal of the cathode ray beam deflecting battery 79. The negative terminal of this battery is connected to the deflector plate 80 of the cathode ray tube 10 and the deflector plate 81, associated with the plate 80, is connected through a variable resistor 82 to the contact electrode bus 56.

An additional set of deflector electrodes 83 and 84 is provided in the cathode ray tube 10 for the purpose of applying the initiating or firing pulse to the electron beam of the cathode ray tube and moving this beam from its initial position, as will be more fully described hereinafter. These auxiliary deflector electrodes 83 and 84 are connected to the pickup coil 86 through switches 87 and 88. The switch 87 is adapted to be closed whenever any one of the keys 36 to 44, inclusive, is closed. Switch 88 is a cam-operated switch adapted to be closed by the cam 90 only during one-half of the revolution of the shaft 89, so that an initiating pulse of only a predetermined polarity is applied to the auxiliary deflector electrodes 83—84.

The shaft 89 is a part of the cycling or firing pulse means, and has mounted thereon a permanent magnet 91, which in the full cycle position of the parts, occupies the position shown in Figure 1 with respect to the pickup coil 86. The shaft 89 is adapted to be cyclically driven by means of a cyclic clutch 92 from an electric motor 93. The cyclic clutch 92 is of conventional construction, being generally of the character disclosed in the patent to Carl M. Friden, No. 2,279,455, dated April 14, 1942, and produces one or more complete cycles of movement of the shaft 89, the cam 90 and the magnet 91.

The indirectly heated cathode 11, control electrode 14a, anode 14 forming parts of the electron gun and vertically deflecting electrodes 80 and 81 of the cathode ray tube 10 may be of generally the same construction as corresponding parts of cathode ray tubes now manufactured. The quenching or de-focusing electrode 16 may be positioned on either side of the anode 14, that is, it may be positioned either between the anode 14 and the auxiliary deflecting electrodes 83, 84 or between the anode 14 and the cathode 11. Furthermore, the auxiliary deflecting electrodes 83, 84 may, if desired, be positioned between the anode 14 and the de-focusing or quenching electrode 16, or they may be positioned on the other side of the deflector plates 80, 81.

The cathode ray tubes 110 and 210, shown in Fig. 3, are of the same construction as the cathode ray tube 10. The respective parts of the cathode ray tubes 10, 110 and 210 are similarly numbered and the corresponding reference numerals applied to the tubes 10 and 110 and associated apparatus are numbered so as to differ by 100, for example, the electrode of the tube 10 designated by reference numeral 83 corresponds to the electrode 183 of the tube 110. Likewise, the reference numerals applied to the tubes 110 and 210 and the corresponding parts differ by 100 so that the corresponding electrode of the tube 210 is designated by reference numeral 283.

The electrical pulses produced by the selection tube 10 as the cathode ray beam transmitted by the electron gun of this tube is stepped across a predetermined number of pairs of the contact electrodes 47 and 65, inclusive, may be utilized for controlling other circuits such as disclosed in the parent application, Serial No. 611,608.

It will be seen by reference to the drawings that the contactors of the tube 10 are divided into two sets, one set being connected to the manually settable keys 36 to 44, inclusive, and the other set being connected to the voltage dividing resistor 75. It will be observed that one side of each of these sets of contactors is connected to one of the common buses 17 or 56.

The above described circuit and associated parts comprise a cyclically operable selection means of one order in which any selected number of electrical pulses from one to nine may be produced during each cycle of operation.

To condition the selection circuit for operation, one of the keys 36 to 44, is depressed to represent the valve to be entered into the machine. For example, if the number 3 is to be entered into the machine, the key 38 or number "3" key is depressed. This setting of the respective keys conditions the units order to produce three electrical pulses for each cycle of operation, as will be apparent from the following description.

The number of times the item is to be entered into the register is controlled by the number of rotations of the shaft 89, i.e., the number of rotations of the permanent magnet 91 with respect to the pickup coils 86, the number of cycles being controlled by the length of time the clutch 92 is maintained engaged.

With the parts conditioned as described above, the clutch 92 is engaged to cause one cycle of operation of the selection mechanism, i.e., one rotation of the shaft 89, the cam 90 and the magnet 91. In the position of the parts shown in Fig. 1, the switch 88 associated with the leads to the pickup coil 86 are open, being engaged with the low portions of the cam 90. With this condition of the parts the south pole of the magnet 91 is ineffective with respect to the associated pickup coil 86. During the rotation of the shaft 89 and the cam 90, the switch 88 is closed for approximately one-half cycle beginning about 90° from the full cycle position of the parts shown in Fig. 1 and continuing for approximately 180° of rotation thereafter so that the switch 88 is closed to enable the respective circuits for the pickup coil 86 as the north pole of the magnet 91 is sweeping past the associated pickup coil.

As a part of conditioning this apparatus for operation, it is also to be assumed that the current supply battery 13 controls electrode battery 15a, and the anode battery 15 is connected so that the cathode ray beam of the tube 10 is on and impinging against the rest position 85 thereof.

The effect of the rotation of the north pole of the magnet 91 past associated pickup coil 86 is to apply an electrical pulse to the auxiliary deflector plates or electrodes 83, 84 of tube 10 to raise the beam from its rest position 85 to impinge upon and close the circuit between the contacts 47 and 57, the electron flow from the electron emissive surfaces of one of these contacts effectively closes the circuit therebetween so that the terminal 66 of the voltage dividing resistor 75 is connected through the contacts 57, 47 to the electrode bus 56 through the variable resistor 82 to the main deflector plate 81, the cooperating deflector plate 80 being connected to one side of the battery 79. The other side of the battery 79 is connected to one side of the variable impedance 75a, and the other side of this impedance is connected to the variable contactor 78 of the resistor 77, the upper terminal 76 of which is connected to the terminal 74 of the voltage divider 75 so that a potential is applied between the plates 80 and 81 across resistor 80a sufficient to raise the cathode ray beam from the contacts 47 and 57 to the contacts 48 and 58. When the circuit between the contacts 47 and 57 is closed, a pulse is supplied to the circuit of the potentiometer 77 across the gas tube 77a to be transmitted to a suitable utilizing circuit.

It will be noted that in raising the beam from the contacts 47, 57 to the contacts 48, 58, it has passed across the contacts 18—27 and closed the circuits therebetween. However, the circuit including these contacts is open at the key 36 so that no result obtains. When the beam impinges upon the contacts 48, 58, another pulse is applied to the utilizing circuit through the portion of the potentiometer between the terminal 76 and the variable contactor 78. At the same time the portion of the volt-

age divider between the terminal 66 and the tap 67 is bypassed and as a result a higher voltage is applied from the source 79 to the deflector plates 80 and 81 across the resistor 80a, this higher voltage being sufficient to move or deflect the cathode ray beam from the electrodes 48—58, across the electrodes 19—28 and to the electrodes 49—59. Since the key 37 is open, no result is produced when the beam is swept across the electrodes 19—28. However, a third pulse is impressed upon the utilizing circuit through the portion of the potentiometer 77 between the terminal 76 and the variable contactor 78.

When the beam of the cathode ray tube was moved to impinge upon the contacts or electrodes 49—59, the section of the voltage divider 75 between the taps 67 and 68 was by-passed, as well as the previously by-passed section between the terminal 66 and tap 67 so that the voltage applied between the deflector plates 80 and 81 across resistor 80a is again increased. The beam is again moved or deflected upward. However, it will be noted that the key 38 is depressed and the contacts thereof closed so that when the beam of the cathode ray tube impinges upon the electrodes 20—29 in its upward movement it effectively closes the gap between these two contacts and a negative potential is applied upon the quenching or de-focusing electrode 16 so that the beam of the cathode ray tube is defocused, quenched or substantially quenched and as a result the circuit between the electrodes 20—29 is open thereby removing the quenching potential from the electrode 16. However, it will be observed that the potential from the battery 79 is also removed from the deflector electrode 81 so that when the beam of the cathode ray tube is re-established it impinges upon the rest position 85 and will continue to impinge upon this position until another pulse is applied to the auxiliary deflector electrodes 83, 84, as previously described.

It will be observed that the stepping of the cathode ray beam of the selection tube 10 is automatic once it was raised or deflected from its rest position 85 to the first pair of contactors 20—29 connected to the depressed key 38. Very rapid stepping of the beam is obtained in this manner and the rapidity of this beam stepping may be controlled by the choke 75a which may be a variable inductance. This choke 75a may be a resistor shunted condenser, if desired, the condenser being charged by the electric pulse from the battery 79 and being discharged through the resistor shunt. The conductor 46 connected to the common bus 45 of the manually settable keys 36 to 44, inclusive, is shown as connected to the negative terminal of the battery 15 and the cathode 11 is also shown as connected to this same terminal. Accordingly, when the de-focusing or quenching electrode 16 is energized it is in effect connected to the cathode 11. It is obvious that the cathode 11 may be connected to some intermediate point of the battery 15 by means of taps or a suitable voltage divider so that the electrode 16 may be made negative with respect to the cathode when it is energized. However, under certain conditions it may not be desirable to make the electrode 16 more negative than the cathode since the purpose of this invention may be accomplished simply by de-focusing the beam and this may be accomplished by making the electrode 16 negative with respect to the anode 14.

The beam of the cathode ray tube 10 may be focused or adjusted so that it is sufficiently large in effective cross-section to be able to establish the circuit between a group of electrodes, such as, electrodes 47—57 and 18—27 simultaneously, and in this way the quenching or de-focusing circuit of the electrode 16 may be energized as soon as the beam is moved up to the appropriate group of electrodes.

In Fig. 2 is shown a modified form of this invention in which the cathode ray beam device employs magnetic beam deflection. The cathode ray tube 10a is provided with an electron gun 10b for projecting a cathode ray

beam consisting of an elongated concentration of electrons 10c in the direction of the electrodes 10d. Alternate ones of these electrodes 10d are connected to the voltage divider resistor 10e. Interleaved between the electrodes connected to the resistor 10e are electrodes connected to the switches 10f having one of the terminals thereof connected to a common bus bar 10g. This bus bar 10g is connected to the positive terminal of the battery 10h, and the negative terminal of the battery is connected to the quenching electrode 10i which is positioned in alignment with the electron gun 10b so that the electron beam normally passes through the aperture thereof. The top terminal of the voltage dividing resistor 10e is connected to the solenoid 10j employed for deflecting the beam 10c of the cathode ray tube and the other terminal of this solenoid is connected to the positive terminal of the battery 10k, the negative terminal of this battery being connected to the positive terminal of the electron gun battery 10m and the negative terminal of the latter battery is connected to the cathode of the electron gun.

The operation of this tube is substantially the same as that of the tube shown in Fig. 1, except that in this case the cathode ray beam 10c is used as a conductor substantially throughout the length thereof so that as this beam 10c impinges upon the electrodes 10d it closes the circuit of the deflector solenoid 10j. Beginning at the bottom electrode of the group 10d and assuming the beam 10c contacts this bottom electrode, current will flow along the beam to this bottom electrode thence through the entire resistor 10e and then through the solenoid 10j through the batteries 10k and 10m to the cathode of the electron gun 10b. This current flow sets up a magnetic field in the solenoid 10j of such strength and polarity as to move the beam 10c up from the first of the electrodes 10d across the second and to the third so that then the current flows from the beam to this third electrode and through the appropriate tap of the resistor 10e, through this resistor and through the solenoid 10j and batteries 10k and 10m to the cathode of the electron gun 10b. Since the portion of the resistor 10e between the first and third electrodes of the group 10d is by-passed out of the circuit, the current flowing through the solenoid 10j is of increased strength so that the magnetic field set up by this solenoid is stronger, specifically of such strength as to move the beam 10c from the third electrode to the fifth electrode of the group 10d, thereby by-passing still another section of the resistor 10e out of circuit and again increasing the strength of the magnetic field of the solenoid 10j sufficiently to raise the beam to the seventh electrode of the group 10d and repeating this operation in step by step fashion increasing the magnetic field of the solenoid 10j until the beam 10c has reached the second to the top electrode of the group 10d. Thereafter, the beam 10c would be swept off of the second to the top electrode and the circuit of the solenoid 10j would be interrupted. However, in tracing the operation as above, no cognizance was taken of the switches 10f which are provided to this apparatus for the purpose of controlling the scanning operation of the beam. If it is assumed that the first switch of the group 10f is closed so that the second electrode of the group 10d is connected through this switch to the positive terminal of the battery 10h, then when the beam 10c is moved by the solenoid 10j upward from the first electrode of the group 10d it would contact the second of these electrodes and apply an electric potential to the quenching electrode 10i and this quenching potential would function to effectively interrupt the beam 10c. Since the electrode 10i functions principally to apply an electrostatic field to disturb the focusing of the beam 10c, this electrode 10i may be enclosed in a sheath 10n of insulating material, such as, "Bakelite," phenol condensation resin, or the like, or a sheath of material which is a very poor conductor, such as, "Bakelite" impregnated with graphite, and this electrode may be supported upon the mouth of the electron

gun 10b. It is, of course, obvious that the electron beam 10c will be shifted in step by step fashion up over the electrodes 10d until it impinges upon an electrode connected to one of the switches 10f that is closed. When the beam 10c contacts an electrode connected to a closed switch of the group 10f, the beam is quenched, as outlined above. In this way the tube 10a may be used to produce a selected number of pulses, depending upon which of the switches 10f is closed, and the desired number of pulses may be utilized, as previously described in connection with tube 10 in a suitable utilization circuit.

The circuit illustrated in Figure 3 is designed to provide successive triggering of a series or cascade of tubes 10, 110 and 210, which are similar in construction to the tube 10 shown in Figure 1, from the lower tube 10 to the higher orders 110 and 210 after an initial triggering pulse is applied to the lowest order tube 10. The circuit also includes means for automatically re-cycling of the successive triggering pulses so that any selected number of cycles of operation of the calculating apparatus can be performed.

Immediately above the electrodes 1462 and 1463 of tube 10 are a pair of electrodes 1466 and 1467 which are similar to the pair of quenching electrodes 18—27 and are similarly controlled by a zero key 1468 so that when the beam closes the contacts 1466—1467, a quenching or de-focusing potential is applied to the quenching electrode 16, as previously described in connection with the quenching contacts or electrodes 18—27.

It will be noted that when the pulse is applied to the primary of the transformer 1464 a corresponding pulse will be induced in the secondary of this transformer and will be applied to the auxiliary deflector plates 183—184 of the "tens" order selection tube 110 to provide a triggering pulse for this tube. Thus, the electron beam of the tube 110 will be raised from its rest position 185 to impinge upon the triggering electrodes 1472 and 1473 of the tube 110 which are connected in series with the secondary of a transformer 1474 through a battery 1475. Immediately above the electrodes 1472—1473, the tube 110 is provided with a pair of quenching contacts or electrodes 1476—1477 connected in the circuit of the selection tube 110 in the same manner as the electrodes 1466—1467 in tube 10. A zero key 1478 is associated with the electrodes 1466—1467 to control the quenching circuit from the electrodes 1476—1477 to the quenching electrode corresponding to the electrode 16.

When a pulse is produced in the primary of the transformer 1474, a triggering pulse is induced in the secondary of this transformer and is applied to the auxiliary deflector plates 283—284 of the third or "hundreds" order of the selection tube 210 so that its electron beam will be raised from the rest position 285 to operate in conjunction with the triggering electrodes 1482—1483 and the quenching electrodes 1486—1487, in the manner previously described, the quenching electrodes becoming effective if the zero key 1488 is in switch closing position.

In connection with the operation of the successive triggering pulses, the zero key 1468, 1478 or 1488 of any order tube is closed only when no value key in this order of the keyboard is depressed. In this way the triggering pulse will be transmitted by a particular order of the apparatus that is otherwise idle during a cycle of operation, and the cathode ray beam thereof will be immediately quenched before it is raised sufficiently to produce a digitation pulse. Where no "zero" key is employed the switch control of quenching of the beam may be effected by providing a normally closed switch between the contact electrodes 1466—1467, for example, and quenching electrode 16, this normally closed switch being opened when any of the value keys 36 to 44 of the order are depressed.

The transformers 1464, 1474 and 1484 may be provided with a sufficient time delay so that, for example, the operation of the units order selection tube 10 and

its utilization circuit operation is performed before the triggering pulse is applied to the auxiliary deflector plates 183—184 of the tube 110 to start the digitation operation in this second order selection tube and in order to control this time delay, variable condensers 1464a and 1484a may be connected across these transformers 1464, 1474 and 1484, respectively.

In order to provide any selected number of successive cycles of operation of the selection mechanism, the triggering electrodes 1482—1483 of the third order selection tube 210 are connected in series with the primary of a transformer 1484 through a battery 1485, and the secondary of this transformer 1484 is connected through a switch 1489 in parallel with the initial triggering circuit, including the key 1461 and the battery 1460. In this way, the triggering pulse from the third order selection tube 210 will be carried back to the first order selection tube 10 to start another cycle of operation of the apparatus and repetition of this cycle of operation is continuous until the switch 1489 is opened.

The circuit shown in Figure 3 for automatic successive cyclic triggering of the apparatus is especially useful for performing multiplying and dividing operations in a rapid fashion as described in our application, Serial No. 611,608.

We claim:

1. Cathode ray tube apparatus comprising a cathode ray tube having means for producing a cathode ray beam, a target for said beam, deflecting means for moving said beam over said target, a source of current supply for energizing said deflecting means and means connected to said deflecting means and controlled by said beam as said beam is deflected over said target for causing said beam to move automatically over said target.
2. Cathode ray tube apparatus comprising a cathode ray tube having means for producing a cathode ray beam and beam deflecting means, a target for said beam, means for deflecting said beam to said target, and means for controlling the deflection of said beam in accordance with the position of said beam on said target after said beam is deflected to said target, said last mentioned means being connected to advance said beam over said target automatically.
3. A cathode ray tube device comprising a cathode ray tube having means for producing a cathode ray beam, a target for said beam, deflecting means for moving said beam over said target, a source of current supply for energizing said deflecting means, said target comprising a series of electrodes connected to said deflecting means and connections for connecting said electrodes so that the voltage applied to said deflecting means is varied by said beam to cause automatic shifting of said beam over said target without holding said beam on any target position.
4. Cathode ray tube apparatus comprising a cathode ray tube having means for producing a cathode ray beam and beam deflecting means, a target comprising an array of electrodes for said beam, and means for energizing said beam deflecting means in accordance with the position of said beam on said target, said last mentioned means being connected to advance said beam over said target automatically without holding said beam on any target position.
5. A cathode ray tube device comprising a cathode ray tube having means for producing a cathode ray beam and beam deflecting means, a target comprising an array of electrodes, means for applying different voltages to selected ones of said electrodes, and connections for connecting said last mentioned means to said beam deflecting means for energizing said beam deflecting means in accordance with the position of said beam on said target, said last mentioned means being connected to advance said beam over said target automatically without holding said beam on any target position.
6. A cathode ray tube device comprising a cathode ray tube having means for producing a cathode ray beam,

a target for said beam, deflecting means for moving said beam over said target, said target comprising two series of electrodes, one of said series having electrodes connected to said deflecting means and means for selectively connecting electrodes in the other series to the cathode of said tube, for controlling the limit of deflection and intensity of the beam.

7. Electronic computing apparatus comprising a tube having means for producing a stream of electrons and means for deflecting said stream, a target for receiving said stream, means for selecting the position on said target to which said stream is to be deflected, means for rendering said stream ineffective after it is deflected to the selected position and an output circuit for receiving a signal characterized by the position to which said stream was deflected.

8. Electronic computing apparatus as set forth in claim 7, further characterized in that the target comprises means connected to said means for deflecting the electron stream so that said stream is automatically deflected to a predetermined extent.

9. Electronic computing apparatus as set forth in claim 8, further characterized in that the means for rendering the stream ineffective comprises an auxiliary electrode connected to an array of electrodes included in said target.

10. Electronic computing apparatus comprising a tube having means for producing a stream of electrons and electromagnetic means for deflecting said stream, a target for receiving said stream, means for selecting the position on said target to which said stream is to be deflected in effecting a computing operation, means for rendering said stream ineffective after it is deflected to the selected position and an output circuit for receiving a signal characterized by the position of said stream when it was rendered ineffective.

11. Electronic computing apparatus comprising a tube having means for producing a stream of electrons, electrode means on which said stream is adapted to be impinged, electromagnetic means for sweeping said stream over said electrode means, means for selecting the position on said electrode means to which said stream is to be swept in effecting a computing operation, means for rendering said stream ineffective after it is swept to the selected position and an output circuit for receiving a signal characterized by the position to which said stream was swept.

12. Electronic computer apparatus comprising cathode ray tube having a series of contacts adapted to be closed by the cathode ray beam in effecting a computing operation, means connected to said tube responsive to the closing of one set of contacts to cause stepping of the beam of said tube to another set of contacts.

13. Electronic computer apparatus comprising a cathode ray tube having electromagnetic beam deflecting means and having a series of contacts adapted to be impinged by the cathode ray beam in effecting a computing operation, means responsive to the impinging of said beam upon selected ones of said contacts by said beam to alter the energization of said electromagnetic deflecting means and cause shifting of the beam to impinge upon a different one of said contacts.

14. Electronic computer apparatus comprising a chain of cathode ray tubes, each of said tubes having a series of target contacts adapted to be closed by the cathode ray beam thereof, means for connecting said cathode ray tubes so that the beams of said tubes are automatically caused to step across the series of contacts thereof, and means for initiating the stepping of the beam of the first tube of said chain.

15. Electronic computer apparatus comprising a chain of cathode ray tubes, each of said tubes having a series of target contacts adapted to be impinged by the cathode ray beam in minor cycles of operation, means for each of said tubes for controlling the minor cycle of operation

thereof, means for initiating the operation of the first tube of said chain, and means for connecting said cathode ray tubes so that the beams of said tubes are automatically controlled to perform their minor cycles of operation after the operation of the first tube of the chain is initiated.

16. Electronic computer apparatus as set forth in claim 15, further characterized in that selected ones of said cathode ray tubes are provided with auxiliary beam deflecting means and the auxiliary beam deflecting means of one of said tubes is coupled to selected target contacts of the preceding tube in the chain.

17. Electronic computer apparatus as set forth in claim 15, further characterized in that each of said tubes is provided with means responsive to the beam thereof for producing a predetermined number of electric pulses in each minor cycle thereof.

18. Electronic computer apparatus as set forth in claim 15, further characterized in that each of said tubes is provided with adjustable means responsive to the beam thereof for producing a predetermined number of electric pulses in each minor cycle thereof.

19. Cathode ray tube apparatus comprising a cathode ray tube having means for producing a cathode ray beam and beam deflecting means, a target for said beam, said beam deflecting means having means for deflecting said beam to said target, and means connected to said beam deflecting means and controlled by said beam for progressively deflecting said beam.

20. In a calculating device the combination of a cathode ray beam tube, said cathode ray beam tube having means for producing a cathode ray beam and auxiliary deflector means and main deflector means and a plurality of sets of electrodes, said electrodes being mounted in said cathode ray beam tube and being adapted to be swept by the beam thereof, a source of potential connected to said main deflector plates through one of the aforesaid sets of electrodes so that predetermined potentials from said source are applied to said main deflectors through said one set of the aforesaid electrodes, a beam controlling electrode positioned in said tube, said beam controlling electrode being connected to said other set of said electrodes, a plurality of manually settable devices connected to said other set of electrodes for controlling said beam through pre-selected electrodes of said other set, and means for applying an initiating pulse to said auxiliary deflectors for initiating the sweeping of the beam of said cathode ray beam device over said electrodes for the production of a predetermined number of electrical pulses.

21. In a calculating device the combination of a cathode ray beam tube, said cathode ray beam tube having means for producing a cathode ray beam and auxiliary deflector means and main deflector means and a plurality of sets of electrodes including a first set and a second set, said electrodes being mounted in said cathode ray beam tube and being adapted to be swept by the beam thereof, a source of potential connected to said main deflector plates through the first set of the aforesaid sets of electrodes so that predetermined potentials from said source are applied to said main deflectors to effect sweeping of the cathode ray beam from one electrode of said first set to the next, a beam controlling electrode positioned in said tube, said beam controlling electrode being connected to said second set of said electrodes, a plurality of manually settable devices connected to said second set of electrodes for controlling said beam through pre-selected electrodes thereof, and means for applying an initiating pulse to said auxiliary deflectors for initiating the sweeping of the beam of said cathode ray beam device over said electrodes for the production of a predetermined number of electrical pulses.

22. In a calculating device the combination of a cathode ray beam tube, said cathode ray beam tube having means for producing a cathode ray beam and main

deflector means and a set of electrodes, said electrodes being mounted in said cathode ray beam tube and being adapted to be swept by the beam thereof to produce pulses, a source of potential connected to said main deflector plates through said electrodes so that predetermined potentials from said source are applied to said main deflectors therethrough to effect sweeping of the cathode ray beam from one electrode to the next, and settable means for quenching said beam after a predetermined number of pulses as determined by said settable means have been produced.

23. In a calculating machine, an electrical circuit including a cathode ray tube and a series of contact sets therein for closing by the electron beam of said tube for providing a pattern of output pulses forming a representation of digits from "1" to "9," said circuit also including means for causing movement of said electron beam along said series of said contact sets and settable means for interrupting movement of said electron beam along said contact sets after a movement thereof corresponding to the value of the digit to be represented.

24. In a calculating machine, an electrical circuit including a cathode ray tube having a first series of contact sets for closing by the electron beam of said tube for providing a representation of digits from "1" to "9" and a second series of contact sets arranged alternately with the first series of contact sets, and settable means connected to said second series of contacts for rendering any selected one of said contact sets effective, the circuit to the contact of said second set selected by said settable means being adapted to be closed by the electron beam to interrupt operation thereof, said circuit also including means for causing step-by-step shifting of said electron beam along said series of said contact sets.

25. In a calculating machine, an electrical circuit including a cathode ray tube having a first series of contact sets for closing by the electron beam of said tube for providing a representation of digits from 1 to 9 and a second series of contact sets arranged alternately with the first series of contact sets for closing by the electron beam, a beam quenching electrode, a means including a plurality of keys representing the digits from 1 to 9 for selectively connecting said second series of contact sets

to said beam quenching electrode, said circuit also including means for causing step by step shifting of said electron beam along said series of said contact sets, the shifting of said beam being halted when said beam reaches a contact set of said second series connected to a closed key.

26. In a calculating device the combination of a cathode ray beam tube, said cathode ray beam tube having means for producing a cathode ray beam, auxiliary deflector means and main deflector means and a plurality of sets of electrodes, said plurality of sets of electrodes corresponding to the digits from 1 to 9, said electrodes being mounted in said cathode ray beam tube and being adapted to be swept by the beam thereof, a source of potential connected to said main deflector plates through one of the aforesaid sets of electrodes so that predetermined potentials from said source are applied to said main deflectors through said one set of the aforesaid electrodes, a beam controlling electrode positioned in said tube, said beam controlling electrode being connected to said other set of said electrodes, a plurality of manually settable devices representing values from 1 to 9 connected to said other set of electrodes for controlling said beam through pre-selected electrodes of said other set, and means for applying an initiating pulse to said auxiliary deflector means for initiating the sweeping of the beam of said cathode ray beam device over said electrodes for the production of a predetermined number of electrical pulses.

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