June 10, 1952 A. M. SKELLETT 2,599,949

ELECTRONIC STEPPING SWITCH

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FIG. 1.

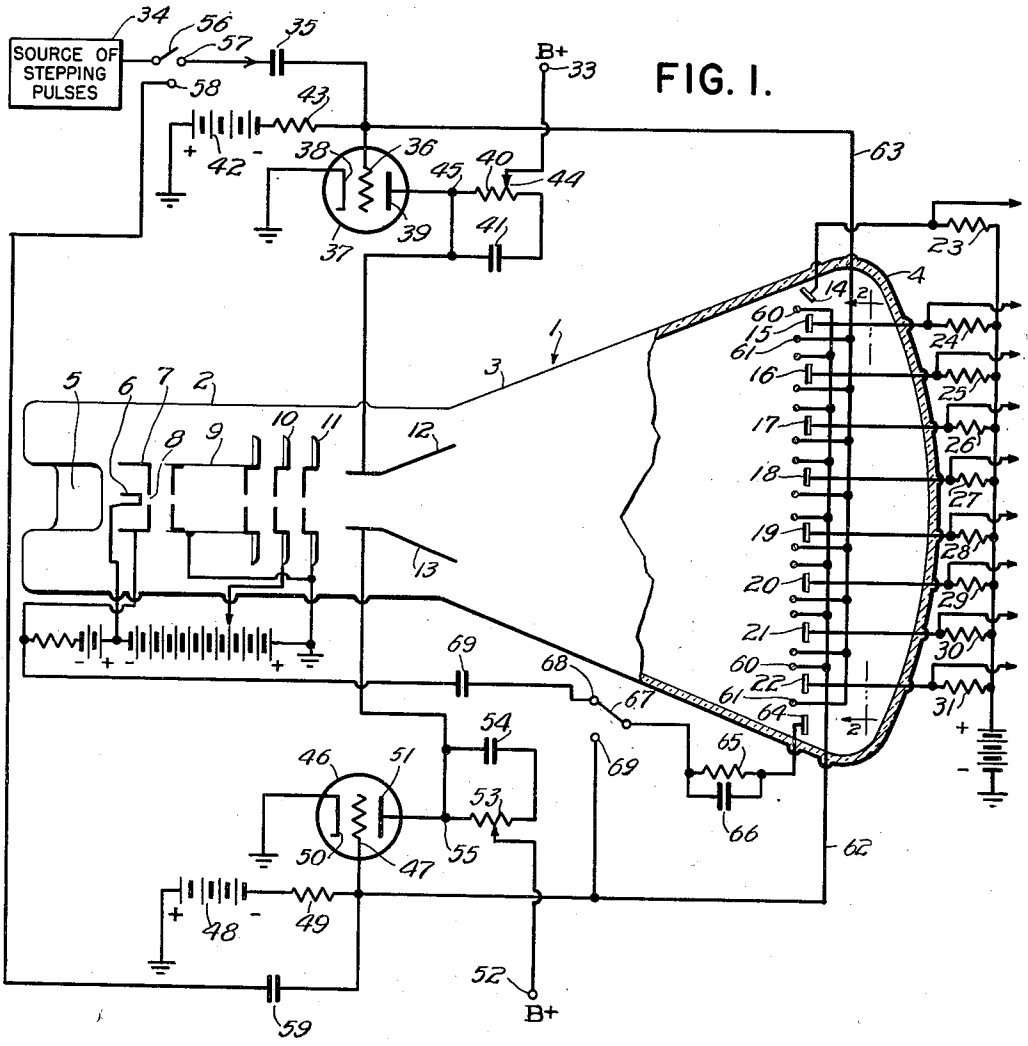
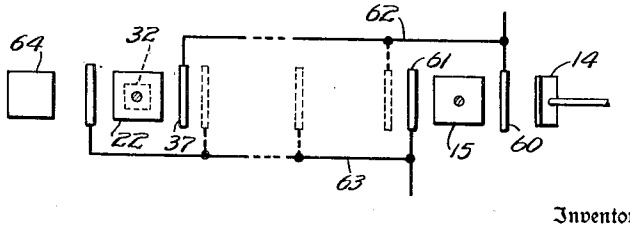


FIG. 2.



Inventor

ALBERT M. SKELLETT

By John J. Rogan

Attorney

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ELECTRONIC STEPPING SWITCH

Albert M. Skellett, Madison, N. J., assignor to National Union Radio Corporation, Orange, N. J., a corporation of Delaware

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6 Claims. (Cl. 315—21)

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This invention relates to step-by-step switches, and more particularly to stepping switches of the electronic type.

A principal object of the invention is to provide an electronic stepping switch having means for accurately stepping an electron beam to any desired one of a series of different circuit closing positions, and means for locking the beam in its selectively stepped position until the receipt of a subsequent stepping impulse.

A feature of the invention relates to an electron stepping switch having means to develop a focussed beam of electrons which beam is deflectable in a step-by-step fashion over a series of circuit controlling target electrodes. Each target electrode is provided with a pair of locking electrodes symmetrically located on adjacent sides thereof to make sure that the stepped beam remains on the particular target to which it has been selectively stepped.

Another feature relates to an electronic stepping switch of the type having a series of target electrodes connected in respective electrical circuits. Each target electrode is provided with a pair of separate beam locking electrodes to maintain the beam on the particular target to which it has been selectively stepped. The said locking electrodes are controlled by respective grid-controlled tubes whereby the beam is automatically restored to the proper target when it tends to drift laterally in either direction therefrom.

A further feature relates to an electronic stepping switch employing a low voltage cathode ray beam and a multiplicity of target electrodes in conjunction with a stepping impulse arrangement for stepping the beam successively to the various targets, and including special beam locking electrodes and grid-controlled tubes for maintaining the beam deflected to a selected target after the cessation of a received stepping impulse.

A still further feature relates to the novel organization, arrangement and relative location of parts which cooperate to provide an improved stepping switch system of the electronic type.

Other features and advantages not particularly enumerated, will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing which shows one preferred embodiment,

Fig. 1 is a composite structural and electrical circuit diagram, of a stepping switch system according to the invention.

Fig. 2 is a sectional view of Fig. 1, taken along the line 2—2 thereof.

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Referring to Fig. 1, there is represented by the numeral 1 any well-known construction of cathode ray tube envelope comprising the usual neck portion 2 joined to the flared body portion 3, which is closed off by the end wall portion 4. The neck portion 2 is closed off by the usual glass header or stem 5 and through which the various lead-in and electrode support wires are vacuum-tight sealed. Mounted within the neck 2 is any well-known form of electron gun comprising, for example, the electron emitting cathode 6 with its usual heating filament or coil (not shown). Mounted in axial alignment with the cathode 6 is a control electrode 7 having a central beam-confining opening 8 for the passage of the electron stream. Mounted in axial alignment with the grid 8, are first, second and final accelerating anodes 9, 10, 11, these anodes having respective central apertured baffles for accelerating and focussing the electron beam after it emerges from the grid opening 8. Axially mounted within the tube 1 are beam deflector plates 12, 13, which are arranged to have suitable D. C. potentials applied thereto to determine the deflected position of the focussed electron beam.

Suitably mounted adjacent the wall end 4 of the tube are a series of targets or anodes 14–22, these targets being connected through respective resistors 23–31 to a suitable positive terminal of the D. C. power supply so that they are at or near ground potential and preferably not over 100 volts positive with respect to ground. The electrodes 9, 10 and 11 are likewise connected to suitable positive terminals on the D. C. power supply, so that the electron beam is focussed in a spot of any desired shape but whose area is preferably less than the area of each target anode. Thus the cathode 6 may be at −500 volts with respect to ground and the anodes 9 and 11 can be at ground potential. Also the grid 7 should be negatively biassed with respect to cathode 6. Preferably the focussing is such that the beam as it strikes a target, covers only the central region thereof, as represented by the dotted rectangle 32. The first target 14 can be considered as the normal target wherein the beam normally rests. For this purpose the deflector plate 12 may be provided with a normal steady bias from the positive terminal 33 causing the beam thus normally to strike the anode target 14.

In accordance with the invention the electron beam is arranged to be moved in a step-by-step fashion successively from the normal target 14 to the various targets 15–22, depending upon the number of stepping impulses that are applied to

the deflector plates. Thus there is indicated in Fig. 1 by the rectangle 34 any suitable source of D. C. stepping pulses which are applied through condenser 35 to the control grid 36 of a grid-controlled amplifier tube 37 whose cathode 38 is grounded and whose plate or anode 39 is connected to the deflector plate 12. The positive potential terminal 33 of the D. C. source is connected through a potentiometer resistor 40 to the plate 39 and the said resistor is shunted by a suitable condenser 41. The control grid 36 is negatively biassed by the battery or D. C. source 42 in series with the resistor 43. The slider 44 of the potentiometer is adjusted so that normally the D. C. potential at the point 45 is such as to bias the cathode ray beam so that it strikes the normal target 14. However, when a positive stepping pulse is applied to the grid 36 through condenser 35, the positive potential of the point 45 is lowered, and permits the beam to be stepped away from target 14 to target 15. It will be understood that the deflector plate 13 has a potential applied thereto which is controlled by another grid-controlled tube 46 whose control grid 47 is biassed by a negative battery or D. C. source 48 through a resistor 49. The cathode 50 of tube 46 is grounded and the plate 51 is connected to the positive terminal 52 of the D. C. power supply through a potential resistance 53 which is shunted by a suitable condenser 54. Thus by suitable adjustment of the potentials at the points 45 and 55, in the absence of stepping impulses, the cathode ray beam is biassed so that it impinges on the target 14. Consequently, when the first stepping impulse is applied to grid 36, the cathode ray beam is deflected so that it strikes target 15. Likewise, for successive stepping impulses applied to grid 36, the beam is successively deflected to the remaining targets 16, 17, etc.

As shown in Fig. 1, the source 34 is connected to the switch arm 56 of a two-position switch, which during the above-described operation, is closed on contact 57 so that the stepping impulses are applied only to the grid 36, but are not applied to the grid 47. If, after the beam has been stepped to any desired target, it is required to be returned to any preceding target, the switch 56 may be closed on contact 58 so that the receipt of succeeding stepping impulses are applied to grid 47 through condenser 59 and cause the beam to move in the opposite direction back towards the normal target 14. On the other hand, once the beam has been stepped to any selected target, it is necessary to make sure that it remains on such selected target until the receipt of a subsequent stepping pulse.

In accordance with the invention, each target has mounted adjacent thereto, and symmetrically spaced from opposite edges therefrom, a pair of beam locking electrodes 60, 61. All the electrodes 60 are connected in parallel to a common return conductor 62 which is connected to grid 47. Similarly, all the locking electrodes 61 are connected in parallel to a common return conductor 63 which is connected to grid 36. While the drawing shows the tubes 46 and 51 of the triode type, it will be understood that this is done merely for purposes of illustration and that any other well-known form of grid-controlled tube having two or more grids may be employed.

It will be clear from the foregoing that the potential of the plate 39, for example, is dependent upon the potential of the associated grid 36. This grid potential in turn will be dependent upon whether or not the cathode ray beam impinges upon any locking electrode 61. Likewise, the potential of plate 51 will be dependent upon the potential of its associated grid 47, which in turn will be dependent upon whether or not the cathode ray beam is impinging upon any one of the locking electrodes 60. The various biassing potentials are so adjusted that if the cathode ray beam after being stepped to a target, for example to target 15, tends to drift upwardly as seen in Fig. 1, it impinges upon the locking electrode 60. As a result, the grid 47 is driven more negatively, and the point 55 assumes a higher positive potential. The net result is that the beam is subjected to a restoring deflection causing it to move downwardly from the locking electrode 60 until it again impinges on target 15.

If, on the contrary, the beam should tend to drift downwardly from the target, it impinges upon the locking electrode 61 which drives the grid 36 more negatively and causes the point 45 to swing more positively, thus subjecting the beam to an upward deflecting action to restore it to target 15. It will be understood, of course, that when the cathode ray beam impinges upon any of the targets, it closes a circuit to a suitable load device connected to the respective target, and while the drawing shows a tube containing eight such targets and load devices, it will be understood that a greater or less number may be employed.

When the beam has been moved in a step-by-step fashion to the last target 22, the next stepping pulse that is received from source 34 causes the beam to be deflected to the target 64. This target is connected through a resistor 65 and shunt condenser 66, through switch arm 67, switch contact 68, condenser 69, to the control grid 7, with the result that a negative or beam blanking potential is applied to the grid 7 of sufficient magnitude to blank off the beam. After the beam is thus blanked off, the electrodes 60 and 61 lose control, so that after condenser 66 discharges, the beam immediately flies back to the normal target 14.

While in the foregoing the beam has been described as returning automatically to the normal target 14, as a result of applying a beam blanking potential to grid 7, the same result can be obtained by applying the blanking signal to the control grid 47, in which case switch 67 is closed on to contact 69. Thus when the beam strikes target 64, it charges condenser 66 to apply a plate current cutoff potential to grid 47, so that when the beam is reestablished, it immediately impinges on target 14 as a result of the previously described normal bias on deflectors 12 and 13.

While certain preferred embodiments have been described herein, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Stepping switch apparatus of the type described, comprising, a cathode ray tube having an electron gun for developing a beam of electrons, a series of circuit controlling targets to which said beam is to be stepped in one direction in response to a corresponding number of applied stepping impulses, a pair of beam locking electrodes for each target and mounted in the path of the beam symmetrically adjacent the lateral edges of the target, a pair of beam deflector plates, a pair of grid-controlled tubes for controlling the potentials applied respectively to said

plates, a circuit connection from one of said locking electrodes to the control grid of one tube, and a separate circuit connection from the other locking electrode to the control grid of the other tube, said cathode ray tube having another normal target upon which the beam normally rests, means to cause said beam to be stepped in the opposite direction in response to a corresponding number of said stepping impulses, and additional means are provided for applying to one of said deflector plates a potential for normally biasing said beam to cause it to impinge upon said normal target.

2. Stepping switch apparatus of the type described, comprising, a cathode ray tube having an electron gun for developing a beam of electrons, a circuit controlling target to which said beam is to be stepped in response to an applied stepping impulse, a pair of beam locking electrodes for each target and mounted in the path of the beam symmetrically adjacent the lateral edges of the target, a pair of beam deflector plates, a pair of grid-controlled tubes for controlling the potentials applied respectively to said plates, a circuit connection from one of said locking electrodes to the control grid of one tube, and a separate circuit connection from the other locking electrode to the control grid of the other tube, said cathode ray tube having an additional normal target, means are provided for normally biasing the beam to impinge on said normal target, means for applying a stepping impulse to one of said tubes to step the beam away from said normal target to said circuit controlling target, and additional means for automatically restoring said beam to said normal target when it has been stepped away from said circuit controlling target.

3. Stepping switch apparatus of the type described, comprising, a cathode ray tube having an electron gun for developing a beam of electrons, a circuit controlling target to which said beam is to be stepped in response to an applied stepping impulse, a pair of beam locking electrodes for each target and mounted in the path of the beam symmetrically adjacent the lateral edges of the target, a pair of beam deflector plates, a pair of grid-controlled tubes for controlling the potentials applied respectively to said plates, a circuit connection from one of said locking electrodes to the control grid of one tube, and a separate circuit connection from the other locking electrode to the control grid of the other tube, said cathode ray tube having a series of said circuit controlling targets for successive registry with said beam, means for biasing said beam to a normal position away from said targets, a normalizing electrode mounted in the path of said beam after it has been stepped from the last target of said series, and circuit connections responsive to the beam striking said normalizing target for automatically restoring the beam to said normal position.

4. Apparatus of the kind described, comprising, a cathode ray tube having an electron gun for developing a cathode ray beam, a plurality of targets mounted in a predetermined array, beam deflector means for deflecting the beam in one direction successively to said targets in response to applied stepping impulses, a pair of beam locking electrodes for each target and cooperating respectively with the opposite edges of the target for maintaining the beam on the target to which it has been stepped even after the cessation of the stepping impulse, means normally biassing the beam away from said targets to a normal position, means for causing said stepping pulses to deflect the beam in the opposite direction in accordance with the number of impulses, and means automatically effective when the beam has been stepped past the last target of the series for restoring it to said normal position.

5. Apparatus according to claim 4 in which the last-mentioned means includes a beam normalizing electrode upon which the beam impinges after leaving the last target of the series, said cathode ray tube having a control electrode and circuit connections between said normalizing electrode and said control electrode for blanking off the beam until it is restored to its normal position.

6. Apparatus of the kind described, comprising, a cathode ray tube having an electron gun for developing a cathode ray beam, a plurality of targets, beam deflector means for deflecting said beam in one direction successively to said targets in response to applied stepping impulses, a pair of beam locking electrodes for each target for maintaining the beam in registry with the target to which it has been stepped, means normally biassing the beam away from said targets to a normal position, a grid-controlled amplifier tube for controlling the relative potentials of said deflector plates, a normalizing electrode upon which the beam impinges after it has been stepped from the last target of said series, means to cause said impulses to deflect said beam in the opposite direction successively to said targets and in accordance with the number of said impulses and circuit connections from said normalizing electrode to a control electrode of said grid-controlled tube for blanking off the potential on one of said deflector plates to permit the other deflector plate to restore the beam to its normal position.

ALBERT M. SKELLETT.

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