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OPTICAL KEYBOARD CONTROL MEANS WITH SERIES AND PARALLEL LIGHT CIRCUITS

Filed May 16, 1968

2 Sheets-Sheet 1

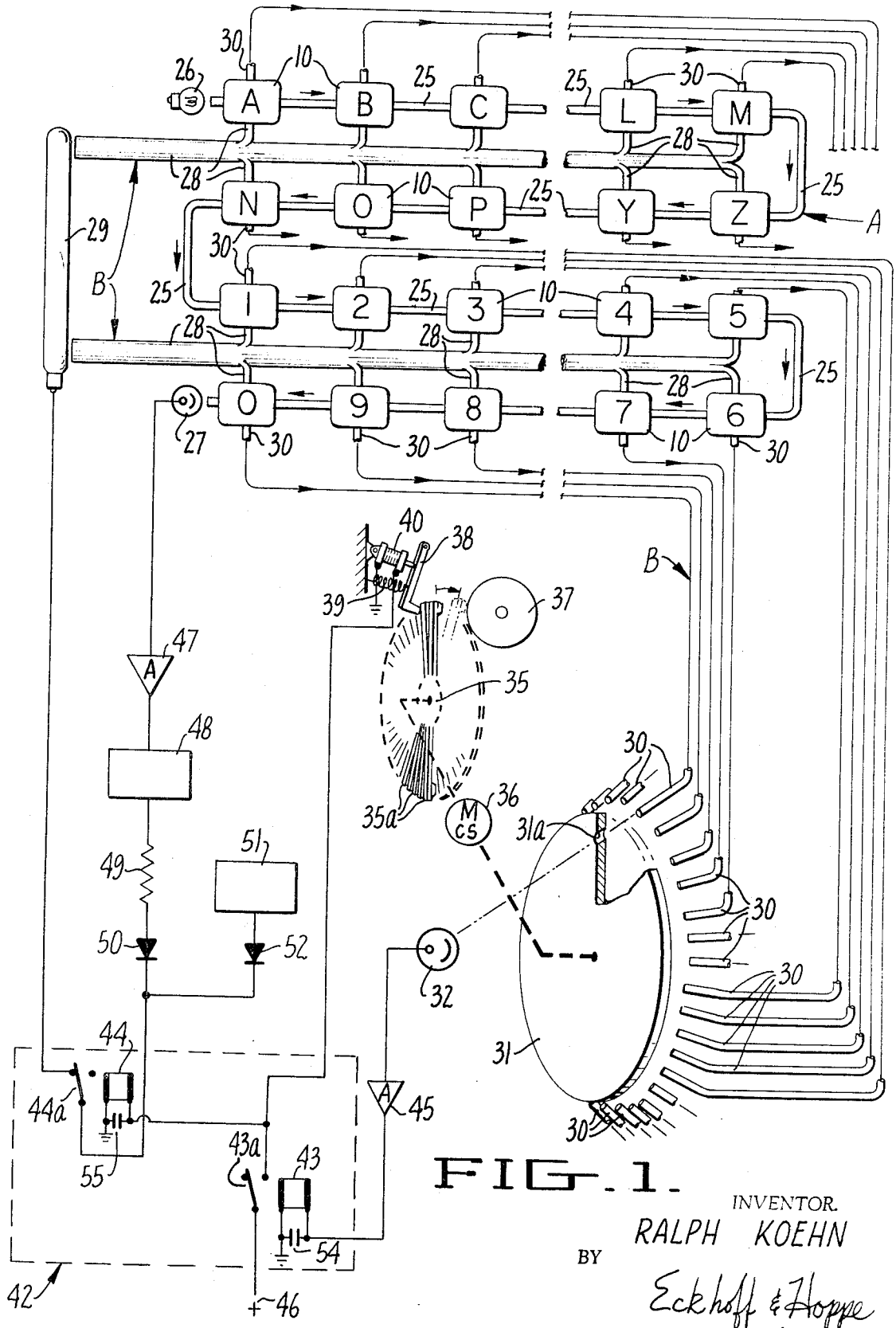


FIG. 1.

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Filed May 16, 1968 2 Sheets-Sheet 2

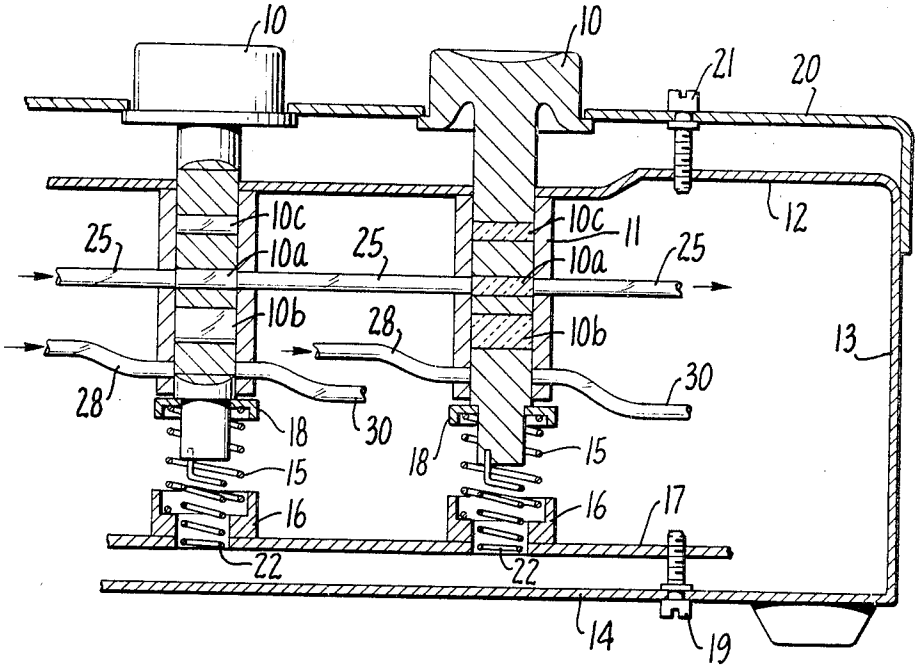


FIG. 2.

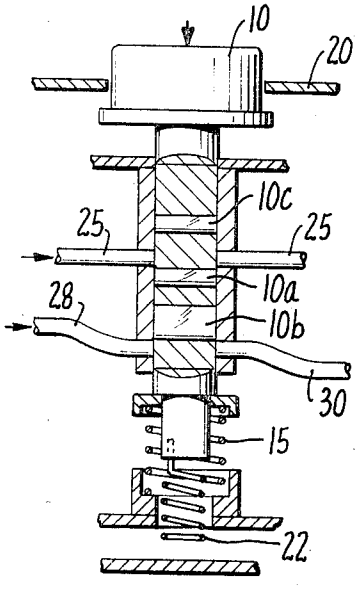


FIG. 3.

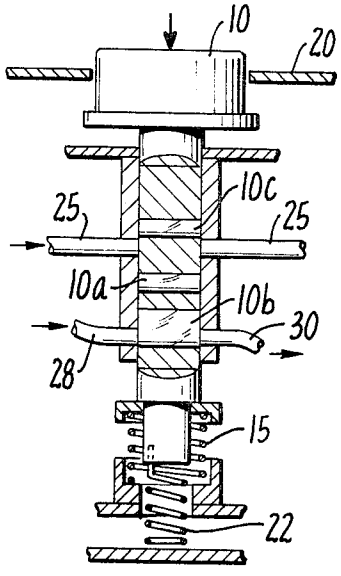


FIG. 4.

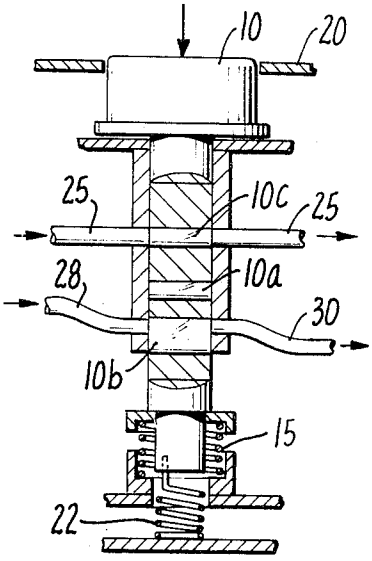


FIG. 5.

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OPTICAL KEYBOARD CONTROL MEANS WITH SERIES AND PARALLEL LIGHT CIRCUITS

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Int. Cl. B41j 5/12; G02b 5/14
U.S. Cl. 197—98 23 Claims

ABSTRACT OF THE DISCLOSURE

A control system for selective operation of a machine, comprising light conducting circuits, a plurality of movable elements having light conductive and light obstructing sections, each element being operatively movable for conducting or obstructing the passage of light through the circuits; and a keyboard arrangement and mountings for a plurality of keys that may be used in a control system of the type described.

This invention relates to control systems for sequentially and selectively operating a machine. The invention particularly involves a control system that is adapted for operating the printing hammer of a conventional typewriter.

In brief, this invention relates to control systems for sequentially and selectively operating a machine, particularly machines that are operated by keys such as a typewriter. The invention comprises a plurality of control elements having light conductive and light obstructing sections, each element being operatively associated with a pair of light conducting circuits. Each element is normally positioned to conduct light through one of the circuits while obstructing the passage of light through a portion of a second circuit. The control system further comprises means responsive to the passage of light in the first light conducting circuit for illuminating a light source for the second circuit, means for maintaining the illumination of the second light source during an interruption in the passage of light in the first light conducting circuit, and means responsive to the passage of light in a portion of the second light conducting circuit for interrupting the illumination of the second light source and actuating the machine.

The control system specified above may be used with a novel keyboard arrangement also forming a part of this invention. In particular, each of the movable elements or keys is reciprocably mounted in an opening of the keyboard, each key being exposed above a top surface of the keyboard and having engagements with the underside thereof which establish the home position of each key. Means is further provided for adjustably mounting the keyboard relative to a support frame and other means for adjusting the bias with which each key is returned to its home position.

A principal object of this invention is to provide a novel control system for sequentially and selectively operating a machine such as a typewriter.

A second object is to provide a control system of the kind described which may be manufactured with relatively few moving parts as compared with control systems having similar capabilities.

Another object is to provide a control system of the kind described that may be made of relatively low cost materials using many standard parts and conventional manufacturing techniques.

A still further object of this invention is to provide a control system that is particularly suitable for use in the manufacture of a low cost typewriter.

Other objects of this invention will become apparent in view of the following detailed description.

In the drawings forming a part of this application and in which like parts are identified by like reference numerals throughout the same,

FIG. 1 is a schematic diagram of a preferred embodiment of the invention in a control system for operating a typewriter;

FIG. 2 is a vertical section taken through a typewriter and keyboard that embodies the control system of FIG. 1;

FIG. 3 illustrates an intermediate position of key operation in which a key element has been depressed to obstruct the passage of light in both of two light circuits;

FIG. 4 illustrates a position of key operation which completes the normal operation for printing the character of the depressed key; and

FIG. 5 illustrates a position of key operation which conditions the control system for repeatedly printing the character of the depressed key.

Referring to FIGS. 1 and 2 in particular, the control system of this invention comprises a pair of light conducting circuits A and B, each controlled by a plurality of movable elements or keys **10** having three light conductive rods **10***a*, **10***b* and **10***c* inserted in openings of an opaque light obstructing body. It will be seen that each element is operatively movable and each light conducting rod may be positioned for passing light through one of the circuits in a manner which is to be explained in further detail.

More particularly, and with reference to FIG. 2, movable elements **10** are mounted for vertical reciprocation in a sleeve guide **11** mounted to the underside of a support plate **12** forming part of a base frame that is also comprised of a side wall **13** and a base plate **14**. Each key element **10** is normally supported in a "home" position, as shown in FIG. 2, by a helical spring **15**, said spring being seated on a spring guide **16** mounted to a support plate **17**. The opposite end of spring **15** engages a ring collar **18**, one collar being mounted to the lower end of each key element. A plurality of screw fasteners **19**, only one of which is shown, is employed for adjustably mounting plate **17** to base plate **14**.

Springs **15** force their respective keys upward until contact is made with the underside of a keyboard **20**, said keyboard being vertically adjustable and mounted to support plate **12** of the base frame by a plurality of screw fasteners **21**. Peripheral flanges formed on the head of each key engage the underside of the keyboard to establish the "home" position for each key as it is moved upwardly under the bias of springs **15**.

It will be readily seen that the return force of each spring **15** may be adjusted by operation of either screw fastener **19**, **21**, or both. However, screw fasteners **21** are principally used to make minor adjustments in the "home" position of the key element **10**, screw fasteners **19** then being used to adjust the return force of the springs relative to the setting of the "home" positions.

Each key element also carries a helical spring **22** on its lower end, one end of the spring being affixed to the element and the other end projecting downward through an opening in the associated spring guide **16**. Springs **22**, while normally inoperative, are utilized to impose a bias in addition to the force of springs **15** when the key elements are moved to condition the control system for repeat operations with a single thrust of the key. Under such circumstances, the lower end of springs **22** make contact with base plate **14** as shown in FIG. 5.

It will be noted that the bias imposed by springs **22** will be independent of any "position" or "touch" adjustments which are made by rotating screw fasteners **19** and **21**.

As indicated above, each key element **10** is operatively

associated with a pair of light conducting circuits A and B. Circuit A comprises a plurality of Plexiglas rods **25** arranged in a series circuit intermediate a light source **26** and a light sensitive photocell **27**. Light source **26** is focused upon the end of one rod leading to the first movable element, and the ends of adjacent rods **25** are received in aligned openings of guides **11**. The light energy of source **26** will, therefore, be conducted through the entire series circuit whenever a light conducting section of all elements occupies a position between the ends of an associated pair of rods **25**. This condition will exist when each of the keys is in its "home" position as shown in FIG. 2, or when one of the keys is moved to what will be termed the "override" position, shown in FIG. 5. However, intermediate positioning of any one key between its "home" position and its "override" position places a light obstructing section of the element between an aligned pair of rods **25**. This condition exists for those intermediate positions of the key elements shown in FIGS. 3 and 4.

Light conducting circuit B comprises a first plurality of Plexiglas rods **28**, each rod extending from a second light source **29** to one of the movable elements **10**, and a second plurality of Plexiglas rods **30** that extend from one of the movable elements and terminate in front of a timing disc **31**, the terminal ends of rods **30** being arranged circumferentially of the disc and directed toward a light sensitive photocell **32**. Rods **28** and **30** are received in aligned openings of guides **11** in essentially the same manner as rods **25**. Accordingly, light energy will be passed from rods **28** to associated Plexiglas rods **30**, but only when a light conductive section of the associated element occupies an intermediate position. This condition exists in the two positions of key actuation shown in FIGS. 4 and 5.

With the foregoing understanding of key construction and operation, attention will be directed to the control system for actuating the printing hammer of a conventional typewriter shown in FIG. 1.

Printing apparatus, particularly typewriters, comprised of a printing disc having a plurality of character pads which may be independently struck against a platen by a printing hammer as the disc is rotated, is now known. The printing hammer of conventional apparatus is actuated by a solenoid which in turn is energized by a timing circuit. FIG. 1 illustrates such an apparatus wherein a disc **35** having a plurality of character pads **35***a* is rotated by a synchronous motor **36**. Character pads **35***a* are adapted to be struck against a platen roll **37** by the printing hammer **38** as disc **35** rotates. Hammer **38** is normally withdrawn by a spring bias **39** and is actuated in timed relation to the rotation of the disc to strike a selected one of the character pads upon energizing solenoid **40**. The energization of solenoid **40**, however, is controlled by the timing circuit of the present invention. This circuit is totally different from that of the prior art devices.

More particularly, the timing circuit for the present invention comprises light conducting circuits A and B, including movable elements **10**, timer disc **31** having an opening **31***a* and rotatably driven by synchronous motor **36**, light sources **26** and **29**, a switching device **42** and a pair of control circuits, one circuit being operated by photocell **27** and the other by photocell **32**. Switching device **42** includes a pair of relays **43** and **44** which operate contact arms **43***a* and **44***a*, respectively.

Relay **43** is energized each time photocell **32** observes a beam of light through the opening **31***a* of timing disc **31**, the output signal of said photocell being amplified by an amplifier **45** connected to the relay. Contact **43***a*, which is normally open, closes upon energizing relay **43**, thereby connecting a power supply **46** to solenoid **40** and to relay **44**, opening contact **44***a*.

Relay **44**, it will be seen, controls a pair of power circuits, one of which is energized by photocell **27**. This circuit comprises an amplifier **47** which turns on a high voltage supply **48** whenever photocell **27** senses a beam of light in light conducting circuit A. The current from voltage supply **48** is applied to light source **29** through a dropping resistor **49** and a blocking diode **50**. A second power source **51** having a relatively low voltage as compared with that of **48** is also provided to supply a current through a blocking diode **52**. This power source has only sufficient voltage to maintain the illumination of light source **29**. The voltage is insufficient to start light source **29** after it has been turned off.

The specific control of light source **29** as shown anticipates the use of a neon tube or equivalent apparatus having a relatively high starting voltage, but one which may be sustained by a much lower voltage. It is with this condition in mind that high voltage **48** may be selected with a capacity for turning on light source **29** while power source **51** is selected with a relatively low voltage sufficient to sustain the light source but insufficient to turn it on.

In operation, each of the components of the control system shown in FIGS. 1 and 2 is positioned in what may be regarded as a starting position, each key member **10** being in a "home" position. It is to be assumed that synchronous motor **36** is in operation and that the timing disc **31** is being rotated synchronously with the printing disc **35**. In this condition, light source **26** which is permanently energized, sends a beam of light through the conducting circuit A, including movable elements **10** and Plexiglas rods **25**. Accordingly, light energy is sensed by photocell **27**, thereby turning on high voltage source **48** and feeding a current through the contact **44***a* to energize and illuminate light source **29**.

Even though light source **29** sends a beam of light energy into Plexiglas rods **28**, each element **10** (being in a "home" position) obstructs the flow of light energy into rods **30**. Thus, photocell **32** does not see a light beam from any of the rods **30**, and relay **43** remains de-energized.

Upon operating any one of the keys **10**, however, the following actions occur: First, as the actuated key reaches the position of FIG. 3, light conducting rod **10***a* of that member is moved out of alignment between the associated rod **25**. In its stead, an opaque portion of the element is placed between the rods as in the position of elements shown in FIG. 3. It will be noted that in such position an opaque portion of the element remains between the associated rods **28** and **30**.

Referring now to FIG. 1, it will be seen that the interruption of light through any one of the elements as caused by the movement into the position of FIG. 3 interrupts the passing of light in series circuit A, thereby de-energizing high voltage source **48**. But this action has no effect upon low voltage source **51**, which then continues to supply a voltage across contact **44***a* to sustain the illumination of second light source **29**. Since each of the elements **10** (including the element actuated to the position of FIG. 3) blocks the passage of light in all terminal connections **30** of light conducting circuit B, no light beam is as yet detected by photocell **32** and, therefore, relay **43** remains de-energized.

The further depression of key **10** to the position of FIG. 4 positions light conducting rod **10***b* between the rods **28** and **30**. Accordingly, a beam of light emanating from light source **29** is now conducted to the terminal end of the associated rod **30**; and when disc **31** is positioned such that its opening **31***a* becomes aligned with the end of rod **30**, photocell **32** receives a pulse of light that triggers the energization of relay **43**, closing contact **43***a* to energize both relay **44** and solenoid **40**. Relay **44** now opens contact **44***a*.

Opening contact **44***a* interrupts the flow of current to second light source **29**. Therefore, even though contact **44***a* may later be closed to conduct current from low voltage source **51** while the actuated key **10** is held in a depressed position, light source **29** cannot be turned on again until high voltage **48** is supplied. This condition will be met only when the light conducting rod **10***a*, or, alter-

nately, light conducting rod **10***c*, is placed between the associated and aligned rods **25**. This control inhibits further operation of solenoid **40** until the key is returned to a "home" position or unless the key is depressed to the "override" position shown in FIG. 5.

A second condition for insuring proper actuation of solenoid **40** is that contact **43***a* must be closed for a time sufficient to actuate hammer **38**. For this purpose, a capacitor **54** may be placed across relay **43**. A second capacitor **55** may also be placed across relay **44** to insure proper timing and operation of contact **44***a*. The value of capacitor **55** is selected to create a delay in the closing of relay contact **44***a*, thereby allowing hammer **38** to complete its operation before light source **29** can be turned on.

In operations where a particular character is to be repeatedly struck, it is only necessary to depress the selected key into the "override" position illustrated by FIG. 5. It will be noted that the keys are then positioned such that light conducting circuits A and B are continuously conditioned for passing light energy from the light sources **26** and **29** to the respective photocell controls **27** and **32**. Thus, after a single operation and as soon as contact **44***a* closes, light energy will be conducted through light conducting circuit B and received by photocell **32**, energizing relay **43**, actuating solenoid **40** and energizing relay **44**, and breaking contact **44***a*, in that order. The control system will then continuously repeat the operation so long as the key remains in its "override" position.

Although switching device **42** has been illustrated and described as a device having electro-mechanical components, it is to be understood that for many applications, especially where speed of switching is essential, electronic switching devices may be preferred. The substitution and use of such devices is expressly contemplated by this invention. Thus, although a single preferred embodiment of this invention has been illustrated and described, various modifications and changes may be made without departing from the spirit of the invention or the scope of the attached claims, and each of such modifications and changes is contemplated.

What is claimed is:

1. A control system for operating a machine comprising: a plurality of control elements, each element having light conductive and light obstructing sections; a first light source; means defining a light conducting passageway connecting each of said elements in series with said first light source, each element being normally positioned to pass light through the passageway but capable of being moved to interrupt the passage of light therethrough; a second light source; means defining a light conducting circuit connecting said second light source with each of said movable elements, each element being connected in parallel with other elements and normally positioned to obstruct the flow of light emanating from said second light source; means responsive to the passage of light in said light conducting passageway for illuminating said second light source; means for maintaining the illumination of said second light source during an interruption in the passage of light in said light conducting passageway; and means responsive to the passage of light through a light conductive section of any one of said control elements in said light conducting circuit for interrupting the illumination of said second light source.

2. A control system for operating a machine comprising: a plurality of movable elements having light conductive and light obstructing sections; a first light conducting means intermediate a light source and extending to first one and then to other movable elements as to connect each element in series with said light source, each element being normally positioned to conduct light through said first light conducting means; a second light conducting means intermediate a second light source and extending to each of said movable elements as to connect each element in parallel with other elements, each element being normally positioned to obstruct the passage of light from said second light source; means responsive to the passage of light in said first light conducting means for illuminating said second light source; means for maintaining the illumination of said second light source during an interruption in the passage of light in said first light conducting means; and means responsive to the passage of light in any one of the parallel portions of said second light conducting means for interrupting the illumination of said second light source.

3. The control system of claim **2**, wherein each movable element is formed with first and second light conductive sections and first and second light obstructing sections, said first light conductive and light obstructing sections being disposed in operative relation to said first light conducting means and said second light conductive and light obstructing sections being disposed in operative relation to said second light conducting means, said first and second light conductive and light obstructing sections being further disposed relative to said first and second light conducting means to conduct light in said first light conducting means while obstructing light in a parallel portion of said second light conducting means.

4. The control system of claim **2**, said means for illuminating said second light source comprising a light sensitive control for applying an illuminating current to said second light source.

5. The control system of claim **2**, said means for maintaining the illumination of said second light source comprising a secondary power source having a voltage for maintaining the illumination of said second light source but incapable of initiating the illumination thereof.

6. The control system of claim **2**, said means for interrupting the illumination of said second light source and actuating said machine comprising an electronic switch normally conditioned for conducting an illuminating current to said second light source, said switch being operated to interrupt the flow of current thereto upon positioning any one of said elements to pass light in one of the parallel portions of said second light conducting means.

7. The control system of claim **2**, said means responsive to the passage of light in any one of the parallel portions of said second light conducting means comprising a light sensitive control connected to an electronic switch, said switch being normally conditioned for conducting an illuminating current to said second light source.

8. The control system of claim **2**, said second light conducting means comprising a plurality of light conduits, each conduit being focused upon a light sensitive control; and further comprising a timing disc rotatably mounted intermediate said light sensitive control and said plurality of light conduits, said timing disc having an aperture for selectively exposing said light sensitive control with the emission of light from any one of said light conduits.

9. The control system of claim **2**, each of said movable elements further including a light conductive section that may be positioned for conducting light through said first light conducting means while said element is also positioned for conducting light in a parallel connection of said second light conducting means.

10. The control system of claim **9** and further comprising a plurality of means for resiliently biasing each of said movable elements, respectively, toward a home position for passing light in said first light conducting means and obstructing light in a parallel connection of said second light conducting means, each of said resilient means comprising a pair of spring members disposed intermediate one element in a support, one spring member of each pair being operative for imposing a bias to return said element to its home position, the other spring member being operative to impose a secondary bias when said element is moved into an override position where

light conductive sections thereof pass light in both said first and second light conducting means.

11. The control system of claim 10, and further comprising a control panel for positioning each movable element at its home position, and means for adjusting the position of said control panel relative to said movable elements to vary the length of stroke of said elements without affecting the secondary bias of said second spring member.

12. The control system of claim 10, and further comprising means for adjusting the position of said support relative to said elements to vary the bias of each spring member that tends to return said elements to home positions without affecting the secondary bias of other spring members.

13. The control system of claim 2, each of said movable elements being biased into a home position that conducts light in said first light conducting means and obstructs light in a parallel connection of said second light conducting means.

14. The control system of claim 2, and further comprising a control panel for positioning each movable element at its home position, and means for adjusting the position of said control panel relative to said movable elements.

15. The control system of claim 2, and further comprising a support panel, resilient means disposed between said support panel and each of said elements, respectively, for biasing said elements into home positions; and means for adjusting the position of said support panel relative to said elements to adjust the strength of the bias with which each is returned to its home position.

16. In combination with a typewriter having a rotatable printing disc and means for striking said printing disc to imprint characters carried thereon as said disc is rotated, an improved control system comprising: a plurality of movable keys, each key having light conductive and light obstructing sections; a first light conducting means intermediate a first light source and extending to first one and then to other movable keys as to interconnect each key in series with said light source, each key being normally positioned to conduct light through said first light conducting means; a second light conducting means intermediate a second light source and extending to each of said movable keys as to connect each key in parallel with other keys, each key being normally positioned to obstruct the passage of light from said second light source; means responsive to the passage of light in said first light conducting means for illuminating said second light source; means for maintaining the illumination of said second light source during an interruption in the passage of light in said first light conducting means; and means responsive to the passage of light in any one of the parallel portions of said second light conducting means for actuating the means for striking said printing disc and interrupting the illumination of said second light source.

17. The improvement of claim 16, said second light conducting means comprising a plurality of light conduits, each conduit being focused upon a light sensitive control; and further comprising a timing disc rotatably mounted intermediate said light sensitive control and said plurality of light conduits, said timing disc having an aperture for selectively exposing said light sensitive control with the emission of light from any one of said light conduits.

18. The improvement of claim 16 and further comprising a keyboard, each of said keys being reciprocally mounted in an opening of said keyboard, each key being exposed above the top surface of the keyboard and having engagements with the underside of the keyboard that establish home positions; and means biasing each of said keys, respectively, to return said keys to home positions.

19. The improvement of claim 18, and further comprising a support frame and means for adjustably mounting said keyboard relative to said support frame to vary the actuating throw of said keys.

20. The improvement of claim 18, and further including means for adjusting the bias with which each key is returned to its home position.

21. The improvement of claim 20, and further comprising a plurality of spring members, one member being mounted to the lower end of each key and engageable with said support frame when said key is moved into an override position where light conductive sections pass light in both said first and second conducting means.

22. A control system for operating a machine comprising a plurality of movable control elements; a first control circuit interconnecting each of said elements in series with a source of energy, each element being normally positioned to transmit energy through the circuit but capable of being moved to interrupt the transmission of energy therethrough; a second control circuit extending from a second energy source to each of said movable elements, each element being connected in parallel with other elements and normally positioned to obstruct the flow of energy from said second energy source; means responsive to the transmission of energy in said first circuit for initiating a flow of energy from said second energy source, means for sustaining the transmission of energy from said second energy source during an interruption in the transmission of energy in said first circuit; and means responsive to the transmission of energy through any one of said control elements in said second circuit for interrupting the transmission of energy from said second energy source.

23. The control system of claim 22, said second control circuit comprising a plurality of light conduits, each conduit being focused upon a light sensitive control; said means responsive to the transmission of energy in said second circuit including a light sensitive control; and further comprising a timing disc rotatably mounted intermediate said light sensitive control and said plurality of light conduits, said timing disc having an aperture for selectively exposing said light sensitive control with the emission of light energy from any one of said light conduits.

References Cited

UNITED STATES PATENTS

2,228,780	1/1941	Roberts	197—98 XR
2,408,754	10/1946	Bush	197—5 XR
2,438,825	3/1948	Roth	197—98 XR
2,518,726	8/1950	Shlenker	350—96 XR
3,017,463	1/1962	Dinsmore et al.	197—98 XR
3,032,163	5/1962	Flieg	197—1.5
3,104,388	9/1963	Balenger	197—98 XR
3,334,237	8/1967	Dodsworth et al.	197—98 XR
3,365,568	1/1968	Germen	350—96
3,372,789	3/1968	Thiel et al.	197—98
3,465,099	9/1969	Harris	197—98 XR

FOREIGN PATENTS

723,793	8/1942	Germany.

OTHER REFERENCES

IBM Technical Disclosure Bulletin, vol. 5, No. 10, March 1963, p. 127, article by Sharp et al. entitled "Optical Keyboard."

IBM Technical Disclosure, Bulletin, vol. 5, No. 1, June 1962, p. 89, article by Brandenberg entitled "Pluggable Fiber Optics Data Searching Apparatus."

EDGAR S. BURR, Primary Examiner

U.S. Cl. X.R.

101—93; 235—145; 250—227; 340—380; 350—96