

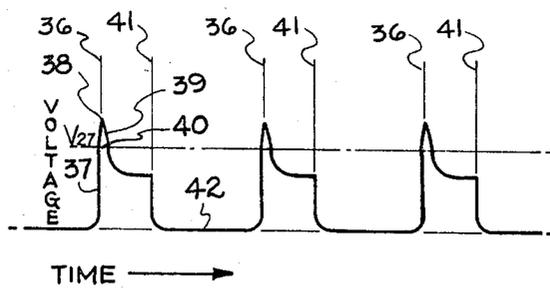
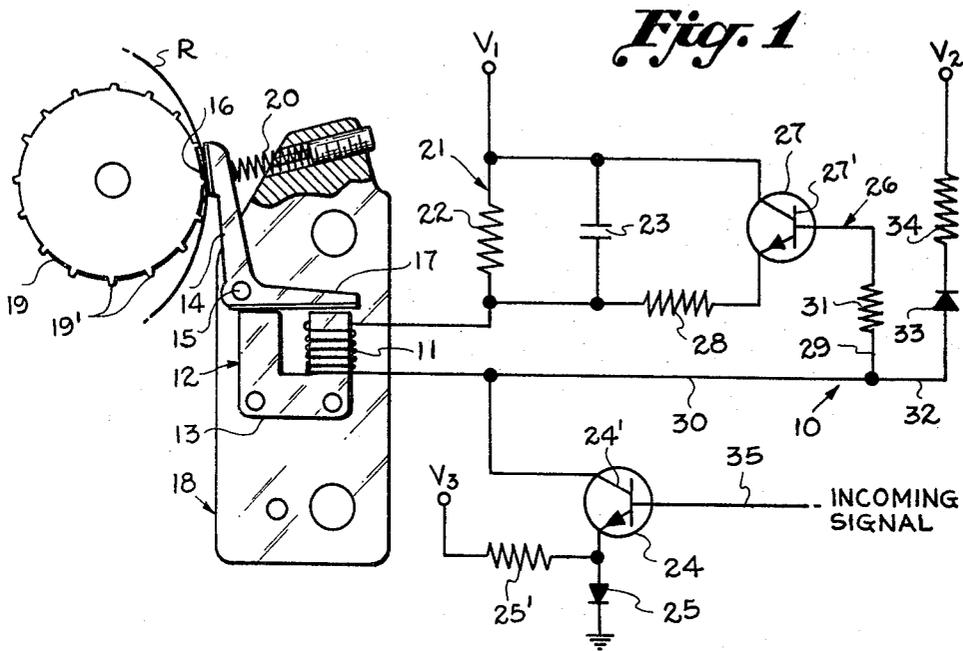
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ELECTROMAGNETIC CONTROL MEANS FOR PRINT HAMMERS

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ELECTROMAGNETIC CONTROL MEANS FOR PRINT HAMMERS

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ABSTRACT OF THE DISCLOSURE

There is disclosed a print hammer cooperable with a platen, and actuating apparatus for the print hammer. A spring is used to drive the print hammer into printing cooperation with the platen and an electromagnet is used to actuate the print hammer out of printing cooperation with the print hammer. The electromagnet is energized by energizing means sequentially with relatively heavy starting current and with relatively light holding current so that the print hammer is relatively rapidly actuated and is held out of printing cooperation with the platen by relatively light holding current. When the print hammer is to be driven into printing cooperation with the platen, the electromagnet is de-energized and the spring is able to perform its function. Structure is provided to drive the energizing means into rapid transition from the holding current condition to a de-energized condition to enable the relatively heavy holding current to be applied to the coil a short time after the coil is de-energized.

This invention relates to actuating apparatus particularly useful for a recorder such as printer.

Where a movable member such as a print hammer is required to undergo a number of cycles of operation in a short period of time, it is desirable in accordance with the invention, especially where only one printing hammer is employed, to energize the coil of the print electromagnet for the print hammer with relatively heavy starting current followed by relatively light holding current, while insuring that the relatively heavy starting current can be applied to the coil a short time after the coil of the electromagnet is de-energized. In accordance with the invention the energizing circuit for the coil of the electromagnet is driven into rapid transition from the holding current condition to the de-energized condition to enable heavy initial current to be applied to the coil shortly after the electromagnet is de-energized. More particularly, there is provided a print hammer actuatable by an electromagnet, an energizing circuit including a resistor-capacitor network connected to one side of the coil of the electromagnet, and circuitry connected to the other side of the coil and to the resistor-capacitor network and including a transistor and a resistor in a loop circuit for rapidly discharging the resistor-capacitor network.

In the drawing:

FIGURE 1 is a schematic view depicting a specific embodiment of a print hammer shown in printing cooperation with a platen, together with actuating apparatus for the print hammer; and

FIGURE 2 is a view showing voltage waveforms in the line 30, formed by three spaced apart symbol pulse units.

Referring now to FIGURE 1 of the drawing, there is shown actuating apparatus generally indicated at 10 for controlling the energization of a coil 11 of an electromagnet 12. The electromagnet 12 has a U-shaped core 13 about which the coil 11 is wound. The electromagnet 12 can actuate a movable member, in particular, a print hammer 14. The print hammer 14 is shown to be pivotally mounted about a pivot pin 15. The print hammer 14 has a print face 16 and an armature 17. The electromagnet

12 and the print hammer 14 are mounted in a carriage 18 which travels lengthwise with respect to a platen 19 while the platen 19 is rotating and while the print hammer 14 is cooperating with the platen 19 to progressively scribe a symbol on a record medium R. The type of printer to which the specific embodiment of the present application relates is disclosed in U.S. patent application Ser. No. 278,241, filed May 6, 1963, and U.S. patent application of Wilburn F. Bradbury entitled "Printer" and having the same U.S. filing date as the present application, both of which U.S. patent applications being owned by the assignee of the present application.

A compression spring 20 mounted by the carriage 18 engages the print hammer 14 and normally urges the print hammer 14 into printing cooperation with the platen 19. As soon the holding force of the electromagnet 12 is insufficient to overcome the force of the spring 20, that is, upon de-energization of the electromagnet 12, the spring 20 drives the print face 16 of the print hammer 14 into printing cooperation with one of the platen elements or flutes 19' of platen 19.

Depending upon the symbol to be scribed, the period of time during which the print face 16 remains in printing cooperation with a platen element 19' of the platen 19 varies. For example in printing the letter E, its vertical line portion is scribed by maintaining the print face 16 in printing cooperation with one of the rotating platen elements until the entire vertical line portion has been scribed. The vertically spaced horizontal line portions of this letter are scribed by printing vertically spaced dots. Each dot requires that the print hammer 14 be actuated so that the print hammer 14 is only in contact with the record medium R for the length of time required to print a dot.

Energization of the coil 11 with sufficient current will cause the print hammer 14 to pivot (clockwise as viewed in FIGURE 1) against the force of the spring 20 and out of printing cooperation with the platen 19. The amount of current required to hold the print hammer 14 out of printing cooperation with the platen 19 is less than the amount of current required to initially energize the coil 11 to actuate the print hammer 14 out of printing cooperation with the platen 19. Inasmuch as dots are likely to be printed in rapid succession, each cycle of energization of the print coil 11 should, according to the present invention, not only be rapidly completed, but the coil should be energized with relatively heavy starting current upon the completion of the reception of each intra-signal pulse unit. According to the invention, the energizing circuit for the coil 11 is driven rapidly from the holding condition to a de-energizing or no-current condition.

The energizing circuit for the coil 11 includes a resistor-capacitor network 21 connected to a source of positive voltage V_1 . The resistor-capacitor network 21 includes a resistor 22 and a capacitor 23 connected in a loop circuit in parallel with each other and connected to one side of the coil 11 in series with the coil 11. The energizing circuit also includes an NPN transistor 24 connected to ground through a diode 25. The diode 25 biases the transistor 24 during its "off" condition. A resistor 25' connected to the positive voltage source V_3 to maintain a current path for the diode 25 when the transistor 25 is in the "off" condition.

A driver circuit 26 drives the energizing circuit into rapid transition from the relatively light or holding current condition to the de-energizing or no-current condition so that as soon as the print signal turns the transistor 24 to its "on" condition the coil 11 can be supplied with relatively heavy starting current because the resistor-capacitor network 21 is discharged. The driver circuit 26 includes an NPN transistor 27 connected in a loop circuit with the

capacitor 23 and with a resistor 28. The base 27' of the transistor 27 is connected to the other side of the coil 11 by conductors 29 and 30. The conductor 29 has a resistor 31 which limits the current in the conductor 29 between the resistor 31 and the transistor 27. A conductor 32 connected to the junction of 29 and 30 contains a diode 33 and a resistor 34 disposed between the diode 33 and a source of positive voltage V_2 . The diode 33 and the resistor 34 serve to limit the voltage in conductor 30 so that the voltage at the collector 24' of the transistor 24 will be within the design limits of the transistor 24. The values of the D.C. voltages V_1 , V_2 and V_3 are equal but they need not be equal.

Operation

Assuming that no print signal appears on the conductor 35, that is, the transistor 24 being in its "on" condition because of current in the conductor 35, holding current flows from the source of positive voltage V_1 , through the resistor 22, through the coil 11, through the transistor 24, and through the diode 25 to ground. According to the present embodiment, when a pulse unit of the print signal, that is, a no-current condition is imposed on the conductor 35, the transistor 24 turns to its "off" condition, thereby breaking the energizing circuit for the coil 11; the spring 20 is now able to drive the print hammer 14 into printing cooperation with the platen 19. When the transistor 24 turns to its "off" condition, an inductive kick or reaction to the de-energization of the coil 11 results in rapid increase in voltage in the leads 30, 29 and 32.

The value of the resistor 31 is such that the voltage at the base 27' of the transistor 27 can rise sufficiently but not inordinately to turn the transistor 27 to its "on" condition at a voltage V_{27} , thereby causing the capacitor 23 to discharge through the loop circuit containing the capacitor 23, the transistor 27, and the resistor 28, in addition to the resistor-capacitor network 21. Upon completion of the reception of the pulse unit a current condition is again imposed on the conductor 35, thereby re-establishing the energizing circuit for the coil 11. Heavy current can flow through the coil 11 because the resistor-capacitor network previously discharged is now storing electrical energy. This heavy current in the coil 11 is adequate to overcome the force of the spring 20 and pivot the print hammer 14 out of printing cooperation with the platen 19. During the charging of the capacitor 23, the current flowing through the coil 11 decreases rapidly until the capacitor 23 is charged, and the relatively light holding current continues to flow through the coil 11 until the transistor 24 is again turned to its "off" condition by a pulse unit.

In FIGURE 2 there are depicted the voltage waveforms in the line 30 for three symbol pulse units of a signal, spaced apart from each other by time intervals equal in time to two pulse units. Such an arrangement of pulse units would be used for example in scribing the first three dots of the three horizontal line portions of the letter E. The beginning 36 of each pulse unit causes a sharp rise in voltage as indicated at 37 until the peak 38 is reached. This sharp voltage rise is caused by the inductive kick of the coil 11. The voltage thereafter drops rapidly as indicated by 39. The transistor 27 is in its "on" condition during the entire time interval indicated at 40 between the line portions 37 and 39 when the voltage of the base 27' of the transistor 27 is above the voltage V_{27} . By the time each symbol pulse unit has been received as indicated at time 41 the value of the voltage has fallen to zero as indicated at 42.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be

considered in all respects as illustrative and not restrictive, the scope of the invention being best defined by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. For a recorder: an electromagnet having an energizable coil, movable means having armature means actuatable by said electromagnet, means for energizing said coil with relatively heavy current during a starting condition to effect movement of said movable means and with relatively light current during a holding condition to effect holding of said movable means in the position into which it was moved, and means responsive to the inductive kick of said coil for driving said energizing means into rapid transition from said holding condition to a de-energized condition to enable the relatively heavy holding current to be applied to the coil a short time after the coil is de-energized.

2. The invention as defined in claim 1, wherein said movable means includes a print hammer.

3. The invention as defined in claim 1, wherein said movable means includes a print hammer, platen means with which said print hammer cooperates to print on a record medium disposed between said platen means and said print hammer, and spring means for driving said print hammer into printing cooperation with respect to said platen means, said energizing means being effective during the starting condition to move said print hammer out of printing cooperation with said platen means and being effective during said holding condition to hold said print hammer out of printing cooperation with said platen means against the urging of said spring means.

4. The inventions as defined in claim 1, wherein said movable means includes a print hammer and said energizing means includes a resistor-capacitor network.

5. The invention as defined in claim 1, wherein said driving means includes a transistor.

6. The invention as defined in claim 1, wherein said movable means includes a print hammer, said energizing means includes a capacitor, and said driving means includes a transistor and a resistor in a loop circuit with said capacitor, said transistor serving to facilitate the discharge of said capacitor in response to the inductive kick.

7. The invention as defined in claim 1, said energizing means having a transistor responsive to a pulse unit for enabling and disabling said energizing means, and means for suppressing the inductive kick of said coil to prevent damage to said transistor.

8. For a recorder: an electromagnet having a coil, print hammer means actuatable by said electromagnet, a resistor-capacitor network connected to one side of said coil, and means connected to the other side of said coil and to said resistor-capacitor network for rapidly driving a capacitor of said network to discharged condition.

9. For a recorder as defined in claim 8, said driving means including a transistor and a resistor in a loop circuit with said capacitor.

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WILLIAM B. PENN, *Primary Examiner*.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,386,378

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Wilburn F. Bradbury et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 29 and column 4, line 19, cancel "holding", each occurrence.

Signed and sealed this 7th day of April 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents