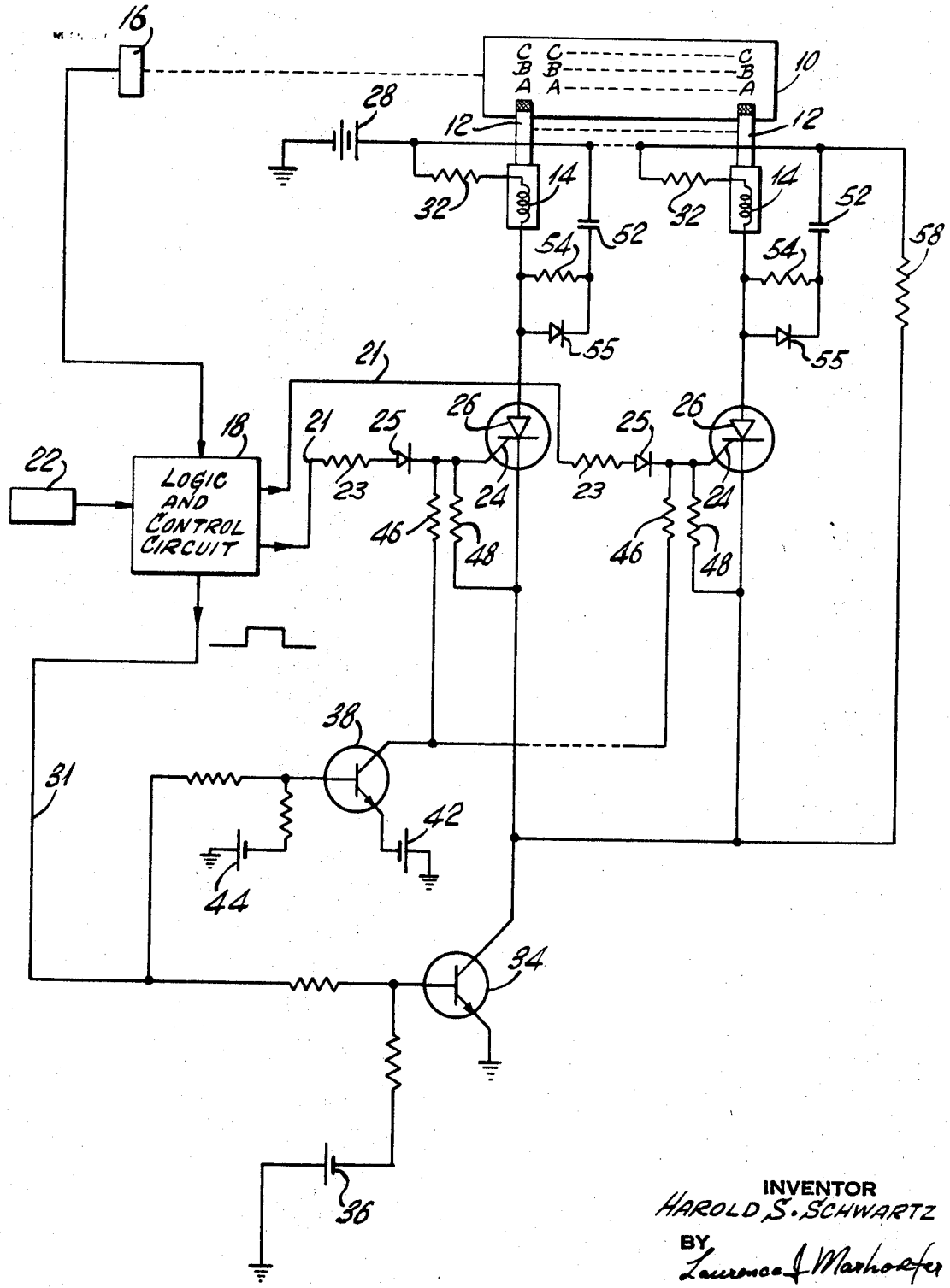
July 7, 1970 H. S. SCHWARTZ 3,519,893

CIRCUIT FOR ENERGIZING ELECTROMAGNETIC OPERATED HAMMERS IN A HIGH SPEED IMPACT PRINTER

Filed Sept. 29, 1967



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United States Patent Office 3,519,893 Patented July 7, 1970

3,519,893

CIRCUIT FOR ENERGIZING ELECTROMAGNETIC OPERATED HAMMERS IN A HIGH SPEED IMPACT PRINTER

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Filed Sept. 29, 1967, Ser. No. 671,752
Int. Cl. H01h 47/32
U.S. Cl. 317—148.5 4 Claims

ABSTRACT OF THE DISCLOSURE

An impact printer has solenoid operated print hammers which are fired by a pulse on the control electrode of a silicon controlled rectifier in series with the solenoid operating coils. A transistor switch in series with the cathodes of two or more SCR's is provided to turn them off, and a resistor coupling the cathodes to the power supply is provided to reverse bias the SCR's and to insure turn off. A capacitor coupled to the SCR anode holds it at a low potential following turn off, preventing noise and allowing a sufficient interval for reverse biasing the SCR.

BACKGROUND OF THE INVENTION

This invention relates to high speed impact printers which employ solenoid operated print hammers and, more particularly, to an improved silicon controlled rectifier (SCR) hammer operating circuit for such printers.

One object of this invention is the provision of a simple, economical SCR print hammer operating circuit which has a low electromagnetic interference (noise) output.

Another object of the invention is the provision of an improved SCR print hammer operating circuit for impact printers which reduces the number of components as compared with prior art SCR hammer operating circuits.

One more object of the invention is the provision of an improved SCR hammer operating circuit which is relatively immune from noise.

A further object of the invention is the provision of an improved SCR hammer operating circuit which can operate over a wide temperature and humidity range with commercially available electronic components.

SUMMARY OF THE INVENTION

Briefly, this invention contemplates a solenoid operated print hammer firing circuit in which an SCR switch is in series with the operating coil of each print hammer. A single transistor switch, coupled in series with the cathodes of several of the SCR's, extinguishes conduction through them by cutting off the flow of current through them, and a resistor coupling the cathode to the power supply back biases the SCR's insuring that conduction is extinguished. A capacitor is coupled to the anode of each SCR to provide a conduction path for the coil following turn off of the SCR and to thereby limit the rate of change of current and voltage following this turn off, reducing the noise generated. In addition, this capacitor holds the anode of the SCR at a low potential for an interval sufficient to allow dissipation of the charge accumulated by the SCR during conduction.

BRIEF DESCRIPTION OF THE DRAWINGS

Having briefly described this invention, it will be described in greater detail along with other objects and advantages in the following detailed description of a preferred embodiment which may be best understood by reference in the accompanying drawing which forms part

of the instant specification and which is to be read in conjunction therewith and in which the sole figure is a schematic drawing of one embodiment of the improved SCR print hammer operating circuit of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, the printer has a row of print hammers **12** disposed adjacent a rotating drum **10**. Only the first and last hammers are shown in order to simplify and clarify the drawing. Each print hammer **12** has a solenoid operating coil **14** which, when energized, causes its hammer to fire.

Although the invention is applicable both to parallel printers in which more than one hammer at a time may fire and character-at-a-time printers in which the columns are printed one at a time from right to left, for example, the invention will be explained particularly with reference to the latter type of printer.

The positive terminal of a direct current (D.C.) power supply **28** is coupled to one side of each of the coils **14** via current limiting resistors **32**. The other side of each coil **14** is coupled respectively to the anode of an SCR **26**. In the character-at-a-time printer of this embodiment of the invention, the collector of a single NPN transistor switch **34** is coupled to the cathodes of all the SCR's **26**. When this transistor is in saturation, it couples the cathodes of the SCR's **26** to ground. When transistor **34** is cut off, it prevents the flow of current through the SCR's and thereby extinguishes any previously fired SCR. In a parallel printer, a single transistor switch **34** may serve a group of hammers, the number of hammers in the group depending upon the current carrying capability of the transistor.

Coupled to the drum **10** is an encoder **16** the output of which is coupled to a logic and control circuit **18** whose other input is from a data buffer register **22**, for example. As is well known in the art for character-at-a-time printers, each time there is a correspondence between a type face on the drum **10** and the information to be printed in a certain column, the logic and control circuit **18** produces a positive output pulse on a selected one of the lines **21** which is coupled via resistor **23** and diode **25** to the control electrode **24** of a selected SCR **26**. This pulse fires the SCR.

Each of the solenoid operating coils **14** is shunted by a network comprising a capacitor **52**, a resistor **54** and a diode **55**. After an SCR has turned off, this network provides a path through which current from coil **14** can continue to flow, gradually diminishing as the capacitor **52** discharges. In this way, the rate of change of current flow through coil **14** following turn off is reduced, thereby reducing the voltage spikes (noise) generated across the coil **14**. It should be noted that diode **55** provides a relatively high impedance path when the SCR **26** turns on so that the coil **14** is not shunted appreciably by the capacitor **52** at turn on. It should also be noted, that alternatively, the capacitor **52** may be coupled between the anodes of SCR **26** and ground rather than the anode and the positive terminal of the power supply, as shown.

In addition to limiting the rate of change of current through coil **14** following turn off of SCR **26**, the network of diode **55**, capacitor **52** and resistor **54** maintains the potential at the anode of SCR **26** at a low potential for an interval sufficient to permit the SCR to be back biased and to discharge the charge it accumulated during conduction. A resistor **58** couples the cathodes of the SCR **26** to the power supply **28** in order to back bias the SCR and provide a discharge path for the charge accumulated. Thus, conduction through an

SCR **26** will be extinguished even if the leakage current of transistor **34** exceeds the holding current of SCR **26**.

The SCR control electrode is biased via an NPN translator **38** whose emitter is coupled to a source of negative bias potential **42** and whose collector is coupled to the control electrodes **24** via resistors **46**. The control electrodes are also coupled to the cathodes of the respective SCR's via resistors **48**, providing a bias when transistor **38** is cut off. When transistor **38** is in saturation, it couples the control electrodes to negative bias source **42**, preventing any non-conducting SCR **26** from being fired by a noise signal during the interval that its cathode is coupled to ground via transistor **34**.

Negative bias sources **36** and **44** respectively bias transistors **34** and **38** to cut off; a lead **31** couples the bases of both these transistors to logic and control circuit **18** which produces a positive output pulse of fixed duration on lead **31** each time it produces a hammer firing pulse on lead **31**.

In operation, when a type face on the drum **10** is properly disposed with respect to a selected hammer **12** and the information from source **22** calls for printing that character in the selected column, a positive pulse from logic and control circuit **18** on an appropriate one of the lines **21** fires the SCR **26** in series with the selected hammer **12**. Simultaneously, a positive pulse of fixed duration on line **31** drives transistors **34** and **38** into saturation.

After the hammer **12** fires, the positive pulse on line **31** terminates, cutting off transistor **34**, and thereby terminating the flow of current through SCR **26**. However, current from coil **14** continues to flow via diode **55** and resistor **54**. This current diminishes gradually as capacitor **52** is discharged, reducing the amplitude of the voltage generated (noise) across the coil **14**. In addition, this network limits the rate at which the anode voltage of the SCR rises, permitting discharge of the SCR **26** and insuring complete cut off of the SCR.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims. It is further obvious that various changes may be made in details within the scope of the claims without departing from the spirit of the invention. It is, therefore, to be understood that this invention is not to be limited to the specific details shown and described.

What is claimed is:

1. In a high speed impact printer having a plurality of solenoid operated print hammers, a firing circuit for such print hammers comprising, in combination:

a plurality of silicon controlled rectifiers each having an anode, a cathode, and a control electrode,

a power supply,

means coupling the solenoid operating coils for the plurality of print hammers between one terminal of said power supply and the anode of one of said SCR's respectively,

a plurality of capacitors,

means respectively coupling each of said plurality of capacitors to each of said anodes to provide a path for current flowing through said solenoid coils following turn off of said SCR's,

a transistor switch in series with the cathodes of said SCR's for providing a low impedance path for SCR current when said transistor switch is turned on and for providing a high impedance path when said switch is turned off, and

a resistor coupling said cathods to said one terminal of said power supply in order to back bias said SCR's when said transistor switch is turned off.

2. In a high speed printer as in claim **1**, a hammer firing circuit also as in claim **1** further including a single transistor switch in series with the cathodes of at least two SCR's for extinguishing conduction through said SCR's.

3. In a high speed printer as in claim **2**, a hammer firing circuit also as in claim **2** further including means for biasing the control electrodes of the SCR's whose cathodes are coupled to said single transistor switch at a first potential when said transistor switch is conducting and at a second potential when said transistor switch is non-conducting.

4. In a high speed printer as in claim **3**, a hammer firing circuit also as in claim **3** wherein said means for biasing includes a transistor switch which turns on and off in synchronism with said single transistor switch.

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U.S. Cl. X.R.

101—93; 317—137