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[56]

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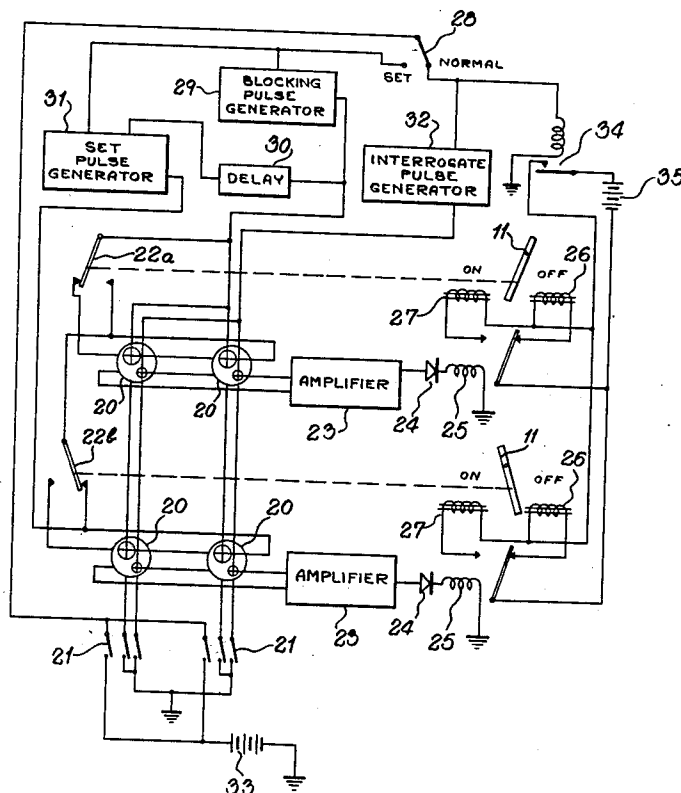
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[54] **CONTROL SYSTEM FOR ORGANS AND SIMILAR MUSICAL INSTRUMENTS UTILIZING MEMORY STORAGE OF DESIRED STOP COMBINATIONS**
5 Claims, 4 Drawing Figs.

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84/1.03, 340/174
[51] Int. Cl. G10h 1/00
[50] Field of Search. 84/1.01,
1.03; 340/174CT

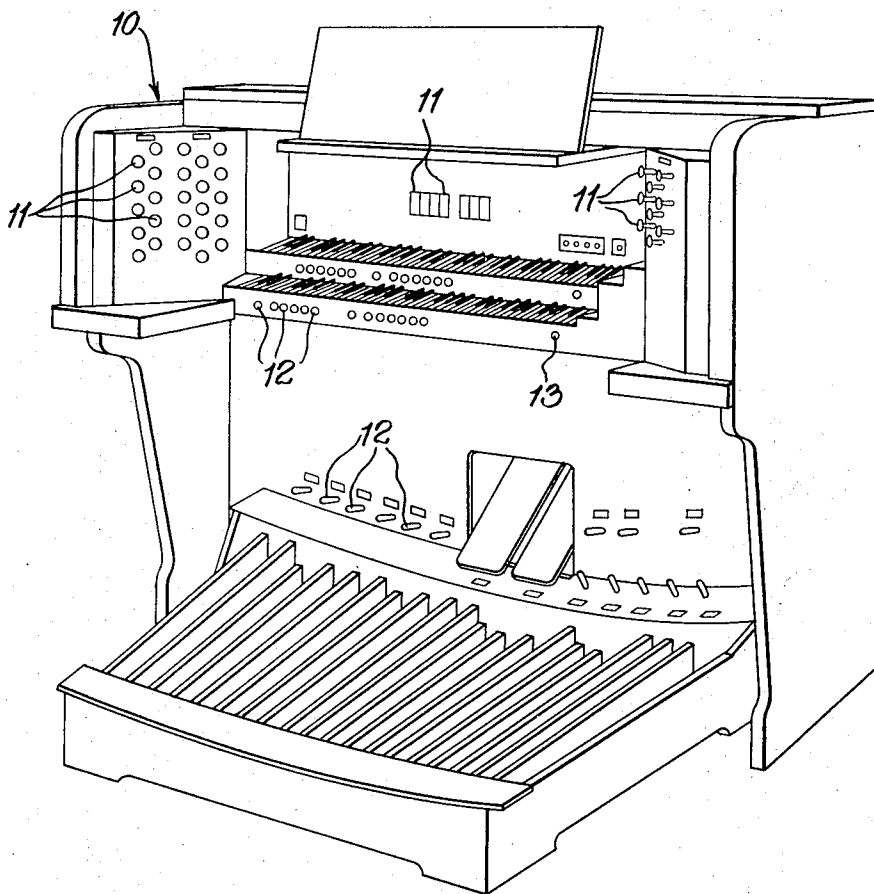
ABSTRACT: A control system for organs and similar musical instruments of the type having a plurality of tone producing elements wherein a memory matrix of multiple aperture cores serves as a prestored memory of tone combinations which will drive the desired stops to a preset combination on command of the performer.



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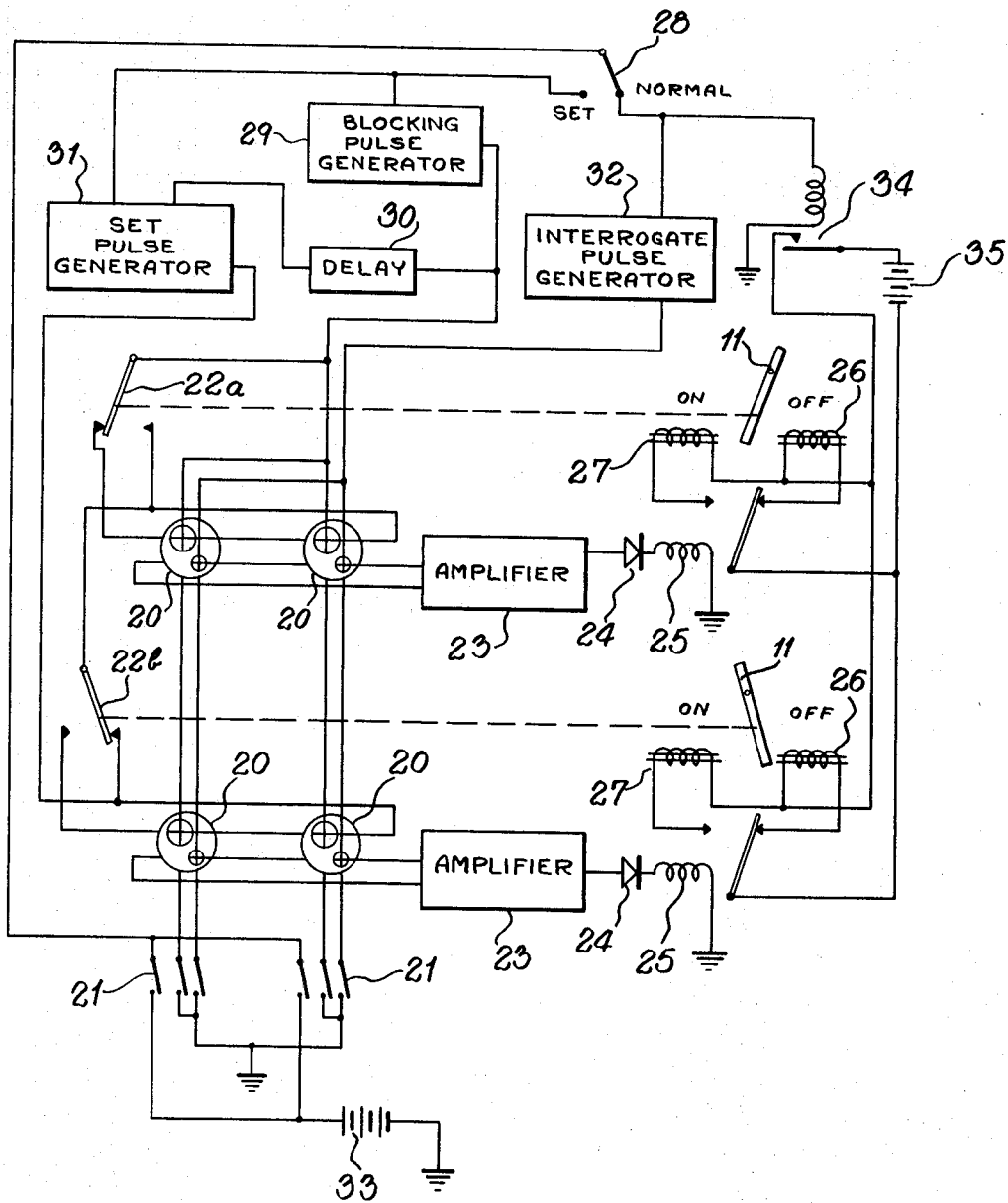
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Fig. 1.



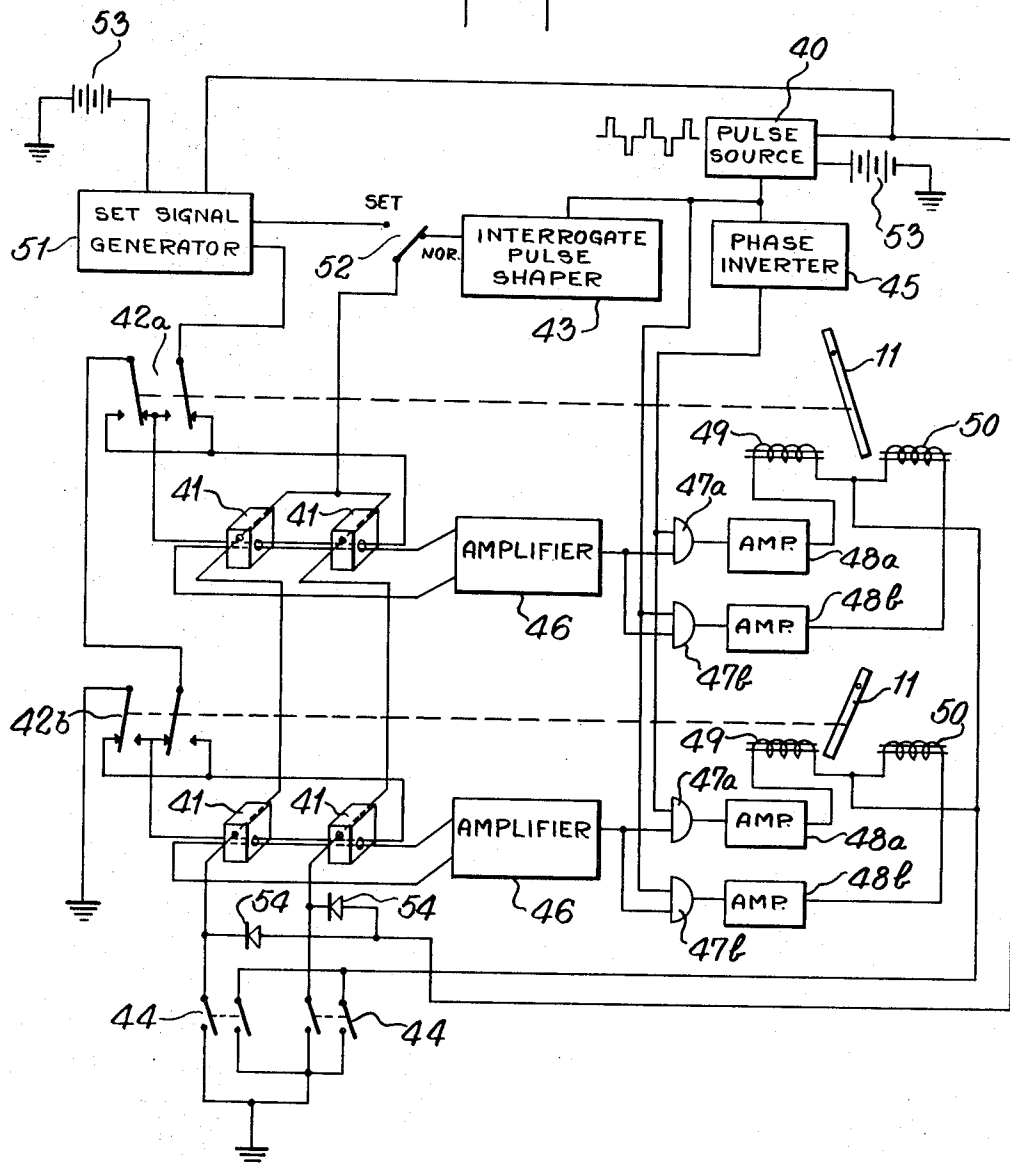
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Fig. 2.



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Fig. 3.



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CONTROL SYSTEM FOR ORGANS AND SIMILAR MUSICAL INSTRUMENTS UTILIZING MEMORY STORAGE OF DESIRED STOP COMBINATIONS

My invention relates to a control system for musical instruments, and in particular to an improved means for controlling the selection of stops on keyboard instruments such as organs. Such means are often called "combination actions".

Pipe organs commonly have a number of ranks or sets of pipes controlled by mechanical, pneumatic or electrical devices known as "stops". In musical performance it is frequently necessary to change a large number of these stops simultaneously, and various systems have been developed to provide for presetting specific combinations of stops, which can subsequently be called forth by pressing a lever or push-button, usually referred to as a "combination piston", "combon", or, simply, "piston". Such systems, or combination actions, have used various mechanical, pneumatic or electromechanical means for storing this information and for moving the stops to their preselected positions, but all such systems in the past have had disadvantages such as excessive size, noisy operation, wear of moving parts, expense, complexity of manufacture, and so on.

It is accordingly an important object of my invention to provide a simple and economical stop combination action which is very compact, quiet and long-lasting, with few moving parts.

It is a further object of my invention to provide a means of storing the preselected combinations of stops in a memory system which can readily be mounted within the available console space in even the most complex instruments, and means of driving the stops quietly to their preselected positions on a single command.

Other objects, features, uses and advantages of my invention will become apparent during the course of the following description.

The operation of my invention will best be understood by referring to the accompanying drawings which form a part of this application, and in which like numerals are used to designate like parts throughout the same.

FIG. 1 is a representation of a typical pipe organ console in which my invention is employed; and

FIGS. 2, 3 and 4 are simplified schematic diagrams, illustrating various embodiments of my invention.

In the drawings wherein for purposes of illustration are shown preferred embodiments of my invention, the numeral 10 designates a pipe organ console generally. It should be clearly understood, however, that this invention may be applied equally to electric or electronic organs and pianos of various types, reed organs, harmoniums, accordions, harpsichords, and other musical instruments where simultaneous manipulation of a number of separated controls is desired.

In FIG. 1, the numeral 11 denotes the stop control devices or, more simply, "stops" which are used to modify the timbre of the organ. These may be of various e.g., such as draw-knobs, tilting tablets, tilting key-levers, etc., and 44 ranks of pipes, coupler mechanisms, tremulants, 332, other tone producing parts of the instrument; all of which are well known in the art and the details of which are not shown. Four Numeral 12 denotes the combination pistons, combons, or, simply, pistons by which preset combinations of stops may be called forth. These may be in the form of pushbuttons mounted columns the slips directly below the manual keyboards, where they are readily operated by the thumb or finger, or they may be switches near the pedals and operated by the foot, commonly called "toe-studs". Switch 13 is an additional switch or push-button which is actuated when it is desired to set a new arrangement of stops into the combination action memory.

FIG. 2 shows a preferred embodiment of my invention wherein multiaperture magnetic memory cores of the "transfluxor" type are used. The operation of the transfluxor is described in technical literature e.g., J. A. Rajchman and A. W. Lo, Volume 44, Proc. I.R.E., pages 321-332, Mar. 1956; and J. A. Rajchman, Volume 49, Proc. I.R.E., pages 104-127, Jan. 1961). Four of these transfluxors, denoted by the numeral 20, are shown in FIG. 2, but in a representative instal-

lation there may be several hundred arranged in a matrix of vertical columns associated with the combination piston switches 21 which are operated by the pistons 12 of FIG. 1, and of horizontal rows associated with stop controls 11 of FIG. 1. These stop controls are operable both manually and electrically by means of electromagnets 26 and 27, arranged so electromagnet 27 turns the stop "on" and electromagnet 26 turns it "off". The stop control also operates the switch contacts 22a and 22b, where 22a is shown in the position with the stop "on", and 22b with the stop "off". Means, usually mechanical or electrical, of controlling the pipes or other mechanisms from the stops are not shown in the FIG., but are familiar to those versed in organ building and design.

To "set up" or store a combination of stops, the desired arrangement of stops is selected and set switch 13 is depressed, transferring contacts 28 to the "set" position. The desired piston 12 is then pressed while set switch 13 remains down. Piston 12 closes contacts 21, with one contact pair applying power from source 33 to the blocking pulse generator 29, which in turn sends a pulse through the large or "block-set" hole of the transfluxors in the chosen vertical column, forcing them into the so-called "blocked" condition. A few milliseconds later this pulse emerges from the delay circuit 30 and triggers the set pulse generator 31. The set pulse is of opposite polarity and weaker amplitude, and it is apparent from FIG. 2 that it flows twice through the transfluxors in the chosen vertical column which are also in a horizontal row whose stop switch contacts are in the "on" position as at 22a, but not more than once through any other transfluxors. The amplitude of the set pulses is so chosen that they will "set" or partially demagnetize the cores through which the current flows twice, but because of the rectangular hysteresis loop of the magnetic material of the transfluxors, it leaves in the "blocked" condition all cores traversed only once.

When the various pistons or vertical columns are set up as desired, set control 13 and its associated contacts 28 are returned to the "normal" position. When the operator wishes to call on this memory matrix to drive the stops to one of these preset combinations, he simply depresses the desired piston 12 closing contacts 21 thereby energizing interrogate pulse generator 32 which sends a bipolar train of pulses into the smaller or "interrogate-read" holes of the transfluxors in the chosen vertical column. In all transfluxors of this column which had previously been left in the "set" or partially demagnetized condition, passage of this pulse train causes an output signal to be passed through amplifiers 23, rectifiers or threshold selectors 24, and into relays 25. Meanwhile, operation of switch 21 has also closed relay 34, so power source 35 is connected through the electromagnets 27 which in turn move the preselected stops to the "on" position.

At the same time the interrogate pulse from 32 also flows in those transfluxors of the selected column which had been left in the "blocked" condition. Because of the characteristics of the transfluxor, however, no appreciable output appears in the horizontal circuits of these transfluxors or through the corresponding amplifiers 23 and rectifiers 24, so these relays 25 are left unoperated. Hence the current from source 35 flows via relay 34 into the electromagnets 26, causing these stops to go into the "off" position if they were "on" previously. The relays indicated by 24 and 34 may be replaced by functionally equivalent solid state circuits and devices familiar to those versed in the art. The matrix formed by the stop and piston circuits may also be divided in such a manner that certain pistons control only a certain group of stops, such as those related to one manual or division of the organ.

FIG. 3 shows an alternate embodiment of my invention using memory storage cores of the type called "biax" which have two holes orthogonally disposed in a rectangular parallelepiped. Four of these cores 41 are shown arranged to symbolize a matrix of vertical columns corresponding to pistons, and horizontal rows associated with stops. Setting up of stop combinations is accomplished as has been previously described. The stops are manually moved to the desired ar-

range, carrying with them the contacts of polarity reversing switches 42 (the upper one in the FIG. is shown with the stop "on" and the lower one with the stop "off"). Set control 13 is operated, placing switch 52 in the "set" position. One of the pistons 12 is depressed thereby closing contacts 44 while switch 52 remains at "set", thereby causing a signal from generator 51 to flow simultaneously through both holes of the biax cores in the selected column. The signal levels are adjusted so that no change is made in the remanent flux of cores in which current flows only in the horizontal row circuits, but in those cores through which current flows in both the row and column circuits, the remanent flux is oriented in a manner depending on the direction of flow of the current in the horizontal row, and hence by the position of the reversing switches 42a and 42b.

After "setting up" the pistons, switch 52 is returned to the "normal" position by releasing set control 13. When it is desired to command the stop switches to take their preselected positions, one of the pistons 12 is pressed closing a switch 44. Operating through diode gates 54, this actuates the bipolar pulse train source 40 by closing the circuit from power source 53. These pulses, properly shaped and regulated in interrogate pulse shaper 43, pass through the biax cores in the chosen column, generating an output signal in each of the associated amplifiers 46. As a result of the magnetic flux orientation in the biax cores, however, the polarity of the output signal is dependent on the previous direction of the current in the horizontal row and hence the previous position of the particular switch 42. This output polarity is determined by a phase-sensitive demodulator or by an arrangement of gates 47a and 47b as we have shown in FIG. 3, where the gating signal, in the case of gate 47b comes directly from the pulse source 40, and in the case of gate 47a, comes from pulse source 40 by way of phase inverter 45. Hence, only one of the output amplifiers 48a or 48b is activated, and current flows only in either electromagnet 49 or 50 depending on the prestored information in the cores 41. As in the embodiment of FIG. 2, these electromagnets drive the stops to their preselected positions.

FIG. 4 shows a third and more general embodiment of my invention in which memory storage devices may be any desired form of ferromagnetic or ferroelectric memory devices, such as single aperture magnetic cores, cells of a monolithic memory block, crystals of barium titanate, crystals of barium-strontium titanate and similar elements. As in the earlier embodiment only four elements are shown, but it is understood that any number of columns (representing pistons) and rows (representing stops) may be employed. Set signal generator 62, properly designed for the chosen memory elements, is actuated by placing the two sections of switch 64 in the "set" position and then closing the desired piston switch 66. The setting signal output level is so chosen, however, that the memory element is not switched to store a "1" unless one of the switches 65, operated by the stop mechanism 11, is also closed. After the combination pistons 66 are properly "set up" in this manner, setting switch 64 is returned to the "Normal" position.

The performer can now command the stops to take their desired positions by closing a selected piston switch 66, allowing the interrogate signal to flow in the memory elements of the selected column. An output flows into sense amplifier 67 from those cores in which a logical "1" has been previously stored. This output properly amplified turns on trigger circuit 71, which may be a locking relay, silicon controlled rectifier, thyatron or other equivalent device. This in turn permits current to flow in solenoid 69, attracting the armature of stop control lever 11 and placing it in the "on" position. If the output is not present from the memory element 11, since a logical "1" was not stored, the trigger circuit 71 is not actuated, but by means of inverter 70 the complementary trigger 71a is ac-

tivated, causing current to flow in solenoid 69a, which drives the stop control lever 11 to the "off" position. If the memory element is of the type frequently designated "destructive readout", the process of interrogation erases the stored information in the memory elements 61. If this is the case, an additional restoring circuit 68 is required for each stop. This operates like the set signal generator 62 to restore the "1" condition in those memory elements in which a "1" was stored before the interrogation, using the coincidence of current in both row and column circuits. Certain other power supply circuits, denoted generally by 53, and pulse control circuits will also be required, but their nature will be dependent on the type of memory elements chosen and are of the type well known in the art.

As we have previously noted, although the embodiments here described have been shown in relation to a pipe organ, my invention is equally applicable to other musical instruments such as electric and electronic organs, electronic pianos, harpsichords, carillons, accordions, and the like. Other embodiments and variations will also be apparent to those versed in the art, such as using other types of magnetic cores, plates, thin film memories or ferroelectric storage devices to accomplish a similar purpose. I do not wish to be limited to the specific examples herein described, for obvious modifications will occur to those skilled in the art without departing from the spirit of my invention or the scope of the subjoined claims.

I claim:

1. A system for positioning the stop controls of organs and similar musical instruments comprising:

- a matrix having at least one row and one column of memory cells formed of ferromagnetic or ferroelectric material;
- an input circuit associated with each row of the matrix and a selector therefor which upon actuation provides approximately one-half the flux necessary to set the memory cells in that row to their "on" position;
- an input circuit associated with each column of the matrix and a selector therefor which upon actuation provides approximately one-half the flux necessary to set the memory cells in that column to their "on" position;
- an interrogate circuit associated with each column of the matrix and a selector therefor which upon actuation causes an output pulse to be emitted from each of the memory cells which had been previously set to "on" by the coincidence of flux supplied by both the row input circuit and the column input circuit;
- an output amplifier associated with each row for amplifying the output pulse from any memory cell in the row which had previously been set to "on" by the coincidence of flux supplied by both the row input circuit and the column input circuit and which had been actuated by the interrogate circuit;
- a stop control switch; and
- an electromagnetic solenoid associated with each row connected to the output amplifier and to the stop control switch such that the output pulse actuates the solenoid to thereby drive the stop control switch to the desired position.

2. The invention of claim 1 wherein the memory cells are nondestructive readout, multiple aperture cores.

3. The invention of claim 1 wherein the memory cells are nondestructive readout cores of the transverse axis type.

4. The invention of claim 1 wherein the memory cells are single aperture cores and including a feedback circuit connected to the stop control switch to restore the memory status of the cores after destructive readout.

5. The invention of claim 1 including a combined control selectable to two positions whereby the column input circuit selector and the column interrogate selector for the same column are operated by the said combined switch.