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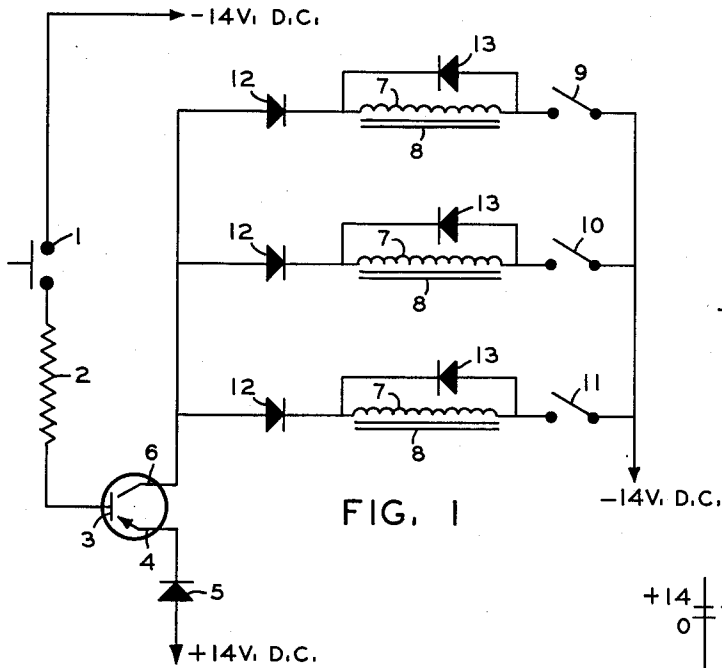


FIG. 1

FIG. 2

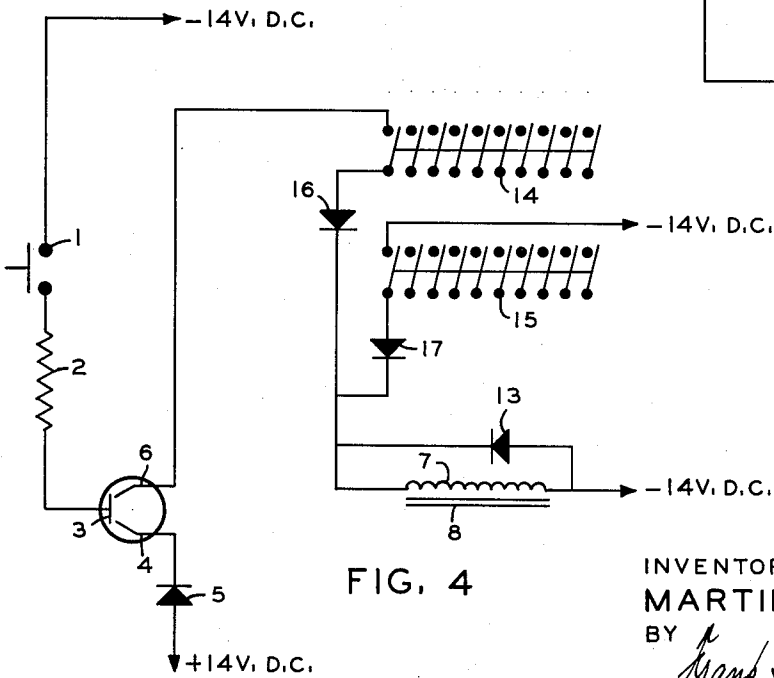


FIG. 4

FIG. 3

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ORGAN KEY CIRCUIT

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The electric pipe organ art has hitherto exclusively used mechanical relays in the organ key circuits. By this I mean that there has been used only the wire-wound coil, accompanied with a centrally-disposed iron core magnet. There have been countless variations of this construction in the art. The organ keyboard has thus been a group of electrical switches, for making and breaking the connections to the coils.

One of the principal objects of my invention is to design an organ key circuit which will not use any electromechanical components. All relay situation requirements can be successfully met by the use of transistor components. I have designed several variations of a solid state circuit for use in the construction of electrical pipe organs which meet all the requirements of the art.

Another object of my invention is to provide a diode and coil combination in which the diode acts as a means of blocking the current from being able to flow in any portion of the circuit where current flow is not specifically desired. This makes it possible to avoid using switches in the chest magnet circuits. A given stop may be turned on or off by simply opening or closing the return circuit connected to that stop.

A further object of my invention is to provide a diode in series with the coil of a chest magnet as a substitute for the customary magnet switch of the art.

A still further object of my invention is to provide a diode in parallel with the coil of a chest magnet in order to provide a direct short circuit to transient voltages developed within the chest magnet coil at the moment when the circuit is broken. The direct short circuit allows the transient voltage to recirculate through the coil and the contact is thereby protected from the arcing of the transient voltage.

Another object of the provision of a diode in parallel with the chest magnet coil is to increase the decay time of the voltage. Since the transient voltage is being recirculated, the decay time has been increased. The result of this is that the closing of valve controlled by the chest magnet is delayed. I find that the delay in closing is an added advantage as it enables the valve associated with the magnet to close in a more uniform manner and thereby improves the "speech" of the organ pipes.

Another object of my invention is in the art of "borrowing" which is familiar to all skilled in the art of an electric organ construction. "Borrowing" is the term applied to selecting a note to be used for a given stop. For instance for a given stop, such as a flute stop, you often wish to make two or three "borrows" to give a certain composite sound to that particular stop. Heretofore it has been impossible to borrow a note simply by using a relay and a single contact. The past practice is an involved one, requiring the use of a multiple contact relay for every note borrowed. Since there were multiple contacts, it was necessary to have multiple wires for those contacts, for every note borrowed. This arrangement simply multiplied the wiring problems for "borrowing." A new result of my invention is that I provide a means for "borrowing" any given note merely by adding a diode and a contact for that note. This greatly simplifies the wiring of the borrows for the stops. And as there are several borrows used for each stop in an electric pipe organ, the new result I have provided means a great saving in time and parts, as well as contributing greatly to the simplification of the wiring problems.

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Various other objects and advantages of the invention disclosed will be apparent to those skilled in the art of constructing electric pipe organs from the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic of my transistorized key circuit for a so-called straight chest, showing the use of diodes in series and in parallel with each chest magnet;

FIGURE 2 is a graph showing the plot of voltage versus time, together with the development of severe transient voltage, when a typical key circuit has been opened;

FIGURE 3 is a graph showing the plot of voltage versus time, when my improved transistorized key circuit is employed; and

FIGURE 4 is a schematic of my transistorized key circuit applied to a unit chest, in order to accomplish borrowing of a note for a given stop.

Referring now to FIGURE 1 of the drawings, numeral 1 is given to the key contact switch, which is connected at one side to the negative side of a typical fourteen volt direct current supply voltage. At the other side the key contact 1 from the keyboard is connected to a resistor 2, which in turn is connected to the base 3 of a 2N250 power transistor. The emitter 4 of the power transistor is connected to a diode 5 which in turn is connected to the positive side of the 14 volt direct current power supply.

The collector terminal 6 of the power transistor is shown connected to three parallel branches, which represent three typical chest magnets. Each chest magnet consists of a coil 7 and a core 8. Each coil 7 is a typical chest magnet wire-wound coil and each core is a typical slug of iron. Together they control a valve on a pipe in the pipe organ. I have illustrated three to illustrate the use of the same note in three uses with three different stops.

The three stops are represented by three stop action return switches 9, 10, and 11. Each of these is a hand actuated stop located as usual on the organ console. Closing of either of the stop action return switches makes a connection for the return supply, since each is connected on the right side of the FIGURE 1 with the negative side of the 14 volt direct current power supply.

Each typical chest magnet consisting of a coil 7 and a core 8, has diode in series with the coil 7 and this is called the series diode 12. Each coil 7 also has a diode connected in parallel with the coil and this is called the parallel diode 13. Each has significant purpose which will be explained in detailing the action of the circuit.

To play the given notes shown the stop action return switches 9, 10 and 11 are closed, connected as they are to the negative side of the power supply, they prepare those stops to be actuated.

Now when the organist closes the key contact 1, by playing the note shown on the organ keyboard, current will flow from the emitter of the power transistor to the collector 6 of said power transistor and thence into the coils, 13. This action will cause those coils in the chest magnets to open the valves of the pipes with which they are associated and the notes of those pipes will resound. Release of the key contact 1 will reverse the process and the valves associated with the chest magnets will close and the notes will be heard no longer.

Now it will be apparent what the function of the series diodes 12 is, for the following reason. If two or more stops are closed at the same time in a given circuit there exists the possibility of sneak circuits or so-called phantom circuits, in which current would pass in reverse through the coils and this current would actually actuate some of the chest magnets.

The series diodes 12 prevent coil currents from passing in the reverse sense through the coils and hence kill the possibility of any phantom circuits. Thus it is impossible

to actuate any of the coil chest magnets by reverse currents generated in phantom circuits.

The purposes and functions of the parallel diodes 13 are more diverse. There are three obvious reasons for using the parallel diodes in this connection. The first reason is to squelch the arc. The valve connections of the typical electric pipe organ have contacts across which the connected currents pass. When those currents pass through an air path during the disconnect phase, the contacts are burnt and gradually destroyed. Squelching of the common arc by the use of the direct short circuit path provided by the parallel diode is the simplest way of avoiding the burning of the contacts.

The second reason for the parallel diode is illustrated by the FIGURES 2 and 3. In FIGURE 2 I show a plot of voltage versus time for the situation in which the parallel diode 13 is not connected in the circuit. When the key contact is closed, current flows through the coil 7. When the key contact 1 is subsequently opened, a transient voltage which is an induced voltage is produced in the coil, and this is a relatively large voltage exerted opposite to the ordinary fourteen volt supply placed across the coil 7 to actuate the typical valve of the note played. The action is thus: The fourteen volts positive drops through zero to about two hundred and thirty volts negative and then rises rapidly to zero as the transient voltage decays to zero.

With the parallel diode 13 connected in the circuit, the situation is different. This is illustrated in FIGURE 3. Again the voltage is plotted versus time for the voltage across the coil 7. With the parallel diode in the circuit a direct short circuit opposes the current. This energizes the coil until the voltage decays gradually to zero. And at no time does the voltage drop below zero.

A third reason is shown for the use of the parallel diode in the coil 7 circuit. The transient of some two hundred and thirty volts would burn out the power transistor.

It will also be noted that the use of the parallel diode 13 serves to lengthen the dropout time. The drop out time is the time it takes the valve to close. Often it is noticed that the drop out time at present is low. The armature of the valve may hit so hard, because of the high transient voltage, against its framework that it may bounce back and close again momentarily. This so-called chatter effect has been observed in many makes of organs. The use of the parallel diode stretches out the decay or drop out time and the note dies away gradually along a decay pattern proportional to the slope of the decay curve shown in FIGURE 3. This is referred to as improving the "speech" of the pipes.

In FIGURE 4 I show my transistorized key circuit for a unit chest, to illustrate the possibility of "borrowing" a note in the new circuit. Previously, until my invention, to borrow a note it was necessary to have a multiple contact relay. With my arrangement I can borrow a note with a single diode and a contact. It is common to make two or three "borrows" for a given "stop." I simply use one blocking diode for each note borrowed.

In FIGURE 4, numeral 1 is again the key contact switch. The resistor 2 joins switch 1 to the base 3 of the power transistor. The emitter 4 is again connected by the diode 5 to the positive side of the fourteen volt supply voltage. The collector 6 of the power transistor, a 2N250, connects to a typical 61 circuit gang switch of which two are shown 14, and 15. Each gang switch is used to play a stop at other pitch or from another manual keyboard. The chest magnet for a given note is represented by the coil 7 and the core 8 as before.

The parallel diode 13 is placed in parallel across the coil 7, whose right side is connected to the negative side of the fourteen volt direct current power supply.

To connect any given note, that is to make a "borrow"

for a given stop, I perform the following simple step: I simply place a blocking diode or what in the FIGURE 1 was called the series diode, in series with the chest magnet coil 7. I show two such connections in FIGURE 1, with the series diodes 16 and 17, which are used to connect the first note switch of each of the two 61 circuit gang switches illustrated. Thus those two first notes are connected to the note controlled by the magnet coil 7 and will be effectively borrowed for the given stop desired.

This is a very simple step to perform the formerly difficult process of borrowing which is commonly known to all practitioners of the organ construction art.

The above and many other modifications and changes can be made in the preferred embodiment of my invention which I have illustrated. I intend no limitations upon my invention other than may be imposed upon the scope of the appended claims.

What I claim is:

1. In an organ key circuit having a direct current power supply, a key contact switch and a chest magnet comprised of a magnet coil and a magnet core controlling the action of the pipe valve of the pipe associated with said key contact switch, a power transistor having a base connected to said key contact, an emitter and a collector terminal, a diode whose input side is connected to the positive side of the direct current power supply, and whose output side is connected to the emitter of said power transistor, a blocking diode whose input side is connected to the collector of said power transistor, and whose output side is connected to the positive side of said magnet coil, a stop action return switch connected at one side to the negative side of said magnet coil, and at the other side to the negative side of said power supply.

2. In an organ key circuit having a direct current power supply, a key contact switch and a chest magnet comprised of a magnet coil and a magnet core controlling the action of the pipe valve of the pipe associated with said key contact switch, a power transistor having a base connected to said key contact, an emitter and a collector terminal, a diode whose input side is connected to the positive side of the direct current power supply, and whose output side is connected to the emitter of said power transistor, a parallel diode connected across said magnet coil, said magnet coil being connected at its positive side to the collector of said power transistor, a stop action return switch connected at one side to the negative side of said magnet coil and at the other side to the negative side of said power supply.

3. In an organ key circuit having a direct current power supply, a key contact switch and a chest magnet comprised of a magnet coil and a magnet core controlling the action of the pipe valve of the pipe associated with said key contact switch, a power transistor having a base connected to said key contact, an emitter and a collector terminal, a diode whose input side is connected to the positive side of the direct current power supply, and whose output side is connected to the emitter of said power transistor, a blocking diode whose input side is connected to the collector of said power transistor, and whose output side is connected to the positive side of said magnet coil, a stop action return switch connected at one side to the negative side of said magnet coil, and at the other side to the negative side of said power supply, and a diode wired in parallel across the magnet coil to oppose induced currents in said magnet coil.

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