peterson

SOLID STATE SWITCHING SYSTEMS FOR PIPE ORGANS

MERGING MODERN TECHNOLOGY WITH THE ART OF ORGAN BUILDING

11601 S. Mayfield Avenue, Alsip, Illinois 60803
Tel: 708-388-3311 or Toll Free: 800-341-3311
FAX: 708-388-3367

CONTENTS

peterson
ELECTRO-MUSICAL PRODUCTS, INC., ALSIP, ILLINOIS 60803 AREA CODE 708 388-3311

DEFINITION OF TERMS AND DESCRIPTION OF PARTS AND ASSEMBLIES USED IN PETERSON SOLID STATE SWITCHING SYSTEMS

DEFINITION OF TERMS AND DESCRIPTION OF PARTS:

BACK E.M.F.

When an electrical current is flowing through a coil (electro-magnet) and the current is suddenly stopped, the collapsing magnetic field causes a reverse polarity voltage to transiently appear across the magnet. This Back E.M.F. Voltage can be as high as several hundred volts and could cause damage to solid state components if not suppressed. (See Flyback Diode.)

BOARD OR PRINTED WIRING BOARD ASSEMBLY

A general term applied to the combination of etched copper wiring secured to an insulating material with components mounted and generally soldered to it.

CAPACITOR

A two-lead component which will pass alternating current (A.C.), but not direct current (D.C.). Small value disc capacitors and tantalum capacitors are used to filter transient and parasitic (A.C.) current in many circuits. Larger values of electrolytic capacitors will also store D.C. and will filter lower frequency A.C. These are often used as rectifier filters.

NOTE: Tantalum and electrolytic capacitors are polarized. The more positive voltage must be applied to the side labeled "+". Their voltage rating must be greater than the voltage applied to them.

CHEST RETURN

The common wire connecting all chest magnets together.

COMMON DIODE (Figures 5, 7 & 10)

A 3 or 6 amp diode, as required, used on coupler driver and pipe driver assemblies to bias the driver transistors to assure that they turn completely off. Note that in the case of pipe driver assemblies, all of the chest magnet current flows through the common diode.

CONNECTOR (Figure 22)

A special disconnectable junction used between various assemblies of solid state switching systems, or between the switching system and the organ console or wind chests.

COUPLER DRIVER ASSEMBLY

(USUALLY CALLED COUPLER DRIVER). The entire assembly consisting of one coupler driver junior board and several one octave coupler driver boards as needed, an output connector board (if the coupler driver assembly is not part of, and cabled by us to, a Peterson relay), and the driver mother board into which all other boards plug via connectors. The input and output polarities are positive. Special versions are available if coils of less than 40 ohms are to be driven.

COUPLER DRIVER, I.C. (Figure 16)

A printed wiring board assembly consisting of input and output connectors, shim diodes, resistors, a fuse, and integrated circuit drivers. Generally, these drivers take the output of the coupler switches and step the current up to drive the switching portion of a Peterson relay. These drivers have positive input and output polarity, and can drive a load as low as 50 ohms.

COUPLER DRIVER JUNIOR (Figure 5)

A printed wiring board assembly consisting of input and output connectors, two common diodes, and the initial driver transistor and final driver transistor for either one or eight notes (as required for the application), as well as a variety of resistors to protect the transistors and insure proper operation. If a magnet is to be driven from the coupler driver junior, a fly-back diode is inserted to protect the coupler driver junior from Back E.M.F. The diode is in place of the 2.2k load resistor normally supplied.

COUPLER DRIVER, ONE OCTAVE (Figure 6)

A printed wiring board assembly consisting of input and output connectors, an initial driver transistor and a final driver transistor for each of the 12 notes encompassed, as well as a variety of resistors to protect the transistors and insure proper operation. If magnets are to be driven from the one octave coupler driver, fly-back diodes are inserted to protect each note from Back E.M.F. The diodes are in place of the 2.2k load resistors normally supplied.

DIODE (Section II, Page 8)

A two-lead solid state device used to pass current in one direction and to prevent current from being passed in the other direction. Diodes come in several sizes having different current carrying capacities and reverse breakdown voltage limits. All diodes have a banded end indicating the cathode. The diode will conduct when the cathode terminal is "negative" compared to the other (anode) terminal. All diodes operate in the same manner except for a special type called a zener diode, which is described later.

DIODE COMMON DIODE

See common diode (Page 1).

DRIVER MOTHER BOARD (Figure 2)

A printed wiring board assembly consisting of the printed wiring board, spacing shoulder washers and wafer pins. The coupler driver junior and one octave coupler drivers, or pipe driver junior and one octave pipe drivers, and the output connector, plug onto the driver mother board. The driver mother board distributes the applied voltages to each of the boards plugged into it.

FLY BACK DIODE (Section II, Page 8)

A diode connected across a magnet (in reverse polarity to normal operating voltage) to prevent the build up of the Back E.M.F. (or kick-back voltage) that would otherwise damage the switching transistors. This diode is usually a one ampere 200 volt peak inverse voltage type which is slightly larger than many of the other diodes used in the switching system. Note that the kick-back voltage across the magnet could be several hundred volts without the fly-back diode connected, but with the diode, the kick-back voltage is not developed. A 200 volt P.I.V. rating is therefore more than suitable for this purpose.

FUSES

Article 650 of the **National Electrical Code®** as revised for 1990 has certain requirements for fusing circuits. Wherever practical to use fuses directly on printed wiring board assemblies, we have done so. In some cases it is necessary to include fuses as part of wiring harnesses. A booklet entitled "IMPORTANT INFORMATION ABOUT THE **NATIONAL ELECTRICAL CODE®**" is available from Peterson.

INTEGRATED CIRCUIT (I.C.) (Section II, Page 8)

A solid state device usually in a rectangular black epoxy case with leads (pins) on the two long sides. The integrated circuits (I.C.s) that we use for drivers have a total of 18 pins. The replacement number for these I.C.s is Peterson #150151, industry #UDN2982. Each of these I.C.s contains 32 transistors, 32 diodes and 40 resistors. These components are connected to provide 8 drivers in each I.C., although when used in driver assemblies, we often use only six drivers per I.C., so that two I.C.s produce one octave of drivers.

I.C. DRIVER ASSEMBLY (Figures 15-17)

A printed wiring board assembly consisting of input and output connectors, integrated circuits, one or more fuses, and resistors and diodes as required. There are 3 types of I.C. drivers that we use; pipe driver, coupler driver and straight driver. The straight driver has a "switch" included in its circuitry. All of these I.C. drivers are positive input (keying) and positive output.

INPUT LOAD OR INPUT CONNECTOR BOARD (Figure 3)

A printed wiring board assembly designed to accept the organ key cable and load the key circuits slightly with 2.2k ohm resistors. The organ key cable wires directly onto the pins, with the cable bundle on the back side, and the individual wires passed through the holes. The connector plugs onto the first row of pins on the switching panel assembly. Organ positive voltage is provided through a fuse to a pin on the input load board as a convenient source of the key common feed.

INVERTER

An assembly made (on special order) to reverse polarity. Generally, to enable our relay to work with an older relay or equipment of other manufacturers.

KEY CONTACT

Only a single key switch contact for each key of the keyboard is required for a Peterson solid state switching system, regardless of the size of the organ. Sometimes 2 or more contacts are connected in parallel, the redundancy assuring that a key will not be dead because of a dirty or otherwise bad contact. Even with a large organ the key contact current is low and there is no burning, pitting, or sparking of contacts. On the other hand, using contacts in parallel is a good idea because otherwise, if there is a bad contact, everything that plays from that key will be silent.

KEY FEED

The common wire connecting all key contacts. When a key is depressed, the key feed voltage is fed to the relay. Peterson switching systems are designed to accept a positive keying voltage.

LOW CAP DIODE (Section II, Page 8)

A term used in connection with the smallest (low capacity) diodes that are used in the system. Most of the diodes used are of the "low cap" type. "Low cap" distinguishes these small diodes from power diodes used for high current applications.

MODULE

Generally any sub assembly which, when plugged together via connectors, cables, or mother boards to other modules comprises a solid state switching system. All modules carrying the same four-hundred-thousand (40XXXX) series part number are interchangeable. Occasionally, modules that look almost identical are in fact slightly different. Therefore, if there is any doubt, always check the part number.

MOTHER BOARD (Figures 1 and 2)

A general term covering any printed wiring board assembly which serves as a base for other printed wiring board assemblies. The Mother Board is usually secured to the mounting surface with wood or sheet metal screws.

NATIONAL ELECTRICAL CODE® ARTICLE 650

The part of the **NEC®** that specifically pertains to pipe organs. Several important changes were made to this section of the code for 1990. We urge you to become familiar with the **NEC®**. Peterson systems have been updated as necessary to comply with the new code, and a booklet entitled "IMPORTANT INFORMATION ABOUT THE **NATIONAL ELECTRICAL CODE®**" is available to help you understand how to use your Peterson equipment in compliance with its requirements.

OUTPUT CONNECTOR BOARD (Figure 4)

A printed wiring board assembly designed to accept the organ chest cables. The chest cable wires directly onto the pins with the cable bundles on the back side and the individual wires passed through the holes. This connector generally plugs onto the output pins of the pipe driver assemblies but can be used whenever this general type of connector is needed.

PIPE DRIVER ASSEMBLY (Figure 20)

(Usually called pipe driver). Consisting of one pipe driver junior board and several one octave pipe driver boards as needed, an output connector board to which the chest cable is connected, and the driver mother board onto which all the other boards plug via connectors. One pipe driver is required for each unit rank of pipes. The input polarity is positive and the output polarity is negative. Special versions are available for driving loads of less than 40 ohms.

PIPE DRIVER, I.C. (Figure 17)

The same as an I.C. coupler driver, but with connectors arranged so that an output connector board will plug onto it. The input and output polarities are positive.

PIPE DRIVER JUNIOR (Figure 7)

A printed wiring board assembly which plugs onto the driver mother board, consisting of two common diodes as well as one driver transistor (150031, orange), 100 ohm protective resistor, and 1 amp fly-back diode for either one or eight notes (as required for the application).

PIPE DRIVER, ONE OCTAVE (Figure 8)

A printed wiring assembly which plugs onto the mother board, consisting of a driver transistor (150031, orange), 100 ohm resistor, and 1 amp fly-back diode for each of the 12 notes encompassed.

PIPE DRIVER JUNIOR, HEAVY DUTY (Figure 7)

(For magnets as low as 20 ohms). A printed wiring board assembly which plugs onto the driver mother board, consisting of 6 amp common diodes, and a heavy duty driver transistor (2SD1292), a 100 ohm protective resistor, and a 1 amp fly-back diode for each of either one or eight notes as required. These extra notes are usually the 61st note of a manual stop, or the top eight notes of a pedal stop.

PIPE DRIVER, ONE OCTAVE, HEAVY DUTY (Figure 8)

(For magnets as low as 20 ohms). A printed wiring board assembly which plugs onto the driver mother board, consisting of a heavy duty driver transistor (2SD1292), 100 ohm protective resistor, and a 1 amp fly-back diode for each of the 12 notes encompassed.

POLARITY

In D.C. circuits, the difference in voltage potential between two points will make one point positive with respect to the other. There are only two points of real concern in the relay, termed organ positive and organ negative. These are the same as the rectifier terminals as far as connection is concerned, and can be thought of as an extension of the rectifier terminals.

PROTECTED POSITIVE (Figure 19)

The red terminal on the test and power junction yields a current-limited positive voltage used for testing purposes.

LOAD RESISTOR

A resistor used to put an electrical point at a desired voltage. In order for something to activate the circuit being loaded, the voltage at the loaded point must be overcome with a voltage of the opposite polarity.

PWBA, OR PRINTED WIRING BOARD ASSEMBLY

See Board (Page 1).

RELAY

A term used somewhat loosely to generally cover the entire assembly of sub-assemblies used to replace, functionally, such organ components generally referred to as couplers, coupler stack, coupler slides or traces, relay, key relay, switch stack, gang switch, stop switch, stop slides or traces, etc. In short, the term generally would cover any switching function involving the keying of magnets, more properly termed a **SOLID-STATE SWITCHING SYSTEM.**

RESISTOR (Section II, Page 8)

A component designed to offer a specific amount of resistance (opposition) to electric current. Resistors are used to limit or control the amount of current that can flow in a circuit.

SERIAL NUMBER (Figure 19)

All relays are assigned a serial number which is applied to the test and power junction and is used for identification of any prints, correspondence, etc., pertaining to a given relay. Please refer to the serial number if you find it necessary to contact us.

SFORZANDO DIODE (Figures 11, 12, 13, 14, 14A)

A diode, labeled D2 on the schematics and photos of all stop switch boards, which turns that stop on with the sforzando control. This diode may be clipped out or unsoldered and removed to prevent any stop from being included in the sforzando.

STANDARD COUPLER ASSEMBLY (Figure 21)

Consists of a mother board incorporating I.C. drivers and a test and power junction, with a 61 note switch, two 32 note switches with jumper cables, three stop switches and input and output connector boards plugged on. The inputs and outputs are for pedal, great and swell key (positive polarity). This assembly provides swell to great, swell to pedal, and great to pedal couplers. There is also provision for a non-coupled stop such as chimes, which requires a straight driver board.

STOP FEED

The common wire connecting all stop contacts. When the stop is in the "on" position, the stop feed voltage is fed to the "relay". Our standard switching systems require a positive stop feed. Negative can be accommodated on special order.

STOP SWITCH (Figure 11-14)

Controls the switch assembly by connecting the switch assembly shunt diode buss to negative (stop "off" condition) or allowing it to go to positive (stop "on" condition). It consists of a variety of resistors, diodes, and transistors. The sforzando diode (1 amp) is also located on the stop switch. To disable the sforzando for any given stop, clip or unsolder the sforzando diode. Any switch can be turned on by simply unplugging the associated stop switch.

STOP SWITCH, NEGATIVE (Figure 11)

Accepts a negative signal from the stop rail to turn the stop on.

STOP SWITCH, POSITIVE (Figure 12)

Accepts a positive signal from the stop rail to turn the stop on.

STOP SWITCH, NEGATIVE UNISON OFF (Figure 13)

Accepts a negative signal from the stop rail to turn the stop off.

STOP SWITCH, POSITIVE UNISON OFF (Figure 14)

Accepts a positive signal from the stop rail to turn the stop off.

STOP SWITCH, UNIVERSAL (Figure 14A)

A printed wiring board, part #404480, which may be configured as either a "Stop Switch, Positive" or a "Stop Switch, Positive Unison Off" depending on the position of a jumper wire or resistor with no color bands (zero ohm resistor). Two versions have been used as illustrated in Figure 14A. They may be identified by the color and position of the light on the top of the board. The newer version has a yellow light and a letter suffix after the part number, such as 404480A. The earlier version has a red light and no suffix letter. A yellow light should be on whenever the stop control contacts are closed. A red light should be on whenever the stop is active.

STRAIGHT DRIVER (Figure 10)

A printed wiring board assembly functioning as a combination of switch and pipe driver used where a given rank (set of magnets) has no borrows. Consists of one 2.2k ohm resistor, 2 low-cap diodes, one transistor (150031, orange dot) and one 1 amp fly-back diode per note. Common diodes for the rank are also included on the straight driver. The chest cable fastens to the straight driver output connector board which then plugs onto the straight driver. Suitable for driving loads of 40 ohms or higher.

STRAIGHT DRIVER, HEAVY DUTY (Figure 10)

A printed wiring board functioning as a combination of switch and pipe driver used where a given rank (set of magnets) has no borrows and has magnets below 40 ohms. Consists of one 2.2k ohm resistor, 2 low-cap diodes, one transistor (2SD1292) and one 1 amp fly-back diode per note. 6 amp common diodes for the rank are also included on the straight driver. The chest cable fastens to the straight driver output connector board which then plugs onto the straight driver.

STRAIGHT DRIVER, I.C. (Figure 15)

A printed wiring board assembly functioning as a combined switch and I.C. pipe driver, used where a given rank (set of magnets) has no borrows. This board consists of input and output connectors, shim diodes, resistors, a fuse, and integrated circuit drivers. The input and output polarities are positive. An I.C. straight driver can operate loads of 50 ohms or higher.

SWITCH ASSEMBLY (Figure 9)

Consists of one 2.2k resistor and 2 low cap diodes per note. The diodes are identified as "A", or series diodes, and "B", or shunt diodes. The "B" diode is identified as it has one end connected to the buss which runs the entire length of the board. This switch has the function of preventing the keying voltage from reaching the pipe driver, if the stop is off, or allowing the keying signal to reach the pipe driver if the stop is on.

SWITCHING PANEL ASSEMBLY (S.P.) (Figure 20)

Consists of switches, stop switches, and straight drivers as required, plugged into a mother board. The mother board distributes positive, negative, sforzando, and keying signals to the sub-assemblies plugged into them.

TEST AND POWER JUNCTION (Figure 19)

A printed wiring board assembly which serves as an input for the organ positive and negative (rectifier connections) as well as including a surge suppressor for same, a green pilot light indicating correct polarity and a red test light and binding post. The surge suppressor is a zener diode which will be a short circuit to reverse polarity as well as a short to any voltage exceeding 30 volts. The test light is merely an L.E.D. in series between the red test post and the positive input terminal. Use of the "protected positive" (red binding post) is covered in the trouble shooting section.

TRANSISTOR (Section II, Page 8)

A three-lead solid state device used to switch a relatively large current with a relatively small control current. The three leads are called the emitter, base and collector. The emitter is generally thought of as the element where the feed voltage is applied; the base is the control lead; and the collector is the output lead. Proper voltage applied to the base, through a resistor (which is needed to prevent excessive base current from destroying the transistor), will cause the emitter voltage to be switched (effectively connected) to the collector. (Technically, a transistor is a current operated device. When sufficient current is made to flow between the base and the emitter of the transistor, the transistor will "switch". Typically, the input current required to cause "switching" is between 1% and 10% of the "switched" current). Removing the applied current from the base will cause the transistor to stop conducting, effectively opening the "switch". There are various types of transistors used for different purposes. Many have a similar appearance but are not necessarily interchangeable. When replacing a transistor, check its part number to be sure it is a suitable replacement. Disregard any suffix letter. Early in 1978, a color coding system was instituted to make identification easier. Always replace a transistor with the same number or color (if color coded), as supplied by us. Other manufacturers may color code transistors and their code is not interchangeable with ours. Following are descriptions and applications of the transistor most commonly used in the Peterson solid-state switching system. A pipe driver transistor, # 15*031, N.P.N. type, orange or gold dot, is used to switch the relatively low current coming from the switches to the higher current required by magnets. Negative is present on the emitter. When current from a positive source is applied to the base (from the switches), the negative on the emitter is switched to the collector (output of the pipe driver). This transistor is also used in the stop switch. A 2SD1292 is sometimes used in place of the orange or gold dot transistor when especially low resistance magnets are encountered.

An initial driver transistor is also a #15*031, N.P.N. type, orange or gold dot, and is the first transistor toward the input of a coupler driver. Negative is present at its emitter. When a current from a positive source is applied to its base via the input of the coupler driver, the negative of the emitter will be switched to the collector and then onto the base of the final driver transistor. A final driver transistor, #15*007, P.N.P. type, red or silver dot is the output transistor of the coupler driver circuit. When a current from a negative source is applied to the base by the initial transistor, the positive applied to the emitter is switched to the collector (output of the coupler driver).

NOTE: There are two families of transistor - the N.P.N. and the P.N.P. The operation of these is similar, but the polarities are just the opposite from one another.

ZENER DIODE (Section II, Page 8)

A solid state device which works like any other diode in that it will conduct when the anode is positive with respect to the cathode. The special characteristic of a Zener diode is that when the polarity across the diode is reversed, current will not flow as in the other types of diodes until the "Zener" voltage is reached; at which time the diode will conduct even though the polarity is reversed, thus preventing the reversed voltage from exceeding the Zener voltage.

TECHNICAL DESCRIPTION AND THEORY OF OPERATION

Peterson Solid State Switching Systems, because of their modular design, are easy to trouble shoot and service even by those who know almost nothing about electronic theory. By swapping modules it is usually easy to identify a defective assembly and replace it with one known to be good. Simple ohm-meter tests then make it easy to locate a defective component on the module (as described elsewhere in this manual.)

Nevertheless, it is useful, and not at all difficult, to learn the "whys and wherefores" of how the system operates. The Peterson Solid State Switching System, unlike some ultra-sophisticated multiplex systems, is really a low technology system that is very elementary in concept, and easy to fully understand by any interested organ technician who will take just a little time to study the manual.

Before proceding, it is important to understand the three, and only three, basic electronic components that you may not be familiar with, and that are the ingredients of all of our electronic switching systems, no matter how large or small.

RESISTOR

A device that "resists" the flow of an electric current. Not a good conductor of electricity such as wire, and not an insulator, but something in between that can be inserted in a circuit to control the amount of current permitted to flow when a given electrical pressure (voltage), is applied. Resistors come in a great many different predetermined values with the resistance values specified in "Ohms". As might be surmised, a resistor of high ohmic value has a higher resistance to the flow of current than a resistor of lower value. The resistance of a given resistor is usually indicated by a color code that consists of various colored bands around the resistor. Resistors do not wear-out, and it is almost unheard of that a resistor will ever need replacement unless some other component failure, or accidental short circuit has resulted in the resistor being overheated because of an excessive current flowing through it. Should a resistor ever need replacement, it is important to replace it with one exactly the same resistance (color code) as the original.

DIODE

The diode is the most elementary solid state device and is perhaps the most useful. A diode is simply a device that has two terminals and that will pass an electric current freely in one direction, and for practical purposes, not at all in the other direction. Low cost diodes have only been available for the last decade or so and have since been used by the billions in all manner of electrical equipment. Diodes come in different sizes and the physical size is a rough indication of the current carrying capacity of the device. Generally speaking, Peterson equipment uses two sizes of diodes, a small one called a "low cap diode" which is suitable for currents up to approximately ¼ amp, (250 milliamp), and a larger unit that is capable of currents of several amperes. One lead of the diode has a band around the end of the unit to indicate the cathode. The other terminal is called the anode. The diode is schematically indicated as follows:

Diodes are extremely reliable components and they do not wear out, but they are subject to damage or destruction if exposed to excessive voltage or current. Diode failures, therefore, are usually due to an accident. Fortunately, they are inexpensive and easy to replace if accidently damaged.

TRANSISTOR

Transistors have countless applications in electronic systems, but in our Solid State Switching Systems the transistor might most directly be compared to a relay or a switch. Transistors have three terminals, with two of the three terminals representing an input to which a small current is applied to cause the transistor to "switch on." One of those same terminals and the remaining terminal are connected to a load, and in the presence of the small input current will switch current from a source of potential to the load as described below. There are many types of transistors available, but only a few types are used in Peterson Switching Systems. It is important if a transistor ever needs replacement that one of identical or equivalent specifications be substituted. Starting in early 1978, Peterson transistors have been color-coded by means of a dot on the end of each transistor, and transistors of the same color supplied by Peterson may be substituted in any system without regard to type numbers or other specifications. In more recent Peterson Switching Systems, Integrated Circuits are often used which incorporate the transistors for several notes, along with biasing resistors and flyback diodes (described later), into a small rectangular plastic package. The Integrated Circuits that we use for this purpose require that the chest magnet common buss be connected to Rectifier negative.

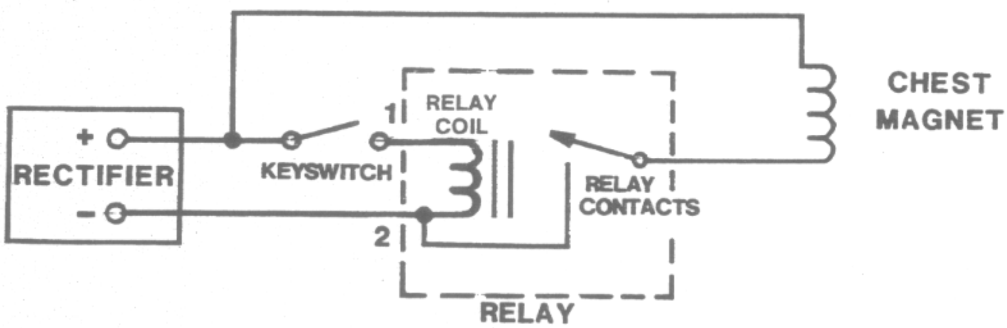


FIGURE A

To proceed now with a description of circuit operation, refer first to Figure A. The rectangle marked rectifier is an ordinary organ rectifier which supplies a voltage in the range of 12-16 volts. The keyswitch is a simple keyswitch such as is commonly operated by an organ playing key. The chest magnet is a conventional chest magnet or an "all electric" magnet, that when energized opens a valve under one of the pipes in the organ. The relay magnet shown corresponds to the relay magnets that have been commonly used in large organs and that usually have many contacts that "make" to a common feed bar or chopper. In this case, however, only a single contact has been shown. As anyone who is familiar with a conventional electric action organ will understand, closing the key switch will cause a magnetic field to develop around the coil of the relay magnet which will in turn attract the armature to the pole piece thus closing the relay contacts and completing the circuit between the rectifier and the chest magnet, causing the valve to open and the pipe to speak.

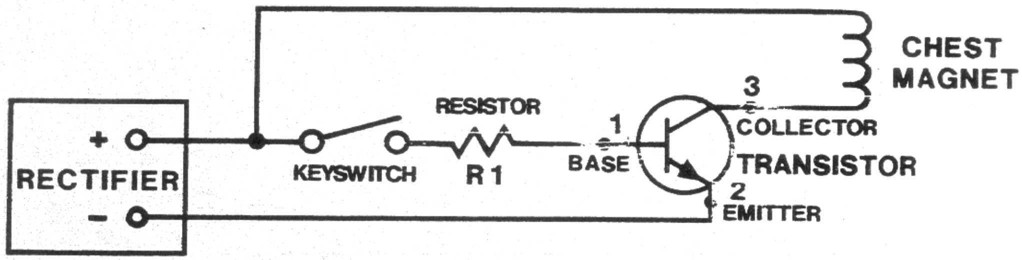


FIGURE B

Referring to Figure B will show how a transistor can perform the same function as the relay magnet, but without the mechanical relay contacts. Note that the relay has been replaced with the three terminal transistor with the three terminals being labeled base, emitter, and collector. Note that closing the keyswitch will cause a current to flow from the positive terminal of the rectifier through the keyswitch, through the resistor R1, through the base-emitter junction of the transistor, and back to the negative terminal of the rectifier. The purpose of the resistor R1 in series with the base of the transistor is to set, and to limit, the base-emitter current to a small valve, but one that is nevertheless sufficient to cause the transistor to "switch". This small base-emitter current (which is typically a few percent of the current required to operate the chest magnet) causes the collector to be electrically (more properly electronically) connected to the emitter. Thus the transistor, between collector and emitter, looks like a closed switch contact which again completes the circuit between the positive rectifier terminal, through the chest magnet, through the collector-emitter terminal of the transistor and back to the rectifier negative terminal. The transistor has eliminated the mechanical relay and has performed this function much more efficiently in that there are now no relay contacts to adjust, or to burn out, or to become pitted, or that take time to close and open. The transistor is capable of switching at a rate of hundreds of thousands of times per second, and since electrical currents travel at a speed of 186,000 miles per second, it can be seen that the delay that is common with conventional mechanical relays is not a factor with solid state equipment. Peterson Solid State Switching equipment utilizes a so-called "Driver Transistor" for each chest magnet in the organ, and these transistors are assembled in octave groups in the form of Pipe Driver assemblies as shown and described elsewhere in this manual.

So far, what has been accomplished is that very small currents controlled by keyswitches (and other electronic switching means to now be described), can feed very low input control currents to the respective Pipe Driver Transistors to cause the chest magnets to operate. The fact that the Driver Transistors require very small input currents, permit very small currents to flow through the organ keyswitches and related switching circuitry, and this permits the use of a somewhat different switching concept than most of us are accustomed to, but which are nevertheless very efficient and simple in concept.

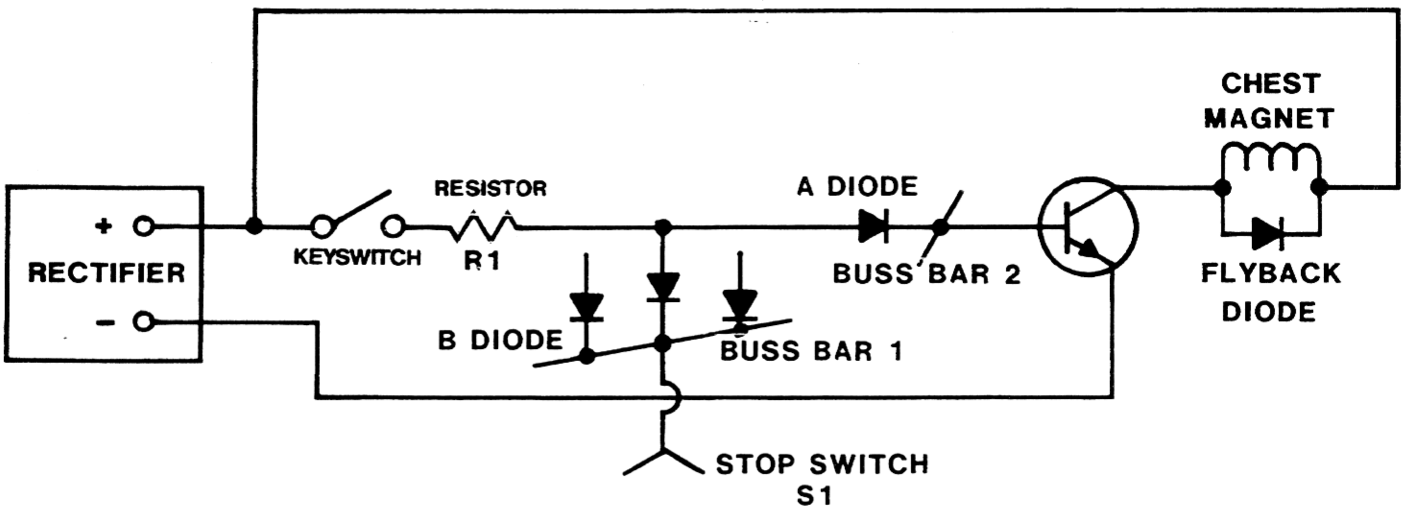


FIGURE C

Referring now to Figure C, much of the figure is the same as Figure B, but more parts have been added. Since one of the advantages of the Peterson Solid State System is to permit the use of but a single keyswitch per playing key, it is important that some additional switch device that does require an additional actual contact be provided to permit the keyswitch current to be channeled selectively to the various pipe driver transistors and chest magnets. For this purpose, a form of shunt switching is employed.

In Figure C, if a diode is connected from the right hand terminal of the Resistor R1 to the negative terminal of the rectifier, through the closed Stop Switch S1, it can be easily seen that since the diode will conduct when its anode (arrow side) is more positive than the cathode, that the "B Diode" will look like a short circuit and will therefore short circuit the current flowing through R1 and thus prevent any current from reaching the base electrode (or input terminal) of the transistor. Therefore, the transistor will remain switched off. If on the other hand the stop switch is opened, the B Diode will be inoperative and the current through R1 will flow through the "A Diode" to the base of the transistor, causing the transistor to switch and operate the chest magnet. The line labeled Buss Bar #1 is to illustrate that the B Diodes of many related notes may all be connected to the same Buss Bar and controlled by a single Stop Switch, S1, as shown. Thus, for example, if the keyswitch shown were the keyswitch associated with the lowest key on the swell keyboard, the components R1, A Diode 1, and B Diode 1, would constitute an electronic switching circuit that would be the equivalent of one part of switch contacts on a conventional electric gang switch with which we are all familiar. The other diodes (which are shown with one terminal connected to Buss Bar #1), would be connected to the output side terminals of the corresponding resistors, R1, for the rest of the notes of the stop that was desired to be switched on and off by the Stop Switch, S1. Note that when any keyswitch such as the one shown in Figure C is operated, the Buss Bar (assuming that the Stop Switch S1 is open), will be brought up to a high positive potential (equal approx. to the rectifier voltage), but that this voltage cannot find a phantom path to turn on other notes because the B Diodes will not conduct current when their cathodes are positive. If on the other hand the stop switch is closed, (returning Buss Bar #1 to the minus terminal of the rectifier), then all of the B Diodes are connected to shunt the current from their respective R1 resistors and prevent any of the Driver Transistors from switching to their "on" states. When the stop is turned off, the current shunted through the B Diodes must flow through the keyswitch and through the various R1 resistors, but this current is negligible. Note however, that this type of switching can only be practical where only small currents need flow through the switching circuits and where this small current is adequate to operate some relay device (i.e.: a Pipe Driver Transistor) to control the much higher current required to actually operate the chest magnets.

So far we have not indicated the purpose of the A Diode. Inserting it in the circuit has done no harm because the A Diode conducts freely in the direction to cause the transistor to switch on when the keyswitch is closed. However, it is often desired to operate the same chest magnet from several different circuits, or from several different keyswitches as in the case for a unified stop. In this case, a point must be provided at which the outputs of a number of switching circuits (i.e.: R1, A Diode & B Diode) can be attached that will not result in phantom paths that will sound notes that are not desired. Buss Bar #2 represents such an input terminal. The A Diodes of any number of separate switches may be connected to this point, and any current supplied to this point through any A Diode will cause the transistor to switch and the pipe to sound. Because of the A Diode (since it will not conduct current when its cathode is positive), undesired phantom paths are eliminated.

One additional diode is provided on the Pipe Driver Assembly for every Pipe Driver Transistor. It is the so-called Fly-Back Diode, sometimes alternately called the "protective" diode or "free-wheeling diode". The purpose of this component, which is connected across the chest magnet, (although mounted on the Pipe Driver Assembly) is to prevent damage to the Driver Transistor by kick-back voltage from the chest magnet coil. Whenever a current flows through a coil of wire, a magnetic field is formed. The collapse of that magnetic field when the current is broken causes a high voltage of a reverse polarity to transiently appear across the magnet terminals. I'm sure that every organ service man has been shocked by this voltage which can build up to several hundred volts. The purpose of the Fly-Back Diode is to short out this transient voltage **and thus prevent it from developing.** Instead of the voltage developing, this magnetic energy is converted to electric energy which is dissipated by the Fly-Back Diode. At this point it would be useful to point out that the voltage rating of the Fly-Back Diode need not be as high as the voltage that would appear across the unprotected magnet, because the presence of the diode prevents this voltage from building up and thus the diode is not subject to a high voltage that never develops. On the other hand, the diode must be capable of withstanding a current at least equal to the current required to operate the chest magnet. It is the practice in Peterson Solid State equipment to use a Fly-Back Diode rated at 1 amp or more.

Finally, it should be pointed out that the Stop Switch as shown in Figure C is a mechanical switch, and although this would be a functional arrangement, it will be noted that to turn the stop on with such an arrangement would require that the switch contacts be open, and to turn the stop off would require that the stop switch be closed. Since this is backwards of what is customary in pipe organ practice, an additional transistor switching circuit is used as an electronic stop switch to accomplish this function. In all recent Peterson Solid State Switching Systems, this stop switch transistor is mounted on a small plug-in circuit board, (called a Stop Switch Assembly, or Stop Switch, for short), and it is operated from a wire connected to a conventional stop tablet switch. The transistor inverts the function so that with the Stop Switch open the stop will be off, and with the Stop Switch closed, the stop will be on. The Stop Switch assemblies are provided in an assortment of types to permit the stop rail to have a negative feed or a positive feed as required by other circumstances. It is important that if a Stop Switch card is replaced that it be replaced with one of identical type.

So far we have described a switching system that requires only one key contact per key. That eliminates the need for relay magnets as well as conventional electric gang switches, and that permits unlimited unification and duplexing. The only major element still missing is a "Coupler System".

It might be useful at this time, to set out in block diagram form, a typical Switching System including a Coupler System. Referring to Figure D, the "Swell" and "Great" Switching Assemblies, and the Pipe Drivers, are as previously described. Inserted between the manual and pedal key switches, and the "Swell" and "Great" unification panels is a Coupler System comprised of a set of Coupler Switching Panels, (one for each organ division that will have other divisions coupled to it), and a set of Coupler Driver assemblies, (including a separate Coupler Driver assembly for each division that is to be coupled to another division). In the system illustrated by the block diagram there are separate groups of Swell coupler "switches" and Great coupler "switches". These "Switches" are controlled by the coupler stop tablets and function in the same manner as the electronic switching circuits previously described. Because the coupler switches cannot pass enough current to directly operate the unification switching panel assemblies, it is necessary to insert Coupler Drivers between the coupler switches and the unification switches. The Coupler Drivers are similar to Pipe Drivers, but use a slightly different circuit, (as shown in Figure 6), to provide positive input voltage to the unification switches. The operation of the Coupler Driver circuit is as follows:

When the keyswitch is open, Transistor Q1 is not conducting (because its base is connected to its emitter via R1 & R2), and a positive voltage will appear (via R3 & R4) at the base of Transistor Q2. Transistor Q2 is a P.N.P. type as compared to Q1 which is an N.P.N. type. This means that Q2 is designed to operate with opposite polarities than Q1. Q2 is held non-conducting by the positive base voltage. When the keyswitch is closed, Transistor Q1 conducts and switches the lower end of R3 to rectifier negative. The base of Q2 is also connected to rectifier negative through R4, and this causes Q2 to conduct and thus connect the output terminal positive.

Where a Pipe Driver Assembly is needed to operate a "Straight" Chest, such as a Pitman or Ventil Chest, (or where a rank is to be played at a single pitch on one manual only), a special Pipe Driver assembly called a Straight Driver is combined with a "switch" and plugged directly into the appropriate Switching Panel mother board. The circuitry is the same as if a separate switch and Pipe Driver were used, but some space is saved and the wiring is simplified.

The above description is necessarily short, but if studied carefully, should provide a basic understanding of how Peterson Switching Systems operate. If there are any questions as to the method of operation, we will be glad to answer them by phone or mail. Just as in the later part of the nineteenth century, electric action was very foreign to organ builders (who were familiar with tracker and tubular pneumatic systems), today Solid State Systems represent a major advance in organ building that greatly improves the reliability and performance of the pipe organ. It is necessary (and fortunately not very difficult) for those of us in the industry to spend a small amount of time to learn a few new things necessary to be able to work comfortably with this major advance.

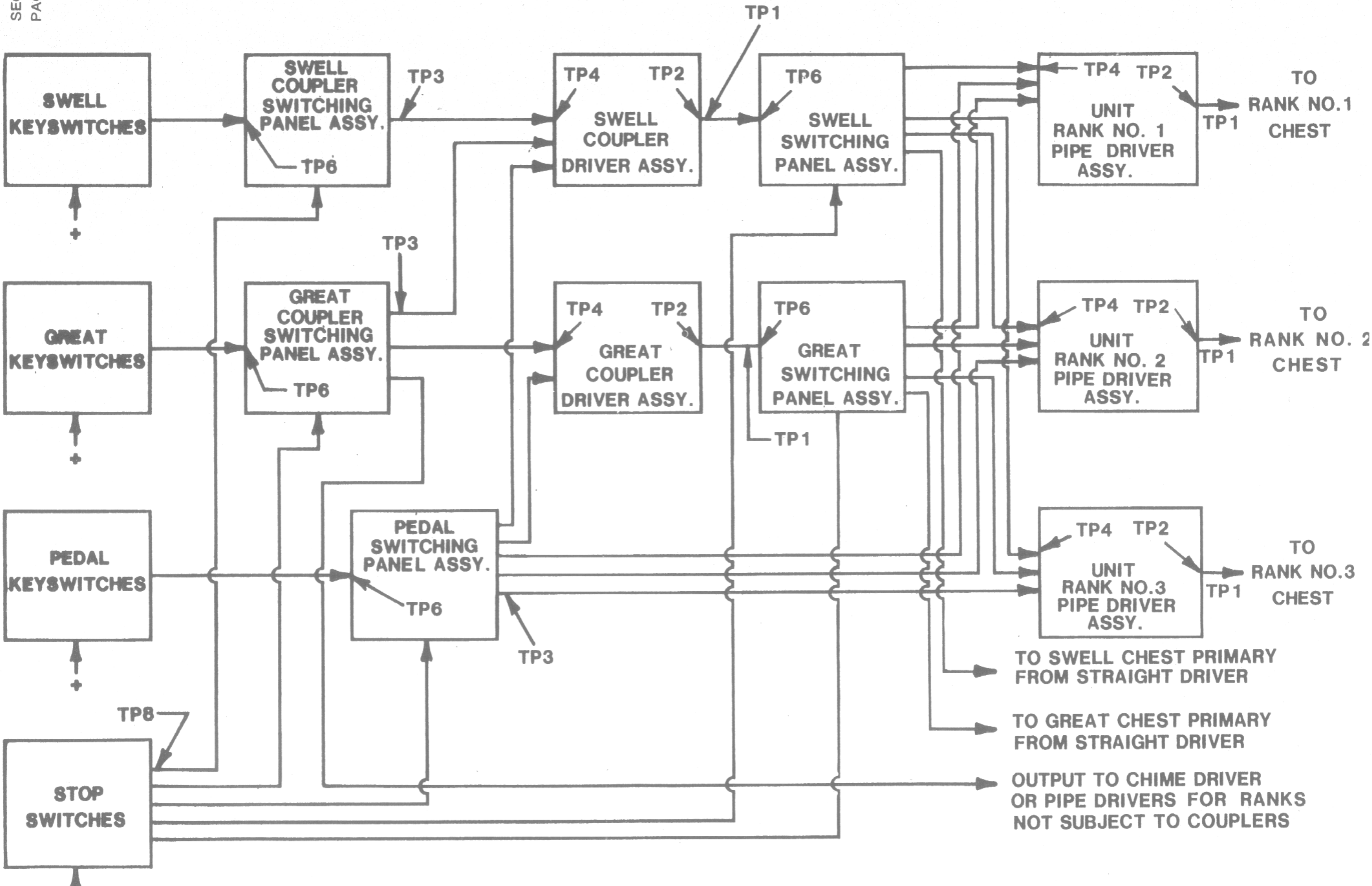
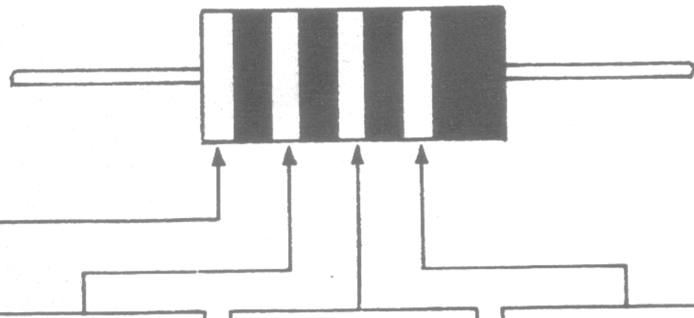

SWELL KEYSWITCHES
SWELL COUPLER SWITCHING PANEL ASSY.
TP6
TP3
TP4
TP2
SWELL COUPLER DRIVER ASSY.
TP1
TP6
SWELL SWITCHING PANEL ASSY.
TP4
TP2
UNIT RANK NO. 1 PIPE DRIVER ASSY.
TP1
TO RANK NO.1 CHEST
GREAT KEYSWITCHES
TP3
GREAT COUPLER SWITCHING PANEL ASSY.
TP6
TP4
TP2
GREAT COUPLER DRIVER ASSY.
TP6
GREAT SWITCHING PANEL ASSY.
TP1
TP4
TP2
UNIT RANK NO. 2 PIPE DRIVER ASSY.
TP1
TO RANK NO. 2 CHEST
PEDAL KEYSWITCHES
PEDAL SWITCHING PANEL ASSY.
TP6
TP3
TP4
TP2
UNIT RANK NO.3 PIPE DRIVER ASSY.
TP1
TO RANK NO.3 CHEST
TO SWELL CHEST PRIMARY FROM STRAIGHT DRIVER
TO GREAT CHEST PRIMARY FROM STRAIGHT DRIVER
TP8
STOP SWITCHES
OUTPUT TO CHIME DRIVER OR PIPE DRIVERS FOR RANKS NOT SUBJECT TO COUPLERS
+
+
+
+

FIGURE D

RESISTOR

SCHEMATIC

Standard Color Code



First Band 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Second Band 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

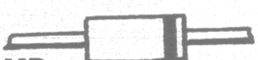
Third Band Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0 1

Fourth Band* Resistance Tolerance	
Color	Tolerance
Silver	±10%
Gold	± 5%
*No Band	±20%

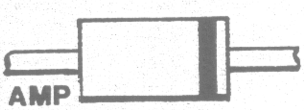
TYPES OF DIODES

BAND INDICATES CATHODE

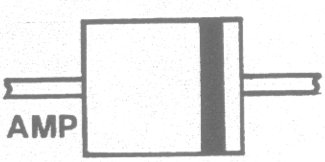
LOW CAP & ZENER



1 AMP



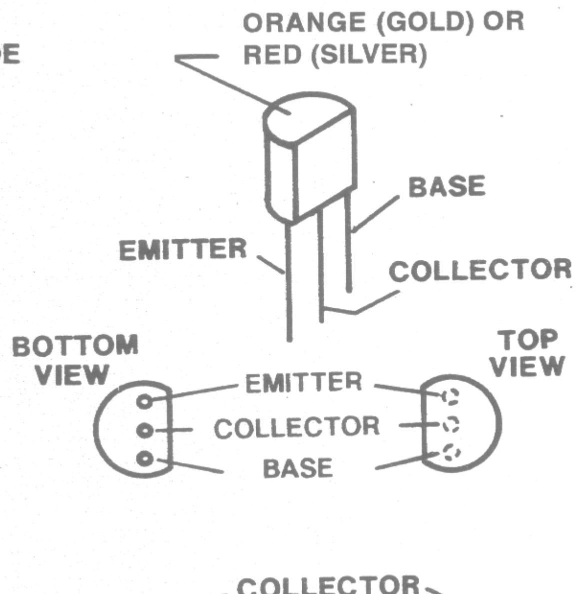
3 AMP

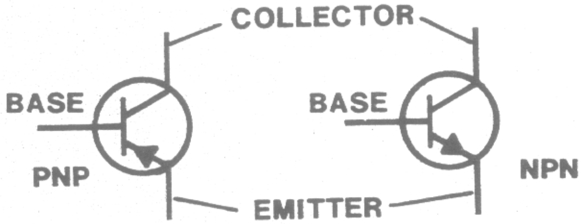


6 AMP

SCHEMATIC

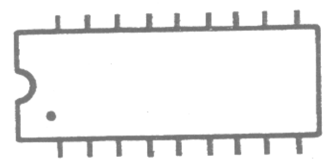
TRANSISTORS



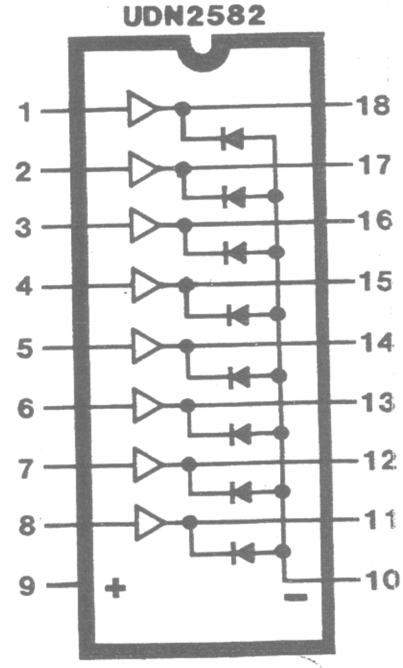


SCHEMATIC

INTEGRATED CIRCUIT



SCHEMATIC
UDN2582



THE PETERSON SOLID STATE SWITCHING SYSTEM

Installation and Maintenance Manual

I. DESCRIPTION

The Peterson Solid State Switching System is a product of space age technology. Having no moving parts, it has a reliability far surpassing that of any conventional electric or electropneumatic relay.

The relay consists of two main parts; the switching network and the pipe drivers as illustrated in Figure 20. The switching network performs the actual functions of the relay itself and each switching panel corresponds to a switch on a conventional relay. For straight stops the pipe driver is combined with the switch assembly.

A feature of the Peterson Solid State Switching System is that any number of stops and couplers may be controlled from one key contact, the current drain on which is no more than is drawn by an ordinary chest magnet. To accomplish this, the switching network operates on very low currents which in themselves are not sufficient to operate the chest magnets. These low currents are used to trigger the driver transistors, which directly control the chest magnets. There is one driver transistor for each chest magnet, and the panels on which the driver transistors are mounted are called pipe drivers. There is one pipe driver for each rank. The driver transistors may be individual parts for each note, but often we use an Integrated Circuit containing the transistors for 6 notes in a single rectangular plastic package.

Another feature of the Peterson Solid State Switching System which makes its modular concept so practical is the special connectors, which are illustrated in Figure 22. They are manufactured in several styles. They are used not only for connections between the organ and the relay, but also within the relay for connecting the switching networks and pipe drivers.

Inter- and intra-manual couplers are easily incorporated into the Peterson electronic relay. In a relay without couplers, the cables from the manuals plug directly into the stop switching networks. When couplers are used, the manual cables plug into coupler switching networks that are identical to stop switching networks which in turn plug into coupler drivers. Coupler drivers appear as shown in Figures 5 and 6. The coupler drivers are cabled and then plug onto the stop switching networks.

II. INSTALLATION

The Peterson electronic relay is connected to the organ exactly as a conventional relay would be, except that the cables are not wired to spreaders on the relay, but to the connectors, which in turn plug into the relay at the appropriately marked positions. The feed lines from the rectifier are connected in the polarity marked on the test and power junction on the relay. Reversal of polarity **will cause damage.** Note that our normal arrangement would have the console keyswitch commons positive, and the stop commons positive. The chest commons are determined by the type of driver employed. The chest common polarity is specified on the blueprint for your specific relay. Connecting the key, stop and chest returns to the wrong polarity will not damage the relay, but it will not function. (Other polarities can be accommodated on special order at extra cost.) Recommended supply voltage is 12 VDC to 15 VDC, and wire size should be selected according to the number of magnets employed.

If the Peterson relay is being used to augment an existing organ with a conventional relay system, the existing relay may have to be modified somewhat in order to be compatible with the new system. In most relays all that will be necessary is to connect the keyswitch commons to the positive side, and chest commons to the negative side, of the DC source. Should there be any question of polarity contact us and we will be happy to assist.

If the Peterson relay system is used for couplers, and unison off couplers are employed, it should be remembered that conventional unison off couplers are usually wired to stop contacts which are closed when the stop is off. The Peterson relay is designed so that either the above arrangement or a contact arrangement like all the others may be used. We can accommodate either if you specify which type you are using.

Each switching panel of the Peterson relay is prepared for sforzando control. A current of the same polarity as the stops applied to the sforzando terminal turns on all the stops and couplers provided for on that switching panel. They will remain on only so long as current is applied to the sforzando terminal. Thus, the system can be used with a sforzando reversible or with a momentary accent pedal such as on theatre organs. If any stop is not desired to be actuated by the sforzando, all that is necessary is to clip (or unsolder) one of the leads of the sforzando diode for that stop's respective stop switch. See Figure 11-14 for the position of the sforzando diode.

Since the Peterson electronic relay is modular in concept, additions may be made to it with little more effort than to plug in a connector. The additions may be in the form of expanded unification of existing ranks, adding additional ranks, or even adding entire manual divisions. The new stops to be added to an existing manual will be supplied as so many switches or straight drivers mounted on a common switching panel. Note that each manual division requires an individual switching panel, with each panel capable of handling up to eleven switches (or stops). When adding stops, or if there are more than eleven stops in any division, it will be necessary to use two or more switching panels with their inputs in parallel. This is accomplished readily by using a jumper cable with a connector on each end. The outputs of the added switching networks are then plugged into the corresponding pipe drivers of the ranks in mind.

At least four additional connections are required on each added switching panel, one for the sforzando, one to connect to the negative side of the DC source, one to connect to the positive side of the DC source, and one for each stop on the network. If additional ranks are to be added, one pipe driver or straight driver will be required for each added rank. The only connection on a pipe driver other than the regular plug-in input and output are the positive and negative DC source connections.

When ordering a new pipe driver, be sure to specify if the chest magnets to be controlled have a resistance of less than 50 Ohms. If so, heatsinks on the Integrated Circuits or heavier duty driver transistors may be necessary. Please consult the factory for assistance if this need should arise.

III. MAINTENANCE

The Peterson electronic relay is the most reliable type of relay in existance. It has no moving parts to wear out, and computerlike reliability of the solid state components. The diodes and transistors in the Peterson electronic relay are factory graded and have an exceptionally low failure rate, together with unlimited life expectancy. Therefore, if trouble with dead or ciphering notes or stops develop, they are most likely the result of some fault in the rest of the organ, and the repairman should investigate these possible troubles before blaming the relay. Our extensive use of plug-in modules greatly simplifies trouble-shooting whenever repairs are necessary.

As an aid in determining the cause of any troubles, one red binding post, test light and the positive and negative terminals are provided for testing the relay. The red binding post is provided for testing at points 3, 4, 5, and 14 within the relay itself. It has a light bulb in series with it to protect the transistors and also is used for checking diodes. If a dead note occurs, for example, and cannot be played by touching a test wire to the output connector on the relay, then the trouble is obviously not in the relay.

Integrated Circuits are usually plugged into sockets, which in turn are soldered to the circuit board. Carefully pry a damaged IC out of its socket and insert the new one, being careful not to let the tiny leads "tuck under" the body of the IC. When replacement of any diode or transistor is necessary, merely unsolder the old component and resolder in the replacement. Use as little heat as possible in order to avoid damaging the component. Be sure the component is not backwards - just check its markings with those of its neighbors. To get at a diode on a switch module, the switch module must be removed from its location on the switching panel. This is accomplished by first removing the cable connector. Start on one (either the high or low) end, and pull away from (off of) the switch to be removed. Remove the switch by firmly pulling the low or high end away from (off of) its switching panel. All components are readily accessible at this point and may be checked with an Ohm meter or the protected test lead.

Carefully reinstall the switch module by starting on the high or low end and using no more force than necessary. Start the first two octaves onto their pins, press down on the switch, working away from the end started. If you should be unable to advance in this way from the original starting point, remove the switch and begin from the opposite end. If this too fails, remove the switch and look for the misaligned pins on the switching panel (mother board) itself. Straighten any misaligned pins with a screwdriver or thin-nosed pliers.

To re-apply the cable connector, start on either the high or low end and coax the connector onto the pins on the switch. **Be extremely careful to insure that the cable wires are out of the way so as not to be caught in the connectors.**

CONNECTING THE POSITIVE AND NEGATIVE MAINS
(Organ Positive and Negative)

As reverse polarity may cause damage to the equipment, and such damage is not covered by the warranty, it is vitally important that the main positive and negative leads be connected to the proper terminal. **DO NOT ASSUME** meter leads or wire colors are properly coded. (Some meters are not polarity sensitive).

The following procedures may be used to verify the proper "mains" polarity.

1. Connect the lead presumed to be positive to the (+) terminal on the test and power junction.

2. Touch the lead presumed to be negative to the red binding post (marked protected +). If the red L.E.D. lights, the polarity is correct and the negative lead then can be connected to the (–) terminal, at which time the green L.E.D. should light.

NOTE: If the red L.E.D. does not light, the presumed polarity is wrong. Connect the opposite lead to the positive terminal and repeat steps 1 and 2.

INITIAL TEST OF RELAY AT INSTALLATION

It is suggested that once you have received your relay, and have it wired to the chest, power supply and console, that you use the following procedure for checking it out. **Bear in mind that polarities are important.**

1. Check to see that the green power light on the "test and power junction" is illuminated. Being lit indicates a voltage of the proper polarity is applied to the relay.

2. Test all magnets of each rank by energizing each chest magnet with a test lead at the chest connection on the output connector of a pipe driver or straight driver. The test lead should be connected to the polarity opposite that shown as the "chest common polarity" on the blueprint. Notes which do not play from this point obviously have defects within the chest cable, magnet, chest, pipe, etc. These defects should be repaired before proceeding.

3. The relay is now ready to test from the console. Bear in mind that dead or ciphering notes or stops may be due to contact or wiring defects. These can be confirmed or discounted by unplugging the appropriate key or stop connector from the relay and testing with a "hot" wire of the correct polarity for the point being tested. If the problem is found to be in the relay, repair assistance will be found in the trouble shooting section.

   If you are unable to repair any malfunction with the information provided in this manual, call us at (708) 388-3311 or 1-800-341-3311 for further assistance.
   Our FAX number is (708) 388-3367.

TROUBLE SHOOTING THE PETERSON RELAY

TESTING POLARITY IS EXTREMELY IMPORTANT. USE OF THE WRONG POLARITY MAY CAUSE DAMAGE TO THE RELAY.

Since mid 1978 the Peterson Relay has been "all plug-in". Once a suspected module has been identified, its malfunction can be confirmed by swapping the suspected module with another one just like it, (identical part number or description), from some other part of the relay. If the problem moves to another location, the suspected module has a defect as suspected, and can, then, be repaired as outlined below. Please do not mark directly on the modules; use masking tape or tags to identify modules.

When replacing a stop switch module, please note that the Universal Stop Switch #404480 may be used in place of #400476 Positive and #400478 Positive Unison Off boards. A jumper or "zero ohm resistor" must be positioned so as to reveal the abbreviation "Pos" or "UNI. OFF" but not both. Please refer to Figures 11-14A and the entry "Stop Switch, Universal" in Section I of this manual.

PROBLEM	PROBABLE CAUSE
Runs	
A. Adjacent notes play together when only one key is depressed.	Mechanical connection (solder short or wire scrap, etc.) between pins or foil conductors.
B. Adjacent notes of a unit rank play when drawn from any one of its borrows.	

HOW TO ISOLATE

To isolate the problem, place it in one of the following categories:

1. When run occurs and either stops or couplers are added on the offending manual and the number of pipes "running" increases, you have a "keying run".

2. When run occurs such that the same two pipes are always involved, the problem is between test point 3 and 1 if a unit stop and directly on the straight driver if a straight stop. Check to make sure the short is not between the chest magnet and the output connection of the relay.

In the case of a keying run where couplers are employed, it must be determined whether or not the problem is in the coupler section of the relay. A keying run in the coupler section will manifest itself in a case where, when couplers are added, more notes "run" (usually an octave offset in the case of sub and super couplers). This type of run can be isolated by first unplugging the console key connector and then keying the input of the relay with a "hot" lead. If the run does not occur with this connector unplugged, the run is between the console and that connector. If the run continues to occur, carefully inspect the printed wiring busses on the bottom side of the switching panel for the manual division involved while scraping between the offending notes' busses with a scriber. If this fails to cure the run, pull the switches or straight drivers from the switching panel involved, one at a time, until the run clears. The problem will then be on the last module removed. If adding couplers does not add to the run, but adding stops does, then the same procedure should be followed with the "unification" switching panels as was done on the coupler switching panels. If only the same two pipes are involved in the run, no matter how the stops and couplers are manipulated, then the short is between test point #4 and test point #1 (Figures 5, 6, 7, 8 and 10) and can be isolated by unplugging modules, cables, connectors, etc. This type of run would also appear whenever the same two notes (pipes) of a unit rank play from any of the borrowed stops.

INDIVIDUAL NOTES DEAD

A. One note key of manual is dead on all stops or couplers

If note can be played at point 6 from a positive terminal, but not at point 7 (Figures 1 and 3) then input connector is not making contact. If it can be played at point 7 from a positive terminal, then the trouble is not in the relay.

B. One note of a unit rank is dead and not playable from any stops of that rank.

If the pipe cannot be played at point 1, the trouble is not in the relay. If that pipe can be played at test point 2, the connector is not making good contact. If it can be played at point 2, but cannot be played at point 3 from the red binding post, then the driver transistor may be defective. (Refer to unusual problems section). If it can be played at point 4 but not at 3 from the red post, then the connector is not making contact or the cable is defective or damaged.

C. One note of a unit rank or coupler is dead on one stop, but is playable from another stop.

On the switch for that stop, the "A" diode of the dead note is defective.

Figure 9

ENTIRE STOPS DEAD

A. One stop of a unit rank or coupler is dead.

Switching transistor, zener diode or isolation diode of that stop is defective or a solder short is holding buss at negative. Check by removing stop switch board. Stop must then play. Further test by swapping stop switch board with a neighboring board and note results. Suspect poor solder connection first, then transistor, then zener diode (if used), then isolation diode.

Figures 11-14A

B. All stops of a unit rank are dead.

If rank cannot be played from point one of each note, the trouble is not in the relay. If it can be played at point one, but cannot be played from red post being touched to point 4 of each note, one of the driver common diodes or the fuse is defective. This may be checked by temporarily shorting out the common diodes, one at a time, and noting which one is defective for replacement. The fuse may **not** be shorted out but must be replaced by one of the same type as supplied.

Figures 5, 7 and 10

C. One stop will not come on with sforzando.

Sforzando diode (shown as D2 in Figures) of that stop is defective.

Figures 11-14A

NOTES PLAY WHEN THEY SHOULD NOT

In an emergency, an entire straight driver or one octave of a transistor pipe driver can be removed to silence an offending note. Removing the "Junior" board from a driver will silence the entire rank associated with that driver. A Driver module should not be suspected of being defective if ciphering notes cease to play when the input (keying) cable is removed from that module.

A. One note of a rank ciphers with no stops on and no keys depressed. (Remove input connector to driver in question).

Driver transistor of that note is defective. (Flyback diode should also be replaced). Check resistance of chest magnet to be sure that the driver is used within its rating.

Figures 7, 8, 10

B. One note of a stop plays when its key is depressed with that stop off.

On the switching panel for that stop, the "B" diode or the "B" diode's solder connection of that note is defective.

Figures 9, 10

C. One particular note of a stop plays when any key is depressed with that stop on.

On the switching panel for that stop, the "B" diode is defective.
Figures 9, 10

D. One note ciphers when a stop is turned on.

The "B" diode for that note and stop is defective on the offending note.
Figures 9, 10

STOPS PLAY WHEN THEY SHOULD NOT

A. Turning on one stop actuates sforzando.

Sforzando diode of that stop is defective.
Figures 11-14A

B. One stop cannot be turned off.

Solder connection or transistor on the stop switch of that stop is defective. Further test by swapping stop switching board with a neighboring board and observe results. The solder connections should be suspected first, then the transistor, then the zener diode (if used).
Figures 11-14A

COUPLERS

The coupler switching networks are tested the same way as stop switching networks.

The coupler drivers can be tested as follows: See Figures 5-6

Apply positive at test point #2. If note fails to play, the trouble is not in the coupler driver. If the note does play at test point #2, but not at test point #4, the coupler driver is defective. Further isolate problem by applying a negative voltage to test point #13. If the note does not play, the final driver transistor is defective. If the note does play at test point #13, the initial driver transistor is defective.

I.C. DRIVERS

The I.C. Drivers, Pipe, Coupler or Straight are all tested in the same way.

Their operation is the same as Coupler Driver assemblies. (Positive polarity input provides positive polarity on the output).

To test, apply positive at test point #2. (See Figure 15-18). If the note fails to play, the trouble is not in the I.C. Driver. If the note does play at test point #2, but not at test point #4, (using positive), the I.C. Driver is defective. Further isolate the problem by applying a positive voltage to test point A. If the note does not play, the I.C. is defective. If the note does play, the lo cap diode is defective.

UNUSUAL PROBLEMS

Individual note dead:

If trouble shooting of Section IV, Page 2 does not correct symptom on a unit or borrowed stop, determine the following: Is the note dead if all stops affecting the pipe in question are turned on? If the note begins to play when some other stop is drawn, the last stop drawn is the one at fault. Example: Given 8' flute unit of 73 notes plays pedal 8, swell 8'-4', note #13 (C2) is dead on the swell on both the 8'&4' stops. Draw the 8' pedal borrow, if C2 begins to play on the manual, the problem is the "A" diode, note #13 on the pedal switch. If the note continues to fail to play, carefully check all connections for C2 (#13) wherever it appears, especially items between test points 1 & 4.

Figure 8

Under certain conditions, a note will play with a test lead at test point 2, but will not play with the protected lead at test point 3. (These would be points 2 and 4 on a straight driver). To determine whether or not the output driver stage is defective, run a lead from the protected terminal to point 1, 2, or any convenient chest magnet terminal for the note in question.

Figure 7, 8, 10

Apply positive at point 6 or depress the dead key. (Pull stop switch board to insure stop being "on"). The test light will light when positive is applied if driver is not defective. If light will not light, change driver transistor and flyback diode for defective note and retest. In a case where the light does light, the problem is that the chest magnet is not adjusted close enough. There is about 1 volt drop through the relay. In cases such as this, the magnet simply will not "pull in" with the available voltage; it must be readjusted.

TESTING PROCEDURE FOR DEFECTIVE DIODE

Use an ohm meter to check the resistance of the diode. Then reverse the leads and check the resistance again.

1. If the resistance in one direction is very high, but in the other direction very low, the diode is OK.

2. If the resistance in both directions is very high or very low, the diode is defective. If no ohm meter is available, a reasonably accurate test can be made as follows.

Use a lead from the red (protected) binding post and a lead from negative. Put one lead at each end of the diode, then reverse the leads. Be sure to use only the red protecting binding post, not unprotected positive, for the above.

1. If the L.E.D. is ON in one direction, but not the other, the diode is probably good.

2. If the L.E.D. is ON in both directions, or if it is OFF in both directions, the diode is bad.

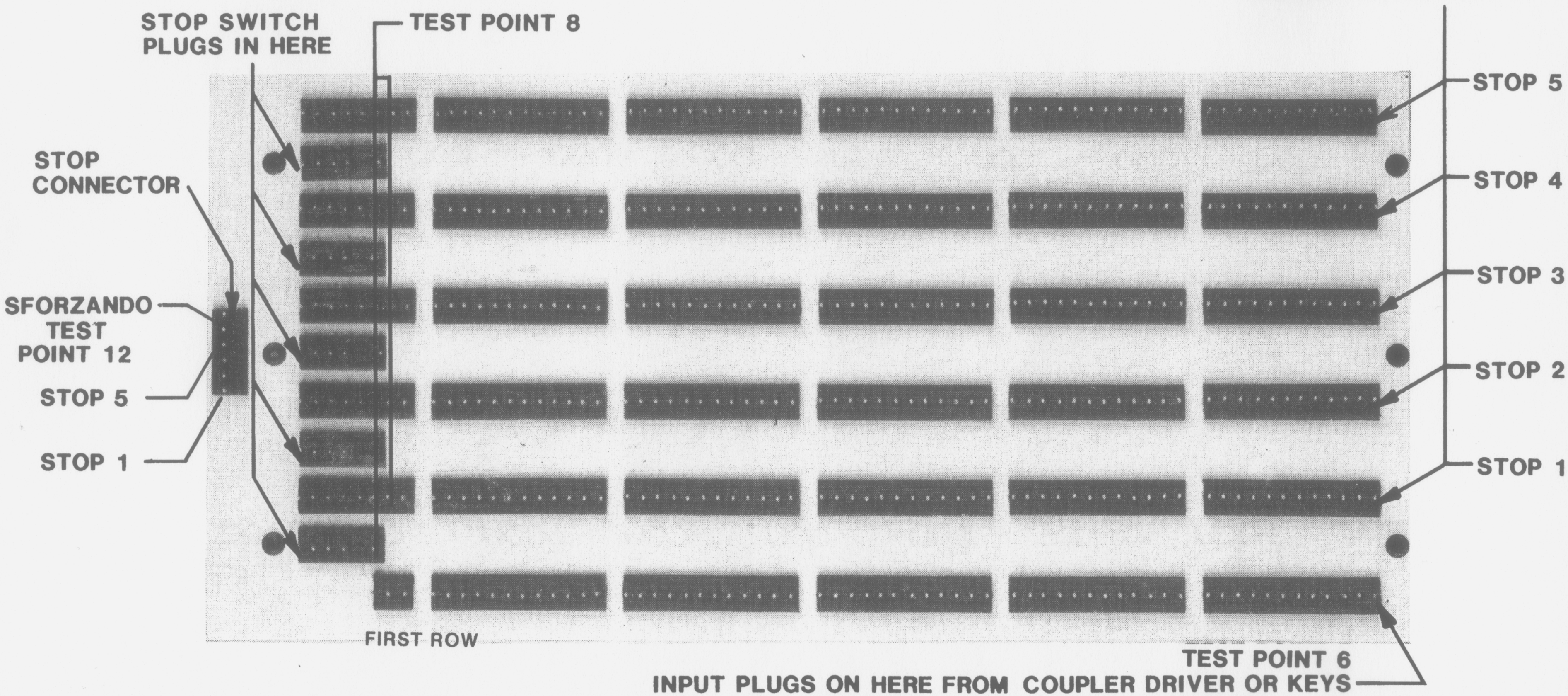
   A. Check the L.E.D. by connecting the red binding post to negative.
   The light should light.

   The above use of the L.E.D. will not show a diode as bad if it is leaky, (low reverse resistance).

The foregoing instructions should enable any organ serviceman, regardless of his familiarity with electronics, to repair nearly any trouble in the relay that may develop. If a problem does arise which the repairman is unable to correct, the modular construction of the Peterson relay permits the troublesome part to be isolate by simply unplugging the suspected module and swapping it with one known good. If the problem moves with the module, that module is defective and should be repaired using the hints above. All modules, when removed from the relay, can be checked with an ohmmeter if only to compare one note with another. If further assistance is required, call (708) 388-3311 or 800-341-3311 for guidance.

FIGURE 1

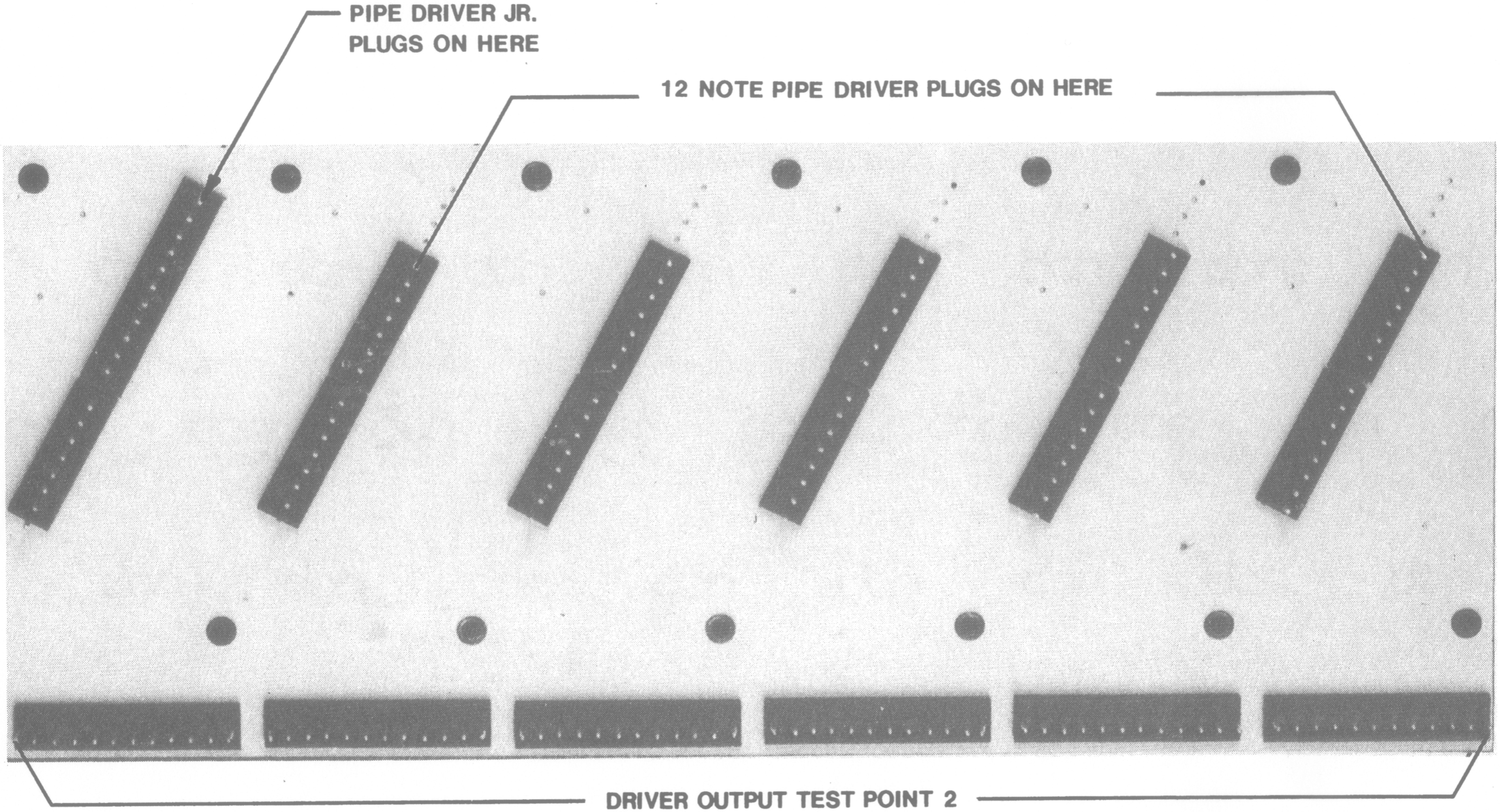
TYPICAL 61 NOTE, 5 STOP MOTHER BOARD



SIMILAR MOTHER BOARDS ARE:	61 NOTE, 11 STOP	PART NO. 400473
	73 NOTE, 5 STOP	PART NO. 400474
	32 NOTE, 5 STOP	PART NO. 400470
	32 NOTE, 11 STOP	PART NO. 400471
	61 NOTE, 5 STOP	PART NO. 400472 (SHOWN)

TYPICAL PIPE DRIVER MOTHER BOARD

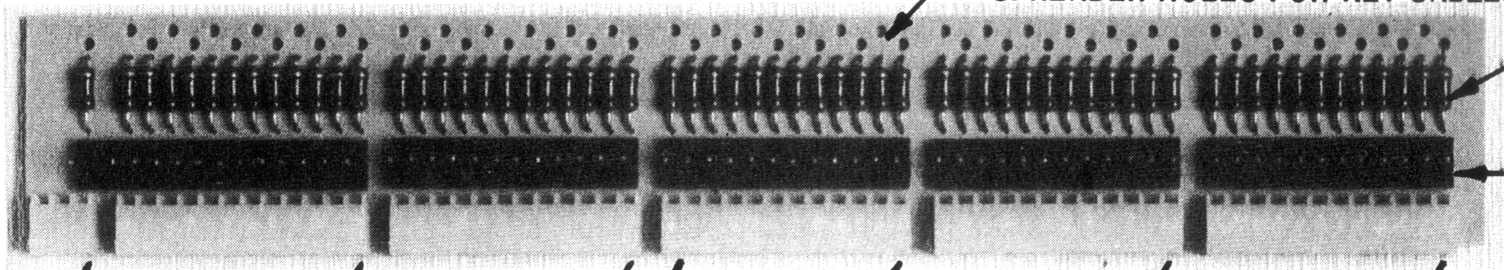
FIGURE 2



THIS BOARD COMES IN VARIOUS LENGTHS TO SUIT THE COMPASS OF THE RANK INVOLVED

A COUPLER DRIVER MOTHER BOARD IS NEARLY IDENTICAL TO THE PIPE DRIVER MOTHER BOARD SHOWN ABOVE, THE DIFFERENCE BEING PLACEMENT OF PINS AND AMOUNT OF BLANK HOLES.

FIGURE 3
TYPICAL 61 NOTE INPUT CONNECTOR BOARD



SIMILAR INPUT BOARDS ARE : 73 NOTE PART NO. 400467
32 NOTE PART NO. 400462
61 NOTE PART NO. 400466 (SHOWN)

FIGURE 4
TYPICAL 61 NOTE OUTPUT CONNECTOR BOARD

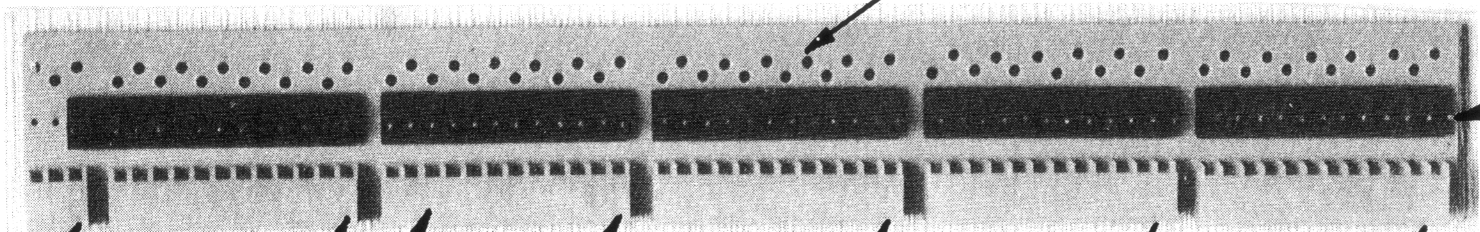
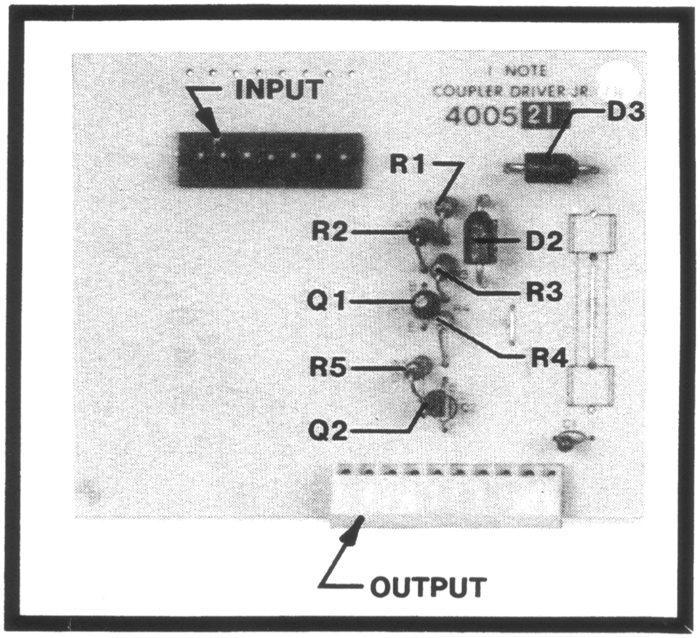
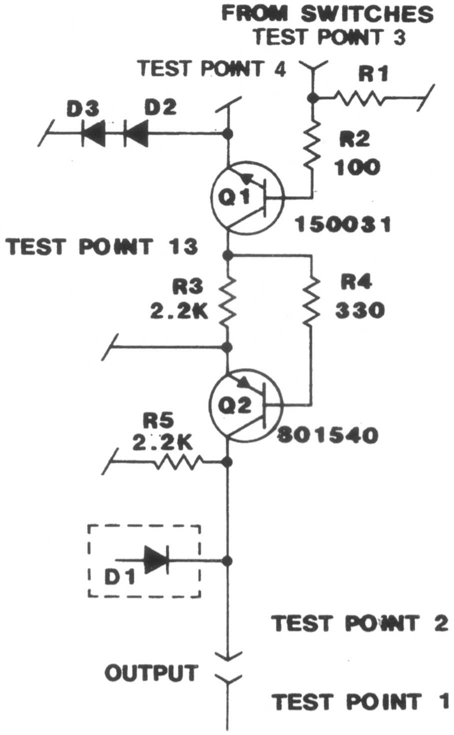


FIGURE 5

1 NOTE COUPLER DRIVER JR.

PART NO. 400521: WITH RESISTOR (SHOWN)
PART NO. 400515: WITH DIODE





WHEN THE COUPLER DRIVER IS USED TO DRIVE OUR RELAY A RESISTOR (R5) IS PROVIDED

WHEN THE COUPLER DRIVER IS USED TO DRIVE A MAGNET, A 1 AMP FLYBACK DIODE (D1) IS PROVIDED (SHOWN IN DOTTED LINES) IN PLACE OF R5

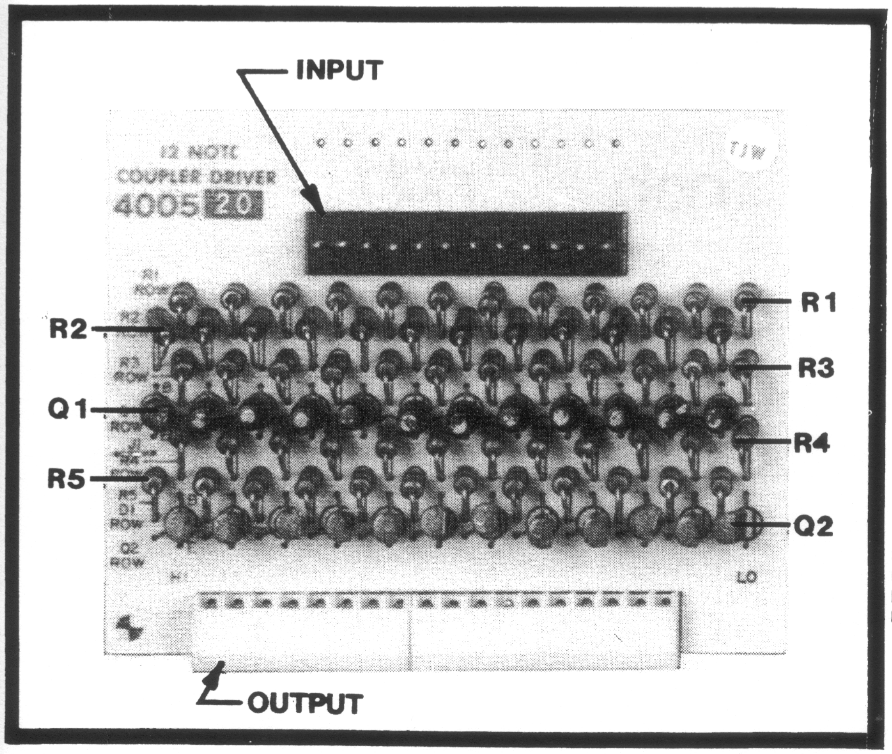
8 NOTE COUPLER DRIVER JR.

(NOT SHOWN)

PART NO. 400522: WITH RESISTOR
PART NO: 400516 : WITH DIODE

12 NOTE COUPLER DRIVER FIGURE 6

PART NO. 400520: WITH RESISTOR (SHOWN)
PART NO. 400514: WITH DIODE



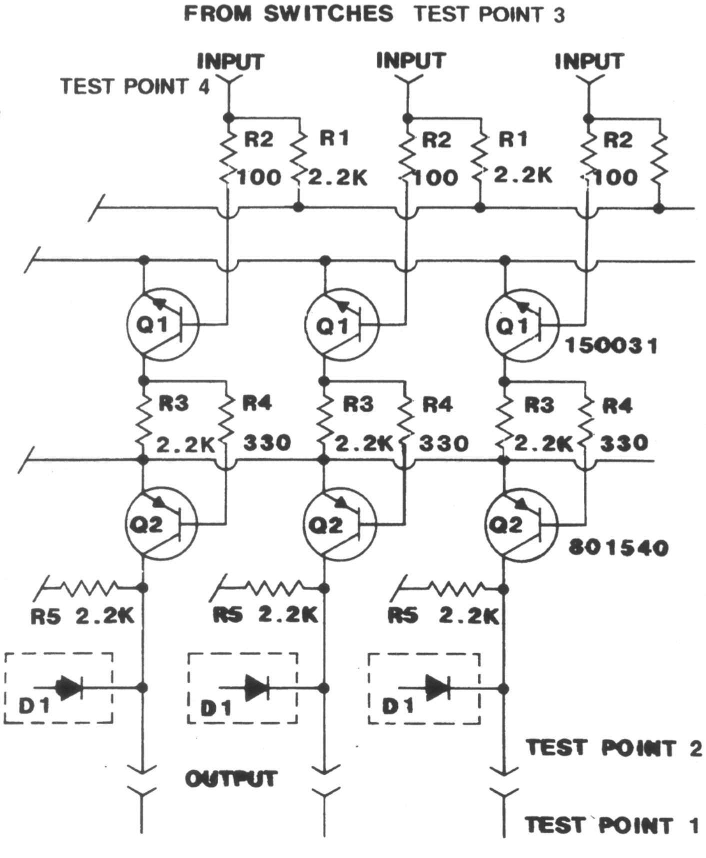
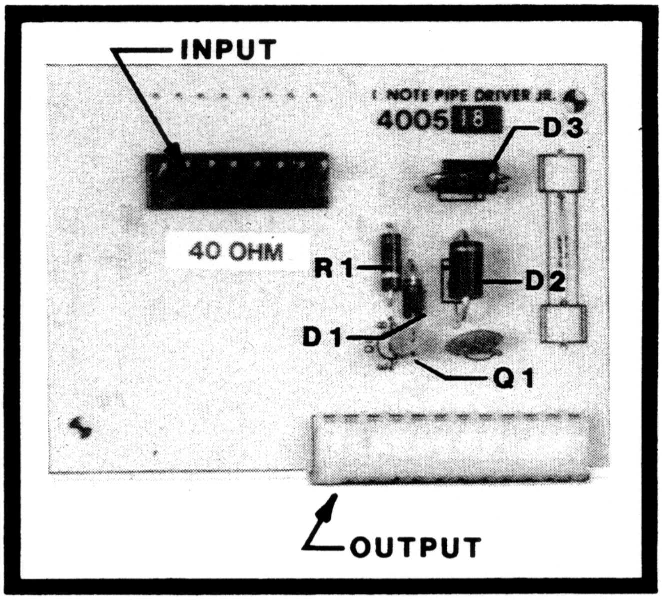
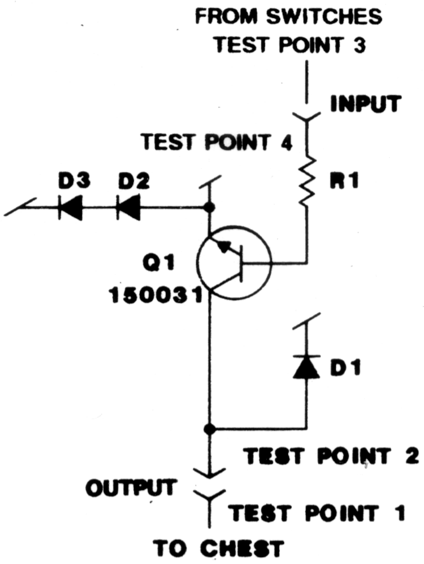


FIGURE 7

1 NOTE PIPE DRIVER JR.

PART NO. 400512: STANDARD
PART NO. 400518: HEAVY DUTY (SHOWN)





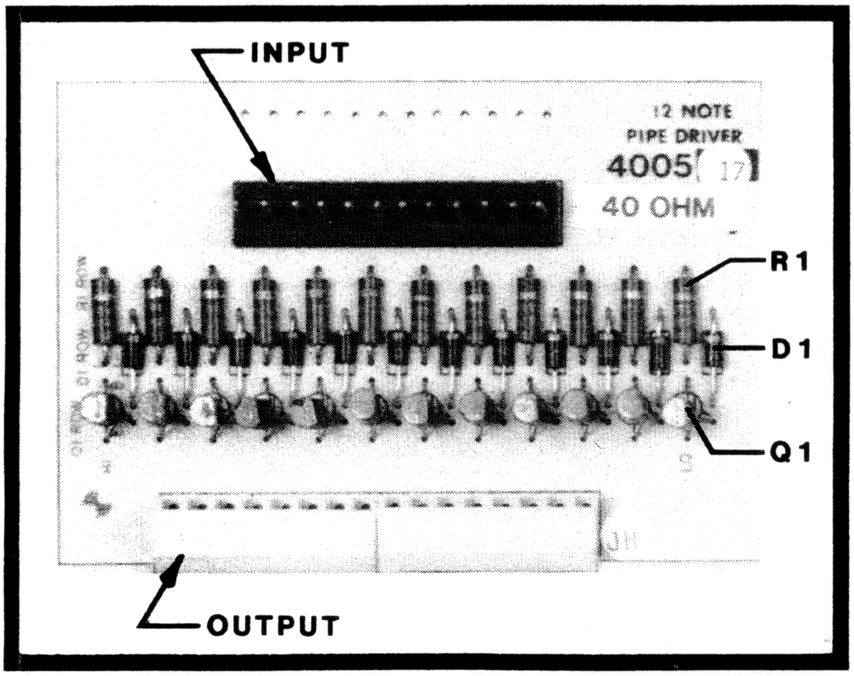
8 NOTE PIPE DRIVER JR.

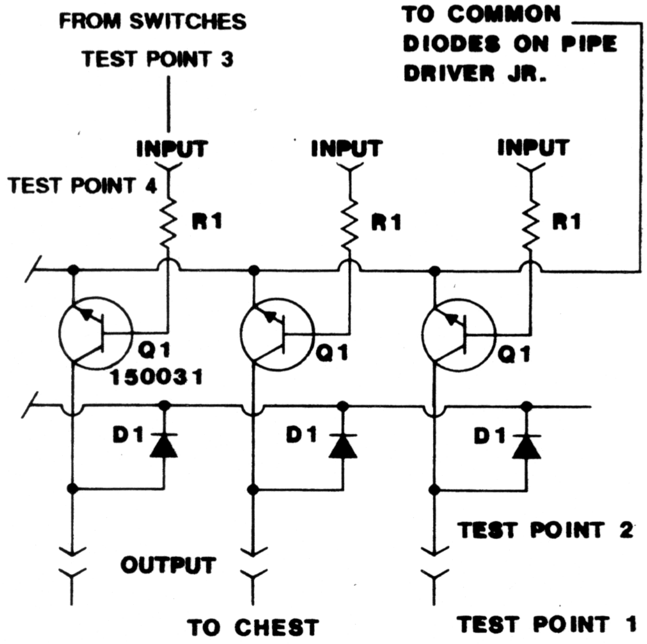
PART NO. 400513: STANDARD
PART NO. 400519: HEAVY DUTY

12 NOTE PIPE DRIVER

FIGURE 8

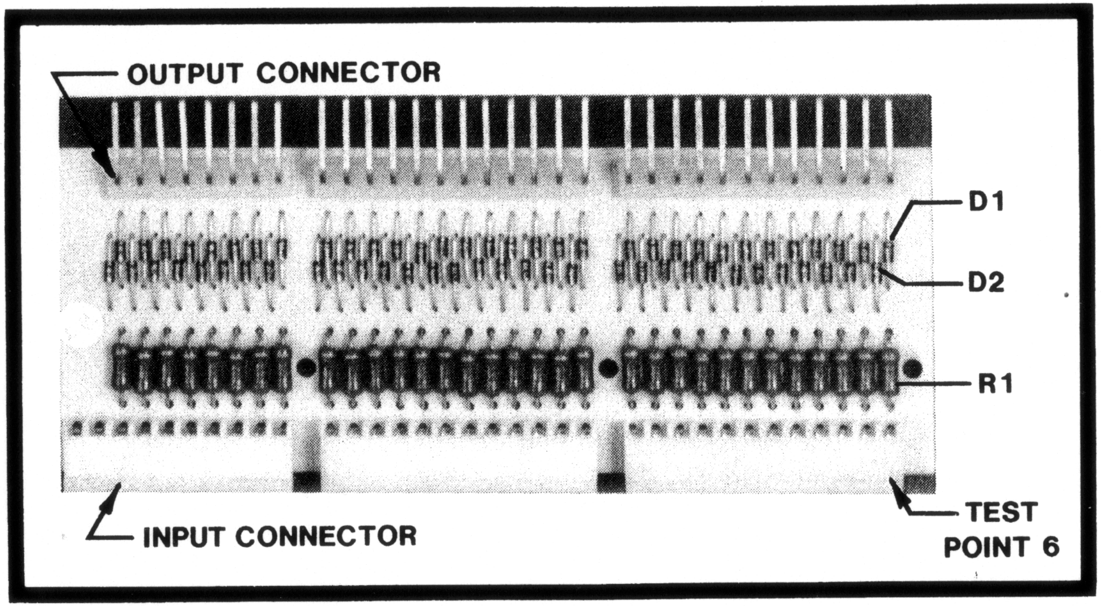
PART NO. 400511: STANDARD
PART NO. 400517: HEAVY DUTY (SHOWN)

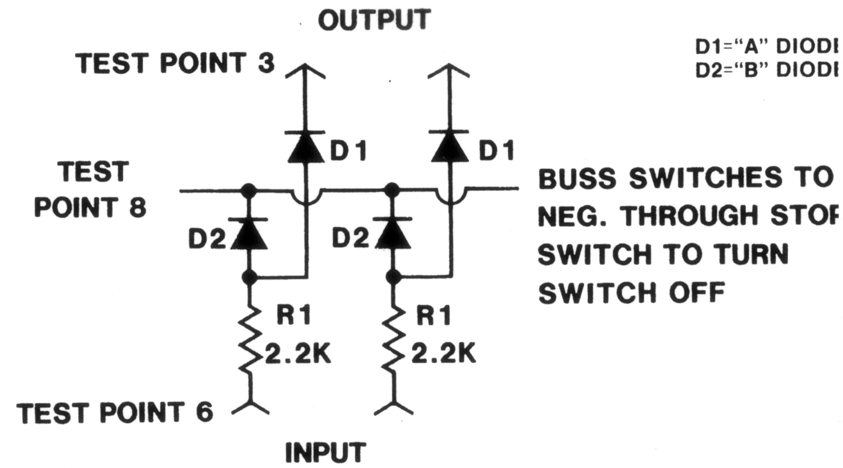




SWITCH

FIGURE 9





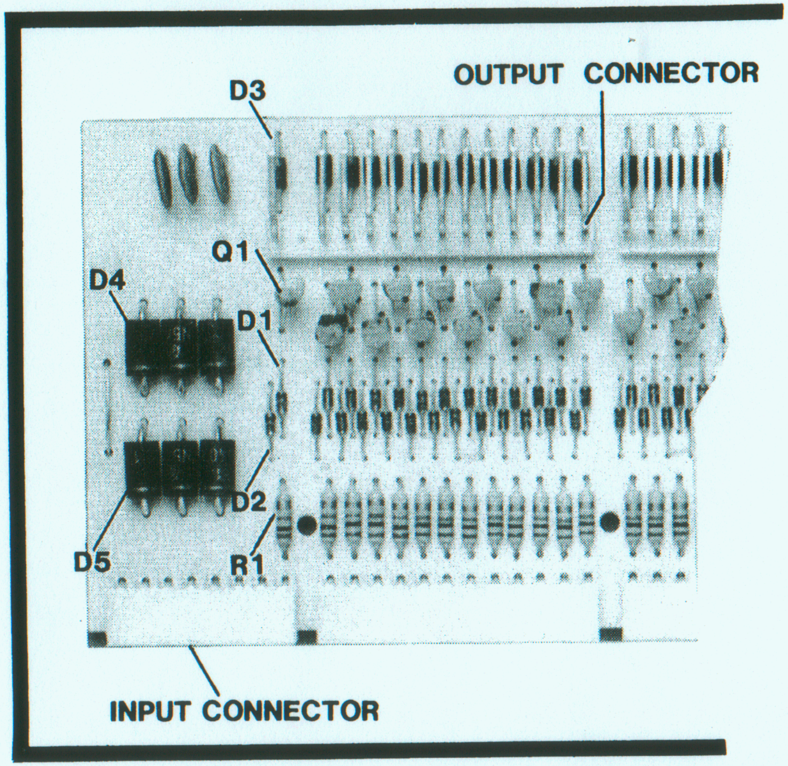
2 NOTES SHOWN

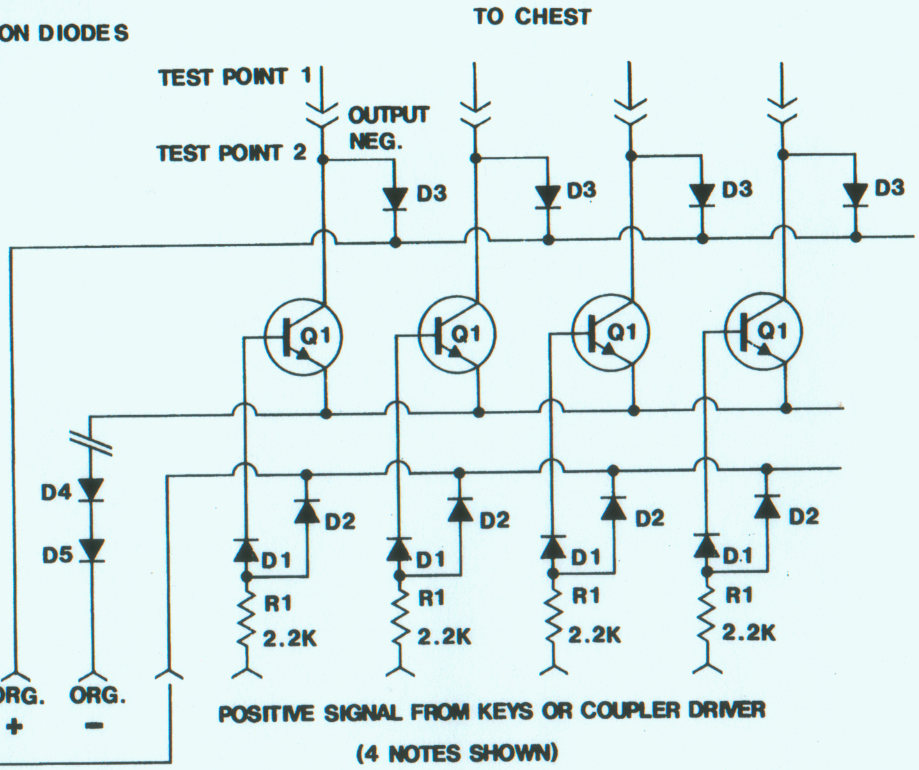
SIMILAR SWITCHES ARE:

32 NOTE BOARD	1 - 32	PART NO.	400442
61 NOTE BOARD	1 - 61	PART NO.	400446
73 NOTE BOARD	1 - 73	PART NO.	400447
61 NOTE BOARD	1 - 49	PART NO.	400450
61 NOTE BOARD	13 - 61	PART NO.	400451
61 NOTE BOARD	13 - 48	PART NO.	400452
73 NOTE BOARD	1 - 49	PART NO.	400453
73 NOTE BOARD	1 - 61	PART NO.	400454
73 NOTE BOARD	13 - 73	PART NO.	400456
61 NOTE BOARD	1 - 44	PART NO.	400459
73 NOTE BOARD	1 - 12	PART NO.	400550
61 NOTE BOARD	1 - 12	PART NO.	400551
32 NOTE BOARD	1 - 12	PART NO.	400552
73 NOTE BOARD	1 - 24	PART NO.	400553
61 NOTE BOARD	1 - 24	PART NO.	400554
32 NOTE BOARD	1 - 24	PART NO.	400555
73 NOTE BOARD	1 - 32	PART NO.	400556
61 NOTE BOARD	1 - 32	PART NO.	400557
61 NOTE BOARD	1 - 36	PART NO.	400558
73 NOTE BOARD	1 - 44	PART NO.	400559
73 NOTE BOARD	13 - 48	PART NO.	400571

FIGURE 10

D3 - FLYBACK DIODE
Q1 - DRIVER TRANSISTOR 150031 (ORANGE)
D1 - A (SERIES) DIODE
D2 - B (SHUNT) DIODE
R1 - RESISTOR
D4 & D5 - COMMON DIODES





61 NOTE STRAIGHT DRIVER

32 NOTE STRAIGHT DRIVER BASICALLY THE SAME EXCEPT SHORTER

STRAIGHT DRIVER AS NORMALLY SUPPLIED WILL DRIVE A MAGNET OF 40 OHMS OR MORE

NOTE 1: MAGNETS AS LOW AS 30 OHMS RESISTANCE CAN BE ACCOMMODATED BY SUBSTITUTING A 1K RESISTOR FOR THE R1 2.2K RESISTOR

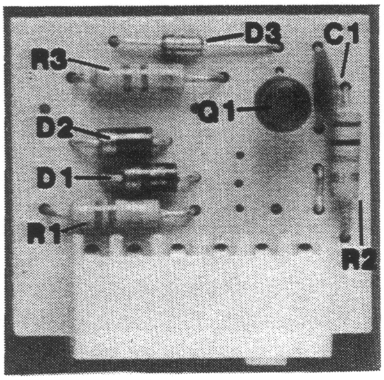
NOTE 2: MAGNETS AS LOW AS 20 OHMS RESISTANCE CAN BE ACCOMMODATED BY SUBSTITUTING A 2SD1292 TRANSISTOR FOR THE 150031 (ORANGE) TRANSISTOR AND SUBSTITUTING A 6 AMP DIODE FOR THE TWO 3 AMP COMMON DIODES.

STRAIGHT DRIVER LOAD RESISTANCES ARE DESIGNATED WITH LABELS FOR EACH OCTAVE.

FIGURE 11

NEGATIVE STOP SWITCH

PART NO. 400477



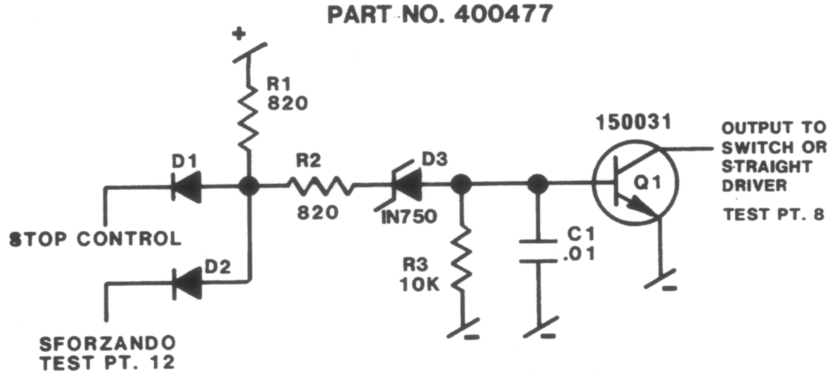
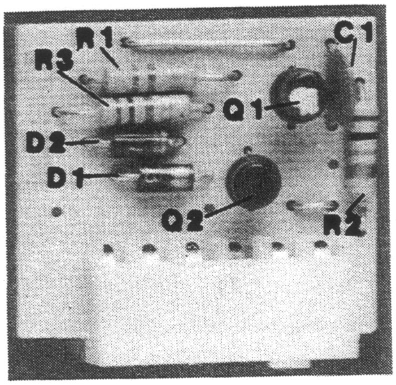


FIGURE 12

POSITIVE STOP SWITCH

PART NO. 400476



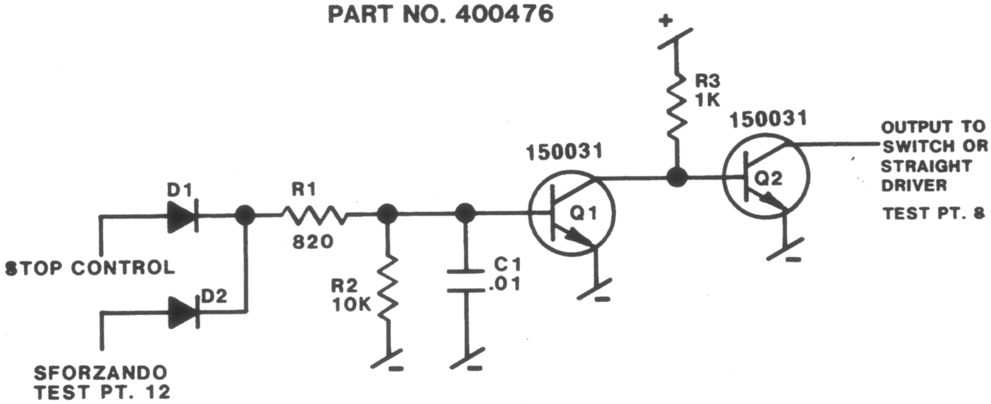
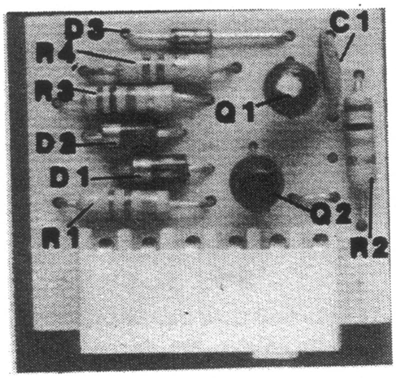


FIGURE 13

NEGATIVE UNISON OFF STOP SWITCH

PART NO. 400479



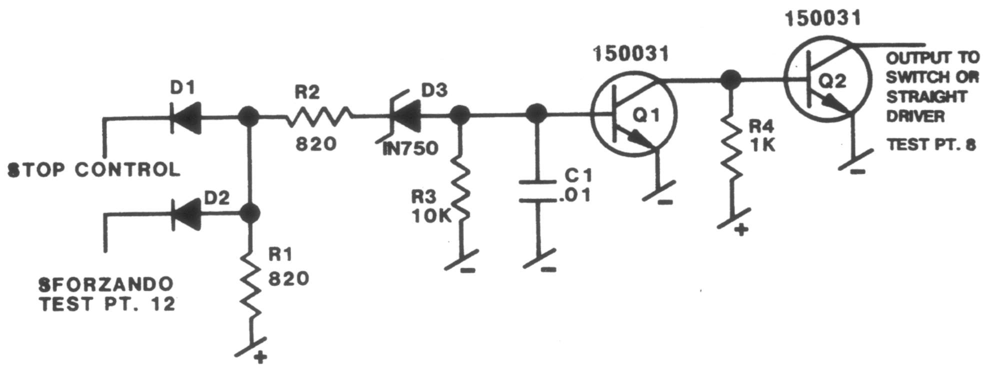
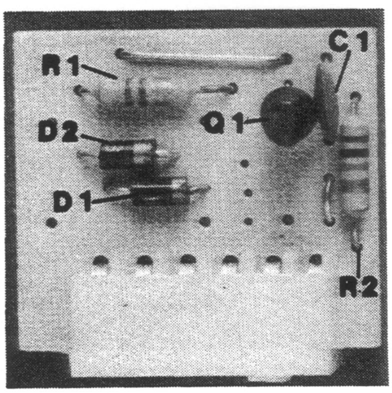


FIGURE 14

POSITIVE UNISON OFF STOP SWITCH

PART NO. 400478



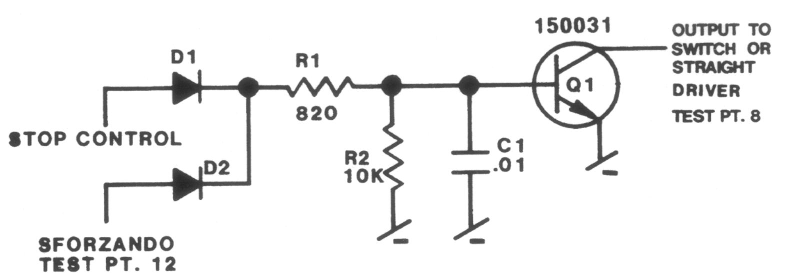
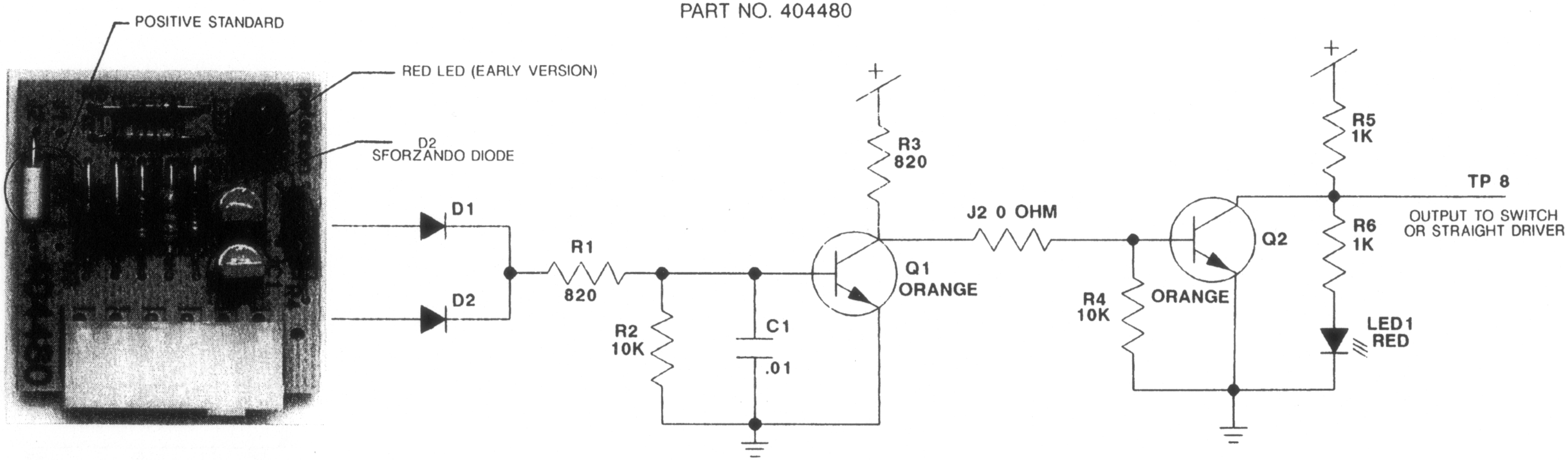
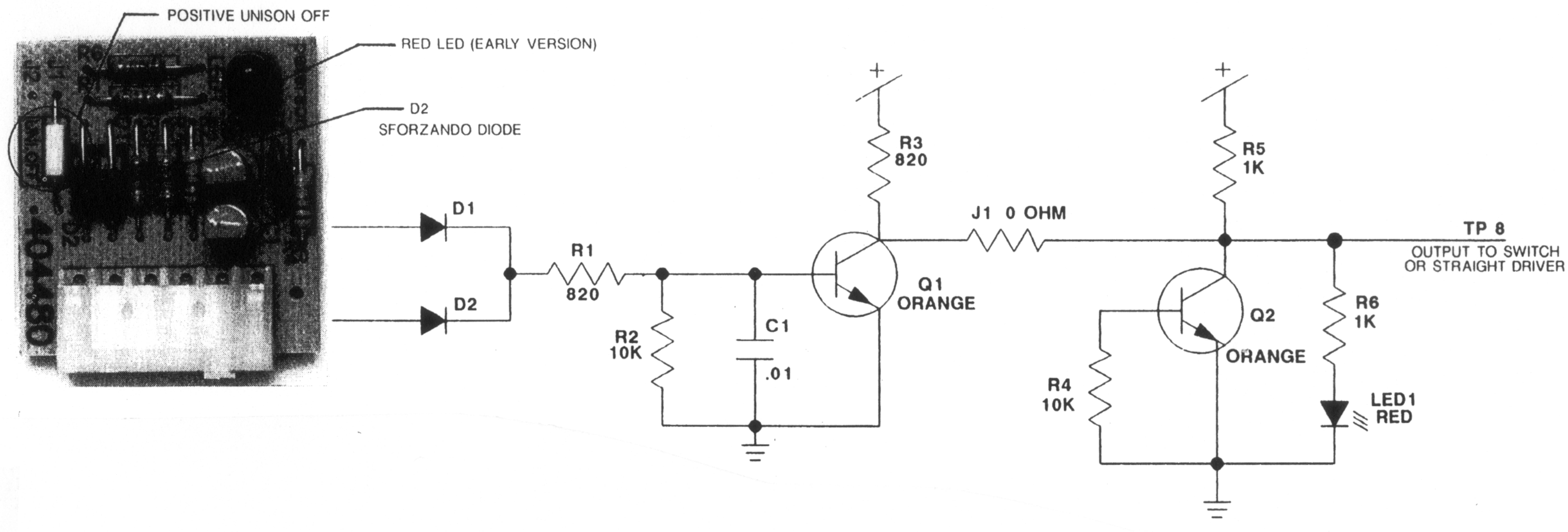


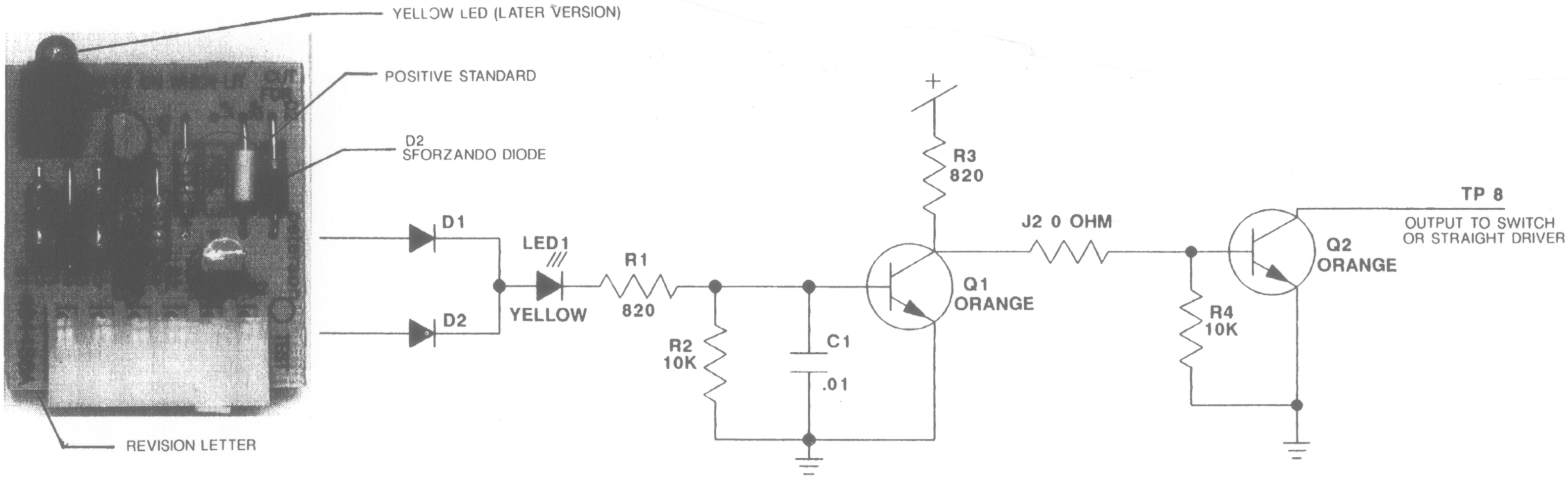
FIGURE 14A

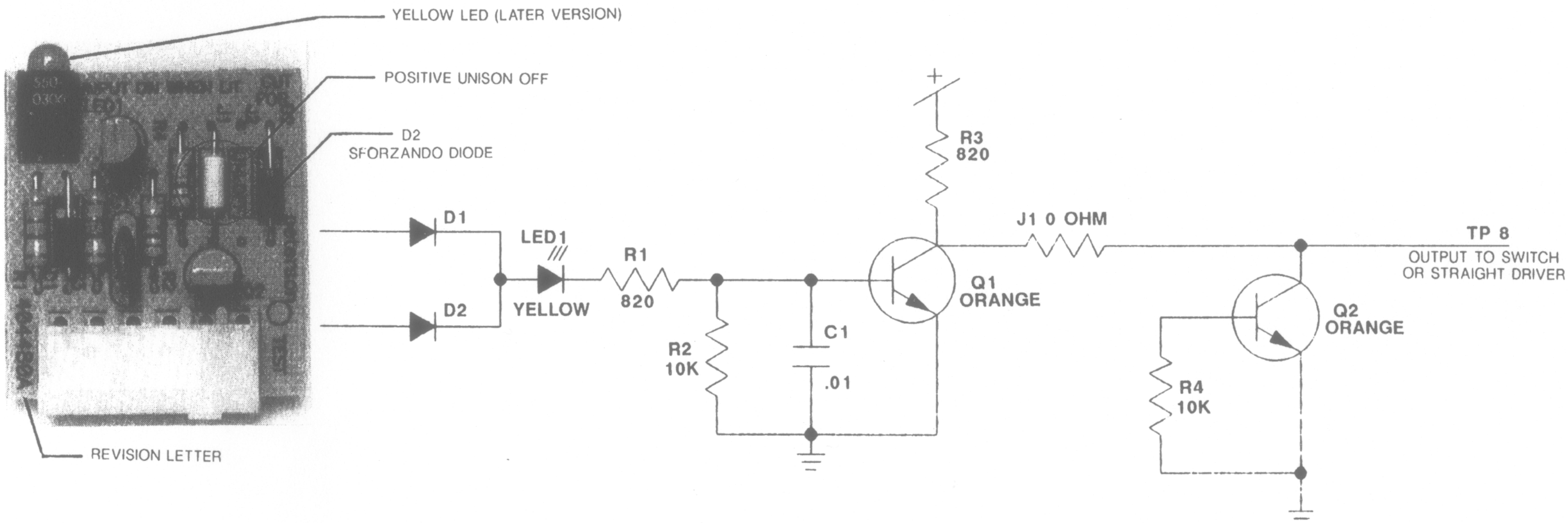
UNIVERSAL STOP SWITCH

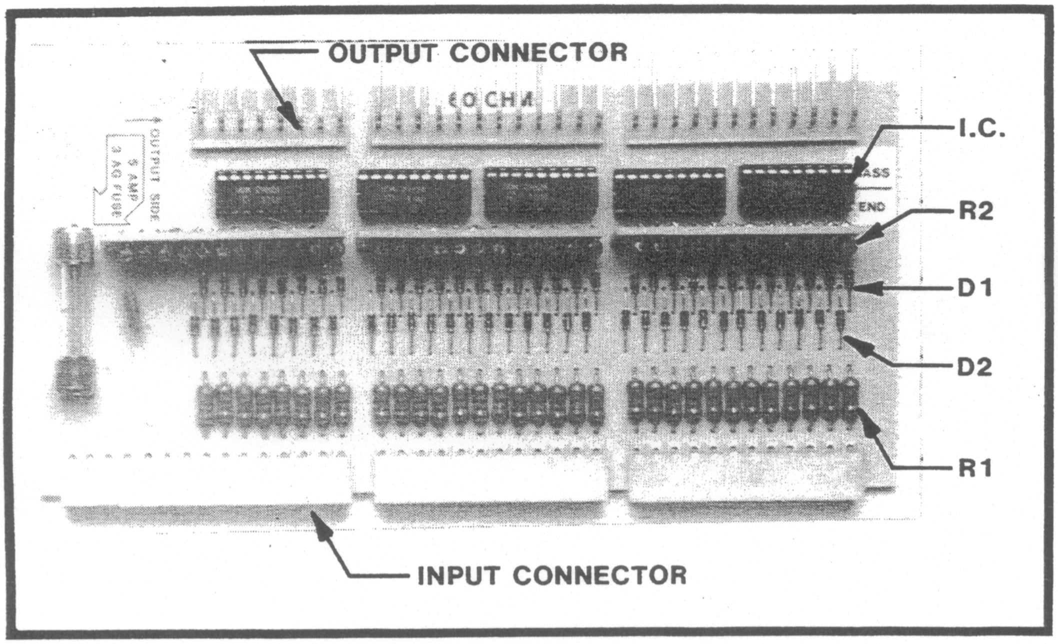
PART NO. 404480

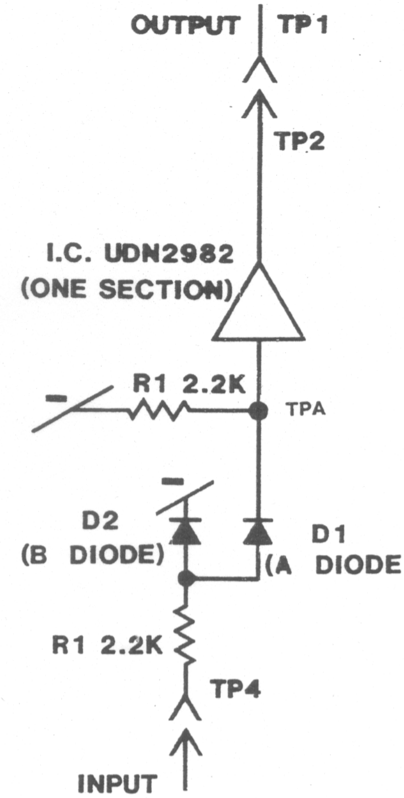




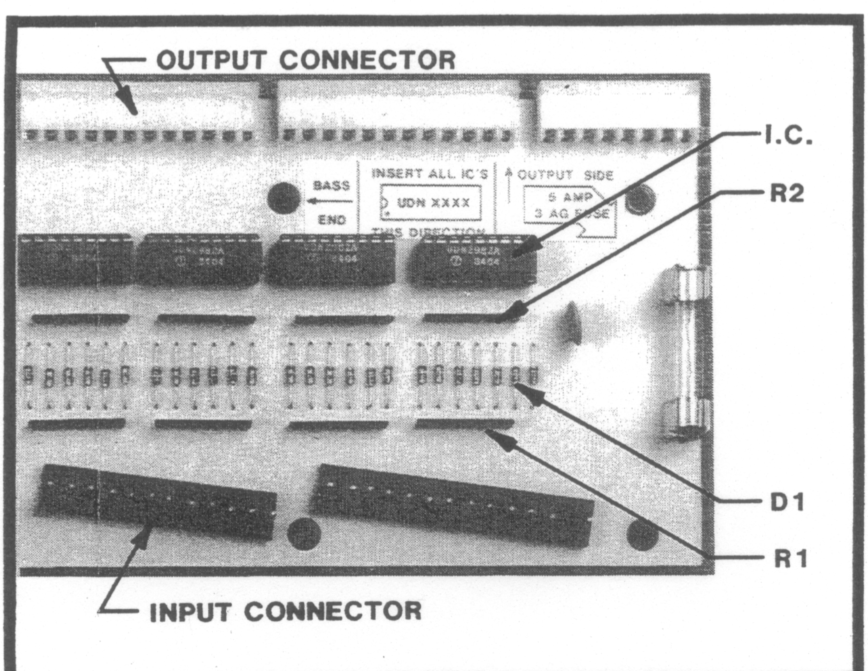

YELLOW LED (LATER VERSION)
POSITIVE STANDARD
D2
SFORZANDO DIODE
REVISION LETTER
D1
D2
LED1
YELLOW
R1
820
R2
10K
C1
.01
Q1
ORANGE
R3
820
J2 0 OHM
R4
10K
Q2
ORANGE
TP 8
OUTPUT TO SWITCH
OR STRAIGHT DRIVER

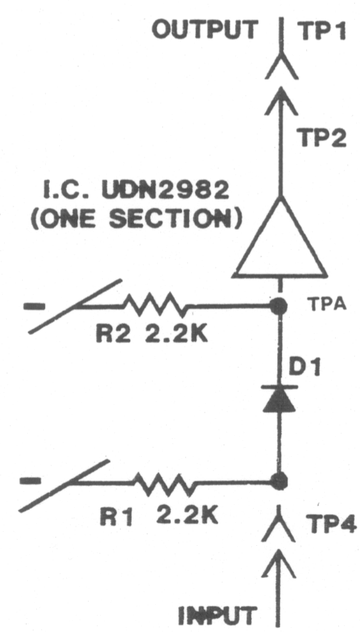

YELLOW LED (LATER VERSION)
POSITIVE UNISON OFF
D2
SFORZANDO DIODE
REVISION LETTER
D1
D2
LED1
YELLOW
R1
820
R2
10K
C1
.01
Q1
ORANGE
R3
820
J1 0 OHM
TP 8
OUTPUT TO SWITCH
OR STRAIGHT DRIVER
Q2
ORANGE
R4
10K





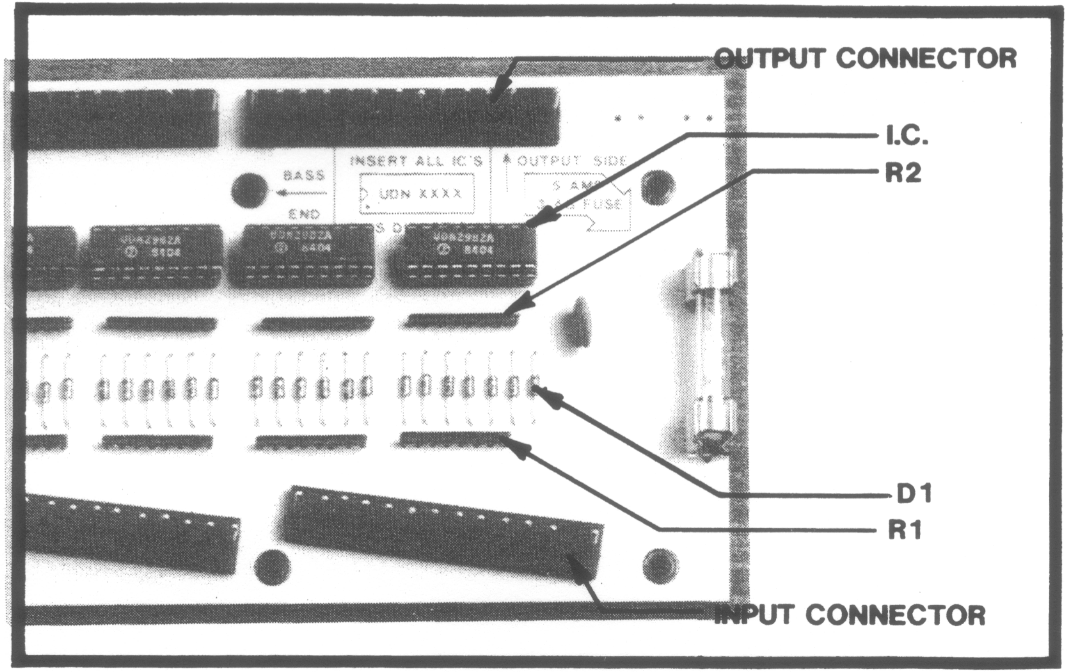
I.C. STRAIGHT DRIVER
FIGURE 15

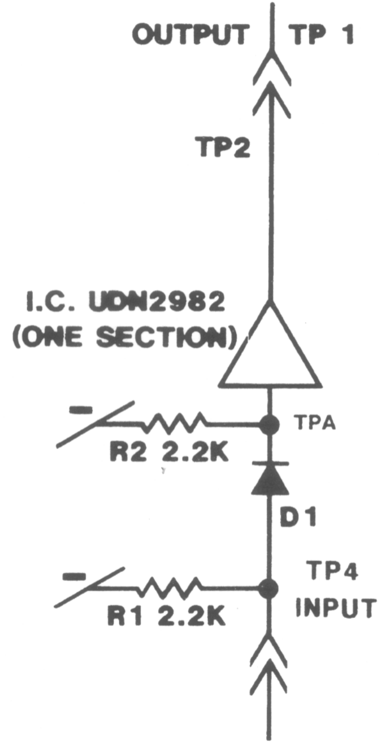




I.C. COUPLER DRIVER
FIGURE 16

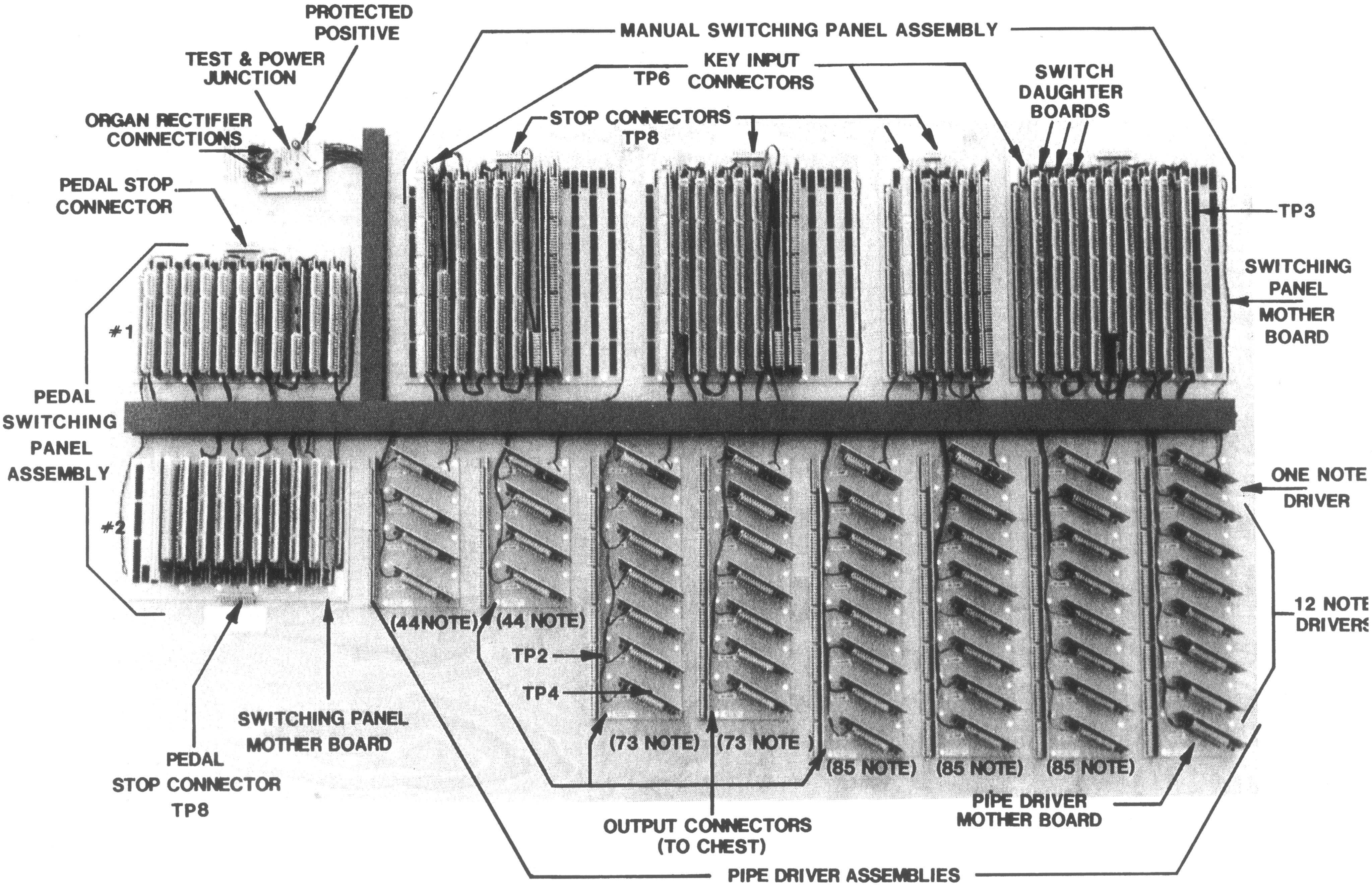
FIGURE 17
I.C. PIPE DRIVER





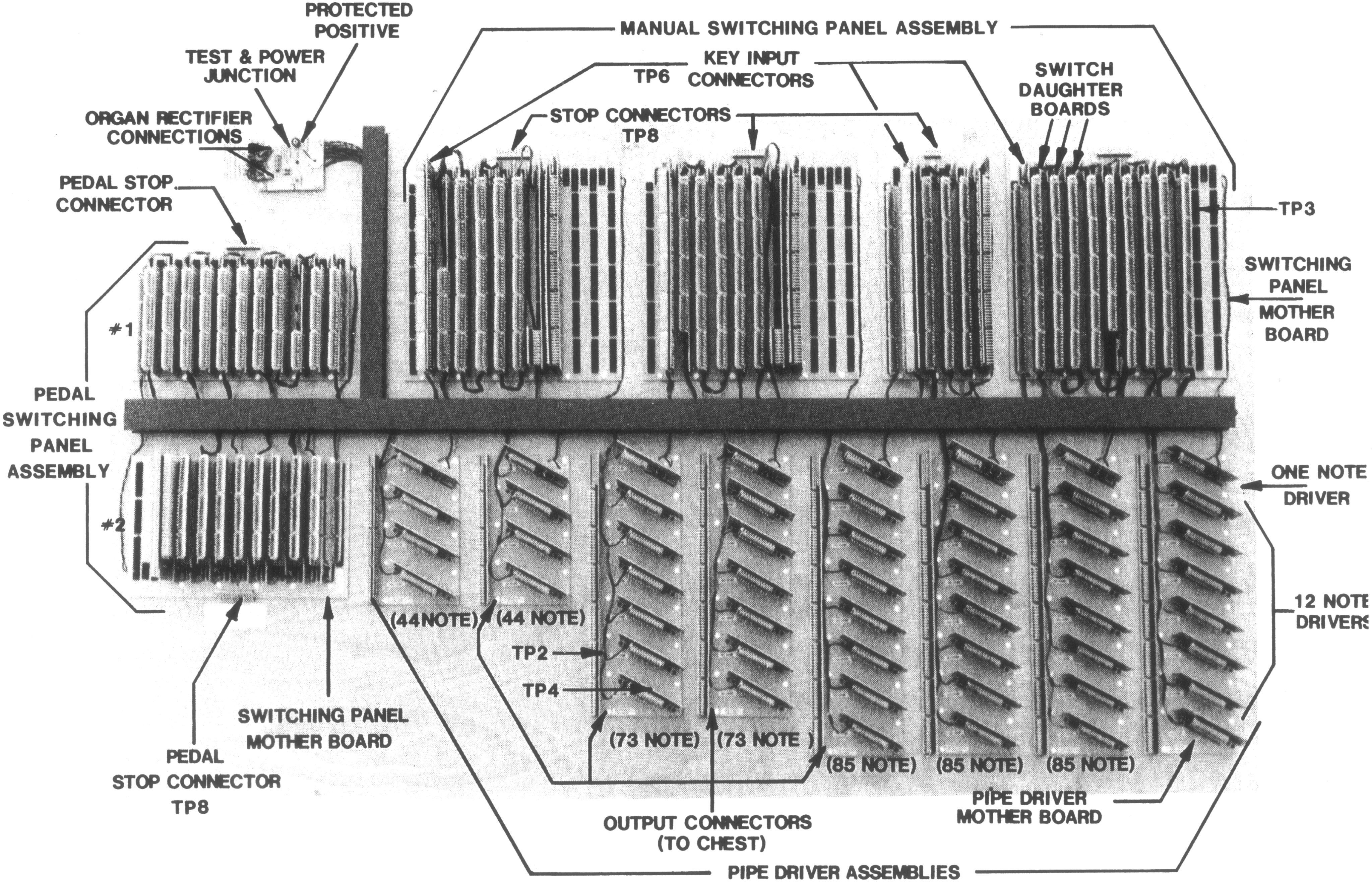
PETERSON SOLID STATE SWITCHING SYSTEM

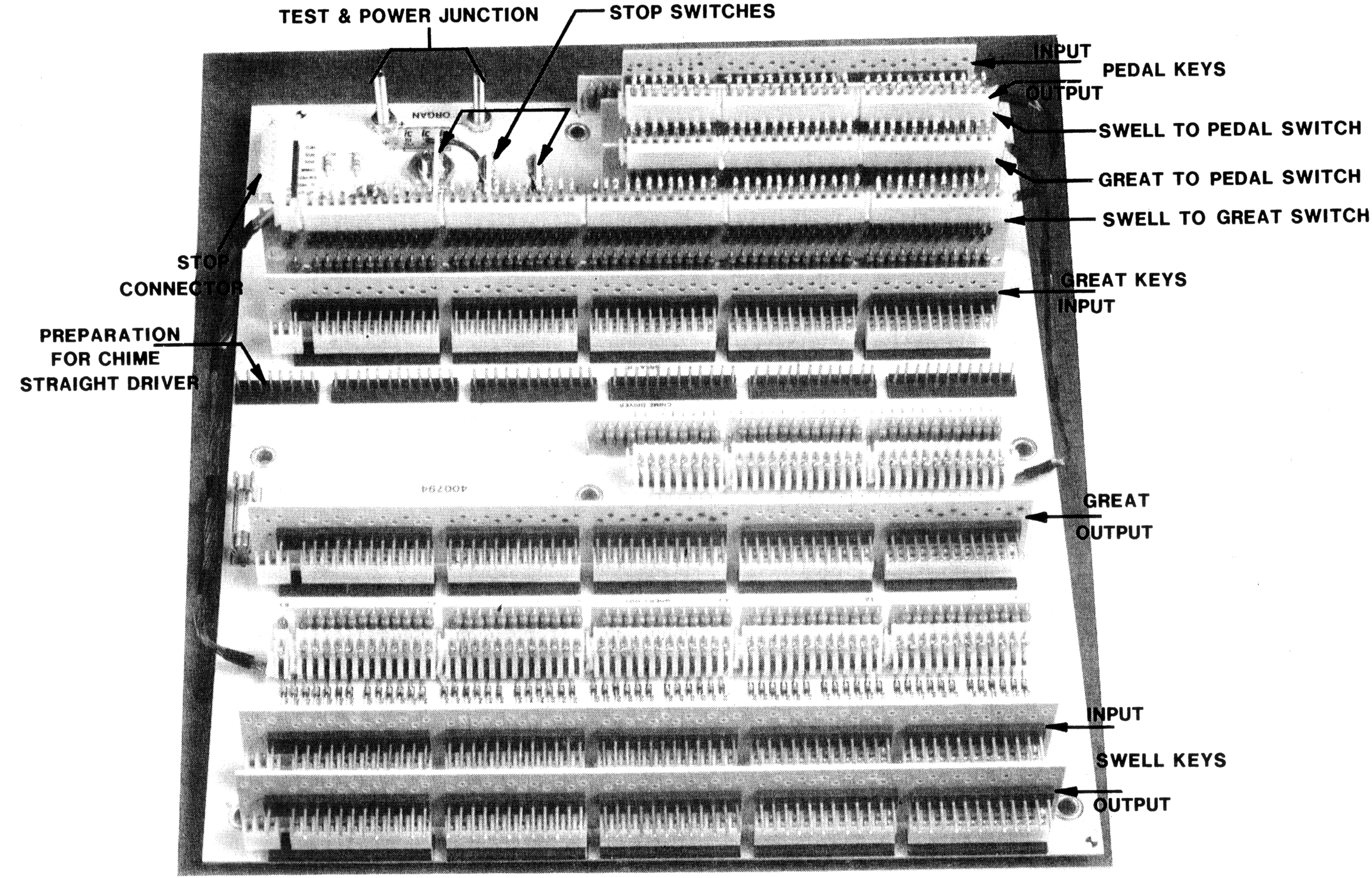
FIGURE 20



PETERSON SOLID STATE SWITCHING SYSTEM

FIGURE 20





STANDARD COUPLER

FIGURE 21

TEST & POWER JUNCTION

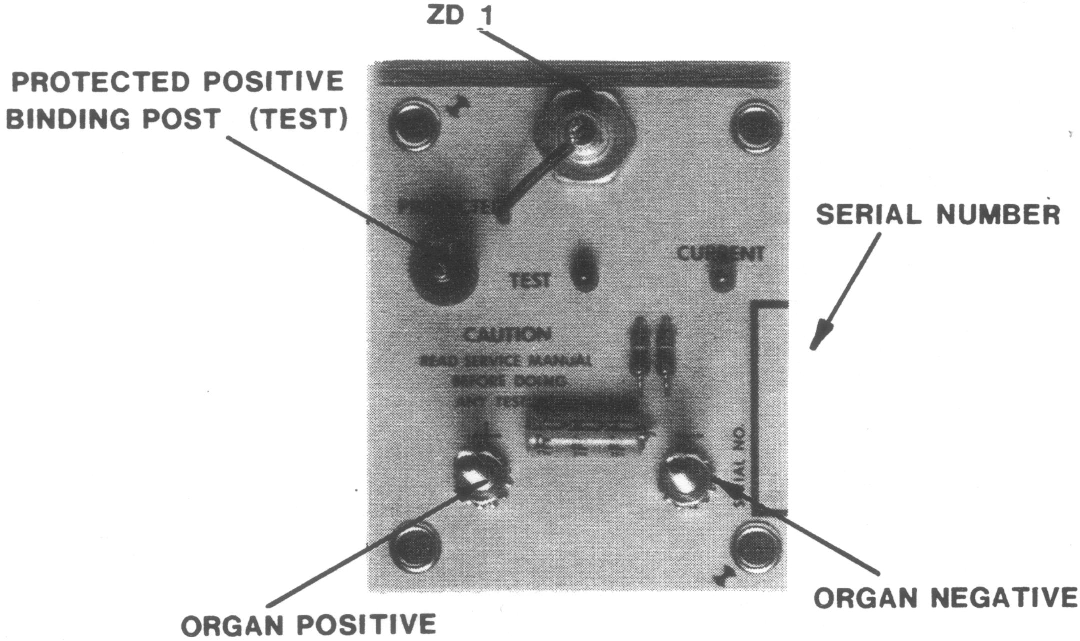
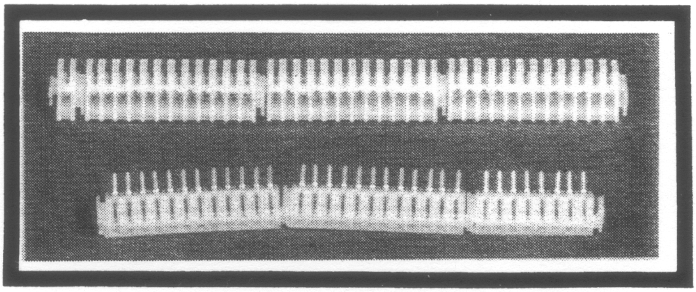


FIGURE 19

FIGURE 22



TYPICAL CONNECTORS