DUO SET "MULTIPLE MEMORY" AND "SINGLE MEMORY" SOLID STATE COMBINATION ACTIONS

Installation and Service Manual

ATTENTION: Please leave instruction booklet on job site for future reference whenever possible.

Revised 10/99

MULTIPLE MEMORY COMBINATION ACTION AND SINGLE MEMORY COMBINATION ACTION

INSTALLATION AND SERVICE MANUAL

GENERAL INFORMATION

BRIEF

Each single memory base system of this combination action was designed to recall the registrations of up to 64 stops that have been set on as many as 16 pistons. Only one base system is needed for organs of 64 stops or less, if only general pistons are required. Multiple Memory base systems will recall the registrations of up 64 stops, that have been set on as many as 20 pistons, with 4, 8, 16, or 32 selectable memories for these pistons. Combination actions built after March 1993 use a new Piston Matrix board (#404968) and Encoder Timer board (#404963) that allow 24 settable pistons on Multiple Memory base systems.

MEMORIES

Both the Multiple Memory and Single Memory combination actions employ CMOS type integrated circuits for their memories. The memory capacity of the multi-level system is large enough to permit up to 32 separate memory levels which can be switch selected. This permits different organists to recall their own preset combinations, without affecting those of other organists using the same instrument.

STOP SENSING

The **standard** system requires **positive** stop sensing. This means that the "feed" voltage to the stop rail must be positive. When a stop is on, organ positive must be connected to the corresponding sense terminal. Negative sensing is available on special order and at additional cost.

STOP MAGNET OUTPUTS

Stop magnet outputs are arranged in groups of 4 stops per "Memory & Stop Action Magnet (SAM) Module". These outputs, on and off, are found on the 8 pin connector on the side of the "Memory and SAM" cards. (See Figs. 1 & 2). Each output is capable of operating a 20 Ohm coil. There is an 18 volt maximum input (900 milliamp maximum continuous current). The magnet (coil) **common is organ negative.** Provisions for a positive magnet coil common are available on special order and at additional cost.

Each 400916 SINGLE MEMORY COMBINATION ACTION MOTHER BOARD "X8" has provisions for 8 "Memory and SAM" boards, giving a capacity of 32 stops.

Each 400917 SINGLE MEMORY COMBINATION ACTION MOTHER BOARD "X16" has provisions for 16 "Memory & SAM" boards, giving a capacity of 64 stops.

Each 400923 MULTI-MEMORY COMBINATION ACTION MOTHER BOARD "X8" has provisions for 8 "Memory and SAM" boards, giving a capacity of 32 stops.

Each 400924 MULTI-MEMORY COMBINATION ACTION MOTHER BOARD "X16" has provisions for 16 "Memory & SAM" boards, giving a capacity of 64 stops.

PISTONS

The single memory system is designed to permit up to 16 pistons; the multiple memory system permits up to 24 pistons. Both also have provisions for a set piston and 2 cancel pistons (for divisional and general cancel). The settable pistons can be wired to be any combination of divisional or general pistons. For example: 8 divisional and 8 general (See Fig. 4).

The contacts of the pistons should be single pole single throw (SPST), normally open, contacts. **The piston common is organ positive** and is available on a connector pin in the same location as the other piston terminals on the "Piston Matrix" board. (See Figs. 1, 2, & 11). It is recommended that this designated pin, and not any other organ positive, be connected to the piston "feed" to avoid possible difficulties which could be caused by voltage drops between different organ positive terminals under certain conditions.

SET MODES

Stop registrations can be "set" or "captured" in two different ways. When stops are registered as desired, press the set button, then the numbered piston that the registration is to be recalled from. Release the numbered piston, and then the set button, in this order. The desired registration is now "captured" on that piston. The other way is to hold a numbered piston and add or subtract stops as desired. (A numbered piston held for more than one second will automatically put the system in the set mode.) This is why it is possible to set the system in either of the two ways. Some organ builders have used "capture systems," others "tripper" systems. The Peterson Duo Set system is comfortable for organists trained on either.

MEMORY PROTECTION

In order to insure that the memories will retain the desired combinations, **"Lock-Out"** circuits and **"Battery Back-Up"** have been provided.

The **"Lock-Out"** circuits which disable setting, can be wired to the crescendo and sforzando to prevent these from being accidentally set into the combination action. A "Lock-Out" keyswitch can also be wired to make the system tamper-proof, but will allow keyholder(s) to change combinations as desired. (See Fig. 4 and 7).

The **"Battery Back-Up"** consists of one rechargeable Nickel Cadmium (NICAD) battery pack for each division, with its own charging and switching, to maintain power to the memories in the event A.C. power is lost. The length of "Battery Back-Up" will vary with the state of charge of the batteries and the size of the system. A minimum of 30 hours, and typically 2 weeks or more, can be expected.

The battery condition can be easily checked using the provided "LED" indicators. See Step 9 of the Test Procedures.

MEMORY BACKUP MODULE

Beginning in early 1998, the Battery Module #400921 will be replaced on most combination action systems by a Memory Backup Module #404969. The Memory Backup Module incorporates a one Farad capacitor in place of four rechargeable batteries to supply the power needed to retain memory. This eliminates the need to replace batteries every five years or so, and increases the memory holding time to at least 30 days under normal conditions.

The Memory Backup Module may be used as a direct replacement for any Battery Module with the part number 400921. While it is generally a good practice to use either all Battery Modules or all Memory Backup Modules on the combination action base systems within a console, they can be mixed if necessary.

Please note that the yellow, red, and green battery monitoring test lights on the Power Module and the 3 Amp Fast Blow battery fuse are no longer needed when Memory Backup Modules are installed, since these items are included for purposes specifically related to the use of batteries.

When the Memory Backup Modules are used, pressing the test button will illuminate the green "under voltage" LED, but this will discharge the capacitor to 4.4 Volts causing the green LED to go out after 3 minutes. The system's memory will not be lost since only 1.5 Volts is required to retain memory. The red "overvoltage" LED will not come on unless an open circuit exists or the backup module is unplugged from its pins on the Motherboard. The yellow "charging" LED will come on if the charging transformer is connected. The Class 2 Transformer (or the wires to the screw terminals labeled "C/A" on a Peterson Console AC Control System) should be kept in place to insure the capacitors are always fully charged.

POWER REQUIREMENTS

Except for battery charging, the Combination Action is powered from the organ power supply (rectifier). **Each division** will draw less than .5 Amp for the electronics, but may draw **up to 50 Amps** to operate 20 Ohm stop action magnets on a X16 mother. (See worksheet, page 18).

The organ power supply (rectifier) voltage required is 10 VDC to 18 VDC and should have adequate

filtering and regulation. At no time, **even for a brief instant,** should the voltage drop below 8.5 VDC or exceed 25 VDC. Voltage below 8.5V will cause erratic operation. Voltages over 25V may damage components. To help the organbuilder identify rectifiers that are not adequately regulated. Peterson has available a "Power Supply Fault Detector". This inexpensive device clips onto Organ Positive and Organ Negative feeds and will indicate "out of range" voltage by latching on a "high level detected" or "low level detected" light. The Power Supply Fault Detector will catch deviations of much shorter duration than can be seen with a meter, and costs much less than an oscilloscope. Please consult the factory for more details.

NOTE: Indicator lamps that flash and dim when pistons are pressed may indicate an inadequate rectifier. Please read the "IMPORTANT PRECAUTIONS" (Page 15) and "ORGAN POWER SUPPLY AND FEEDWIRE SIZE WORKSHEET" (Page 18) for more information.

SAFETY PROCEDURES AND CAUTIONS

1. **Never** apply power to the system during installation. All wiring must be completed and thoroughly checked before applying power and starting the test procedure.
2. Organ rectifiers supply voltages and currents similar to arc welders. Due to these high currents it is highly recommended that the organ power be turned off whenever the system is being worked on.
3. If it is necessary to work on the system while the power is on, for your own **personal safety** we recommend removing jewelry, such as watches, rings or pendants, before work is attempted. Jewelry that shorts across the organ supply **will heat up** rapidly and may cause severe burns. Electronic components can also be damaged.
4. Do not lay tools, wire, solder, hardware, or any conducting material on the system's printed wiring boards, connectors or cables.
5. Should any conducting item such as tools or hardware fall on, in or near the system, turn the power off immediately. Then remove the item. Do not assume hardware has fallen clear, **find it.**
6. If you detect any defects in the cabling or circuit boards, such as burned insulation or melted foils, it is imperative that you check for and find any shorts within the system or its wiring. Merely fixing the obvious could result in further damage. Call us at 1-800-341-3311 if in doubt.

Peterson now offers custom-made wiring harnesses to connect the "on" and "off" coil and "sense" lines of the combination action to connectors that plug onto "Powertab" and "Powerknob" stop control units. Peterson will also mount all base systems to a wood panel and wire all lockout and power connections between Mother Boards and to junctions if you desire. **A cabled and mounted combination action from Peterson is supplied with all of the appropriate fusing, wire sizes, and other considerations necessary for compliance with the National Electrical Code® (NEC®).** Because of our efficient wire-wrap and dip solder techniques, many organ companies, both large and small, have found this to be a very cost effective alternative to wiring their own combination actions. Please consult the factory for more information.

INSTALLATION INSTRUCTIONS

1. Carefully unpack all cartons and check for damage which may have resulted from shipping.
2. Mount mother boards using seven (7) screws (supplied) for each #400916 or #400923 X8" mother, and thirteen (13) screws for each #400917 or #400924 "X16" mother board. Be sure to leave sufficient space around these boards to allow for neat cabling along each side. Provide a loop in all cables to allow easy removal of the connectors.
3. Cable the "on" and "off" coils and the "sense" contacts to their respective terminals, as indicated in Fig. 1 & 2. **NOTE: We highly recommend that the on and off coil wire cabling be bundled separately from the sense and piston wire cabling. Do not run the wires of these two categories together since this has been found to occasionally cause problems under certain circumstances. This is especially important with long cables.**

The "sense" contact is usually the same contact that is used to operate a relay or a stop action in the organ; this is the simplest and preferred arrangement. If this "sense" contact is connected to a magnet, it is necessary that a "flyback" (spark suppression) diode be connected **across** the magnet to protect the combination action. The polarity of the diode is important. To determine polarity, operate the magnet involved and measure the voltage across it, noting which end is positive. Always connect the banded end (cathode) of the diode to the positive end of the magnet. Sense input protection circuit boards are available from the factory. These include flyback diodes for each sense wire and plug onto the mother boards. Flyback (spark suppression) diodes for the "on" and "off" coils are built into the "Memory and SAM Driver" modules. Each stop magnet of each division should be assigned a number, in some logical manner (from left to right, for example). It would be a good idea to list the stop assignment on the form supplied (Fig. 3), for future reference. **Each position's "on", "off" and "sense" pins must all be connected to the same stop action magnet.**

Stops can be controlled from more than one base system (division). For example, it might be desired that the Swell to Pedal coupler be wired to work from both the Swell and Pedal pistons, but not the Great pistons. Simply wire the Swell to Pedal stop action magnet to pins on each of the Swell and Pedal base systems (three wires to each).

"Unison off" stops must use a sense contact which is closed when the unison is "off".

If stop sensing polarity is not positive, a "sense inverter" **must** be used to allow negative stop sensing. One #400938 "sense inverter" will be supplied with each mother board when negative stops are specified. Be sure the pigtailed (red) wire from the "sense inverter" is connected to organ positive. Use of the "sense inverter" does not affect the wiring, except that the wires from the stops wire onto the sense inverter and not the mother board. NOTE: When the sense inverter is used the "lock-out" card must also be negative (#400479).

4. Cable the piston buttons to their terminals on the "piston matrix" boards (See Figs. 1 & 4).

   A. Wire piston commons to a convenient "piston common" terminal on any piston matrix board. The "piston common" terminal is the same as organ positive, but the provided terminal is preferred. This could avoid difficulties from voltage drops, etc. All pistons can be fed from one terminal.

   B. Wire the "set" piston to the "set" terminal on all piston matrix boards. The "set" piston has the same common (organ positive) as the other pistons.

      Options for "set" wiring. In cases where an old mechanical tripper action is being replaced, and the set button is not used, or not desired, this pin may be left not connected. in cases where a "capture" system is desired (no hold and set) the "set" terminal may be connected through a 2.2 K Ohm resistor to the "lock-out" terminals (of the barrier) on the mother boards. This will allow the set button or key switch to operate both functions and defeat the hold and set. **Do not** wire the lock-out key switch to negative in this case.

   C. There are two cancel terminals on each "piston matrix" board. Wire the "general cancel" piston to one of these terminals on each piston matrix board.

   D. Wire each "divisional cancel" piston to the remaining cancel terminal on that division's "piston matrix" board.

   E. Wire "general" pistons to the "piston matrix" boards. Example: General #1 should be wired to Great #1 piston terminal, Swell #1 piston terminal, and Pedal #1 piston terminal.

   F. Wire "divisional" pistons to the "piston matrix" boards on their respective "mother" boards. Example: Swell piston #3 connects only to a piston terminal on the swell piston matrix board.

NOTE: A standard 400916 or 400923 "X8" mother board will accommodate up to 32 stops. If more than 32 stops are required in any division, a 400917 or 400924 "X16" mother board can be used for up to 64 stops.

IN SPECIAL CASES: Where more than 16 pistons in a single memory system are required in a division, a second mother board can be used for that division. The two mother boards will be connected with each of their stops' on, off, and sense terminals in parallel (up to 64), providing up to 32 pistons. If more than 64 stops are required in any division, a second mother board with the pistons wired in parallel, can provide up to 128 stops.

If a multi-memory combination action is used, and more than 24 pistons but no more than 16 memories are required, a Piston Expander Assembly may be used. For 1-5 divisions use part number 400886. For 6-11 divisions specify part number 400887. See Figure 5 and Section 13 for wiring instructions. ALSO, if the total number of settable pistons is 24 or less, a Division Splitter may be used to allow divisional pistons from one multiple memory base system. See Figure 12 for details.

5. If your combination action has #400921 Battery Modules, wire the two 12 VAC terminals of each mother board in parallel to the 12 VAC Class II transformer supplied, or to the terminals of a Peterson Console AC Control System labeled "12 VAC C/A BATTERY" (See the Peterson catalog for more information on this system). This is required to assure that the memory back-up batteries are kept charged. (See Fig. 4). Use the supplied wire which is coded with one copper and one tinned conductor. **Be sure the same color wire is on the corresponding terminal of each mother board.** A red dot is provided on one terminal of each mother board for reference. Bear in mind that this transformer will be required to plug into a 117 VAC outlet in which the power is maintained (not switched). **DO NOT PLUG IN AT THIS TIME.**

   NOTE: The following Steps 6 to 8 should be followed because of the "hold-and set", or "tripper" feature. Steps 6 and 7 "lock-out" the "set" while either the crescendo or sforzando are in use. If this was not done and the sforzando or crescendo was in use, and you were to press and hold a piston, the stops which are activated by the sforzando or crescendo would be "set" onto the piston pressed.

6. If a multi-contact sforzando switch is used, wire one contact to the sforzando terminal on each combination action mother board (See Fig. 1 & 4). This terminal, or contact, may be shared with an indicator bulb, but not with a stop. If a **PETERSON** solid-state sforzando reversible is employed, wire the sforzando output terminal on the reversible to the "sforzando" terminals on the combination action mother boards. (See Fig. 4).

7. Wire the first contact to "make" on the crescendo switch (roller, etc.) to the "crescendo" terminal on each combination action mother board. This terminal or contact may be shared with an indicator bulb but not with a stop.

8. If you desire a "master lock-out" feature, wire one terminal of a single pole, single throw (SPST) switch to the "lock-out" terminal on each mother board, and the other terminal to organ negative. (See Fig. 4). With the contacts of this switch closed, the combination action cannot be "set", therefore making it "tamper-proof". The following switches are available from Peterson.

Part Number	Description
140612	Key operated switch (only)
400648	Lock out keyswitch with nameplate
400649	Memory select switch with lockout - 4 memory
406818	Memory select switch with lockout - 8 memory
406817	Memory select switch with lockout - 16 memory
406819	Memory select switch with lockout - 32 memory

(See figure 7 for mounting details. Please specify Metallex (plastic) or solid brass engraved switch plate).

NOTE: Many times problems with stops not setting, combinations forgetting, or previously set combinations changing by themselves, may not be the fault of the combination action. These symptoms can be caused by sluggish drawknobs or stop keys, or by dirty, corroded, or open stop switch contacts.

Mechanically sluggish knobs or tabs may not move to their proper setting in the time the combination action energizes their coils. If the piston is held more than one second longer than the coils are energized, the combination action will go into the "tripper" set mode. Any stops not having moved to the intended position, or any contacts not properly opened or closed, will cause a new but wrong combination to be set into the memory.

Dirty or corroded contacts become resistive and essentially put a resistor in series with the stop wire from the feed. Although this resistance is usually quite low, it forms as voltage divider. There may be enough voltage to energize the stop magnet, but not enough to address the memory properly. This drop should not exceed 2 volts

across the stop contacts. This voltage can be measured with a voltmeter connected across the contacts.

Open contacts will not address the memory at all. Some organs have separate contacts for the combination action "sense" and for the stop switch. With this arrangement it is possible for the stop to work but the combination action to not be "addressed". For this reason it is preferred to use only one contact for both the sense and stop switching.

It is important to be sure the stop controls and their contacts are in good working condition to properly address the combination action. Do not assume the contacts are "making" because they appear to be touching (Any contacts in question can be confirmed by measuring with a voltmeter).

Problems associated with sluggish knobs and tabs setting improperly in the tripper mode can be minimized by wiring a Master Lockout Switch as in step 8 of the Installation Instructions. The Master Lockout will defeat the tripper mode, thus preventing setting. A much better answer however is to see that the knobs and tabs are properly adjusted and supplied with adequate power.

9. Connect organ positive (+) and negative (–) from the "rectifier" to their respective terminals on the combination action mother boards. The negative (–) lead connects to the "organ negative" screw on the barrier terminals. The positive (+) lead should go to each mother board under the single screw terminal. **Bear in mind that the positive (+) lead has to be of sufficient size to carry feed current to all stop tablet magnets simultaneously. Likewise, the negative (–) lead connected to the "on" and "off" coil returns must be of sufficient size to carry return current from all stop magnets simultaneously. (See worksheet on page 18.)** It is a good practice to run one wire of adequate size from place to place rather than to run two smaller conductors in parallel, unless the smaller conductors are the same length and follow identical paths. Check polarities carefully before applying power to the system. **Reversed polarities will most likely result in damage to the equipment. Warranty does not cover this kind of damage.**

If one organ power supply (rectifier) of adequate size is not available, two or more rectifiers can be used in the installation. One of the following wiring schemes should be chosen, based on the type of power supply, power supply locations, existing wiring, and overall system requirements.

Power supply (rectifier) designs which use selenium diodes, or use "choke" filters (and some solid state regulator types) should not be paralleled. The ferro-resonant transformer type rectifier can be paralleled. Paralleled rectifiers should be set to the same voltage output. In cases where paralleling is not possible, the positive sides of the rectifier outputs should be tied together as the common. (If sense inverters are used for negative stops, then the negatives should be common.) One rectifier can then be used to power the relay and chests, and the other for the stop knobs or tabs. Ideally, the stop action magnet ("SAM") supply should be in or as near the console as possible to reduce the voltage drops in the feed wires. Connect the common positive from the rectifiers to the organ positive (single screw) terminal on each mother board. This positive feed wire must be of sufficient size to supply current to all the stop action magnets simultaneously. Connect the "SAM" supply negative to the single screw terminal (marked SAM/NEG.) on the mother board(s). A #16 wire can be used.

NOTE: A bare wire jumper will have to be cut and removed to gain access to this screw. This jumper normally connects the "SAM/NEG" terminal to organ negative. Be sure the "SAM" negative wire does not touch either of the cut ends of this jumper.

Connect the other organ power supply (rectifier) negative to the barrier terminal marked organ negative on each mother board. An 18 AWG wire will be adequate.

With separate rectifiers connected in this way, and when a PETERSON solid state switching system is used, the SAM supply output voltage can be set 1V to 2V higher than the organ supply voltage to provide a "snappier" action. (Setting the voltages different when used with an electro-pneumatic or electro-mechanical relay may cause problems with false settings or improper reversibles operation).

A "pulse" power supply is available from Peterson that is designed to be used for moving tabs or drawknobs. Please see the Peterson catalog for details.

If there is any question as to whether your particular rectifiers can be paralleled or wired as described above

please call (1-800-341-3311) and ask for advice.

10. **REVERSIBLES.** Each Peterson Reversible X2 Board (406366) provides two independent reversibles that permit two separate reversible stops. The Reversible X2 can be plugged into any combination action division mother board, where Memory and SAM boards normally plug in. The Reversible X2 uses the "sense" input terminals of that position for both its sense inputs and piston inputs. Refer to Figure 8 for details of terminal assignments.

    The preferred arrangement is to plug the Reversible X2 into the division that has the stop(s) that is to be reversed. If a division is full, the Reversible X2 may be plugged into another division that has an empty position.

    Wire the Reversible X2 "on" and "off" outputs to their respective Memory and SAM "on" and "off" outputs (for the stop(s) to be reversed).

    Wire the terminal(s) for the Reversible X2 "sense" to the "sense" terminal for the stop(s) to be reversed.

    Wire the piston input terminal(s) of the Reversible X2 to their respective piston buttons. The reversible pistons must be fed by organ positive (+).

    Note that there is one "on" coil terminal and two "off" coil terminals for each reversible. This allows for a situation as in this example: Swell to Pedal 8' work as a reversible. The Swell to Pedal 4' can be made to cancel if it is "on" by simply wiring the second off coil terminal to the "off" coil on the Swell to Pedal 4' stop action.

11. Sforzando reversibles are separate from the above reversibles. Install sforzando type reversible (if included), with screws supplied. Connect power, pistons, etc., to terminals as indicated on the sforzando reversible card

    proper. Pistons must be fed from organ positive (+). The sforzando piston(s) or "tutti", will cause an output to appear at the "sforzando output" on alternate pressings. The sforzando reversible is "self holding." Therefore the output will continue ue to be present indefinitely with only a momentary signal at the sforzando piston terminal. Sforzando output can be removed by:

    A. Re-pressing the sforzando reversible piston.

    B. Pressing a cancel piston (usually general cancel if connected to the cancel piston terminal on the sforzando reversible), or

    C. Turning the organ "off" for a short period of time. When the organ is turned "on" the sforzando will automatically stay "off". The only way to turn it on is with a momentary organ positive (+) applied to the sforzando piston terminal (as by pressing the sforzando piston).

12. The Peterson multi-memory combination action can be wired for 4, 8, 16, or 32 selectable "memory banks" for all pistons. In each case a different memory select switch assembly is used. Mount the switch assembly using Figures 6 and 7 as a guide. Note that the shaft of each switch may need to be cut off with a hacksaw, or a spacer used between the switch plate and the mounting surface, so that the knob will come close enough to the console surface. A flat should be filed on the shaft in the appropriate place for the knob's set screw to seat against. DO NOT OVER TIGHTEN THE KNOB'S SET SCREW.

    A. For a four memory system, wire the switch contacts labeled "B", "C", and "D" to the terminals marked "B", "C", and "D" on the Piston Matrix Boards. (See Figures 4 and 6). The switch contact labeled "A" should not be connected to anything. Wire the common terminal of the switch (usually offset from the other switch terminals) to the pin labeled "com" on one Piston Matrix Board, or to another organ + terminal.

    B. For an eight memory system, a switch with eight contacts plus the common terminal will be supplied. You will also receive a Diode Matrix Board, #400910. Mount the Diode Matrix Board near the rest of the combination action. Wire all eight contacts of the switch, and the common terminal, to the input side of the Diode Matrix Board as shown in Figure 4. Wire each group of "+ EFG" pins to the Memory Select Option connector on a Mother Board. Use one group for each Mother Board. If more than six Mother Boards are used, you will receive a second Diode Matrix Board. In this case connect all inputs in parallel. **DO NOT CONNECT ANYTHING TO THE TERMINALS**

MARKED "C and "D" ON THE PISTON MATRIX BOARDS when an eight memory system is wired. Do not connect anything to the "B" terminal unless a Piston Expander Assembly is used. See Section 13 for details.

C. For a sixteen memory system, two switches are used; one labeled "A,B,C,D" and the other labeled "1,2,3,4". The combination of these two switches gives 16 possible memories. For example: A1, A2, A3, A4, B1, B2, etc. Wire the "A,B,C,D" switch as in #12A above. Wire the "1,2,3,4" switch terminals, and the common terminal of this switch, to the input side of the Diode Matrix Board as shown in Figure 4. Wire each group of "+EF" pins to the Memory Select Option connector on a Mother Board. Use one group for each Mother Board. Note that in this case the input pins labeled 5,6,7 and 8 and the "G" terminals on the Diode Matrix Board will not be connected.

D. For a thirty-two memory system, one switch labeled "A,B,C,D", and another labeled "1,2,3,4,5,6,7,8" are used. To wire these switches, follow all directions in steps #12A and #12B above.

If some number of memories other than 4,8,16, or 32 is required, a custom switch assembly may be special ordered from Peterson at additional cost.

An optional Digital Memory Selector Assembly, part #404436, may be used in place of the rotary knob selectors described in this section. This assembly consists of a Digital Memory Select Decoder/Driver board, a Readout Module, and a cable to connect the two. The Digital Memory Selector Assembly is easily installed as indicated in the instructions included with it.

13. If the combined number of general and divisional pistons affecting the stop tabs of any division is more than twenty-four, a Piston Expander Assembly may be installed as shown in Figure 5. The Piston Expander Assembly allows a total of twenty generals PLUS twenty divisional pistons on any Multiple Level Base System by using memory space that would otherwise be used for extra memory levels. To use the Piston Expander Assembly, wire all general pistons to the "General Piston Daughter Board" as shown in Figure 5. Wire divisionalpistons to their corresponding "Divisional Daughter Board". Then wire all twenty pins of each Divisional Daughter Board to the "P1" to "P20" pins on the appropriate Piston Matrix Board. For example, wire pins on the Swell Piston Matrix to the Swell Divisional Daughter Board. On 4 and 16 memory level systems, connect the wire from the General Piston Daughter Board to the "G" terminal on the "+EFG" (Memory Select Option) connection of each Combination Action Mother Board. Do not connect anything to the "G" terminals on any #400910 Diode Matrix Board. On 8 memory systems, connect the wire from the General Piston Daughter Board to the "B" terminal of each Piston Matrix Board.

14. If the combination action uses #400921 Battery Modules, plug the 12 VAC Class II transformer or Peterson Console AC Control System into the 117V 60 Hz A.C. power. (Note: This power must be maintained, not switched, to keep the back-up batteries charged.) The yellow light emitting diode on each power module should light, indicating that the batteries are being charged.

15. Insert the 3 Amp "fast-blow" AGC (or 3AG) fuses into their clips on each battery module if applicable, one on each base system. If a fuse replacement is ever needed, be sure to replace only with the proper type fuses. This is important to prevent damage to the system and to assure safe operation. NOTE: If for any reason the Class II transformer is going to be left unplugged for an extended period of time (such as shipping the console) the battery fuses should be removed and re-installed when the power can be restored. This will keep the batteries from totally discharging and possibly being damaged.

16. Proceed to the "test" section of the instruction manual.

TEST PROCEDURE FOR PETERSON COMBINATION ACTION

Before testing the combination action "electronics", the stop action units should be tested for proper operation and wiring. To do this, unplug the on-off coils from the "Memory and SAM" driver boards, turn on the organ power and use a test lead from organ positive to key each magnet at the connector pins (now unplugged). Be sure each stop unit moves to the proper position, on and off, when keyed from its designated pin (see Fig. 2 and 3). Sense contacts can be tested by measuring with a voltmeter. Connect the meter's negative lead to organ negative. Organ

rectifier voltage should be measured at the sense terminal when the stop is on. Once all stop units have been tested, turn off the power and plug the connectors back onto the "Memory and SAM' boards. (Be sure pins line up). Test the combination action "electronics" in the following way:

NOTE: Several conditions can result in damage to the equipment. Should such conditions develop, determine the problem in the shortest possible time.

SMOKE (Serious damage likely to result). Turn off power, unplug Class II transformer and remove fuses promptly before pinpointing source.

STOP ACTIONS HUNG "OFF" or "ON" (One or both coils energized). This may cause the coil or output transistor to overheat and be damaged. This type of damage can happen quickly. It is important to check for this condition and remove power if it occurs.

1. Turn organ "ON".
2. Check that all stop actions will stay in the "ON" or "OFF" position when moved to either position. If they "spring back" to one position or the other with the organ "ON", but not "OFF", turn organ "OFF" and refer to the trouble-shooting section before proceeding.
3. Manually turn all stops "ON".
4. Press divisional cancels. All stops in given division should go "OFF". If they do not, refer to trouble-shooting section before proceeding.
5. Turn all stops on manually and then press general cancel. All stops should turn off. If they do not, refer to trouble-shooting section.

6A. Set one piston for all stops "ON", Set as a capture action; select stops, press "set" piston, select and press piston desired, release piston, release set piston.

6B. Set a different general piston using the tripper (hold and set) mode. To set as a tripper action, simply press piston desired, manipulate stops to desired combination, release piston. Remember that it takes about one second after the piston is pressed before the system automatically goes into the "set mode. When in the set mode, a green light labeled "LED2" on the applicable Mother Board(s) should be illuminated.

NOTE; If action will not "set", check to be sure crescendo, sforzando, or "Lock-out" are not activated, and that sforzando indicator bulbs return to the proper polarity.

7. Set the divisional pistons in some easily recognizable sequence. For example: Piston 1, stops 1 and 2 on, and all others, off. Press pistons to make sure they do what they were set to do. If they do not, refer to the trouble-shooting section before proceeding.
8. Set general pistons to some easily recognizable sequence. For example: Piston 1, stops 1, 2 and 3 on, all others off. Piston 2, stops 4, 5 and 6 on, all others off. Press pistons to make sure they do what they were set to do. If they do not, refer to the trouble-shooting section before proceeding.
9. Each power module has 3 light emitting diodes (LEDs) a test button and two test terminals for checking the batteries and regulated voltage.

   The Yellow LED indicates power (12 VAC) is applied and the batteries are being charged. The Red LED indicates **over-voltage** on the battery (bad battery or open fuse). This LED should normally be off. The Green LED will light only when the **test** push button is depressed. This LED indicates that the battery voltage is not too low (cells are not weak or shorted).
10. The test terminals TP1 and TP2 are for connecting a voltmeter to the 5 VDC regulated output. TP1 is positive and TP2 is negative. The voltage should be 4.75 VDC to 5.25 VDC under all conditions.

11. Connect a voltmeter to read the organ rectifier voltage at the organ + and organ - terminals on one of the combination action mother boards. You should read 10V-18VDC. Then reiterate the general cancel button and observe the voltage reading. If it drops below 8.5VDC refer to the "ORGAN POWER SUPPLY AND FEEDWIRE SIZE WORKSHEET (Page 16). Remove A.C. power from the CLASS II transformer and turn the organ power off for a short period of time, at least 10 minutes, and then reapply power. Check to be sure the combination action has remembered the previously set combinations. If it has not, refer to the trouble-shooting section.

END OF TEST

TROUBLE-SHOOTING

Trouble-shooting the PETERSON Combination Action is easily accomplished once a few basic things are understood. Our modular design greatly simplifies trouble-shooting. Field repairs to electronic circuits are generally not necessary, since it will usually be easier to plug in a replacement module than to attempt to repair a defective one. **Be sure to read this Trouble-Shooting Guide in its entirety before attempting any repairs.**

WARNING
There are "CMOS" I.C.s (integrated circuits) on the Piston Matrix, Encode/Timing and Memory and SAM modules.

"CMOS" I.C.s can be damaged by Electro-Static Discharge (ESD)!

There are protection circuits designed into these modules to prevent "ESD" damage in their normal operating conditions. Some caution should be used to prevent "ESD" damage to modules that are being removed or replaced while servicing.

Before removing or replacing modules

1. Always turn organ power off
2. Touch a finger across test points TP1 and TP2 on the power module (to discharge ES)

After removing modules

1. **Do not touch the backs of the boards where there are I.C.s, and don't touch the bottom edge connectors.**

Returning defective modules

1. Handle as above
2. Wrap the boards in tin foil or re-use the pink conductive foam from the original shipping material for packing.

ALWAYS TURN THE ORGAN "OFF" WHEN REMOVING AND REPLACING MODULES!

Be sure, also, to plug the modules in carefully and be sure they are facing in the proper direction. Remember too, that if a board is removed, it may be necessary to reset the combinations affecting its associated stops. **A short circuit in a stop action magnet or its associated wiring can "take out" a transistor or other electronic component, so before changing modules, check the stop magnet coil resistance and its wiring to avoid damaging the replacement modules.** Also, check the fuse at the top of the Mem + SAM Board before replacing the board. A red LED next to this fuse will be illuminated each time a piston is pushed whenever organ power is on if the fuse is blown.

WARRANTY DOES NOT COVER DAMAGE AS A RESULT OF CARELESSNESS OR ABUSE

Before suspecting individual modules, it is a good idea to check for proper operating voltage. Refer to step 9 of the

test procedures to check the battery and regulated 5 volts. The Lock Out Terminal should read approximately 0 Volts (with respect to Org +) unless the set function is to be locked out, in which case the lock out terminal is connected to Org. - ("0" volts with respect to the Org - terminal). The Org + and Org - (or SAM -) terminals are connected to the power supply (rectifier) intended to move the knobs or tabs. This will usually be between 10 and 16 Volts depending on the knobs and tabs used. For the knobs and tabs to operate dependably, this power supply must have adequate capacity and voltage regulation. NOTE, however, that about.5 Volts will be lost in the combination action so that the actual voltage reaching the stop action magnet coil will be .5 Volts less than the power supply.

As shown in Figure 1, there are only 5 basic module types (not counting special modules for reversibles, etc.) The modules plug into a large printed wiring panel called a **"Mother Board".**

A separate "Memory and SAM Driver Board" (400919 or 400945) is provided for each four stop tablets or draw knobs. All memory elements associated with a specified group of four stops, as well as all electronic components associated with "driving" (operating) the same four stops, are included as a part of each of these boards. The chart shown in Figure 3 shows which stops go with which Memory and SAM Driver Board. When installing the system, it is a good idea to fill out this form and keep it with the system. It is obvious than **any** fault that affects only a single stop, or group of stops that are all associated with the same Memory and SAM Driver Board would suggest trying a new board. Alternately, a suspect board can be "swapped" with a board associated with another group of stops that are working properly, and if the suspect board is in fact defective, the "trouble" will move with the board.

Each Mother Board assembly requires one Power Module (400922), one Battery Module (400921), one Encode/Timing Module (400913 or 404963), and one Piston Matrix Module (400918 or 404968). These modules work together to "address" the proper memories and to initiate the sequence that results in either the movement of the stop actions, or the "setting" of a combination into the memory. Any malfunction that affects all of the stops in a division, would be a reason to suspect any of these modules. Generally, if pushing a piston does not move any stops in the division (in other words, if you push a piston and nothing happens, or if stops "flutter"), first try replacing the Encode/Timing Module. If there is evidence of **improper** operation, as for example if wrong stops move, suspect the Piston Matrix Module.

Only a few components are attached directly to the Mother Board. "Open" circuits in the foil pattern (such as cracks, scrapes, or burned foil) can be located visually.

The integrated circuits (I.C.s) on the Piston Matrix Board are part of an address matrix that causes a given piston button to address the proper memory elements in the memory integrated circuits. Generally speaking, if an I.C. is open or shorted, it will result in improper addressing. An example of this type of malfunction would be when stops that were set on one piston move when pushing a different piston. Any type of piston "inter-action" would be reason to suspect this module. Similar symptoms can be caused by the Piston Matrix Board, the Encode/Timing Board or Mother Board problems. Determine which board is at fault by using the following procedure:

> If apparent "piston interaction" occurs in only one division, suspect the Encode/Timing Board or Piston Matrix Board. Swap Piston Matrix Boards with another division to determine if one is defective. If the problem "moves" to a different division, that board is bad. If the problem does not move, unplug all piston cables from all Piston Matrix Boards except the division where the problem exists, then swap the Piston Matrix Board from an unused division and test the malfunctioning division. The Encode/Timing Board can be swapped in the same manner. If swapping Encode/Timing or Piston matrix Boards does not make the problem "move", suspect the Mother Board or Memory and Stop Action Magnet Drivers for "shorts and "opens" in the foil pattern. Test for malfunctions by swapping modules. This should determine the defective module in the least amount of time.
>
> **CAUTION:** The heatsink for the 5V regulator will be **HOT** to the touch when the organ is on (about the same as HOT tap water). Caution should be exercised when handling this board or heatsink.

If a problem should occur after the installation is completed, the following guide should be helpful in pinpointing the source of the trouble. Find the heading(s) that matches your problem and then follow the steps (in the order listed) until the problem clears up or moves (after swapping boards). The defect will be in the removed board or cable, or in the swapped board.

If a step asks to "swap" a board, **TURN THE ORGAN POWER OFF**. Then unplug the suspected board and replace it with a known good board from another division.

Once the problem is pinpointed, if a replacement board is needed or if you need further assistance give us a call at (708) 388-3311 or Toll Free (800) 341-3311.

1. **STOPS FORGET** when power is off for a short time
   - A. If Enc/Timing Assy, is #400913A, remove R33 (2.2K resistor on right edge). This component has been deleted in later type boards.
   - B. Bad battery fuse or battery (check with indicator lights)
     1. Battery fuse bad (red light on).
     2. Battery checks bad (green light does not come on when test button pushed).
   - C. Defective Enc/Timing #400913 or #404963 (swap with one from another division).
   - D. Defective Mem & SAM #400919 or #400945 - unplug all but one from the Mother Board and try one at a time.
   - E. Defective power module #400922 - swap with another division.

2. **STOPS FORGET WHEN POWER IS OFF** for a long period of time
   - A. Be sure power is continuously applied to class II transformer (yellow light on) Test for continuous power by plugging a clock into the same circuit; if it loses time, the power is not continuous.
   - B. Battery fuse bad (red light on).
   - C. Battery checks bad (green light does not come on when test button pushed.)
   - D. Check replacement date of batteries (on battery cover).

   NOTE: Batteries are nickel cadium rechargeable type. Replace only with AA size nickel cadmium cells. **Never replace with drycells** or damage to the equipment may result.

3. **STOPS FORGET** after pushing pistons several times
   - A. Test for sufficient organ rectifier capacity and feed wire size by referring to Test Procedure #11.
   - B. If one division only, swap Encode Timing #400913 or #404963, then power module #400922, then try one Mem. and SAM #400919 or #400945 at a time.

4. **DEAD-ALL DIVISIONS,** All pistons and cancel don't work
   - A. Check for org + and - and SAM - with voltmeter on screw terminals of Mother Boards.
   - B. Unplug all piston wire connectors from piston inputs on Piston Matrix Board #400918 or #404968, then use test leads from + to piston inputs. If combination action works on each division then check for stuck general button (or check for shorts in wiring).
   - C. Be sure stop action magnet coil common is negative. If a positive common is required, **an output inverter assembly must be used.**
   - D. If Piston Matrix #404968 is used, be sure Encode Timing is #404963.

5. **ONE DIVISION DEAD**
   - A. Unplug piston connectors on dead division, then try + test lead to piston inputs. If it works check divisional pistons for shorts or stuck button.
   - B. Swap Power Module #400922.
   - C. Swap Encode/Timing Module #400913 or #404963.
   - D. Swap Piston Matrix Module #400918 or #40968.
   - E. Try Mem and SAMs #400919 or #400945 one at a time in dead division.

6. **WON'T SET - ALL DIVISIONS** (stops will move when pistons are pushed)
   - A. Be sure cresc., sforz. or master lockout are not actuated.
   - B. Remove all cresc. sforz. and lockout wires from all Mother Boards and try setting. If only one division is now bad see #7.

C. Be sure sense wire supplies positive when on. If negative, a sense inverter must be used.

7. **ONE DIVISION WON'T SET**
   A. Remove lock out card, #400478 or #404480U, and try to set.
   B. Swap Enc/Timing Module #400913 or #404963.
   C. Try with one Mem. and SAM #400919 or #400945, at a time plugged in.

8. **ONE STOP WON'T SET ON** but does cancel
   A. Use positive test lead on output of Mem. and SAM. #400919 or #400945. If dead, then wiring or stop action magnet is bad.
   B. Swap Mem. and SAM. #400919 or #400945; if problem moves, then suspect a bad driver transistor on that card.

9. **ONE STOP WON'T SET ON** or cancel
   A. Test as in #8
   B. Unplug sense wires and try to set. If it now sets off, the problem is in the wiring, stop action magnet, or relay.

10. **ONE DIVISION WON'T SET** but stop moves on and off in other combinations
   A. Measure sense input with voltmeter. Voltage must go to organ + when stop is on. If not check wiring, soldering, and stop action magnet contact (if organ has negative stops and a sense inverter is used, measure at the bottom of the inverter on the connector into the Mother).
   B. If sense voltage is O.K., swap Mem. and SAM #400919 or #400945 with a known good one.

11. **LOCK-OUT DOES NOT PREVENT SETTING**
   A. Use a voltmeter to measure the lock out voltage by putting the negative lead on the lockout terminal, and the positive lead on TP1. This should read organ rectifier voltage when locked out. If not, check lock-out switch contacts or wiring.
   B. Use a voltmeter to measure the voltage on the sforz. and crtesc. terminals by putting the negative lead on organ negative, positive lead on sforz. or cresc. terminal. This should read organ rectifier voltage when the sforz. or cresc. is actuated.
   C. Remove lockout cards #400478 or #404480 (or #400479 if sense input inverters are used) from base systems one at a time until lockout works. The last one removed is the defective board.
   D. If problem is on one division only, swap Enc/Timing card #400913 or #404963.

12. **INTERMITTENTLY GET WRONG COMBINATION** on all pistons (get right one if tried again)
   A. Measure organ rectifier voltage at Mother Board terminals while reiterating general cancel. If 9V or less, problem is in feed wire size or rectifier capacity (see power worksheet page 18)
   B. If problem is in one division only, swap cards one at a time, in order listed below, until problem moves.
      1. Power Module #400922.
      2. Enc/Timing #400913 or #404963.
      3. Piston Matrix #400918 or #404968.
      4. Unplug all but one Mem. and SAM, try with one Mem. and SAM at a time #400919 or #400945.

13. **INTERMITTENTLY GET WRONG COMBINATION** on 1 or 2 pistons (apparently shorted together)
   A. Unplug piston wiring and try with an org + test lead. If O.K. check wiring for short between two buttons
   B. Swap Piston Matrix #400918 or #404968.

14. **HUM, BUZZING, OR SINGING FROM COILS** when piston is pressed

A. Measure organ rectifier voltage at Mother Board while reiterating general cancel button. If reading is 9V or less, problem is in feed wire size or rectifier capacity (see power worksheet page 18).

B. If Power Module #400922 has letter A, B or C, look for.01MFD capacitor near TP1-TP2 or near connector (on back). If not found, one should be added (consult us for details).

C. If one division only, swap Power Module #400922, then Enc/Timing #400913 or #404963 then try one Mem. and SAM at a time #400919 or #400945.

15. **STOPS FLIP WHEN POWER IS TURNED ON** (one division only)

A. Stuck piston (divisional). Check to see if pistons are dead (see #5).

B. Swap Enc/Timing card #400913 or #404963.

C. Swap Power Module #400922.

16. **STOPS FLIP WHEN POWER IS TURNED ON** (all divisions)

A. Stuck general piston. Check for stuck or shorted piston (see #4B).

B. Shorted piston wiring for generals.

17. **STOPS FLIP WHEN SET BUTTON IS HELD** and piston is pressed

A. Used voltmeter to be sure organ positive is on set terminal of Piston Matrix when button is held. If voltage is not measured, check wiring and set button contacts.

B. Swap Enc/Timing card #400913 or #404963.

18. **GEN CANCEL AND/OR DIVISIONAL CANCEL WON'T WORK**

A. Use voltmeter to measure cancel inputs of Piston Matrix with respect to organ negative. Should read rectifier voltage when cancel is pressed.

B. Swap Piston Matrix #400918 or #404968.

C. Swap Enc/Timing Module #400913 or #404963.

19. **ALL OFF COILS OF ONE DIVISION ARE "STUCK" ON.**

A. Swap Encode/Timing Module #400913 or #404963 with another division. If problem moves, Encode/Timing Module is defective.

B. Inspect connector pins, foil and soldering of "TE" pin from the Encode/Timing going to the Mem. and SAMs on the Mother Boards.

20. **STOPS TRIES TO MOVE** ("Flutters") but won't change position

A. Measure organ rectifier voltage on screw terminals of Mother Board while reiterating general cancel. If it is less than 10-11V try raising voltage (or see power worksheet).

B. Check for stop action magnet binding or sticking.

C. Swap Mem. and SAM #400919 or #400945.

21. **COMBINATION ACTION** works O.K. but a stop is "on" (speaking) even though the knob or tab is "off"

A. Unplug sense wires from the combination action Mother Board for the division in which the stop is "stuck on". If the stop quits speaking, the problem is in the Mem. and SAM #400919 or #400945 associated with that stop. To repair, check the diodes (D1-D4) in the lower right corner of the Mem. and SAM board with an OHM meter. Use 1000 OHM scale. The diodes should read low in one direction, high in the other. The one that reads lower in the high direction is bad.

B. Refer to switching system service manual for problems in the relay.

TEST LIGHTS (ON MOTHER BOARD)

An additional aid for testing and troubleshooting is the red test light (LED 1) located near sense input #32, on the Mother Board.

This test light can be used to indicate the proper operation of many functions in the combination action.

It is not necessary to test these functions normally. However, If a problem is encountered it would be useful to check these before calling us at the factory, as it will aid us in determining the cause.

Figure 9 is a "TRUTH TABLE CHART" for use with TP3 and the test LED. TP3 is the terminal (near the test LED) that is to be connected with a test lead (or clip lead) to the function (terminal) to be tested. The names of these functions are listed in the left column of the truth table. The same function (terminal) name that is in the truth table is also on the Mother Board near the connector pin to be tested.

With TP3 connected to a function, the LED will light or "blink" as indicated on the chart (refer to the legend in the lower left corner). Some functions will respond the same no matter what piston is pressed, others will change each time a different piston is pressed. The chart shows the patterns that will be seen.

The comments in the right column of the chart describe the action of the light when a piston is pressed.

The "write enable" function will be normally off and will "blink" on after a 3/4 second delay when any numbered is pressed. The "memory enable" function will be normally off and will "blink" on when any numbered piston is pressed, and go off when the piston is released. The "tab enable" function will normally be on and will blink off for 1/4 second when any piston (except set) is pressed. The piston address functions will go to the state shown on the chart when a piston is pressed and remain in that state until the next piston is pressed.

An additional troubleshooting LED, is provided on the Combination Action Mother Board. The green light labeled "LED 2" will be illuminated whenever the base system is the write-enable state. When properly wired, the combination action is prevented from going into the write-enable state if a lockout keyswitch is in the locked position, or if a Crescendo or Sforzando is active. If none of these lockout conditions apply, LED 2 should light immediately whenever the set button is pushed. It should also light up after a 3/4 second delay if any numbered piston is pushed and held in. In either case the LED should stay on until the piston button is released. Keep in mind that a general piston should illuminate the green LEDs on all mother boards, while a divisional piston will illuminate the LED on the mother board for the one division only. The solder terminal immediately next to LED 2 on each mother board allows an external LED to be connected. This can be used to put a "write enable" indicator in the organist's view at the front of the console. All of these solder terminals can be connected together and then run to a single indicator LED. It is necessary to use a 220 ohm resistor in series with the external LED to prevent the LED from being destroyed. See Figure 10.

IMPORTANT PRECAUTIONS

CONTACTS for stop sensing, and piston buttons, on older organs that are being rebuilt, may be corroded and/or pitted from prior use with unsuppressed magnets. We do our best to make our combination actions work with poor contacts, but sometimes it becomes necessary to scrape and clean the contacts for improved reliability.
TRANSIENT SUPPRESSION is built into our combination actions to protect the solid state components, and to keep unsuppressed transients from other sources from interfering with its operation. We have found, though, that on some organs without solid state switching, or where wires to other unsuppressed magnets (such as swell shades) are bundled in the same cables with the stop lines (going to the sense terminals), false setting can occur. This due to the capacitive coupling of these unsuppressed transients in the cable. In these cases, some suppression, such as flyback diodes, may have to be added to the interfering source. If you suspect this type of problem we will help you determine your requirements.
Some electro-magnets (coils) manufactured by Kimber Allen use a "metal oxide varistor" ("MOV") to suppress reverse voltages of the coils. **These devices are not sufficient to suppress the reverse voltage when used in connection with solid state components.**

If there is any question as to whether the device is an "MOV" or a diode, remove one end from the magnet and check the device with an ohmmeter. Use the RX1000 (or closest scale to it) and measure the device with leads across the device one way, then reverse the two meter leads and measure the other way. If it is a diode it will read low resistance one way and high resistance (or open) the other way. If it is an "MOV" it will read the same (high)

piston wires. These separate bundles can be run next to each other as long as they are not tied tightly together. This helps prevent capacitive coupling from the high current outputs to the low current inputs. This is especially important when using long cables, such as when the combination action is remotely mounted.
Errors in the **wiring order** of "on" and "off" coils and sense wires are not uncommon. It is extremely important to match up #1 "on", #1 "off", and #1 "sense". Refer to figures 1 and 2 in the installation manual and to the labeling on the boards. Be absolutely sure of the wiring order before proceeding.

TESTING OF WIRING with a "buzzer" should not be done unless all connectors are unplugged and not connected to solid state components. "Buzzers" can have reverse voltages (flyback voltages) of 100V, or more, just like other magnets, but in a "Buzzer", these voltage transients occur at the "Buzz" rate (frequency). This can destroy solid state parts, instantly. A safer method is to use a low voltage continuity (lamp) tester or OHM meter.

THE CONDUCTOR SIZES of the wires used for connecting the organ positive to the combination action mother boards, and the organ negative to the stop action magnets, are important. Bear in mind that the positive (+), to the mother board, has to be sufficient size to carry the feed current to all the stop action magnets simultaneously. Likewise, the negative (-) to the "on" and "off" coil returns must be of sufficient size to carry return current from all stop magnets simultaneously.

A full "X8" mother board (32 stops) operating on a 15V power supply assuming 30 ohm coils will draw 17 AMPS and would require a #12 wire, for both the positive feed to the mother board and negative return from the stop magnets. The negative to the combination action mother board "X8" or "X16" will not draw more than 2 AMPS and a #18 wire is adequate. Individual coil wires will draw approximately 1/2 AMP, and #28 wire is all that is required for these. These wire sizes apply to the short runs within the console only. Note that 20 feet of #12 wire with 17 AMPS flowing through it will drop about 1/2 volt. Wire size should be increased for longer funs. Bear in mind that an increase of 3 wire sizes (for example 12 to 9) will reduce the resistance (and voltage drop) by half.

ALUMINUM WIRE and aluminum lugs are **NOT** recommended for use in feed and/or return conductors. This applies to any brand or type of combination action or relay. Aluminum wire or lugs that are bolted or screwed to a buss or junction will flow over a period of time, and become loose. When aluminum must be used, be sure to use terminating lugs designed for aluminum wire, that when properly installed, minimize the flow problem.

SOLDERING of wires to connector pins is important. Wire wrapping alone is not recommended. **Under no conditions should acid flux be used.** We recommend using 60/40 rosin core solder. (Rosin flux may be brushed on if care is taken to avoid getting flux into the connector where contact is made. If magnet wire (or other coated wire) is used be sure enough heat is used to break down the insulation and that the solder is not just covering the wire, but bonding it to the pin. So called "No-Korrode" solder paste is in fact extremely corrosive, and should never be used anywhere around the electrical parts of an organ.

ORGAN POWER SUPPLIES (rectifiers) have an important part to play in how well the completed installation will operate. In general the organ supply should be capable of supplying enough current to operate all the stop action magnets and the chest magnets, etc. The nominal voltage should be 10 VDC to 18 VDC. At no time should the output voltage drop below 8.5 VDC or exceed 25 VDC during surges caused by peak demands. Other transients greater than 50 VDC should not exceed 1 millisecond in length. These surges and transients usually cannot be measured with a voltmeter. A "Power Supply Fault Detector", available from Peterson, detects voltage outside the normal, safe operating range of Peterson and most other solid state equipment for pipe organs. Even extremely short transients will cause a high level or low level indicator LED to latch on. We recommend checking any old or questionable rectifier with our Fault Detector, especially if any problems re encountered when using solid state equipment. The minimum voltage under full load can also be measured with a voltmeter while reiterating the general cancel button.

RECTIFIERS OF INADEQUATE SIZE will cause the stop actions to appear sluggish or slow or forgetful or dead. This is most apparent on general pistons or cancel. To approximate the capacity of the rectifier required, divide the total number of stops by two, then add 10% of that number to it. Example: 50 stops divided by 2 = 25 + 2.5 = 27.5 AMPS. This is the current required for the combination action only. If the organ has all electric chest actions, considerably more current may be required. (See worksheet page 15).

SOME RECTIFIER DESIGNS are not as good as others, and may not be suitable for use with the combination action. This is due to the brief high peak currents that are required to work all the stop action magnets (coils). Older rectifiers that use **SELENIUM RECTIFIERS** have a higher resistance, which can cause severe voltage drops. These rectifiers (diodes) can be identified by their appearance. Selenium rectifiers are made with many plates

stacked and bolted together (some times referred to as bread slicers). Also, **RECTIFIERS THAT USE A "CHOKE"** filter in their output are less desirable. The "choke" resists the flow of current at the peak demand, causing a momentary voltage drop. Also, when the load is removed, the "choke's" magnetic field collapses and induces a voltage greater than the normal output. This can be observed by watching the brilliance of any pilot lamp. The lamp will dim at the moment of demand, and flash brighter when the load is removed.

GENERATORS OR MOTOR-GENERATOR SETS seem to work fairly well. However, a large value capacitor may have to be added to eliminate "hash" and other transients (See "additional capacitors")

THE MOST SUITABLE RECTIFIER design is the type now manufactured by Peterson. This type uses a constant voltage transformer and capacitor filters. The peak demand current is supplied by the energy stored in the capacitors, while the transformer automatically adjusts itself to maintain a steady voltage. Transients generated elsewhere in the organ are also filtered by the output capacitors. This type of design can be severely overloaded (even short circuited) without damaging the unit. Also, greater peak demands can be supplied with the use of **ADDITIONAL CAPACITORS.** (A good rule of thumb is 1000 MFD, per stop). The use of additional capacitors with other rectifier designs may work; however, interaction between the "choke" (inductor) and the capacitor(s) can cause "ringing" in the output voltage (pilot lamps would flutter). This kind of situation can cause malfunctions in the combination action. We highly recommend the **Peterson Pulse Power™** Stop Action Magnet Supply that is designed to be used with our combination actions. Its advantages over a traditional rectifier are small size, quietness, console mounted (no need for long heavy gauge feed wires), and built in protection circuitry that virtually eliminates the possibility of damage to drawknobs and tabs. (Call or write for more information).

LOCATION OF THE RECTIFIER and the size of the conductors from it to the combination action, are also important. Too small a conductor for too long a run can cause voltage drops that will affect performance. The following chart shows voltage drops per 100 feet at various size wires. The actual drop would be doubled considering both feed and return lines. (See chart page 18 for selecting conductor sizes).

STOP ACTION MAGNETS manufactured by Syndyne Corp. may cause erratic operation if the polarity of the stop action magnet does not match the polarity required by the combination action. The "SAM" polarity is determined by the termination of the coil wires and the direction of the magnetic poles of the permanent magnets. When the wrong polarity is used residual magnetism on the pole magnet may pull in the reed switch when the stop is turned off. Magnetic fields of adjacent "SAMs" may also affect the reed switch and cause erratic operation. Therefore, it is important to specify the proper polarity when ordering stop action magnets. Do not reverse the polarity of the coil common unless you reverse the coil wires, or another alternative would be to use inverters.

If you have any unanswered questions regarding the installation, testing, or operation of any of our products, give us a call at (800) 341-3311. or (708) 388-3311.

We would appreciate any comments to help us improve our installation and instruction manual, drawings, or labeling. If anything is incomplete, unclear or inaccurate, let us know.

THANK YOU,

PETERSON ELECTRO-MUSICAL PRODUCTS, INC.
11601 South Mayfield Avenue
Alsip, Illinois 60803-2476

ORGAN POWER SUPPLY (RECTIFIER) AND FEED WIRE SIZE

WORKSHEET

This worksheet is being supplied as an aid in determining the current required by combination (stop) actions and chest magnets. We advise using this worksheet to assure proper operation of combination actions and relays. Our experience has shown that most combination action and relay problems are the result of inadequate rectifier and/or feedlines.

1. To determine the current required for the combination action, fill in the blanks and perform the simple arithmetic as shown for the example organ, which has pedal, great, swell, and coupler stops totaling 50.

EXAMPLE

TOTAL NUMBER OF DIVISIONS ..... (MOTHER BOARDS) = 4

TOTAL NUMBER OF STOPS ..... = 50 x ½ = 25

TOTAL AMPERES ..... (DIVISIONS + ½ TOTAL STOPS) 29

TOTAL NUMBER OF DIVISIONS ..... (MOTHER BOARD) = _____

TOTAL NUMBER OF STOPS ..... = _____ × ½ = _____

TOTAL AMPERES ..... (DIVISIONS + ½ TOTAL STOPS) _____

2. To determine the current required by the chests, take the total number of ranks and/or primaries that are electro-pneumatic, and multiply by 1.5. Multiply by 3 for ranks that have "electric" type valves. The sum of these two is approximately equal to the current required by the organ chests in normal use.

The following example has two electro-pneumatic primaries and eight ranks of "electric" type chest magnets.

TOTAL NUMBER OF ELECTRO-PNEUMATIC RANKS ..... 2 × 1.5 = 3

TOTAL NUMBER OF "ELECTRIC" TYPE RANKS ..... 8 × 3 = 24

TOTAL NUMBER OF AMPERES FOR ORGAN ..... = 27

TOTAL NUMBER OF ELECTRO-PNEUMATIC RANKS ..... _____ × 1.5 = _____

TOTAL NUMBER OF "ELECTRIC" TYPE RANKS ..... _____ × 3 = _____

TOTAL NUMBER OF AMPERES FOR ORGAN ..... = _____

3. The capacity of organ power supply (rectifier) is the sum of the totals from 1 and 2.

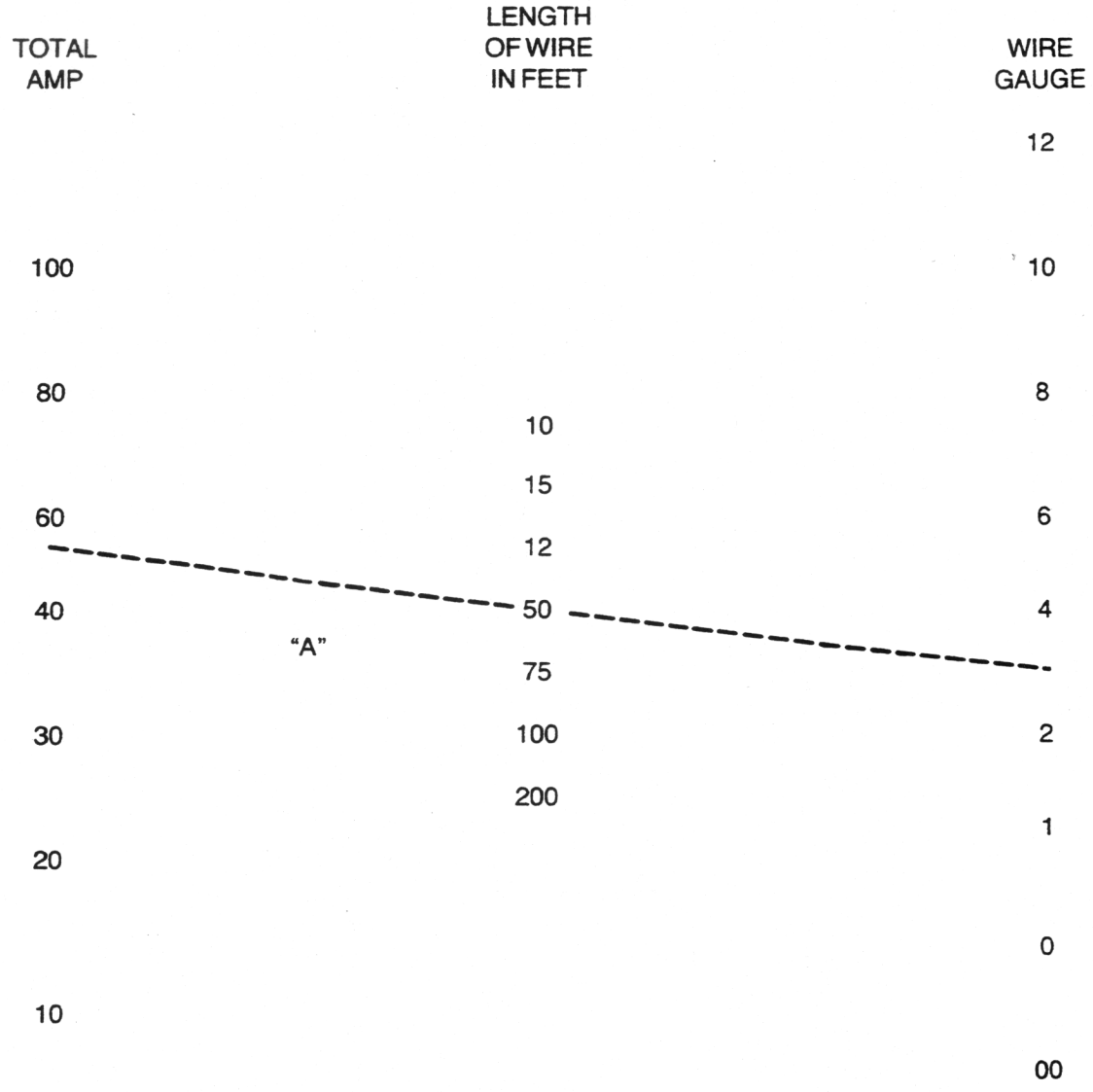
EXAMPLE:
1. TOTAL COMBINATION ACTION AMPS 29
2. TOTAL ORGAN AMPS 27
TOTAL AMPS REQUIRED 56

1. TOTAL COMBINATION ACTION AMPS ..... _____
2. TOTAL ORGAN AMPS ..... _____
TOTAL AMPS ..... _____

4. The proper wire size for feedlines from the rectifiers can be determined by using the following nomograph. (This graph is based on keeping the voltage drop of the combined feed and return wire to 1 volt or less.)

   EXAMPLE "A" IS FOR TOTAL OF 56 AMPS WITH A 50 FOOT RUN, WHICH REQUIRES #2 WIRE.

To use this chart, plot a line from the total amps through the distance in feet and read the closest wire gauge.



If existing feed lines must be used and do not meet the above recommendations, refer to "additional capacitors", page 17.

5. Some rectifiers, such as older "selenium" types and "choke" output types may not be adequate even if rated at the required amperage. The higher resistance of the selenium diodes and the series inductance of chokes actually cause momentary drops in voltage when the current is at its peak demand. It is recommended that these type rectifiers be replaced when new combination

actions are being installed. (The rectifier types mentioned above can be tried and will not cause damage, but if problems are experienced, such as forgetting, flipping stops when power comes on, or incomplete canceling, the rectifier should be suspected as the cause).

In some cases, the inadequacies of the rectifiers can be overcome with the use of large value "storage" capacitors.

6. The use of large value "storage" capacitors, in many cases, can effectively increase the capacity of rectifiers and feedlines, by supplying the current required for peak demands of short duration.

   As much as two times the capacity can be achieved for intermittent loads such as working the stop action magnet coils of a combination action. For constant loads, such as chests, the capacity **CANNOT** be effectively increased.

   Where "storage" capacitors are used, their minimum capacitance and their placement must be carefully determined. A good rule of thumb for determining the value of the capacitor is 2000 MFD per amp, or 1000 MFD per stop. (Our example organ of 50 stops would require 50,000 MFD). The voltage rating of these capacitors must be greater than the working voltage. (We recommend a 20-25V rating or higher for use with 12-15V organ supplies). Be sure to observe polarity when wiring (+ to positive, - to negative). These capacitors should be mounted as close to the load as possible and wired with a wire gauge sufficient to handle the peak demand current. In our example organ. If we used a 60,000 MFD (at 20V) to work the combination action, we would mount it in the console, and wire it with #12 wire to the junction points that feed the combination action and stop action magnets.

If you have any questions about the proper size of rectifiers, feedlines or "storage" capacitors, give us a call at 1-800-341-3311 and we will be glad to help.

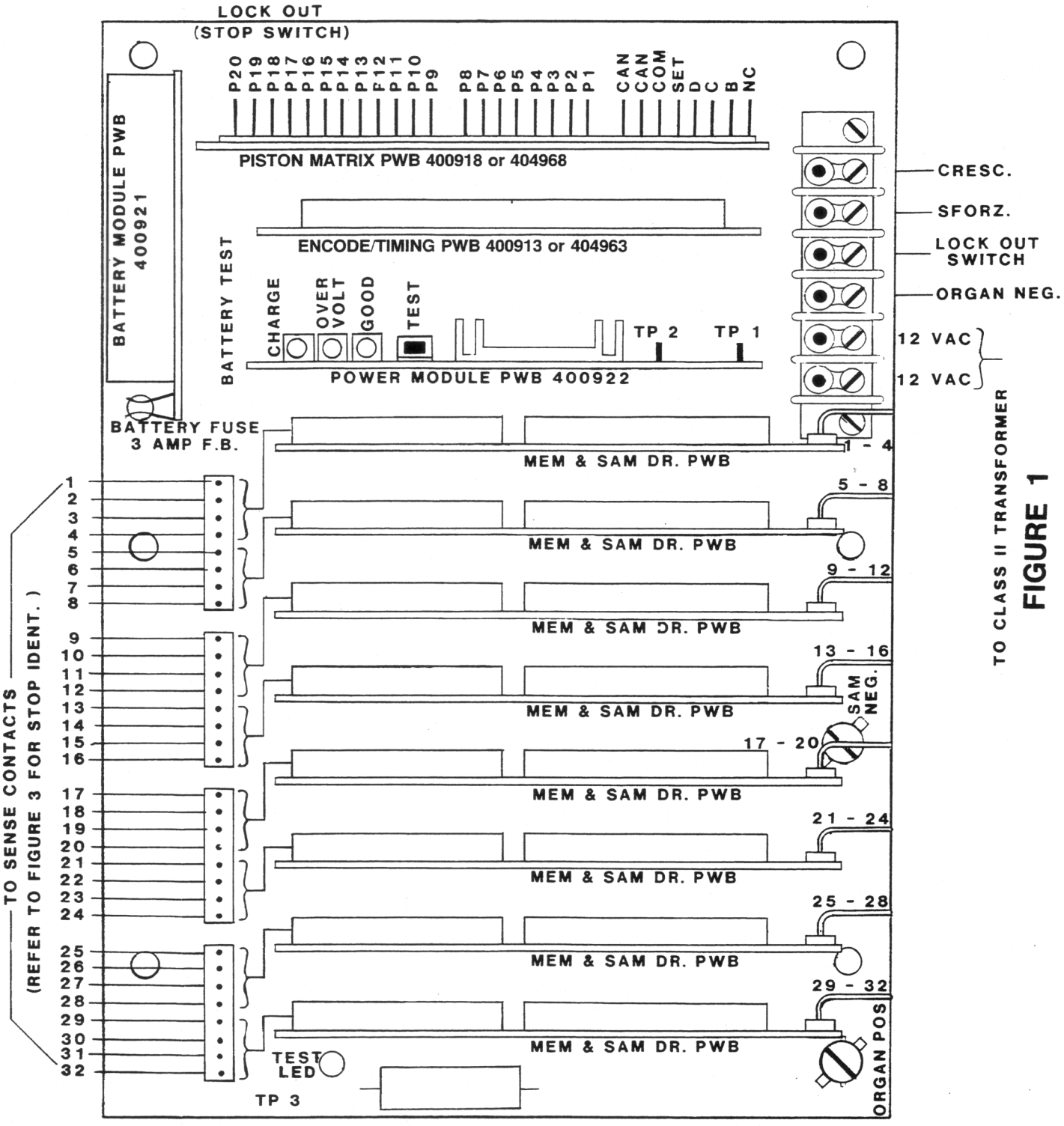

LOCK OUT
(STOP SWITCH)
P20 P19 P18 P17 P16 P15 P14 P13 P12 P11 P10 P9 P8 P7 P6 P5 P4 P3 P2 P1 CAN CAN COM SET D C B NC
PISTON MATRIX PWB 400918 or 404968
BATTERY MODULE PWB 400921
ENCODE/TIMING PWB 400913 or 404963
BATTERY TEST
CHARGE
OVER VOLT
GOOD
TEST
TP 2
TP 1
POWER MODULE PWB 400922
CRESC.
SFORZ.
LOCK OUT SWITCH
ORGAN NEG.
12 VAC
12 VAC
TO CLASS II TRANSFORMER
BATTERY FUSE 3 AMP F.B.
1 - 4
MEM & SAM DR. PWB
5 - 8
9 - 12
13 - 16
SAM NEG.
17 - 20
21 - 24
25 - 28
29 - 32
ORGAN POS.
TEST LED
TP 3
TO SENSE CONTACTS
(REFER TO FIGURE 3 FOR STOP IDENT.)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

FIGURE 1

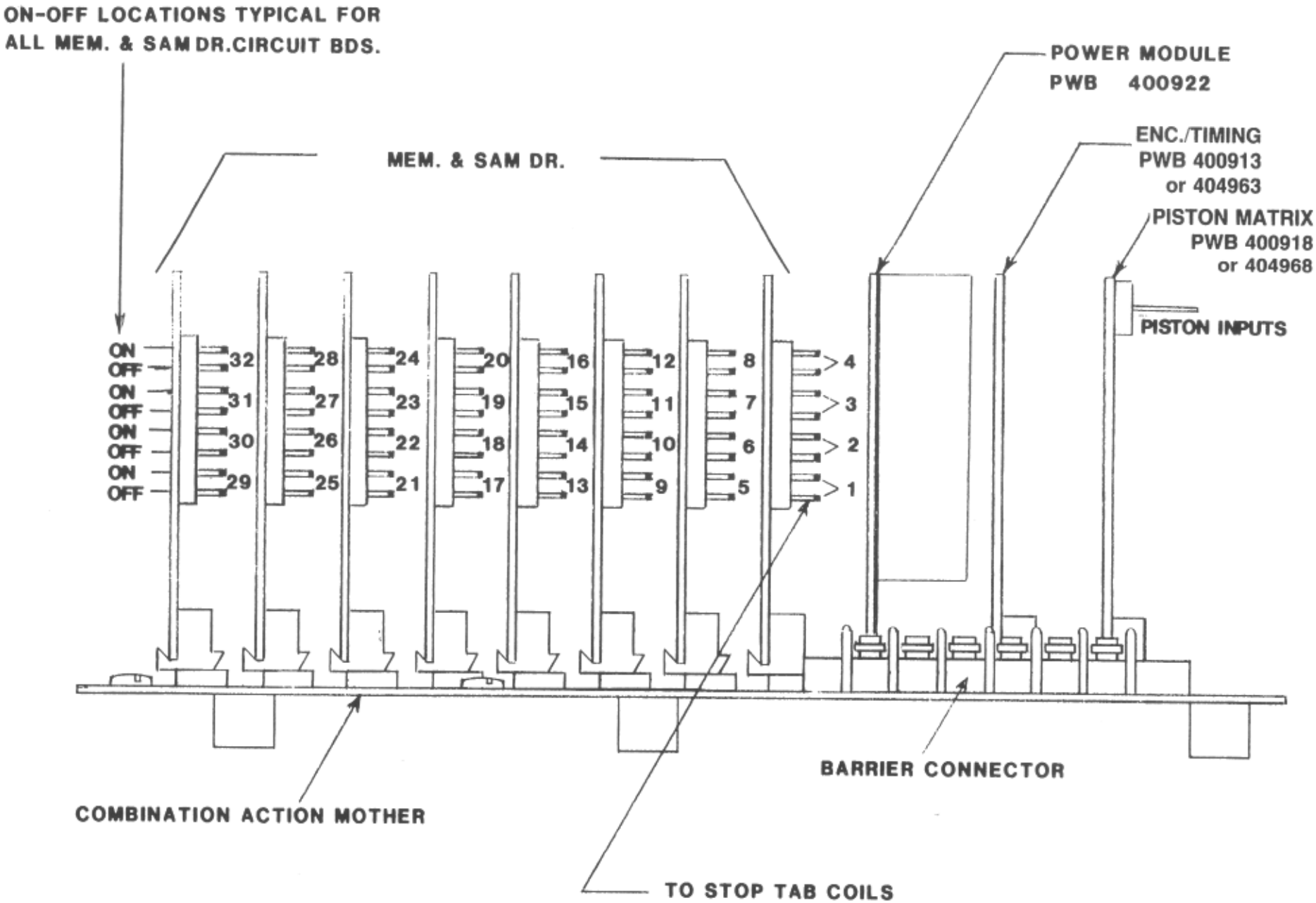

ON-OFF LOCATIONS TYPICAL FOR
ALL MEM. & SAM DR.CIRCUIT BDS.
POWER MODULE
PWB 400922
MEM. & SAM DR.
ENC./TIMING
PWB 400913
or 404963
PISTON MATRIX
PWB 400918
or 404968
PISTON INPUTS
ON
OFF
ON
OFF
ON
OFF
ON
OFF
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
COMBINATION ACTION MOTHER
BARRIER CONNECTOR
TO STOP TAB COILS

FIGURE 2

_____ DIVISION

A	FUNCTION
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

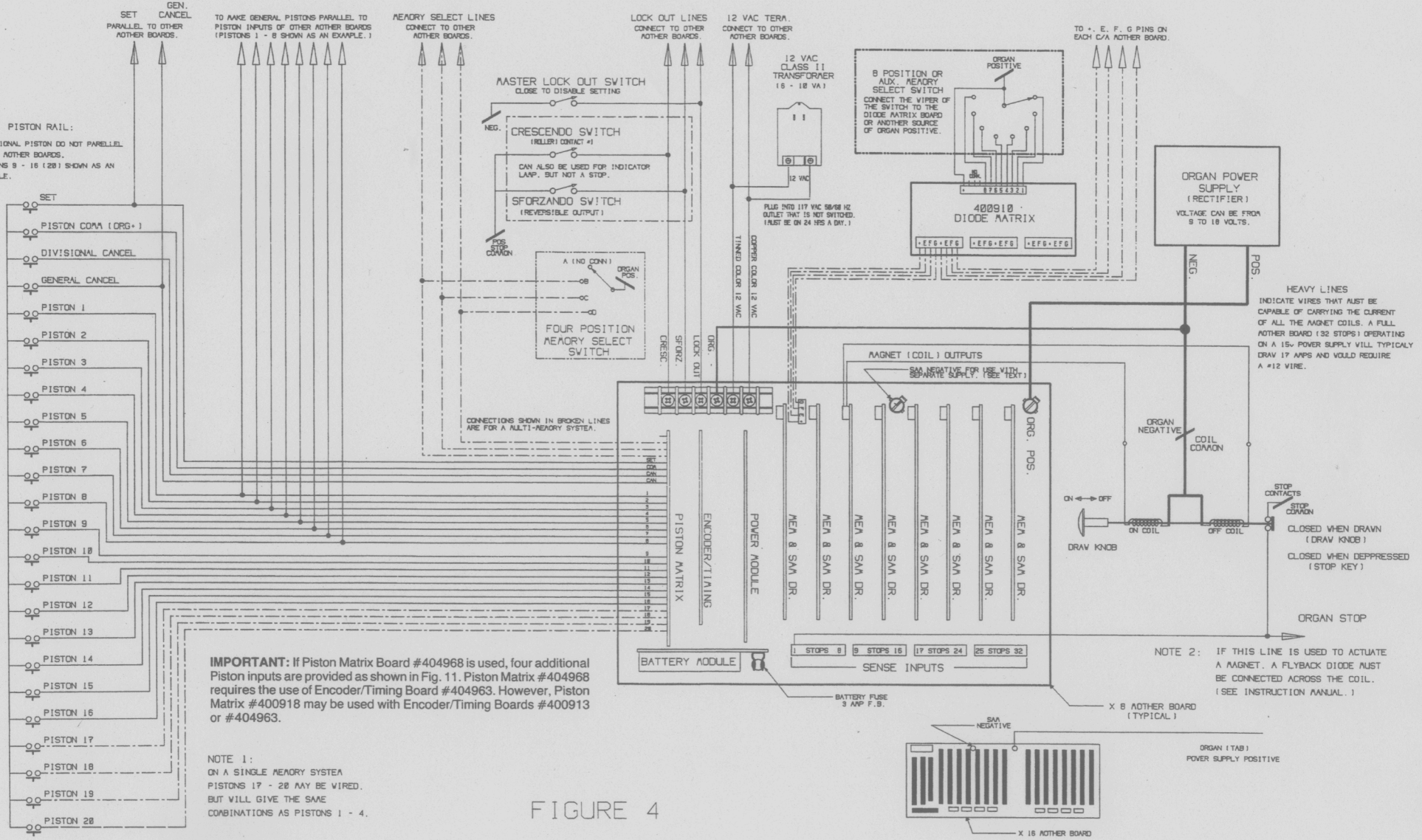
A= PISTON TERMINAL NUMBER ON PISTON MATRIX BOARD

B= STOP NUMBER (FROM FIGURES NUMBER 1 AND 2)

B	STOP IDENTIFICATION
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	

peterson
ELECTRO-MUSICAL PRODUCTS, INC./ALSIP, IL 60803

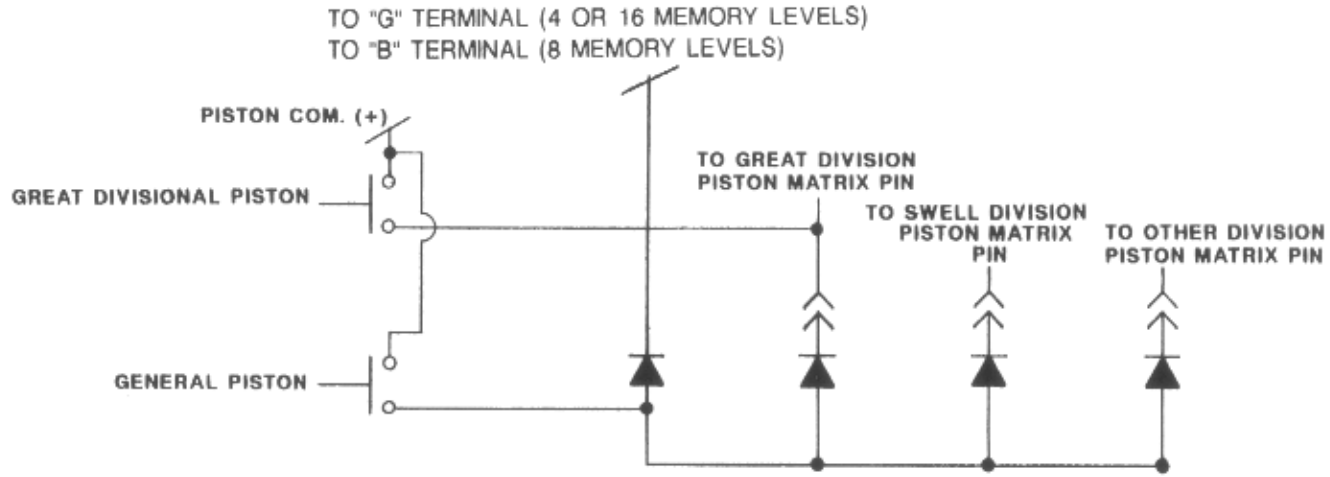
FIGURE 3



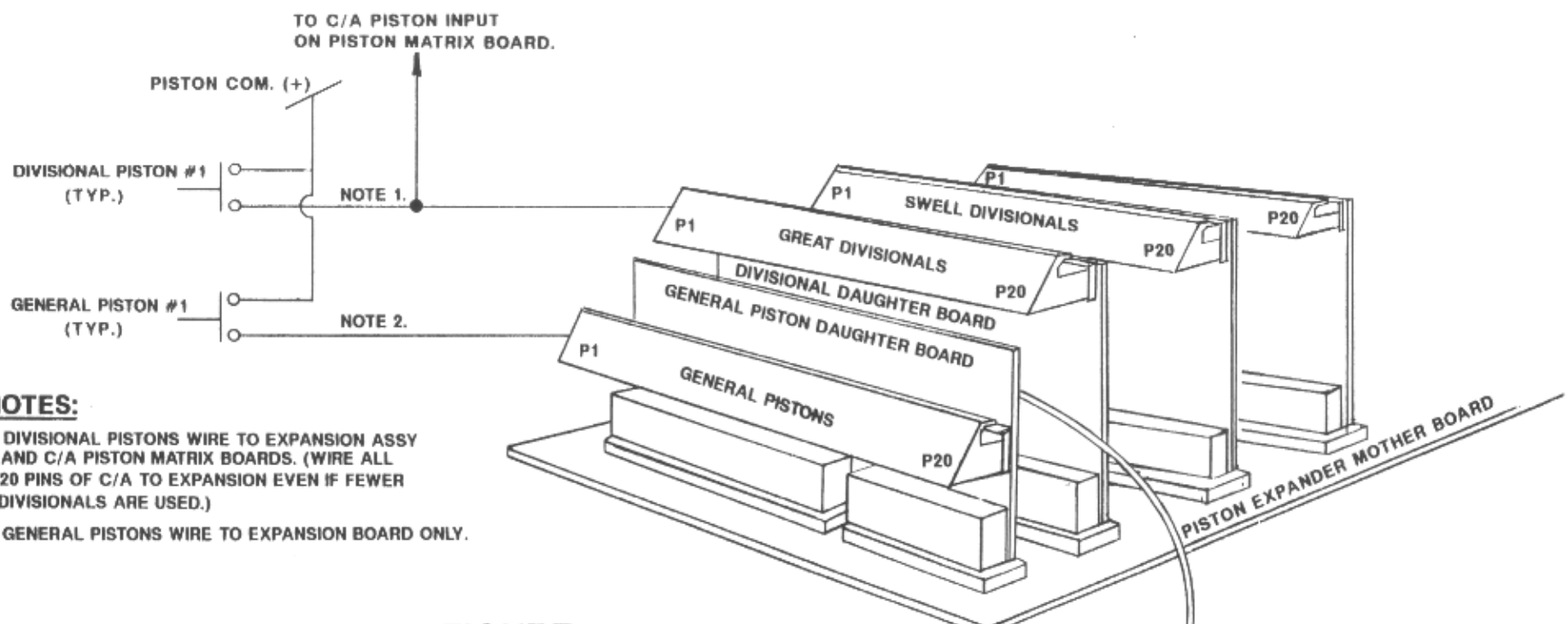
IMPORTANT: If Piston Matrix Board #404968 is used, four additional Piston inputs are provided as shown in Fig. 11. Piston Matrix #404968 requires the use of Encoder/Timing Board #404963. However, Piston Matrix #400918 may be used with Encoder/Timing Boards #400913 or #404963.

NOTE 1:
ON A SINGLE MEMORY SYSTEM PISTONS 17 - 20 MAY BE WIRED, BUT WILL GIVE THE SAME COMBINATIONS AS PISTONS 1 - 4.

FIGURE 4



SCHEMATIC (TYP.)

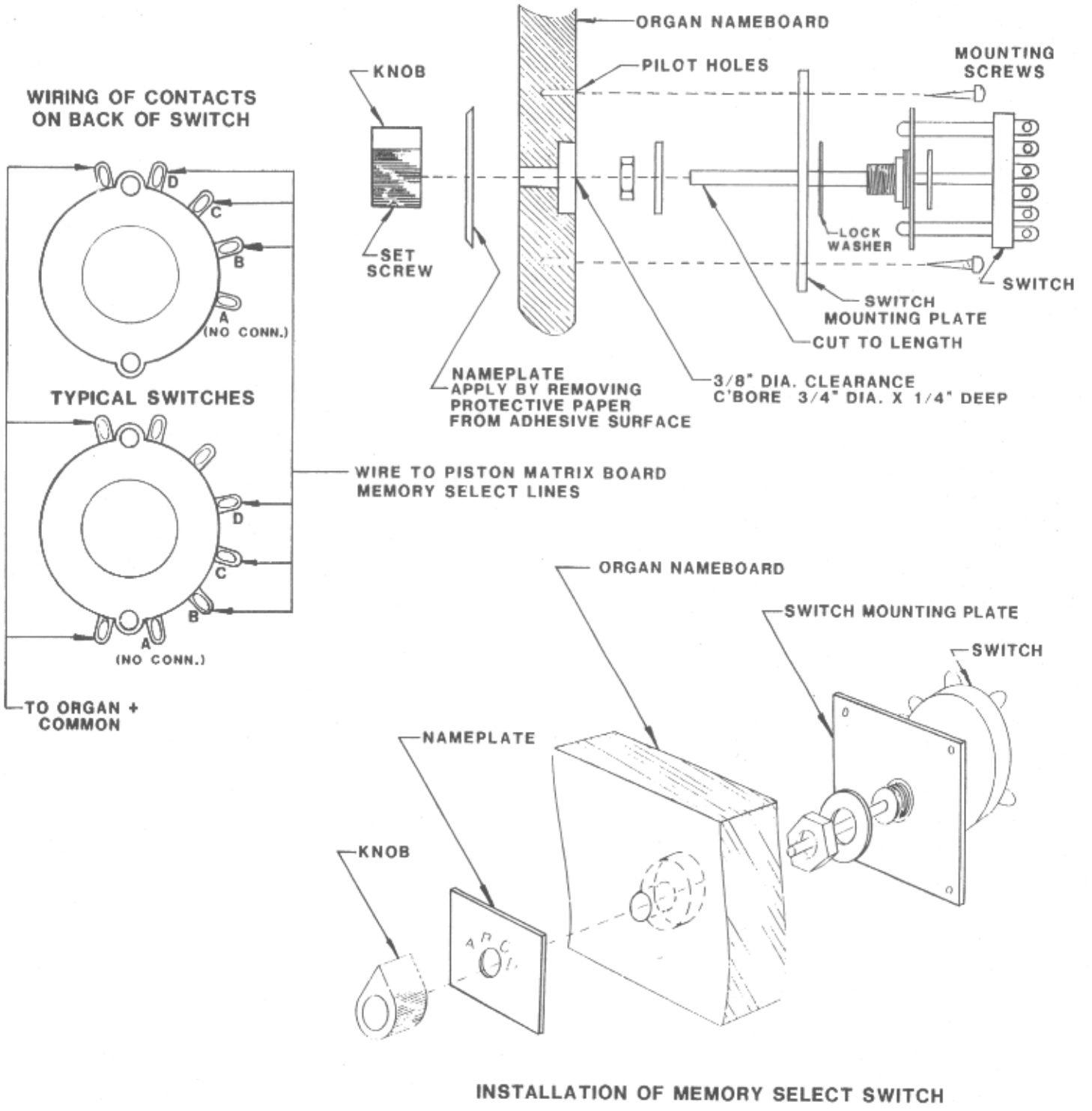


NOTES:

1. DIVISIONAL PISTONS WIRE TO EXPANSION ASSY AND C/A PISTON MATRIX BOARDS. (WIRE ALL 20 PINS OF C/A TO EXPANSION EVEN IF FEWER DIVISIONALS ARE USED.)
2. GENERAL PISTONS WIRE TO EXPANSION BOARD ONLY.

FIGURE 5

WIRE TO "G" TERMINALS OF +,E,F,G, CONNECTORS ON ALL C/A BASE SYSTEM MOTHER BOARDS FOR 4 OR 16 MEMORY LEVELS.
WIRE TO "B" TERMINAL ON ALL PISTON MATRIX BOARDS FOR 8 MEMORY LEVELS.

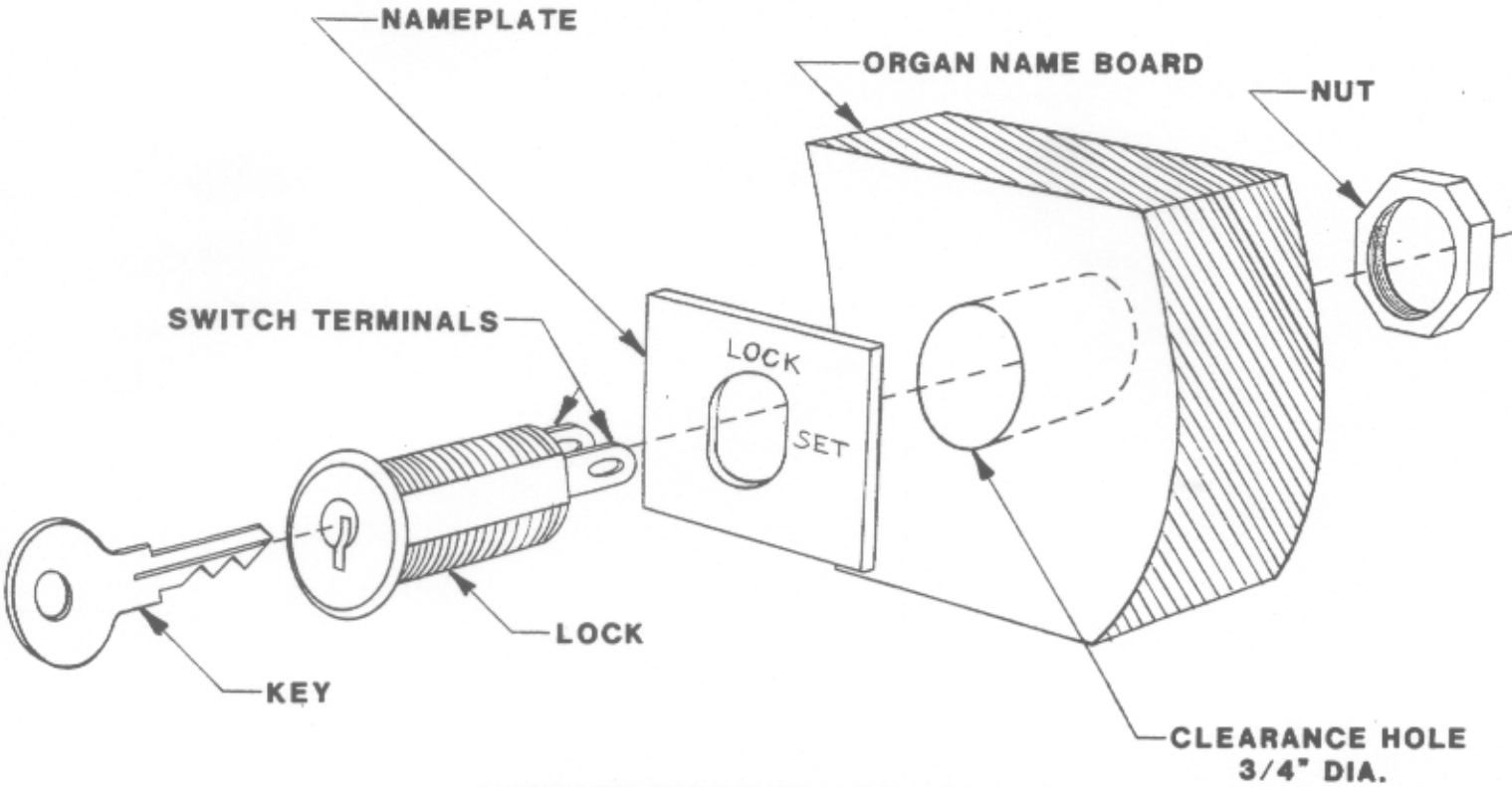


INSTALLATION OF MEMORY SELECT SWITCH

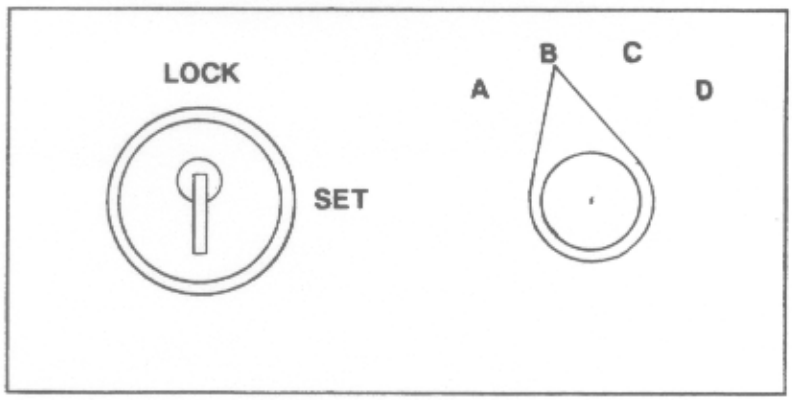
FIGURE 6

FIGURE 7

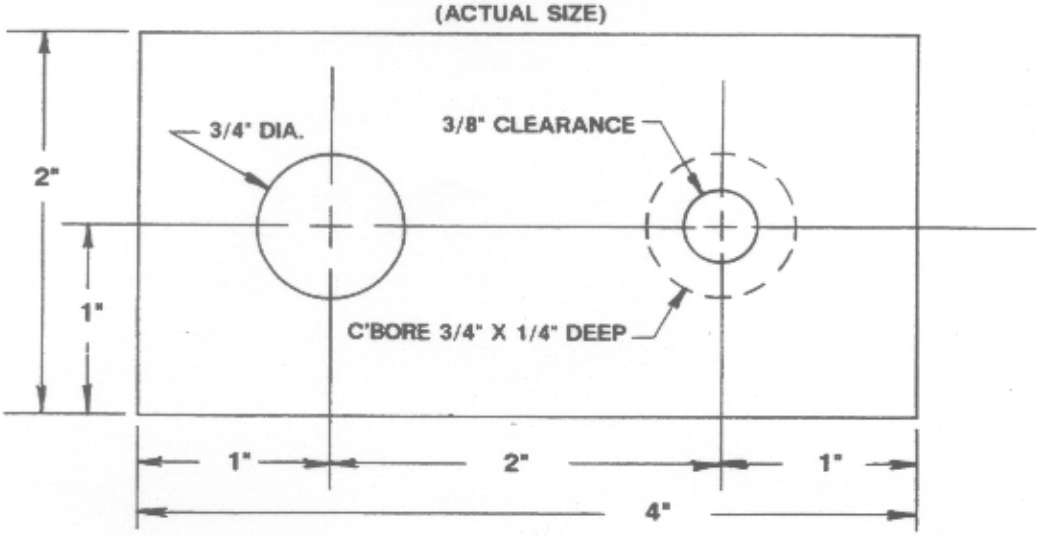
INSTALLATION OF LOCK-OUT SWITCH



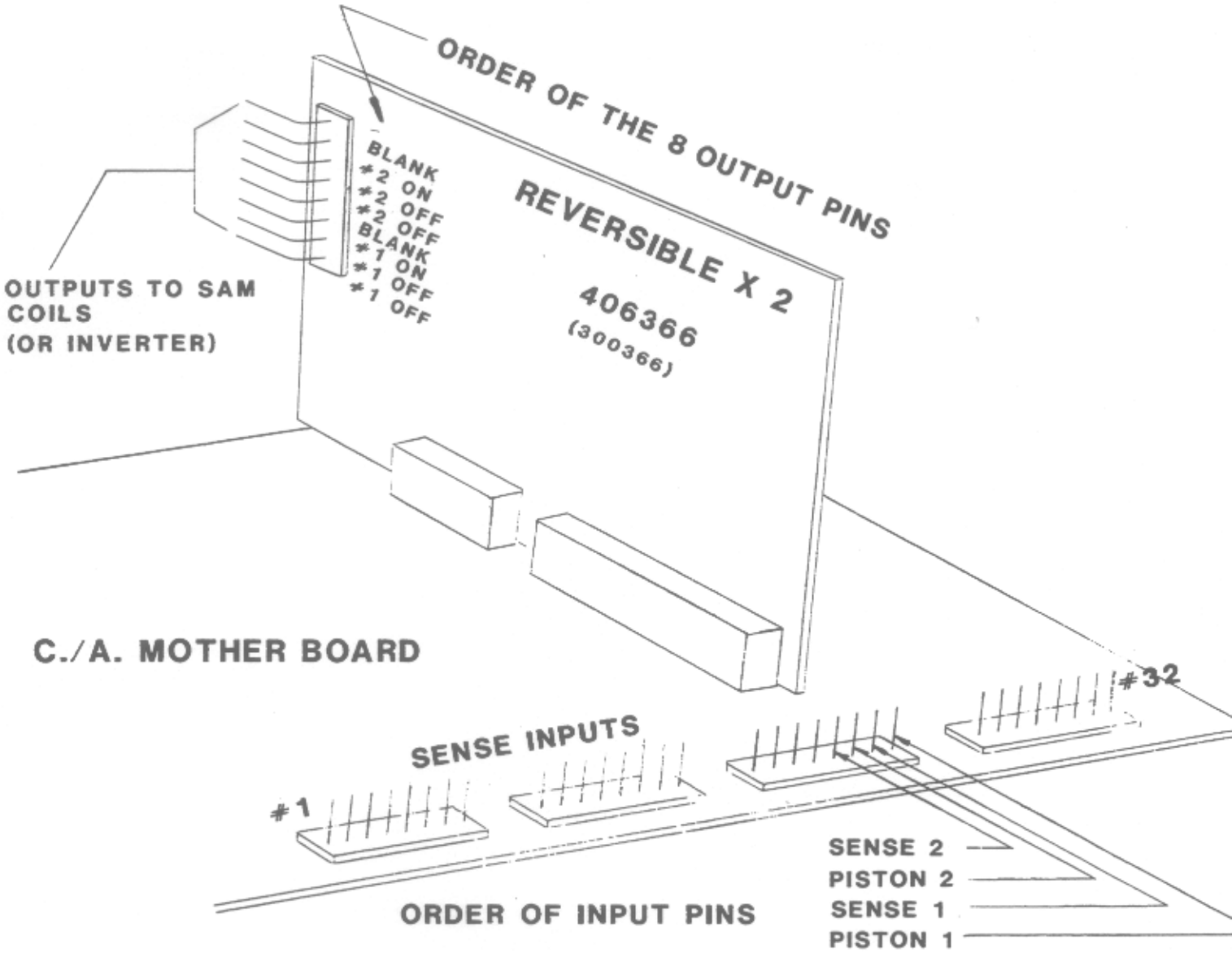
MEMORY SELECT SWITCH WITH LOCK-OUT
(SEE TEMPLATE FOR DRILLING DETAILS)



DRILLING TEMPLATE
(ACTUAL SIZE)



REVERSIBLE X 2 WIRING DIAGRAM



NOTE: IF THE REVERSIBLE X 2 IS PLUGGED INTO THE MOTHER BOARD IN THE POSITION NUMBERED 21,22,23, & 24

THEN 21 = SENSE (REV. 2)
22 = PISTON (REV. 2)
23 = SENSE (REV. 1)
24 = PISTON (REV. 1)

FIGURE 8

TRUTH TABLE CHART - FOR USE WITH TP3 AND TEST LED

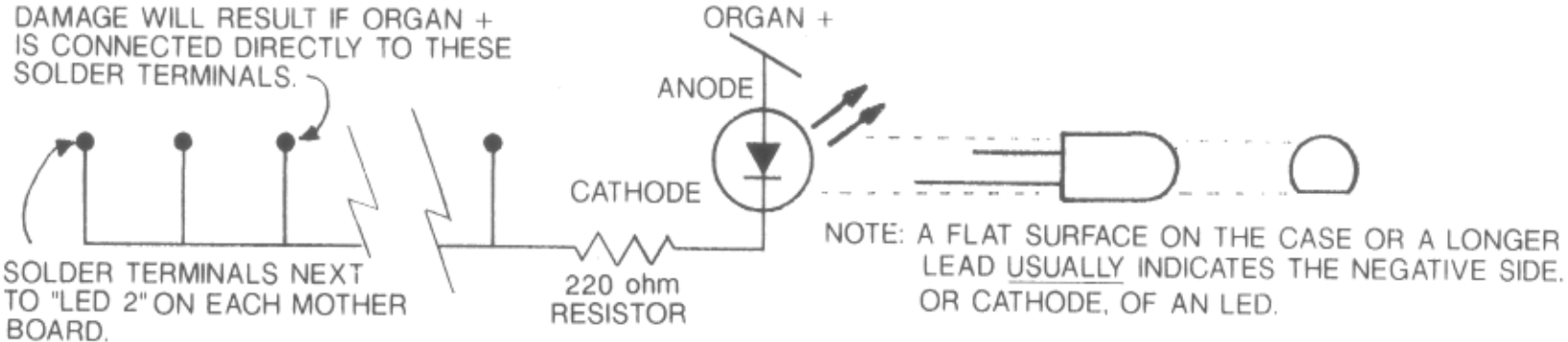
TERMINAL NAME	FUNCTION	PISTON NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	COMMENTS
WE	WRITE ENABLE	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	3/4 SEC. DELAY
ME	MEMORY ENABLE	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	FOLLOWS PISTON
TE	TAB ENABLE	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	1/4 SEC. PULSE
A0	PISTON ADDRESS	○	●	○	●	○	●	○	●	○	●	○	●	○	●	○	●	○	●	○	●	●	○	●	○	READING AFTER
A1	PISTON ADDRESS	○	○	●	●	○	○	●	●	○	○	●	●	○	○	●	●	○	○	●	●	●	●	○	○	PISTON IS PRESSED
A2	PISTON ADDRESS	●	●	●	●	○	○	○	○	●	●	●	●	○	○	○	○	●	●	●	●	○	○	○	○	AND REMAINS UNTIL
A3	PISTON ADDRESS	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	NEXT PISTON
A4	PISTON ADDRESS	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	IS PRESSED
P1-24	PISTON INPUTS	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	FOLLOWS PISTON

TERMINAL NAME	FUNCTION	MEMORY SELECT SWITCH SETTINGS A	B	C	D	1	2	3	4	5	6	7	8
A5	Mem. Sel. Adr. ABCD	●	●	○	○								
A6	Mem. Sel. Adr. ABCD	●	○	●	○								
A7	Mem. Sel. Adr. 1-8					●	○	●	○	●	○	●	○
A8	Mem. Sel. Adr. 1-8					●	●	○	○	●	●	○	○
A9	Mem. Sel. Adr. 1-8					●	●	●	●	○	○	○	○
B	Mem. Sel. In (B)	●	○	●	○								
C	Mem. Sel. In (C)	●	●	○	○								
D	Mem. Sel. In (D)	●	●	●	○								
E	Mem. Sel. In (1)					●	○	●	○	●	○	●	○
F	Mem. Sel. In (2)					●	●	○	○	●	●	○	○
G	Mem. Sel. In (4)					●	●	●	●	○	○	○	○

TERMINAL NAME	FUNCTION	NORMAL (OFF)	OPERATED (ON)
LO	LOCK OUT	○	●
CAN	CANCEL	●	○
SET	SET	●	○
SENSE 1-32	SENSE (STOP) INPUTS	●	○
ON 1-32	ON COIL OUTPUTS	●	○
OFF 1-32	OFF COIL OUTPUTS	●	○
L-	LOGIC NEGATIVE	○	●
O-	ORGAN NEGATIVE	○	●
M-	MEMORY NEGATIVE	●	●
B-	BATTERY NEGATIVE	●	●
TP2	TEST POINT 2	○	●

	LEGEND
SYMBOL	LIGHT EMITTING DIODE (LED) CONDITION
○	OFF
●	ON
★	NORMALLY OFF, BLINKS ON
□	NORMALLY ON, BLINKS OFF

FIGURE 9



CONNECTIONS FOR AN EXTERNAL "SET-ENABLED"INDICATOR

FIGURE 10

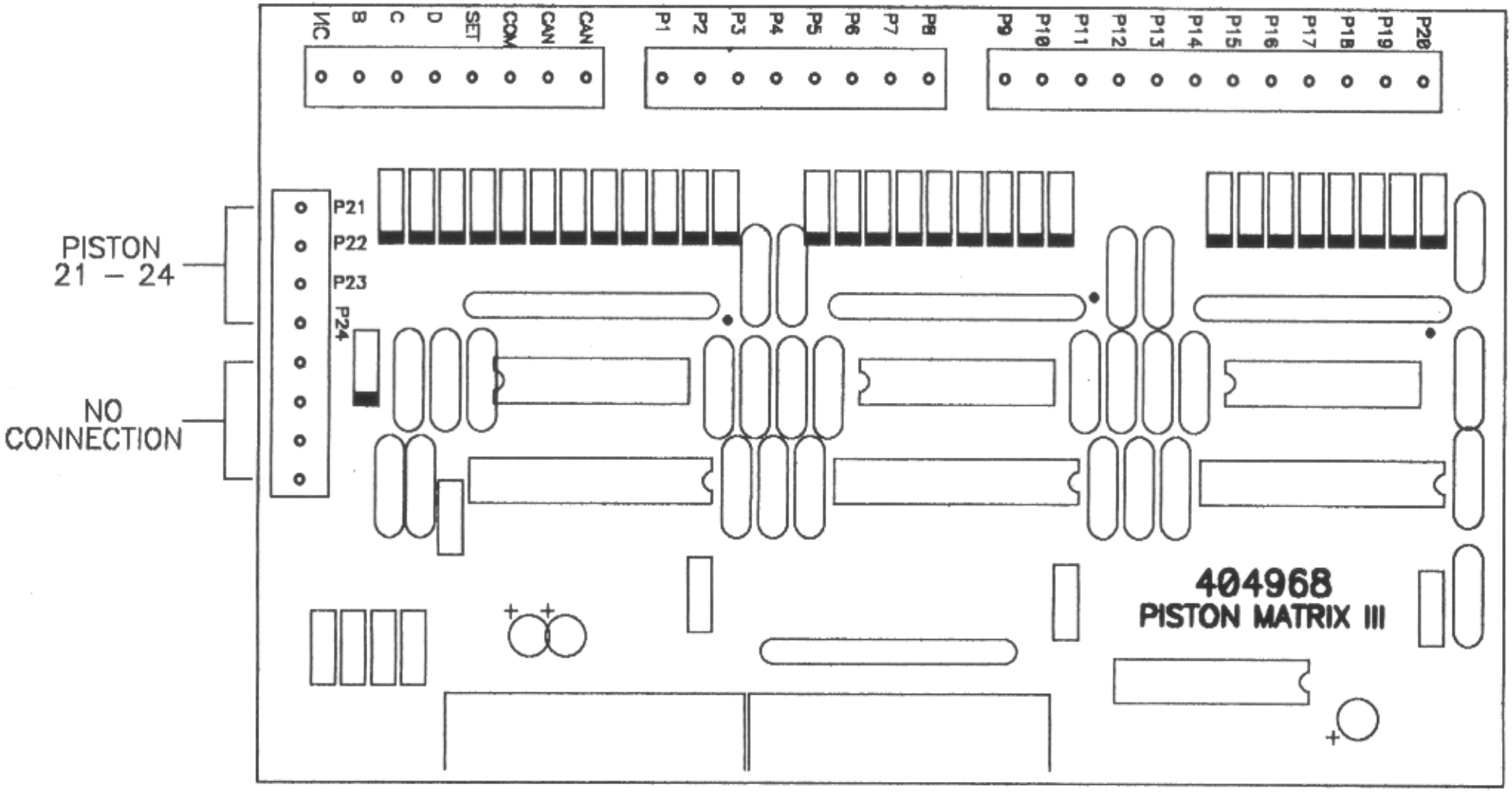


FIGURE 11

PISTON MATRIX III BOARD FOR 24 PISTONS
(NOTE: ENCODE/TIMING III, PART # 404963 MUST BE USED.)

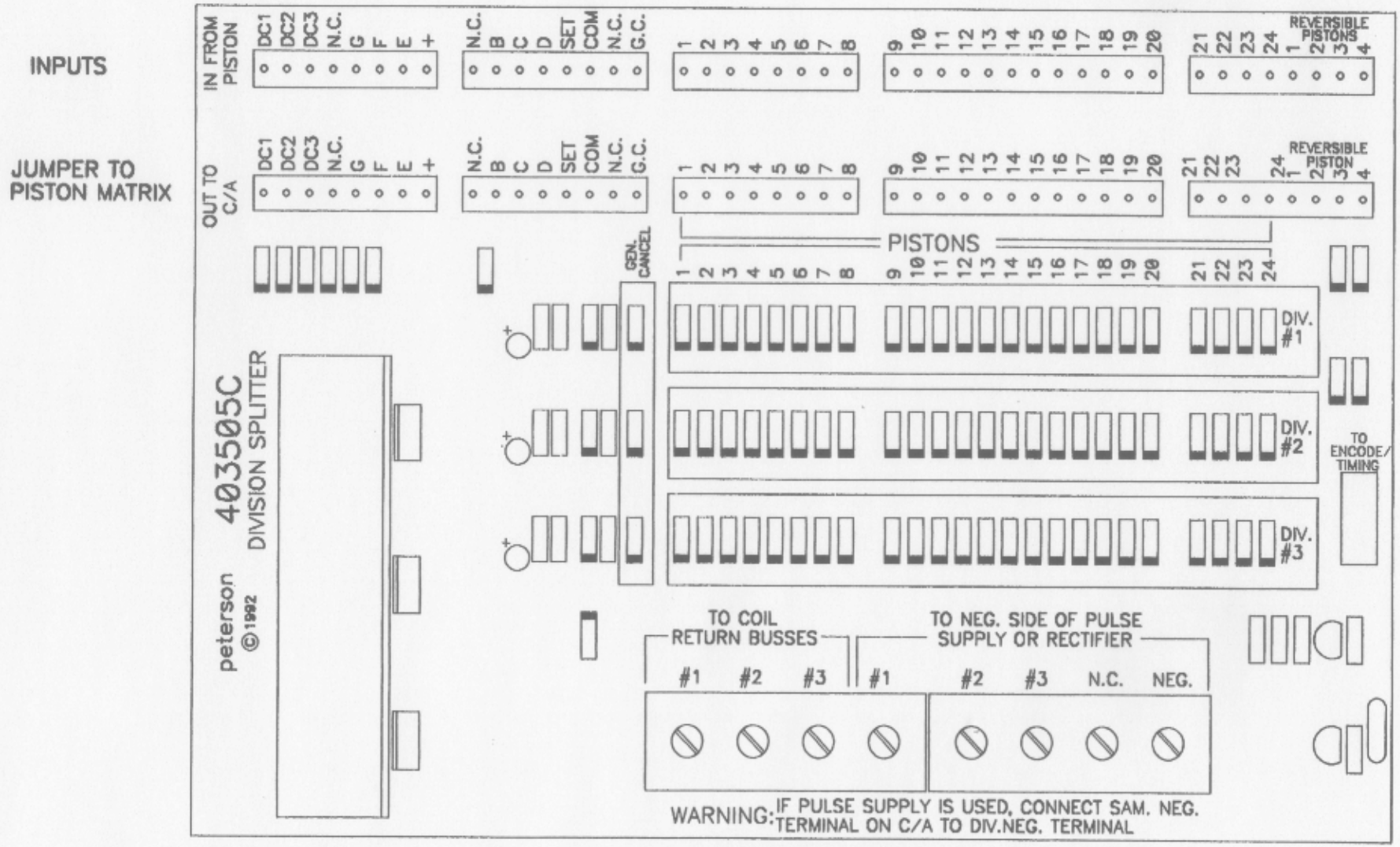


FIGURE 12
DIVISION SPLITTER