Solid-State Switching Systems

Technical Information

THE Reuter ORGAN COMPANY / Lawrence, Kansas

PREFACE to Reuter Solid-State Technical Manual

Robert J. Vaughan, Senior Engineer at Reuter, adds: "…Albert Sabol, Jr. showed me an electronic solid state switch that he made and used to switch a set of pipes in 1956. That would make him one of the very first people in the organ business who began experimenting with solid state systems for organs. Reuter began manufacturing complete relay systems in 1970 and we produced them for a number of organs through 1974 when we began using the Peterson systems. We still have a rather large inventory of new driver cards for the Reuter relays as we maintain support for them, for there are still some systems in use today".

IMPORTANT INSTALLATION CAUTIONS

1. When installing an organ that uses a Reuter Organ Company solid state switching system, take time to inspect each chest as it is installed. Check each diode on offset chests, on stop actions or wherever found to be sure it:

   A. -has not come loose in transit. (If it has, it will not suppress the transient currents that the magnet produces. Such currents, if not suppressed will damage the note or stop transistors.)
   B. -has not been pushed (in transit) into such a position so as to short against the common negative buss line or a magnet frame, etc.

2. Be sure that all polarities are correct before making final rectifier connection. Unnecessary damage to solid state equipment can be done by careless connection of these lines.

3. Be sure all switch cards are firmly plugged in. Clean gold plate contacts with alcohol before inserting.

4. Be sure all input and output plug-in connections are firmly connected and are clamped to relieve unnecessary strain.

5. Be sure that switch cards with the proper number of transistors are being used. Three sizes are provided:

   A. Cards with components for 12 notes.
   B. Cards with components for 13 notes.
   C. Cards with components for 8 notes.

The 12 note cards are used for all octaves except the top octave of a manual stop. A 13 note card is used for all manual top octaves. The 12 note cards are also used for all octaves of Pedal stops except for use of an 8 note card on the top octave of all Pedal stops.

6. Under no circumstances should soldering paste be used when making any connections in an organ using solid state switching equipment. Rosin core solder is the only acceptable solder and flux for making electrical connections.

Remember, 99% of the time, a trouble in the system will not be a component failure, but rather will be a mechanical failure such as a poor connection, an inaccurate solder joint, a broken wire, or some such physical problem.

If a note repeatedly goes dead or cyphers as a result of a faulty transistor, replace the spark suppression diode associated with that note also. The repeated failure of the transistor is likely caused by the diode not protecting it from the transient currents as it should.

THEORY OF OPERATION
SOLID STATE SWITCHES

1. Symbols used in diagrams (Fig. O)

   (a) Resistor

   (b) Diode

   (c) Transistor (Type PNP) B= Base, C=Collector, E- Emitter

   (d) Reisner Chest Magnet

   (e) Switch or Key Contact

2. Circuit diagram of a transistor switch (Fig. 2)

   (a) Through two resistors a & b the base is biased positive (+) which keeps the transistor turned off.

   (b) The chest magnet is connected to the collector through a diode. The return of the magnet is negative (-).

   (c) By the use of the St. Act. Switch a positive (+) voltage is applied to the emitter.

   (d) Since the transistor is in the off state, no current will flow through to operate the magnet until a negative (-) voltage is applied to the base by means of the key contact.

   (e) With the St. Act. off, or no positive (+) voltage applied to the emitter, the magnet cannot operate by the key voltage because it is the wrong polarity. With the key contact closed, the transistor is in a state of conduction, however, with the St. Act. voltage off there can be no conduction or energizing of the magnet. The positive (+) voltage applied to the base cannot conduct through the transistor

and energize the magnet because the diode between the base and resistors will not conduct in that direction.

3. Switch cards (Fig. 3)

   (a) All switch cards consist of: a printed circuit on Fiberglas cloth impregnated with Epoxy plastic; one transistor for each note to be connected to the card; two diodes and one resistor for each transistor.

   (b) All switch cards have circuitry on both sides while the parts are mounted on one side only.

   (c) Contacts on each side of the card are for plugging into a plug connected to the circuit card. All contacts on the switch cards and plugs are gold plated.

   (d) One side of the switch card contains the contacts for the stop action and keys. The opposite side of the card contains the contacts for the chest magnets.

4. Circuit card (Fig. 4)

   (a) The circuit card consists of a sheet of plastic having circuitry on both sides. In Fig. 4 we are showing a circuit card with the necessary wiring to play a chest at three different pitches. For simplicity sake we show only the first note on each octave. (It should be understood that there actually will be 61 circuits, one for each key which plays the switch.)

   (b) Three coupler lines run the length of the circuit card as shown in Fig. 4. These lines connect to their proper tablet at the console.

By means of the tablets the coupler lines may be energized positively (+) at will.

(c) On one side of the circuit card are diagonal lines which connect to the chest magnets. One line for each magnet (Fig. 5).

(d) On the same side of the circuit card as the stop action are lines running the short way of the card which connect to a resistor. All these lines connect to the keys. (Fig. 6)

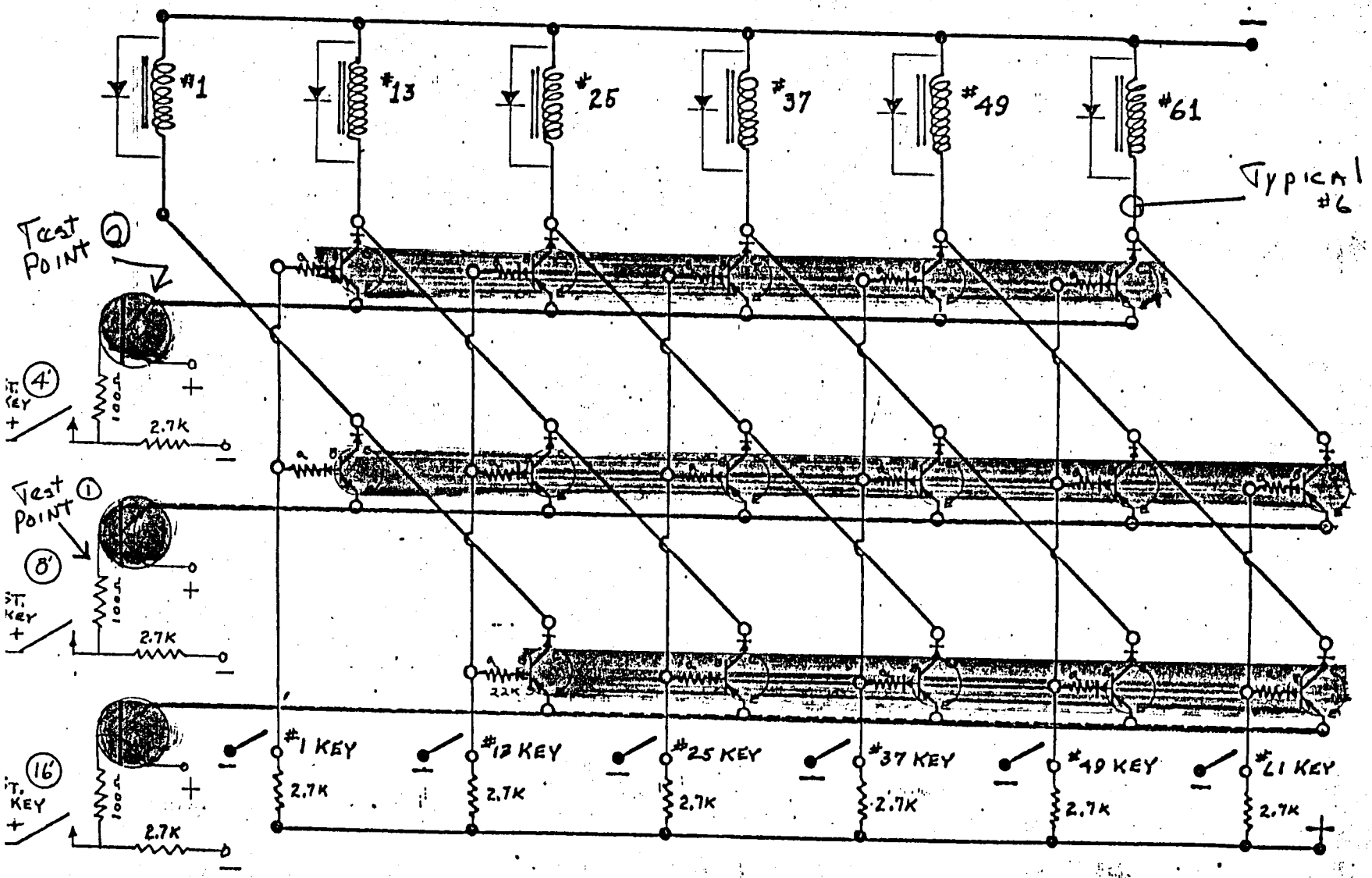
5. Complete solid state switch connected to keys, magnets and switch cards plugged into circuit card. (Fig. 7)

(a) Referring to Fig. 2 and Fig. 7, it can be seen that Fig. 7 is Fig. 2 in multiple. When a positive voltage is applied, for example, to the 8' coupler wire, all transistor emitters which are connected to this wire are energized positively. Since the base of all transistors are biased positive through the resistors a and b, no transistors will conduct. When a negative voltage is applied to the base of the transistors by the key contact, the base of the transistor will go negative allowing the transistor to conduct through the collector and its diode on to the chest magnet, thereby operating that particular magnet. All other transistors connected to that magnet will not conduct since the diode connected to the collector prevents current flowing in the opposite direction through to the collector. Any combination or all couplers can be turned on at the same time and the transistors associated with these couplers will operate when any of the keys are depressed which causes the transistors to conduct, thereby operating the individual magnets.

In an inverse manner, as mentioned before under part 2, if coupler voltage is not applied but key voltage is, no transistors conduct. If coupler voltage is applied but no key depressed, then no transistors conduct.

Note: It is possible for the diode which is connected to the collector on the switch cards to be faulty. If it is, it may cause the Positive signal from an energized chest line to short out the transistor on a note, usually an octave away. If this happens, the Positive signal will then feed into the stop action line which in turn would allow the note an octave above or below to sound in addition to the note being held.

This is a rare occurrence, but it can happen. In checking out switch cards, if changing what seems to be the appropriate card does not correct the problem, try changing cards in other pitches of the same or related stops.



COUPLER SWITCH, MANUAL OR PEDAL

Fig. 1

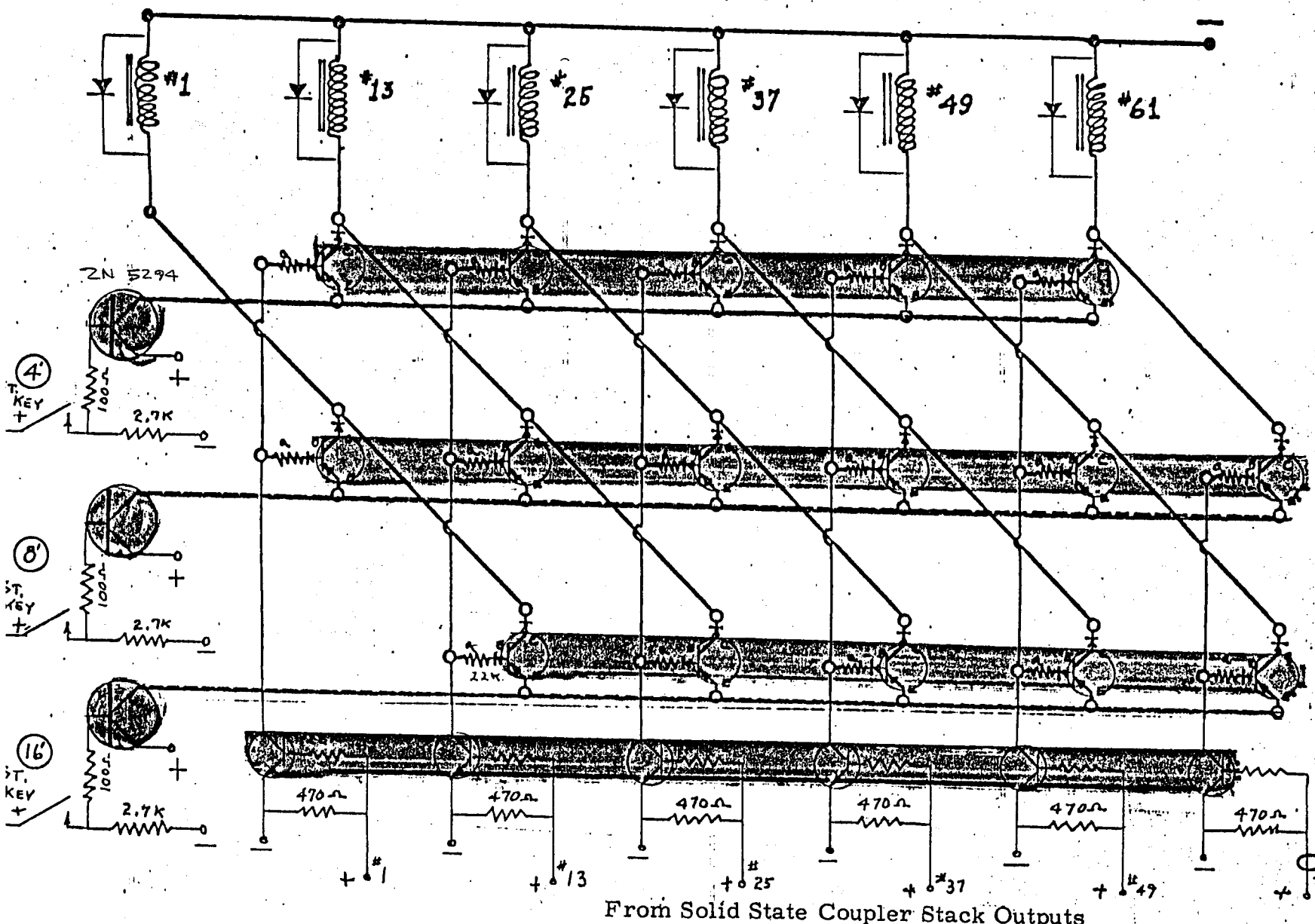


Fig. 1A

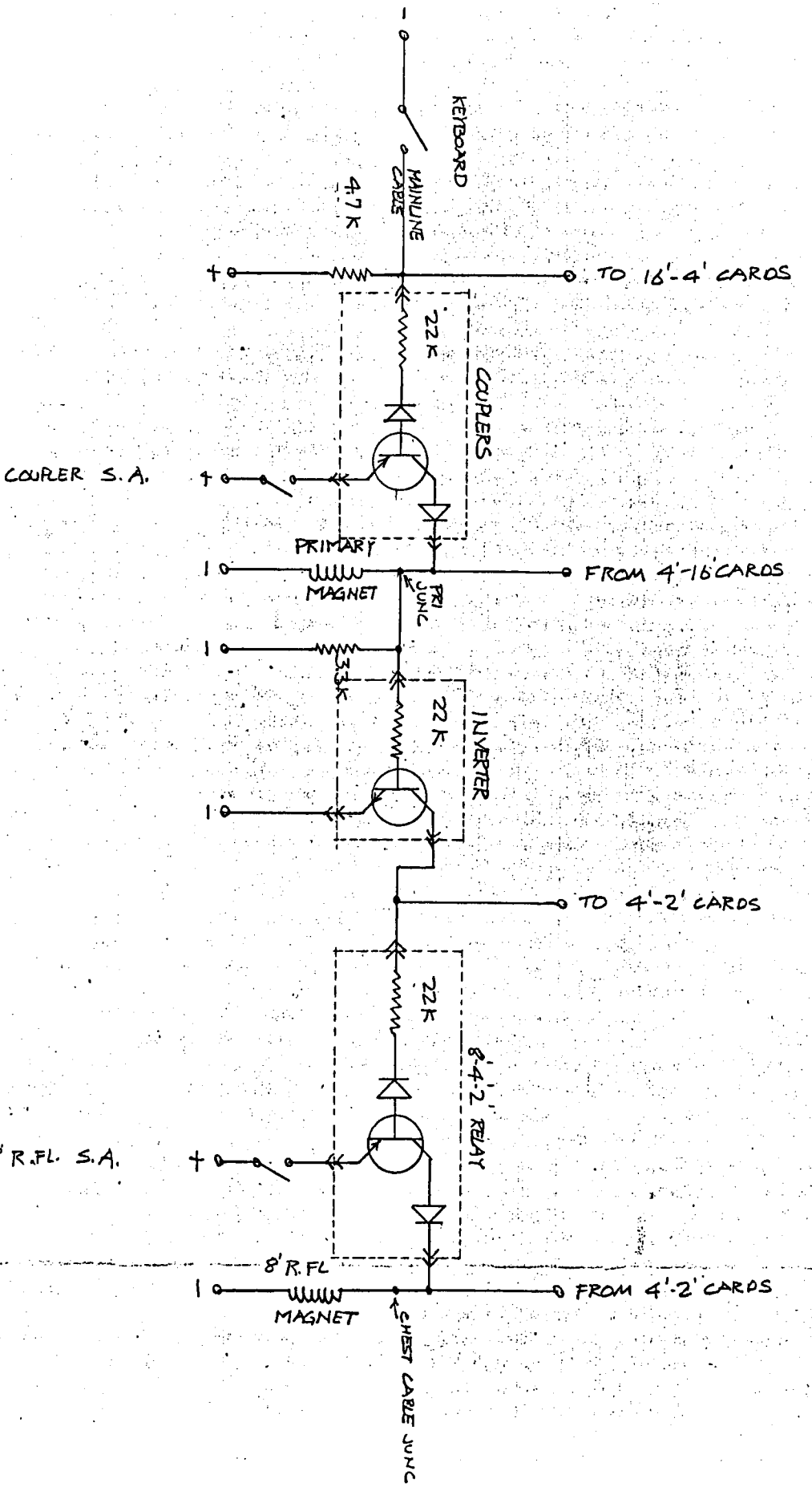

KEYBOARD
MAINLINE CABLE
4.7 K
TO 16'-4' CARDS
22 K
COUPLERS
COUPLER S.A.
PRIMARY
MAGNET
FRI JUNC
FROM 4'-16' CARDS
33K
22 K
INVERTER
TO 4'-2' CARDS
22 K
8'-4'-2' RELAY
8' R.FL. S.A.
8' R.FL.
MAGNET
FROM 4'-2' CARDS
CHEST CABLE JUNC

FIG 2

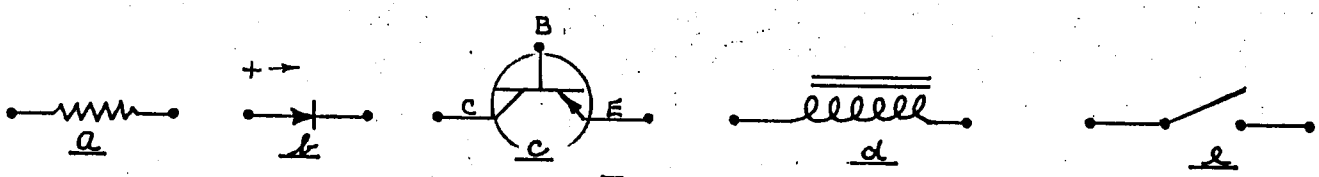
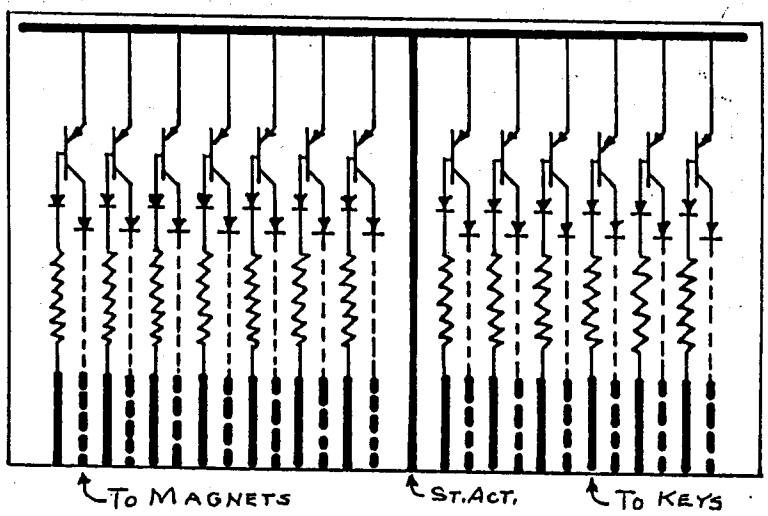


FIG. 1



SWITCH CARD

FIG. 3

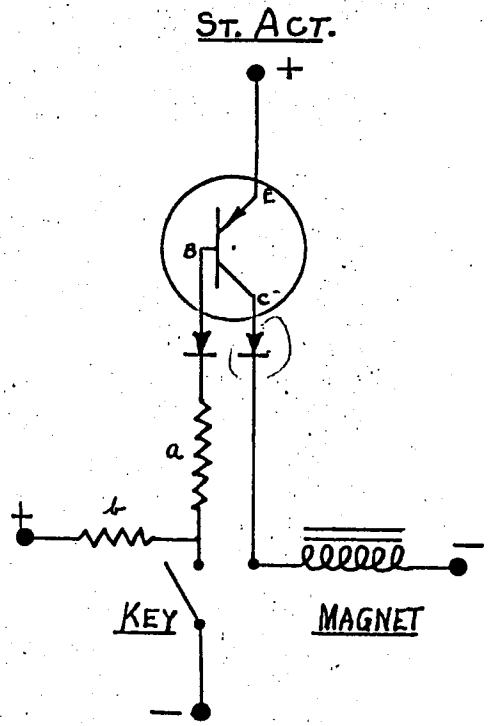


FIG. 2

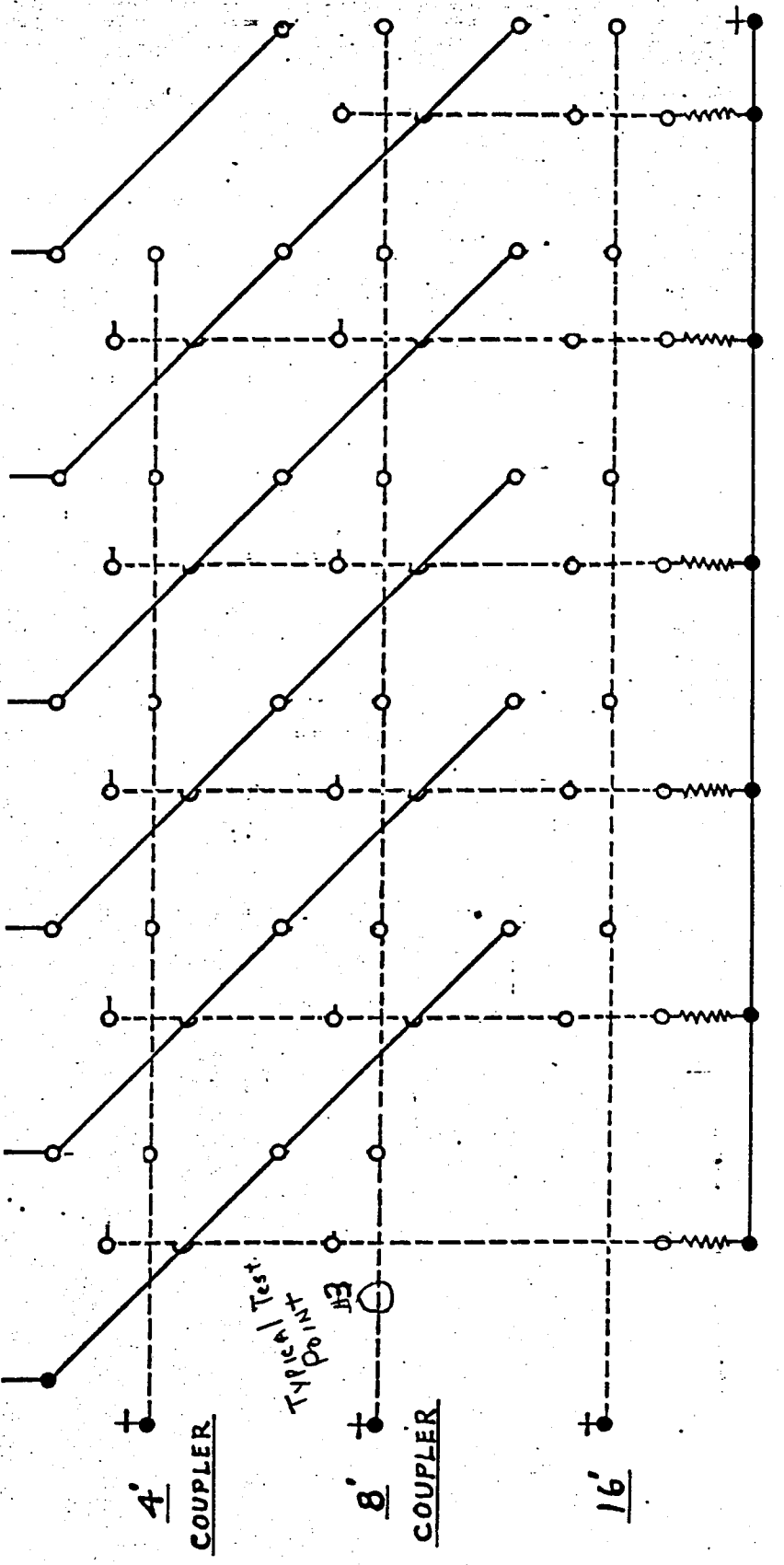


FIG. 4

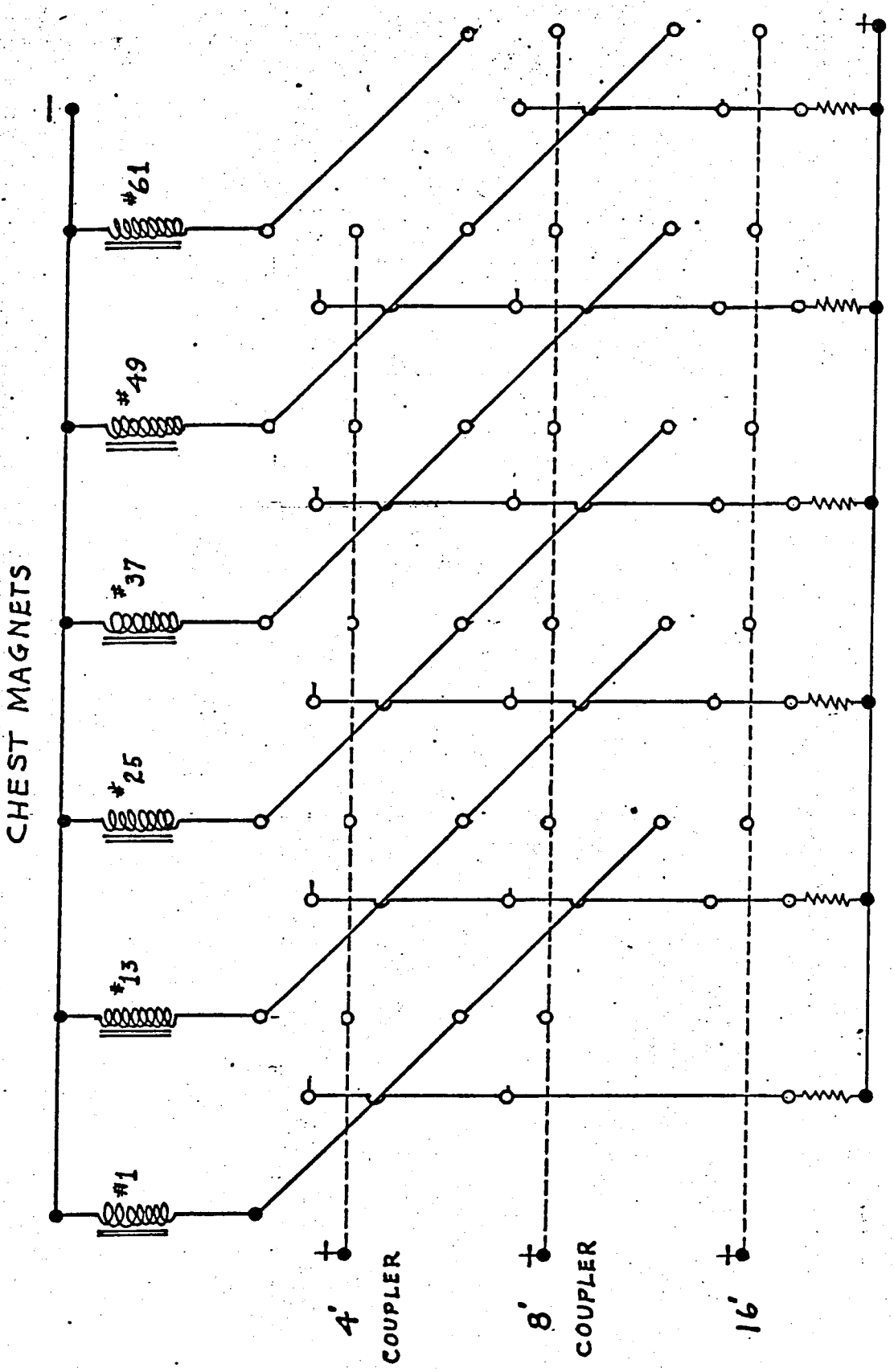


FIG. 5

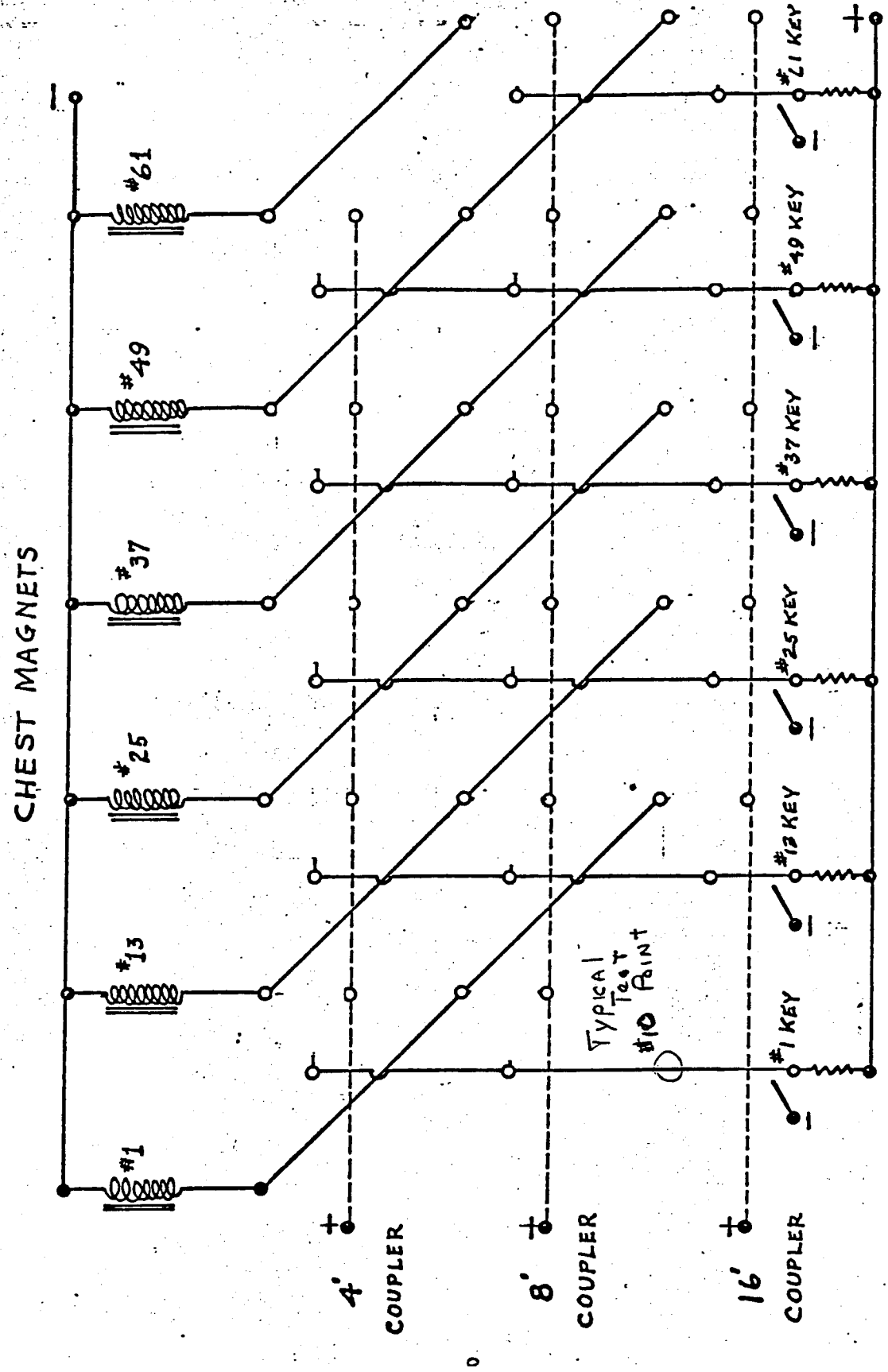


FIG. 6
REUTER SOLID STATE SWITCH

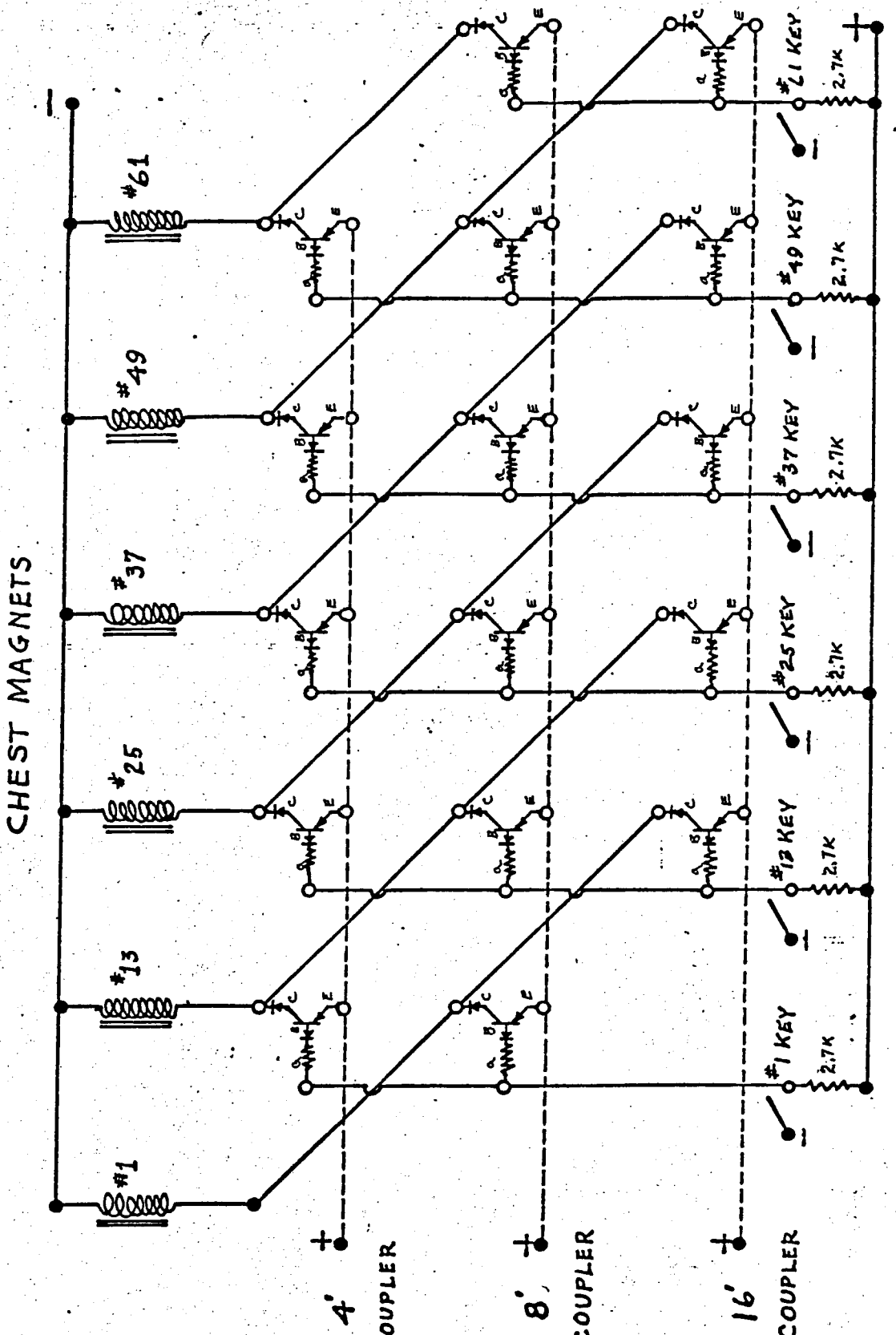


FIG. 7
REUTER SOLID STATE SWITCH

TROUBLESHOOTING REUTER ORGAN COMPANY SOLID STATE SYSTEMS

I. Problem: Entire stop is dead.

Probable cause: Stop action line (see figure 4 - typical test point #3) is not being energized.

Test Procedures:

A. Using a volt-ohm meter, check stop action transistor at test point #1 (see figure 1). The reading with the stop "on" should be approximately 14 volts Positive. If there is no reading at this point, the trouble is not in the solid state circuitry. Check stop action cable from console.

B. If O.K. at test point #1, check test point #2. It should read approximately 14 volts Positive with the stop "on". If no reading at this point, the stop action transistor is faulty and should be replaced. (Check solder joints at transistor.)

C. If O.K. at test point #2, check the stop action line all along its length. Since this line zig-zags to get across the board, there may be a faulty connection where it goes from the front to back side of the circuit board. This line will intersect pin #8 of each switch card plug, thus supplying the Positive stop action voltage for each octave. If working properly, a 14 volt Positive reading can be taken at any point along this line when the stop is "on". When the stop is off, this line will have no reading.

II. Problem: A single note is dead on any stop drawn. (Solid state relay applications.)

Probable cause: The key line on the circuit board (see figure #6, typical test point #10) is not being energized.

Test Procedures:

A. Be sure the key signal is reaching the solid state switching equipment from the console. This can be determined by taking a voltage reading at the main line input on the circuit card. With the key depressed, a reading of approximately 14 volts Negative should be obtained. If no reading at this point, check cables from console.

B. If a voltage reading is obtained at the input plug as described in A, then check on the face side of the board, testing the etched key line as it goes up the board. As noted, 14 volts Negative should appear all along its length. If a section is dead, it is likely due to a break in the etched line. As a further test, 14 volts Negative should also appear on the top clip of the appropriate plug into which the switch cards insert. The end of each clip forms a finger, which intersects a key line and goes thru the circuit board and is soldered on the reverse side.

C. With the organ off, continuity can be checked with meter set on ohms, by testing the key line to the top clip of each plug. No continuity reading should appear when probing the bottom clip, under these conditions.

D. If there is such a reading, the bottom and top clip are shorted together. Look for a solder run on back side of circuit board where these two points are soldered.

III. Problem: A single note on a single stop is dead.

Probable cause: Assuming the chest magnet and/or pouch assembly is working, the transistor for that note is suspected of failure.

Test Procedures:

A. With a positive "hot wire" probe the plug-in or junction output which goes directly to the chest magnet (Figure #1, typical test point #6). If the note does not play then the trouble is not in the solid state equipment. Check magnet and/or chest.

B. Check diode which will be found on each chest magnet. (Diodes for straight chest primaries are located on coupler board.) It should be connected with the red band towards the cable terminal of the magnet and the other end connected to the common negative buss bar (return line). If not connected in this manner, it will create a direct short and will burn out the note transistor instead of protecting it, thus showing up as a dead note. Occasionally, a diode will be mis-marked in manufacture, thus it is important to also test for correct diode polarity. In order to test a diode, the end of the diode which connects to the magnet input must be disconnected. If the diode to be checked is on a coupler circuit board, you need only unplug the cable line to the chest. If the diode is on a unit or offset chest then the diode will have to be unsoldered on the cable terminal end. With meter set on ohms, place the negative probe on the side of the diode away from the red band and touch the Positive probe to the side nearest the red band. Under these conditions continuity <u>should</u> register. Reverse the probes and

continuity should NOT register. If a continuity reading shows up in the second test or any other condition other than specified is manifest - replace the diode.

C. If the note did play under "A" conditions, replace plug in switch card for the octave in which that note appears.

D. If note is still dead, check clip readings as described in #2 (B & C) to be sure the note on the card is receiving and is capable of transmitting the signal to the chest. Check solder joints on reverse side of board in particular.

Note:

A magnet can be energized in the following manner. Remove the switch card. With a Positive hot wire or probe, carefully touch the bottom clip of the note in question on that plug. If all the wiring from that point to the chest magnet is in good order, the magnet should operate. In other words, the Positive signal you are providing with the hot wire is the same signal that the switch card should give if it is in good working order and the stop is "on" and the console key is depressed.

IV. Problem: A run occurs between two or more notes.

Probable cause: Inaccurate soldering or some type of conductive material on etched circuits.

Test Procedures:

A. Unplug or otherwise disconnect the chest cable in question from the output of the solid state switching system.

B. Using a Positive hot wire, touch the suspect wire on this plug leading to the chest. If the run still occurs then the trouble is not in the solid state equipment. Check cable and/or junctions to chest.

C. If O. K. in (B), reconnect the cable to the solid state output. With suspect key depressed, check etched key line for this note. Only the key line for the depressed note should register 14 volts Negative. If more than the one key line reads 14 volts Negative, check the input line from console to the solid state switch board for solder run or note wires shorted together.

D. If only one key line reads 14 volts Negative, and the run is still evident, inspect the etched line from the note in question and adjacent lines on the back side of the circuit board. These etched lines, which are fairly close together run on angles to the next switch to accomplish the sub and super octave unification or coupling. If not in unison multiples, this etching will be cut thru and the off unison pitches will be hand wired. Close inspection of all these lines should reveal the trouble spot. (Test voltage reading on these lines, if energized will be 14 volts Positive.)

V. Problem: A note "hangs on" for a moment or two after the key is released.

Probable cause: Defective transistor.

Test Procedure:

A. Replace appropriate switch card.

VI. Problem: Note cyphers (unified stop) when stop action is "on" though no key is depressed.

Probable cause: Defective inverter transistor.

Test Procedures:

A. Make tests as in #2 (Exceptions).

B. If relay key line still reads 14 volts Negative with no key depressed, replace inverter card as it is apparently shorted "on", feeding the key line all the time. If inverter is all right, no reading, Positive or Negative, should appear on a relay key line with no keys depressed.

Exceptions:

When a unified stop is subject to couplers, the key line that feeds the solid state relay will come from the solid state coupler stack output for that particular division. This output, which also will feed the straight chest primary will be producing a Positive voltage. Therefore, it is important to realize that this voltage must be reversed or "inverted" in order to operate the solid state relay key lines. The first row of cards on such a relay board is a row of inverter cards (note different shape of the transistors) which change the polarity of the key signal from Positive to Negative and then feed it into each key line. Therefore, when troubleshooting a dead "unified note", take a meter reading at the relay key line input (figure #1A, typical test point #5). With a note depressed, the reading should be approximately 14 volts Positive. If O. K. at this point, then check the key line on the face side of the circuit board. Fourteen volts Negative should be available all along its length. See procedures outlined in No. 2 (B).