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MODEL A
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SOLID STATE COMBINATION ACTION
SERVICE MANUAL
SCHANTZ ORGAN CO., ORRVILLE, OHIO

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CONTENTS Dec. 30, 1970

Page	1
	2
	3
	4
	5
	6
	7
	8
	9
	10
	11
	12
	13
	14 & 14a
	15
	16
	17

Fig.	1
	2
	3
	4
	5
	5A
	6
	7
	8

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The inclusion of a solid-state, computer type memory in the remote control system of an organ will require that the serviceman adopt somewhat different techniques in seeking any possible malfunctions of the system. This does not imply, nor is it expected, that the serviceman must become an electronic technician. It is the purpose of this manual to provide the serviceman with guides to localizing the possible troubles and, once located, give directions for field repair or replacement.

Each remote control unit, of the solid state type, is furnished complete with spare boards and parts which will make it possible for the serviceman to make proper replacements. It is intended that any board so replaced be returned to the factory for service.

Before proceeding with trouble shooting methods, a brief description of the solid state system is offered in order that a better understanding of "what is happening" may be had. This description will make use of several terms unfamiliar to the organ industry and these terms will be defined first.

1. Write. Any memory system is a storage bank for information. When information is placed into a memory bank it is said that we are "writing" into memory.

2. Read. Checking the memory bank to see what is stored therein is termed "reading" from memory. Pressing a piston to set up a combination of stops is "reading" a block of information from memory.
3. Bit. One piece of information stored in memory. It may be either an "on" or an "off". In our application, one bit represents the status of one stop on one piston.
4. Flip-flop. The circuitry, consisting of several transistors, which is the heart of the memory system. A flip flop, like a toggle switch, may be either "on" or "off".
5. Integrated Circuit (IC). A preassembled group of transistors, or combinations of transistors, within a small package. The integrated circuits used in this memory system contain 16 flip-flops. Each IC, therefore, is able to remember 16 bits of information about one stop. This means that one IC is capable of serving up to 16 pistons on its one stop.
6. Ground. The common (or negative) side of the power supply. All measurements are made with reference to this point.

The Schantz solid state remote control system is made up of printed circuit boards which contain the transistors, IC's, etc. Each printed circuit memory board provides circuitry for six organ stops or couplers. A memory board is diagrammed in Fig. 1. These boards are "plug-in".

making it possible to replace a board without difficulty. The circuitry for one stop (one sixth of a board) includes the following:

1. A 16 bit memory cell, which is one integrated circuit.
2. Two transistors which permit "writing" of information into the IC.
3. Two transistors which, upon command of a piston, allow the state of a bit in memory to be "read".
4. Two transistors which amplify the information retrieved from memory, and actuate the "kickers" (knob/tablet positioning device).
5. A connecting lead from the stop action magnet with which this IC is associated. This lead gives "position sense" so that, when one is setting a combination or "writing into memory", the IC will know whether it is to remember an "on" or an "off". This lead is at +12 volts when the stop is "on", and is at zero volts when the stop is off.
6. Eight leads from the piston board which allow us to select one of the 16 locations within the IC into which we want to write or from which we want to read information.

It will be noted (item 6 above) that only eight leads are required to select one of the 16 locations in the memory cell. This is done by a matrix addressing or

selection scheme. Referring to the block diagram for one IC, Fig. 1, will reveal that the eight lines cross each other in such a manner that 16 intersections are defined. The eight lines are labelled X1, X2, X3, X4 and Y1, Y2, Y3 and Y4. If X1 and Y1 are energized simultaneously, the flip-flop located at the intersection of these two lines will be "addressed" or brought into electrical view and will be available for either writing or reading. By the same token, if X4 and Y4 are simultaneously energized, a different flip-flop will be addressed.

Addressing of the various memory cells is controlled by the pistons. The pistons when depressed, operate the addressing relays which are mounted on the piston board. The piston board is diagrammed, schematically, in Fig. 4. When any piston is depressed, two memory addressing relays are caused to operate - one X relay and one Y relay. These addressing relays, when operated, remove ground from two memory address lines. Removal of ground from an X and a Y line, simultaneously, allows reading or writing from a particular memory cell.

Further examination of Fig. 1 will reveal the manner in which the 16 bits of available memory (in each IC) are assigned. This shows that all combinations of Y1 and Y2 with the "X" leads, are used for the general pistons. This means that all IC's, for each stop of every division, are wired with the Y1 and Y2 leads in parallel. In like manner, all

IC's have their X lines wired in parallel. When a general piston is depressed, an X and a Y1 or Y2 address relay will operate causing all IC's to be addressed simultaneously thereby writing or reading for every knob or tablet on the console.

The remaining 8 combinations, represented by addressing an X line along with Y3 or Y4, are used for pistons associated with a division of the organ. The Y3 and Y4 lines are paralleled only within a division. This means that each division has a Y3 and Y4 relay. When a Pedal piston is depressed, an X relay and a Pedal Y3 or Y4 address relay will be operated - causing only the pedal knobs to be affected.

A location map is furnished with each combination system showing which X and Y relays operate for each piston on the console. A typical location map is included with this manual, Fig. 2. The location map also indicates which stops are controlled or served by each of the memory boards in the system.

A location map is provided with each solid state system and placed in the solid state box.

The piston board also includes a "piston hold-on" circuit which keeps the selected address relays energized for a sufficient time to allow the actuator mechanism (kickers) to complete its movement of all knobs/tablets, even though only a short "tap" is given to the piston.

The period of hold-on time is adjustable by means of a screwdriver adjuster.

Also mounted on the piston board are relays which operate from the "cancel" piston and "set" piston.

When the cancel relay is operated, all "off" magnets in the kicker assembly are caused to operate - if the stop is in the "on" position. The cancel relay applies +12 to the actuator transistors on all the memory boards and also grounds the cancel diodes for every stop. Grounding the cancel diodes is the same as though the memory cell were telling the actuator transistors that an "off" is stored in memory.

When the "set" relay is operated (by the set piston), contacts on the relay are opened which prevent +12 from reaching the actuator transistors when an address relay is operated. This is to prevent any possible knob/tablet movement while a combination is being "set". Another set of contacts on the set relay puts ground on the "write" buss to all memory boards. When the write buss is grounded, and a memory cell is addressed (by pushing a general or manual piston), the present position of each knob, for the entire organ (general) or for a division (manual), is remembered by the addressed flip-flops.

In summary, the following happens when a piston is depressed:

1. Two address relays will operate, one X and one Y.

2. The operated X relay removes ground from that X line on all IC's in the system. The operated Y relay removes ground from the Y lines of those IC's which are wired to this relay. (All IC's if a Y1 or Y2 general or those IC's for a division if a Y3 or Y4).
3. The operated X and Y relays apply +12 volts to all actuator transistors in the system. (keyed +12)
4. The two operated relays are connected to the hold-on circuit so that they will remain operated for at least one second.
5. Those IC's which have been addressed by the operated X and Y relays will cause the actuator transistors to operate the kicker magnets in accord with memory contained within the addressed memory cells. (Either on or off).
6. Upon release of the piston, address relays return to normal position, restoring ground to the X and Y lines and removing keyed +12 from the actuator transistors.

The following happens when "setting" a combination:

1. "Set" piston is depressed. Set relay operates.
2. Keyed +12 is prevented from reaching the actuator transistors by the opening of contacts on set relay.
3. Ground is applied to the "write" buss to all IC's in the system. This ground prepares all IC's for

the insertion into memory of the state of the knob/tablet associated with each IC. Whether or not the state of a particular knob/tablet is remembered depends upon the next step.

4. A piston is depressed. If this is a general piston, a memory cell will be addressed in every IC in the system. If this is a manual piston, a memory cell will be addressed only in those IC's associated with this manual. No writing or changing of memory will occur on those IC's which have not been addressed by the operation of an X and a Y relay.
5. Upon release of the piston, address relays return to normal position, restoring ground to X and Y lines.
6. Upon release of the set piston the set relay will return to normal position. The write buss becomes ungrounded, preventing any further possibility of writing into memory.

The memory boards, (Fig. 3), are built so that half (3 circuits) may be used on one division and the other half (3 circuits) may be on a different division. When the system is wired for a particular organ, the sockets for the plug-in boards are wired to the appropriate Y3 and Y4 relays. All boards are wired, in parallel, to the X1, X2, X3 and X4 as well as the Y1 and Y2 addressing relays. The remaining

connections to the boards are bussed (paralleled) on the socket panel so that all boards are connected to the write buss, cancel buss, keyed +12 buss, +5 volt buss and ground. Each socket is wired so as to connect each of the twelve transistor actuators to the appropriate on/off magnets on the kickers. (6 circuits = 6 on's and 6 off's).

An actual-size print of the socket wiring panel is included in this manual as Fig. 7. Reference to this print will show the above mentioned busses as well as the connection points for the stop actuator (kicker) magnet wires. Cross referring this print (Fig. 7) and the location map (typical Fig. 2) will make it possible to trace the kicker wiring for any particular stop.

Three sockets, at the left hand end (rear view) of the wiring panel, are dedicated to the reversible boards. The reversibles are constructed on printed circuit boards similar to the memory boards. The memory boards and the reversible boards are keyed in such a manner that makes it impossible to insert them into the wrong sockets.

Connections to the reversible boards are also indicated on the wiring panel print, Fig. 7. Connections to these boards include, for each reversible: on and off leads to the kicker magnets, a lead to the stop action wire for the stop affected by the reversible, +12 volts, -12 volts and two leads to the reversible piston. The reversible pistons are double-throw switches with the contact normally (at rest)

in the "NC" (normally closed) position. When the piston is depressed the "NO" circuit is completed. The common arm of the piston is tied to ground.

A schematic diagram of the reversible printed circuit board is given in Fig. 8. Each reversible board contains circuitry for 3 reversible actions. Each circuit includes the following:

1. A flip-flop memory circuit (IC-1) which, so long as the reversible piston is "at rest", remembers the present position of the affected stop, on or off.
2. A "buffer" amplifier (IC-2) which provides enough current drive to the actuator transistors (Q3 or Q4) when the reversible piston is depressed.
3. An output "clamp" circuit which prevents the kicker actuator transistors, Q3 and Q4, from operating the kicker magnets so long as the reversible piston is "at rest".
4. An input "clamp" circuit which prevents the memory flip-flop from changing state while the reversible piston is depressed.
5. Two transistors (Q1 and Q2) which are controlled by the reversible piston and which direct the proper action of the two clamping circuits.

Power is provided to the memory system from a separate, continuously energized 5 volt rectifier. This rectifier is

connected to a 115 volt AC circuit which cannot easily (or accidentally) be turned off. Loss of power to the memory will mean loss of combinations since the flip-flops are electrical devices.

To safeguard against loss of memory, a backup battery is provided which will retain the memory during short power interruptions. The battery, when new, will protect memory for several hours. Once depleted, it must be replaced.

To warn the organist of possible loss of memory due to power failure, a sensing circuit is provided in conjunction with the memory power rectifier. This circuit keeps a relay energized so long as power is present. If power is removed, and remains off for more than approximately 20 seconds, the relay becomes deenergized. When the organ is turned on, the deenergized relay will cause a signal lamp on the console (labeled "Remote Control") to be lighted. Upon seeing this lighted signal, the organist should check to see if his combinations have been affected by the power failure. If the battery was adequate for the period of failure, he will find his combinations unaffected. It would be wise to replace the battery with a fresh one if the warning light is found to be lighted, even though memory was retained.

The signal light may be reset from the console. Pushing the reset button turns off the signal lamp and restores power to the sensing relay which then will remain energized until again interrupted for more than 20 seconds.

The power supply for the combination system is diagrammed, schematically, in Fig. 6. Fig. 5 diagrams and explains the operation of the power failure alarm system. Fig. 5-A is the physical layout of the power alarm. It will be noted that only two special wires are required from this alarm unit to the console; one to turn the alarm light on in case of power failure and the other to reset the alarm.

TRUBLE-SHOOTING PROCEDURES

The purpose of this section is to outline the steps to be taken when trouble is reported with the combination action system.

The memory circuits are built on replaceable printed circuit boards. Should the trouble prove to be within the electronic circuitry, the spare memory board may be substituted for the defective board. Before any substitution, however, several other possibilities should be explored. The following section lists several possible troubles which may indicate problems other than the memory boards.

1. System totally inoperative, i.e., no pistons, including cancel, will cause movement of knobs/tablets.
 - a. Probably loss of memory power (5 volts).
Signal lamp on console should be lighted.
2. No response of knobs/tablets when a piston is depressed.
 - a. Check to see that the two piston relays associated with this piston are operating.
Possible defective relay or relay diode.
 - b. If both relays are operating properly, check to see if affected knobs/tablets may be moved from on to off with the cancel button.
 - c. If cancel button works ok, check to see that the appropriate X and Y lines are being ungrounded

by the relays. Possible shorted transistor on piston board for X or Y line. When an X or Y is operated, its associated transistor output terminal should read 3 volts or more.

3. Chattering or oscillation of knobs/tablets when a piston is depressed.
 - a. Check to see that not more than two relays are operating when the piston is depressed. If more than two are operating, it is probable that a short circuit exists on the piston wiring.
 - b. Check to see that no X or Y line shows a voltage of more than .1 volts, with no pistons depressed. Measure at transistor output terminals. If voltage exists on any X or Y line, with no pistons depressed, replace the associated relay for that X or Y line.
4. Random, erratic changes of combinations.

(Combinations do not turn out as they were set).

 - a. This condition may obtain if the power supply voltage drops below the nominal 5 volt level. Check the voltage at the combination action box. It should be between 4.85 and 5 volts, measured with an accurate voltmeter. If the voltage drops below 4.85 volts the IC's do not operate properly.

Report #50
Aug. 23, '72

TO HOLDERS OF REPORT #50 DATED DEC. 30, '72 WHICH IS: A SERVICE MANUAL FOR MODEL A COMBINATION ACTION, CAPTURE TYPE, SOLID STATE.

Subject: Addition of a note to page 13 which is the section of the manual titled Trouble Shooting Procedures.

Note that this sheet is numbered 14a. Please insert it in your copy of the service manual between pages 14 & 15, and write in this note at the top of page 14: "See page 14a for an additional note that applies here".

If a peculiar defect on one of the memory chips develops, in the system, it may cause some pistons to appear dead. Such a problem may be evidenced by odd numbered (or even numbered) pistons not causing response of knobs/tablets. The defect in a memory chip does not allow an X or Y line to become ungrounded by the piston relay since a ground exists within the faulty chip. If, after the 3 checks listed in paragraph 2 on page 13 and 14 have been completed, the X or Y line does not read 3 volts or more when the piston is depressed, the following procedure should be used to check for a defective memory chip within the system:

- a. Attach the voltmeter to the X or Y line which is failing to rise above 3 volts (minimum).
- b. Lock one of the defective pistons in the depressed position.
- c. Pull out the memory boards, one at a time, while watching the voltmeter. If no change is noted, plug the board back in and proceed to the next board. If the trouble exists in one of the memory chips on a board, it will reveal itself as a sudden rise in the X or Y voltage when that board is removed. Such a defective board should be replaced with the spare.

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CAUTION

Do not use bells, buzzers, etc., in checking the Solid State system. Use only a Volt-Ohmmeter such as Simpson 260.

If the foregoing list of troubles does not fit the problem at hand, it is likely that trouble exists on one of the printed circuit boards. Recalling that one printed circuit board serves 6 stops, any trouble that affects more than 6 stops will not be repaired by substitution of one board.

If substitution of a board proves to cure the trouble, ship the defective board to Schantz Organ Company for repair. Do not attempt to make repairs in the field. A statement, outlining problems encountered, should accompany any board returned to the factory.

INSTALLATION NOTES

When the organ is installed, consideration must be given to the location and wiring to the combination system power supply.

Since the combination system draws about 6 amperes from the 5 volt supply, the power supply (rectifier) should be located as near as possible to the console. The 5 volt leads connecting the combination system to the power supply must be of sufficient size to keep the voltage drop in the leads to a minimum. The following table lists recommended wire sizes to be used for various cable lengths:

Up to 25 feet	--	#8 wires
25 to 50 feet	--	#6 wires
50 to 75 feet	--	two #8 wires in parallel

After installation is complete, it is recommended that the correctness of polarity be observed, at the console, before attaching the feed wires to the combination system + and - 5 volt blocks. Set the adjuster potentiometer, in the power supply, to give 5 volts at the console before connecting the leads to the block.

After the leads are connected to the block it will be necessary to re-adjust the 5 volt level since there will be some drop in the feed wires. For this adjustment the voltmeter must be attached to the +5 and -5 terminals at the combination system enclosure. A convenient place to clip the voltmeter is across the large capacitor which is mounted on the rear of the socket mounting panel. The end of the

capacitor which connects to the Zener diode is the + end. The voltage should be adjusted to show exactly 5 volts at this point. A voltmeter of known accuracy must be used for this adjustment since it is quite important that the voltage be a correct 5 volts.

