South Abbotsford M.B

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ELLIS ELECTRONICS LIMITED

UNIT SWITCHING

Unit switching is used in pipe organs in order to make greater use of the available pipes, based on the fact that many stops on the organ are identical except for the pitch of the pipes, usually one being an octave above or below the other. It is possible through some type of switching arrangement to use one set of pipes for as many as three or four such stops. This organ uses the TTL switching system described in this manual to make the necessary switching arrangements. The same method is used with the electronic ranks, as it is possible at some time in the future to replace any electronic rank with a set of pipes. A specification sheet is included in this manual to show which ranks the various stops are derived from.

One additional variation is used in the case of some electronic voices when controled by TTL switching. By pulsing the stop input of any given pitch, a resulting LOWER input voltage appears at the generator. This makes possible two different stops of the SAME pitch. This is used in the Pedal system, with the FAGOTTO 16, which is a softer BOMBARDE, and the GEDECKT 16, a softer BOURDON. The pul   are taken from a higher pitched tone generator at random. Generator square waves result in about half the normal input voltage when used to strobe the stop inupt.

Note that all PIPE stops use electronic notes for the lowest octave in 8' pitches, and in 4' pitch in Great Principal. Swell and Choir flutes also use high octave electronic extensions. These may be located on unused sections of other generator boards. In cases where Celeste board is used, Keying diodes are cabled to other generator boards for correct tuning.

THEORY OF OPERATION - TTL Switching

The centre of any ELLIS organ system is the data switching network made up of a number of circuit boards containing the data routing equipment using TTL technology.

Switching operation is based on the Two-Input inverted AND (NAND) gate. The condition required to produce a logic 0 at the output is that both inputs be held to logic 1. The board is wired so that one gate receives data from a key and the other receives data from a stop. When both conditions are met, i.e. a key pressed with a stop ON, the appropriate gate output will switch to logic 0. The system is wired common positive, so the output will read -5 volts when ON. Tone generators and pipe drivers are designed to respond to an input of -5 volts.

All gate outputs which are to drive the same generator or pipe are diagonally tied on the face of the circuit board. The switching gates are of the Open Collector type, and only drive in the (-) direction. A resistor on each set of outputs common to a note pulls the line to (+) when no gate is ON (-).

Keyboard outputs are normally (+) when off, switching to (-5) when keys are pressed. Each switching board, therefore has a row of gates at the keyboard inputs for the purpose of inverting the keyboard data so that a key ON will produce the required (+) at the input of the NAND gates. Each key inverter is tied to all gate inputs in vertical line with it. STOP inputs are tied together in horizontal lines on the board. Usually, a transistor inverter / shunt circuit keeps all stop inputs in a common horizontal row in the logic 0 condition when its stop is turned off.

A variation has bee used in several models where the stop inputs of the gates are either left open or tied to the key input gates next to them. Stop control is effected by wiring all VCC (+5 volt) pins of the IC's together and applying the 5 volts via the stop control. No output is possible anywhere in the row unless voltage is provided by turning ON the stop. Switching action is the same in either method.

IT SHOULD BE NOTED that both types of output devices driven by these switching systems contain other voltages considerably higher than the 5 volts used by the TTL components. *APPLYING VOLTAGES HIGHER THAN THE SUPPLY VOLTAGE TO EITHER THE INPUTS OR THE OUTPUTS AS WELL AS THE COMMON POWER SUPPLY WILL BURN OUT TTL DEVICES*. As many as 10 or 12 common gate outputs may be connected to any given output line, so *ACCIDENTAL SHORTING to OTHER SUPPLY VOLTAGES could cause EXTENSIVE DAMAGE*.

BE CAREFUL

TONE GENERATION and KEYING

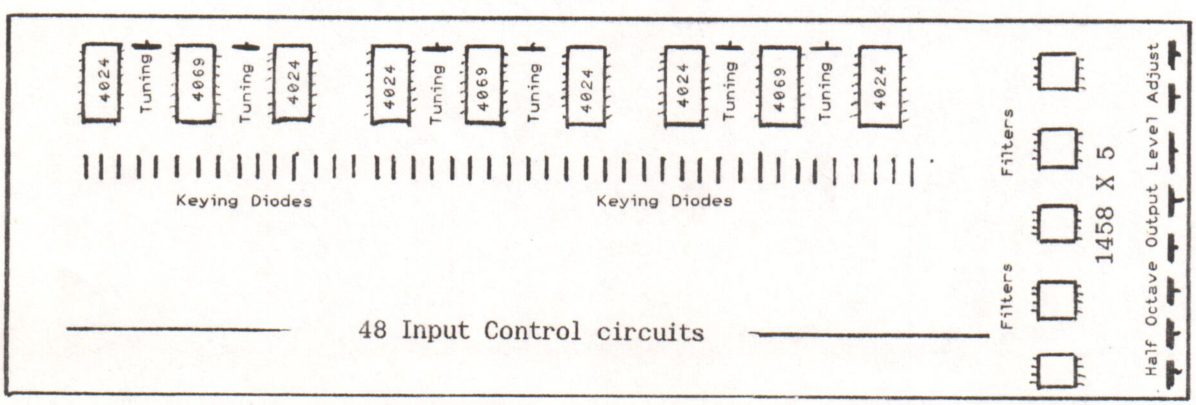
Tone generators are arranged in sets of two circuit boards, one containing notes C to F, the other notes F# to B, up to eight octaves of each. Highest octaves are produced by six CMOS three-gate oscillators on each board. Type 4069 hex inverters provide two oscillators per chip. Common emitter transistor buffers are used if the oscillator outputs are to be played, otherwise the outputs are connected to the clock inputs of six 4024 7-stage dividers which provide all of the lower octaves.

Keying is accomplished through biased diodes. One diode per note is used in some voices and in others a second diode is connected to the next octave higher. Input voltage of about 5 volts from switching logic outputs is processed through resistor-capacitor network in each note input circuit. Outputs are mixed through the 22k resistors half octave groups (6 notes) and connected to filter inputs. Outputs of the filters are mixed through trimmer resistors to mixer/output stage on only ONE of the two boards. Mixer output goes directly to power amplifier.

Two variations will be found on some DIAPASON and REED generators. Extra circuitry to provide the characteristic attack and vaveforms are added to the main circuit boards using a small circuit board for each note. These circuits usuall replace the 22K mixing resistors and connect to their solder points, and also connect acrross the Electrolytic Capacitor of each input.

Separate tremulants are provided for each set of generators, using the other half of the 1455 OP amp used for the mixing amplifier. The tremulant is a phase shift oscillator set at about 6 Hz.. Output is connected either to the supply voltage of the master oscillator chips, or to the bias line which runs along the top of each circuit board, connecting to each oscillator through 1 to 2 meg. resistors. Tremulant stop control simply biases the shunt transistor connected across the negative feedback resistor, stopping oscillation.

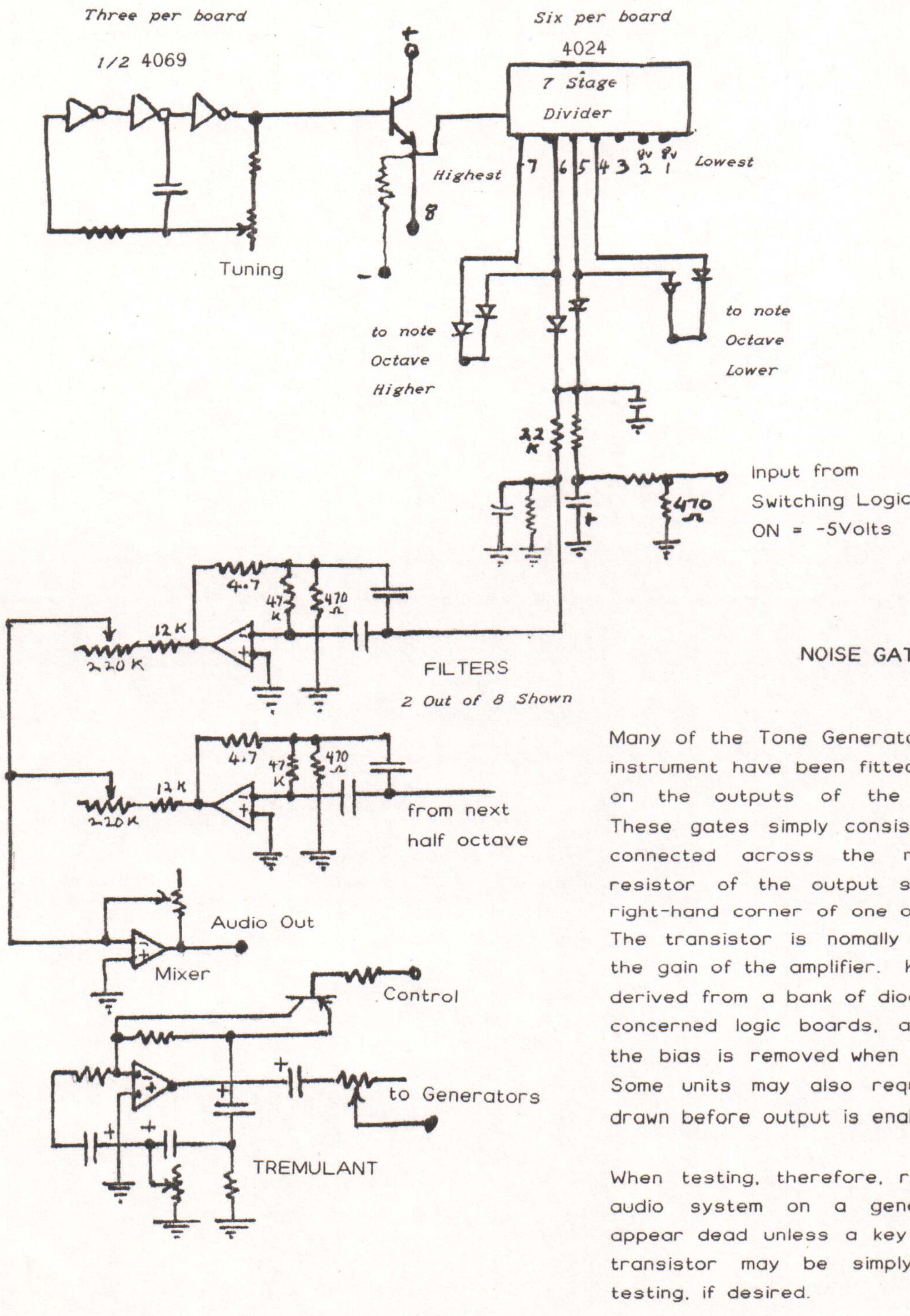
Generator / Keyer Board *ONE of TWO BOARDS PER SET*



KEYER INPUTS from LOGIC CONTROL - up to 48 per board

POWER SUPPLY and AUDIO CONNECTIONS

TONE GENERATORS and KEYERS - Diapason and String

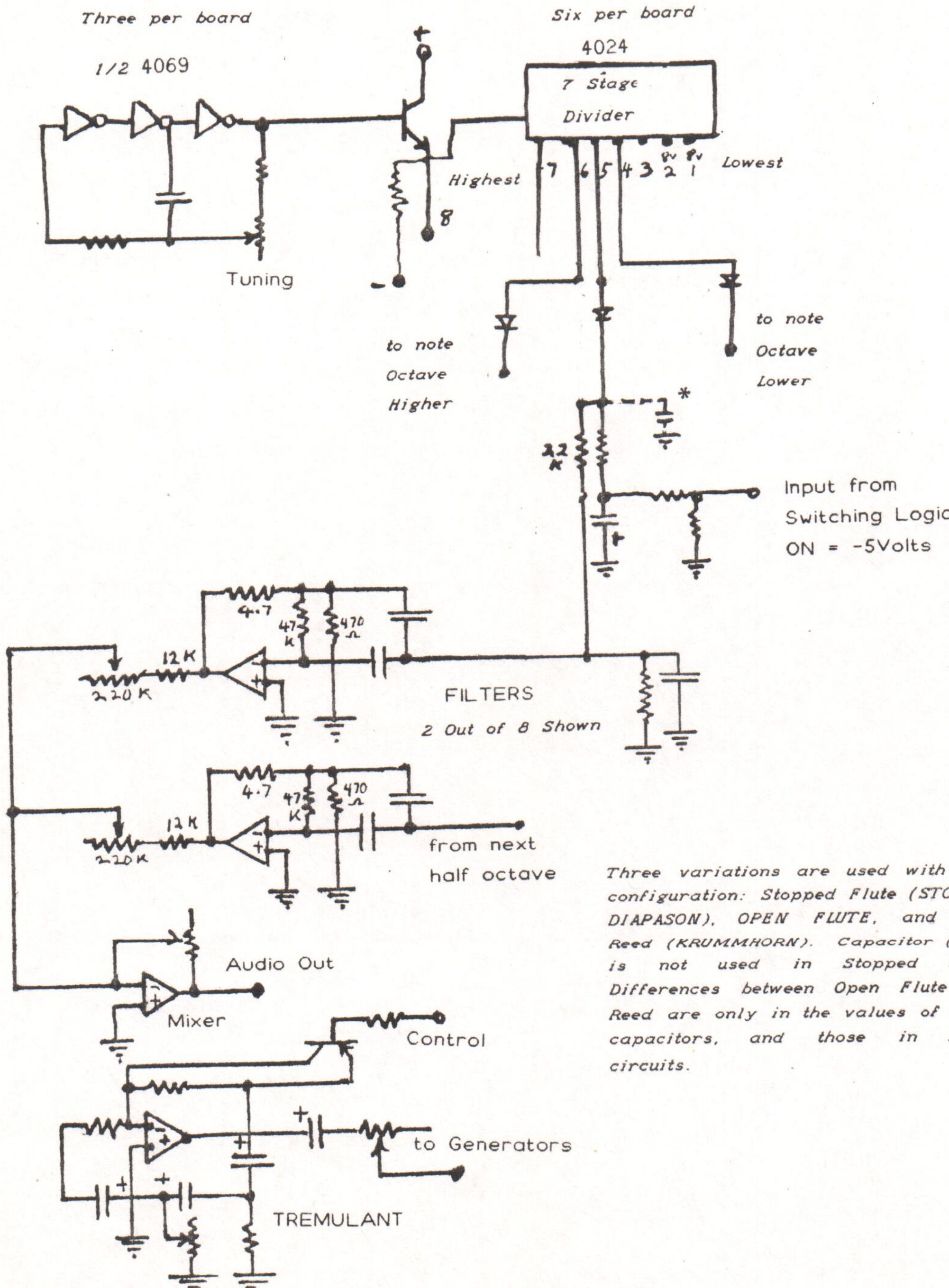


NOISE GATES

Many of the Tone Generator systems in this instrument have been fitted with noise gates on the outputs of the mixing amplifiers. These gates simply consist of a transistor connected across the negative feedback resistor of the output stage at the top right-hand corner of one of the two boards. The transistor is nomally biased to cancel the gain of the amplifier. Keydown voltage is derived from a bank of diodes on one of the concerned logic boards, and wired so that the bias is removed when a key is pressed. Some units may also require the stop be drawn before output is enabled.

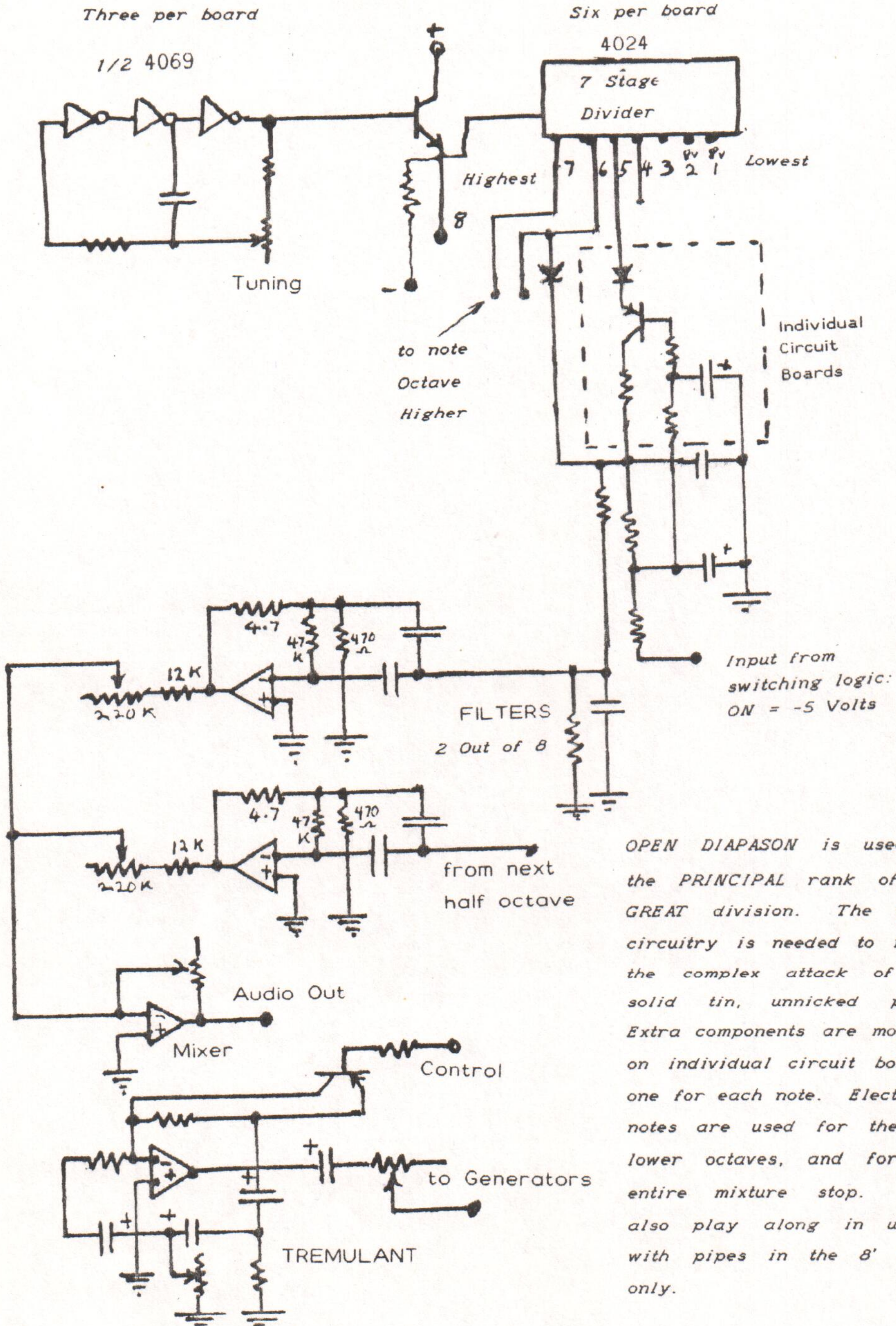
When testing, therefore, remember that the audio system on a generator board will appear dead unless a key is pressed. The transistor may be simply removed during testing, if desired.

TONE GENERATORS and KEYERS - FLUTE / SOLO REED



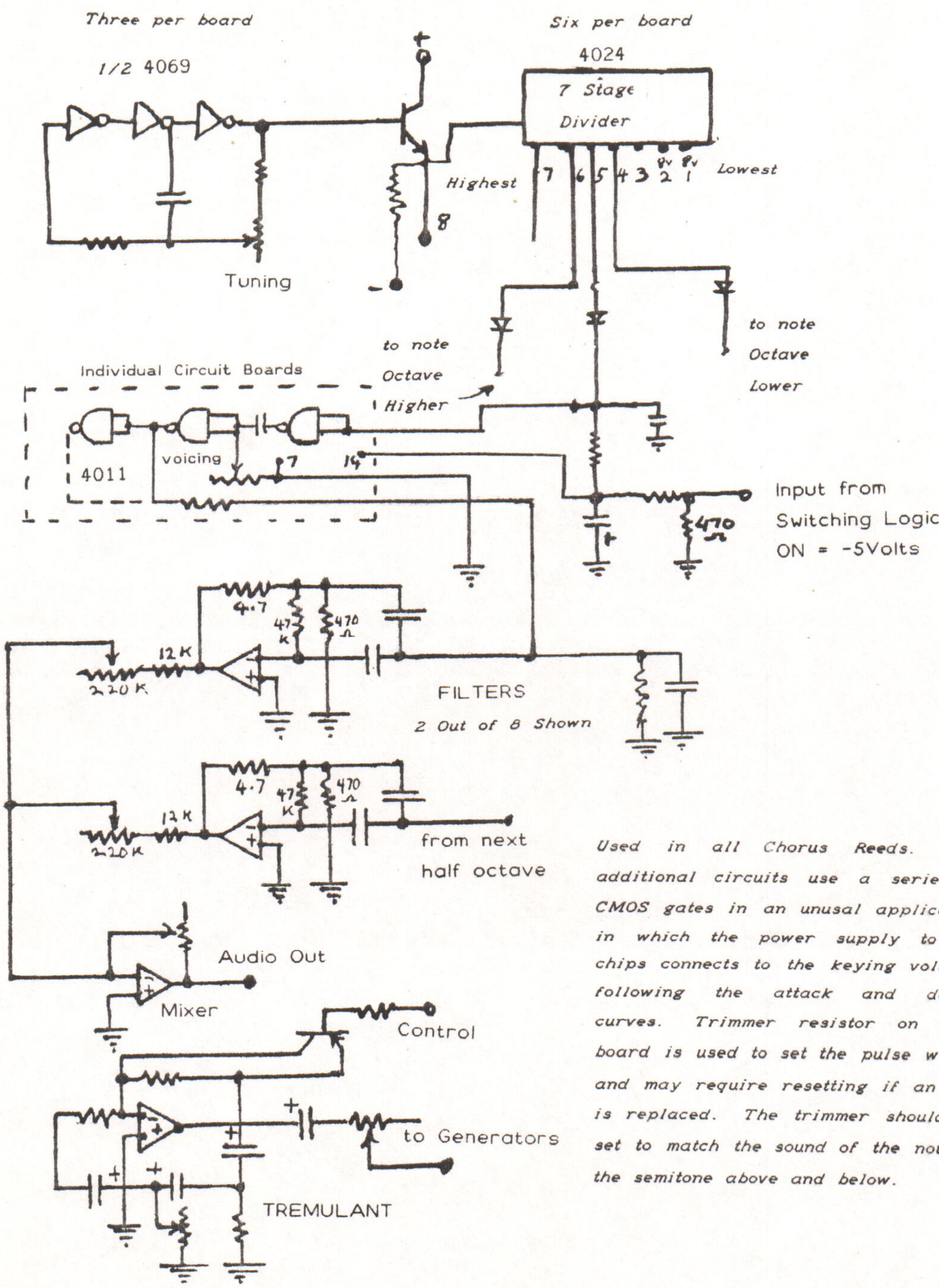
*Three variations are used with this configuration: Stopped Flute (STOPPED DIAPASON), OPEN FLUTE, and Solo Reed (KRUMMHORN). Capacitor (*) is not used in Stopped Flute. Differences between Open Flute and Reed are only in the values of these capacitors, and those in filter circuits.*

TONE GENERATORS and KEYERS - OPEN DIAPASON



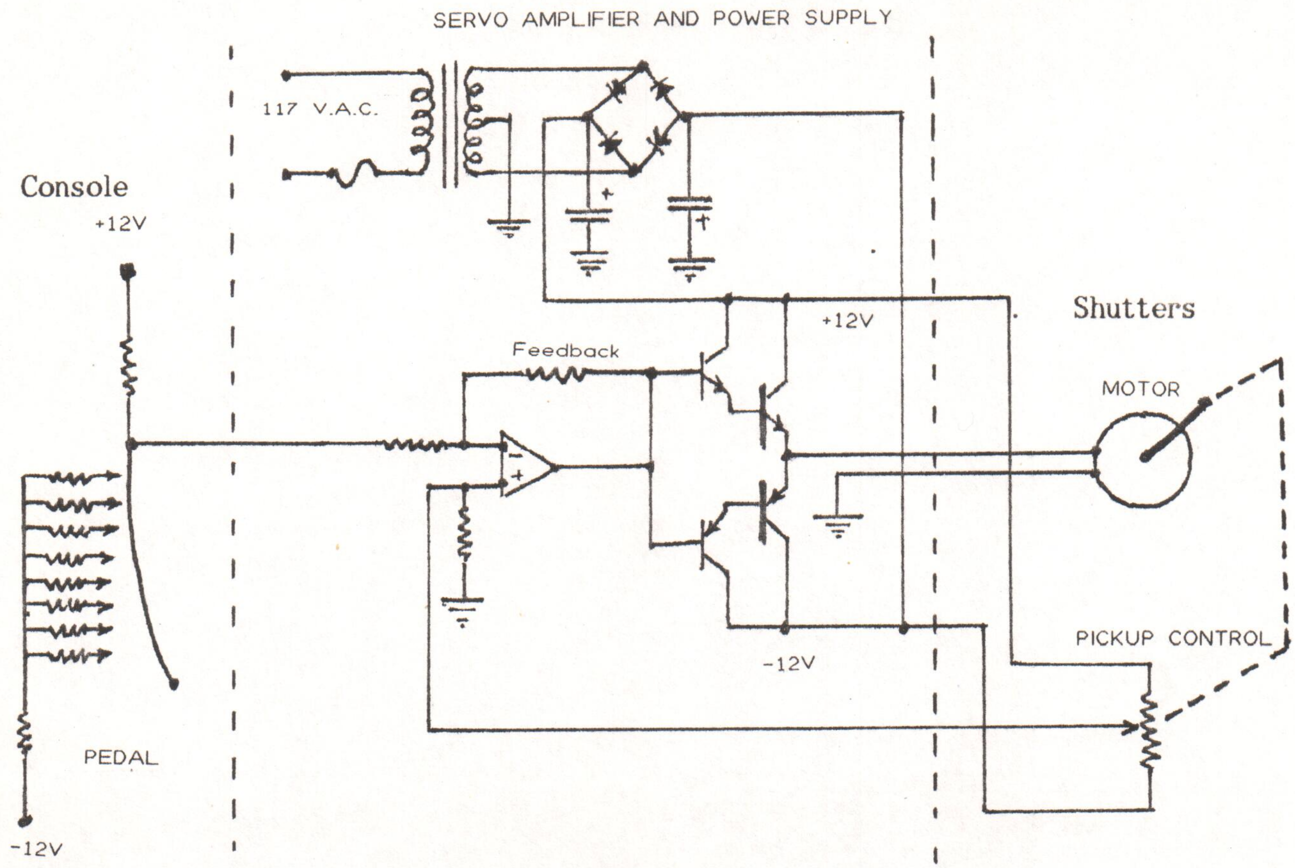
OPEN DIAPASON is used in the PRINCIPAL rank of the GREAT division. The extra circuitry is needed to match the complex attack of the solid tin, unnicked pipes. Extra components are mounted on individual circuit boards, one for each note. Electronic notes are used for the two lower octaves, and for the entire mixture stop. They also play along in unison with pipes in the 8' pitch only.

TONE GENERATORS and KEYERS - CHORUS REED



Used in all Chorus Reeds. The additional circuits use a series of CMOS gates in an unusal application in which the power supply to the chips connects to the keying voltage, following the attack and decay curves. Trimmer resistor on each board is used to set the pulse width, and may require resetting if an I.C. is replaced. The trimmer should be set to match the sound of the note to the semitone above and below.

SWELL and CHOIR SHUTTER CONTROL SYSTEMS



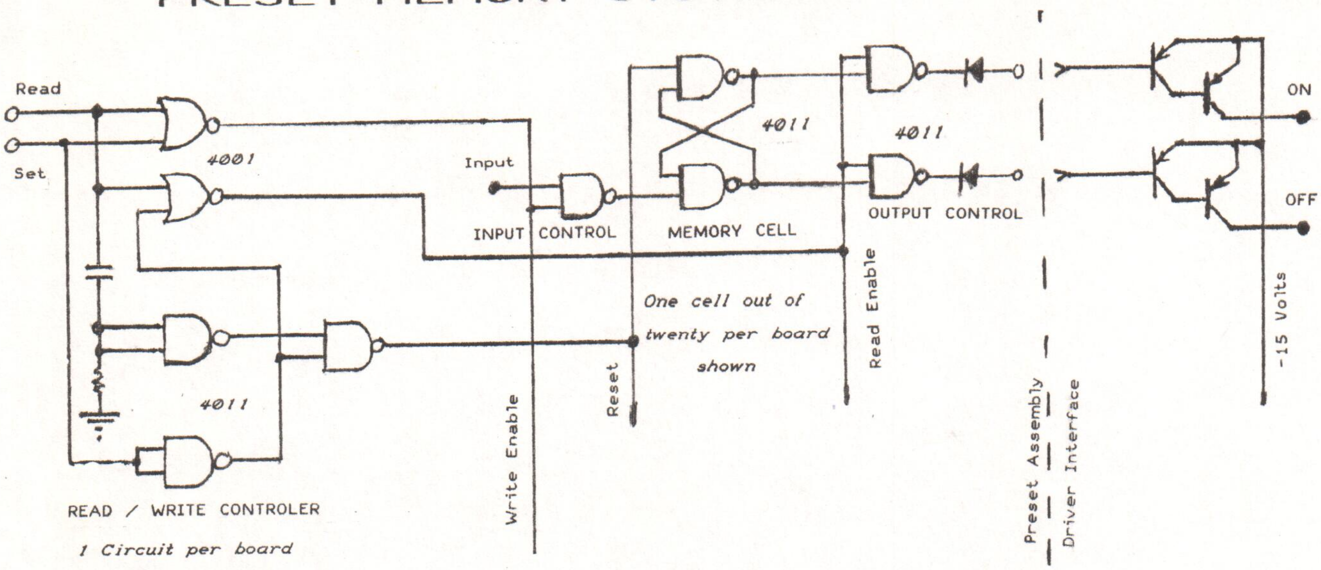
The control systems for the Swell and Choir shutters each consist of three parts: The pedal in the console, the power supply and servo amplifier in the chamber, the servo motor and the position sensing pickup, both coupled to the shutter assembly.

The action works on the principle of a differential amplifier which constantly compares the position of the shutters and the control pedal. When a difference occurs, the amplifier reacts by shifting its output either positive or negative, turning the motor in the appropriate direction until the difference is eliminated, at which point the amplifier output returns to zero and the motor stops. Amplifier gain can be adjusted at the feedback loop. Excess gain will cause overshooting, with resulting oscillation of the shutters, while insufficient gain will not provide enough power to drive the shutters to an equalized position, resulting in the motor stalled with a low voltage applied. This condition could damage motor brushes or over heat driver transistors.

The motor used is simply a common automotive windshield wiper motor, which is designed for much heavier duty than is likely to occur here, and should require little or no attention. Position sensing is accomplished using a slider type potentiometer, which may need cleaning with a good quality control cleaner from time to time. This condition would cause sudden or changes in shutter position, not relative to pedal position. The pedal is a 32-contact progressively liked switch with self cleaning sliding contacts, and should require little attention.

Both Choir and Swell systems are the same, but may vary from the digram in polarity of inputs and motor connections. Either polarity works the same, as long as the overall direction is maintained. Reversing polarity of one device only would result in shutters driven to one extreme and stalling under full power. If any rewiring is done, polarity should be tested for this condition.

PRESET MEMORY SYSTEM



The preset system consists of about 500 individual memory cells made up of cross-connedted 2 input NAND gates with associated input and output controls, also in the form of NAND gates. System is organized into boards containing twenty such cells each, plus one Read/Write control circuit per board. All cells common to a board connect to common write enable, reset, and output enable lines from the read/write control. One board is usually controled by one preset button, and serves up to twenty stops, having one input and two outputs per stop. General presets (those which control all stops on the organ) usually have one button controling several boards. In such cases, the read/write circuit is left out of the extra boards, with the control lines interconnectd.

To write into the memory, also called *Setting* the memory, the user first presses the *SET* or *WRITE* button, then while holding this button, presses the desired Preset button. The SET button is connected to the WRITE input of ALL boards with read/write controlers. This simply disables the read-enable lines and makes the write-enable lines available. When the selected Pre-set button is pressed, no action occurs in the stops because the Read-enable line is held off. With the Set button held, the input enable line is raised, and all of the cells under the control of the button are first reset by a momentary reset pulse on the reset line, then allowed to assume the information from the inputs, which are simply connected to the stop switches. The reset pulse, generated by the capacitor in the read/write circuit is ingnored during READ operations, because the Write-enable line is off.

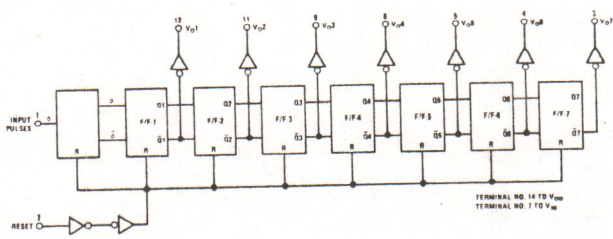
Reading from the memory is simply a matter of raising the output enable line, which sends data from both legs of the memory cells to the external driver circuits. Two outputs are required per stop because the switches have both ON and OFF solenoids.

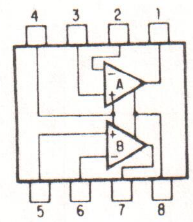
Power for the memory circuitry is supplied from an independent source which is not controlled by the main power switch. If power is removed, all data is lost. Data may be retained for a considerable time during power failures with a simple 9 volt alkeline battery, connected through a 4 or 5 volt zener diode so that while normal power is available, no drain is made on the battery. When the supply voltage drops below about 4 volts, the battery then takes over. the CMOS memory cells will retain their data down to about 2.5 volts, at which virtually no current is drawn.

PINOUTS FOR INTEGRATED CIRCUITS

I.C.s Used in TONE GENERATORS

logic diagram

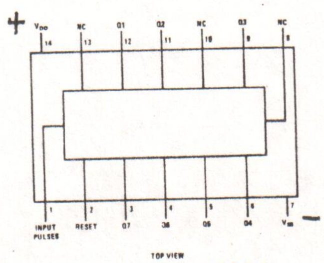




1. Output A
2. Inverting Input A
3. Noninverting Input A
4. V^-
5. Noninverting Input B
6. Inverting Input B
7. Output B
8. V^+

1458 CS

connection diagram



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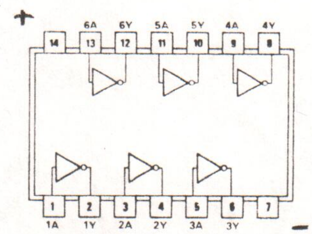

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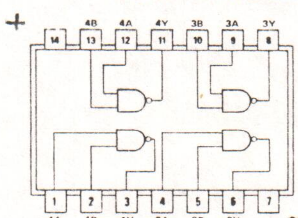
I.C.s Used in TTL SWITCHING



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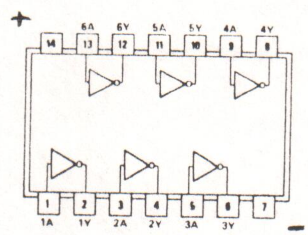
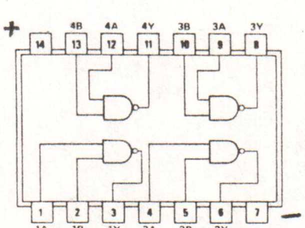


I.C.s used in MEMORY BOARDS



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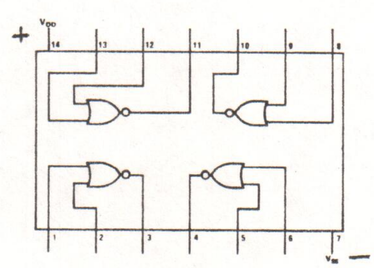

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