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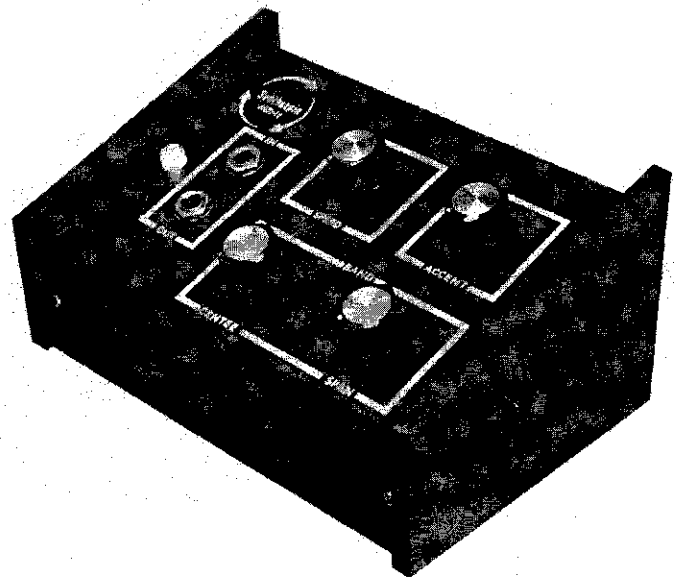
1702

SYNTHESPIN MK - II



For years electronic organs have used mechanical rotating speakers to produce a tremolo effect and recently these speakers have gained added popularity with other musicians because the sound they produce is totally unlike most electronic forms of tremolo.

The problem with mechanical speakers is that they are too bulky and heavy to be conveniently carried from one date to the next and their high cost puts them beyond the means of many amateur and semi-professional musicians. The Synthespin MI-II has been designed as a low cost, portable electronic simulator of the rotating speaker effect.

Other than the rotating speaker sound the Synthespin can produce numerous effects ranging from very slow phasing type sounds to a bubbling pseudo-reverb. Electrical inputs on the rear of the case provide for foot pedal control of both speed and range of the rotating effect as well as allowing instantaneous foot switch cancellation and bypass functions.

SOLDERING

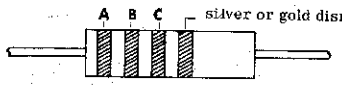
Use care when mounting all components. Use only rosin core solder (acid core solder is never used in electronics work.) A proper solder joint has just enough solder to cover the round soldering pad and about 1/16 inch of the lead passing through it. There are two improper connections to beware of: Using too little solder will sometimes result in a connection which appears to be soldered but actually there is a layer of flux insulating the component lead from the solder head. This situation can be cured by re-heating the joint and applying more solder. If too much solder is used on a joint there is the danger that a conducting bridge of excess solder will flow between adjacent circuit board conductors forming a short circuit. Unintentional bridges can be cleaned off by holding the board up-side down and flowing the excess solder off onto a clean, hot soldering iron.

Select a soldering iron with a small tip and a power rating not more than 35 watts. Soldering guns are completely unacceptable for assembling transistorized equipment because the large magnetic field they generate can damage solid state components.

CIRCUIT BOARD ASSEMBLY

( ) Prepare for assembly by thoroughly cleaning the conductor side of the board with a scouring cleanser. Rinse the board with clear water and dry completely.

Solder each of the fixed value resistors in place following the parts placement diagram fig. 1 and the parts placement designators printed on the circuit board. Note that the fixed resistors are non-polarized and may be mounted with either of their two leads in either of the holes provided. Cinch the resistors in place prior to soldering by putting their leads through the holes and pushing them firmly against the board; on the conductor side of the board bend the leads outward to about a 45° angle. Clip off each lead flush with the solder joint as the joint is made.



	DESIGNATION	VALUE	COLOR CODE A-B-C
( )	R1	270 ohm	red-violet-brown
( )	R3	39K	orange- white-orange
( )	R4	470K	yellow-violet-yellow
( )	R5	47K	yellow-violet-orange
( )	R6	470K	yellow-violet-yellow
( )	R7	220K	red-red-yellow
( )	R8	470K	yellow-violet-yellow
( )	R9	470K	yellow-violet-yellow
( )	R10	1K	brown-black-red
( )	R11	68K	blue-grey-orange
( )	R12	68K	blue-grey-orange
( )	R13	470K	yellow-violet-yellow
( )	R14	6800	blue-grey-red
( )	R15	33K	orange-orange-orange
( )	R16	47K	yellow-violet-orange
( )	R17	6800	blue-grey-red
( )	R18	6800	blue-grey-red
( )	R21	33K	orange-orange-orange
( )	R22	33K	orange-orange-orange
( )	R23	680	blue-grey-brown
( )	R24	2200	red-red-red
( )	R25	910K	white-brown-yellow
( )	R26	47K	yellow-violet-orange
( )	R27	3.9 meg.	orange-white-green
( )	R28	2.2 meg.	red-red-green
( )	R29	33K	orange-orange-orange
( )	R30	1.2 meg.	brown-red-green
( )	R31	1.2 meg.	brown-red-green
( )	R32	220K	red-red-yellow

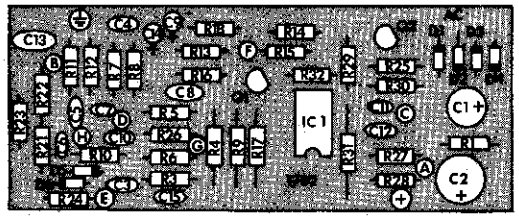
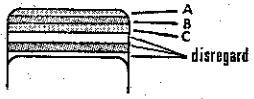


figure 1

Install the ceramic disc and mylar capacitors. The ceramic discs without exception have their value marked on the body of the part but the mylar capacitors may be color coded as shown below:

	DESIGNATION	VALUE	COLOR CODE A-B-C
( )	C3	.05 mfd. disc.	
( )	C4	.01 mfd. disc.	
( )	C5	.01 mfd. disc.	
( )	C6	.001 mfd. disc.	
( )	C7	.001 mfd. disc.	
( )	C8	.1 mfd. mylar	
( )	C10	.01 mfd. disc.	
( )	C11	470 pf	
( )	C12	.005 mfd. disc.	
( )	C13	.22 mfd. mylar	red-red-yellow
	C15	.01 mfd. disc.	



Up to this point all components have been non-polarized and either lead could be placed in either of the holes provided without affecting the operation of the unit. Electrolytic capacitors are polarized and must be mounted so that the "+" lead of the capacitor goes through the "+" hole in the circuit board. In the event that the "-" lead of the capacitor rather than the "+" lead is marked it is to go through the unmarked hole in the circuit board.

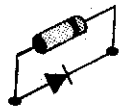
Note that the operating voltage (v.) specified for a capacitor is the minimum acceptable rating. Capacitors supplied with specific kits may have a higher voltage rating than that specified and may be used despite this difference. For instance, a 100 mfd. 25v. capacitor may be used in place of a 100 mfd. 16v. capacitor without affecting the operation of the circuit.

Mount the following electrolytic capacitors and solder them in place. The values, voltage rating and polarization are marked on the body of the part.

	DESIGNATION	VALUE
( )	C1	100 mfd. 16v.
( )	C2	1,000 mfd. 10v.
( )	C9	2.2 mfd. 6v.
( )	C14	2.2 mfd. 6v.

Install the diodes D1 through D4. The diodes are polarized components and must be properly oriented in order to operate properly. Polarization of the part will be indicated either by a colored band on one end of the part or by the bullet shape of the case. These two orientation methods are related to the schematic symbol used on the circuit board in the drawing below. Diodes are heat sensitive and may be damaged if allowed to get too hot while soldering. To be on the safe side heat sink during the soldering operation by grasping it with a pair of needle nose pliers at a point between the circuit board and the body of the part.

	DESIGNATION	TYPE NO.
( )	D1	1N4003
( )	D2	1N4003
( )	D3	1N4003
( )	D4	1N4003



In a similar manner mount the remaining diodes D5 and D6. Orientation is as on the diodes above. Heat sink during soldering.

	DESIGNATION	TYPE NO.
( )	D5	1N914
( )	D6	1N914

Install the transistors. Note that the orientation of these parts is keyed by the flat molded into one side of the case. Orient as shown in the parts placement diagram figure 1 and the parts placement designators printed on the circuit board. Heat sink during installation.

DESIGNATION	TYPE NO.
( ) Q1	2N5129
( ) Q2	2N5129

Mount the integrated circuit. Note that the orientation of the integrated circuit is keyed by a notch at one end of the case which aligns with the semi-circular key on the designator printed on the circuit board. Use particular care when installing this part, like any other semi-conductor it is heat sensitive and should not be exposed to extraordinarily high soldering temperatures. Make sure that the orientation is correct before soldering, once the unit is in place it cannot be removed without destroying it.

DESIGNATION	TYPE NO.
( ) IC-1	LM3900

In the following steps wires will be soldered to the circuit board that in later steps will connect with the front panel controls. At each step prepare the wire by cutting it to the specified length and stripping 1/4 inch of insulation from each end. "Tin" each end of the wire by twisting the exposed strands tightly together and melting a small amount of solder into the wire.

Using the wire provided make the following connections to the circuit board:

( ) a 6 1/2 inch length to point "A".
( ) a 9 inch length to point "B".
( ) a 7 inch length to point "C".
( ) a 6 1/2 inch length to point "F".
( ) a 6 3/4 inch length to the point marked "+".
( ) a 7 1/2 inch length to the point marked with the ground symbol (⏚).
( ) a 6 3/4 inch length to either of the holes marked "a.c.".
( ) a 5 1/2 inch length to the remaining hole marked "a.c.".

( ) Prepare a 7 1/2 inch length of RG-174/U co-axial cable by stripping away 3/4 inch of of the black insulating sleeving and unbraiding the exposed shielding wire. Strip 1/4 inch of insulation from the inner conductor. Twist the braid together and "tin" the tip end of it. On the other end of this wire strip away 1/2 inch of the outer insulation and clip away the exposed shield flush with the outer insulation. Strip 1/4 inch of insulation from the end of the exposed inner conductor.

( ) Using the co-ax prepared in the previous step, insert the inner conductor of the end with the shield totally removed into the circuit board hole marked "D" and solder in place.

( ) In a similar manner as above prepare a second 8 3/4 inch length of co-ax.

( ) Insert the inner conductor of the end of the above cable which has the shield totally removed into the circuit board hole marked "E" and solder in place.

( ) Prepare a 9 inch piece of RG1174/U as follows:

On one end strip away 3/4 inch of outer insulation and un-braid the exposed shield. Twist the shield braid together and tin the tip end of it. Remove 1/4 inch of insulation from the inner conductor. At the other end of this cable remove 1-1/2 inches of the outer insulation and un-braid the exposed sheild. When the shield is completely un-braided back flush with the outer insulation cut the strands off to a length of 3/8 inch. Before twisting together the shield braid cut away approximately half of the strands flush with the outer insulation. Twist together the remaining strands and tin. (this step will make it easier to solder the shield into the circuit board hole provided for it.) Remove 1/4 inch of insulation from the inner conductor.

( ) Using the cable prepared above, solder the longer of the two exposed inner conductors to the circuit board hole marked "H".

( ) Solder the shortened and thinned shield from this same end of the cable to the circuit board hole marked "G".

THIS COMPLETES THE ASSEMBLY OF THE 1702 CIRCUIT BOARD. TEMPORARILY PUT THE CIRCUIT BOARD ASIDE AND PROCEED TO THE INSTALLATION AND PARTIAL WIRING OF THE FRONT PANEL CONTROLS.

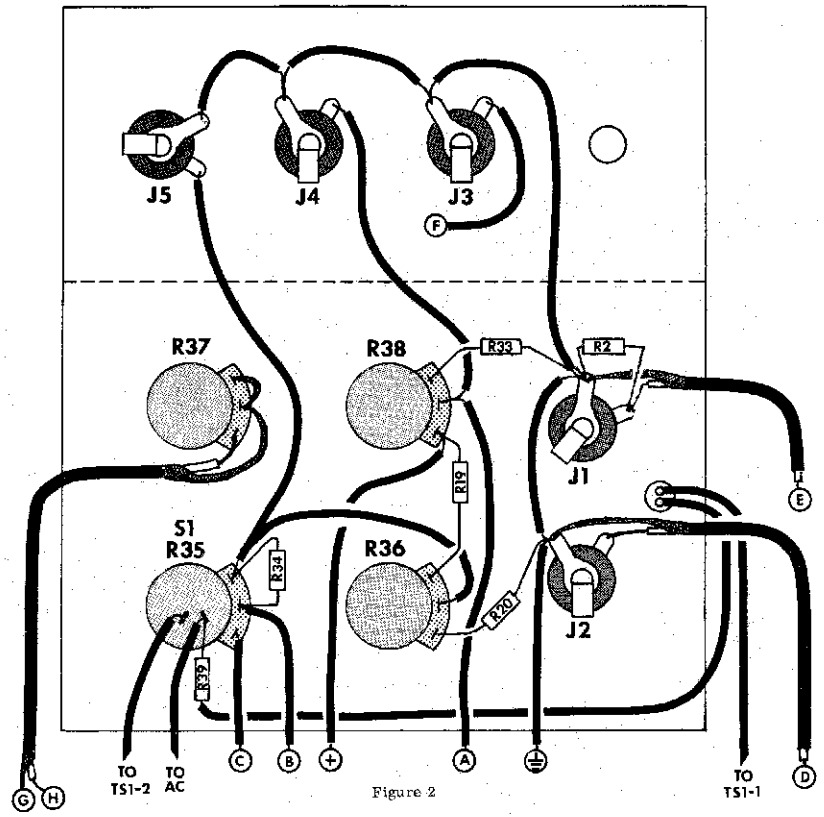


Figure 2

Figure 2 is a drawing of the inside of the top portion of the case. The dotted line in the drawing represents the fold line along the rear edge of the case. The front edge of the case is not shown.

The potentiometers that will be mounted in the following four steps can be identified as follows: The 5K linear taper pot is marked with the legend 5K Ω, The 75K reverse audio taper pot is marked with the legend 75K Ω, the 500 K audio taper pot w/switch is the only potentiometer with a switch on the back and the 500K linear taper pot is the remaining control.

( ) Mount the 500K potentiometer R38 in the position shown in figure 2. Use two 3/8 inch nuts, one behind the front panel as a spacer and the second on the front side of the panel to secure the pot. Adjust the rear nut so that none of the threaded shaft of the control is exposed when the front nut is tightened down. This will allow the control knob which will be mounted in a later step to seat as closely as possible to the panel. Orient as illustrated.

( ) In a similar manner mount the 5K linear potentiometer R36 in the position shown in fig. 2. Orient as illustrated.

( ) In a similar manner mount the 75K reverse audio taper potentiometer R37 in the location shown in figure 2. Orient as illustrated.

( ) In a similar manner mount the 500K audio taper potentiometer with S1 attached in the location shown in figure 2. Orient as illustrated.

( ) Using the nut provided mount open circuit phone jack J1 in the position shown in figure 2. Place the flat washer included with the jack between the nut and the front panel. Orient as illustrated.

( ) In a similar manner mount jack J2. Orient as illustrated.

( ) In a similar manner mount jack J3. Orient as illustrated.

( ) In a similar manner mount jack J4. Orient as illustrated.

( ) In a similar manner mount jack J5. Orient as illustrated.

( ) **Mount pilot lamp I1 by sliding the lens into the hole provided from the front panel. Push the lamp into the lens from the rear of the panel. Carefully slip the provided tinnerman nut over the lens making sure the leads of the lamp have been threaded through the hole in the tinnerman nut. Press the nut down against the panel.**

( ) Using a 3 inch piece of wire make the connection from the center lug of R36 to the top lug of R35. Do not solder the connection at R35.

( ) Using a 3 1/2 inch length of wire make the connection from the lower lug of J5 to the top lug of R35. Do not solder the connection at R35.

( ) Using a 3 1/2 inch length of wire make the connection from the right hand lug of J4 to the middle lug of R38. Do not solder the connection at R38.

( ) Using a 2 3/4 inch length of the bare wire provided make the common connection between the upper lug of J5 and left hand lugs of J4 and J3. Do not solder the connection at J3.

( ) Using a 4 inch length of insulated wire make the connection between the left hand lug of J3 and the upper lug of J1. Solder the two wires connected to J3 but do not solder the connection to J1.

( ) Connect the 330K resistor R34 (orange-orange-yellow) between the upper and middle lugs of R35. Solder the three connections at the upper lug. Do not solder the middle lug.

( ) Connect the 47K resistor R33 (yellow-violet-orange) between the upper lug of R38 and the upper lug of J1. Solder the connection at R38 but do not solder the connection at J1 at this time.

( ) Connect the 2200 ohm resistor R19 (red-red-red) between the upper lug of R36 and the lower lug of R38. Solder the connection at R36 but do not solder the connection at R38 at this time.

( ) Connect the 680 ohm resistor R20 (blue-grey-brown) between the lower lug of R36 (solder) and the left hand lug of J2 (do not solder).

( ) Using a 1 3/4 inch length of wire make the connection between the upper lug of J1 and the left hand lug of J2. Do not solder either connection.

( ) Cut both leads of the 270 ohm resistor R39 (red-violet-brown) off to a length of 1/2 inch. Fasten one end of this resistor to the right hand lug of switch S1 (part of R35). Do not solder.

( ) Wrap one of the leads of Pilot lamp I1 around the free lead of the above resistor and slide the connection close to the body of the resistor before soldering the two together. Clip off any excess wire.

This completes preliminary wiring of the case. Proceed to the mounting of the circuit board and transformer.

( ) Use four each 4-40 X 1/2 inch screws, 1/4 inch spacers and 4-40 nuts to mount the circuit board as shown in base plate drawing figure 3 .

( ) Use two each 4-40 X 1/4 inch screws and 4-40 nuts to mount the power transformer and two terminal strips as shown in figure3.

( ) Cut two 1 1/2 inch pieces of the tubing provided and slip one piece over each of the bare wires coming from T1. Attach one of these wires to each of the outside terminals of TS-1. Do not solder these connections.

( ) Connect one of each of the two black leads coming from T1 to each of the outside terminals on TS-2. Do not solder these connections.

( ) Connect the shorter of the two leads coming from the circuit board holes marked "a. c." to TS-1 terminal 1. Do not solder this connection.

PROCEED TO THE CONNECTIONS BETWEEN THE FRONT PANEL AND BASE-PLATE. (see figure 2)

( ) Cut both of the leads on the 47K resistor R2 (Yellow-violet-orange) off to a length of 1/2 inch. Connect one of each of these leads to each of the solder lugs on J1 as shown in figure 2. Do not solder either of these connections at this time.

( ) Connect the wire coming from circuit board point "A" to the center lug of R38. Solder the two wires connected to this point.

( ) Connect the wire coming from circuit board point "B" to the center lug of R35. Solder the two wires connected to this point.'

( ) Connect the wire coming from circuit board point "C" to the lower lug of R35. Solder this connection.

( ) Connect the wire coming from circuit board point "F" to the right hand lug of J3. Solder this connection.

( ) Connect the longer of the two wires coming from circuit board holes marked "a. c." to the right hand lug of switch S1. Solder the two wires at this point.

( ) Connect the wire coming from the circuit board hole marked "+" to the lower lug of R38. Solder the two wires at this point.

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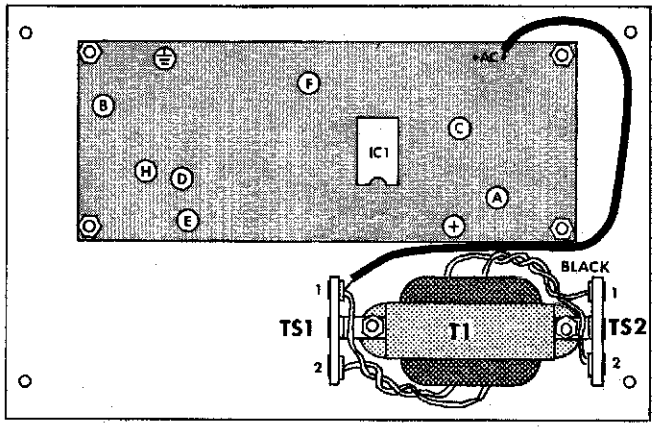


Figure 3

( ) Connect the wire coming from the circuit board hole marked with the ground symbol (⏚) to the left hand lug of J2. Do not solder.

( ) Connect the shield of the co-ax originating at circuit board point "D" to the left hand lug of J2. Solder the 4 wires at this point.

( ) Solder the inner conductor of the above co-ax to the right hand lug of J2.

( ) Connect the shield of the co-ax originating at circuit board point "E" to the upper lug of J1. Solder the 3 wires at this point.

( ) Solder the inner conductor of the above co-ax to the lower lug of J1.

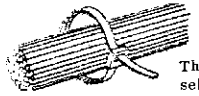
( ) Solder the inner conductor of the co-ax originating at circuit board points "G" and "H" to the lower lug of R37.

( ) Solder the shield of the above co-ax to both the center and upper lugs of R37.

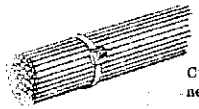
( ) Connect one end of a 8 3/4 inch length of wire to TS-1 terminal 2. Solder both wires at this point.

( ) Solder the other end of the above wire to the left hand lug of Power Switch S1.

At this point all the wires connecting the circuit board to the controls may be bundled together using the nylon wire tie provided (note that one lead of the pilot lamp I1 is still not connected and this lead will not be included in the bundle.) Pull all of the wires together and put one of the wire ties loosely in place. Push this tie as far down the bundle as it will go toward the circuit board and pull it tight. Put the second wire tie on the bundle and push it as close to the front panel as possible.



Thread strap through self-locking eye.



Cut off excess for neat bundle.

Re-orient the assembly so that the case top is standing on the edge closest to the input and output jacks.

( ) Connect the remaining wire from I1 to TS-1 terminal 1. Solder the 3 wires at this point.

( ) Seperate the two wires in the power cord to a point 3/4 inch from the end of the cord and strip 1/4 inch of insulation from each wire.

( ) Fold the black plastic strain relief over the line cord so that 2 inches of the end of the cord protrudes beyond the strain relief. Tightly close the strain relief with a pair of slip joint pliers and push it through the hole provided so that the stripped end of the cord protrudes into the case.

( ) Connect one of each of the wires of the line cord to each of the end terminals on TS-2. Solder two wires at each terminal (Note that the center lug of TS-2 is not used.)

THIS COMPLETES ELECTRICAL ASSEMBLY OF THE SYNTHESPIN MK-II.

FINAL ASSEMBLY

There are no internal adjustments to be made to the 1702K so after a final inspection for proper parts placement and proper soldering the unit may be closed up as follows:

Install the left and right hand wood ends in the case top as shown in figure **4** and fasten each in place with two #4 X 3/8 inch wood screws. If possible pre-drill the holes for the screws with a 1/16 inch drill or center punch starting holes for the screws.

Carefully fold the wires connecting the circuit board to the front panel controls into the top part of the case until the bottom panel is flush with the cut in the wood ends. Note that when the unit is completely assembled the transformer T1 is next to the rear edge of the case. Be extremely careful of any shorting between the front panel jacks and controls and circuit board components (there should not be any problems if the jacks and controls are oriented as shown in figure **2**.)

Fasten the bottom plate in place with four #4 X 3/8 inch screws and note that each of these screws passes through a rubber foot and secures the foot to the bottom of the unit. Once again center punch or pre-drill starting holes for the screws.

Rotate all four of the potentiometer control shafts fully counter-clockwise as viewed from the front of the case. Make sure that the switch that is part of R35 has clocked "off". Install the four control knobs by aligning the pointer of each knob with the 7 O'clock position of an imaginary clock face and firmly pushing the knob onto the shaft of the potentiometer. Once installed these knobs are difficult to remove so make sure that the potentiometer mounting hardware is fully tightened.

THIS COMPLETES ASSEMBLY OF THE 1702K SYNTHESPIN MK-II.

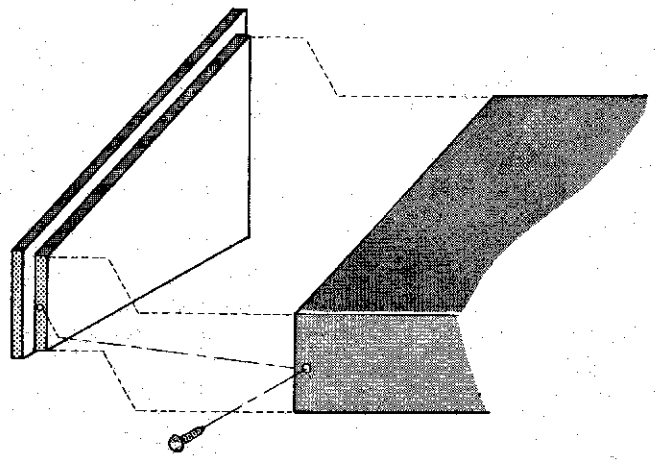


Figure 4

OPERATION

The Synthespin MK-II is designed for low level signal processing and peak to peak signal amplitudes should in general be kept below 0.5v. When the unit is being used to process the signals from electrified musical instruments such as guitar, accordian, saxophone, etc. there is no problem as the signal levels from these instruments are typically considerably below this limit. When using the 1702 with an electronic organ, however, the insertion point must be carefully chosen. An organ with an expression offers the easiest possible installation because the connections to this pedal are often made with RCA type phono connectors. It is a simple matter to unplug the input to the expression pedal and extend the lead by a sufficient amount to reach the location of the Synthespin unit. The extension cable must be terminated in a phone plug to match the jacks on the 1702 and a new jumper cable with phono plug on one end and phone plug on the other must be made up to connect the output of the 1702 to the input of the expression pedal. On organs that do not have expression pedals the 1702 must be inserted between the organ's pre-amplifier and power amplifier. This will require that small modifications be made inside the organ. If in doubt about proper insertion point or procedures consult a repairman qualified to service the organ you are using. If a service man is not available further information can be obtained by writing:

PAIA Electronics, Inc.
Customer Service
P.O. Box 14359
Oklahoma City, OK 73116

If at all possible please include a schematic diagram of the organ circuitry with your letter.

When using the 1702 with instruments that connect to an outboard amplifier installation is simply a matter of plugging the instrument into the 1702 "input" jack and using a jumper to connect the "output" to the amplifier input.

You may find that you do not need to advance the volume controls of the instrument and/or amplifier quite as far when using the 1702. This is normal and is caused by a slight power boost designed into the Synthespin.

Operation of the controls is as follows:

SPEED The apparent "speed" of the rotating effect is variable from one cycle every three seconds to 15 cycles per second using this control. Rotating the knob in a clockwise direction increases the speed

ACCENT This control allows the performer to select the presence of the Synthespin effect. As the control is rotated in a clockwise direction the effect becomes more pronounced. After some experimenting with the Synthespin you may notice that as the speed control is advanced the effect becomes more noticeable and a lower setting of the accent will produce an equivalent sound. This phenomena is purely subjective, there is no interaction between these controls.

SPAN This control permits the range of the instrument's frequencies that are affected by the 1702 to be restricted if desired. Normally this knob will be set fully clockwise but counter-clockwise rotation will narrow its operating range. When fully counter-clockwise the rotating effect disappears completely. The span control is also connected to the power switch. Rotating the control fully counter-clockwise past the "click" turns the power off.

CENTER With the Span control at its normally fully clockwise setting this control has no effect but as the Span control is turned back the center control has a greater effect on the portion of the instrument's tonal range that is modified by the 1702. When the "span" control is fully off the "center" control can be used to manually phase the signal.

Function of the rear panel jacks is as follows:

CANCEL Closing a switch plugged into the "cancel" jack turns off the effect. Best results are obtained using a push on - push off switch such as that in the PAIA foot switch.

With the cancel switch closed only the rotating effect is turned off, the unit should still pass the signal at the same relative level as when the effect was on.

SPEED The jack on the rear of the case marked "speed" accepts an external 0 to 9 volts D.C. control voltage and sets the speed of the effect proportional to the external voltage. The positive side of the supply goes to the tip of the 1/4-inch phone jack used to make the connection while the negative side goes to the sleeve contact of the jack.

When using a remote control voltage the "speed" control on the front panel must be turned fully counter-clockwise.

CENTER This jack allows remote foot pedal control of the function of the front panel "center" cont Like the "speed" jack, this input accepts a 0 to 9 volt control voltage. As the control voltage increas it has the effect of turning the front panel "center" knob in a clockwise direction. Polarity of the cont voltage at the phone jack is the same as for the auxiliary "speed" input so the same voltage source m be used for either of these functions.

When using an external control voltage source the front panel "center"control should be rotated fully counter-clockwise.

DESIGN ANALYSIS

At the heart of the Synthespin MK-II is a new integrated circuit package, the LM3900 quad Norton amplifier (IC-1). This device consists of four seperate differential input amplifier sections each of which is somewhat similar to the more familiar operational amplifier. Similar, but different in two subtle but very important respects.

First, unlike standard op-amps the Norton amplifier is designed as a current differencing rather than a voltage differencing device and secondly, the Norton amplifier is meant to work from a single voltage supply rather than the split-supply usually used for op-amps.

The fact that the inputs of the Norton amplifier are intended as current sinks is implied by the schematic symbol for the device shown in fig. 5. The arrowhead on the non-inverting (+) input denotes a current flow into this input and the circled arrowhead between the inverting (-) and non-inverting inputs is meant to imply that there is a constant current sink at this input which is controlled by the signal at the non-inverting input.

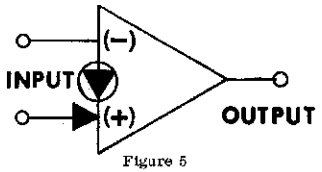


Figure 5

Because of this current differencing configuration the Norton amplifier is capable of performing some functions that are beyond the capabilities of a standard op-amp. Typical of this versatility is the voltage controlled oscillator composed of amplifiers IC-1C and IC-1D (Note that in schematic diagram figure 6 the four seperate sections of IC-1 have been labeled as IC-1A through IC-1D for clarity). Experimenters used to working with operational amplifiers will recognize the circuitry surrounding IC-1C as some sort of strange integrator. Assume for a moment that Q2 is off, with this condition there is a current flow into each of the inputs of the amplifier and the amplifier works to make these currents identical. If C12 were not present this would of course be impossible because the value of the resistor at the (+) input (R28) is almost half the value of R27 at the inverting input. With C12 in the picture however the situation is different and by constantly and linearly increasing the voltage at its output the amplifier can cause a current to flow through C12 that when added to the current through R27 causes the two input currents to be identical. The result is a linearly increasing voltage ramp at the output of IC-1C that would continue to rise almost to the supply voltage if it were not for the Schmitt trigger built around IC-1D.

For the moment disregard C11 and notice that there is positive feed-back from the output of IC-1D to the + input. As happened above, the amplifier compares the two input currents and acts in such a way as to try to make them equal. There is a constant current supply into the inverting input of this amplifier through R31 which is compared to the sum of the current supplied to the non-inverting input through R25 and R30. When the circuit is first turned on the output of IC-1D is for all practical purposes at ground as is the output of IC-1C so that the current into the non-inverting input of IC-1C is very low compared to the current flow through R31. Because of this the output of IC-1D is held low. As the integrator that was discussed above begins to ramp up, the current flow through R25 increases until it exceeds the current flow through R31. At this point IC-1D "switches" and the output changes from near ground to close to supply. The sum of the currents through R25 and R30 now far exceed the current flow through R31 so the amplifier stays in this high output state.

When the output of IC-1D goes high it turns on Q2. This transistor now acts as a current sink to prevent any current from being supplied through the non-inverting input of IC-1C. The only current now being supplied to the inputs of IC-1C is through the inverting input and the amplifier must act in such a way as to make this current equal to the current at the non-inverting input. The only way it can do this is to constantly and linearly decrease the voltage at its output so that a current flows through C12 that is equal and opposite to the current through R27. This of course causes the voltage at the output of IC-1C to decrease until at some point the current flow through R31 is greater than the combined current flow through R25 and R30 at which time IC-1D "switches" back to its low state thereby turning off Q2 and causing the integrator to begin "ramping up" again. The end result is a triangular wave at the output of IC-1C as it integrates up and down and a square wave at the output of IC-1D as it switches between its high and low states. The rate at which the voltage rises and falls at the output of IC-1C is a function of the voltage input at point A. "Speed" control R38 varies the voltage at this input point and therefore the frequency of this oscillator within the limits of .3 Hz. and 15 Hz., equivalent to over 5 octaves.

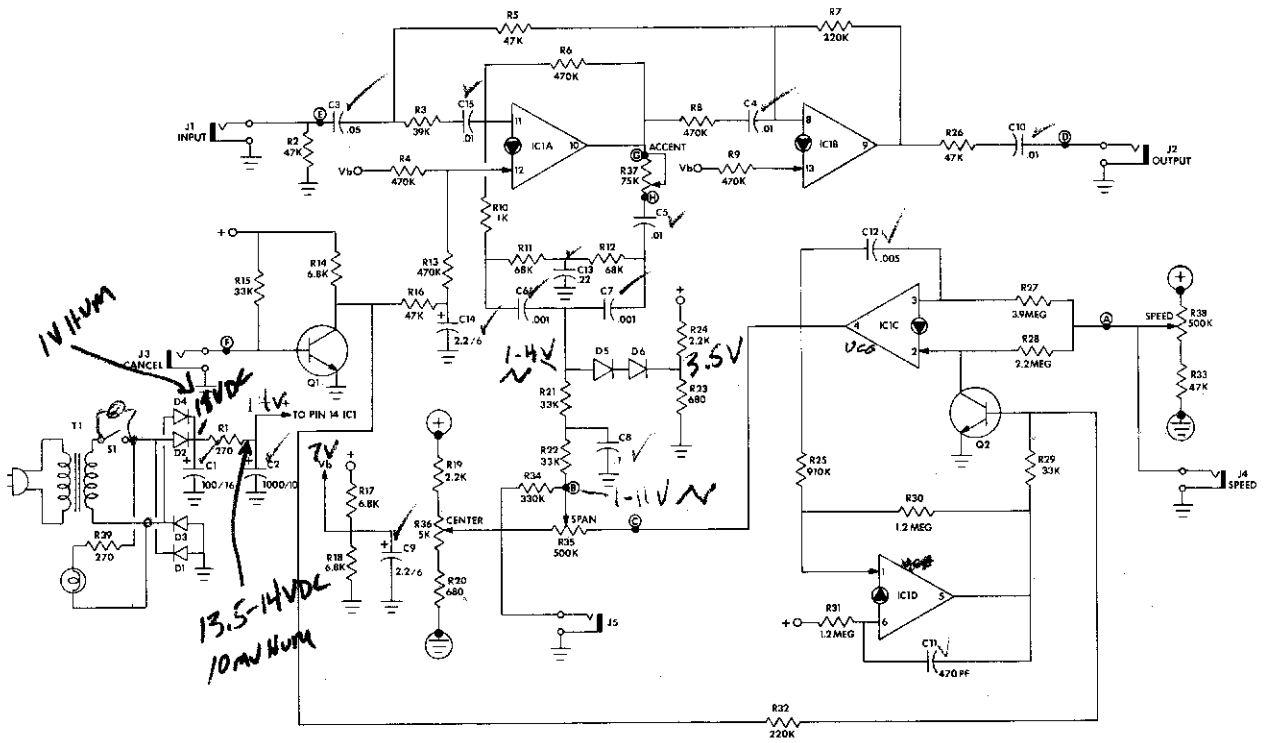
IC-1A is arranged as a voltage controlled band-pass filter. R11, R12, C6, C7, C13 and the equivalent impedance of diodes D5 and D6 form a notch filter which is in the negative feedback loop of this amplifier stage. Frequencies outside the notch of this filter pass through the feed-back loop with little attenuation and tend to cancel the original input signal of that frequency at the amplifier's input. Signals that are attenuated by the notch are not fed back to the input and therefore do not cancel but are allowed to pass through the amplifier without attenuation. The

"Q" of the active filter is controlled by the attenuator R37 in the feed-back loop and the time constants of the notch filter section are selected for maximum variability and flattest response over a roughly two and a half octave band from 350 Hz. to 1.2 kHz. As the voltage across D5 and D6 increases, its equivalent impedance decreases causing the center frequency of the notch filter to shift up.

There are three biasing and control voltage sources for diodes D5 and D6. The first, R23 and R24 places the cathode of D6 at about .1v. above ground.. The second is a biasing source consisting of R19, R20 and the potentiometer R36, this combination is capable of voltages between 1v. and 8v. at the wiper of R36. The third supply is the triangle output of the voltage controlled oscillator which appears across the potentiometer R35. The wiper of R35 picks off a voltage that is a combination of the oscillator output and the voltage at the wiper of R36. When the wiper of R35 is at the end of the pot closest to point "C" the voltage from R36 is isolated by the parallel combination of R35 and R34 and therefore has little effect on the voltage at point "B". But as the wiper of R35 is moved away from point "C" the contribution of the oscillator becomes progressively less while the influence of the voltage at the wiper of R36 becomes progressively greater. This arrangement allows the voltage at point "B" to be anywhere between 1 and 8v. with any percentage of that voltage coming from either the oscillator or the constant supply. The voltage at point "B" is applied to the anode of diode D5 through the low pass filter section composed of R21, R22 and C8 which convert the triangular output of the control oscillator to roughly a sine wave by filtering out the higher order harmonic content.

The transistor Q1 provides a means of turning the active band-pass filter section IC-1A on and off. As long as there is no connection between the base of Q1 and ground it is held on by R15. With Q1's collector at ground the total biasing current to IC-1A's non-inverting input must come from R4. When the base of Q1 is grounded - as it would be by closing a switch plugged into J3 - the voltage at the collector jumps to near supply causing C13 to charge through R16. This in turn causes an increased current flow into the non-inverting input through R13 and will eventually result in the saturation of IC-1A. With IC-1A saturated and therefore not functioning, the only element in the signal path is IC-1B which is arranged for a slight gain into a moderate load at the output jack J2.

Part of the original musical input to the circuitry is coupled directly to the amplifier section IC-1B where it is summed with the output of the band-pass filter. Because of the gains of the band-pass filter and its natural 180 degree phase shift the final output is actually a partial cancellation of the signal passed through the band-pass filter and a distortion of phase relationships of frequencies just outside this pass-band. As the pass band sweeps back and forth under the influence of the oscillator the effect is roughly the same as the frequency shifts generated by a rotating speaker.



IC1	LM3900, CA3401
Q1, Q2	2N5129 (TO-62 case style), TO-92 OK, but mount 'backwards'
T1	12vac 100mA