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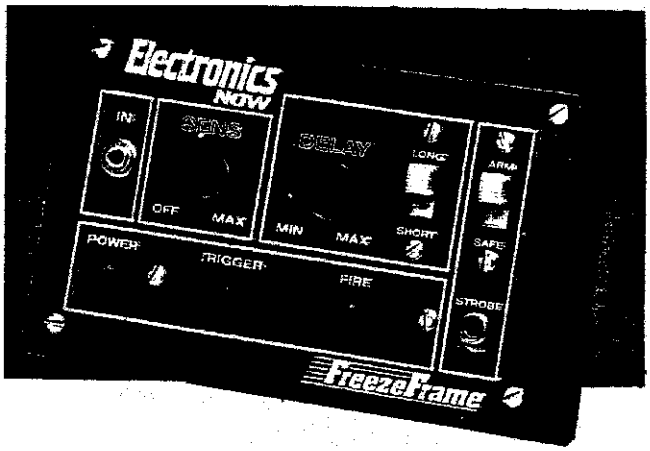
FreezeFrame

Model 9208
ASSEMBLY/USING MANUAL



So much of life is a blur, when you can slow it down and savor it, you discover the most interesting things.

The FREEZE FRAME strobe trigger lets you use photographic techniques that substitute a strobe flash for high shutter speeds. You can produce stop-action shots either for serious scientific purposes or just because them make such interesting pictures. This inexpensive, easily built unit has been designed to use interchangeable sensors, so that anything that pops, snaps, flashes, reflects or blocks light can trigger your camera's strobe.

ASSEMBLING THE FREEZE FRAME

Before beginning assembly, go through the manual. Look at the drawings. Feel the parts. We know that you're anxious to plunge right in, but take a few deep breaths first.

Notice that each step in the manual is marked with a check-off box like this:

() R27 100 ohm brown-black-brown

Checking off each step as your perform it may seem silly and ritualistic, but it greatly decreases the chance of your omitting a step and also provides some gratification and reward as each step is completed.

Numbered illustrations are printed in the Illustrations Supplement in the center of this manual. This page may be removed for easy reference during assembly.

THE CIRCUIT BOARD

The **FREEZE FRAME** is built on a single-sided circuit board. Before beginning assembly, clean oxidation from the copper side of the circuit board using scouring cleanser and water. The copper must be bright and shiny before beginning assembly.

TOOLS

You'll need a minimum of tools to assemble the kit - a small pair of diagonal wire cutters and pliers, screwdriver, sharp knife, ruler, soldering iron and solder.

Modern electronic components are small (in case you hadn't noticed) and values marked on the part are often difficult to see. Another handy tool for your bench will be a good magnifying glass. Also use the magnifier to examine each solder joint as it is made to make sure that it doesn't have any of the problems described in the SOLDERING section which follows.

SOLDERING

Select a soldering iron with a small tip and a power rating not more than 35 watts. Soldering *guns* are completely unacceptable for assembling

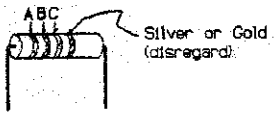
solid state equipment because the large magnetic field they generate can damage components.

Use only rosin core solder (acid core solder is for plumbing, not electronics work). A proper solder joint has just enough solder to cover the soldering pad and about 1/16-inch of 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 bead. This situation can be cured by reheating 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. Accidental bridges can be cleaned off by holding the board upside down and flowing the excess solder off onto a clean, hot soldering iron.

Use care when mounting all components. Never force a component into place.

RESISTORS

Solder each of the resistors in place following the parts placement designators printed on the circuit board and the assembly drawing Fig 1. Note that resistors are non-polarized and may be mounted with either of their two leads in either of the holes provided. Before mounting each resistor, bend its leads so that they are at a right angle to the body of the part. Put the lead through the holes and then push the resistor firmly into place. Cinch the resistor in place prior to soldering by bending the leads on the solder side of the board out to an angle of about 45 degrees. Solder both ends of each resistor in place as you install it. Clip each lead flush with the solder joint as the joint is made.



DESIGNATION	VALUE	COLOR CODE A-B-C
() R1	1000 ohms	brown-black-red
() R2	5600 ohms	green-blue-red
() R3	10k	brown-black-orange
() R4	10k	brown-black-orange
() R5	680k	blue-grey-yellow
() R6	10k	brown-black-orange
() R7	10k	brown-black-orange
() R9	330k	orange-orange-yellow
() R10	10k	brown-black-orange
() R11	100k	brown-black-yellow
() R13	680	blue-grey-brown
() R14	1 megohm	brown-black-green
() R15	10k	brown-black-orange
() R16	10k	brown-black-orange
() R17	2200 ohms	red-red-red
() R18	1000 ohms	brown-black-red
() R19	10k	brown-black-orange
() R20	1.5 megohm	brown-green-green
() R21	470 ohm	yellow-violet-brown
() R22	330 ohm	orange-orange-brown
() R23	33k	orange-orange-orange
() R24	1500 ohm	brown-green-red

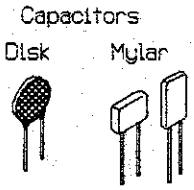
CERAMIC DISK CAPACITORS

Some of the capacitors used in the **FREEZE FRAME** are non-polarized ceramic disks, either lead can go in either of the holes on the circuit board. Leads

are already parallel to one another but still may need to be bent slightly to match the spacing of the circuit board holes. Like the resistors, push the leads through the holes in the board and push the part against the circuit board as far as it wants to go. Don't force it, it's OK if it sits a little off the board.

Capacitors are rarely marked with something so simple as their values these days, instead component manufacturers prefer obscure codes. For example, the .01 mFd. capacitors may be marked "1M103K7". It is the "103" part of this that tells you that its value is .01 mFd, but the reasoning behind this is beyond the discussion we can have here. Since there are one each .05uF, two each .005uF and three each .01uF used in the **FREEZE FRAME** there is not much opportunity for confusion.

DESIGNATION	VALUE/TYPE	MARKING
() C1	.005 uF	502
() C4	.01 uF	103
() C6	.01 uF	103
() C7	.05 uF	503
() C8	.01 uF	103
() C9	.005 uF	502



Two of the capacitors are mylar types

() C2	.1 uF	104
() C5	.1 uF	104

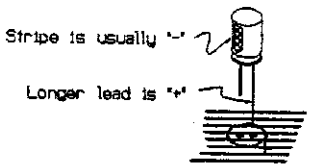
ELECTROLYTIC CAPACITORS

The remaining capacitors are electrolytic types. Unlike the previous components, electrolytic capacitors are polarized and the leads are not interchangeable. Leads are marked "+" and/or "-" and the "+" lead must go through the "+" hole in the circuit board. Frequently the positive lead of the capacitor is significantly longer than the negative lead (see illustration on the following page).

Usually the Negative lead of the capacitor is marked rather than the positive. It naturally goes through the hole not marked "+".

Capacitors supplied with specific kits may have a higher Voltage (v) rating than that specified for the part.

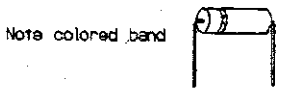
DESIGNATION	VALUE
() C3	2.2 uF / 10v.
() C10	1 uF / 10v.



DIODES

Diodes are polarized and must be installed so that the lead on the banded end of the part corresponds to the banded end of the designator on the circuit board. Bend the leads so they are at right angles to the body of the part and insert them through the holes provided in the circuit board.

Diodes are also somewhat heat sensitive so the soldering operation should be done as quickly as possible.



DESIGNATION	TYPE
listed below:	1N4148 (may be 1N914)

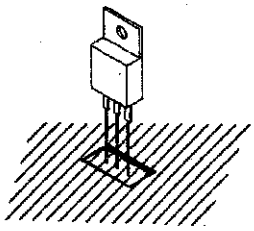
() D1 () D3 () D5

JUMPERS

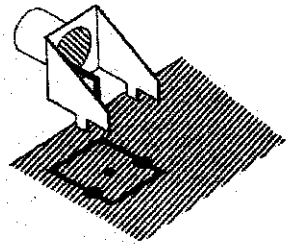
() Using appropriate lengths of leads clipped from resistors and capacitors, form and install the 3 circuit board jumpers which are marked with solid bold lines on the circuit board. Be careful that the jumpers do not touch any nearby component leads.

SCR

() Install the T106 Silicon Controlled Rectifier on the circuit board at the location marked Q1. Notice that the SCR is polarized and must be mounted so that its tab corresponds to the tab marking on the circuit board graphics. Solder all three leads and clip any excess off flush with the solder joint.



PHONO JACK



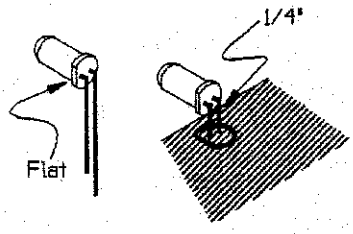
() Install the pc mount phono jack on the circuit board at the location marked J2. Solder both tabs and the center lead.

LEDs

Prepare the three red LEDs for installation by bending their leads perpendicular to the body of the part as shown in the illustration below. Note that LEDs are polarized and that when viewed from the back with the leads down, the polarization flat must be to the left, as shown.

Push the two leads through the holes provided in the circuit board and space the LED above the board so that 1/4" of the lead is on the component side of the board. If you look carefully at the LEDs you will notice that there is a "shoulder" on the leads where they meet the part. 1/4" is about the length of this shoulder. Solder both leads and check the spacing from the board to the LED before trimming the leads of flush with the solder joint.

DESIGNATION	PART
() D2	red LED
() D4	red LED
() D6	red LED



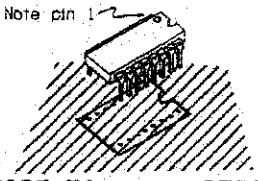
INTEGRATED CIRCUITS

Of all the parts, the ICs are the most easily damaged and should be treated with some respect. In particular, they may be damaged by discharges of static electricity. Modern ICs are not nearly as sensitive to this kind of damage as were earlier versions, but it is still good practice to handle these parts as little as possible. Also good practice: don't wear nylon during assembly. Don't shuffle around on the carpet immediately before assembly (or if you do, touch a lamp or something to make sure you're discharged.) Don't be intimidated, it's rare for parts to be damaged this way.

ICs are polarized in one or both of two ways; a dot formed into the case of the IC corresponding to pin 1 or a semi-circular notch that indicates the end of the package with pin 1. Circuit board graphics

indicate orientation of the packages using the notch; also notice that the circuit trace for pin 1 has a square pad and the rest are rounded.

The pins of the ICs may be splayed somewhat and not match up exactly with the holes in the circuit board. Carefully re-form the leads if necessary so that they are at right angles to the part. Solder each IC in place as it is installed by initially soldering two pins in diagonal corners of the pattern. Make sure that the part is seated firmly against the pc board by pressing it down while re-melting the solder joint at first one corner, then the other. Finally, solder the remaining connections.

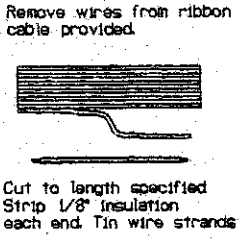


DESIGNATOR	PART NO.	DESCRIPTION
() IC1	LM324	Quad Op-Amp
() IC2	555	Timer

"FLYING" WIRES
(i.e. those that go from circuit board to case mounted parts.)

In the following steps, wires will be soldered to the **FREEZE FRAME** board which in later steps will be connected to the front panel controls. Individual wires are stripped from the length of ribbon cable supplied.

At each step, cut the wire to the specified length and strip 1/8" of insulation from each end. Twist the exposed wire strands together and "tin" them by melting a small amount of solder into the strands. This will make soldering easier when the wires are installed and prevents fraying of the wire strands when they are pushed through the holes.



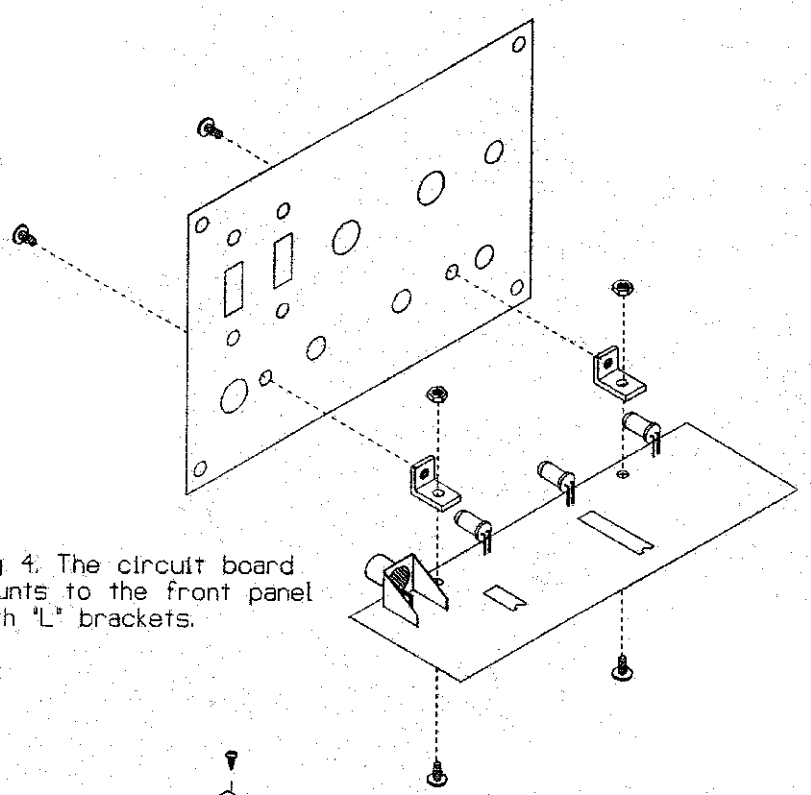


Fig 4. The circuit board mounts to the front panel with "L" brackets.

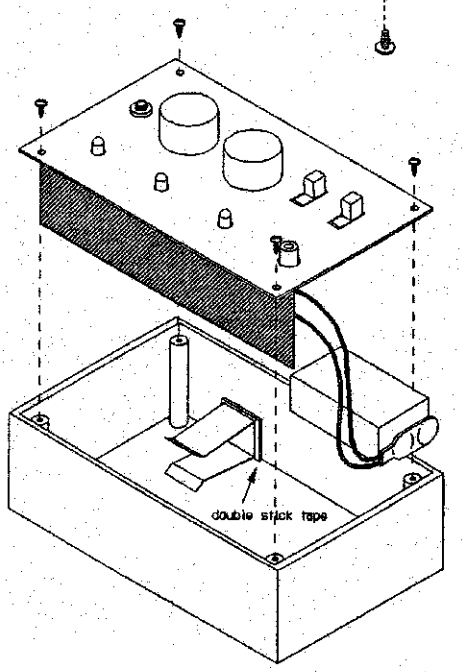


Fig 5. The battery holder attaches to the case with double-stick tape. The front panel is secured with (4) 4X3/8 self tap screws.

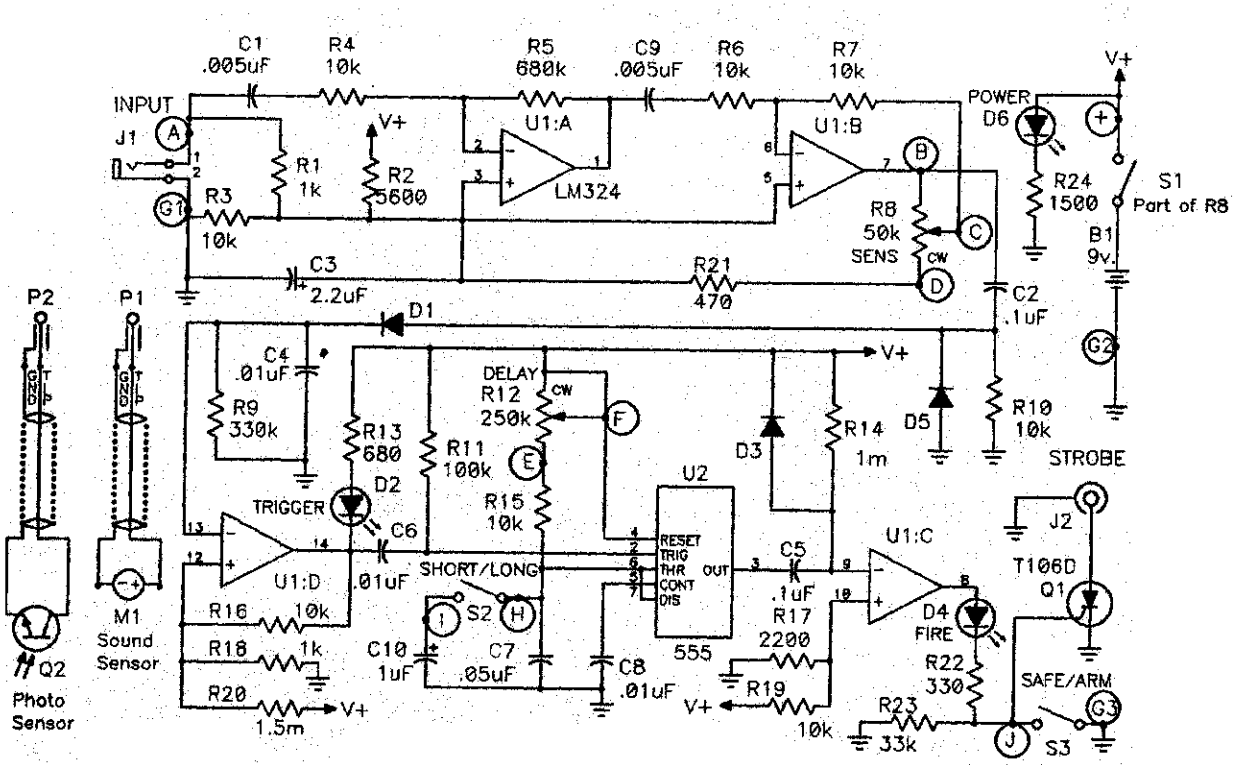


Fig 6. FREEZE FRAME schematic.

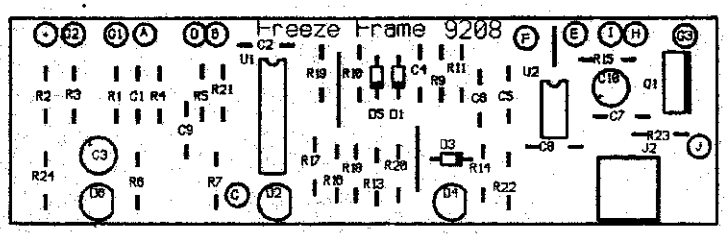


Fig 1a. Parts placement. Components mount on the circuit board at the locations shown above.

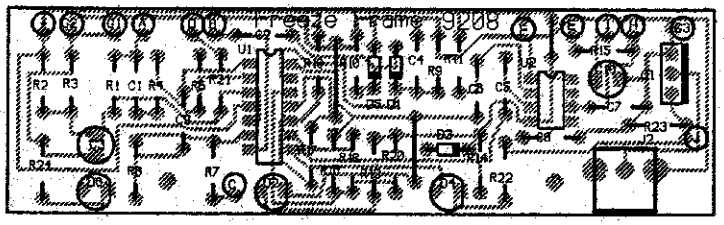


Fig 1b. This parts placement drawing with phantom circuit board conductors may be useful if you have to trace out the circuit.

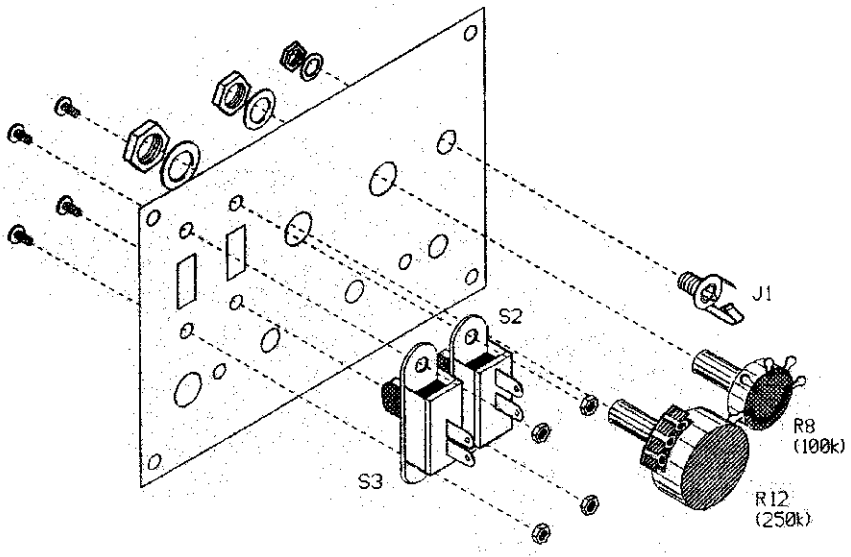


Fig 2. Mount the Switches, Potentiometers and Jacks in the locations shown. Before fully tightening the nuts orient the solder lugs as shown in Fig 3.

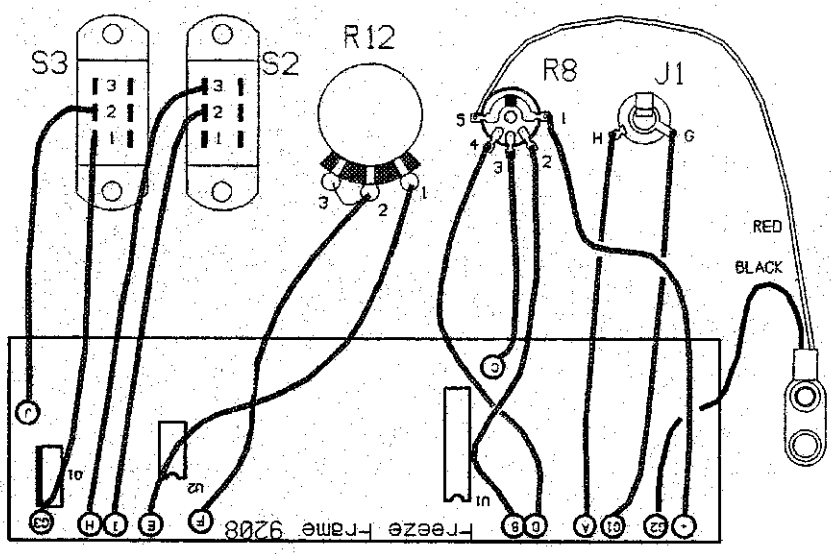


Fig 3. Wiring from circuit board to controls.

Solder each connection as it is made and clip any excess wire from the solder side of the board.

PC POINT	WIRE LENGTH
() "A"	2-3/4"
() "B"	2-1/2"
() "C"	1-3/8"
() "D"	2-1/2"
() "E"	3"
() "F"	2-3/4"
() "G1"	2-3/4"
() "G3"	3"
() "H"	3"
() "I"	3"
() "J"	2-1/2"
() "+"	3"

() Solder the tinned end of the black lead of the battery snap to circuit board point "G2".

Now we will put the circuit board aside temporarily and mount the jacks and controls on the front panel.

MOUNTING CONTROLS

We will now use the hardware provided to mount the controls and input jack to the front panel as shown in Fig 2. Notice that this drawing shows a rear view of the front panel.

-*-

The value of R8 was 50k ohms in the authors prototype and this value was printed in **Electronics Now.** *The change in value to 100k ohms was made in consideration of standard inventory parts and has no effect on the performance of the unit.*

-*-

() Using the nuts and flat washers provided, mount potentiometers R8 and R12 and miniature phone jack J1 to the front panel. Orient these parts so that their lugs are pointing down as shown in Fig 3 before fully tightening the nuts which secure the parts.

() Using the (4) 4-40 X 1/4" machine screws and (4) #4 nuts mount the slide switches S2 and S3. If the switches provided have only two solder lugs apiece as those shown in Fig 2, orient them as shown. If the switches have 3 or 6 lugs, orientation is not important.

() Using a piece of excess lead clipped from a resistor or capacitor, connect together lugs 2 and 3 of R12. Solder the connection at lug 3 only. In a later step another wire will be added to lug 2 and the connection soldered at that time.

MOUNTING THE CIRCUIT BOARD

It is now time to mount the circuit board to the rear of the front panel as shown in Fig 4.

() Using the 2 "L" brackets, 2 #4 nuts and 4 4-40 X 1/4" machine screws provided, attach the partially wired circuit board to the rear of the panel. Notice that the "L" brackets have both threaded and un-threaded holes. Use the unthreaded holes and machine nuts to attach the bracket to the circuit board and the threaded holes to attach the bracket to the panel. Fully tighten this hardware.

We can now finish the wiring of the **FREEZE FRAME** by connecting the wires previously soldered to the circuit board to the pots and jacks as detailed in Fig 3.

This convention will be followed in these steps: Do not solder a connection to a lug until told to do so with an instruction such as (S-2) which means that at that point there will be two wires on the lug in question. If there are not the number of wires specified at the lug when you get ready to solder, recheck to see what has gone wrong.

FROM PC	TO
() "A"	J1-H (S-1)
() "B"	R8-2 (S-1)
() "C"	R8-3 (S-1)
() "D"	R8-4 (S-1)
() "E"	R12-1 (S-1)
() "F"	R12-2 (S-2)
() "G1"	J1-G (S-1)
() "G3"	S3-1 (S-1)
() "H"	S2-3 (S-1)
() "I"	S2-2 (S-1)
() "J"	S3-2 (S-1)
() "+"	R8-1 (S-1)

() Solder the tinned end of the red lead of the battery snap to lug #5 of R8.

We're finished with electronic assembly of the **FREEZE FRAME** controller. Now we can temporarily put that part aside and make the InfraRed and Sound sensor assemblies.

SHIELDED CABLE

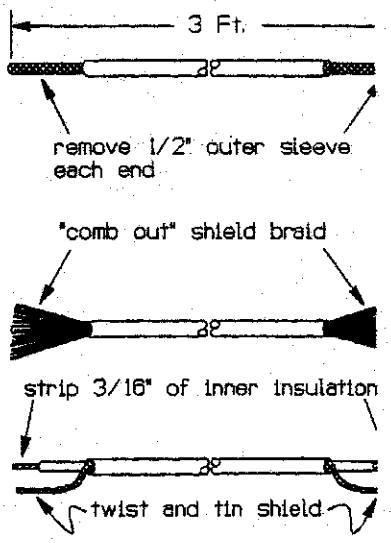
RG-174/U coaxial cable will be used to make shielded connections between the sensors and input jack. Cut the 6 ft. length of co-ax supplied in half to yield two 3 ft. sections. Prepare both ends of both pieces in the same way:

Strip 1/2" of the outer insulation at each end to expose the braided shield beneath it.

Unbraid the shield by "combing" it with the dull edge of a knife blade or a ball-point pen. This will expose the separately insulated inner conductor.

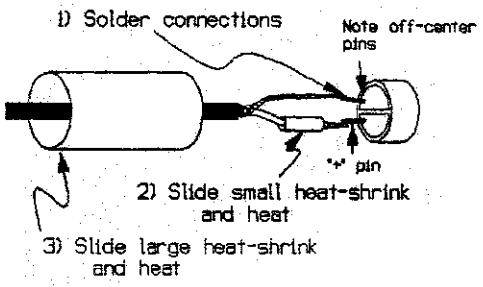
On each end pull the strands of shield to one side and twist them together. Tin these pigtails by melting a small amount of solder into them.

Strip about 3/16" of the insulation from the inner conductor and twist and tin the exposed strands.



Locate the three 1" pieces of heat shrink tubing supplied. Note that the three sizes are .5" diameter (the largest), .25" diameter (medium) and .09" diameter (the smallest). Cut the smallest piece (.09 dia) in half to yield two 1/2" long pieces.

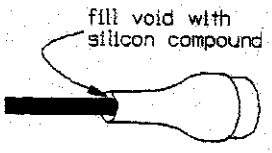
() Slide one of the smallest diameter sections of heat shrink tubing over the center conductor of one end of one of the sections of co-ax. It will be a little long, so trim its length so that it just covers the inner conductor. Solder this same conductor to the "+" pin of the electret microphone (see illustration on the following page).



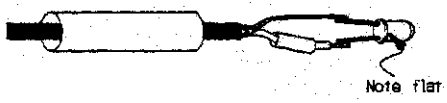
() Slide the heat-shrink tubing over the solder joint and heat the tubing to shrink it. If you don't have a heat-shrink gun designed for this purpose (who does?) the flame from a cigarette lighter will work well. Be quick when heat-shrinking; don't hold the flame in place for more than second or you may fry the mic or melt the insulation on the center conductor of the co-ax.

() Solder the shield braid of the co-ax to the other pin of the electret microphone.

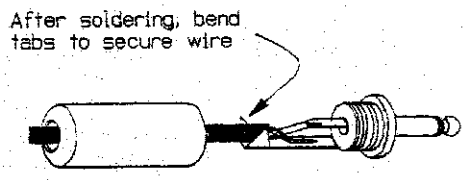
() Slide the 1" long piece of .5" dia (largest) heat-shrink over the connections and the microphone so that all of the connections and about half of the mic is covered. Shrink in place.



() In a similar manner to the above steps, assemble the InfraRed sensor. Trim the IR phototransistor's leads to a length of 3/16". The InfraRed phototransistor used for Q2 is polarized and the correct leads must be connected to the co-ax shield and center conductor for the part to function. Notice the polarizing flat on the body of the part.



() Complete the sensor assemblies by soldering the miniature phone plugs supplied to the free ends of the co-ax. Make sure you slide the cover over the cable before soldering any connections. Be careful that the center conductor of the co-ax connects to the "tip" of the phone plug and the shield connects to the "ring". Bend the strain relief tabs over the wire and screw the cover in place to complete assembly.



THIS COMPLETES THE ELECTRONIC ASSEMBLY OF THE **FREEZE FRAME.** Before connecting a battery and testing the unit, take a break then come back and check your work completely. Make sure that all polarized parts are mounted properly, that the leads from the front panel controls and jacks are correct and take a good look at all your soldering.

TESTING IT

Don't plug in a sensor yet, our initial tests won't need one. Snap a fresh 9v battery into the battery connector and turn the unit on by rotating the sensitivity control clockwise beyond the detent. The power LED should light. If not, check for dead battery, short circuits, etc.

Set the SENS and DELAY controls to about the mid-point of their rotation and SHORT/LONG switch to SHORT. Using a wire jumper or clip lead, short together the hot (tip) and ground lugs of the input jack J1 together. If everything's working properly you should see both the TRIGGER and FIRE LED's flash briefly and apparently simultaneously. If neither LED flashes it may indicate problems in the sensor processing amp, so check the circuitry associated with IC1:a and b, the polarity and assembly integrity around diodes D1 and D5 and the circuitry associated with IC1:d. If only the TRIGGER LED lights, but not the FIRE, it may indicate problems in the timer circuitry associated with IC2 or the final comparator IC1:c.

Switch the SHORT/LONG switch to LONG and once again

short the input. Now you should be able to see a discernible time delay between the flash from the TRIGGER and FIRE LED. If you don't see an obvious delay it may mean problems with the timer or with switch S2 and cap C10.

Now plug in a sensor, let's start with the MIC. With the SENS control set to about mid-range, a finger snap within a foot of the MIC should cause the TRIGGER and FIRE LED's to both light. At MAX sensitivity a finger-snap within several yards should trigger the unit and at minimum sensitivity you will have to be within a inch or so from the mic. If there are no obvious differences in the sensitivity of the unit as the SENS control is rotate over its range of control, check the wiring around the pot R8. If there's no response with the MIC as an input, check the wiring of the phone plug and co-ax of the microphone itself as well as the polarity of the microphone.

Plug in the IR sensor and point it at an incandescent lamp (florescent or Krypton lights may not have sufficient infra-red energy to be detected by the phototransistor) and set the SENS control to mid-range. Passing your finger in front of the phototransistor should cause the TRIGGER and FIRE LED's to flash briefly. Striking a match or lighting a cigarette lighter in front of the sensor should trigger the unit. If there are problems here, check the wiring of the sensor, in particular the polarity of the phototransistor.

You will need to modify a flash extension cord by replacing its normal camera-end connector with an RCA plug. There are a couple of things to be aware of here; first make sure of the polarity of the voltage appearing on the flash cord, the positive side must go to Anode of SCR (tip of RCA jack) and the negative to ground. Also, the voltage on these leads varies widely; on some strobes it may be only a couple of volts, on others over may be over 200 volts. There is fairly low energy here in either case so we're not talking about a lethal situation, but the higher voltage will definitely "yipe" you if you touch it. If you don't want to purchase an extension cord to be dedicated to the Freeze Frame, you may be able to cut you existing cord and patch the two ends together with in-line plug and jack pair. Make sure the male connector is on the end of the cord connected to the flash.

Finally, mate the RCA plug on the end of your modified flash extension cord with the STROBE jack

and turn the strobe on. Set the ARM/SAFE switch to ARM and trigger the Freeze Frame. The strobe should flash when the FIRE LED flashes. If not, check the strobe first, make sure its battery is good by firing it with its own test switch and then check the modifications you've made to the flash's extension cord and make sure that the positive voltage from the strobe connects to the tip of the RCA plug. If still no results, check the SCR.

FINAL ASSEMBLY

When everything's working, you can install the FREEZE FRAME in its case.

() Fasten the aluminum battery holder to the rear edged of the plastic case using the double-stick foam tape supplied as shown in fig 5.

() Clip the battery into the holder and complete the assembly of the device by securing the front panel to the case using the (4) 4 X 3/8" self tapping screws.

() Install the knobs. Rotate the shaft of the control on which the knob will be placed fully CCW and align the pointer with the marking at the extreme counter-clockwise end of the dial marking. Push the knob on only slightly and rotate it back and forth to see how well it's range of rotation is balance with the panel graphic. Reorient if not satisfied and then push the knob firmly in place on the shaft.

HOW IT WORKS

The complete schematic for the Freeze Frame is shown in Fig 6. Either of the sensors, the phototransistor Q2 or the electret microphone M1, acts like a variable current sink in series with R1. As light or sound levels change and more or less current sinks into the sensor, a voltage develops across R1.

The processing amp for the sensors is built around two stages (IC1:a and b) from an LM324 quad operational amplifier. The amplifier is AC coupled so that only *changes* in the triggering signal are detected. The values of coupling capacitor between stages are intentionally made small so that only changes with higher frequency components (above about 5kHz.) are allowed to pass through the amplifier. In the case of the microphone this

means that snaps and pops will be more likely to trigger the unit than other ambient noise such as speech, fans, etc.

Capacitor C2 couples the output of the processing amplifier to the rectifier and peak detector consisting of D1, D5, R9, R10 and C4. The ground reference DC voltage which appears across R9 is approximately the same as the peak-to-peak voltage at the output of the amplifier.

This voltage is applied to a threshold detector which is a Schmitt trigger built around IC1:d with R16, R18 and R20 setting the trigger level at a couple of volts and hysteresis of about a volt. LED D2, on the output of this amplifier indicates when a stimulus has exceeded the threshold.

When the output of the threshold detector goes low, it is coupled by C6 to the timer and triggers it. The amount of delay produced by the timer is set by the DELAY control R12 and the capacitors C7. S2 is provided to switch in the added capacitor C10 when longer delays are needed.

The output of the timer is coupled by C5 to the final amplifier stage in IC1 which is wired simply as a comparator. At the end of the time-out, IC2's output goes low and this signal is inverted by IC1:c to a positive transition which turns on the SCR. LED D4 is the current path to the SCR's gate and provides an indication that the triggering signal has happened. As a convenience during set-up, switch S3 can be closed to grounds the gate of the SCR and prevents it from firing.