Canon AE-1

National Camera
Technical Training Division
2000 West Union Ave., Dept. LBA
Englewood CO 80110 USA

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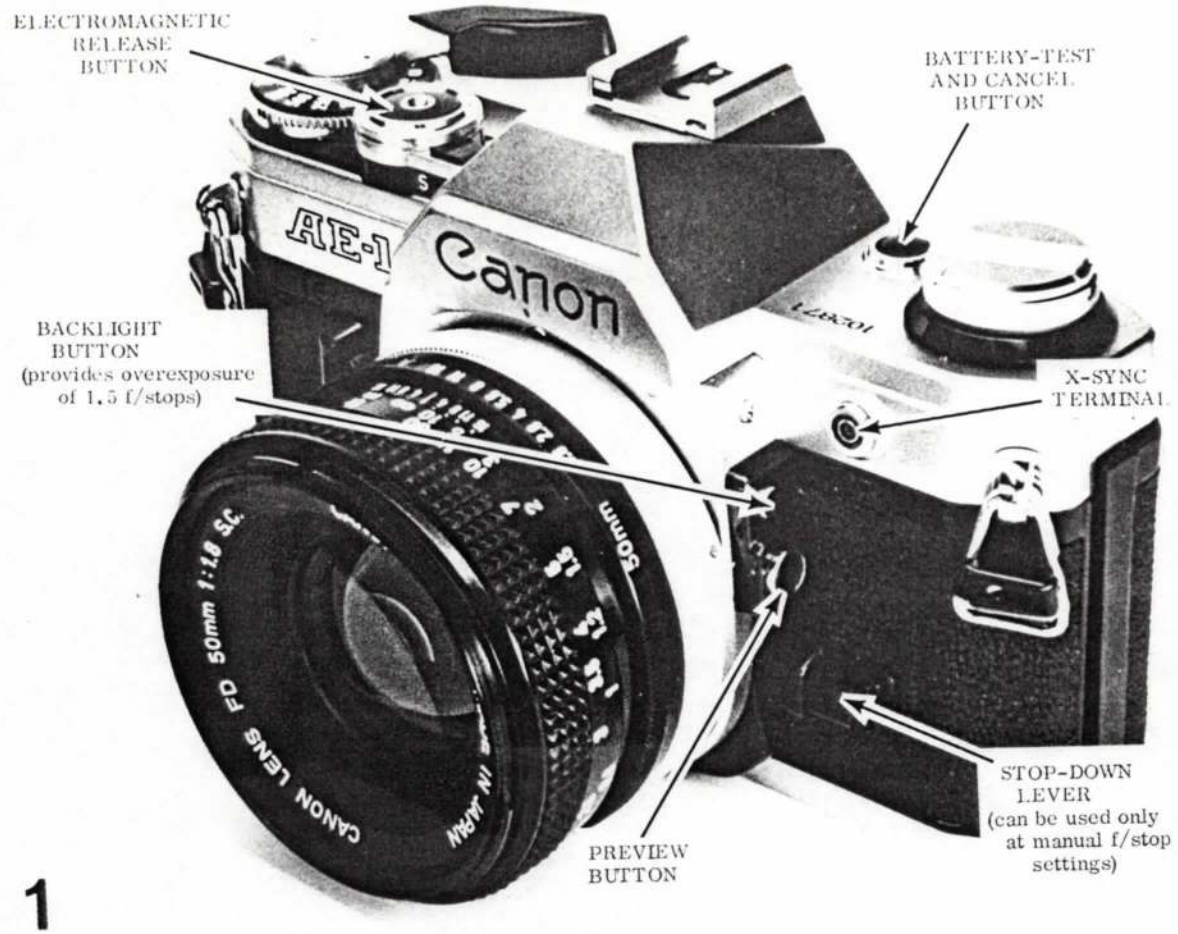
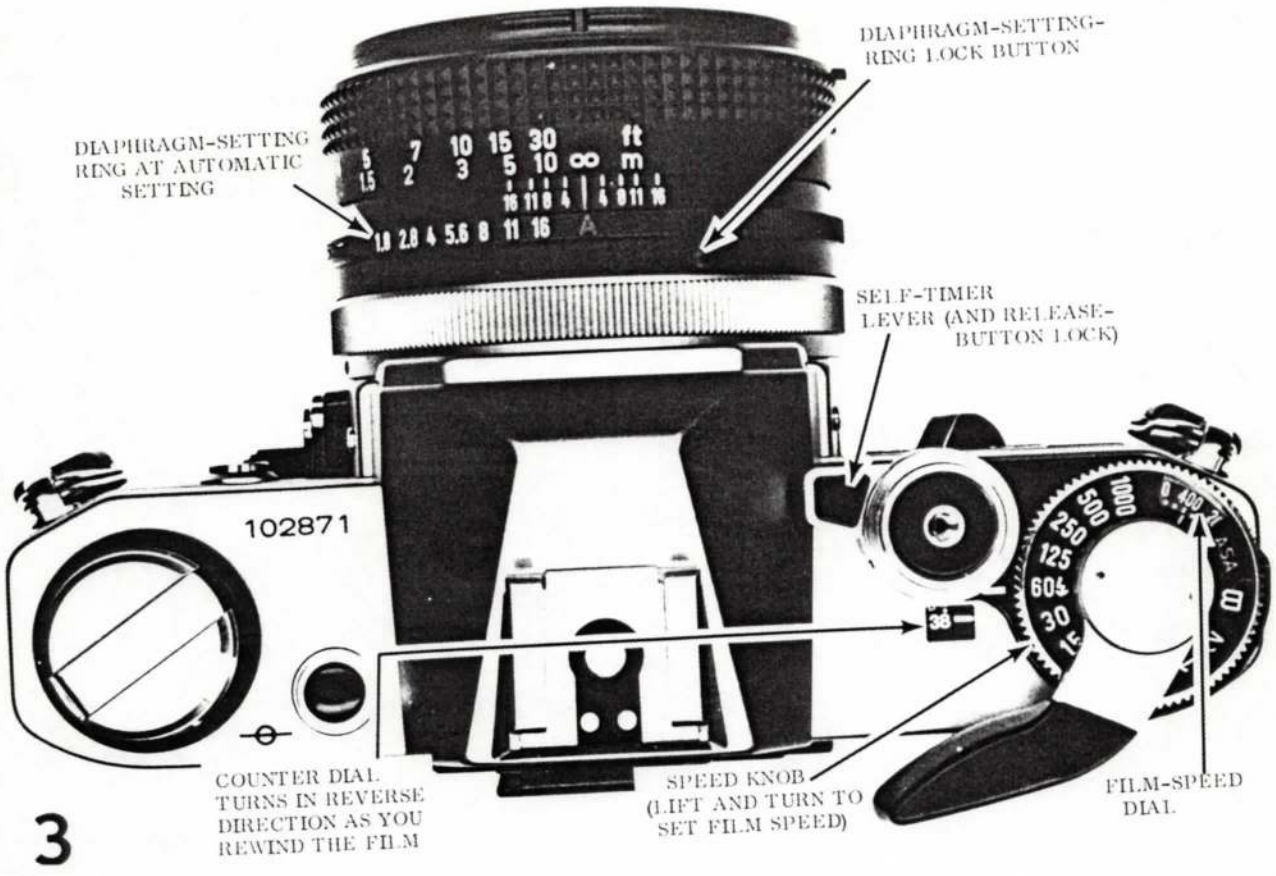


1

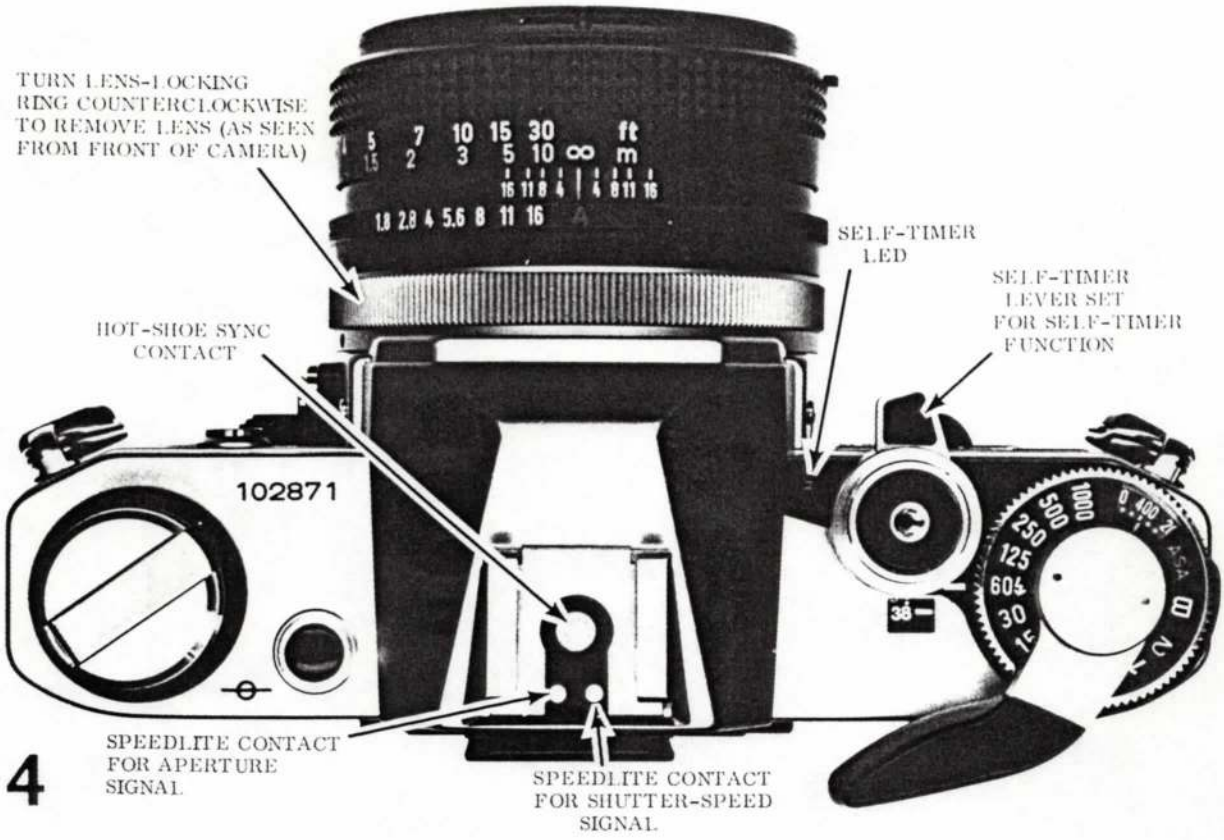
You can lock the stop-down lever at the stopped-down position when you're set to a manual f/stop setting. You can then use the FL lenses with stopped-down metering.

Suppose that your diaphragm-setting ring is at "A" and you decide to use the depth-of-field preview. You turn the diaphragm-setting ring to a manual setting and push in the stop-down lever. But before you return the diaphragm-setting ring to the "A" position, set the largest aperture. Otherwise, the camera won't program the aperture automatically.


BATTERY COMPARTMENT FOR 6-VOLT SILVER-OXIDE BATTERY
Canon
AE-1
CANON LENS FD 50mm 1:1.8 S.C.
CANON
LENS MADE IN JAPAN
2

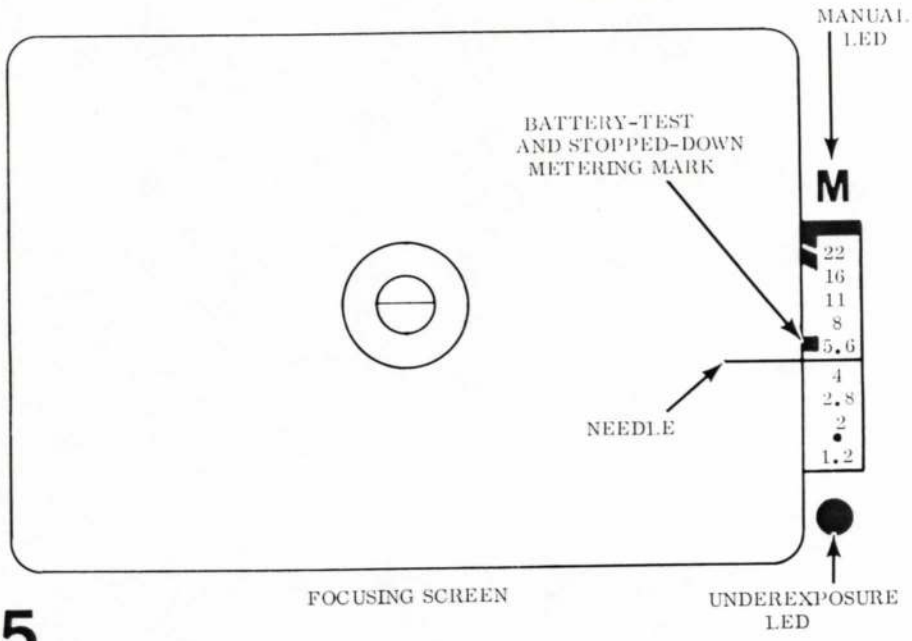

DIAPHRAGM-SETTING RING AT AUTOMATIC SETTING
DIAPHRAGM-SETTING-RING LOCK BUTTON
SELF-TIMER LEVER (AND RELEASE-BUTTON LOCK)
102871
COUNTER DIAL TURNS IN REVERSE DIRECTION AS YOU REWIND THE FILM
SPEED KNOB (LIFT AND TURN TO SET FILM SPEED)
FILM-SPEED DIAL

3



4

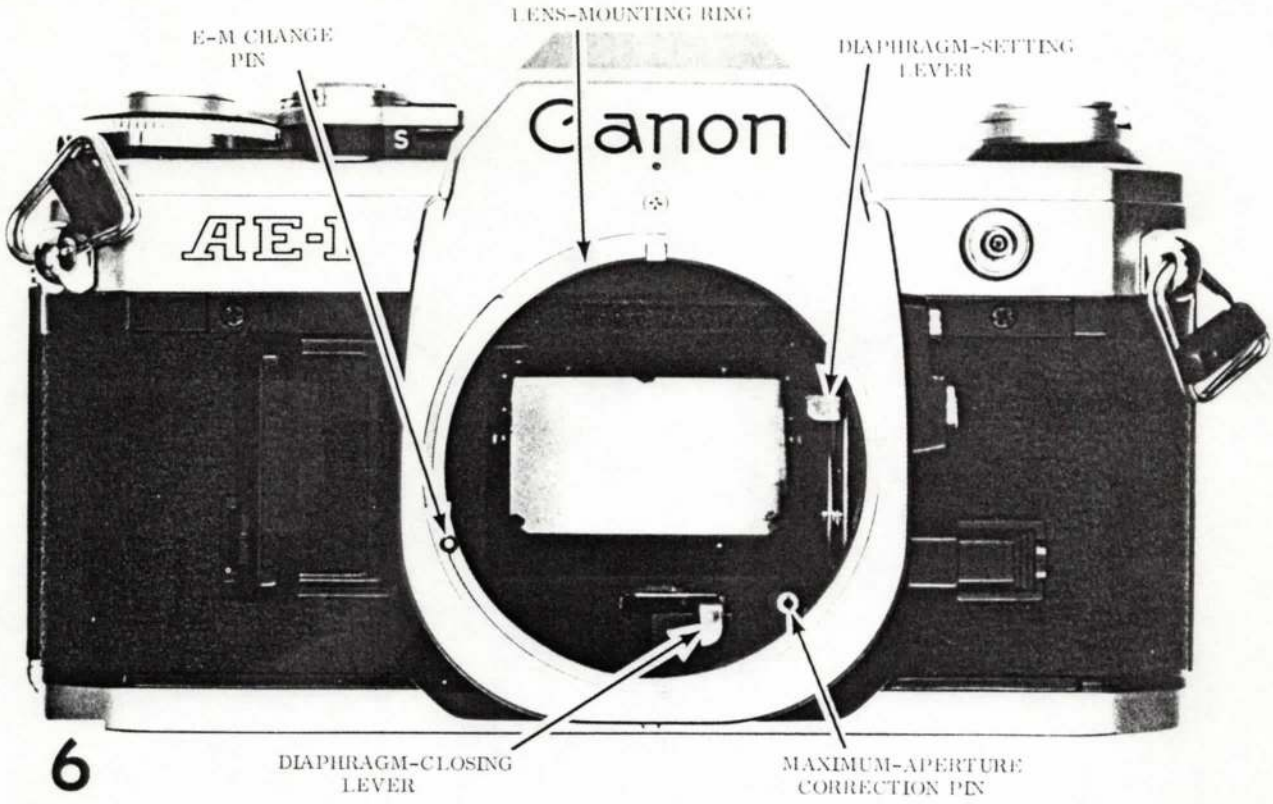
The self-timer function delays the shutter release for 10 seconds. During the self-timer operation, the self-timer LED flashes on and off twice a second (2 Hz).



5

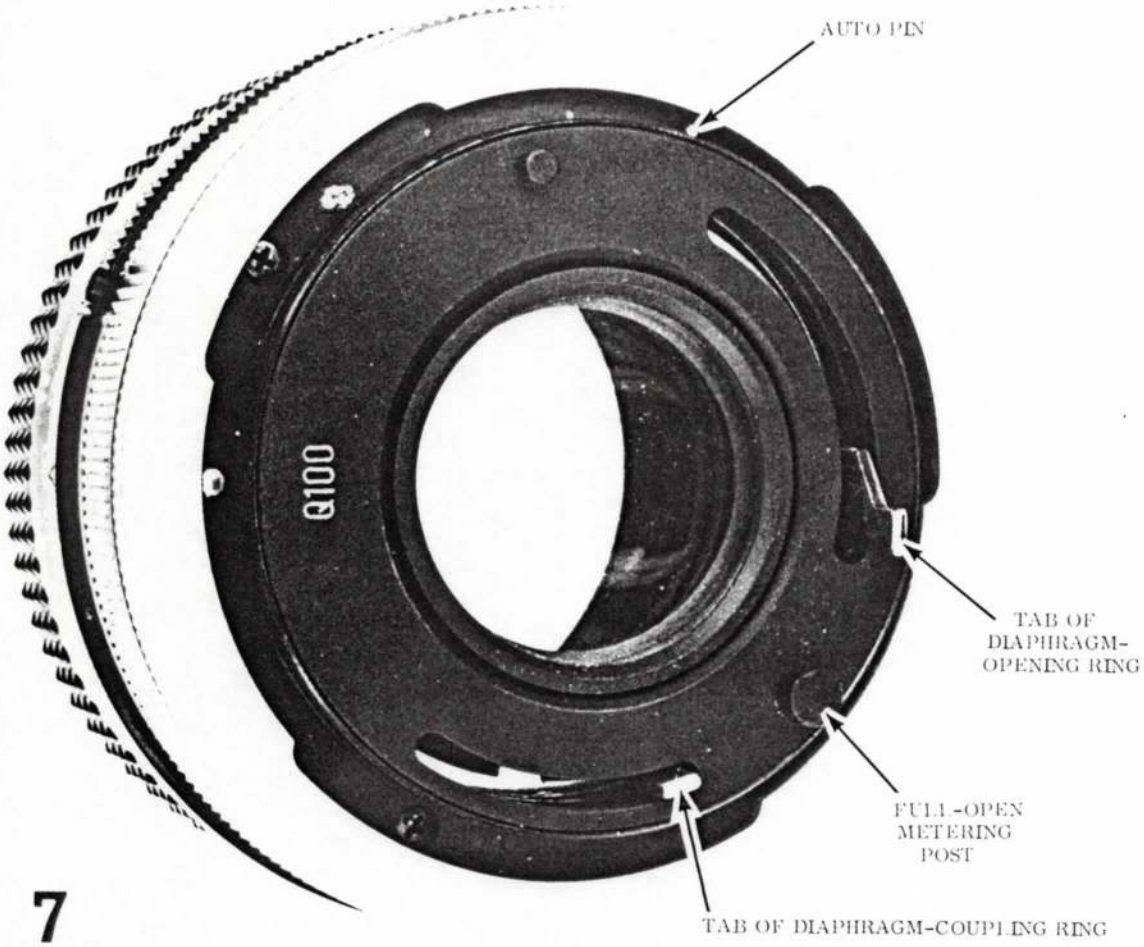
There are two warning LED's visible through the finder. If you're set to a manual f/stop, the LED at the top of the aperture scale flashes on and off as you start depressing the release button. The LED then illuminates the letter "M" for "manual." A second LED at the bottom of the aperture scale flashes on and off to warn of underexposure. Both LED's flash at 4 Hz.

When you push the battery-test button, the needle should move to the battery-test mark or below it. The battery-test mark also provides the stopped-down-metering mark when you're using the FL lenses.

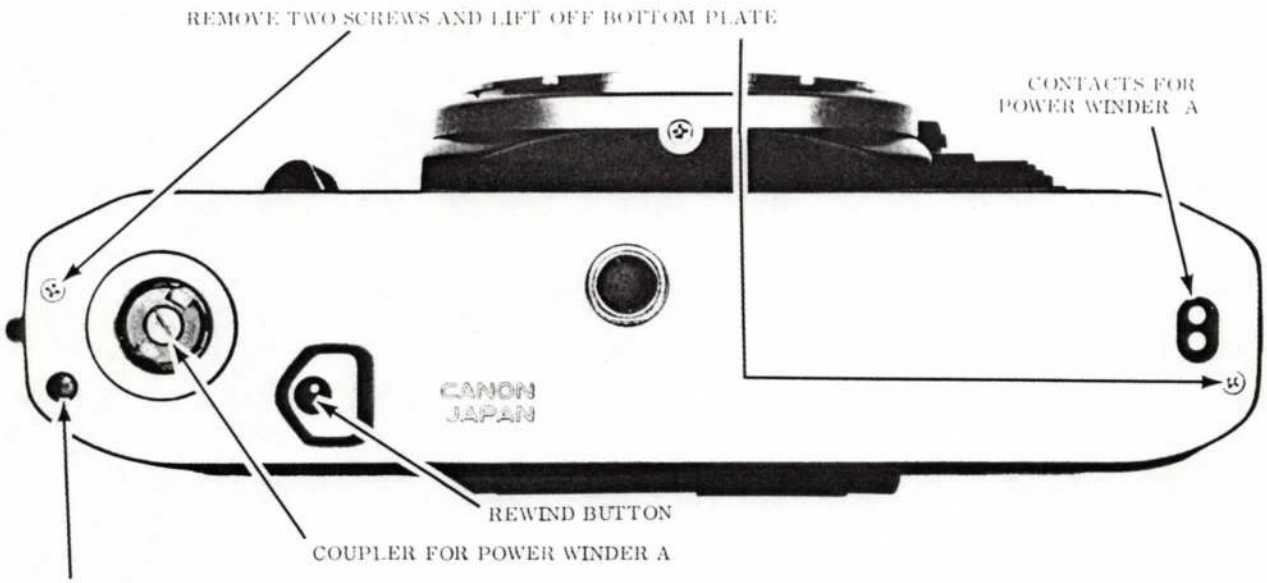


6

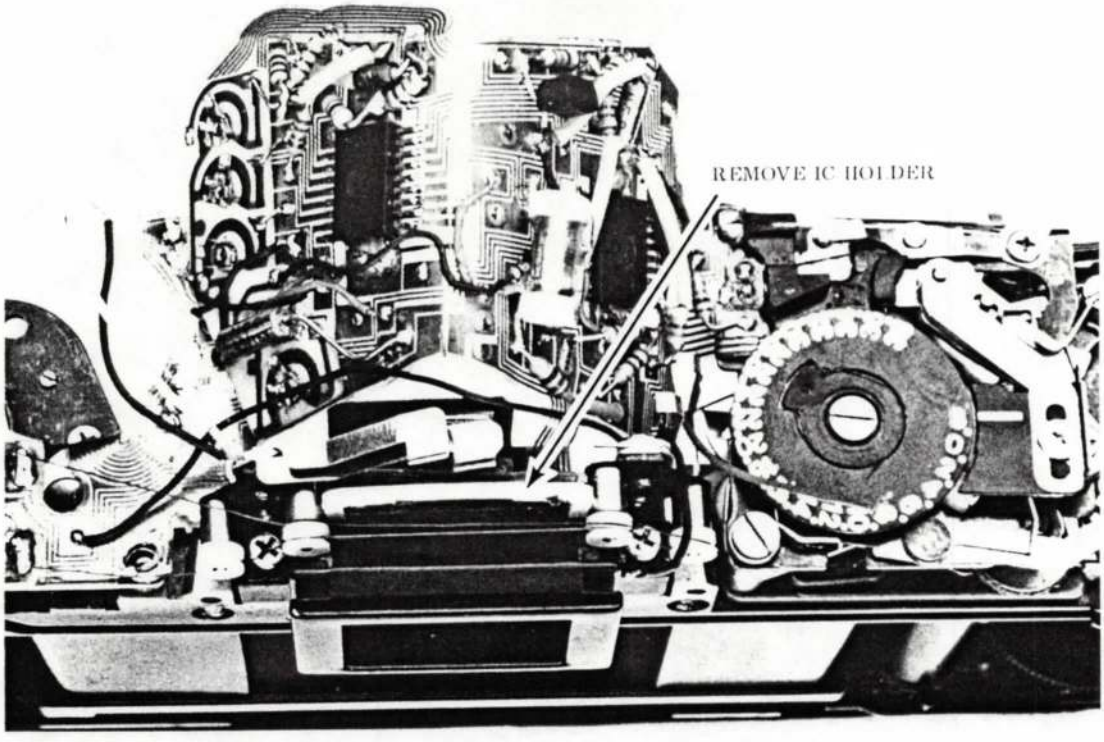
The front surface of the maximum-aperture correction pin should be 5.7mm (+0, — 0.2mm) from the front surface of the lens-mounting ring. To make the adjustment, first loosen the setscrew in the center of the maximum-aperture correction pin. You can then turn the maximum-aperture correction pin clockwise to increase the distance. To decrease the distance, turn the maximum-aperture correction pin counterclockwise and turn in the setscrew to hold the adjustment.

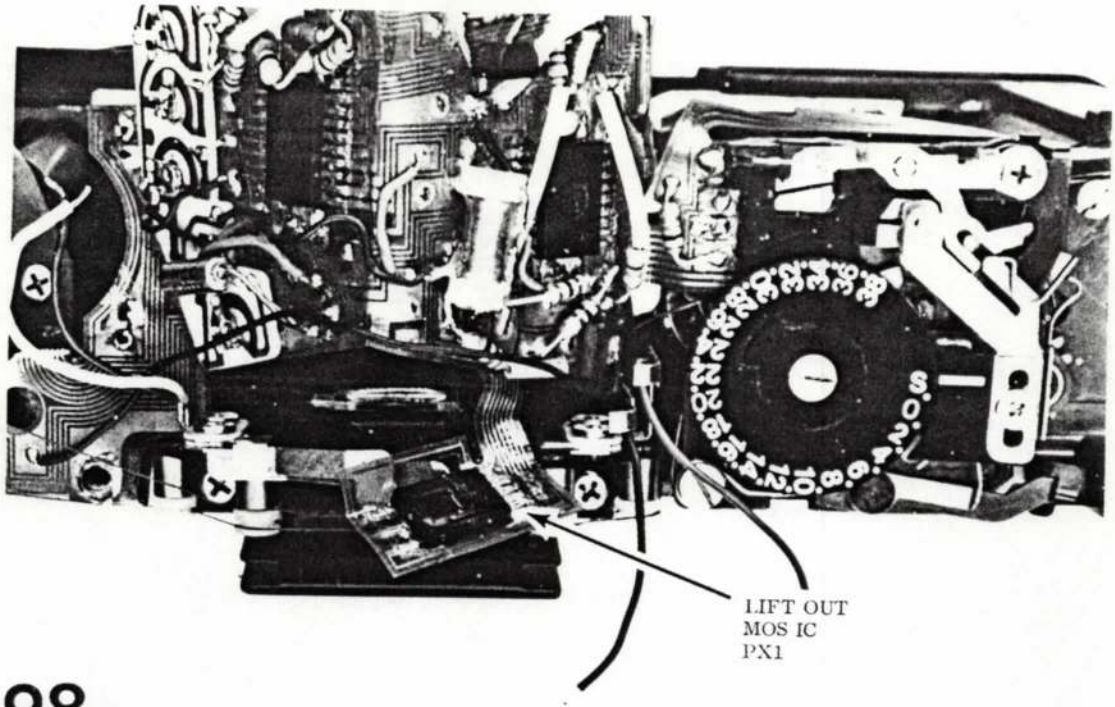

AUTO PIN
Q100
TAB OF
DIAPHRAGM-
OPENING RING
FULL-OPEN
METERING
POST
TAB OF DIAPHRAGM-COUPLING RING

7



CAUTION: BUSHING FOR POWER WINDER A LOCATING PIN MAY BE LOOSE


REMOVE IC HOLDER

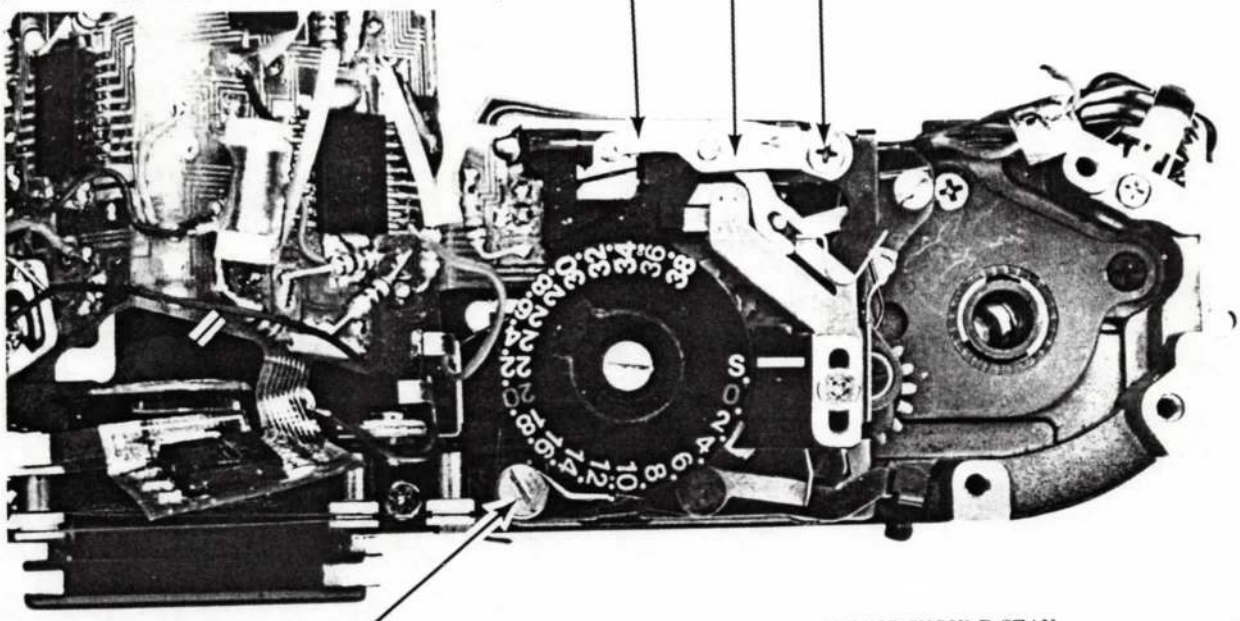

LIFT OUT
MOS IC
PX1

1. REMOVE SCREW

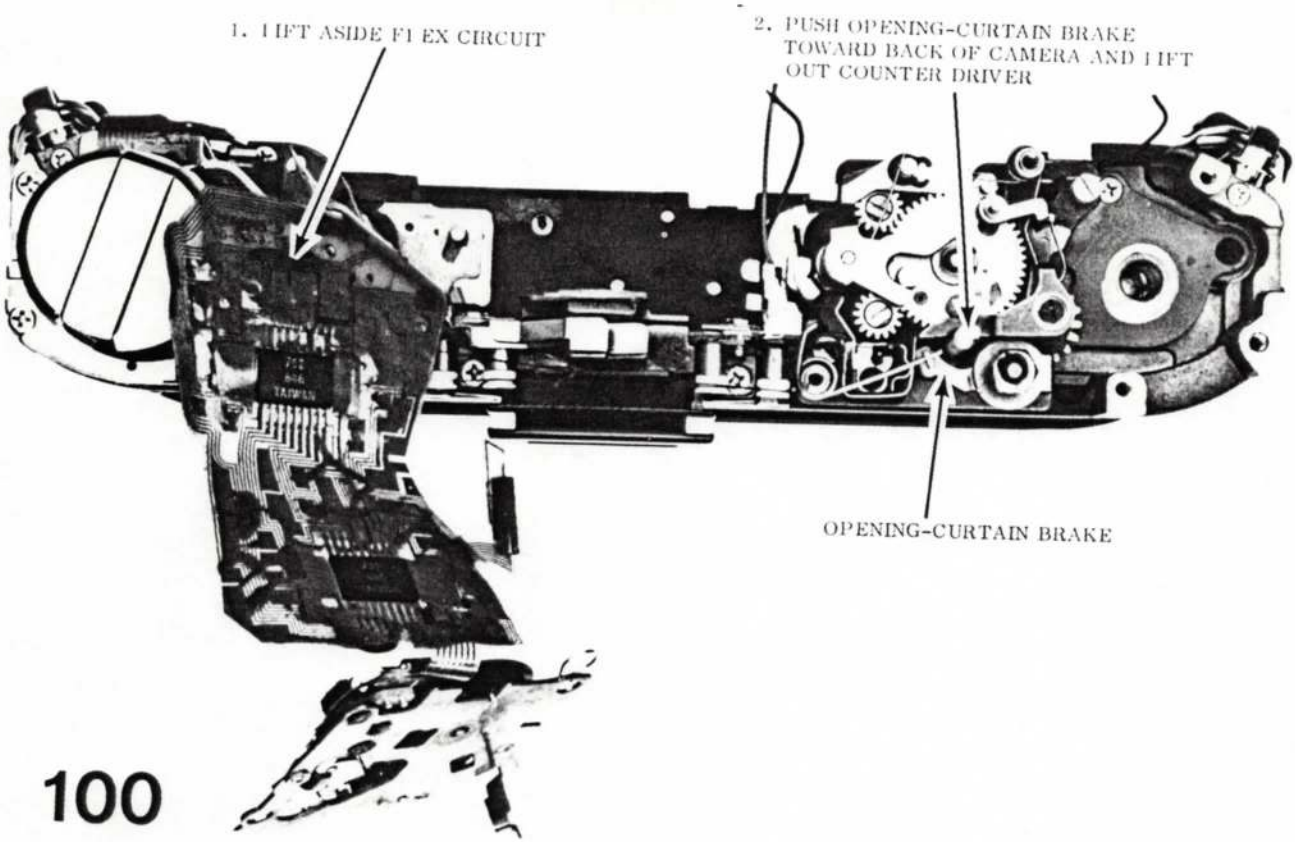
2. LIFT OUT SW5 CONTACT HOLDER

3. LIFT OUT SW5 CONTACT BLADE

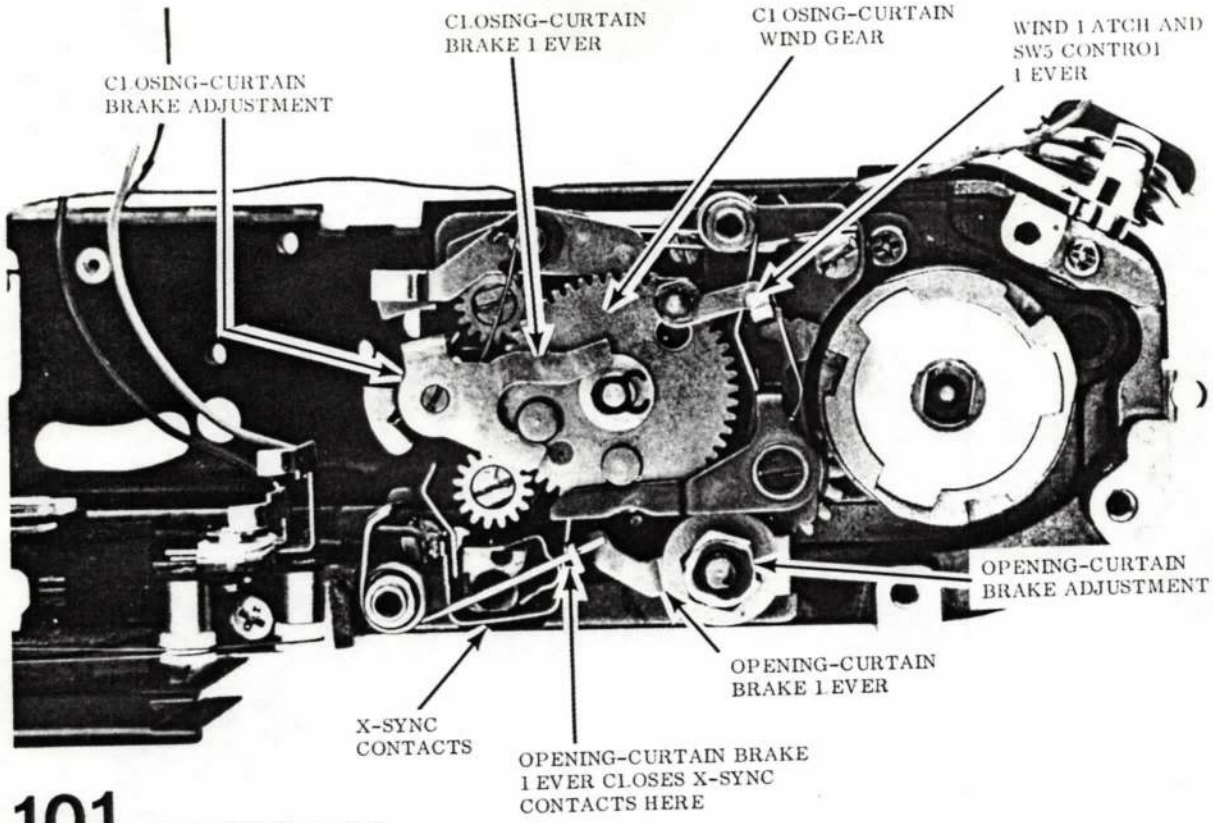
(THERE MAY BE A WASHER
BETWEEN THE HOLDER AND BLADE)



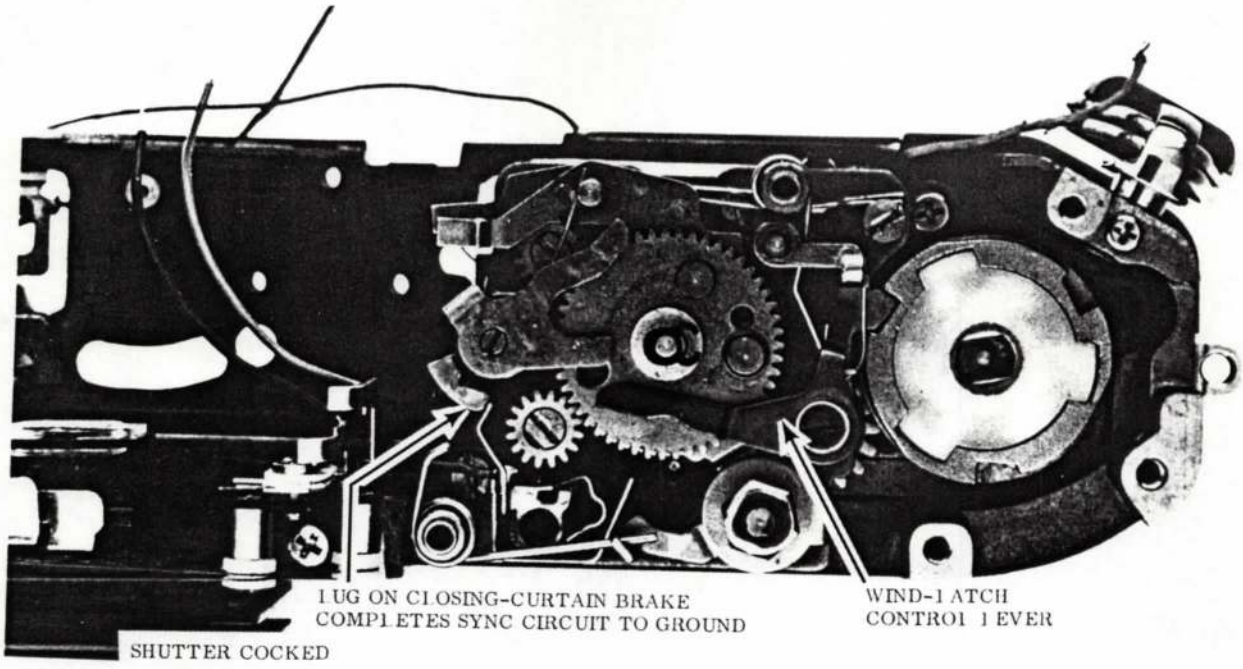
4. REMOVE SHOULDER SCREW -- COUNTER-RETURN-LEVER SPRING SHOULD STAY ON COUNTER PLATE

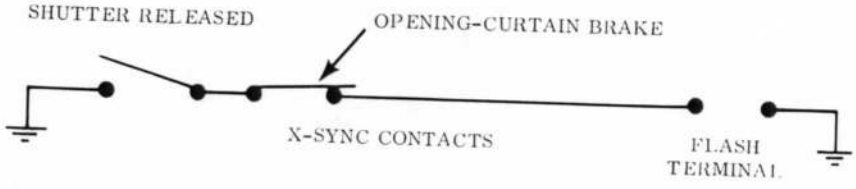

1. LIFT ASIDE FLEX CIRCUIT
2. PUSH OPENING-CURTAIN BRAKE TOWARD BACK OF CAMERA AND LIFT OUT COUNTER DRIVER
OPENING-CURTAIN BRAKE

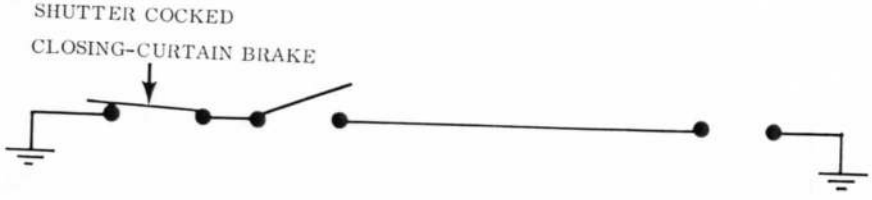
100

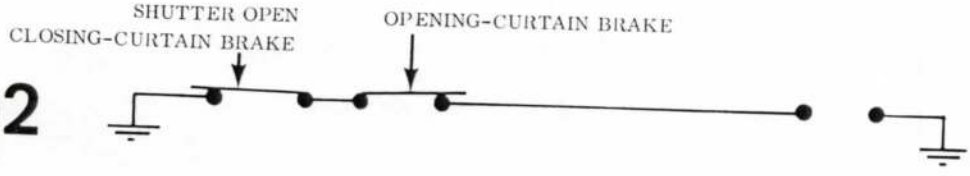


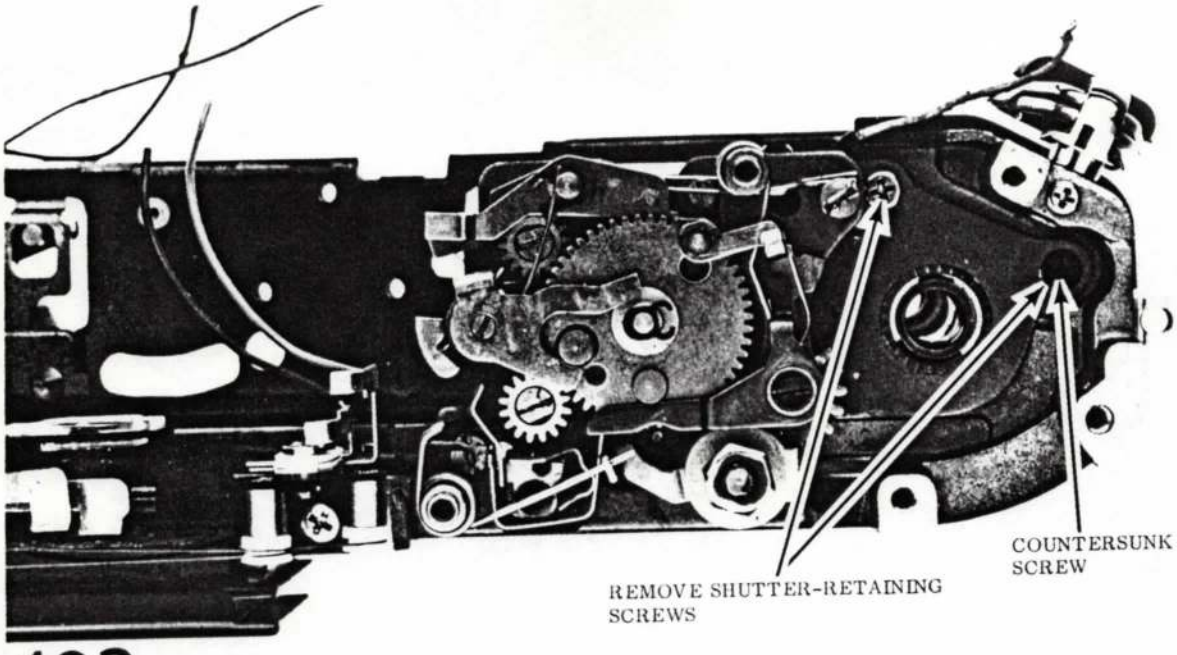
101 SHUTTER RELEASED


LUG ON CLOSING-CURTAIN BRAKE
COMPLETES SYNC CIRCUIT TO GROUND
WIND-LATCH
CONTROL LEVER
SHUTTER COCKED

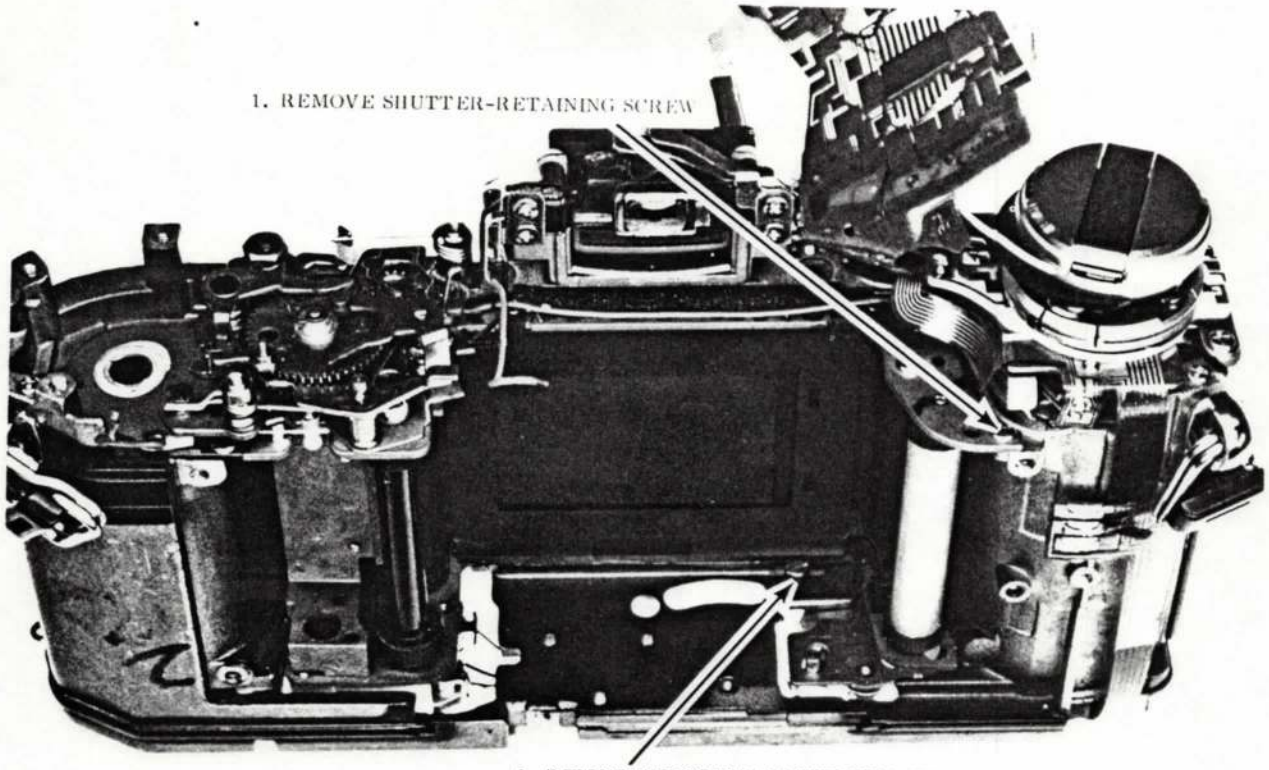

SHUTTER RELEASED
OPENING-CURTAIN BRAKE
X-SYNC CONTACTS
FLASH
TERMINAL


SHUTTER COCKED
CLOSING-CURTAIN BRAKE

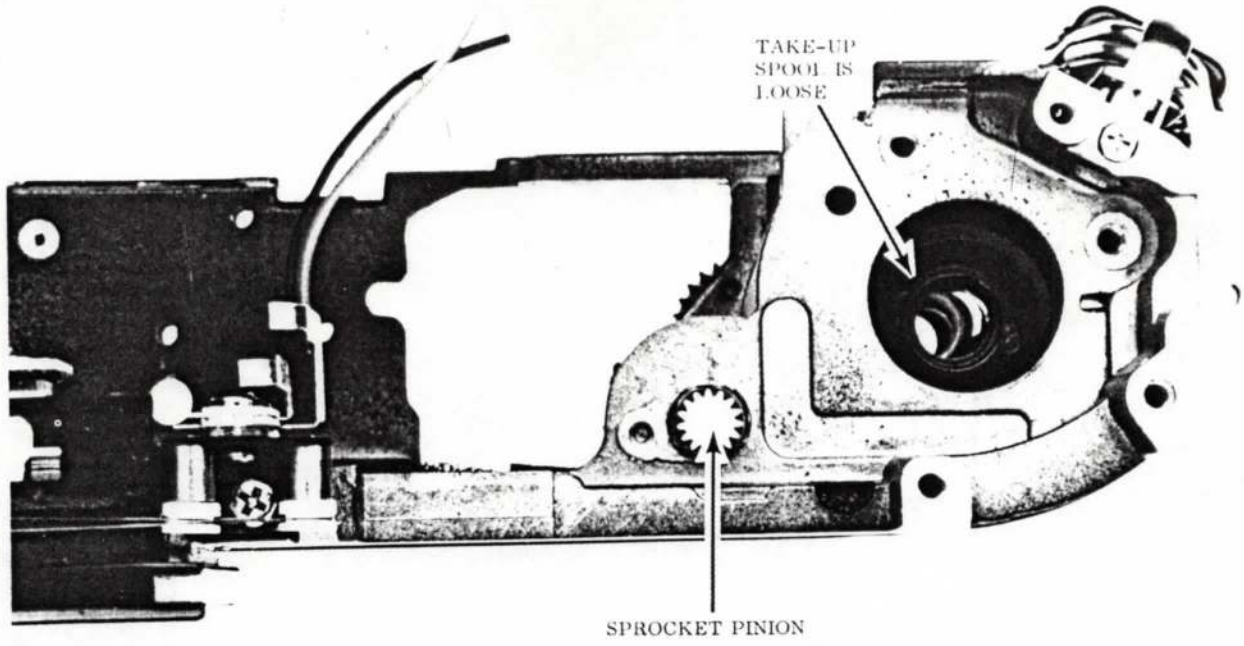

SHUTTER OPEN
CLOSING-CURTAIN BRAKE
OPENING-CURTAIN BRAKE



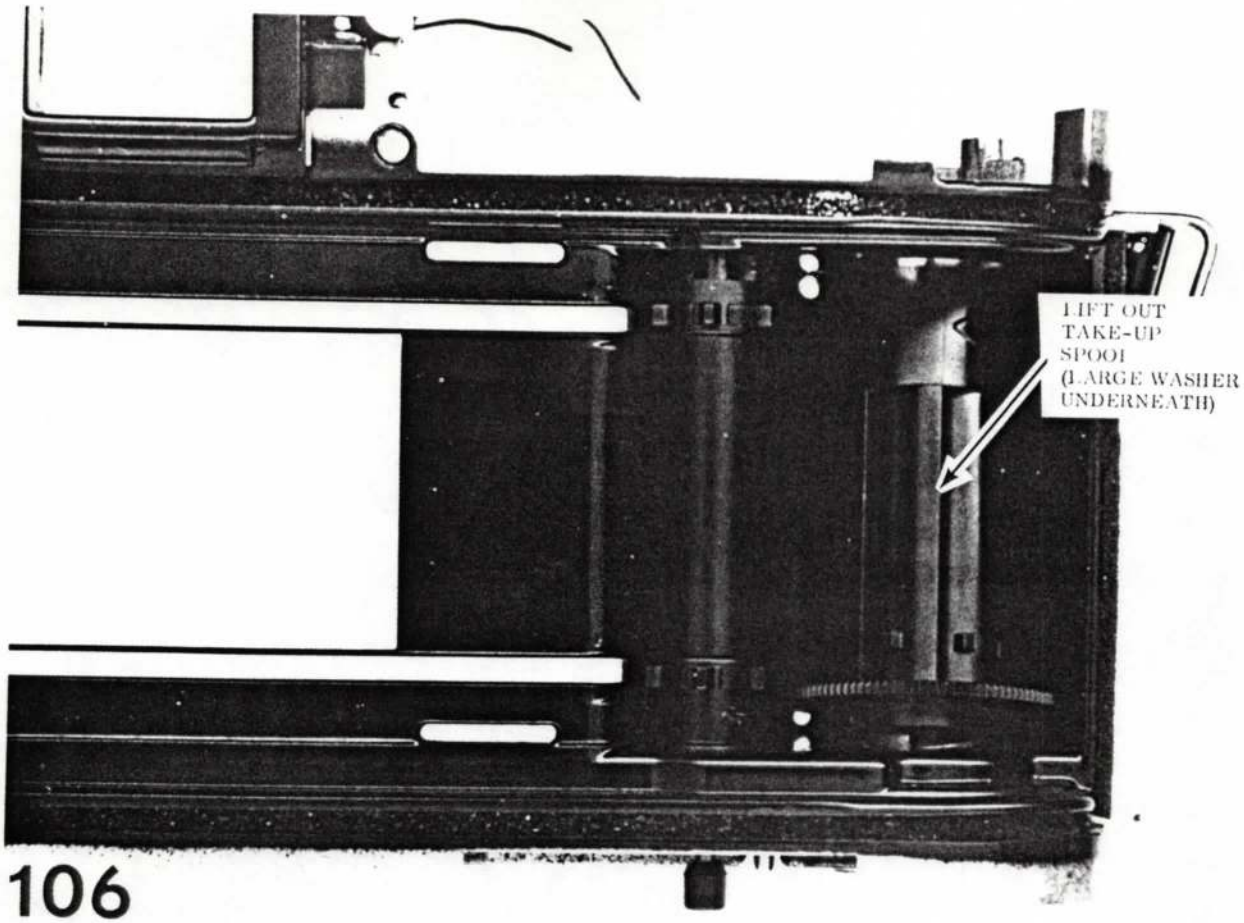
103


1. REMOVE SHUTTER-RETAINING SCREW
2. REMOVE SHUTTER-POSITIONING SCREW
3. LIFT OUT SHUTTER MODULE

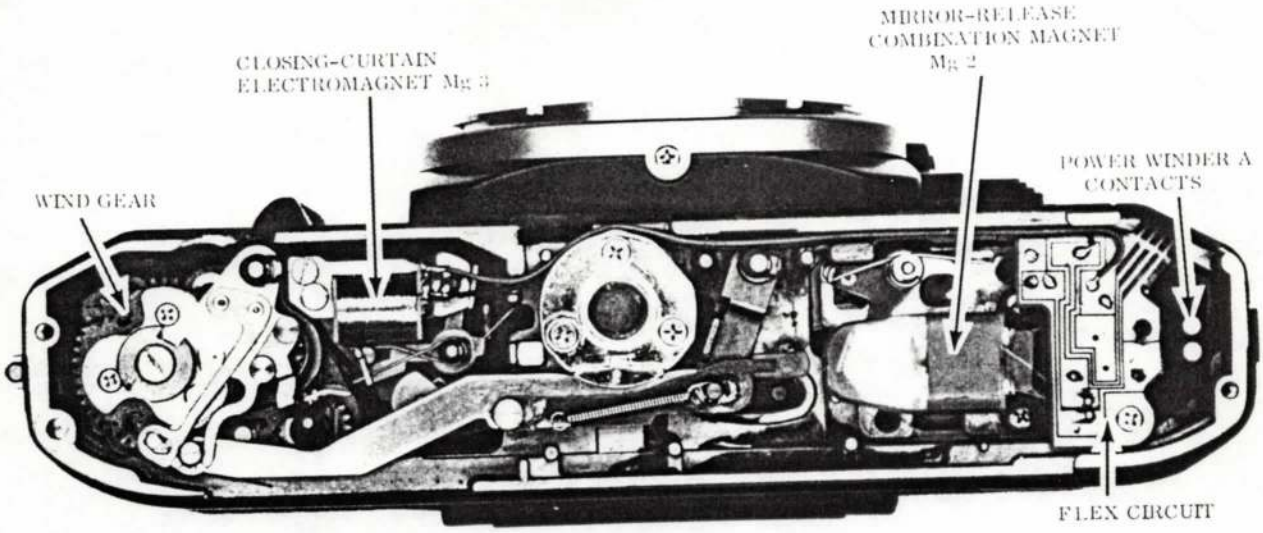
104



105

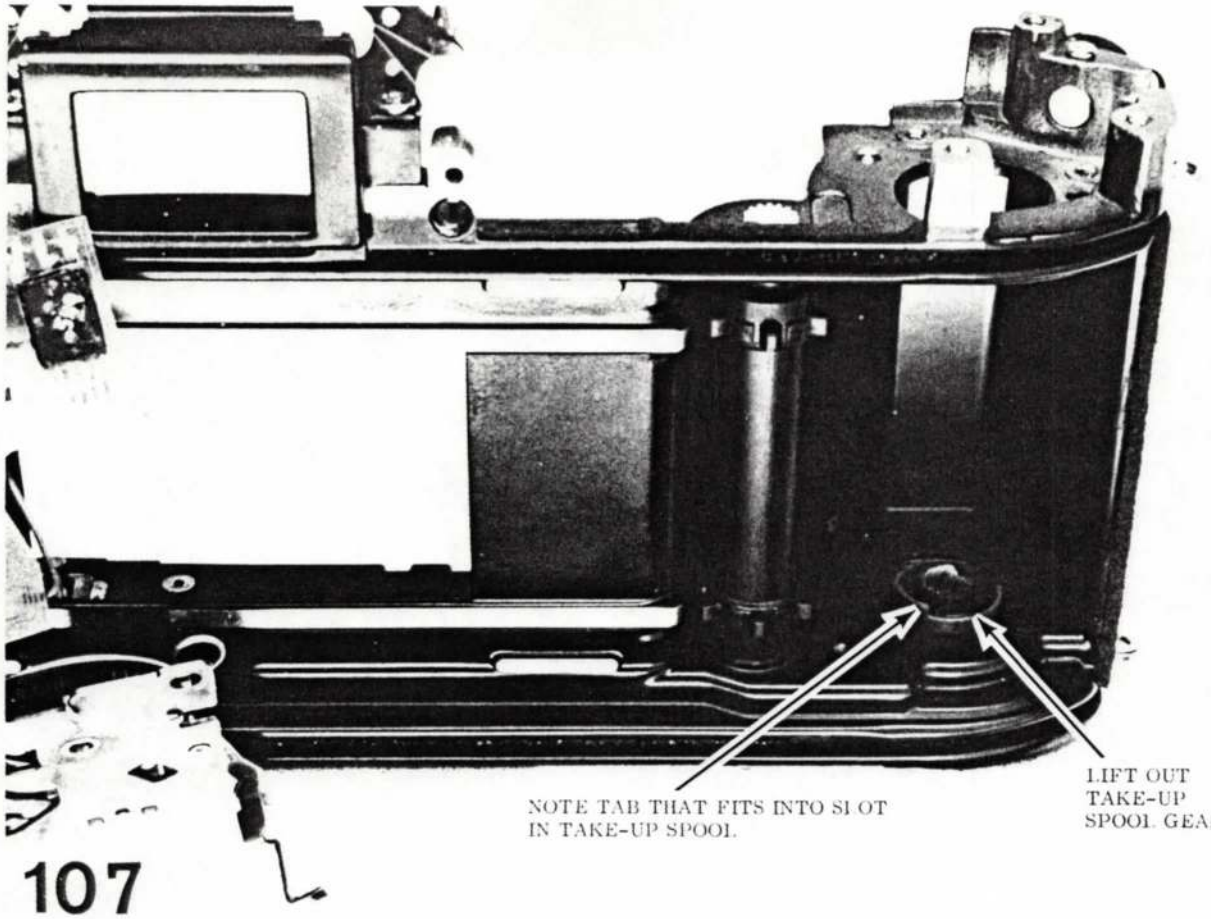


106

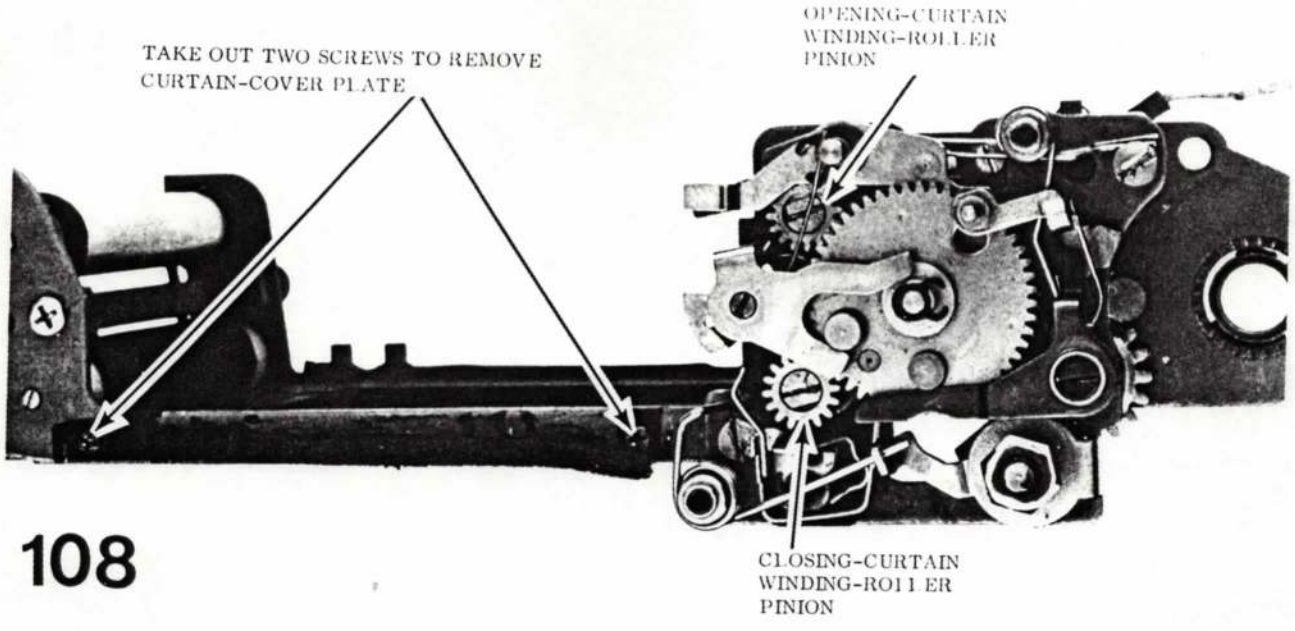


9

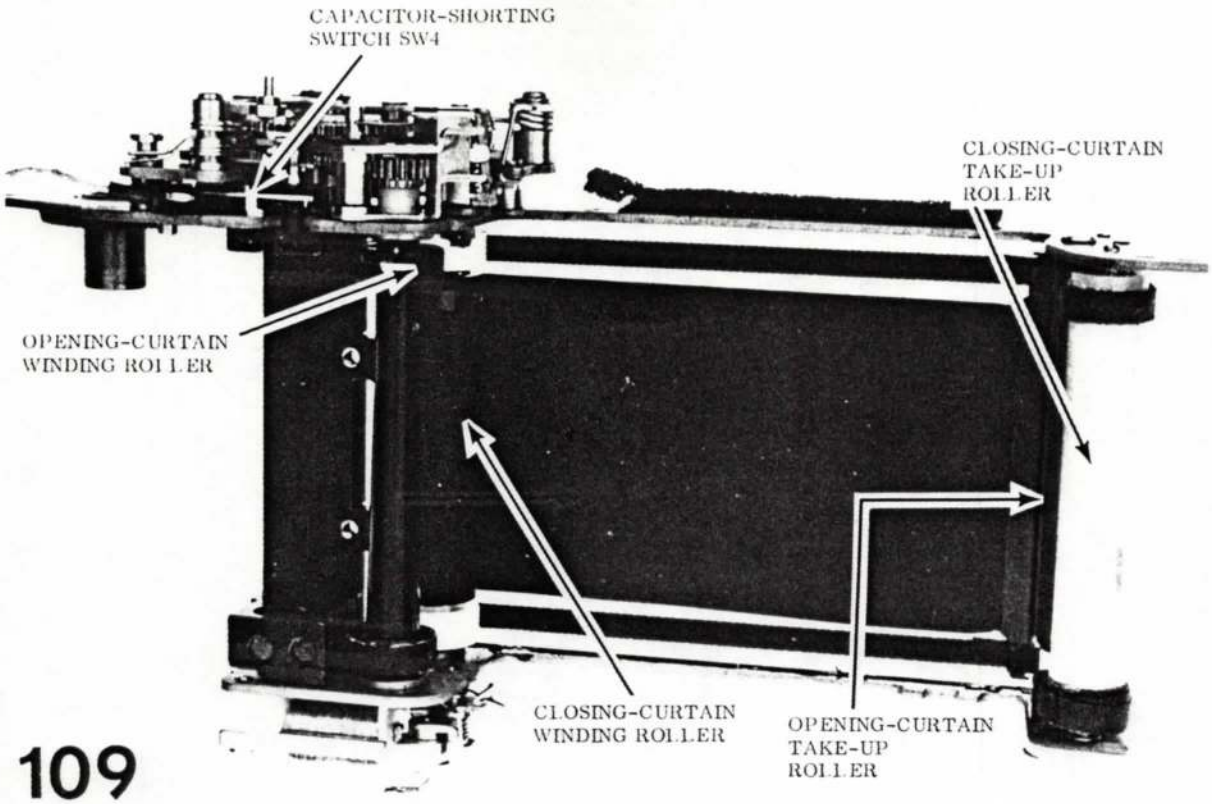
SHUTTER RELEASED

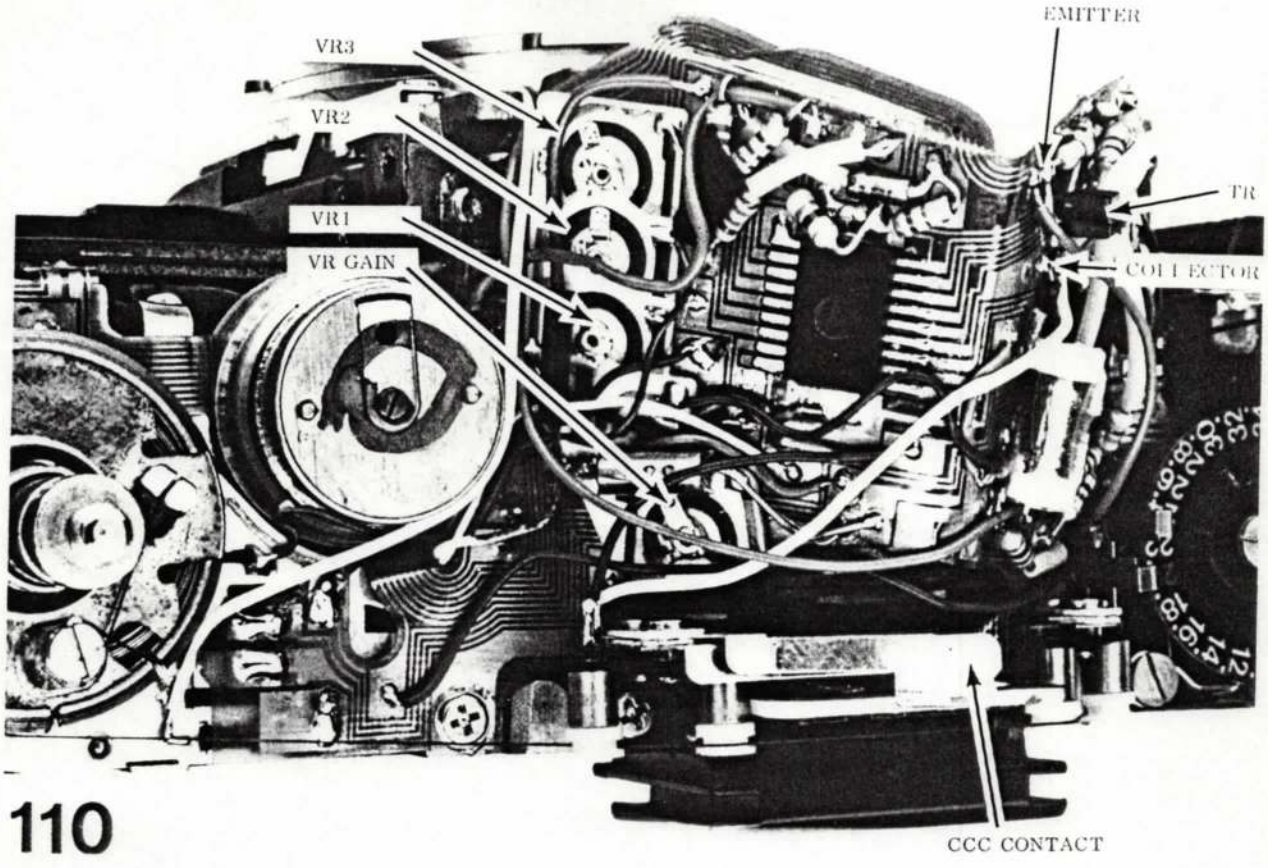

NOTE TAB THAT FITS INTO SLOT
IN TAKE-UP SPOOL
LIFT OUT
TAKE-UP
SPOOL GEAR

107


TAKE OUT TWO SCREWS TO REMOVE CURTAIN-COVER PLATE
OPENING-CURTAIN WINDING-ROLLER PINION
CLOSING-CURTAIN WINDING-ROLLER PINION

108

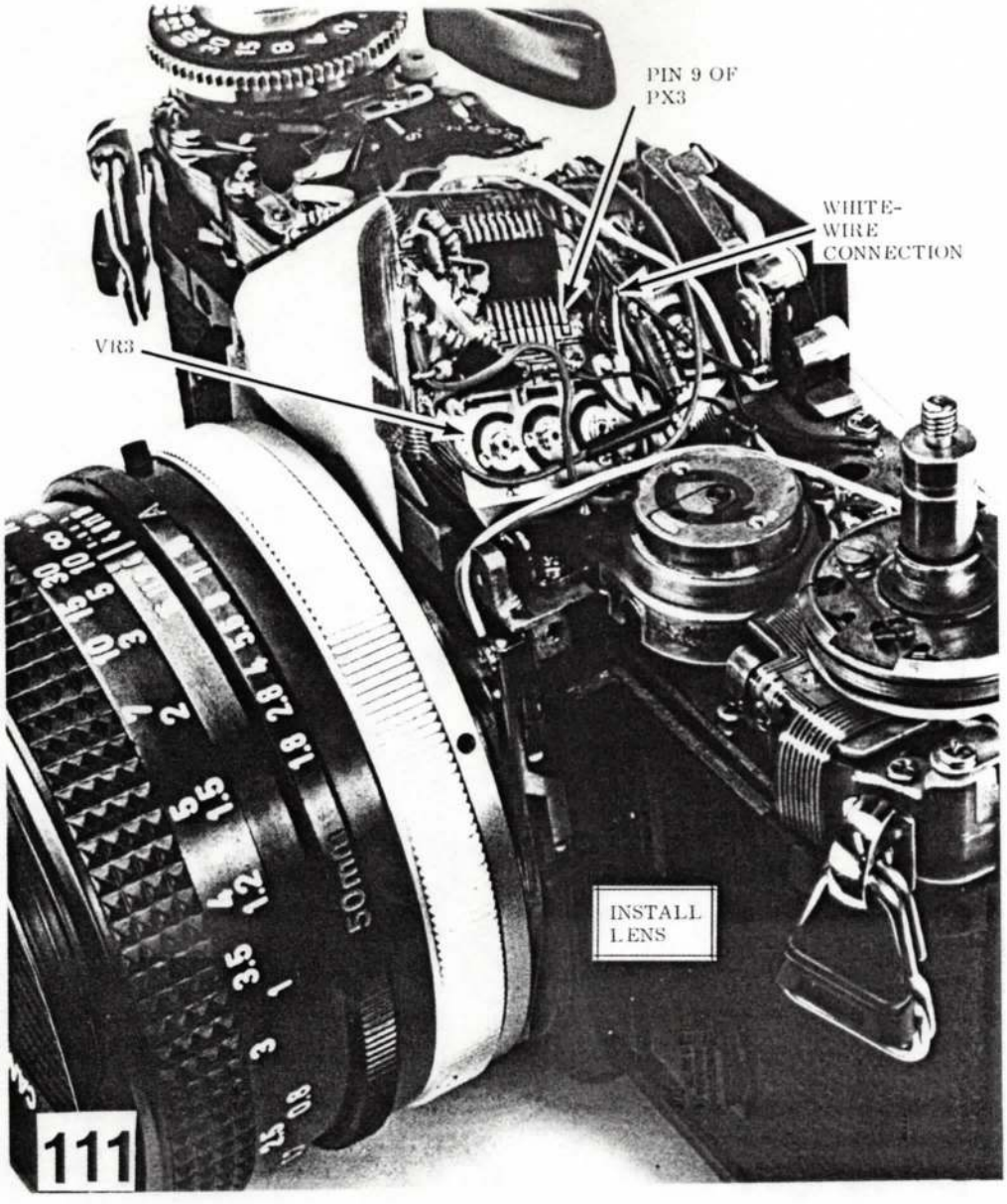

CAPACITOR-SHORTING
SWITCH SW4
CLOSING-CURTAIN
TAKE-UP
ROLLER
OPENING-CURTAIN
WINDING ROLLER
CLOSING-CURTAIN
WINDING ROLLER
OPENING-CURTAIN
TAKE-UP
ROLLER



1. Test the supply voltage by measuring between ground (negative) and the emitter of the discrete transistor TR without closing SW1. You should measure the full battery voltage (around 6.35 volts). You should also measure the full battery voltage at the base of TR. At the collector of TR, you should measure 0 volt.

2. Use a mini-clip to hold switch SW1 closed. You should now measure voltage E1 at the collector of the discrete transistor. This voltage will be slightly less than the battery voltage -- around 5.5 volts (the difference between the battery voltage and the voltage dropped across the transistor).

3. Check the Vc voltage between ground and the CCC contact (the lower, longer of the two flash contacts). With SW1 closed, you should measure 1.2 volts $\pm$ 0.06 volt. A voltage regulator maintains Vc at a constant level despite variations in battery voltage. But Vc varies slightly from camera to camera. You'll use the Vc voltage in your particular camera as a reference in making the other voltage adjustments. So record your Vc voltage measurement.



ADJUSTMENTS

1. AVO (maximum-aperture correction) ADJUSTMENT

Use the following formula to calculate what your AVO should be:

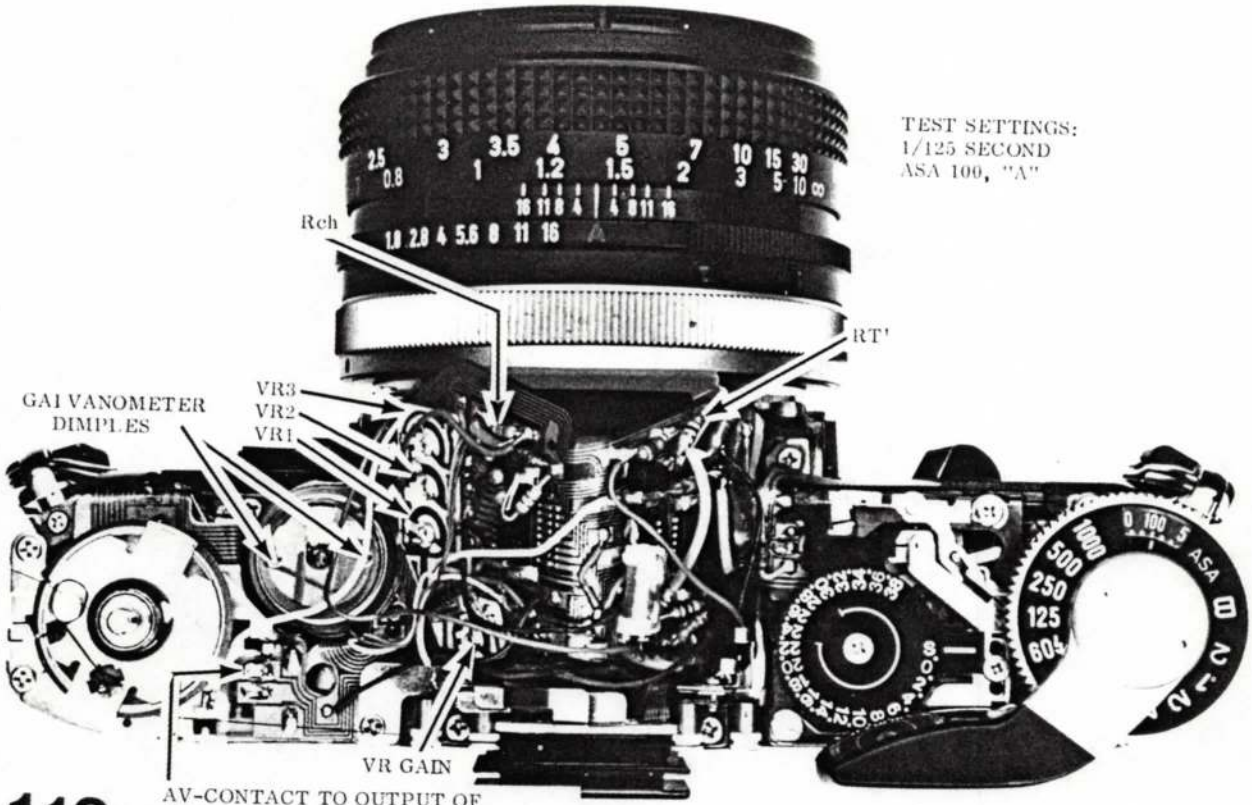
$$\text{Voltage AVO} = \frac{\text{APERTURE VALUE} - 4.5}{16} \times \text{Vc} + \text{Vc}$$

Use the aperture value of your largest lens opening. If you have the f/1.4 lens, the aperture value is 1. If you have the f/1.8 lens, the aperture value is 1.7.

Example: Suppose your measured Vc is 1.24 volts. And you're using the f/1.8 lens. Putting these values in the formula, you get:

$$\text{Voltage AVO} = \frac{1.7 - 4.5}{16} \times 1.24 + 1.24 = 1.023$$

So your measured voltage should be 1.023 volts. Measure VAVO between ground and pin #9 of PX 3. Or, rather than measuring to pin #9, you can measure to the white-wire connection indicated above. With switch SW1 closed, your measured voltage should be within 0.020 volt of your calculated voltage. If it isn't, make the adjustment using VR3.


TEST SETTINGS:
1/125 SECOND
ASA 100, "A"
Rch
RT'
GALVANOMETER
DIMPLES
VR3
VR2
VR1
VR GAIN
AV-CONTACT TO OUTPUT OF
AR1 (PIN # 13 OF PX3, PIN #5 OF PX2)

2. GAIN ADJUSTMENT

The gain adjustment levels the slope so that equal changes in light input will cause equal output voltage changes. To make the gain adjustment, you must measure the output of AR1 at two different light levels. Subtracting these two values gives you the voltage change at the range of EV's covered by the difference in your light levels.

First, though, you must calculate what the voltage difference should be. Use the following formula:

$$\frac{Vc}{16} \quad X \quad \text{EV RANGE}$$

For example, suppose again that your measured Vc is 1.24 volts. And your two light levels cover an EV range of 6 EV's -- such as EV15 and EV9. The formula then becomes:

$$\frac{1.24}{16} \quad X \quad 6 = 0.465$$

Calculate and record your voltage difference_____

When checking the light transmission, you must shield the photocell from ambient light. Ambient light can cause a significant error, especially at the lower light levels. So you need a special tool -- a "dummy" top cover with clearance holes cut for the variable resistors.

Solder a long wire to the AV contact of the flex circuit (shown in Fig. 112). You'll make your voltage measurements between this wire and ground. Then, run the wire through the clearance cutout in the dummy top cover. And install the dummy top cover to shut out the ambient light.

Set your light source to EV 15 (f/16 light level on the Comparalumen or Autolumen-CV). Now, while holding the lens to the light source, close SW1. And measure the voltage between the test wire and ground. Record this voltage. EV 15_____

Next, measure the voltage at EV 9 (f/2 light level on the Comparalumen or Autolumen-CV). Record this voltage.

EV 9_____

Finally, subtract the voltage reading made at EV 9 from the reading at EV 15. This difference should equal your calculated voltage. If it doesn't, make the adjustment with the gain-control resistor VR gain. Your tolerance is $\pm$ 0.012 volt for a 6 EV range.

3. Δ AV LEVEL ADJUSTMENT

Make your Δ AV level measurement in the same manner as you made your gain measurements. But now you should get a specific voltage. Set the light level to EV 12 (f/5.6 on the Comparalumen or Autolumen-CV). Set the film speed on the camera to ASA 100, the shutter speed to 1/125 second, and the diaphragm to "A."

Before making your voltage measurement, compute what the reading should be. If you're using the f/1.4 lens, use the following formula:

$$\Delta AV = \frac{4.5\ Vc}{16} + Vc$$

For any other lens, use the formula:

$$\Delta AV = \frac{4.5\ Vc}{16} + Vc - (0.075\ (\text{aperture value} - 1))$$

Notice that the only difference is that you're subtracting a value from the original formula. For the f/1.8 lens, the second part of the formula comes out 0.0525. So, if you're using the f/1.8 lens, subtract 0.0525 from the original formula.

Record the Δ AV level _____.

Now, measure the voltage between the temporary wire and ground at the specified settings. Your voltage reading should be within 0.020 volt of your calculated voltage. If it isn't, make your adjustment with VR1.

4. COMPARATOR ADJUSTMENT

Use the same light level (EV 12) and the same camera settings (ASA 100, 1/125 second, and "A"). Then, measure the light transmission. The lens should stop down to f/5.6 when you release the shutter.

If you don't have an instrument that measures light transmission, you can check the diaphragm opening visually. Release the shutter at the EV 12 light level. Then, turn the diaphragm-setting ring off the "A" position -- toward the manual f/stop settings.

Lock the stop-down lever in the stopped-down position. Then, while watching the diaphragm from the front of the lens, slowly turn the diaphragm-setting ring toward the larger apertures. The diaphragm will start to open at the last f/stop it automatically programmed. That f/stop should be f/5.6. So the diaphragm should start to open when you reach the f/5.6 setting.

5. METER ADJUSTMENT

At the settings in step #4, the meter should read f/5.6. The dimples in the top of the meter housing allow you to use a Multispan wrench to rotate the galvanometer. Turn the galvanometer housing until the needle indicates f/5.6.

6. BATTERY-TEST ADJUSTMENT

Remove the battery and hook a continuously variable power supply to the battery terminals. Set the power supply to 0 volt. Then, hold the release-button switches SW1 and SW2 depressed. And slowly raise the setting on the power supply until the shutter releases.

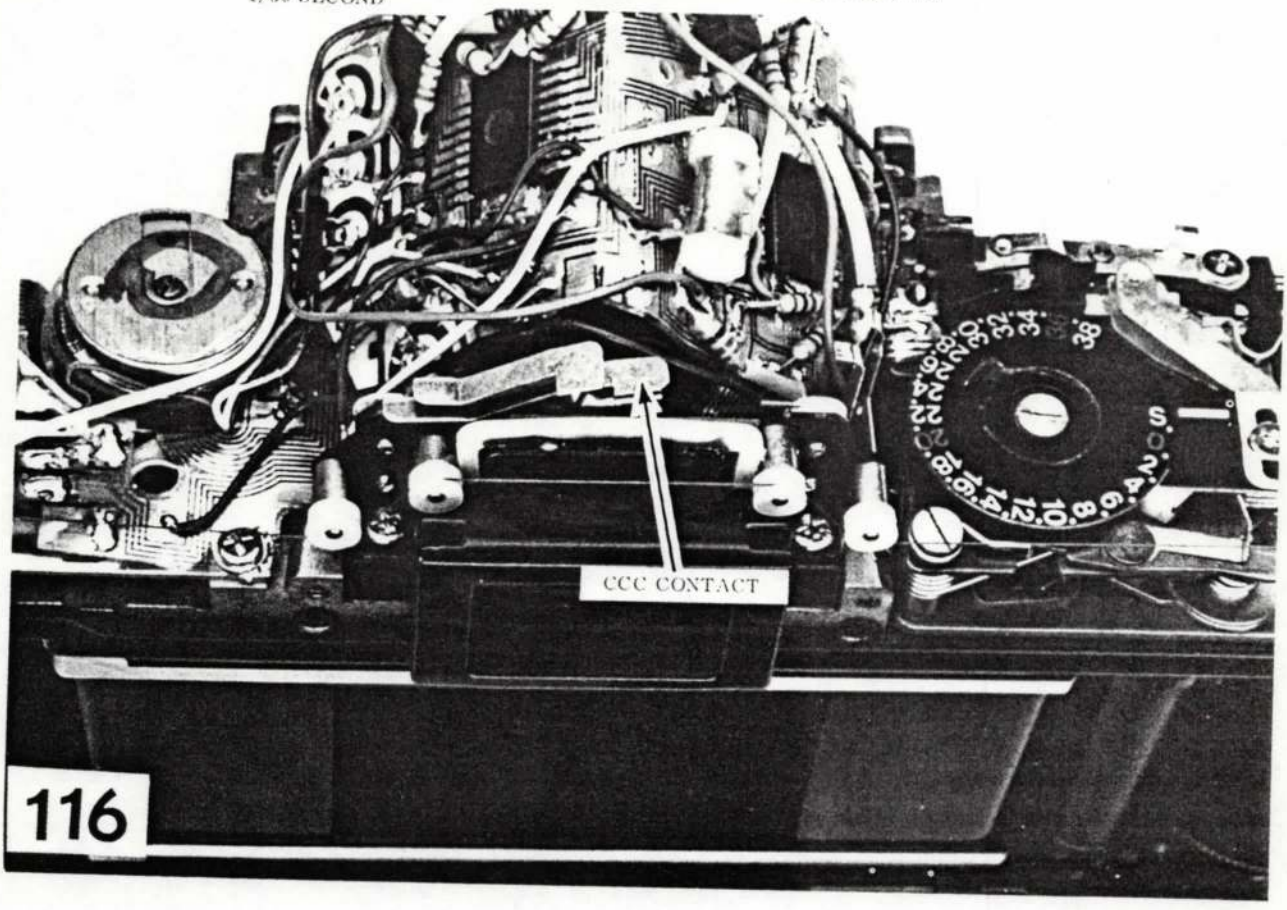
Record the voltage of the power supply at the time the shutter releases _____

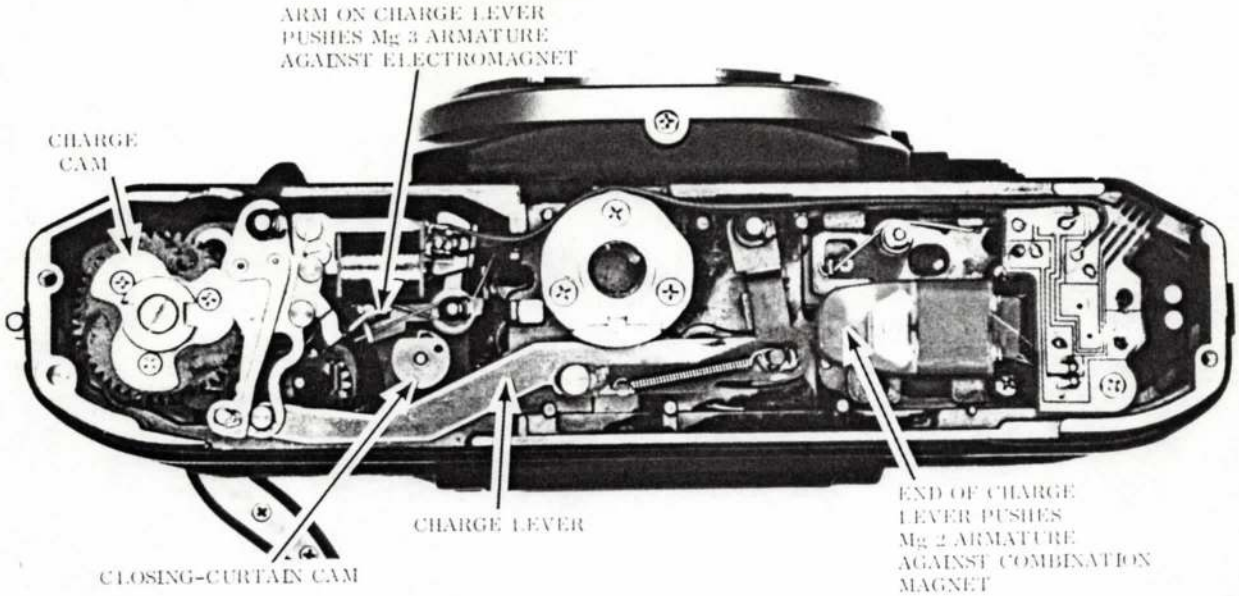
Next, set the power supply according to your recorded release voltage. If the shutter released at a voltage setting of 4.2 - 4.39 volts, set the power supply to 4.6 volts. If the shutter released at a voltage setting of 4.4 - 4.59 volts, set the power supply to 4.7 volts. If the shutter released at a voltage setting of 4.6 - 4.8 volts, set the power supply to 4.7 volts.

With the power supply set to the proper voltage, push the battery-test switch SW8. The needle should move to the battery-test mark. If it doesn't, you can change the value of the fixed resistor Rch.

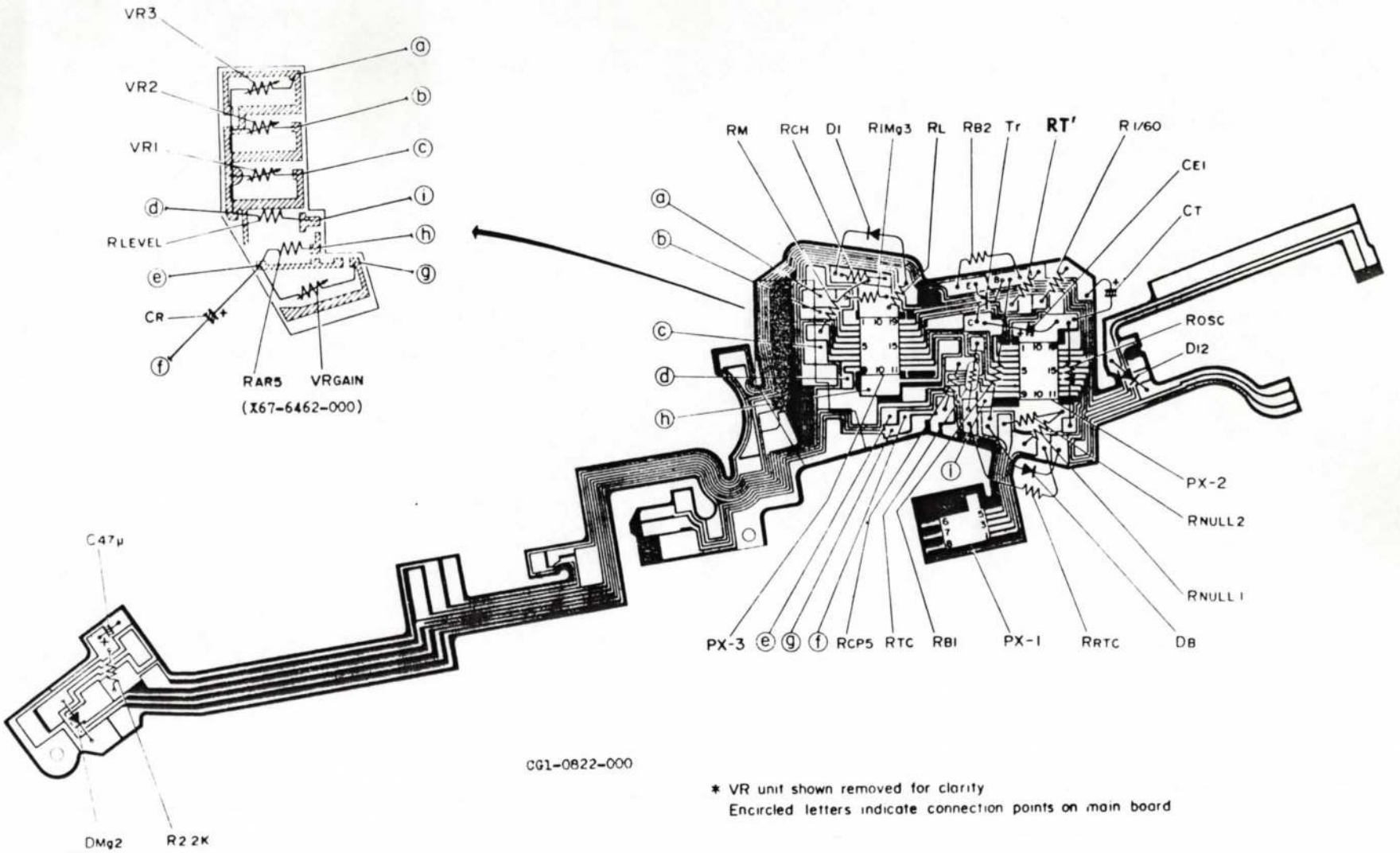
Temporarily replace Rch with a variable resistor that can be adjusted to either side 4.7 K. And adjust the variable resistor until the needle centers on the battery-test mark. Measure the resistance of the variable resistor to see what value you need for Rch.

CHECK FLASH EXPOSURE BY HOOKING 4.7 K RESISTOR BETWEEN CCC CONTACT AND GROUND -- THE SHUTTER SHOULD DELIVER 1/60 SECOND



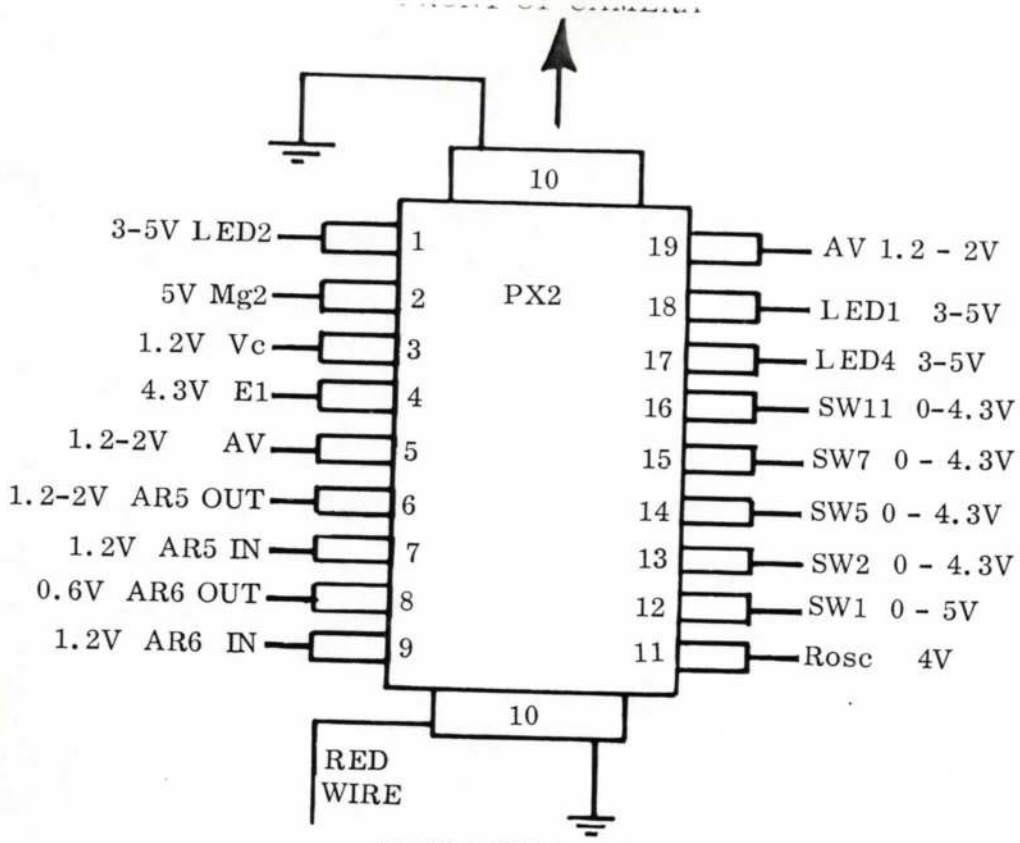


DURING COCKING CYCLE

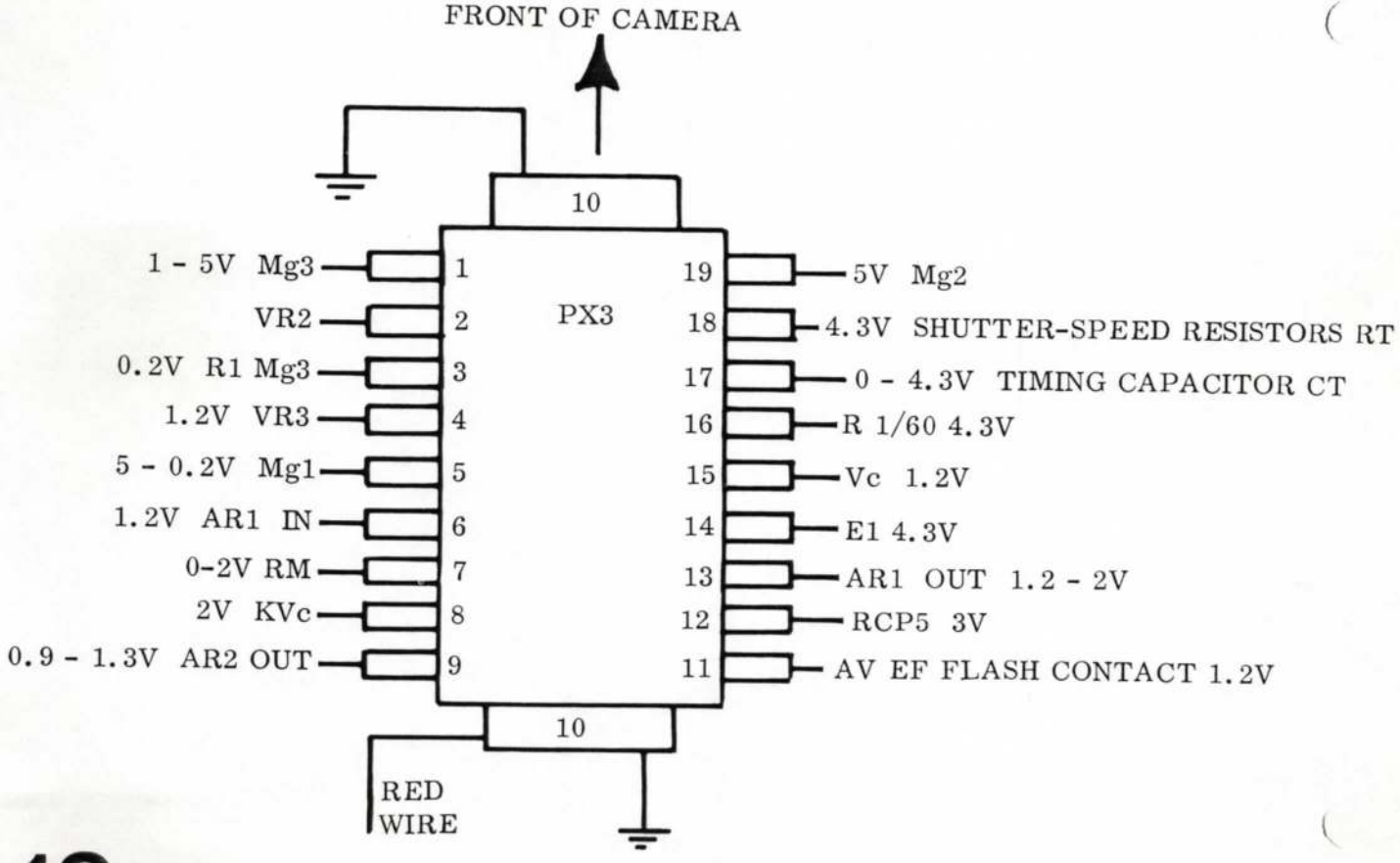


* VR unit shown removed for clarity
Encircled letters indicate connection points on main board

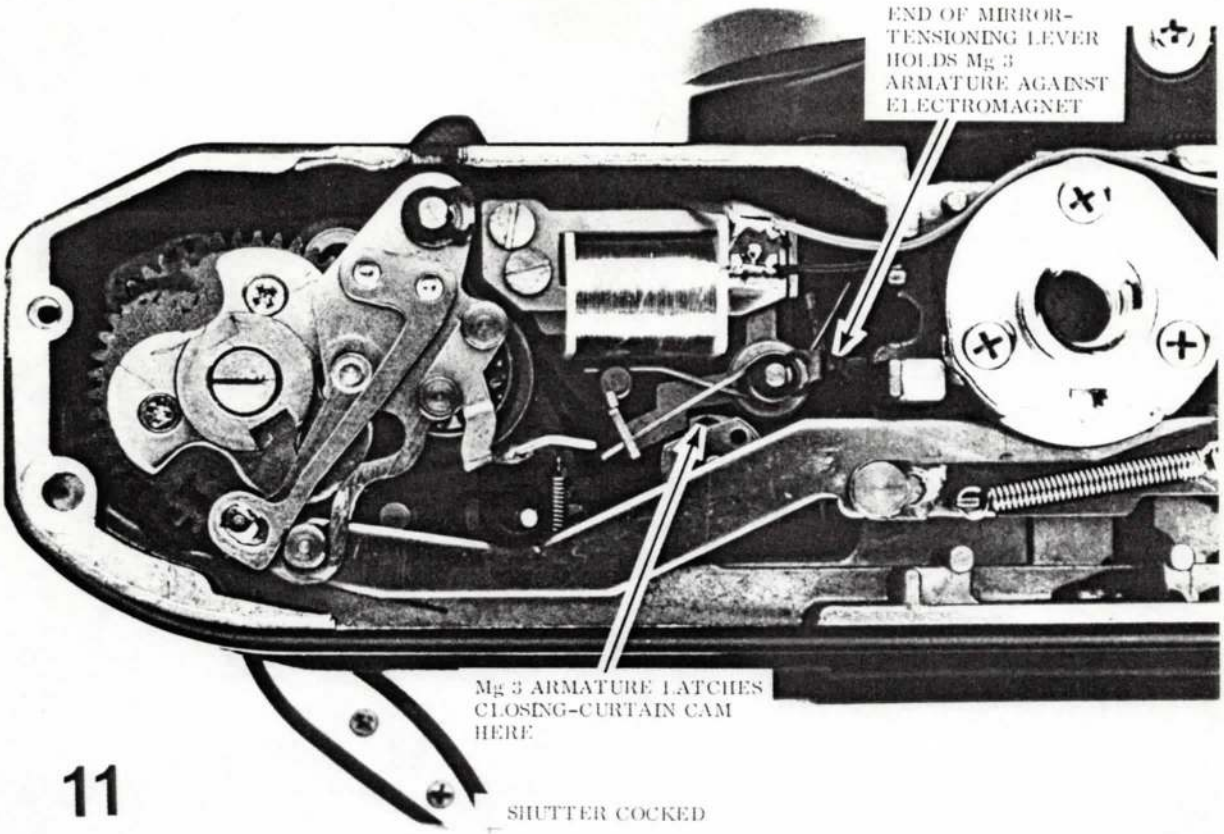
Courtesy of Canon



WIND-LEVER SIDE

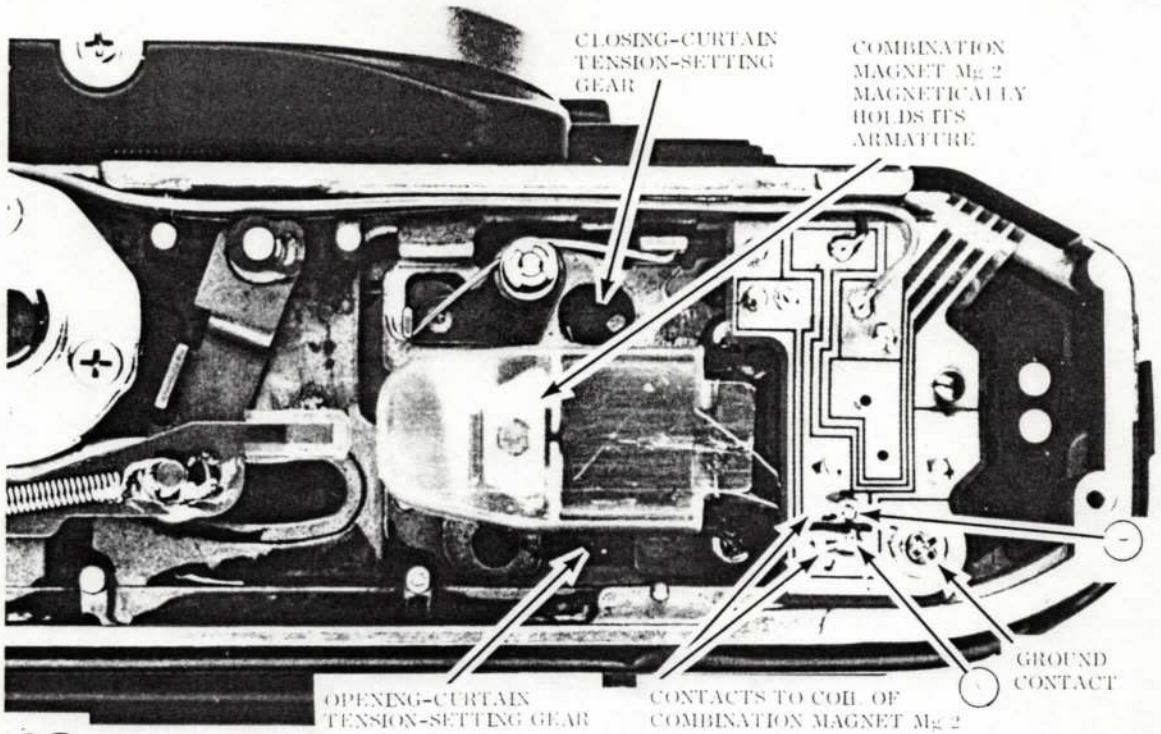


REWIND SIDE



11

In the shutter-cocked position, the overtravel measured between the latching surface of the closing-curtain cam and the Mg3 armature should be 0.05 - 0.15mm. Make the overtravel adjustment by first loosening the two allen-head screws on the closing-curtain cam. Then, rotate the closing-curtain cam to change the overtravel.



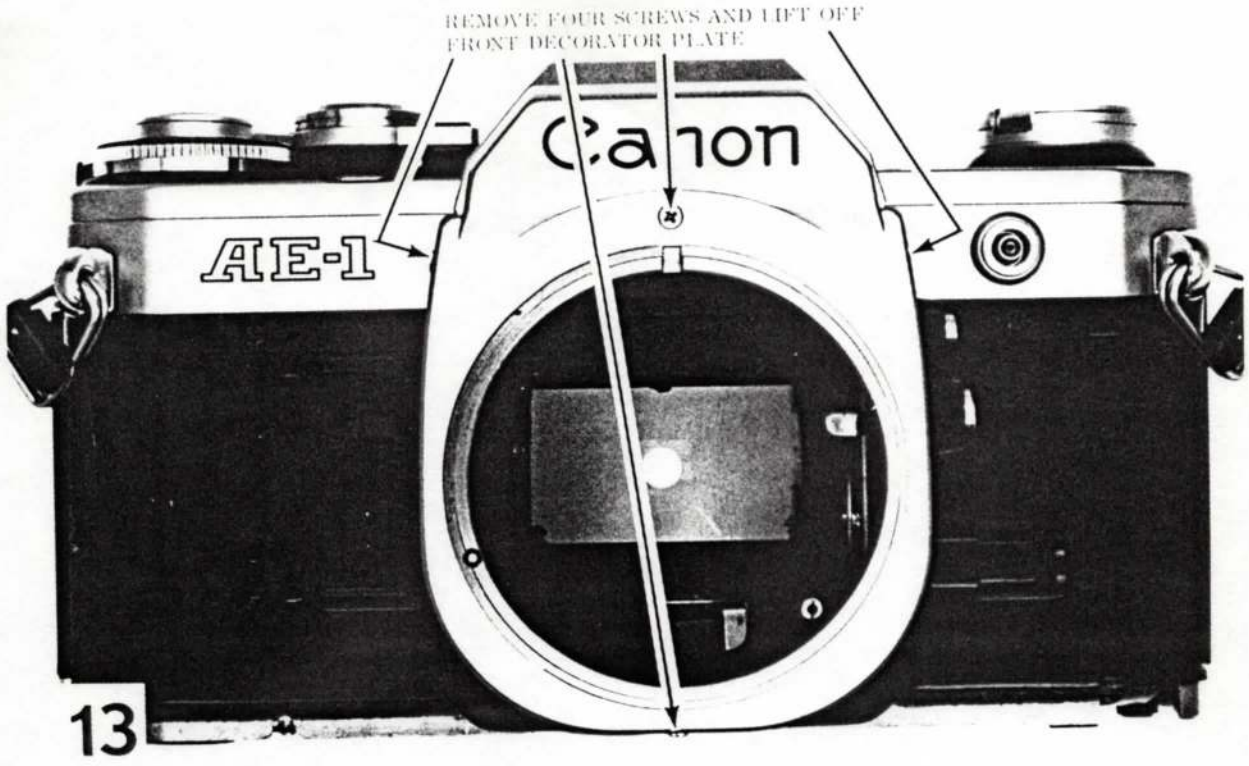
12

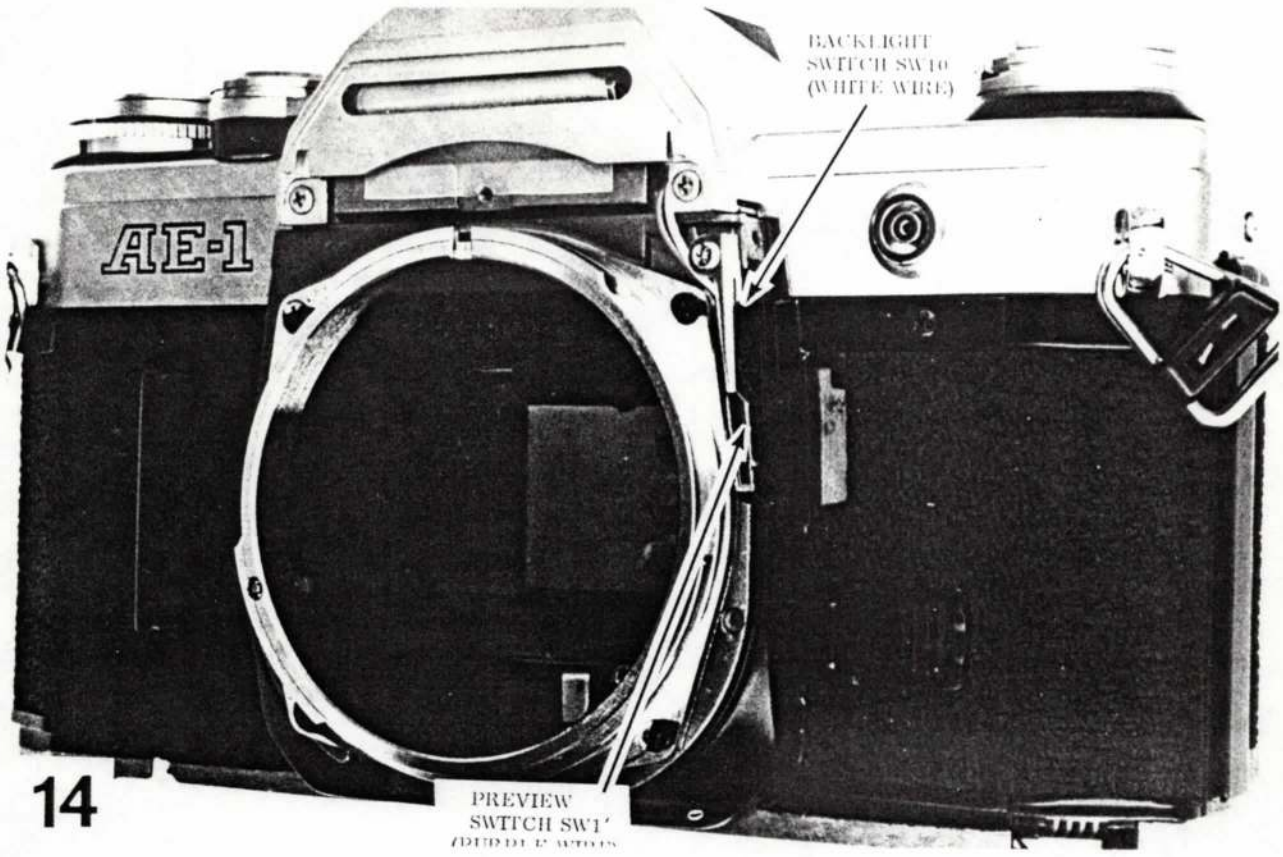
SHUTTER COCKED

When you depress the release button, a spurt of current flows through the Mg2 coil. That reverses the polarity of the permanent magnet. And the permanent magnet releases the armature to disengage the mirror.

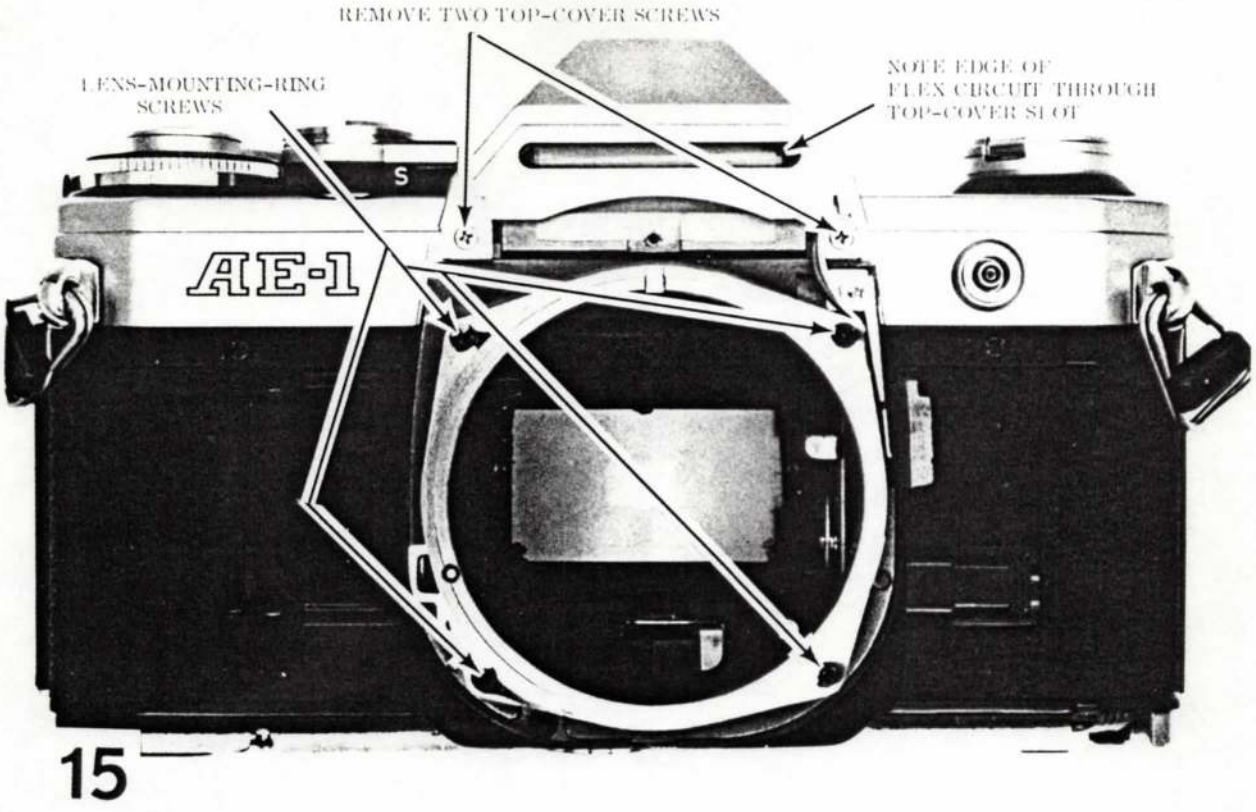
You can test the Mg2 coil by applying 2 volts from a power supply to the two coil connections on the flexible circuit board. With the polarity noted on the photograph, the Mg2 armature should release.

It's possible to reach both curtain-tension adjustments without removing the combination magnet. Turn the tension-setting gears clockwise to decrease the tension, counterclockwise to increase the tension. The proper curtain-travel time is 11.3 ms.

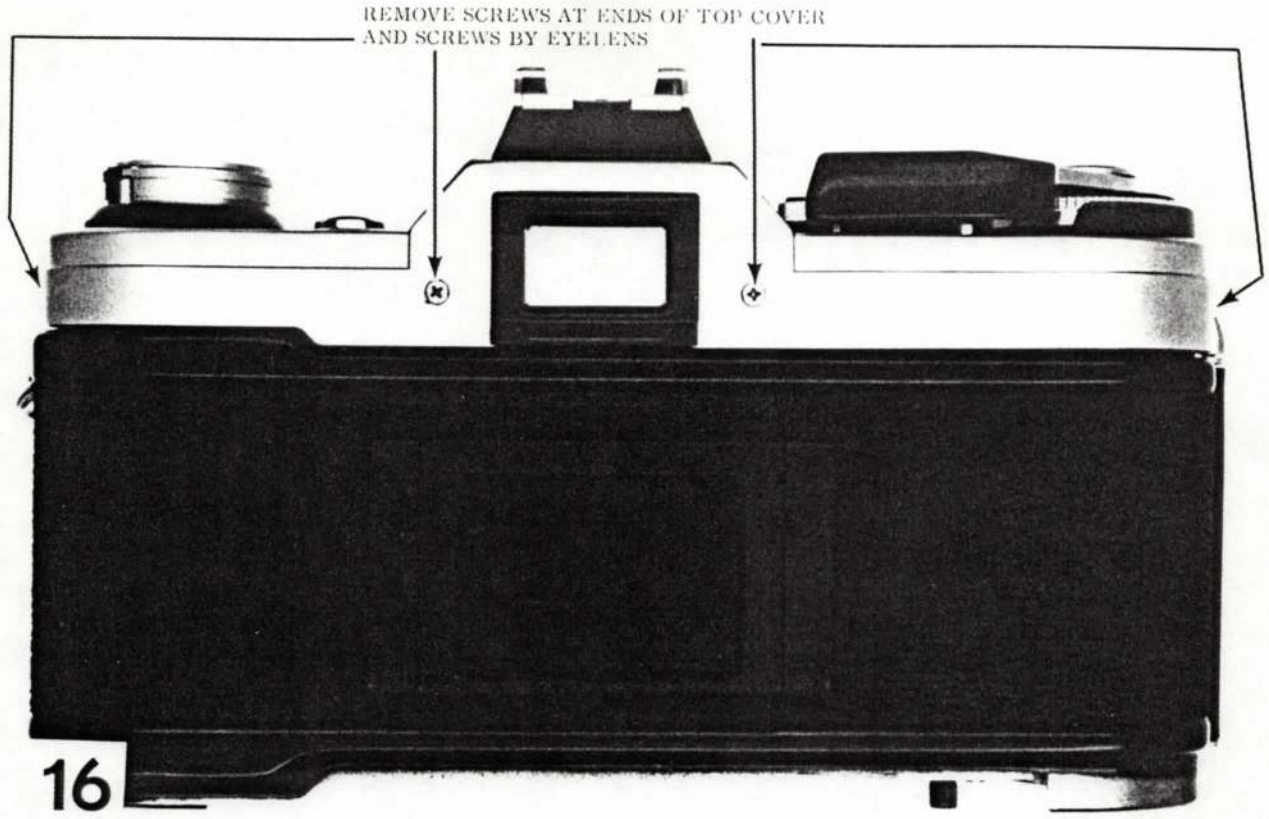

REMOVE FOUR SCREWS AND LIFT OFF
FRONT DECORATOR PLATE
Canon
AE-1
13

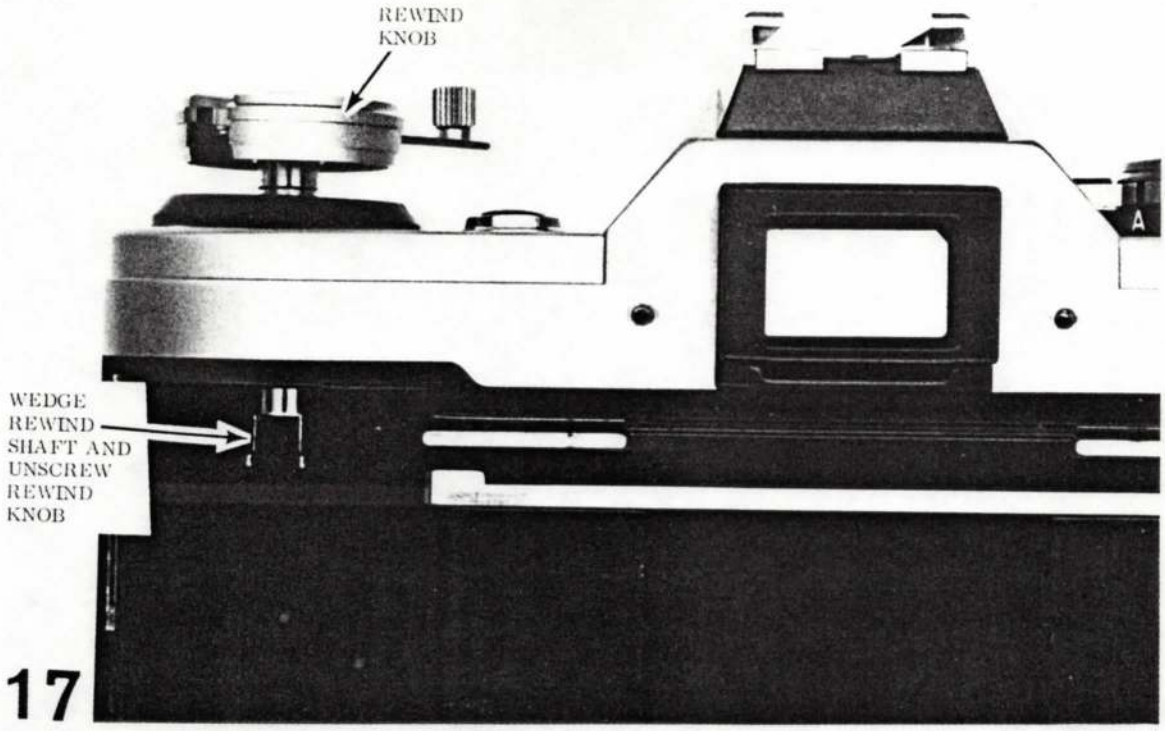


14

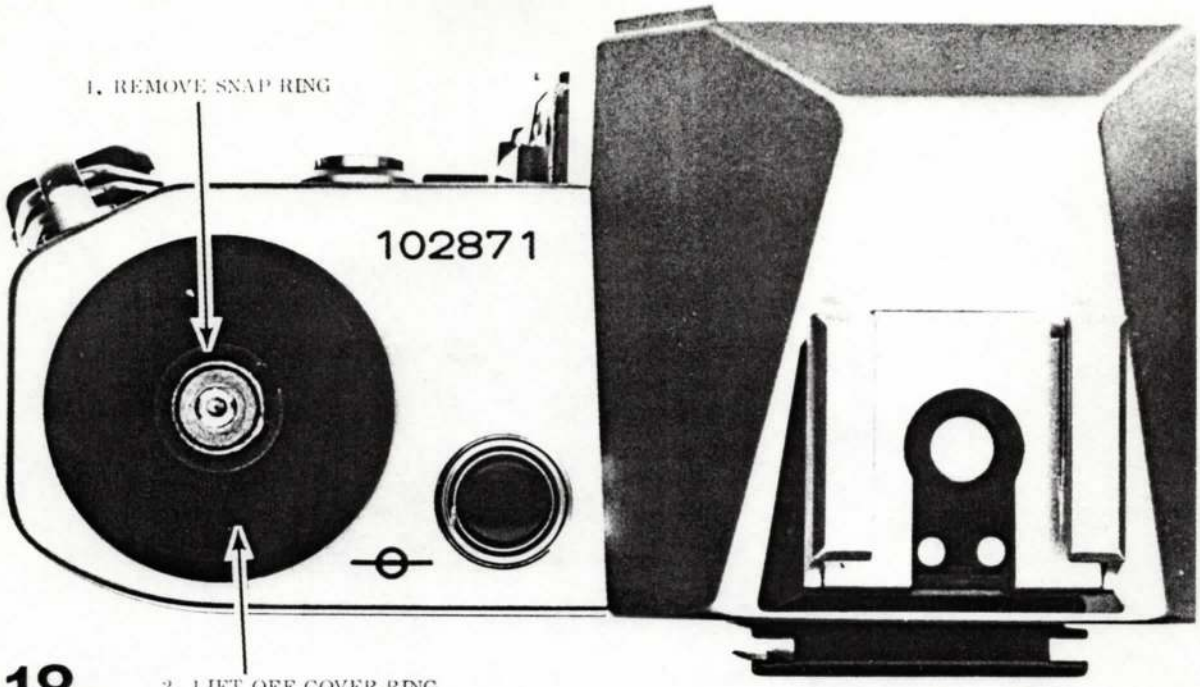


Washers under the lens-mounting ring control the flange-focal distance and parallelism. Adjust the flange-focal distance to 41.9mm between the front of the lens-mounting ring and the film-guide rails -- or to 42.14mm between the lens-mounting ring and the pressure-plate rails.


REMOVE SCREWS AT ENDS OF TOP COVER
AND SCREWS BY EYELENS
16

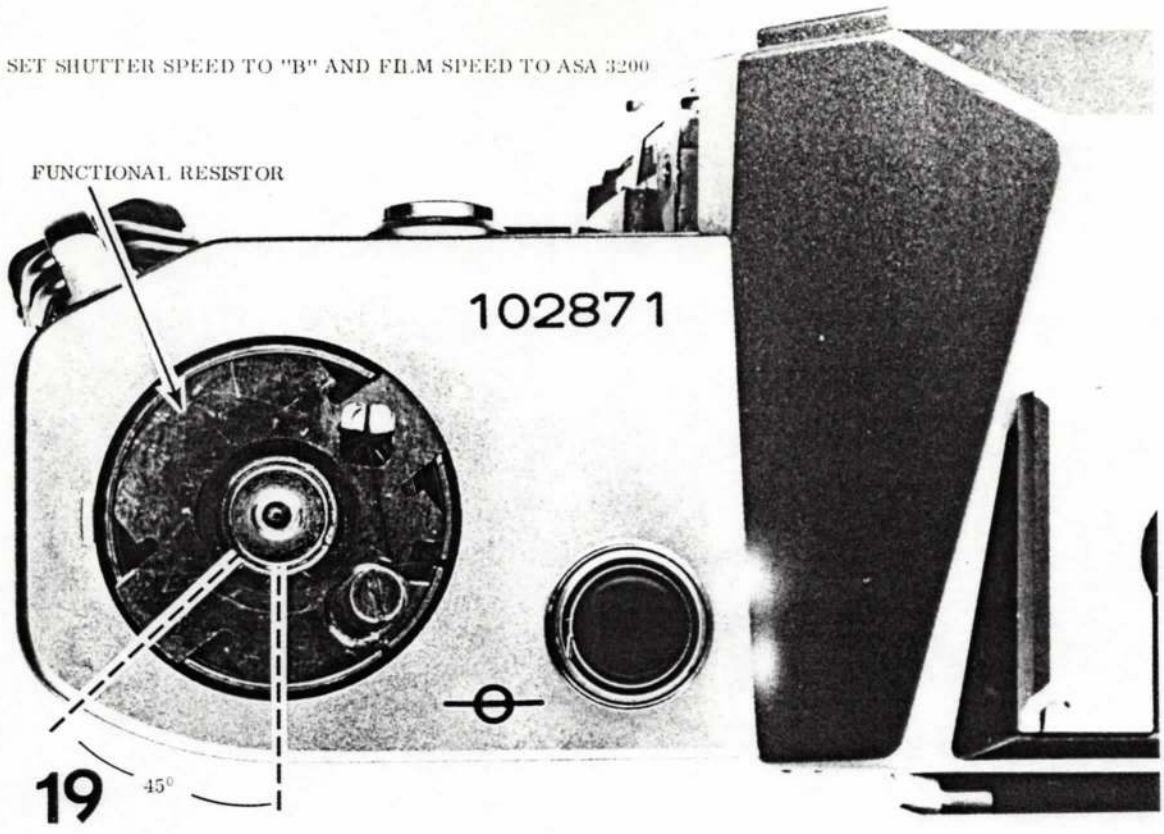


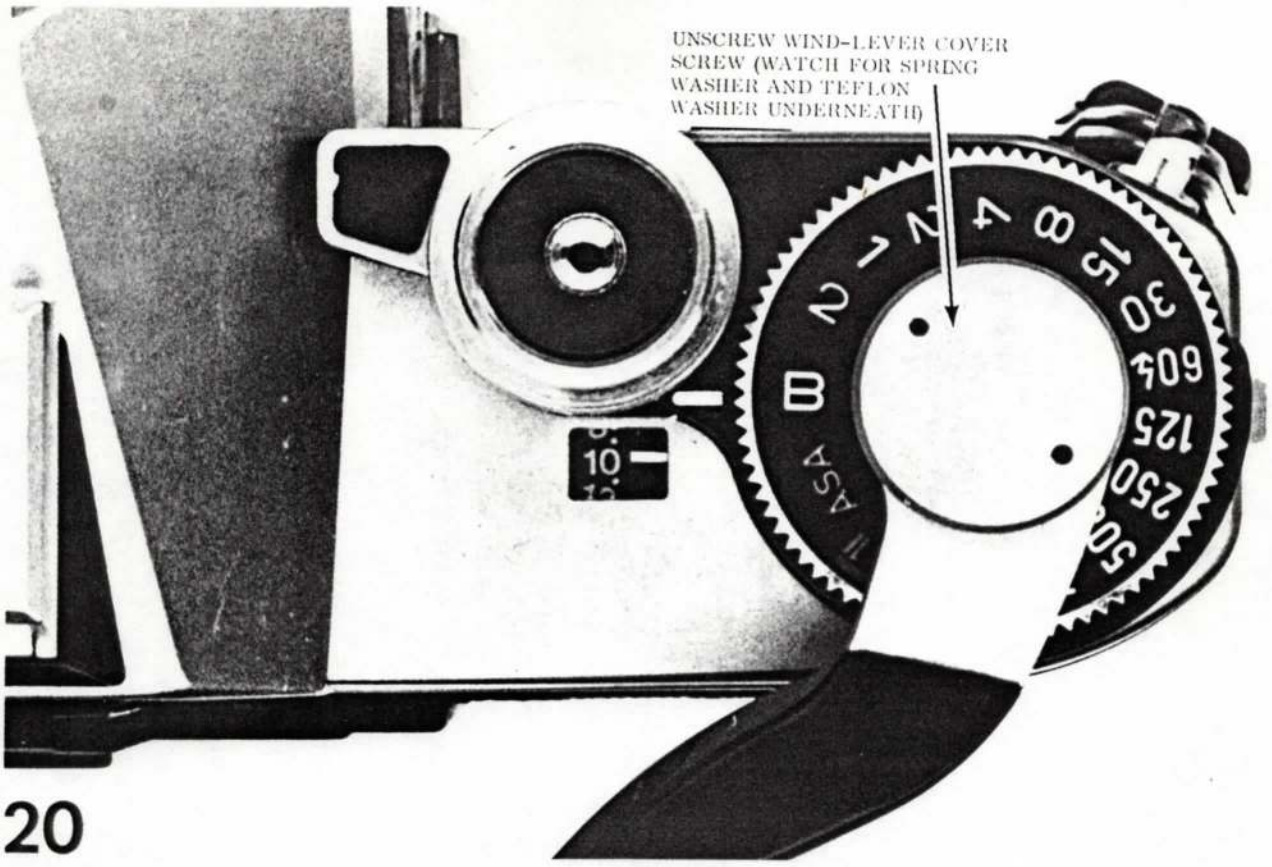
17



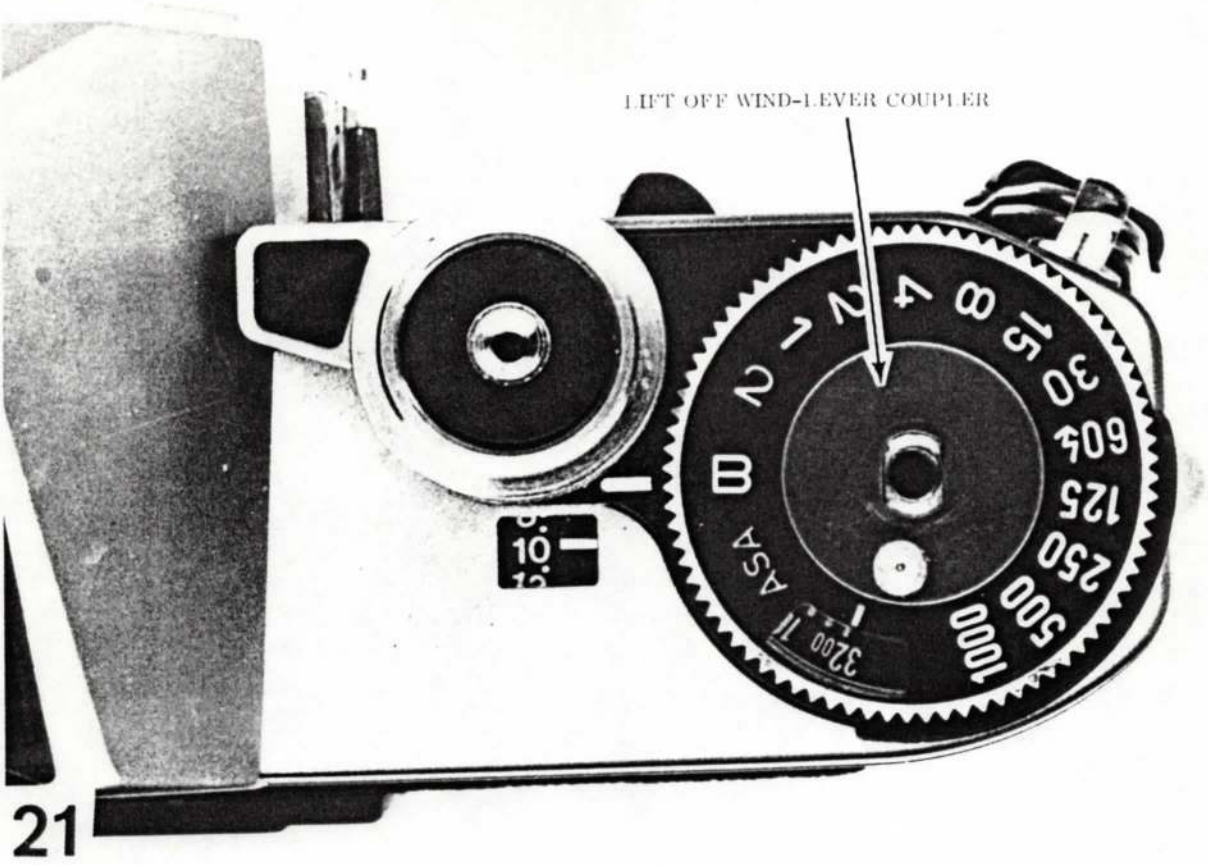
18

SET SHUTTER SPEED TO "B" AND FILM SPEED TO ASA 3200

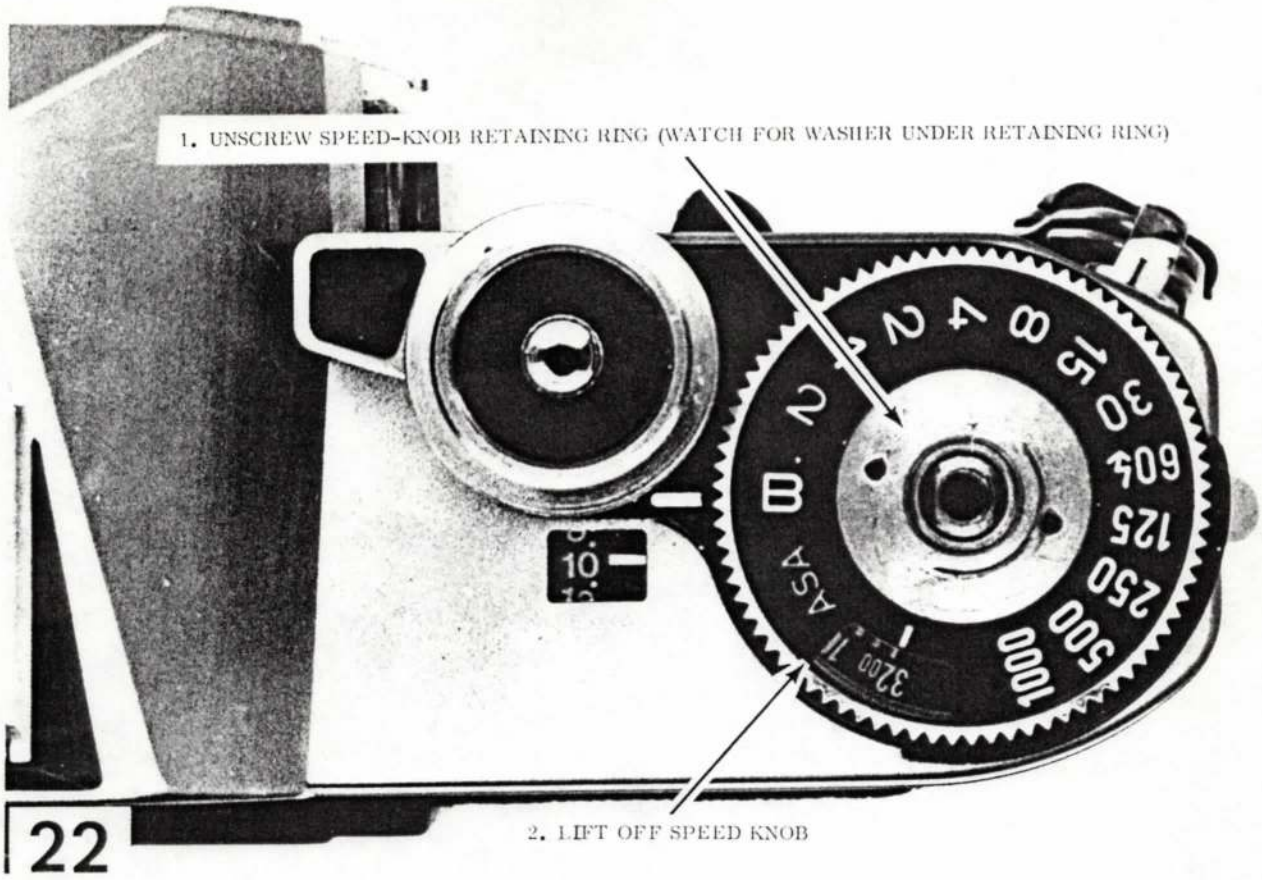


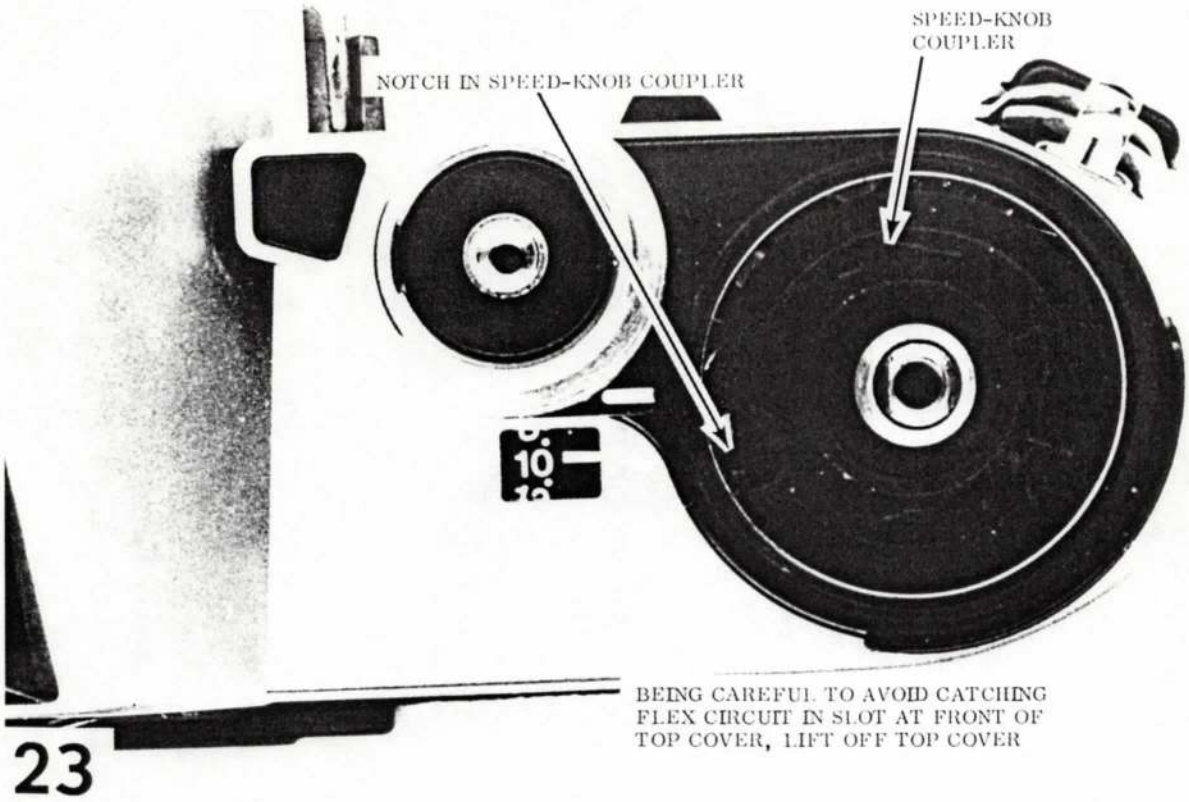

UNSCREW WIND-LEVER COVER SCREW (WATCH FOR SPRING WASHER AND TEFLON WASHER UNDERNEATH)
ASA
B
2
4
8
15
30
60
125
250
500
10

20



21

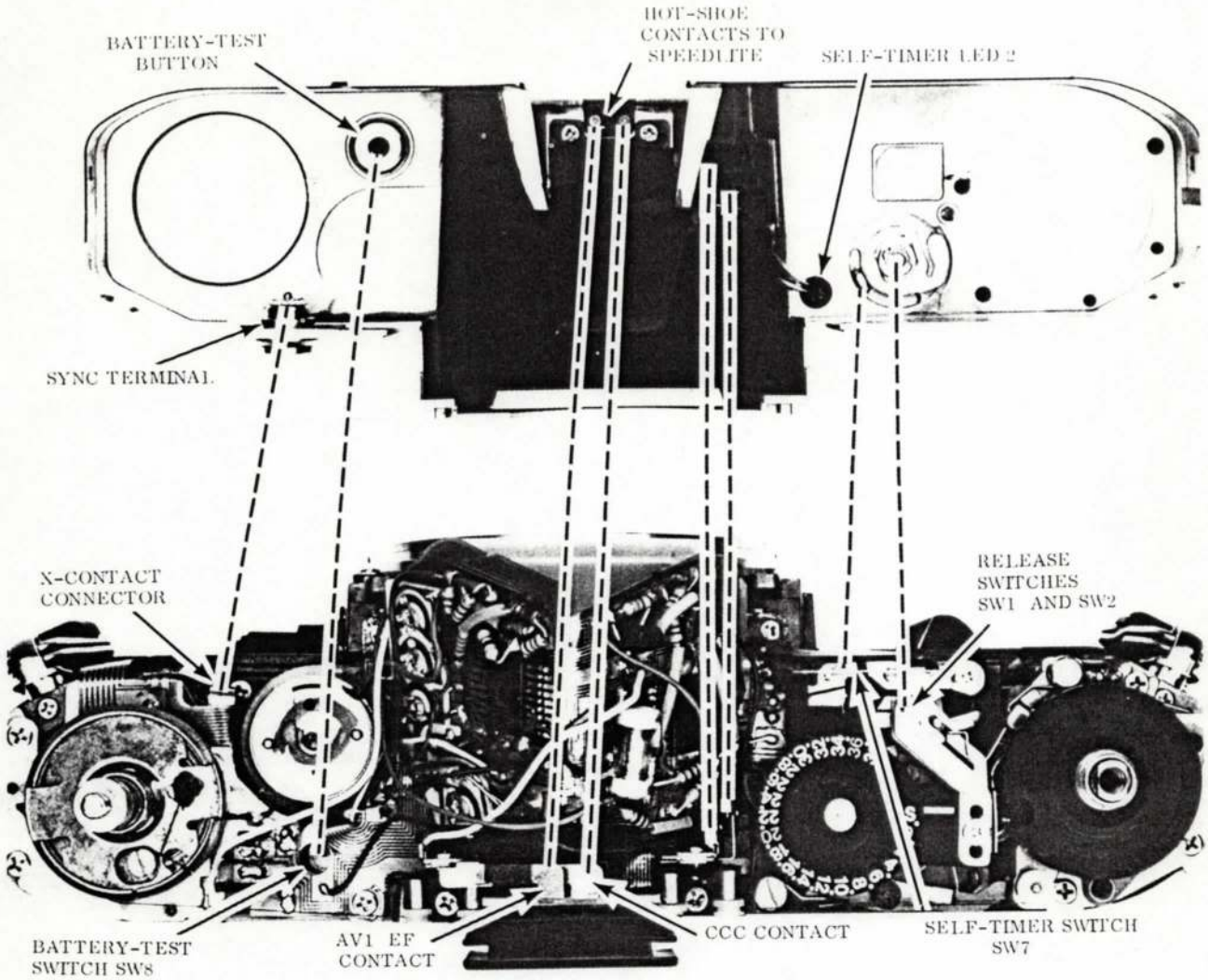

1. UNSCREW SPEED-KNOB RETAINING RING (WATCH FOR WASHER UNDER RETAINING RING)
2. LIFT OFF SPEED KNOB
B
ASA
2
4
8
15
30
60
125
250
500
1000
10

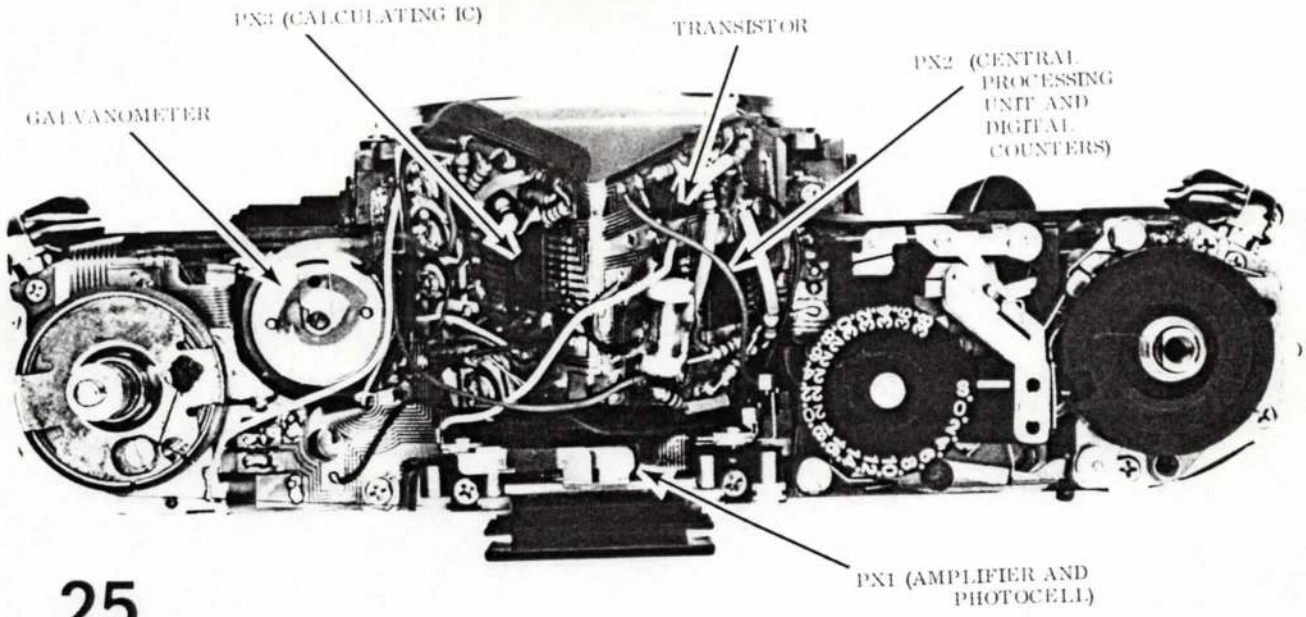


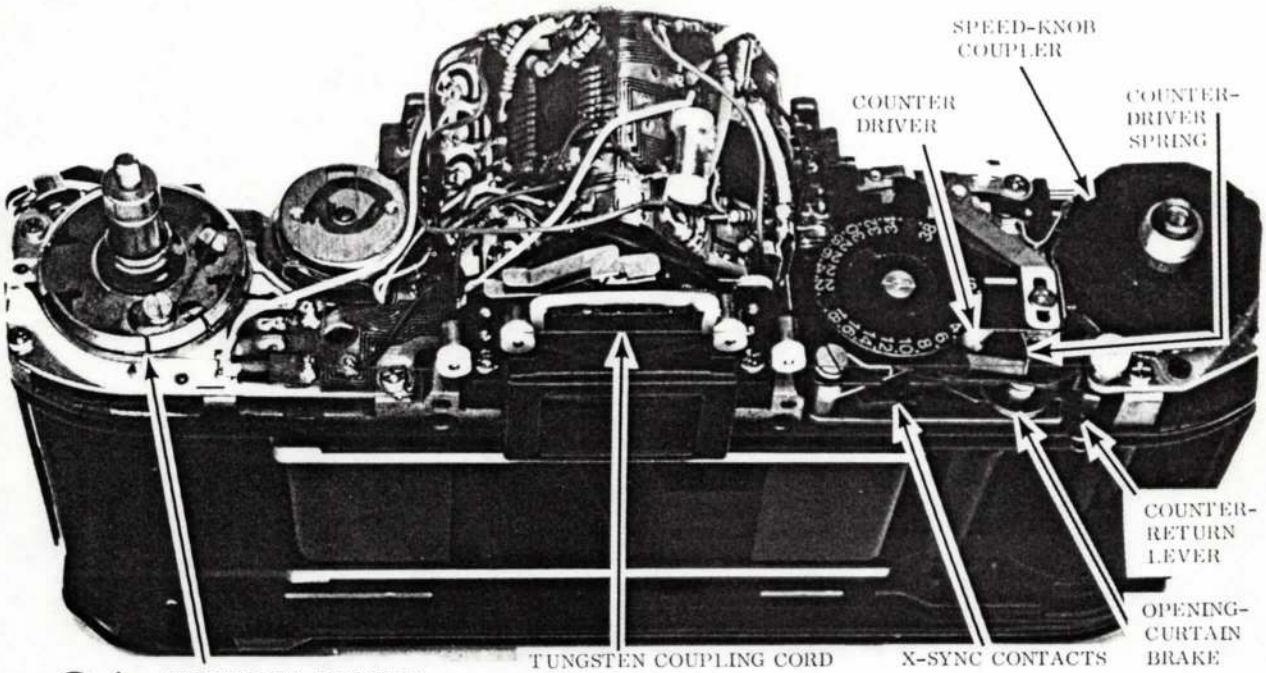
23

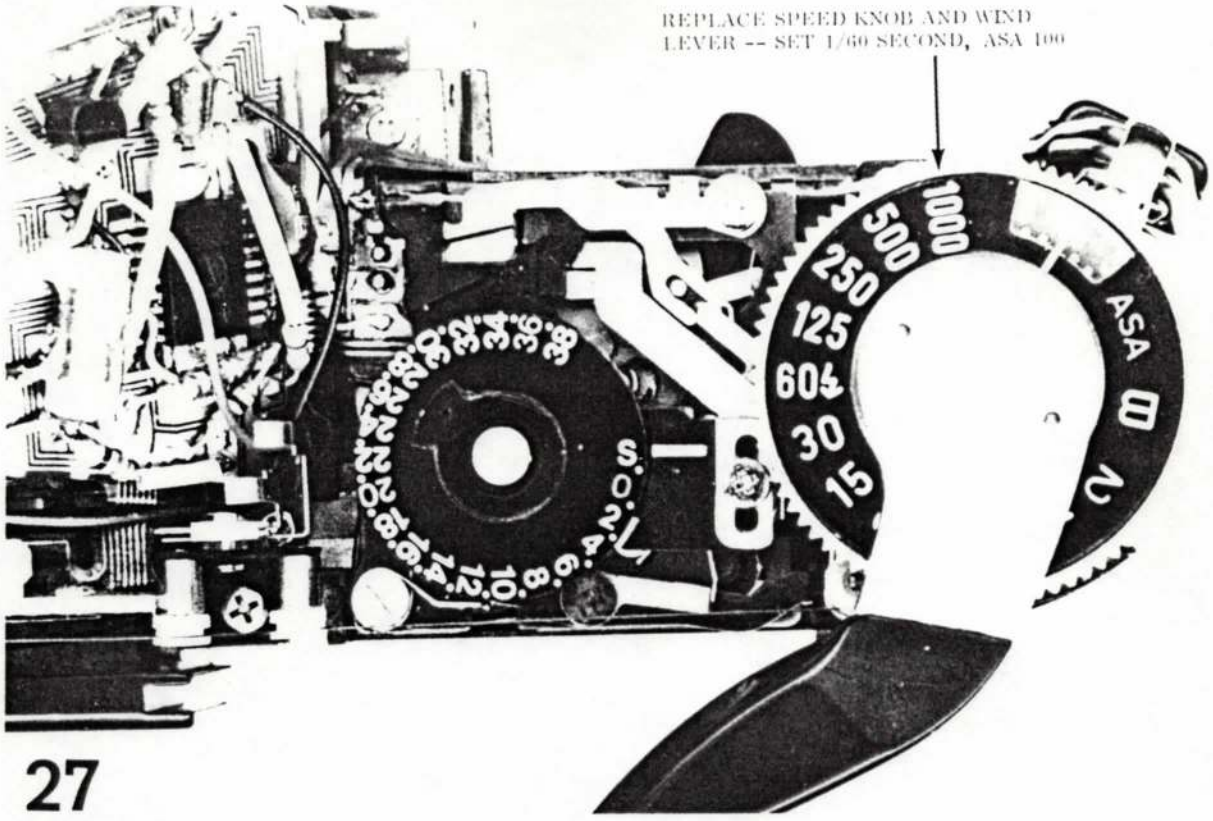
BEING CAREFUL TO AVOID CATCHING FLEX CIRCUIT IN SLOT AT FRONT OF TOP COVER, LIFT OFF TOP COVER

The speed-knob coupler couples the speed knob to the functional resistor. Notice the tab on the underside of the speed knob -- this tab must fit into the notch in the speed-knob coupler. You'll sometimes find that the speed-knob coupler has two notches. In that case, use the notch closer to the front of the camera. To replace the speed knob, place the tab in the coupler notch. Then, turn the speed knob counterclockwise until it drops into place at the "B" position.

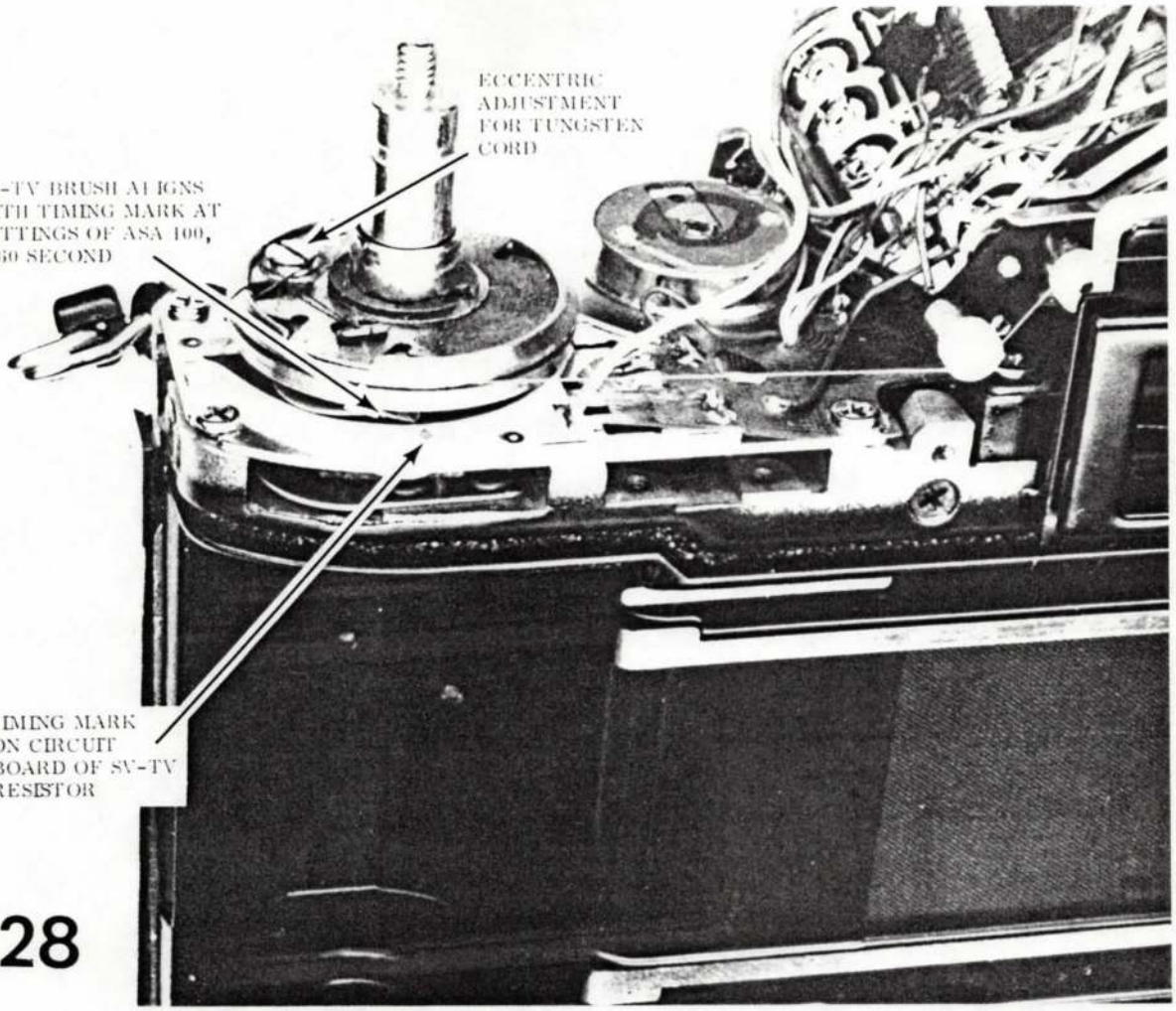

BATTERY-TEST BUTTON
HOT-SHOE CONTACTS TO SPEEDLITE
SELF-TIMER LED 2
SYNC TERMINAL
X-CONTACT CONNECTOR
RELEASE SWITCHES SW1 AND SW2
BATTERY-TEST SWITCH SW8
AV1 EF CONTACT
CCC CONTACT
SELF-TIMER SWITCH SW7

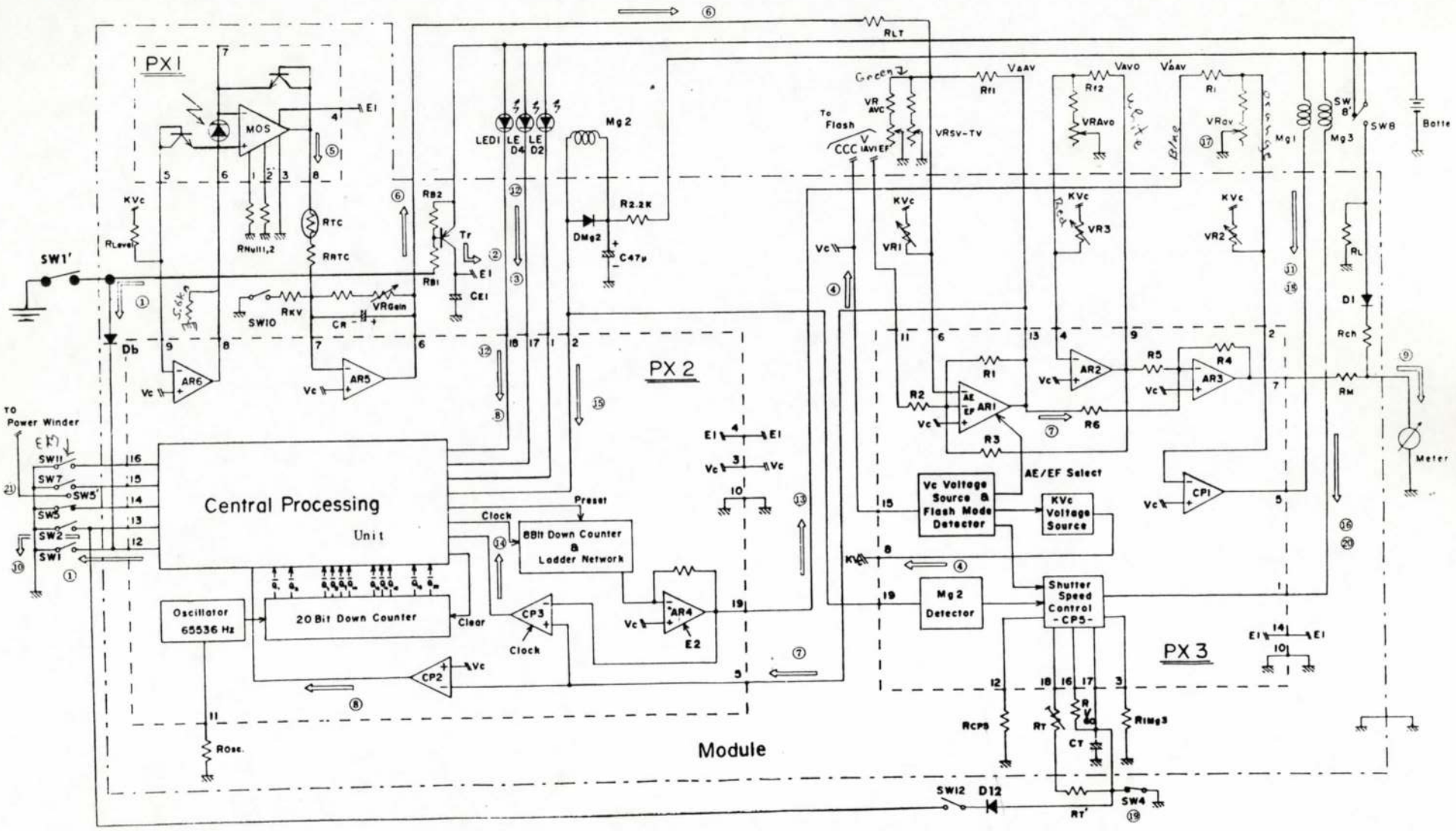

PX3 (CALCULATING IC)
TRANSISTOR
PX2 (CENTRAL PROCESSING UNIT AND DIGITAL COUNTERS)
GALVANOMETER
PX1 (AMPLIFIER AND PHOTOCELL)

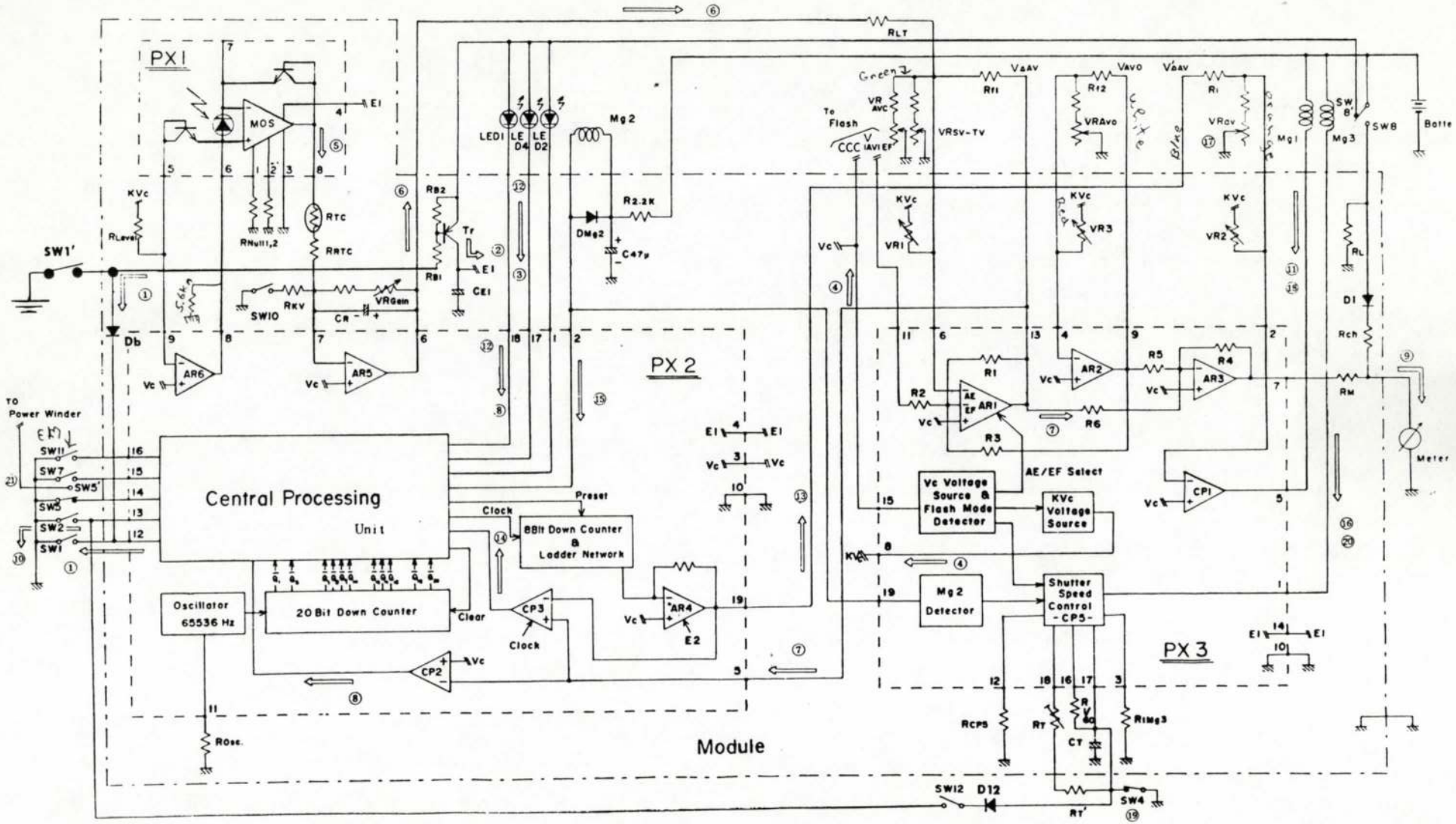

SPEED-KNOB COUPLER
COUNTER DRIVER
COUNTER-DRIVER SPRING
COUNTER-RETURN LEVER
OPENING-CURTAIN BRAKE
FUNCTIONAL RESISTOR (SV-TV)
TUNGSTEN COUPLING CORD
X-SYNC CONTACTS

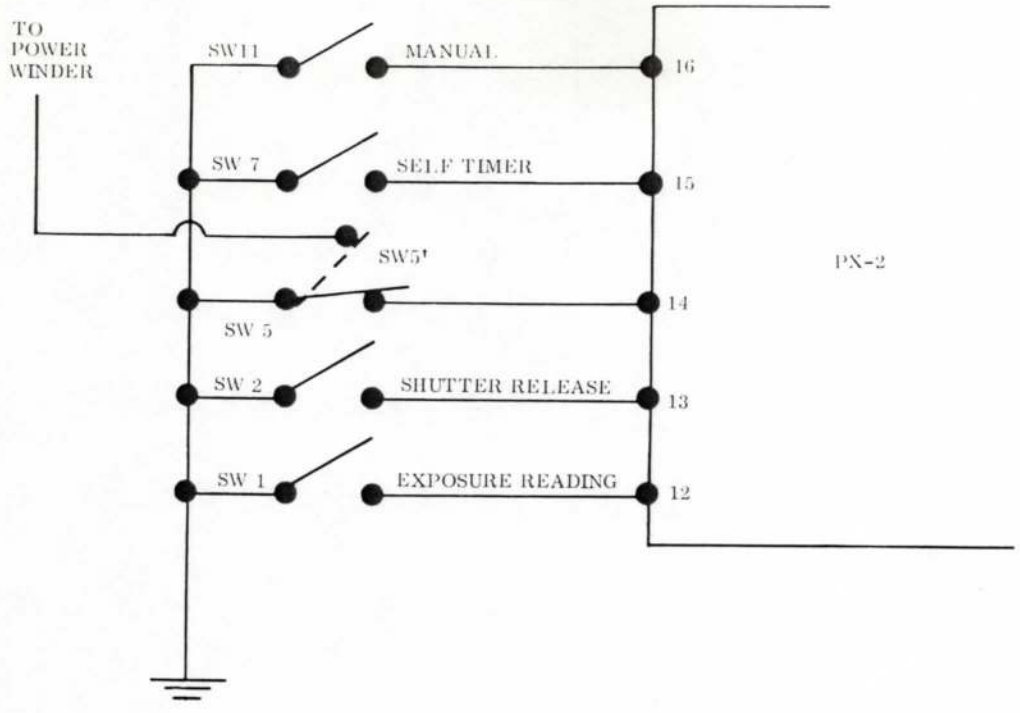

REPLACE SPEED KNOB AND WIND
LEVER -- SET 1/60 SECOND, ASA 100
1000
500
250
125
60
30
15
ASA

27

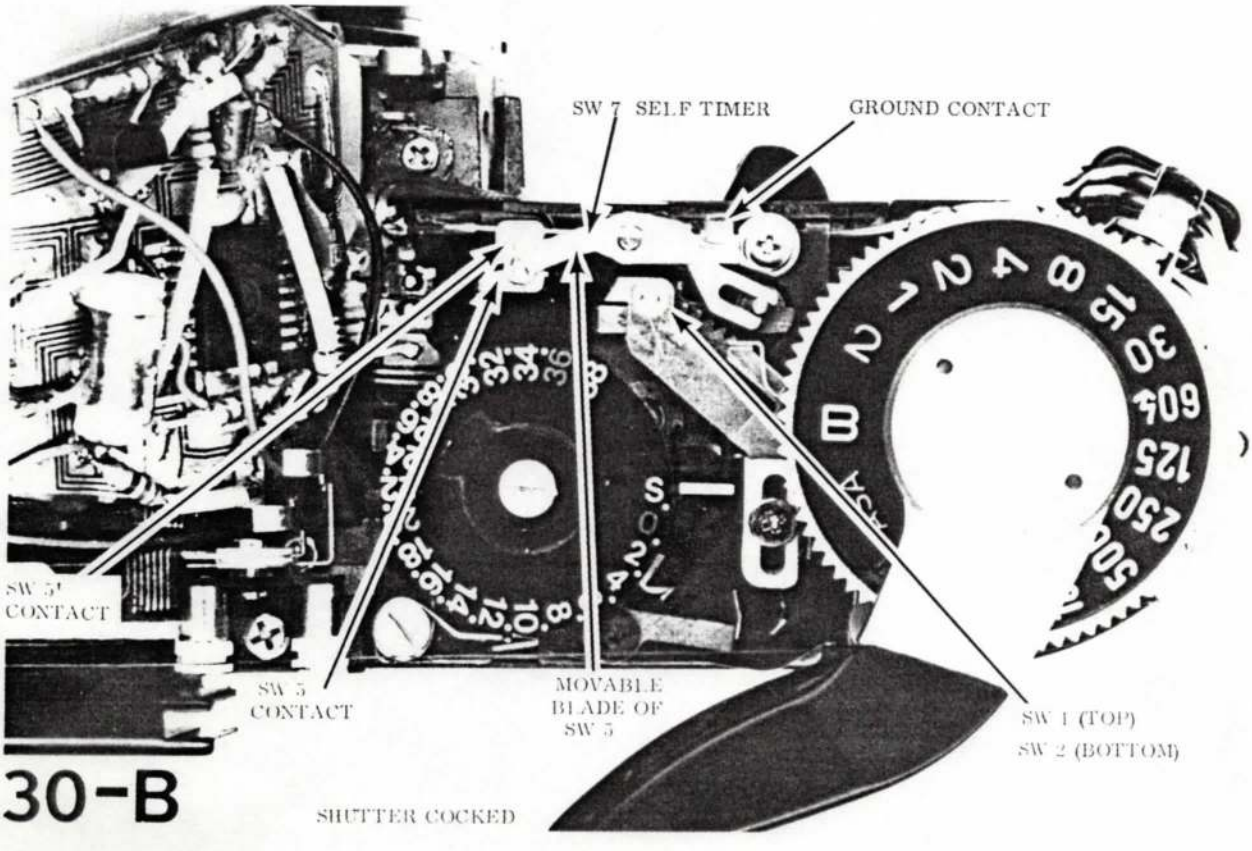

ECCENTRIC ADJUSTMENT FOR TUNGSTEN CORD
SV-TV BRUSH ALIGNS WITH TIMING MARK AT SETTINGS OF ASA 100, 1/60 SECOND
TIMING MARK ON CIRCUIT BOARD OF SV-TV RESISTOR


PX1
PX2
PX3
MOS
LED1
LED4
LED2
Mg2
DMg2
R2.2K
C47p
RLT
Rf1
Rf2
Ri
VR AVC
VRSV-TV
VRAvo
VRAv
VR1
VR2
VR3
SW1'
SW10
Rkv
VRGain
CR
RB2
RB1
Tr
CE1
RTC
RRTC
RHull1,2
RLevel
Db
AR6
AR5
AR1
AR2
AR3
AR4
R1
R2
R3
R4
R5
R6
RL
Rch
RM
D1
Meter
Batte
SW8
SW8'
Mg1
Mg3
Central Processing Unit
8Bit Down Counter & Ladder Network
20 Bit Down Counter
Oscillator 65536 Hz
CP1
CP2
CP3
Clock
Preset
Clear
E1
E2
Vc
KVc
AE/EF Select
Vc Voltage Source & Flash Mode Detector
KVc Voltage Source
Mg2 Detector
Shutter Speed Control -CPS-
RCPS
RT
CT
RImg3
ROsc.
SW11
SW7
SW5'
SW5
SW2
SW1
SW12
D12
SW4
RT'
TO Power Winder
To Flash
Module

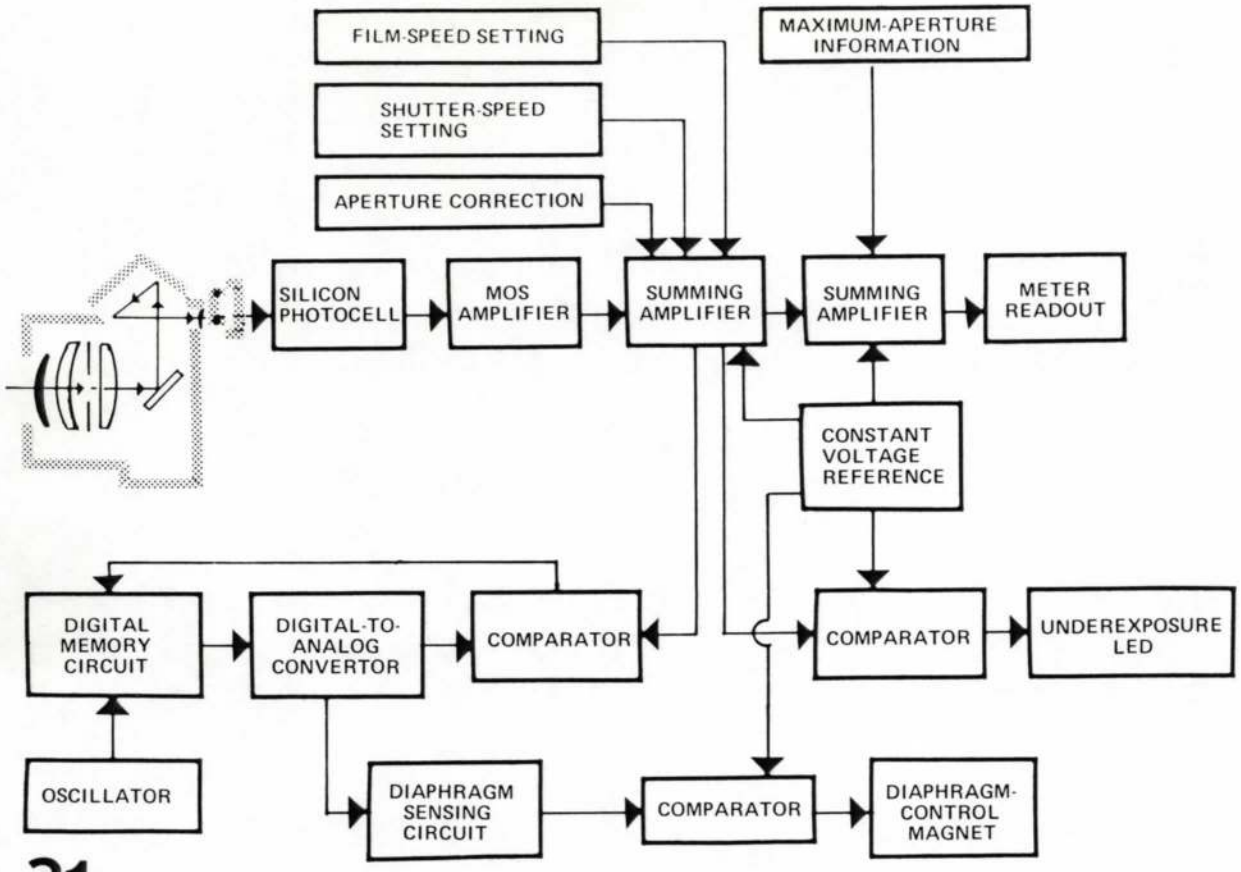

PX1
PX2
PX3
MOS
LED1
LED2
LED3
Mg2
Mg1
Mg3
SW8'
SW8
Batte
RLT
Green
To Flash
VRSV-TV
VRAvo
VRAv
Blue
Orange
KVc
VR1
VR2
VR3
RLevel
RNull1,2
RTC
RRTC
RB2
RB1
Tr
CE1
R2.2K
DMg2
C47p
SW1'
SW10
RKV
CR
VRGain
Db
AR6
AR5
AR1
AR2
AR3
AR4
R1
R2
R3
R4
R5
R6
RL
D1
Rch
RM
Meter
TO Power Winder
SW11
SW7
SW5'
SW5
SW2
SW1
Central Processing Unit
Clock
Preset
8Bit Down Counter & Ladder Network
Oscillator 65536 Hz
20 Bit Down Counter
Clear
CP3
CP2
E1
E2
Vc
Rosc.
AE/EF Select
Vc Voltage Source & Flash Mode Detector
KVc Voltage Source
Mg2 Detector
Shutter Speed Control -CP5-
CP1
RCP5
RT
CT
RTMg3
RT'
SW12
D12
SW4
Module

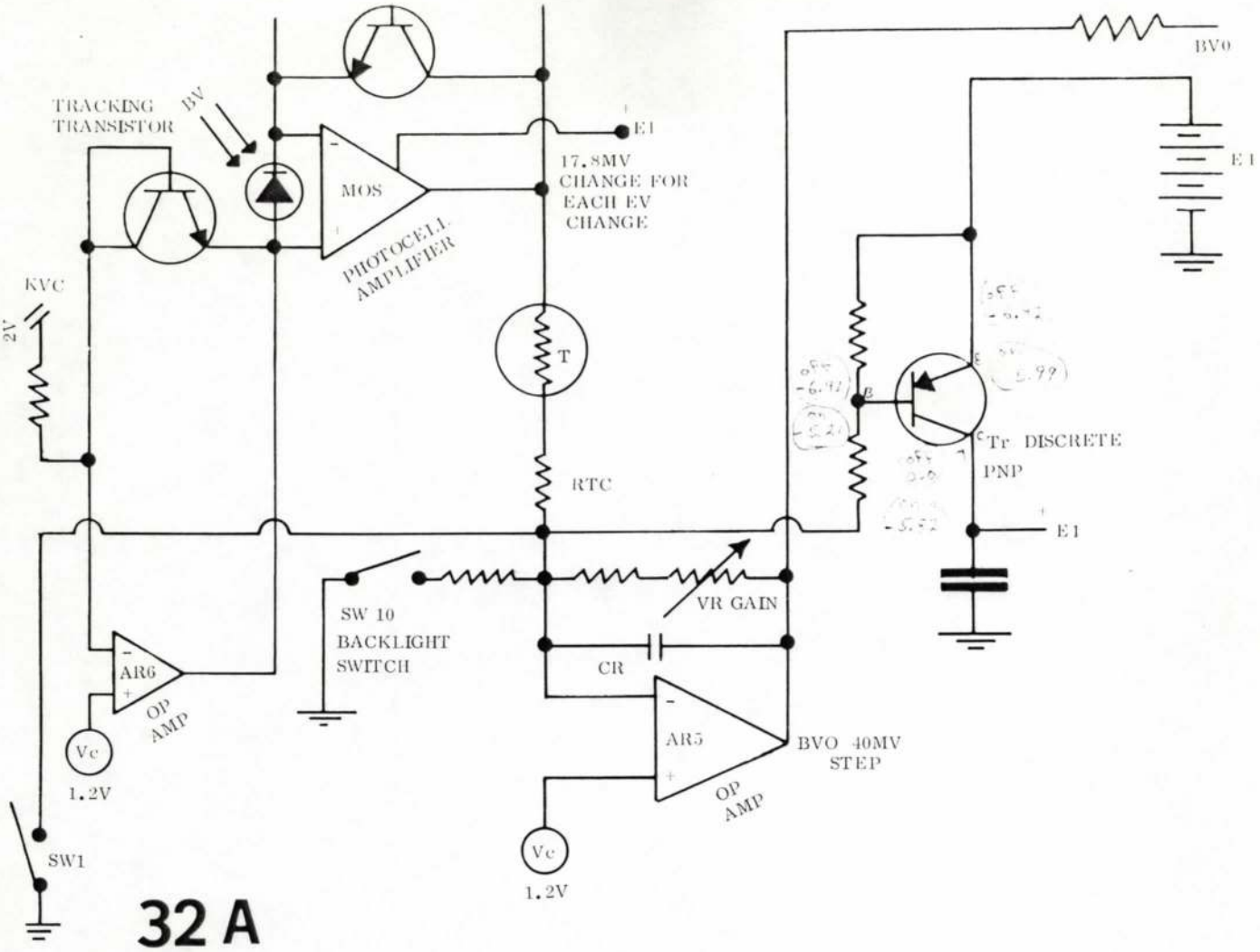

TO
POWER
WINDER
SW11
MANUAL
16
SW 7
SELF TIMER
15
SW5'
PX-2
SW 5
14
SW 2
SHUTTER RELEASE
13
SW 1
EXPOSURE READING
12

30-A

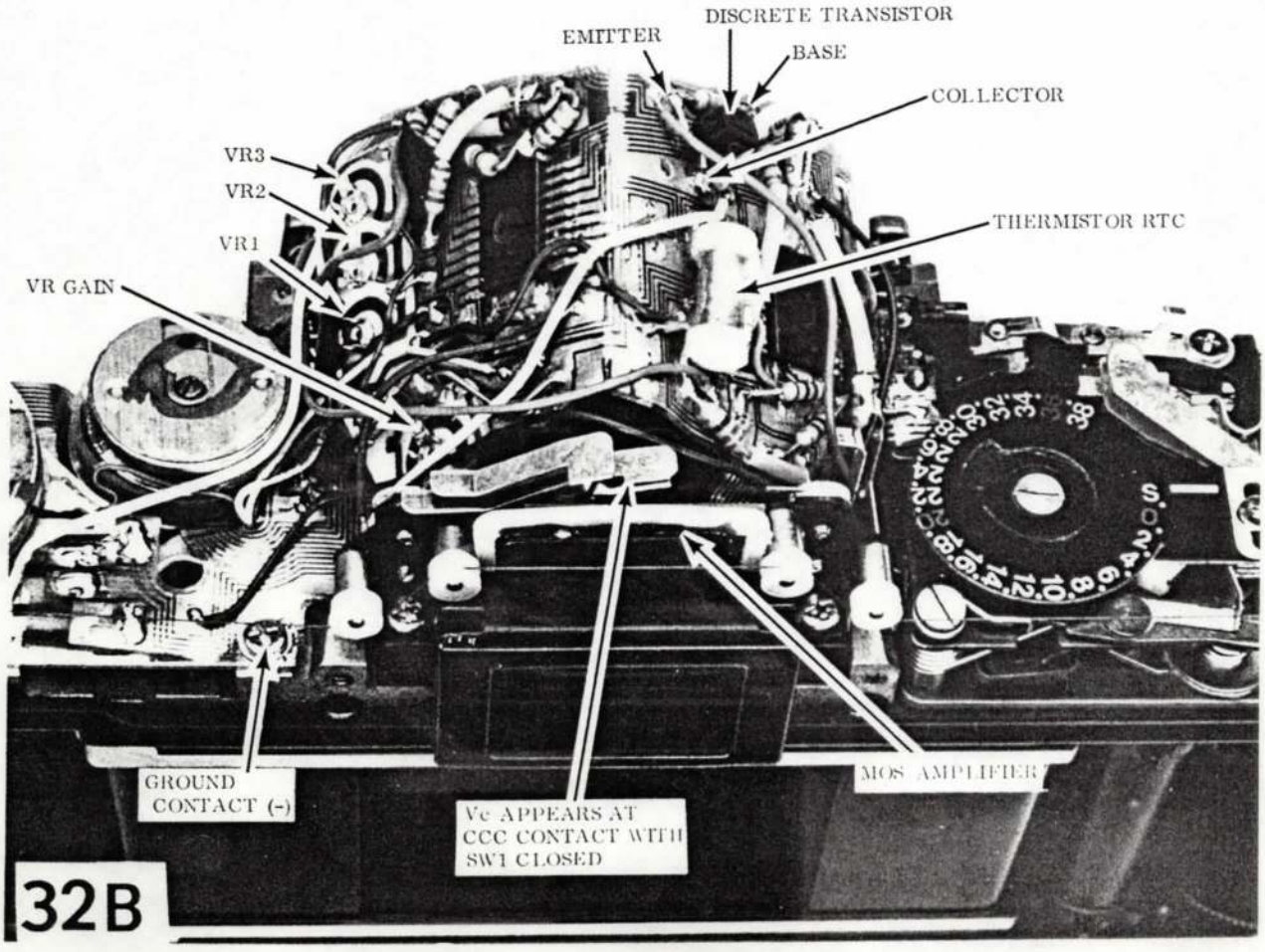

SW 7 SELF TIMER
GROUND CONTACT
SW 5'
CONTACT
SW 5
CONTACT
MOVABLE
BLADE OF
SW 5
SW 1 (TOP)
SW 2 (BOTTOM)
SHUTTER COCKED

30-B


FILM-SPEED SETTING
MAXIMUM-APERTURE INFORMATION
SHUTTER-SPEED SETTING
APERTURE CORRECTION
SILICON PHOTOCELL
MOS AMPLIFIER
SUMMING AMPLIFIER
SUMMING AMPLIFIER
METER READOUT
CONSTANT VOLTAGE REFERENCE
DIGITAL MEMORY CIRCUIT
DIGITAL-TO-ANALOG CONVERTOR
COMPARATOR
COMPARATOR
UNDEREXPOSURE LED
OSCILLATOR
DIAPHRAGM SENSING CIRCUIT
COMPARATOR
DIAPHRAGM-CONTROL MAGNET


TRACKING TRANSISTOR
BV
MOS
PHOTOCELL AMPLIFIER
E1
17.8MV CHANGE FOR EACH EV CHANGE
KVC
2V
T
RTC
BVO
E1
Tr DISCRETE PNP
E1
SW 10 BACKLIGHT SWITCH
VR GAIN
CR
AR6
OP AMP
Vc
1.2V
AR5
BVO 40MV STEP
OP AMP
Vc
1.2V
SW1

32 A


EMITTER
DISCRETE TRANSISTOR
BASE
COLLECTOR
VR3
VR2
VR1
VR GAIN
THERMISTOR RTC
GROUND CONTACT (-)
Vc APPEARS AT CCC CONTACT WITH SW1 CLOSED
MOS AMPLIFIER

32B

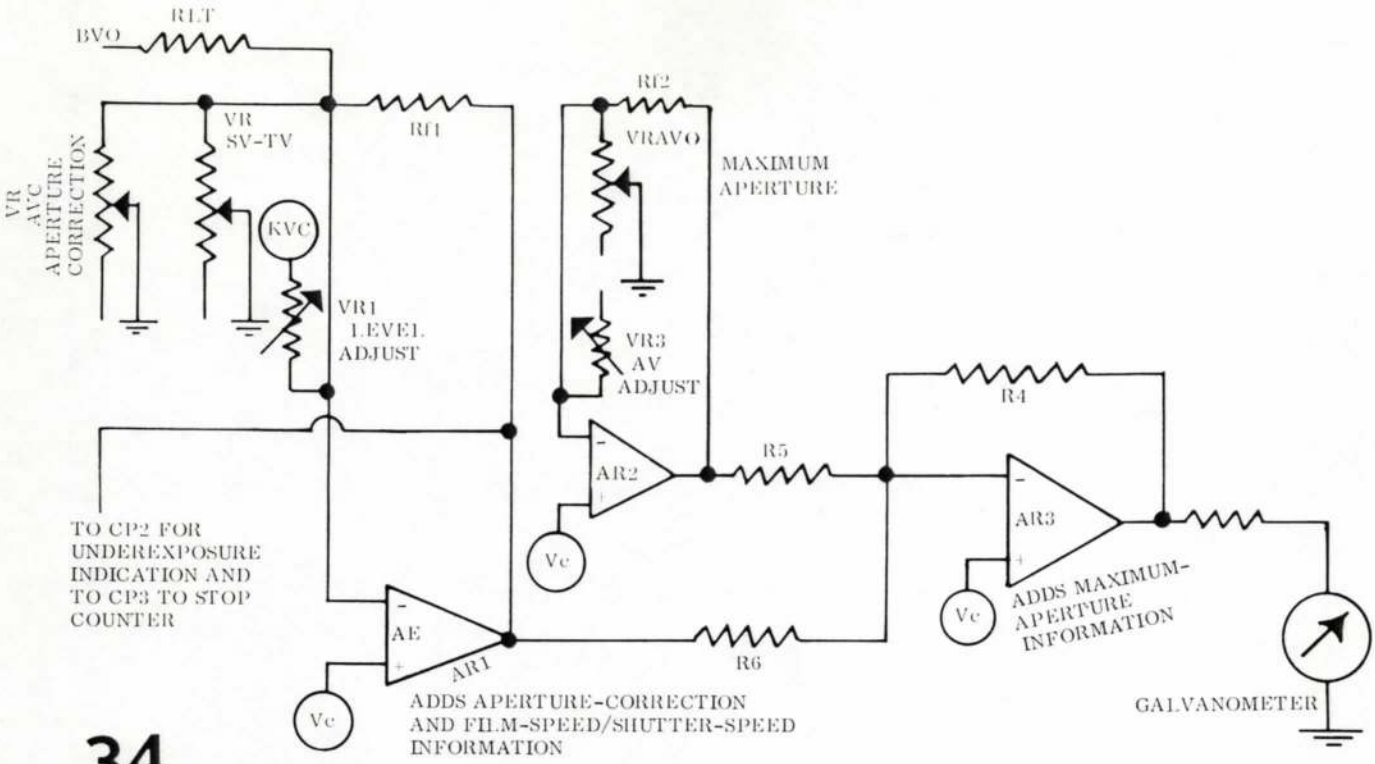
Closing the release-button switch SW1 applies a negative bias to the base of the discrete transistor TR. TR then switches on. So the battery voltage E1 appears at the TR collector. This is the operating voltage applied to each of the three IC's.

Now, the MOS amplifier amplifies the output of the silicon photocell. The transistor between the MOS output and inverting input, connected as a diode, serves as a log converter -- it provides a nonlinear feedback signal. As a result, the MOS amplifies the square root of the input.

A higher light level causes the silicon photocell to apply a more negative signal to the inverting input of the MOS amplifier. So the output of the MOS amplifier goes less negative, or more positive. This amplified output goes to another amplifier -- AR5, which is part of PX 2. AR5 further amplifies the output which goes to the summing resistor RLT. As the output of the MOS goes more positive (higher light level), the output of AR5 goes more negative.

Notice that both AR5 and amplifier AR6 have the precisely regulated reference voltage Vc applied at the noninverting input. This reference voltage, generated within PX3, holds the noninverting inputs constant despite variations in battery voltage. The output of AR6 (pin 8 of PX2) goes to the noninverting input of the MOS (pin 6 of PX1). So AR6 holds the MOS noninverting input constant. The diode-connected transistor that's also hooked to the noninverting input of the MOS tracks changes, such as might be caused by temperature variations.

The feedback circuit for AR5 includes the gain adjustment. The backlight switch SW10 also affects the gain of AR5. When you close the backlight switch, you get an increase in exposure of 1.5 f/stops. Capacitor CR serves as a noise filter to filter out fluctuations that may be present in the light source.


BVO
RLT
VR
SV-TV
Rf1
VR
AVC
APERTURE
CORRECTION
KVC
VR1
LEVEL
ADJUST
Rf2
VRAVO
MAXIMUM
APERTURE
VR3
AV
ADJUST
R4
R5
AR2
AR3
TO CP2 FOR
UNDEREXPOSURE
INDICATION AND
TO CP3 TO STOP
COUNTER
Vc
Vc
Vc
AE
AR1
R6
ADDS MAXIMUM-
APERTURE
INFORMATION
GALVANOMETER
ADDS APERTURE-CORRECTION
AND FILM-SPEED/SHUTTER-SPEED
INFORMATION

BVO, the brightness value after passing through the lens, now appears at the summing resistor RLT. This voltage goes to the inverting input of amplifier AR1. But there are two other input resistors at the AR1 inverting input -- VR AVC, the aperture correction, and VR SV — TV, the film-speed and shutter-speed information.

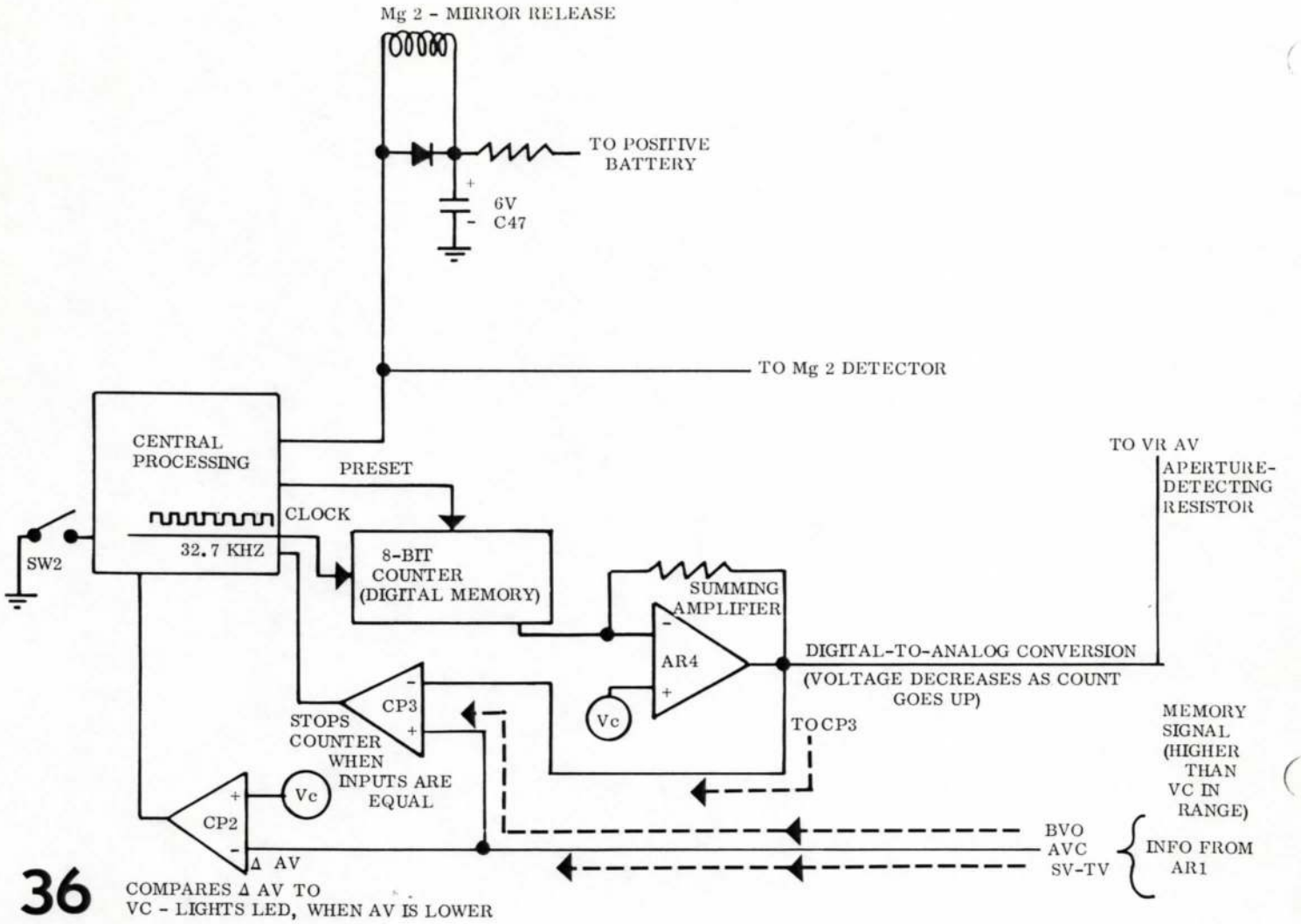
The maximum-aperture post on the back of the lens sets the resistance value of VR AVC. This resistance provides the 0.7 f/stop correction required between f/stops f/2.8 and f/1.2. And the functional resistor, controlled by the speed knob, provides the VR SV — TV information.

With its three input resistors, amplifier AR1 serves as a summing amplifier. It adds the aperture-correction and film-speed/shutter-speed information to BVO. The output of AR1 then goes to the inverting input of AR3, the amplifier that actually drives the galvanometer.

AR3 also serves as a summing amplifier. It adds the output of AR1 to the output of AR2. And the output of AR2 is determined by the maximum aperture of the lens. The maximum-aperture correction pin controls two resistors -- VR AVC (the aperture correction) and VR AVO (the maximum-aperture information).

As the light level striking the photocell increases, the output of AR3 goes down (less positive, or more negative). Consequently, the galvanometer needle doesn't deflect as far. The more the light, the less the needle deflection.

Notice that the maximum-aperture information is added only for the sake of the meter readout -- this information isn't needed by the memory system in determining the actual f/stop to be delivered automatically. So the information sent to the memory circuit comes from the output of AR1.


Mg 2 - MIRROR RELEASE
TO POSITIVE BATTERY
6V
C47
TO Mg 2 DETECTOR
CENTRAL PROCESSING
PRESET
CLOCK
32.7 KHZ
SW2
8-BIT COUNTER (DIGITAL MEMORY)
SUMMING AMPLIFIER
AR4
TO VR AV APERTURE-DETECTING RESISTOR
DIGITAL-TO-ANALOG CONVERSION
(VOLTAGE DECREASES AS COUNT GOES UP)
CP3
STOPS COUNTER WHEN INPUTS ARE EQUAL
Vc
TO CP3
MEMORY SIGNAL (HIGHER THAN VC IN RANGE)
CP2
Vc
Δ AV
BVO
AVC
SV-TV
INFO FROM AR1
COMPARES Δ AV TO VC - LIGHTS LED, WHEN AV IS LOWER

The digital memory system starts counting when the second release-button switch, SW2, closes. A pulse applied to the preset input of the 8-bit counter clears the counter. A clock signal of 32.7 KHz then feeds the second input of the 8-bit counter. And the 8-bit counter starts counting. The output of the 8-bit counter goes to the inverting input of amplifier AR4. AR4 turns the count to an analog voltage which decreases as the count increases.

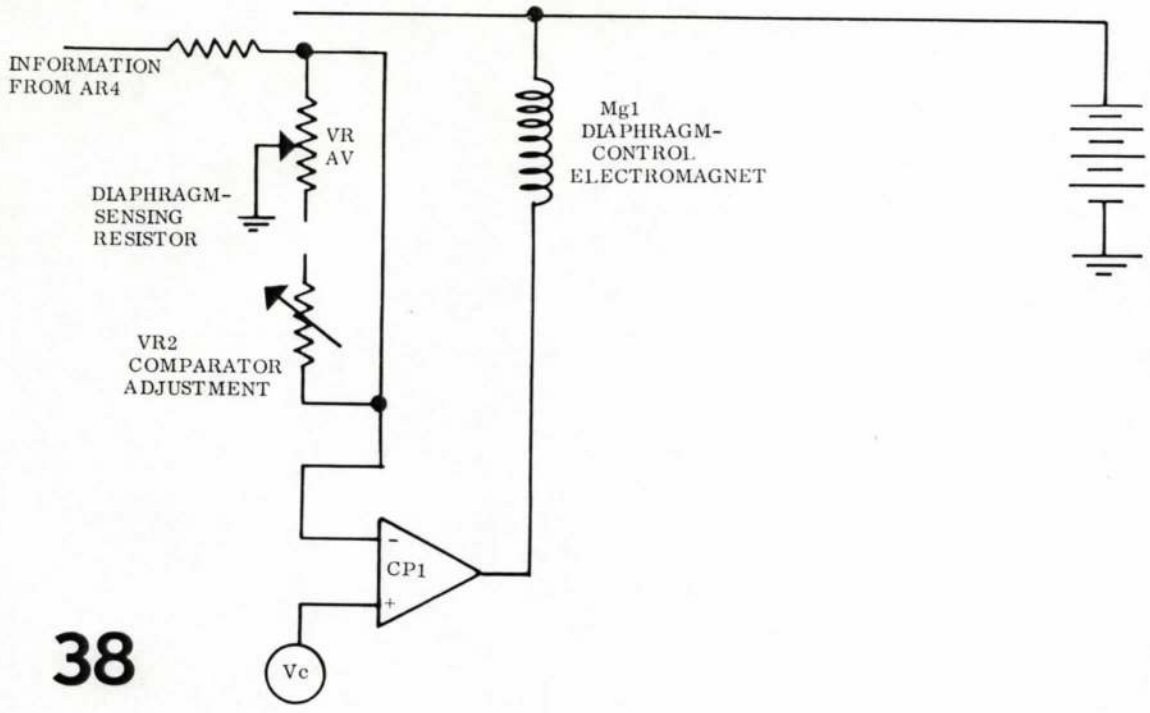
The output of AR4 then goes to one of the inputs of comparator CP3. The other input of CP3 comes from the output of AR1, the summing amplifier for the brightness value, the aperture correction, the shutter speed, and the film speed. When the two inputs are equal, CP3 shuts off the counter. The 8-bit counter stays at this count as long as it has operating power.

A 10ms time delay provided by the central processing unit gives the digital counter more than enough time to reach its maximum count. After this time delay, capacitor C47 discharges through the coil of the combination magnet Mg2. And Mg2 releases the mirror. Now, the photocell can no longer see the light coming through the lens. But it doesn't matter -- the information is stored in the 8-bit counter.

The current flow through the Mg2 coil simultaneously energizes the closing-curtain electromagnet Mg3. An output taken from the Mg2 coil circuit goes to the Mg2 detector. So Mg3 draws no current until the mirror releases.

Besides going to CP3, the information from AR1 goes to another comparator -- CP2. CP2 compares the information from AR1 with the reference voltage Vc. As the light level decreases, the AR1 output goes down -- less positive. When the AR1 output goes less positive than the reference voltage Vc, comparator CP2 turns on LED1. That provides the underexposure warning.

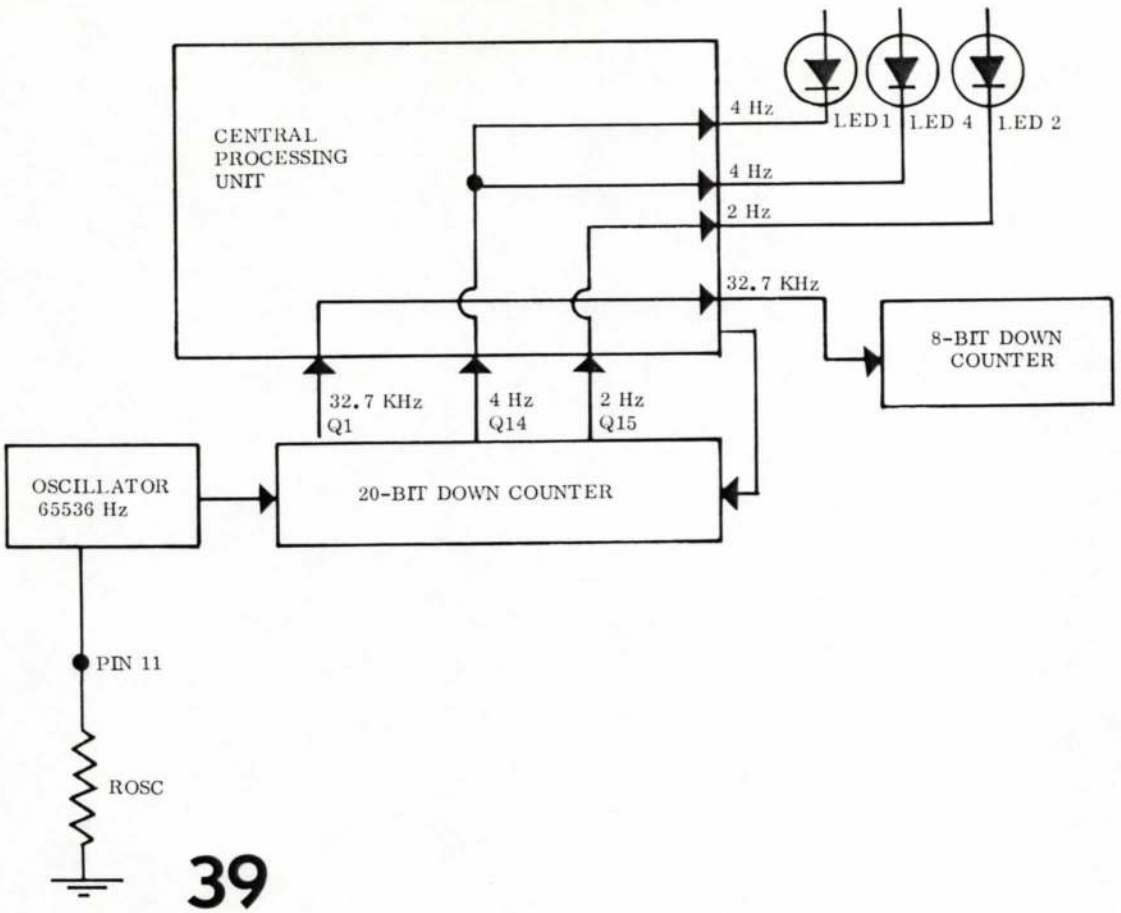
A second output from AR4 goes to the diaphragm-sensing resistor VRav. Here's where the voltage stored in the memory circuit decides the actual diaphragm opening -- how far the lens stops down automatically.



The memory information from AR4 goes to comparator CP1. This information is added to the information provided by the diaphragm-sensing resistor VR AV. As long as the output of CP1 is low, current can flow through the diaphragm-control electromagnet Mg1 -- CP1 then effectively supplies a connection between Mg1 and ground to sustain current flow.

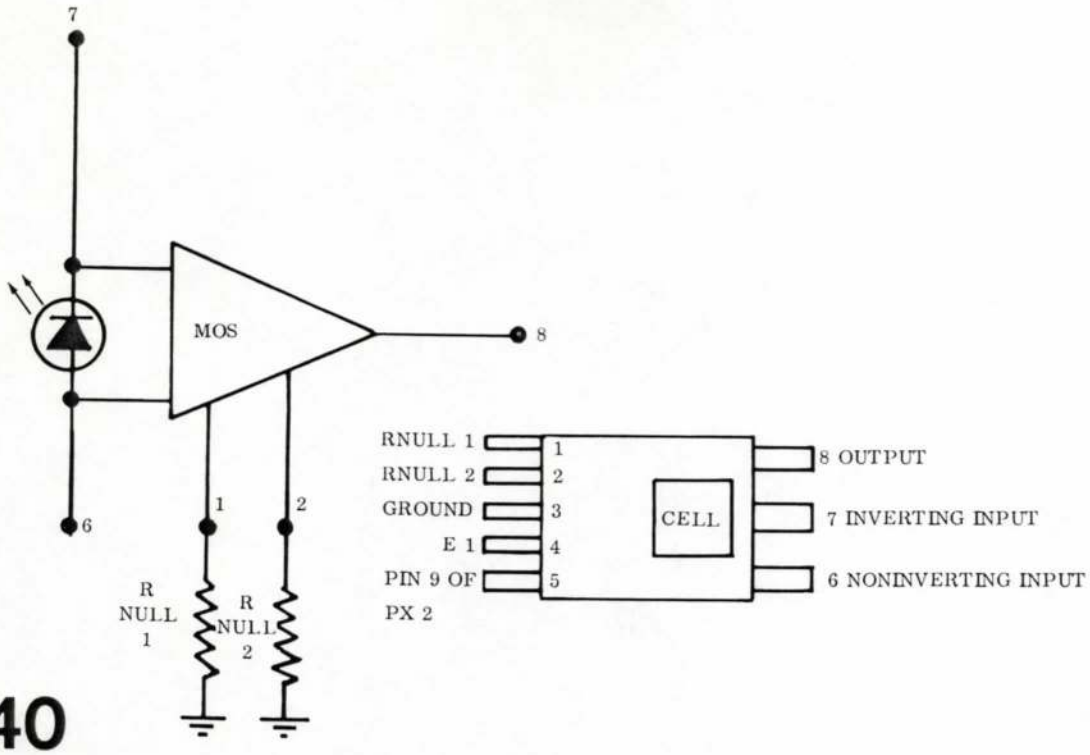
As the diaphragm closes, though, the wiper on the diaphragm-sensing resistor moves down. That brings the inverting input of CP1 closer to ground. When the voltage inputs to CP1 are equal, CP1 shuts off. Now, there's no longer a current flow through Mg1. So Mg1 releases its armature to arrest the diaphragm.

VR2, the comparator adjustment, provides your adjustment point for the actual diaphragm opening.



The oscillator within PX2 supplies a 65536 Hz. signal to the 20-bit down counter. The 20-bit down counter then cuts the frequency in half at each of its 20 bits. So, at the first bit, the 20-bit down counter supplies the 32768 frequency for the 8-bit counter. At the fourteenth bit, there's the 4 Hz. signal for the two warning LED's, LED 1 and LED 4. And at the fifteenth bit, you have the 2 Hz. signal for the self-timer LED, LED 2.

A discrete resistor Rosc controls the frequency of the oscillator. Rosc hooks between ground and pin 11 of PX 2. If you replace PX2, you can check the frequency of the oscillator by counting the number of flashes of the self-timer LED -- it should flash exactly 20 times. Also, you can time the self-timer operation -- it should be within 8 to 12 seconds. If the oscillator frequency is incorrect, change resistor Rosc. A higher resistance increases the self-timer delay time.

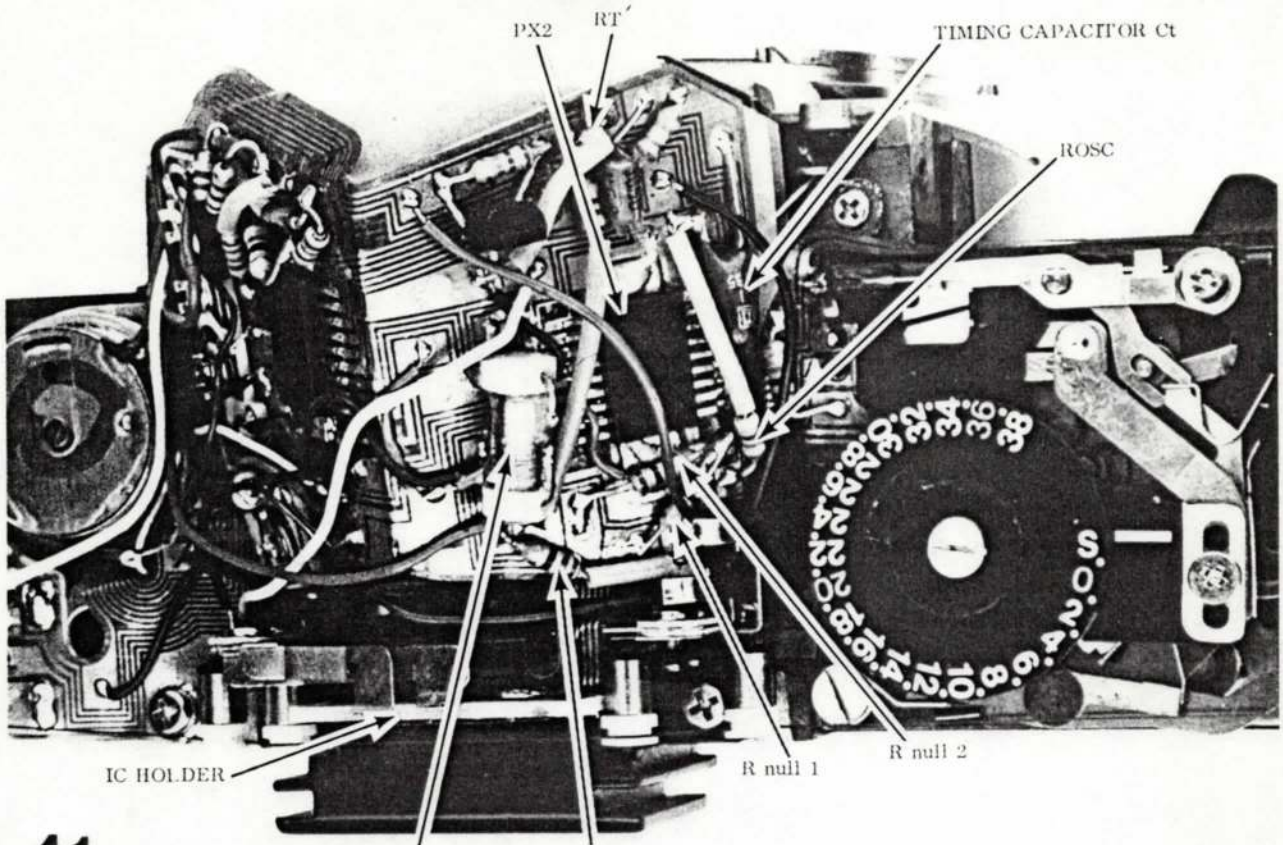


40

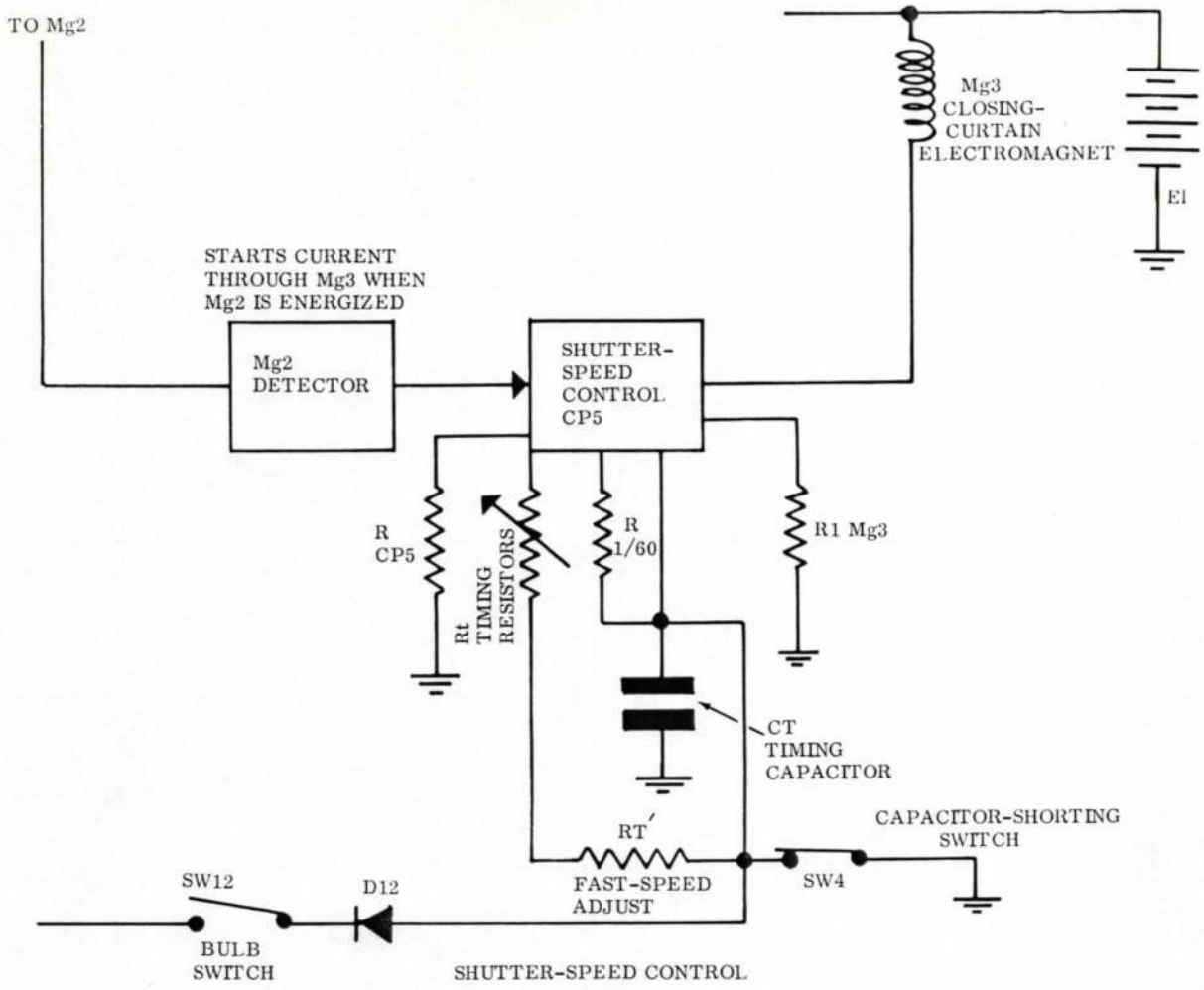
If you replace the photocell amplifier PX1, you may have to make the offset adjustment. First, unsolder one end of resistor RTC (the resistor in series with the thermistor RTC) to open the circuit. Then, remove the IC holder and lift aside the section of the circuit board containing PX1.

Short the output of the amplifier to the inverting input -- pin 8 to pin 7. And measure the voltage between the output (pin 8) and the noninverting input (pin 6). When you close SW1, you should measure 0 volt $\pm$ 5 mV.

If you have a reading of more than 5 mV, remove the larger of the two null resistors. And connect a 30K variable resistor in its place. Adjust the variable resistor until the voltage reading between pins 6 and 8 is 5mV or less. Then, measure the resistance of the variable resistor. Install a fixed resistor of the same value. If you can't bring in the adjustment using the larger of the two null resistors, follow the same procedure to find the proper value for the smaller null resistor.


PX2
RT´
TIMING CAPACITOR Ct
ROSC
IC HOLDER
THERMISTOR RTC
RRTC
R null 1
R null 2

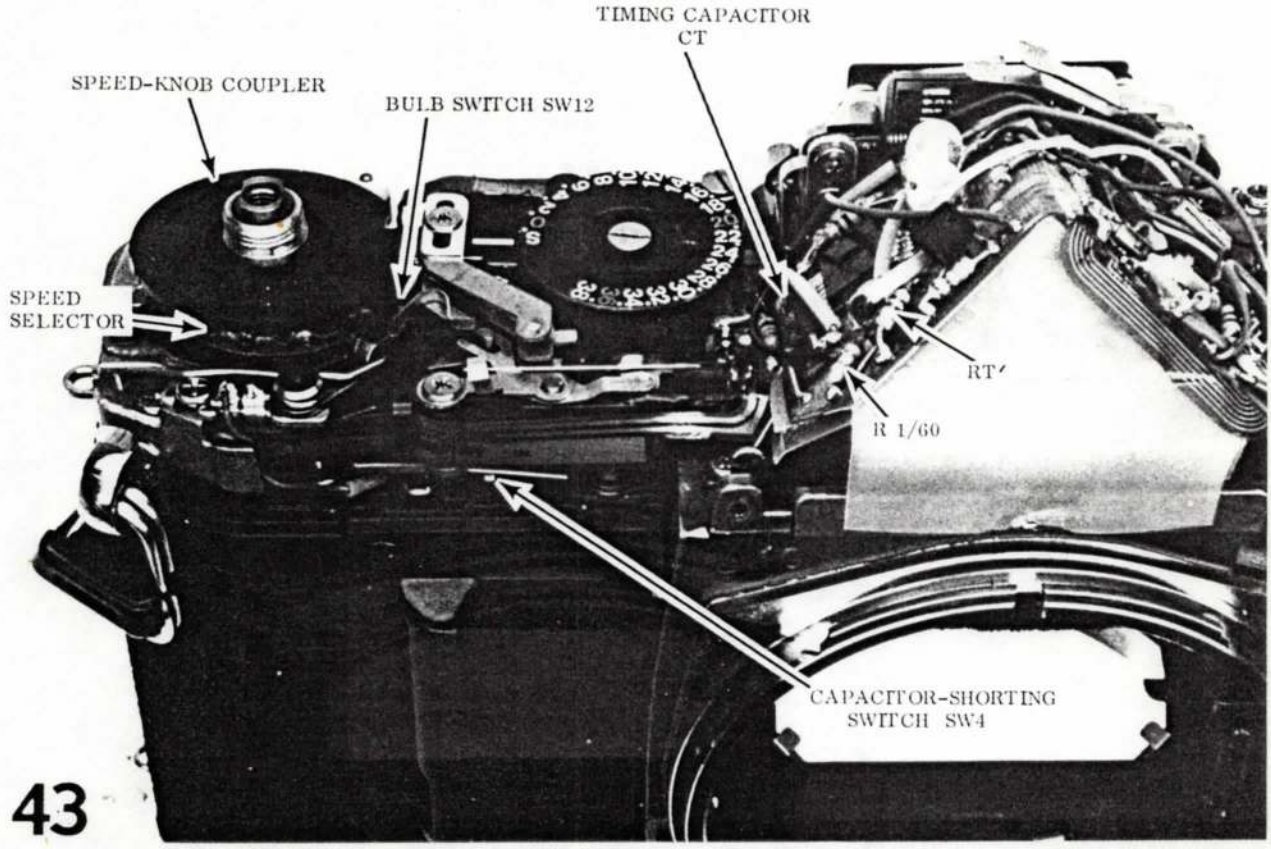
41



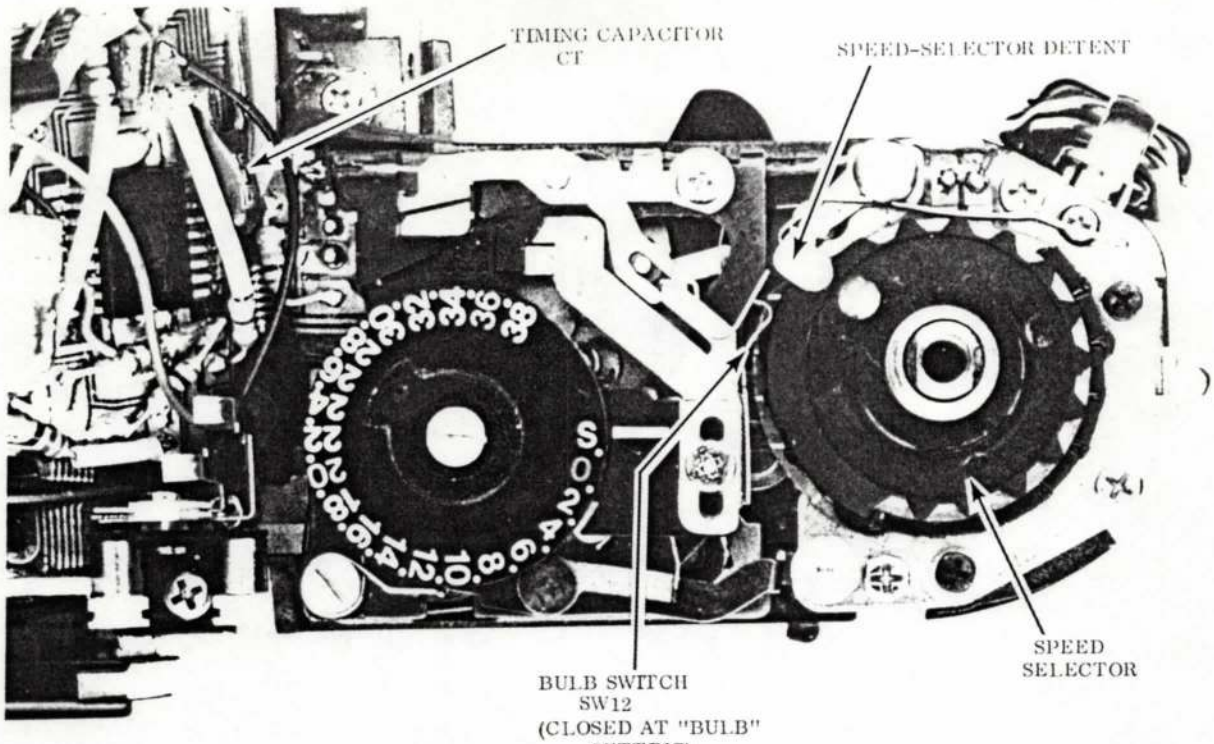
42

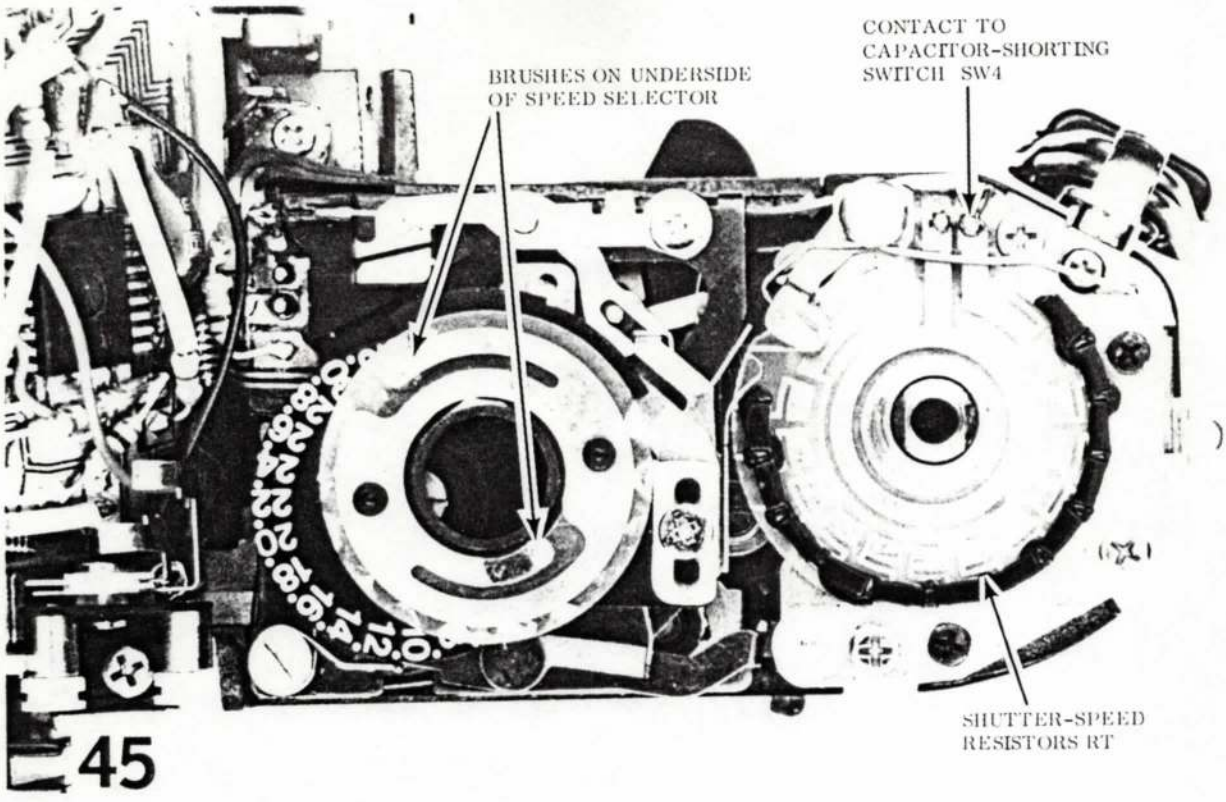
The Mg2 detector senses when the current flows through the Mg1 coil. It then turns on the shutter-speed control circuit to energize the closing-curtain electromagnet Mg3. When the opening curtain releases, the opening-curtain latch opens the capacitor-shorting switch SW4. Now, the timing capacitor CT starts charging through the resistance of RT, selected by the speed-knob setting. When the timing capacitor reaches the proper voltage, it shuts off the comparator CP5. And CP5 shuts off the current flowing through the closing-curtain electromagnet Mg3.

NOTE: SPEED KNOB HAS BEEN REMOVED TO POINT OUT PARTS

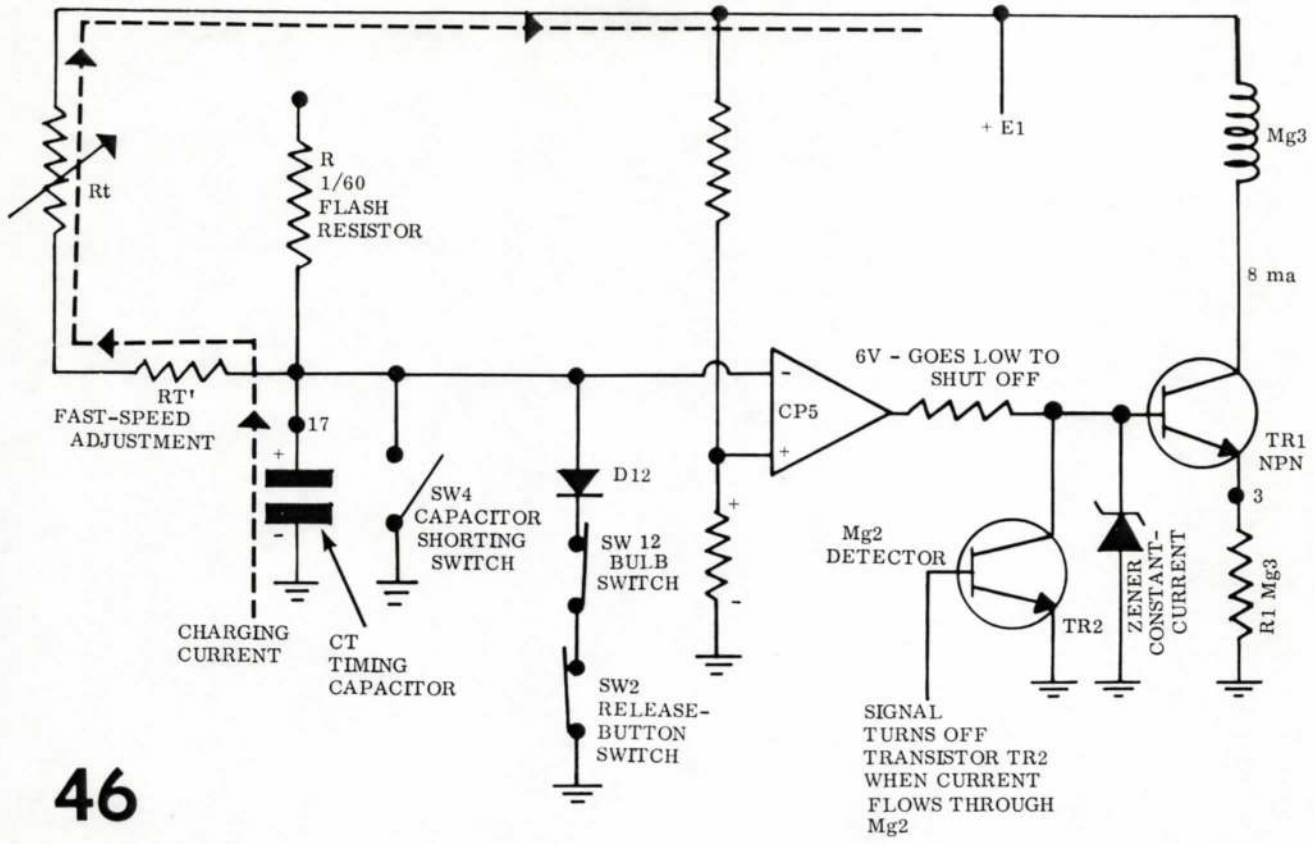


43


TIMING CAPACITOR
CT
SPEED-SELECTOR DETENT
SPEED
SELECTOR
BULB SWITCH
SW12
(CLOSED AT "BULB"
SETTING)


BRUSHES ON UNDERSIDE
OF SPEED SELECTOR
CONTACT TO
CAPACITOR-SHORTING
SWITCH SW4
SHUTTER-SPEED
RESISTORS RT

45


Rt
R
1/60
FLASH
RESISTOR
+ E1
Mg3
8 ma
6V - GOES LOW TO
SHUT OFF
CP5
RT'
FAST-SPEED
ADJUSTMENT
17
D12
SW4
CAPACITOR
SHORTING
SWITCH
SW 12
BULB
SWITCH
TR1
NPN
3
Mg2
DETECTOR
TR2
ZENER
CONSTANT-
CURRENT
R1 Mg3
CHARGING
CURRENT
CT
TIMING
CAPACITOR
SW2
RELEASE-
BUTTON
SWITCH
SIGNAL
TURNS OFF
TRANSISTOR TR2
WHEN CURRENT
FLOWS THROUGH
Mg2

Here, the shutter-speed control circuit has been redrawn with more detail to show the operation. Transistor TR2 (within PX3) serves as the Mg2 detector. TR2 switches on when release-button switch SW2 closes to short between the base of TR1 and ground. So, without base bias, TR1 can't turn on. And no current flows through the closing-curtain electromagnet Mg3.

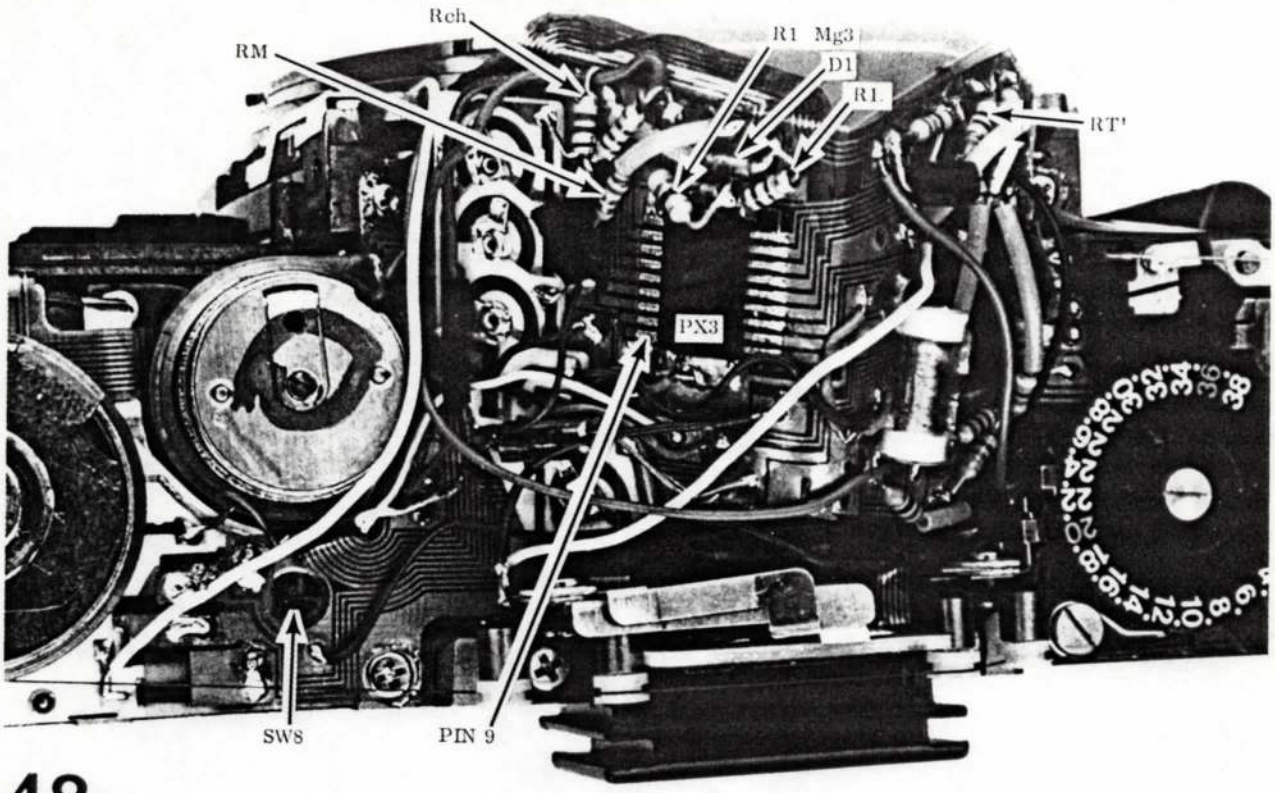
But current flowing through the coil of Mg1 applies a negative signal to the base of TR2. Consequently, TR2 switches off. The high collector voltage of TR2 now applies the forward bias to turn on TR1 and energize the closing-curtain electromagnet. The zener diode hooked to the base of TR1 maintains a constant base bias. So TR1 maintains a constant current of 8 ma through the coil of Mg3.

Opening the capacitor-shorting switch SW4 allows the timing capacitor CT to charge through the shutter-speed resistors. As the timing capacitor CT charges, it applies an increasingly positive signal to the inverting input of comparator CP5. The output of CP5 then goes less positive, finally going low enough to shut off TR1. That shuts off the current flow through Mg3 to release the closing curtain. The slower the shutter speed you select, the longer it takes CT to charge sufficiently.

Notice that the capacitor-charging current also flows through resistor RT'. So resistor RT' provides one of your shutter-speed adjustments. Changing the resistance of RT' has the greatest effect on the fast speeds. One adjustment procedure is to first check 1/2 second. If the 1/2-second exposure is too fast (less than 476 ms), hook a 0.1 microfarad capacitor in parallel with CT. That increases the capacitance of CT, meaning it takes longer for the timing capacitor to charge.

If the 1/2-second exposure is too slow (more than 525 ms), hook a 100K variable resistor across CT. Adjust the variable resistor until the shutter speed is within tolerance. Then, replace the variable resistor with a fixed resistor of the same value. Next, test the shutter at 1/1000 second. And replace RT' to bring in the shutter speed. If the shutter speed is too fast, use a larger resistance value to slow down the capacitor-charging time.

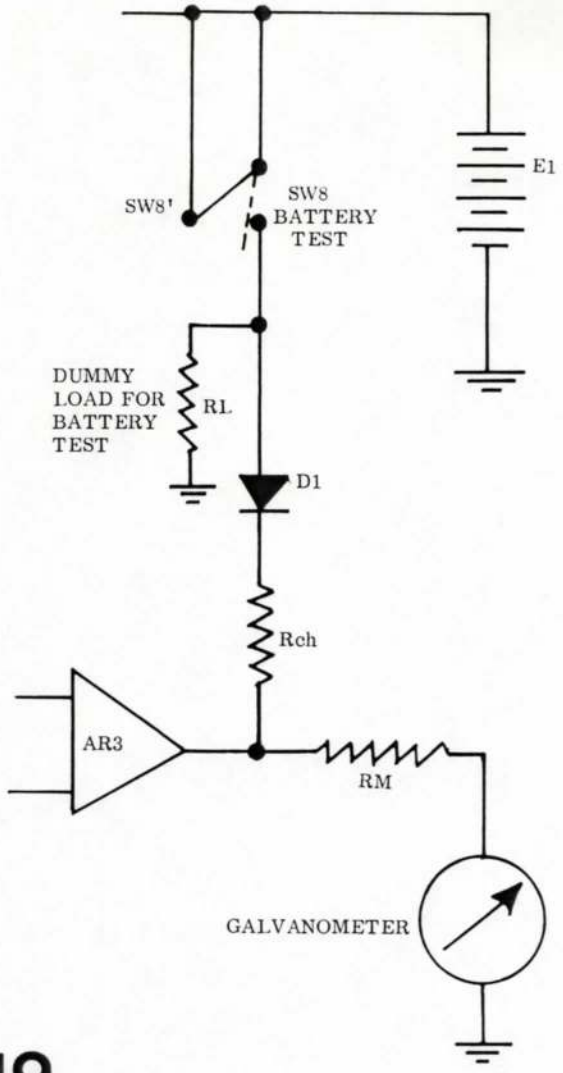
On bulb operation, the speed selector closes the bulb switch SW12. Now, the effect is the same as when the capacitor-shorting switch is closed -- the timing capacitor CT can't charge sufficiently to shut off the electromagnet current. As long as you hold the release button down, switch SW2 remains closed. And the timing capacitor can only charge to the voltage dropped across D12. Letting up the release button allows SW2 to open. That allows the timing capacitor to charge through the flash resistor R 1/60. R 1/60 also provides the charging path when you're using the Speedlite 155A to automatically program the 1/60-second exposure.



48

If you replace the complete flex circuit, the replacement board comes without resistor Rch (for the battery test) and resistor RT' (for the shutter-speed adjustment). The battery-test adjustment is described under the adjustment section at the end of the Workbook.

If you replace PX3, check the current through the closing-curtain electromagnet Mg3. Disconnect one of the electromagnet's leads and hook a digital ammeter in series with the coil. Then, hold open the shutter on bulb. You should measure a current of 8ma $\pm$ 10%. If the current is incorrect, replace resistor R1Mg3 with a different value.



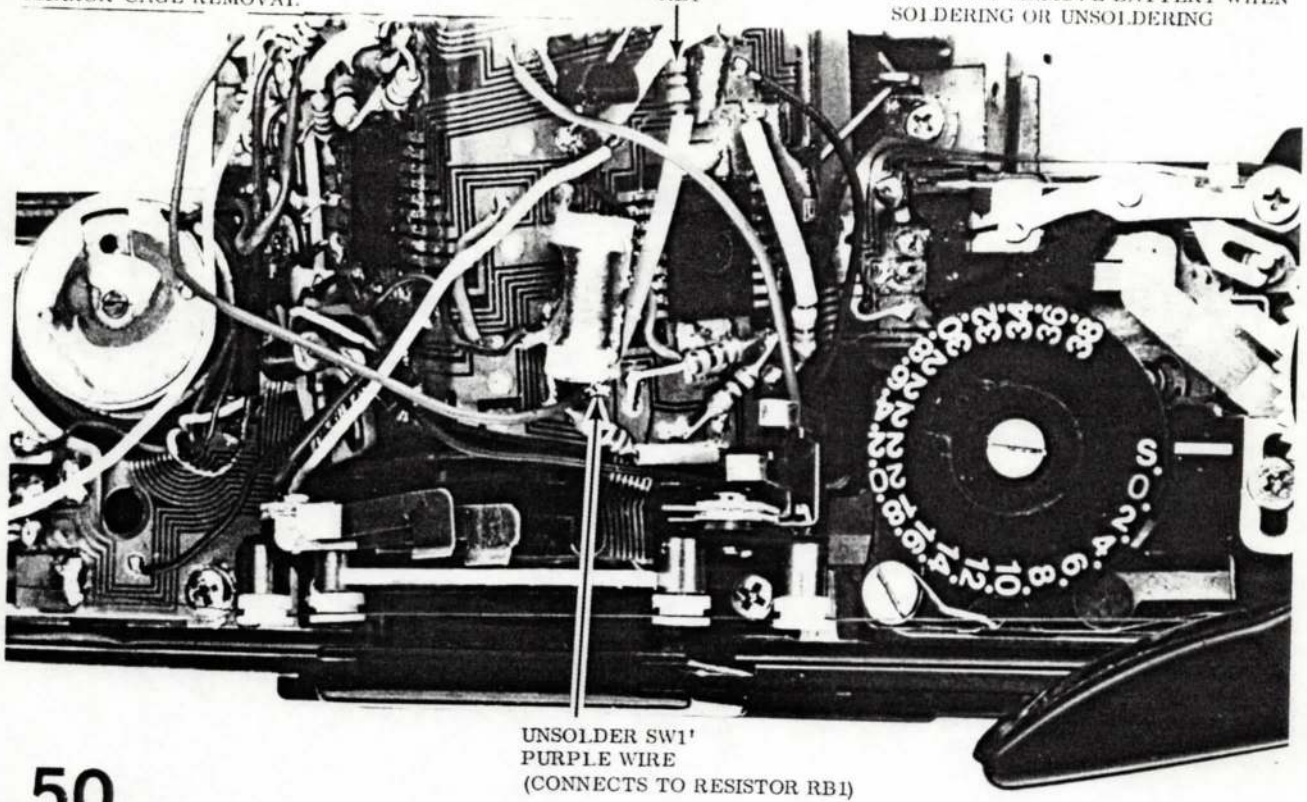
49

Pushing the battery-test switch moves SW8 to the dashed-line position. That removes power from the rest of the circuit. And it simultaneously applies power to the battery-test circuit. Battery current now flows through the galvanometer, Rch, and D1. Resistor RL serves as a dummy load for the battery-test circuit. And diode D1 prevents RL from drawing current in normal operation when the output of AR3 goes high.

FRONT-PLATE/
MIRROR-CAGE REMOVAL

RB1

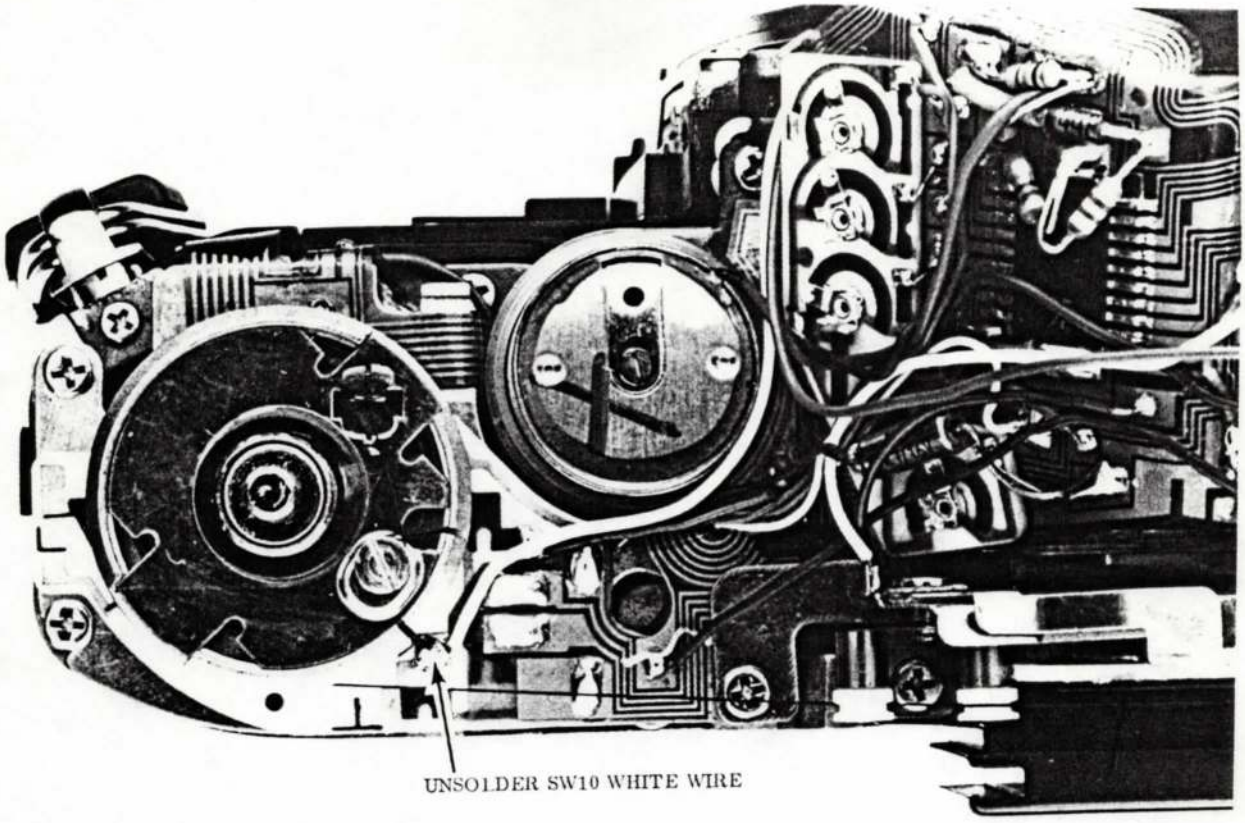
CAUTION: REMOVE BATTERY WHEN SOLDERING OR UNSOLDERING

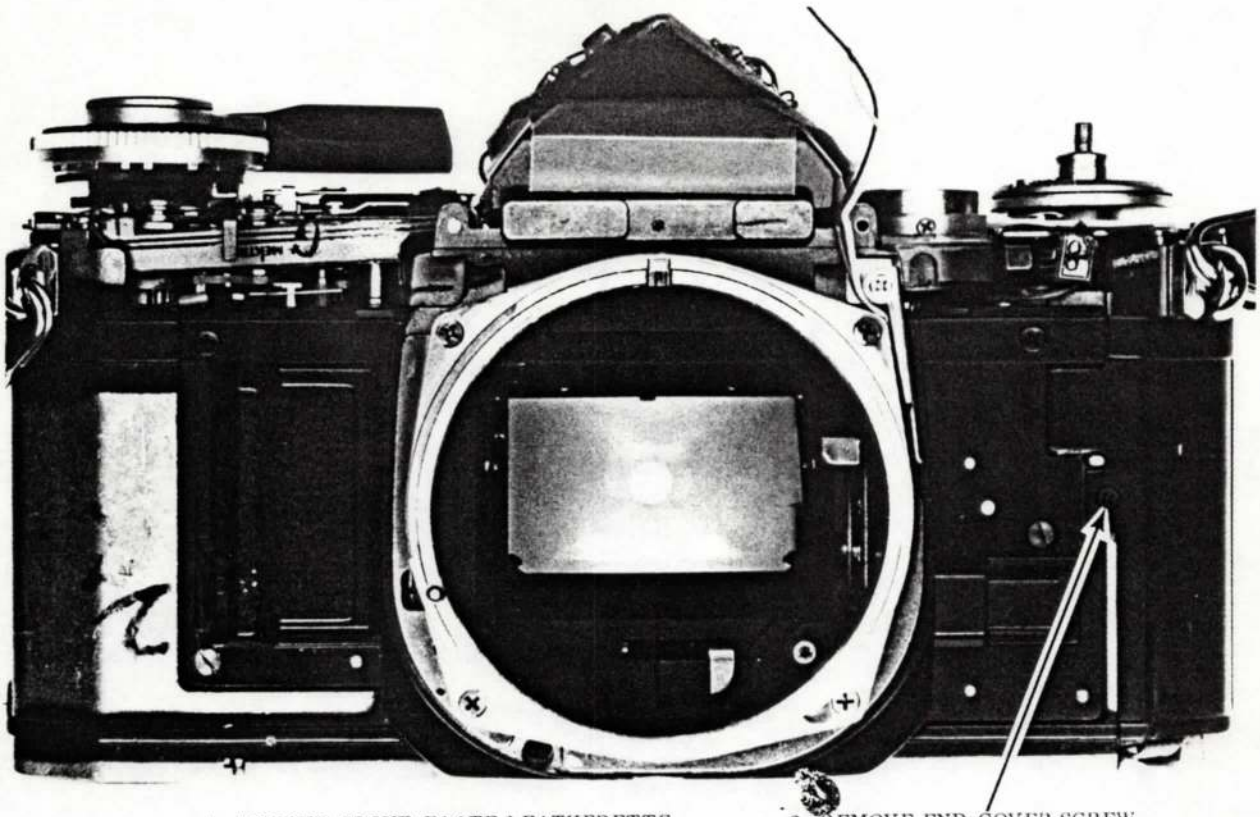


UNSOLDER SW1'
PURPLE WIRE
(CONNECTS TO RESISTOR RB1)

50

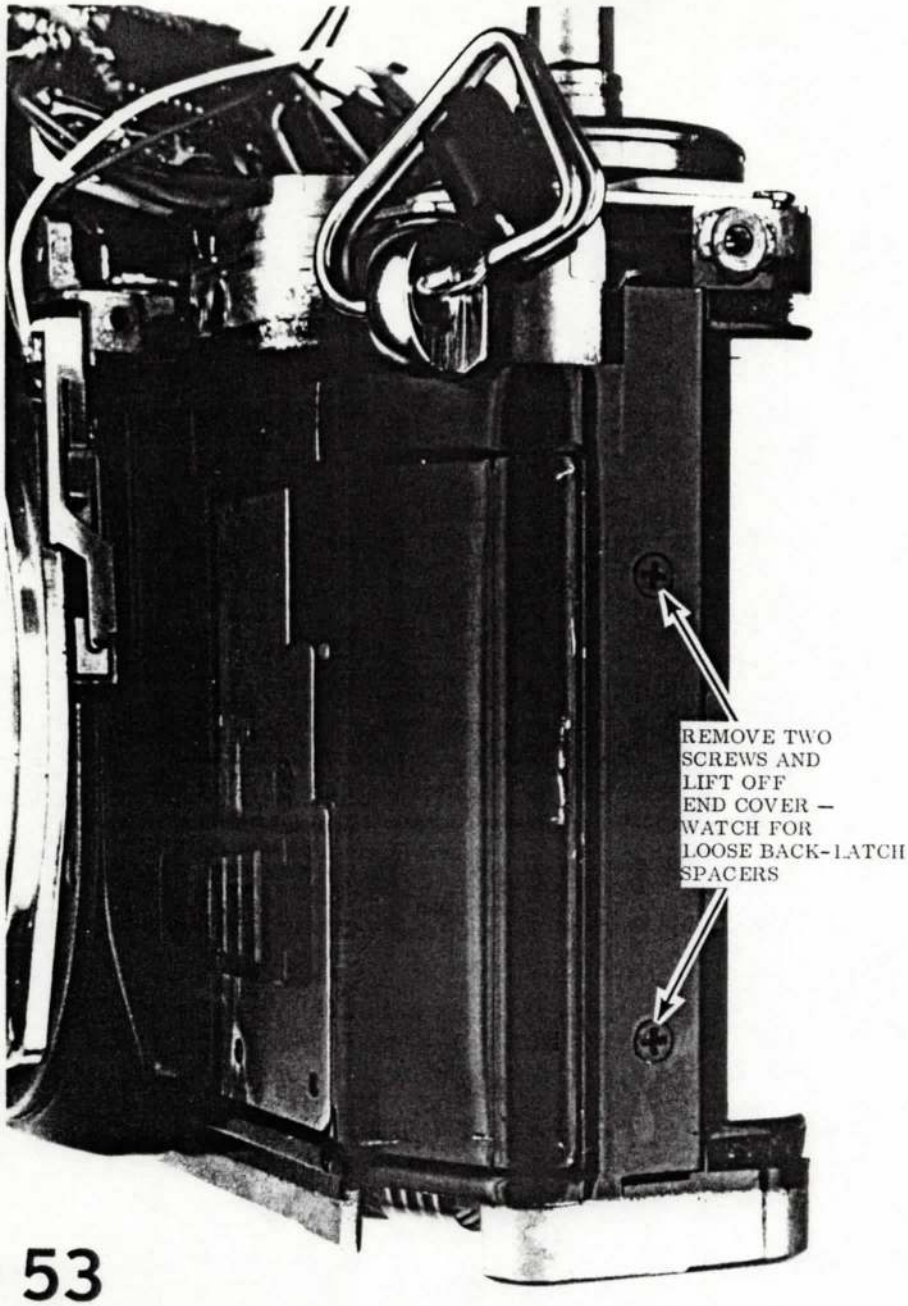
or goes to Anode of Diode


UNSOLDER SW10 WHITE WIRE

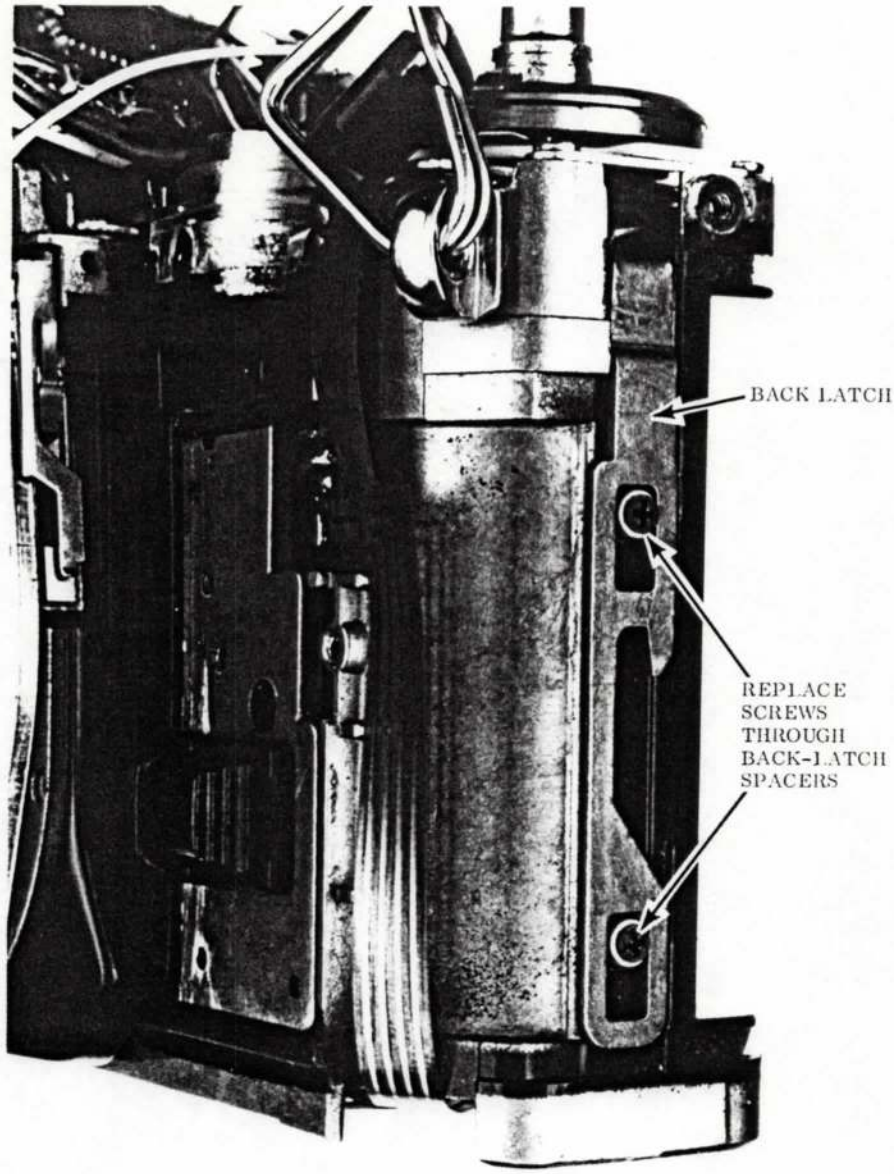


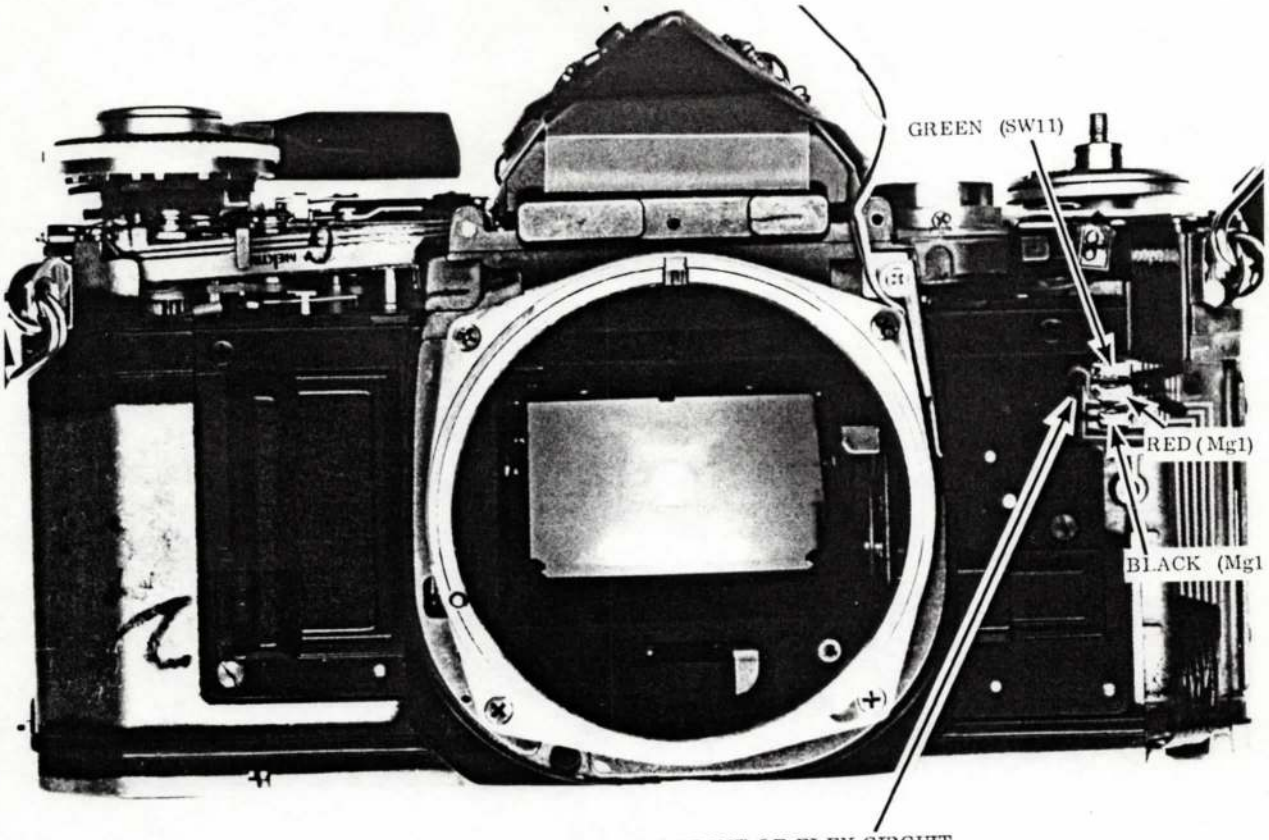
1. REMOVE FRONT-PLATE LEATHERETTE

2. REMOVE END-COVER SCREW

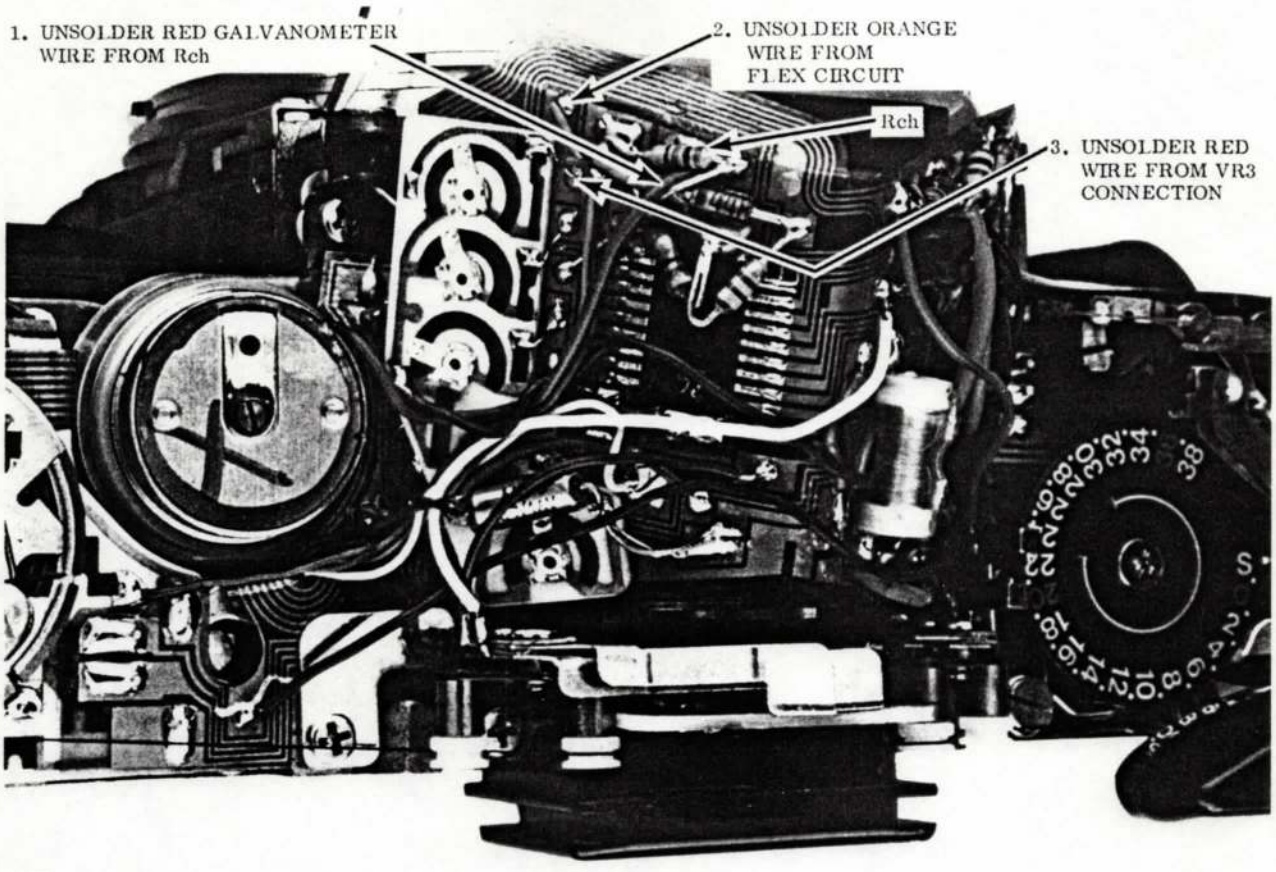

REMOVE TWO
SCREWS AND
LIFT OFF
END COVER –
WATCH FOR
LOOSE BACK-LATCH
SPACERS

53


BACK LATCH
REPLACE SCREWS THROUGH BACK-LATCH SPACERS



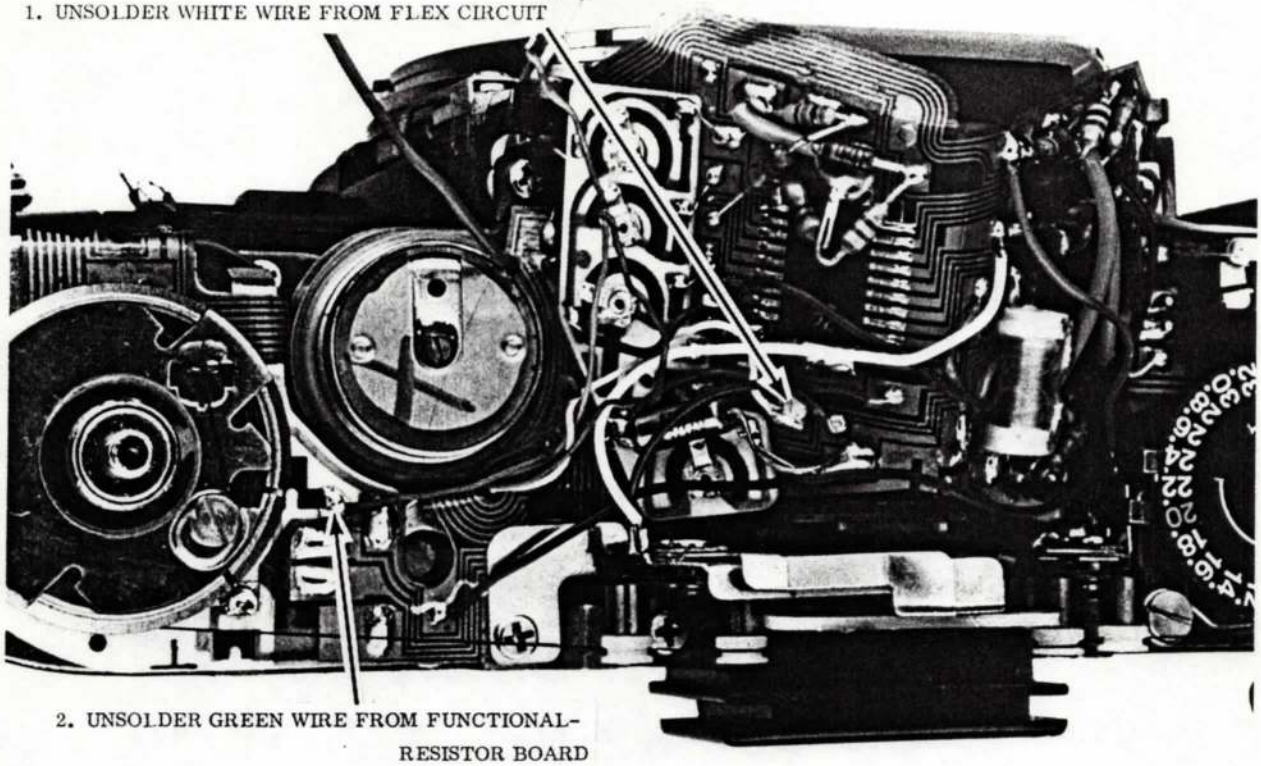
UNSOLDER WIRES FROM FRONT OF FLEX CIRCUIT



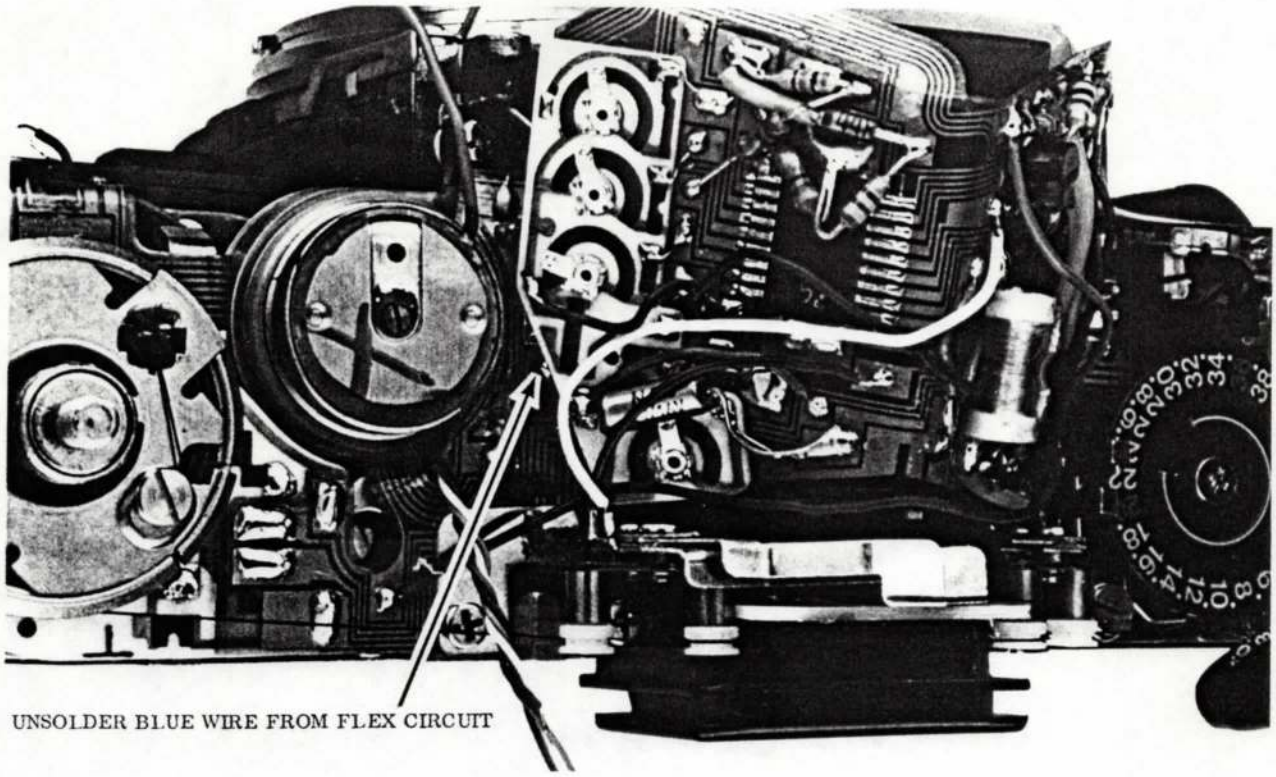
56

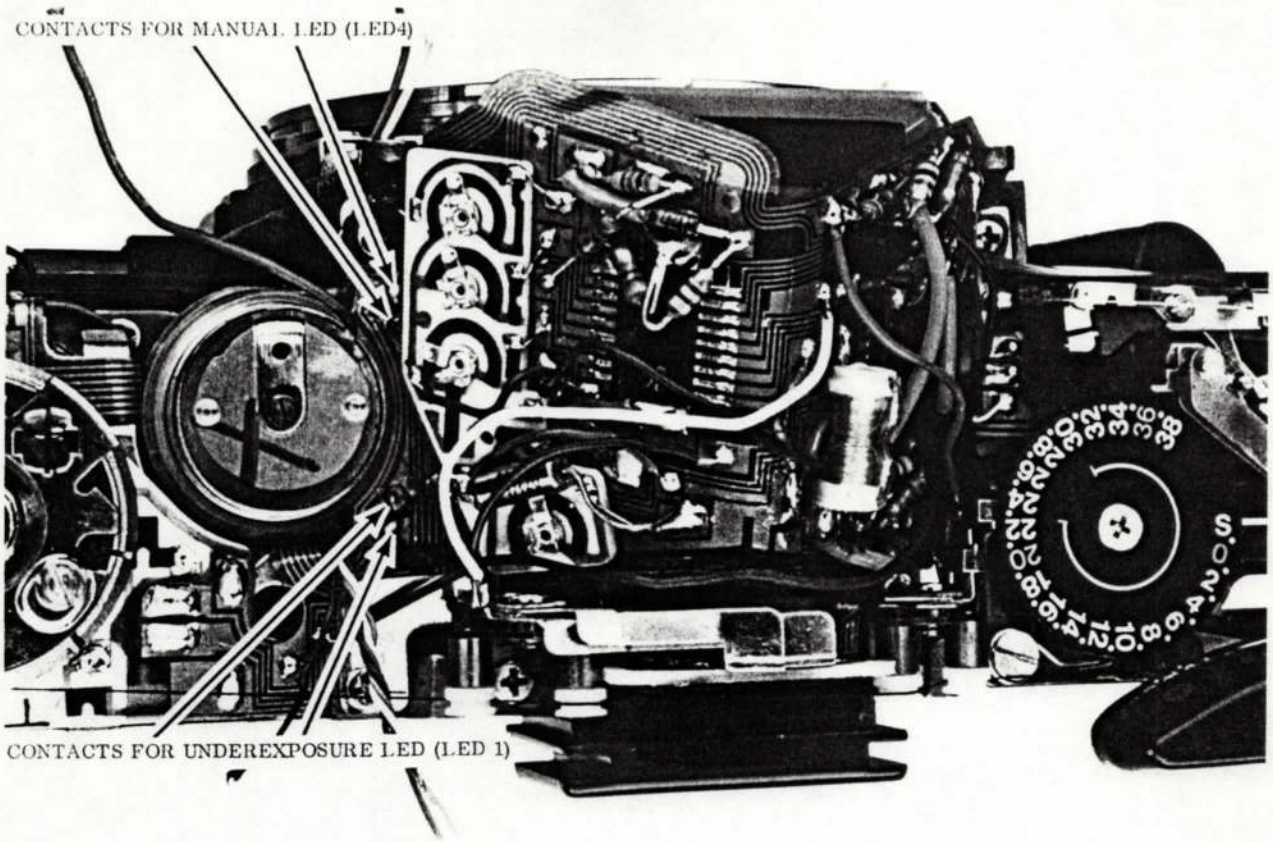
Red to First contact of VR board
Orange to 2nd contact of VR board

1. UNSOLDER WHITE WIRE FROM FLEX CIRCUIT

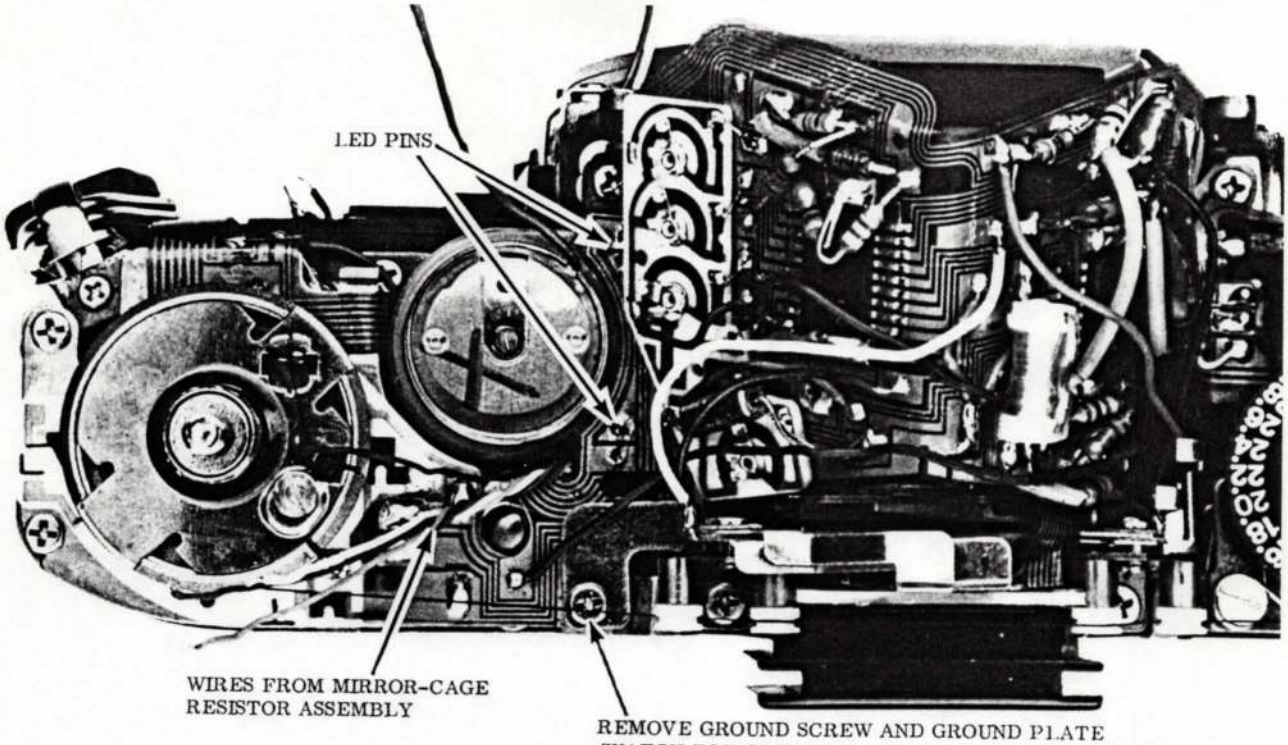


2. UNSOLDER GREEN WIRE FROM FUNCTIONAL-RESISTOR BOARD


UNSOLDER BLUE WIRE FROM FLEX CIRCUIT

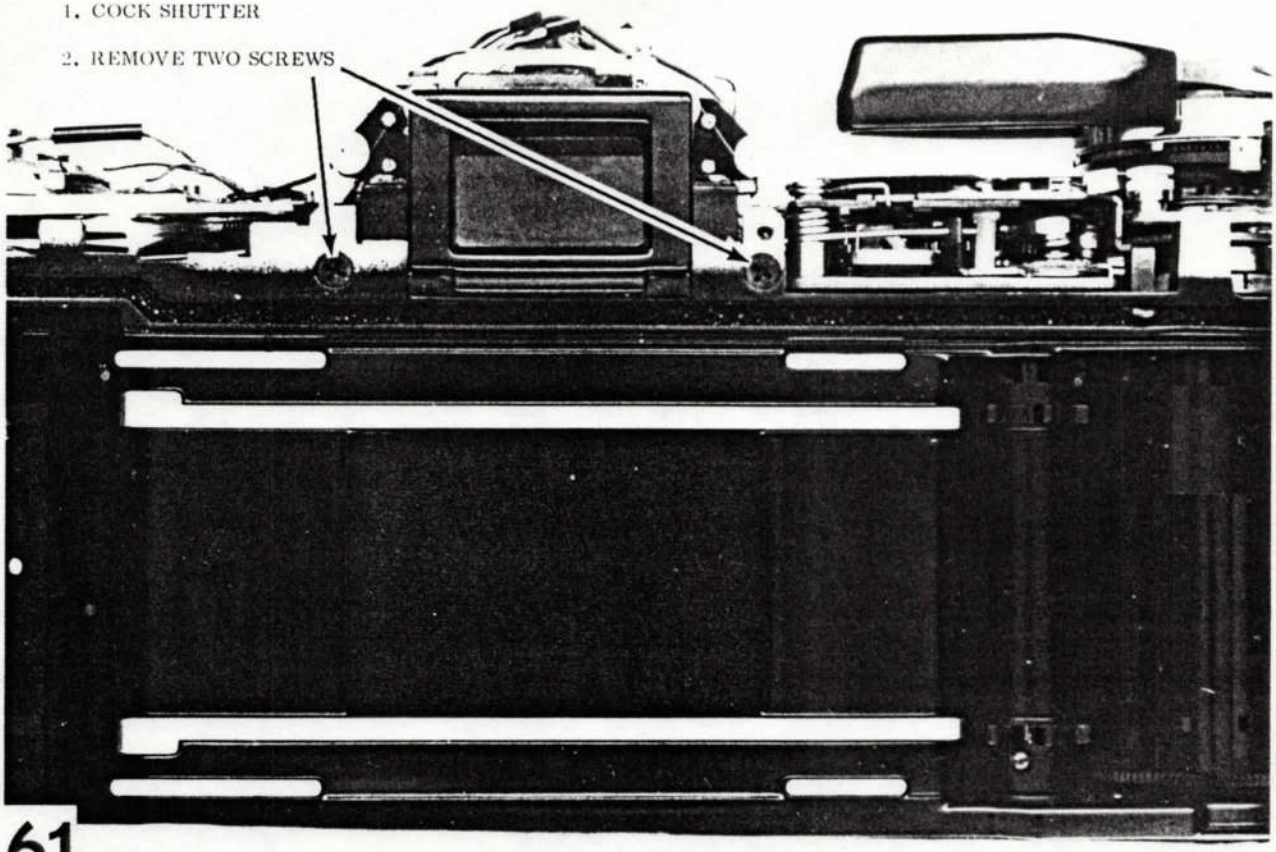


USE SOLDER WICK TO REMOVE SOLDER FROM LED CONTACTS


LED PINS
WIRES FROM MIRROR-CAGE
RESISTOR ASSEMBLY
REMOVE GROUND SCREW AND GROUND PLATE
(WATCH FOR GROUND WASHER UNDER GROUND PLATE)

1. COCK SHUTTER

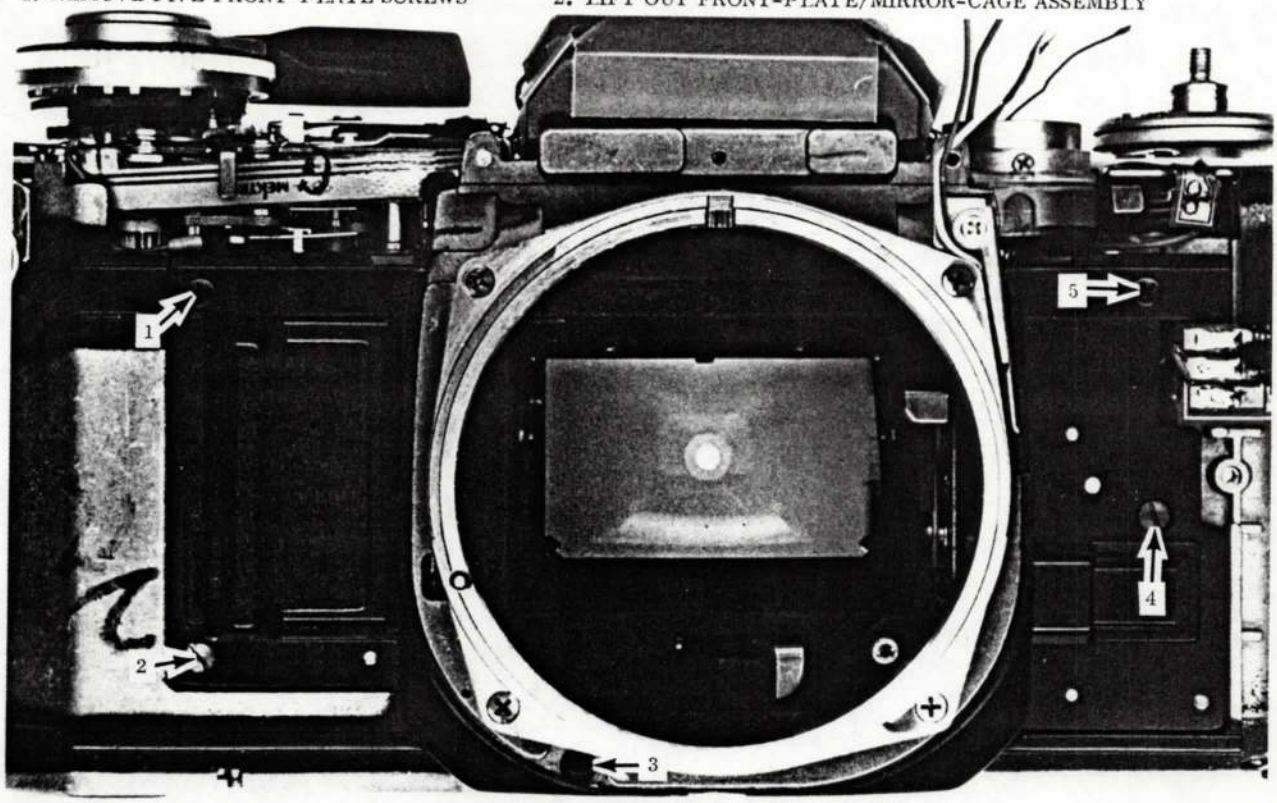
2. REMOVE TWO SCREWS



61

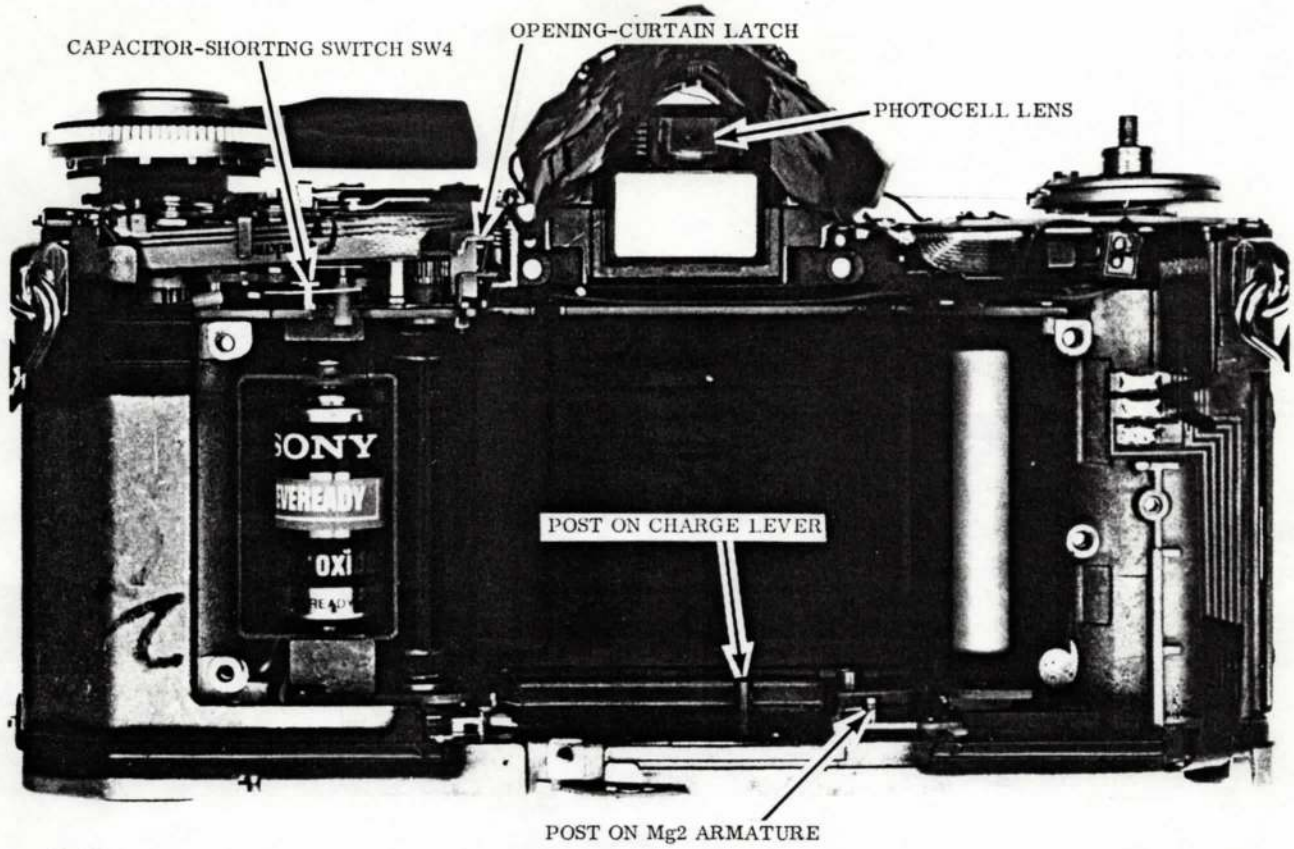
1. REMOVE FIVE FRONT-PLATE SCREWS

2. LIFT OUT FRONT-PLATE/MIRROR-CAGE ASSEMBLY



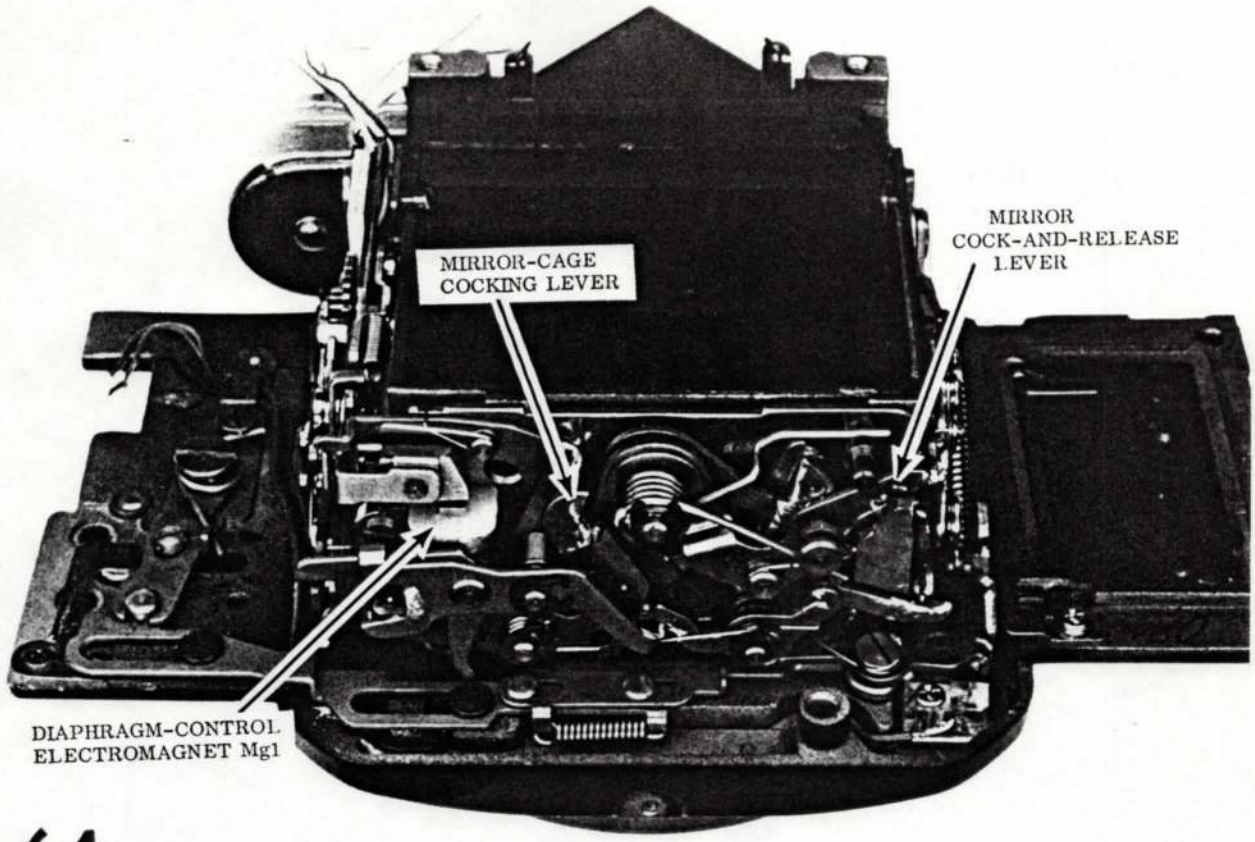
NOTE DIFFERENT SHAPES OF SCREWS --

2 AND 4 ARE SHOULDERED POSITIONING SCREWS, 3 IS THE SAME AS THE TWO AT THE BACK OF THE MIRROR CAGE



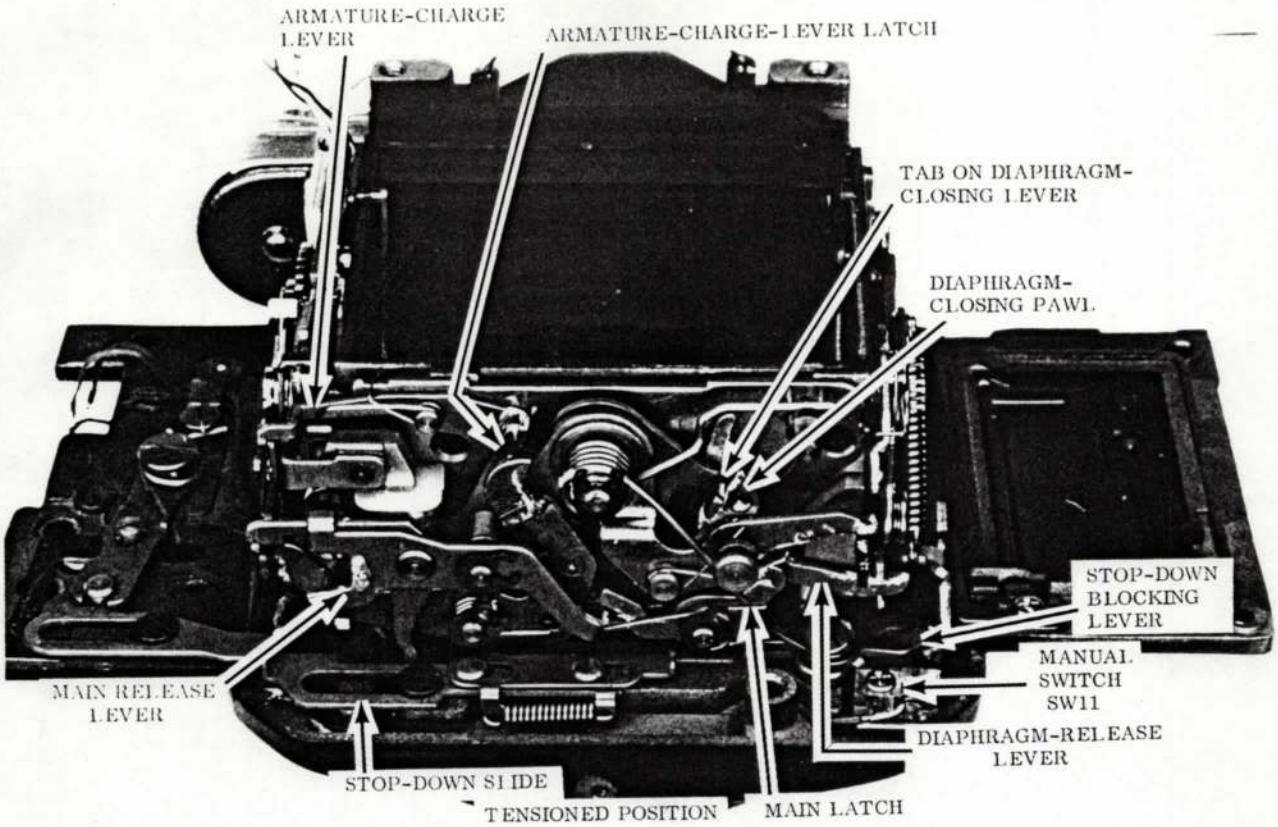
63

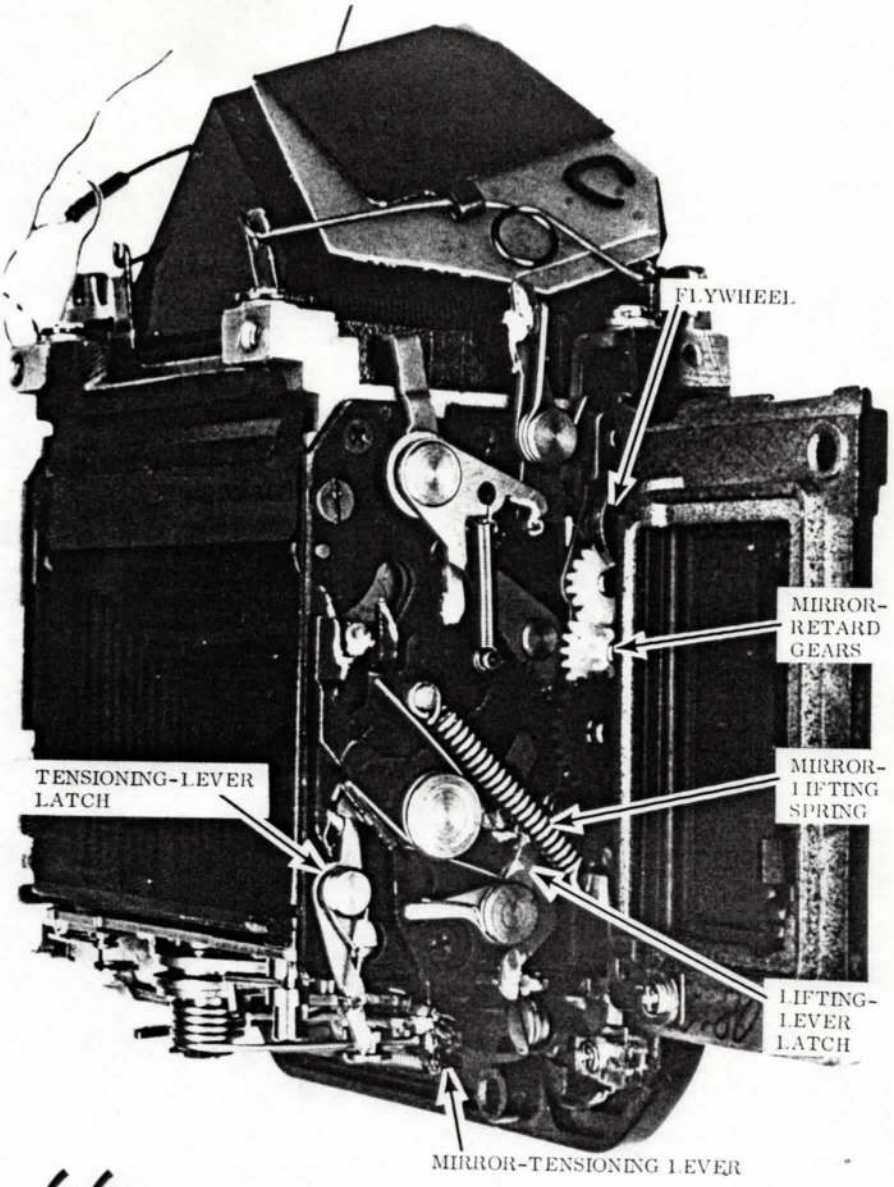
To operate the shutter, first replace the ground plate and the battery. Then, cock the shutter and depress the release switch -- the armature of Mg2 should jump away from the combination magnet. Next, push the Mg3 armature against the closing-curtain electromagnet -- the electromagnet should hold the armature. Push in the opening-curtain latch to release the shutter. If you hold the opening-curtain latch, the shutter should deliver whatever shutter speed you've selected.



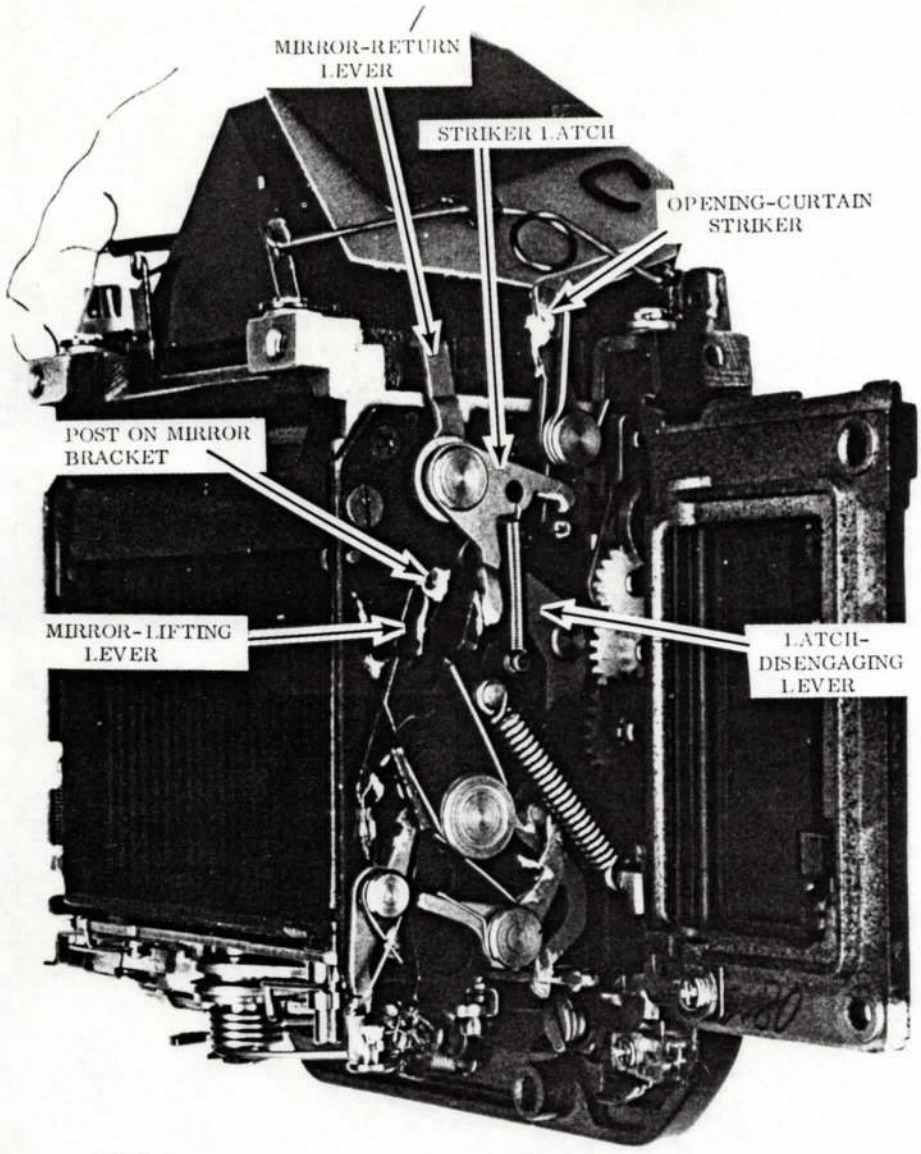
64

RELEASED POSITION


ARMATURE-CHARGE LEVER
ARMATURE-CHARGE-LEVER LATCH
TAB ON DIAPHRAGM-CLOSING LEVER
DIAPHRAGM-CLOSING PAWL
STOP-DOWN BLOCKING LEVER
MANUAL SWITCH SW11
DIAPHRAGM-RELEASE LEVER
MAIN RELEASE LEVER
STOP-DOWN SLIDE
TENSIONED POSITION
MAIN LATCH

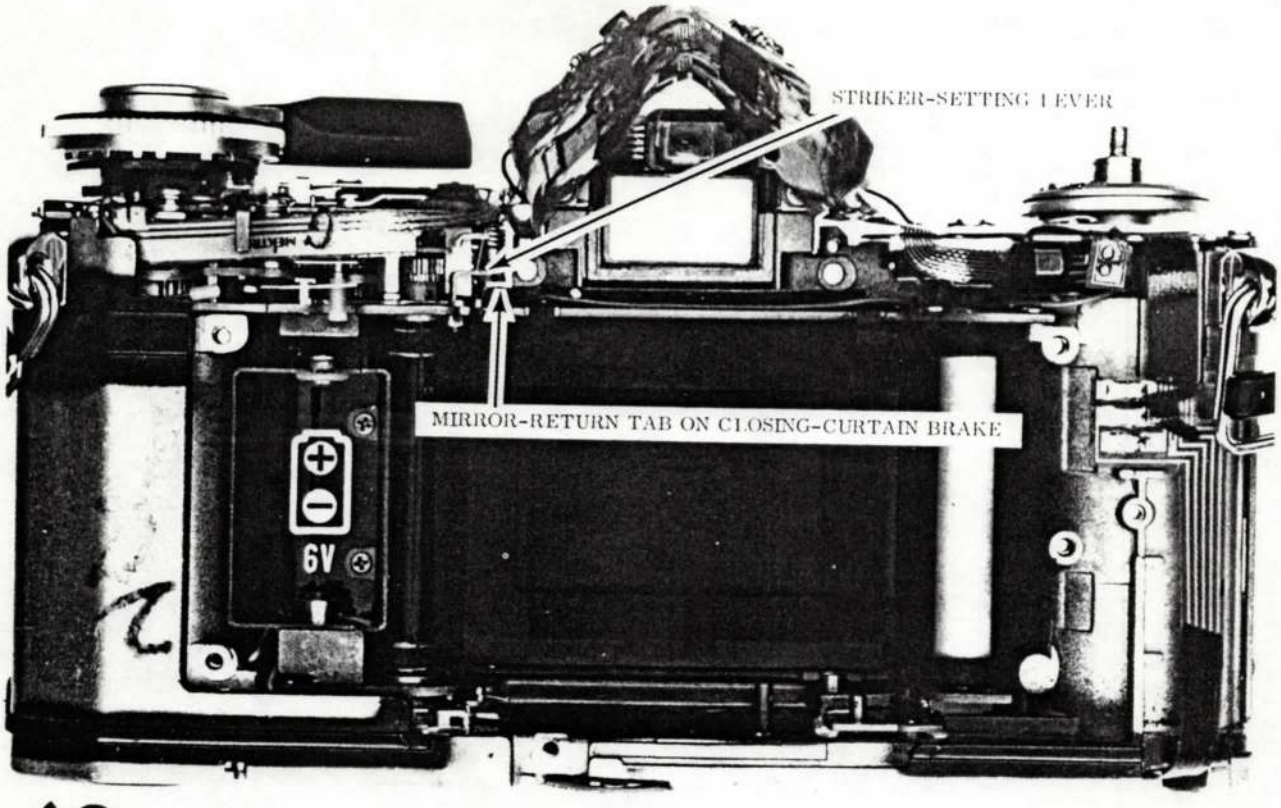


66 MIRROR TENSIONED

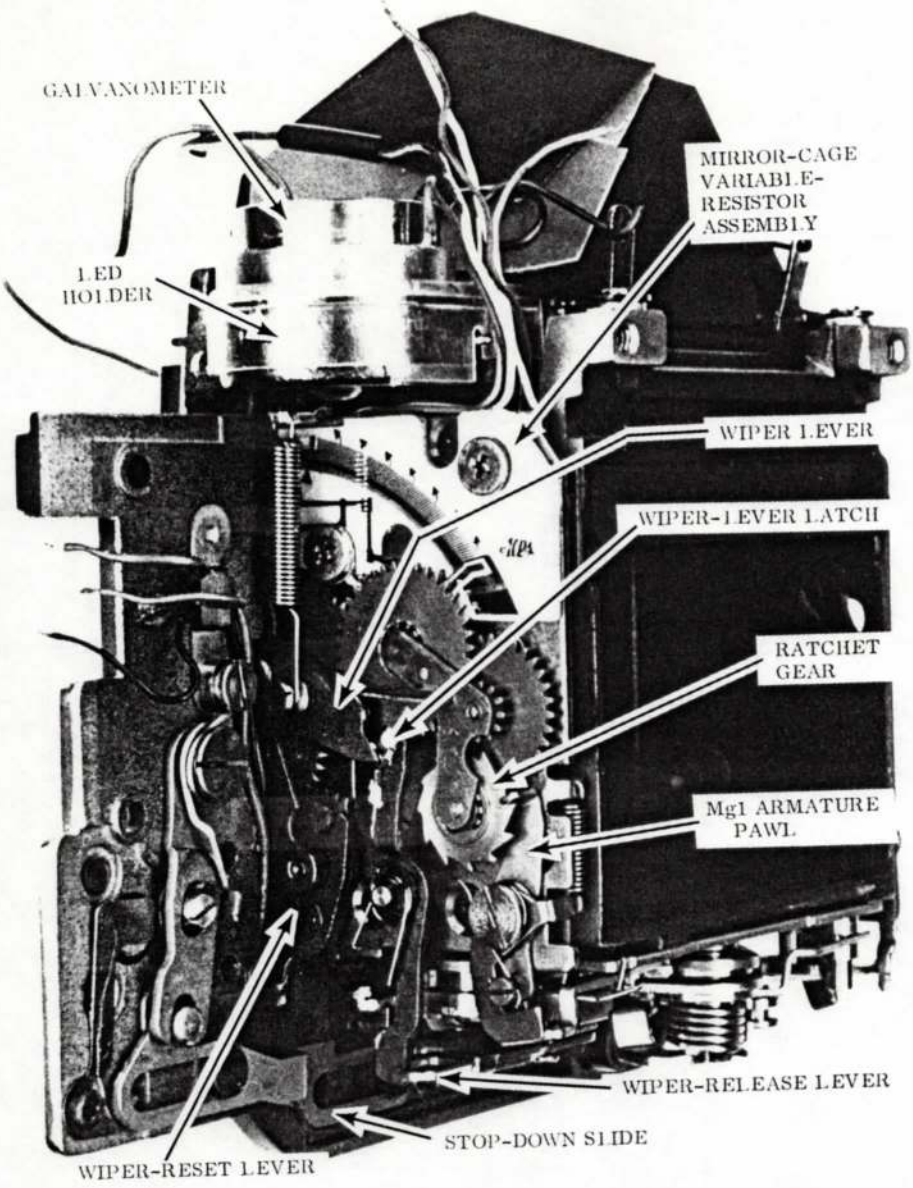


67 MIRROR UP

The shutter should release when the mirror is 2 $\pm$ 1 mm from the edge of the porous-plastic pad at the front of the mirror cage. Make the adjustment by bending the end of the mirror-lifting lever that contacts the mirror-bracket post.

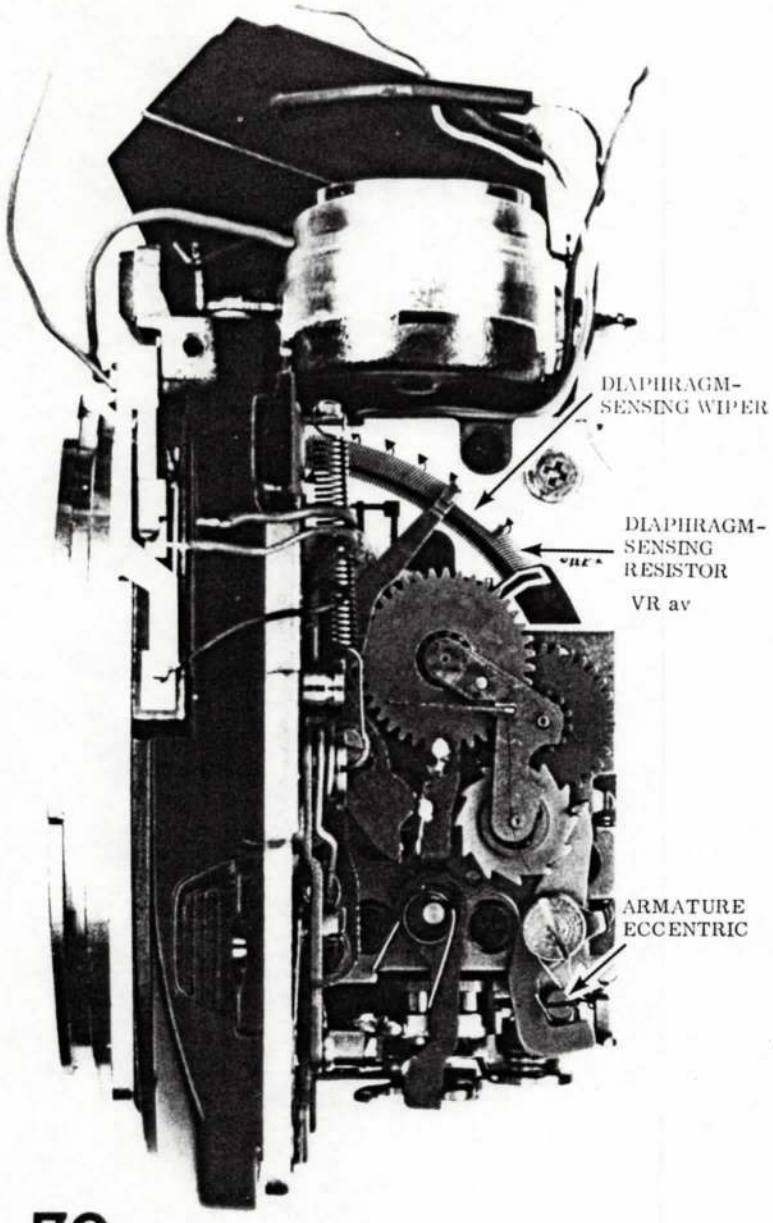

STRIKER-SETTING LEVER
MIRROR-RETURN TAB ON CLOSING-CURTAIN BRAKE
6V

68



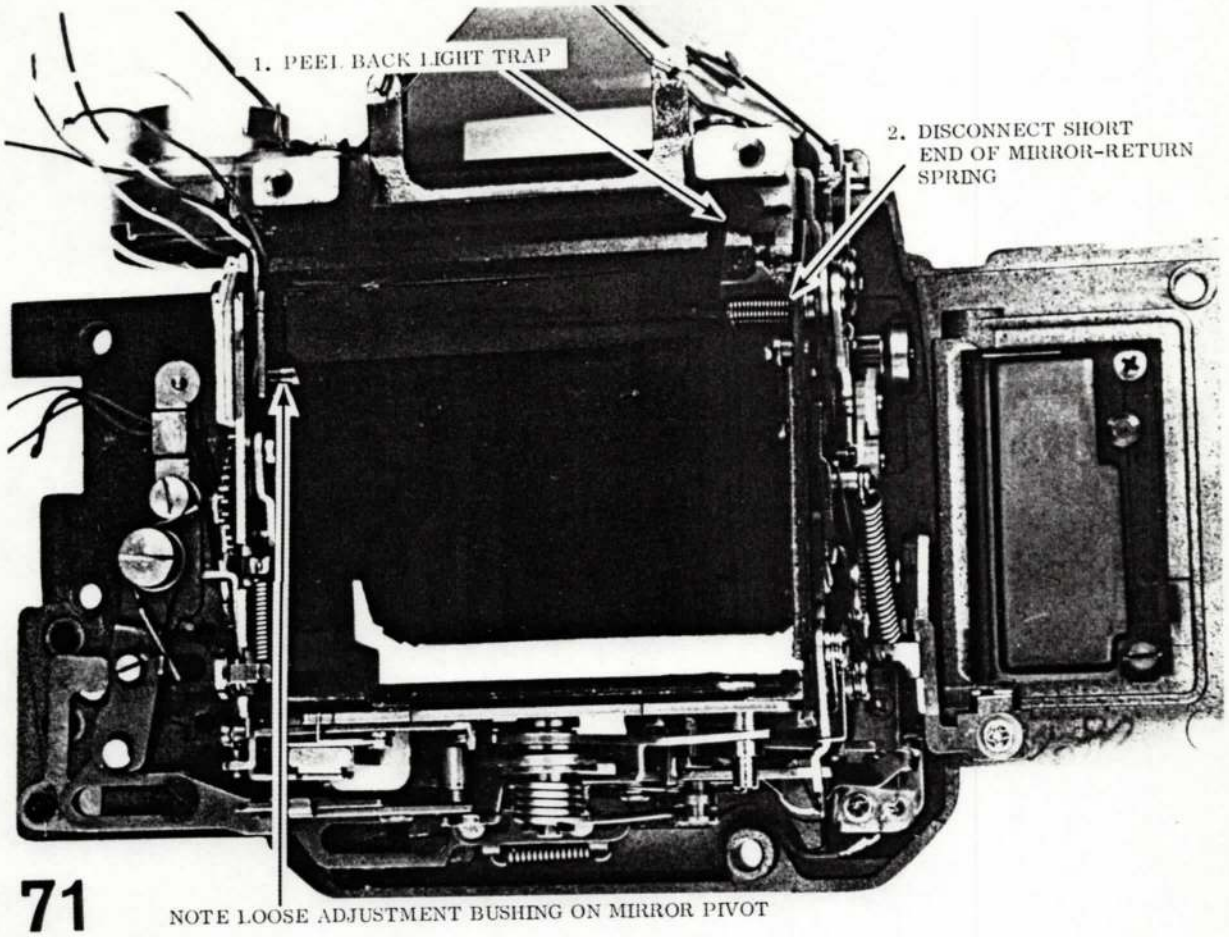
69

When you cock the shutter, the wiper lever latches on the top of the wiper-lever latch. Notice that the wiper-lever latch also has a second step. The second step allows you to go from "A" to a manual f/stop setting and use the depth-of-field preview. When you push in the stop-down lever, the wiper-lever latch frees the wiper lever. So, if you then go back to "A," the camera won't program the f/stop automatically. You must first set the largest lens aperture -- that allows the wiper-lever latch to engage the wiper lever when you disengage the stop-down lever. The wiper lever now latches on the second step of the wiper-lever latch.



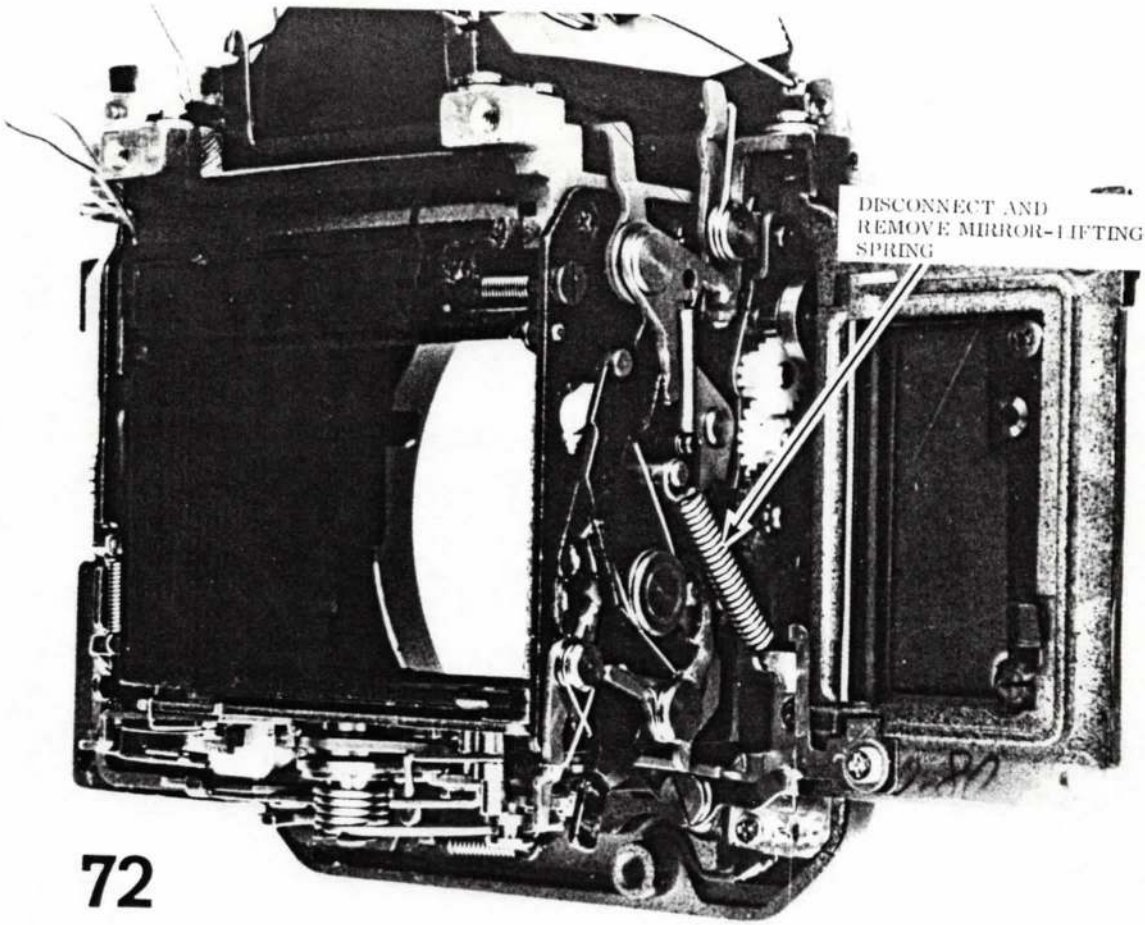
70

To check the overtravel of the auto-control mechanism, install the lens. Cock and release the mirror cage -- but hold the Mg1 armature pawl and the wiper-lever latch disengaged. The diaphragm should stop down to the smallest f/stop. Then, slowly cock the mirror cage while counting the turns of the ratchet gear. If you're using the f/1.4 lens, the ratchet gear should make 6 complete turns plus an additional 8 teeth when the wiper lever latches on the top step of the wiper-lever latch. If you have the f/1.8 lens, the ratchet gear should make 6 complete turns plus an additional 4 teeth. The adjustment point is the eccentric under the wiper-lever latch.

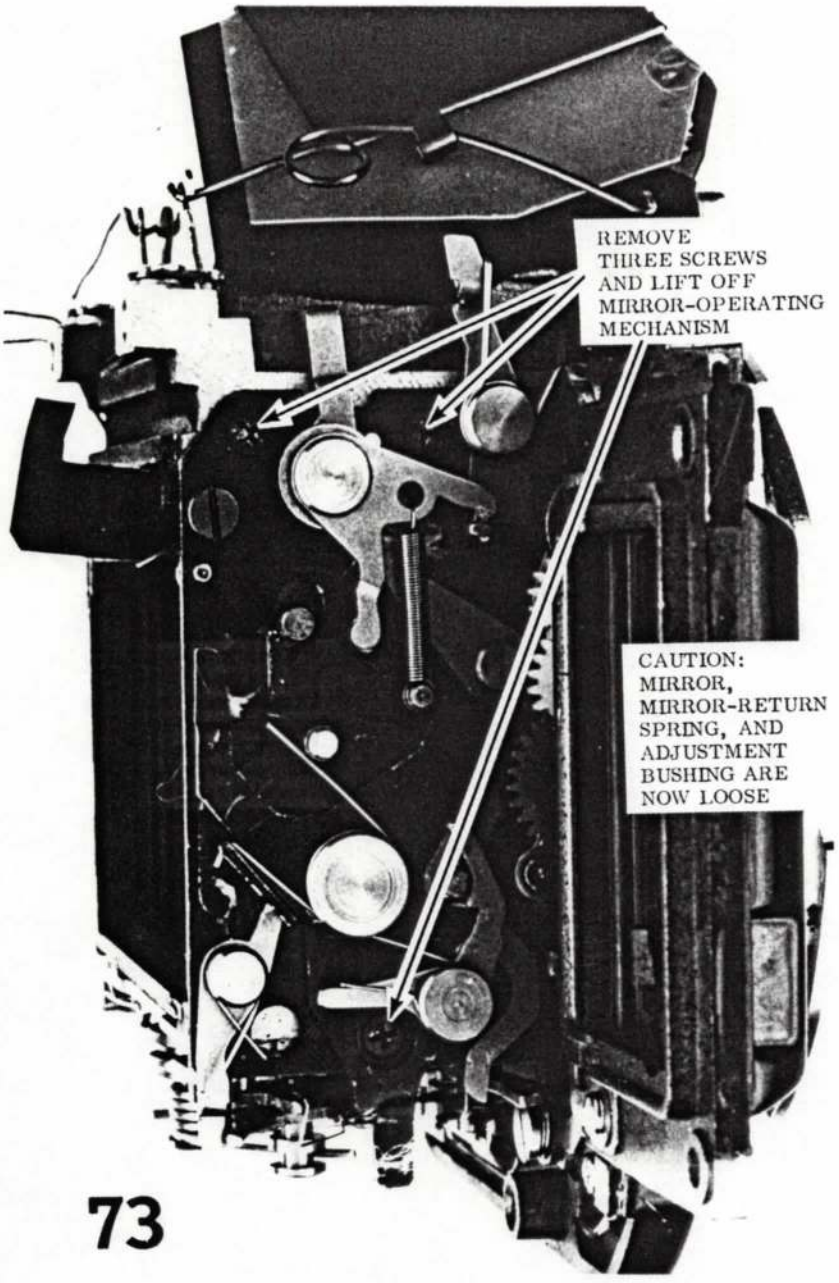


71

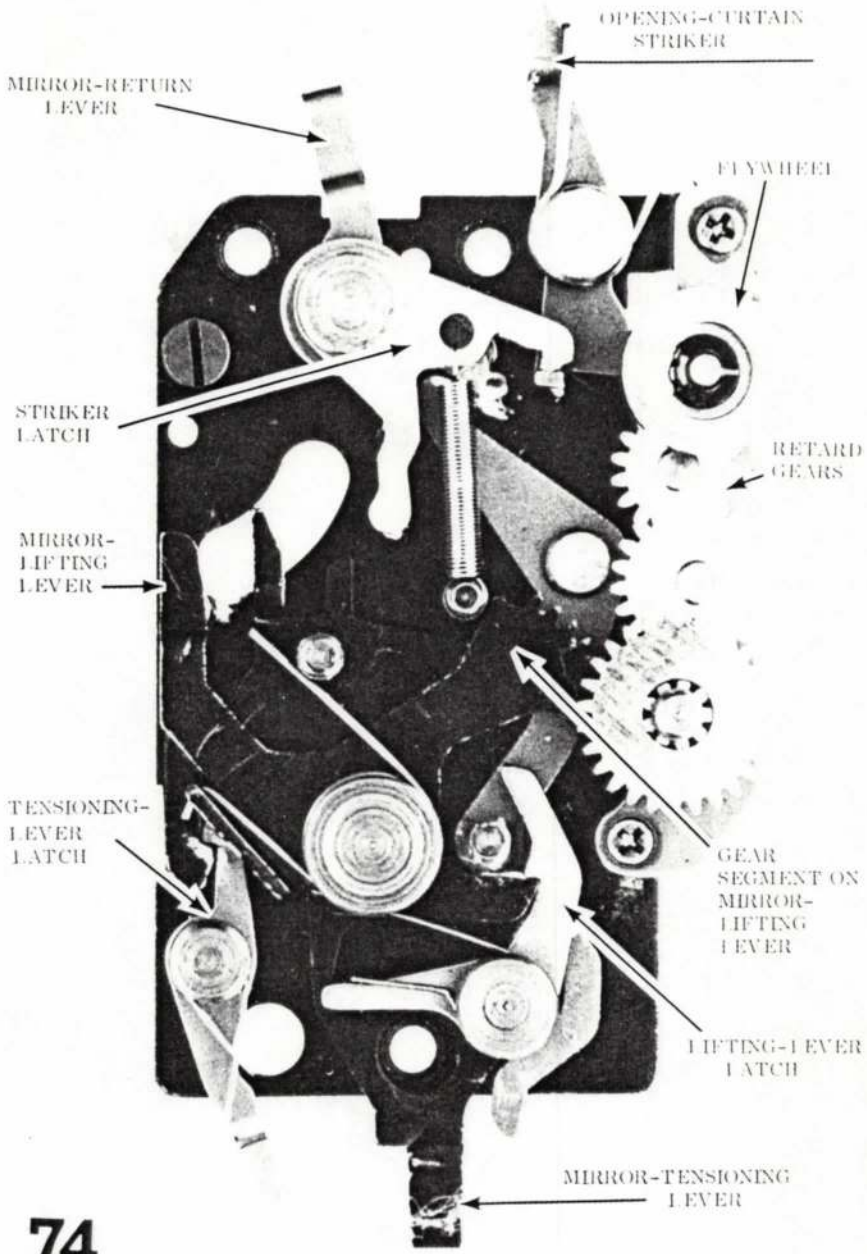
The adjustment bushing on the mirror pivot controls the lateral movement of the mirror mirror. The sideplay should be 0.05 - 0.15mm.



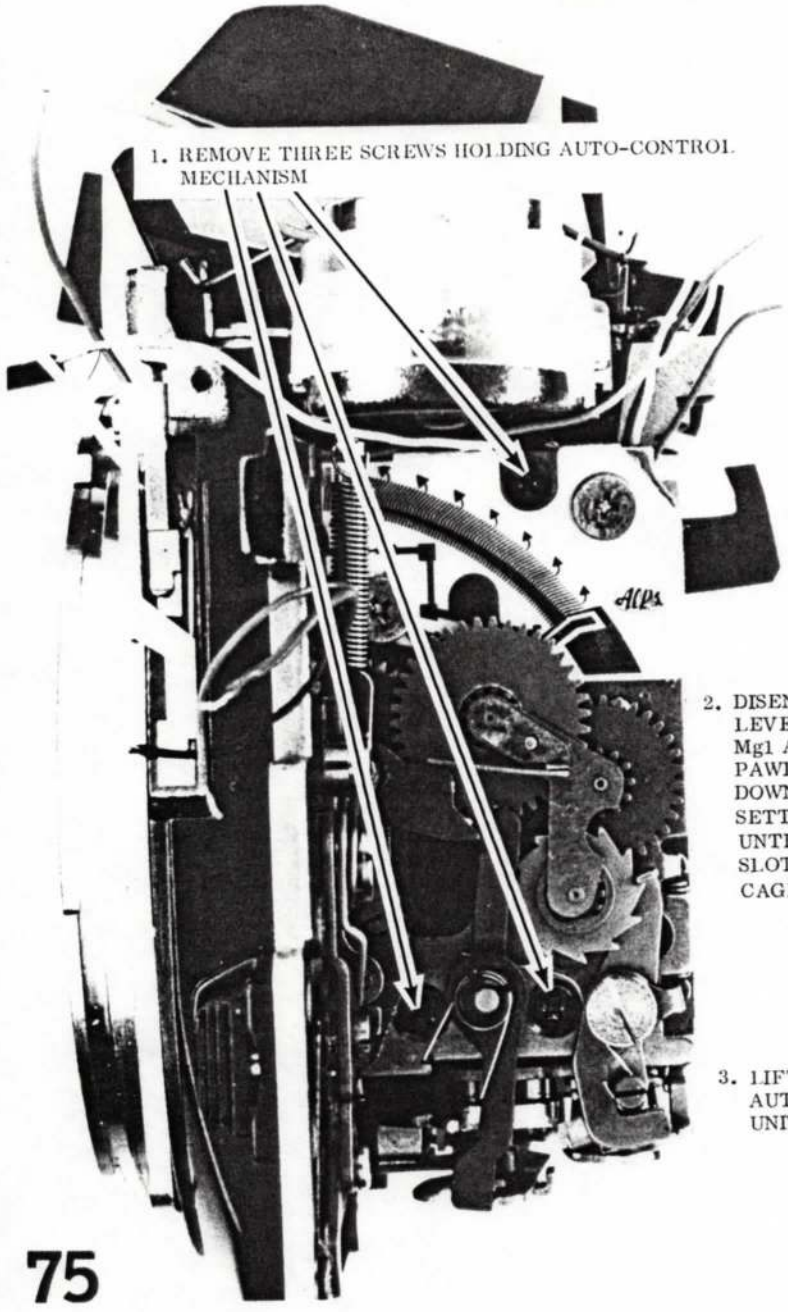
72


REMOVE
THREE SCREWS
AND LIFT OFF
MIRROR-OPERATING
MECHANISM
CAUTION:
MIRROR,
MIRROR-RETURN
SPRING, AND
ADJUSTMENT
BUSHING ARE
NOW LOOSE

73



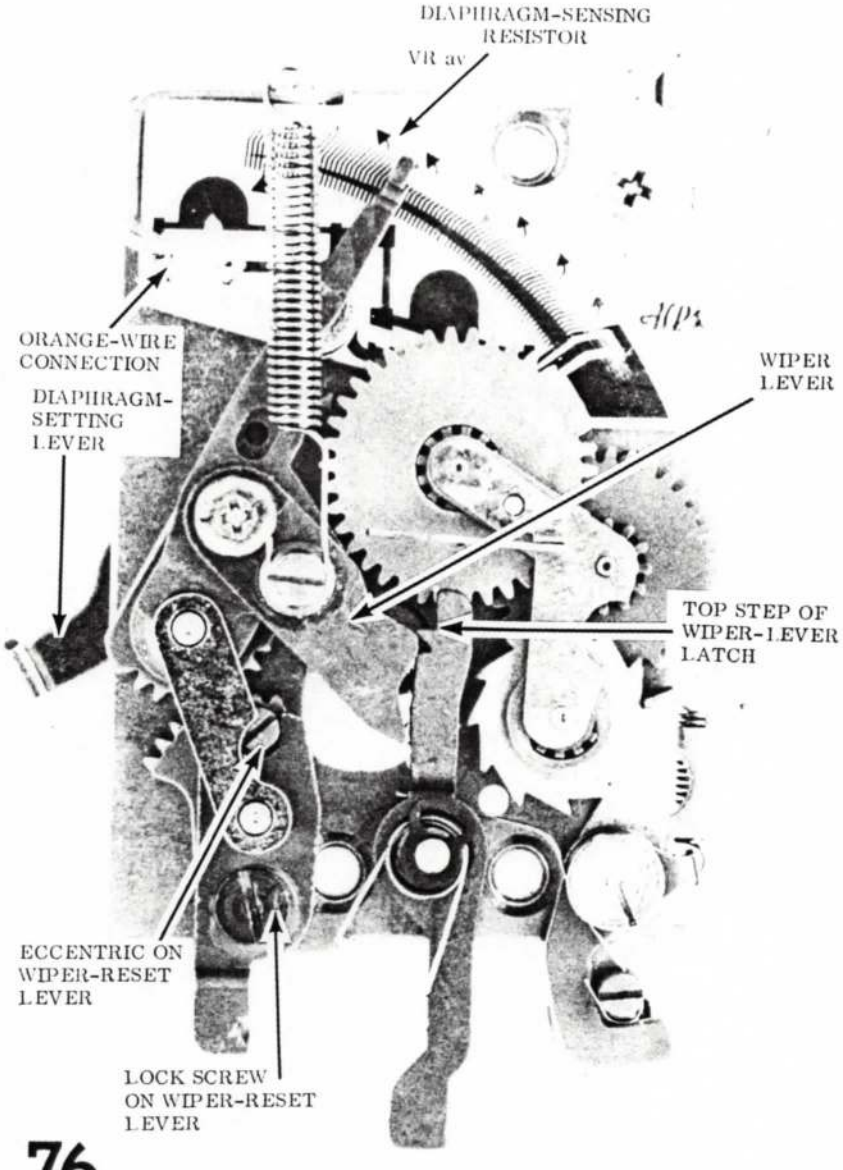
MIRROR-OPERATING MECHANISM



1. REMOVE THREE SCREWS HOLDING AUTO-CONTROL MECHANISM

2. DISENGAGE WIPER-LEVER LATCH AND Mg1 ARMATURE PAWL - MOVE DOWN DIAPHRAGM-SETTING LEVER UNTIL IT CLEARS SLOT IN MIRROR CAGE

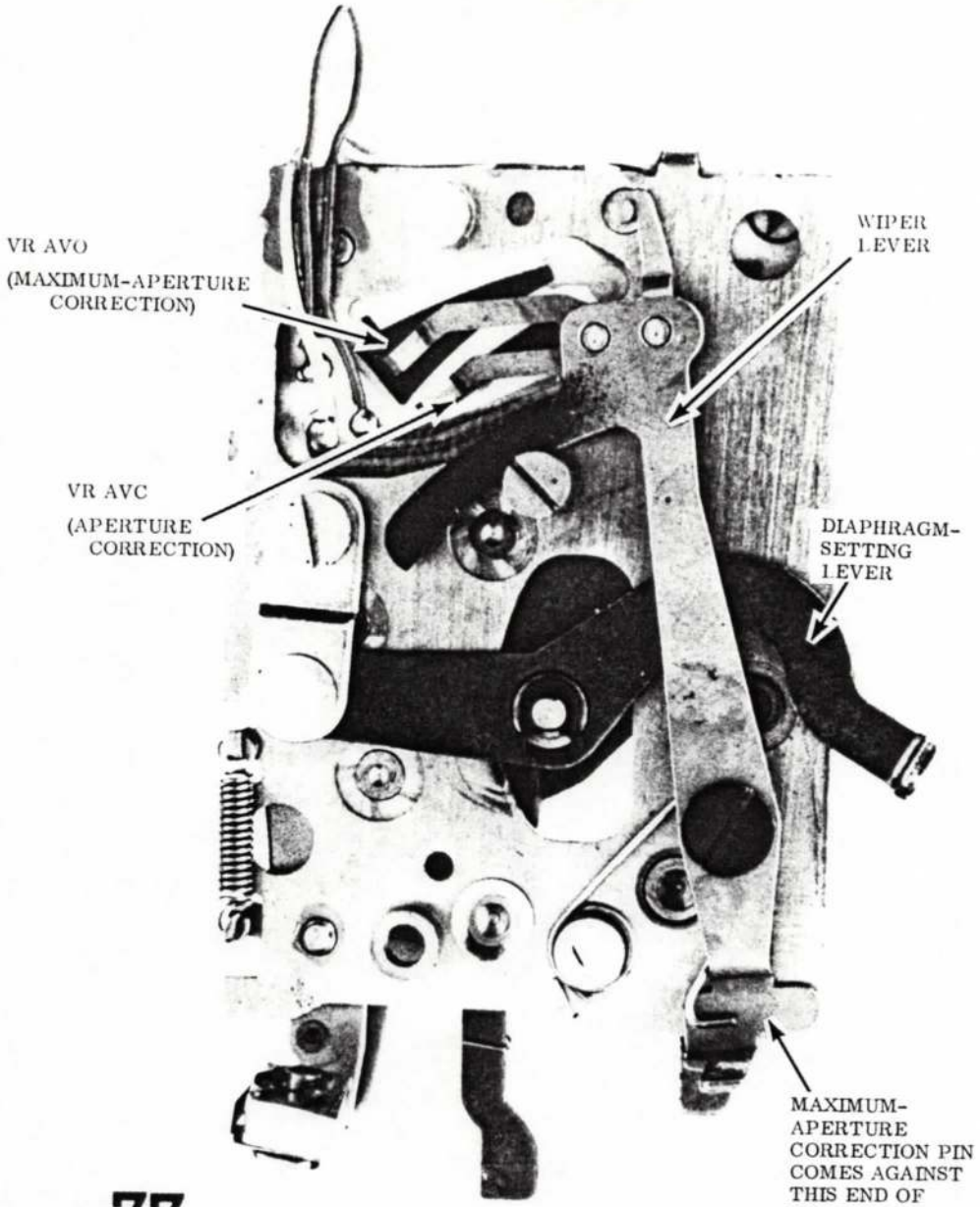
3. LIFT OUT AUTO-CONTROL UNIT



76 AUTO-CONTROL MECHANISM

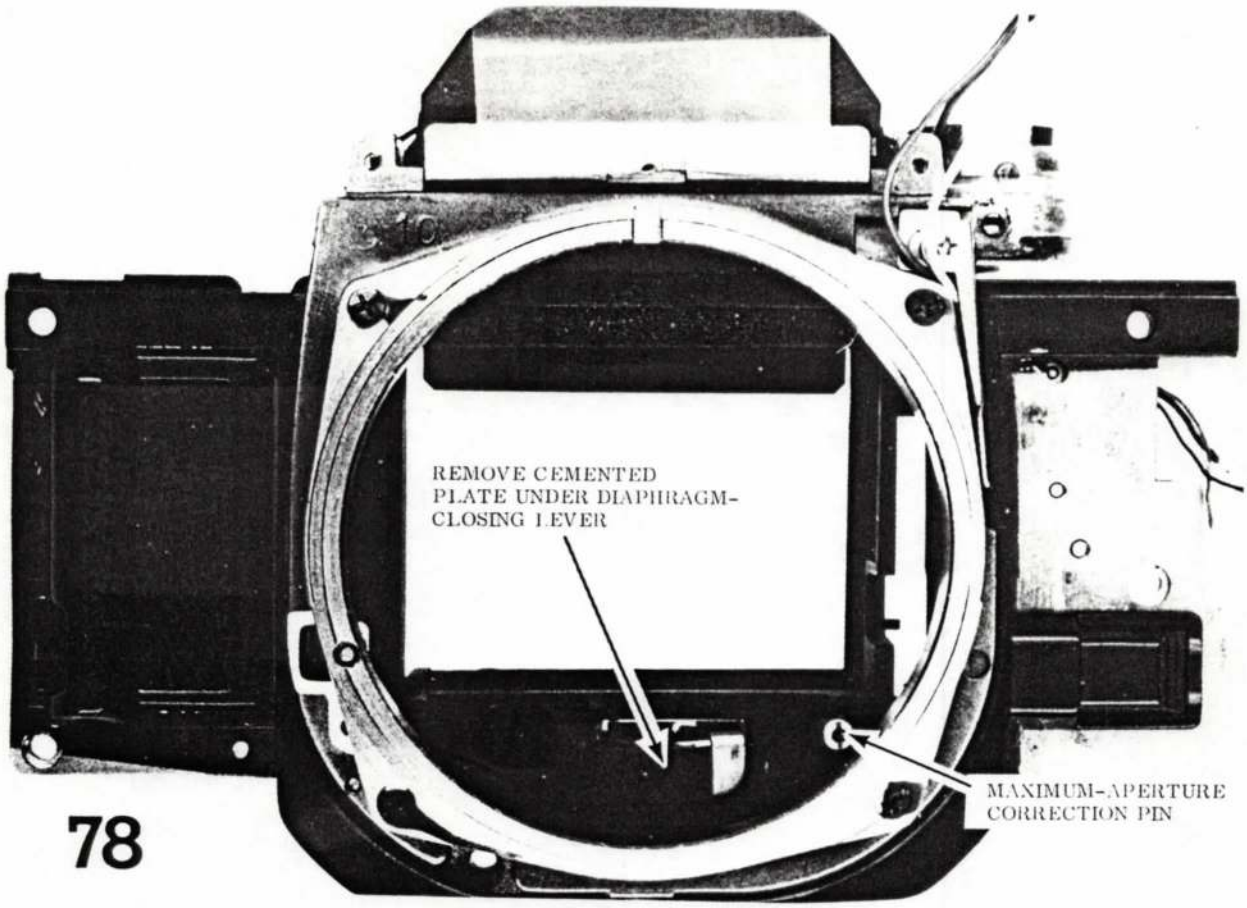
The eccentric on the wiper-reset lever allows you to adjust the overtravel of the wiper lever. With the mirror cage assembled, hold the mirror-cage cocking lever fully advanced. There should then be a 0.5mm clearance between the latching end of the wiper lever and the top step of the wiper-lever latch. To make the overtravel adjustment, first loosen the lock screw on the wiper-reset lever. Then, turn the eccentric.

When the wiper lever is latched on the top step of the wiper-lever latch, the wiper should not touch the resistance band. So you should measure infinite resistance between the orange wire and ground.

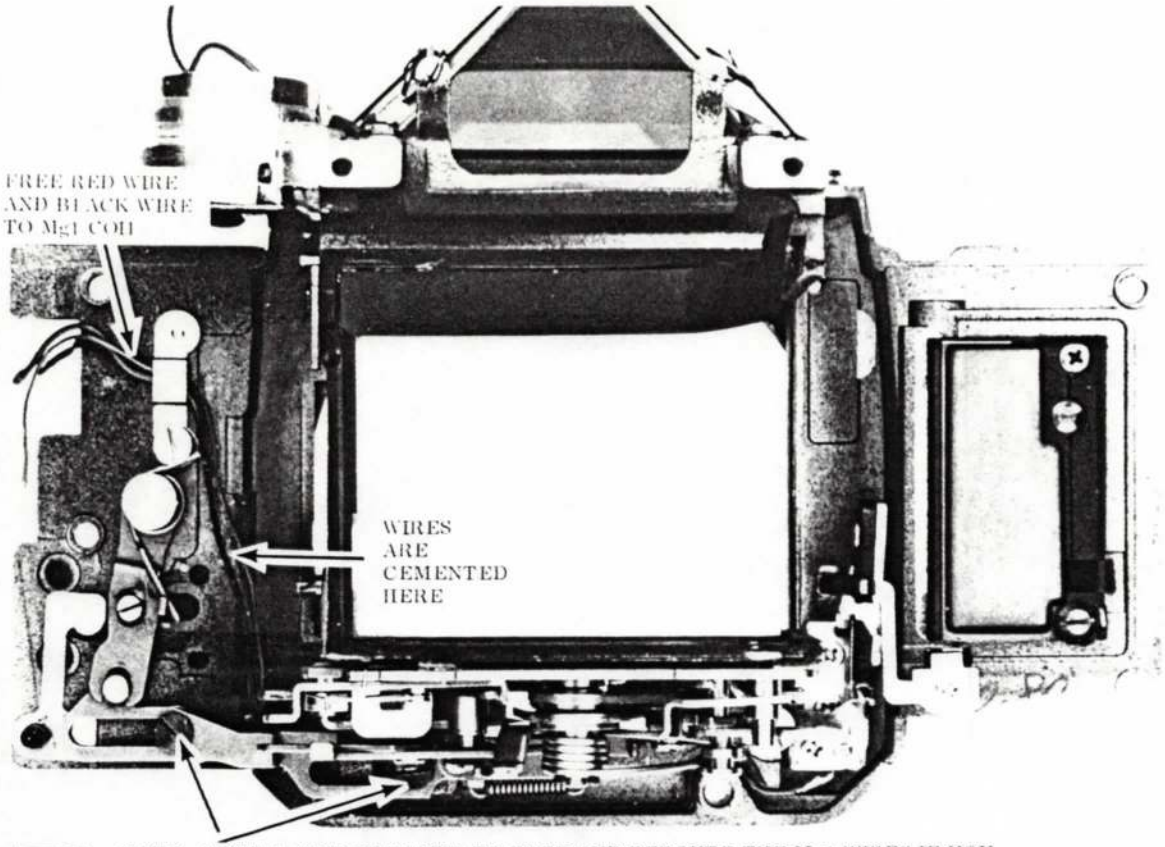


77

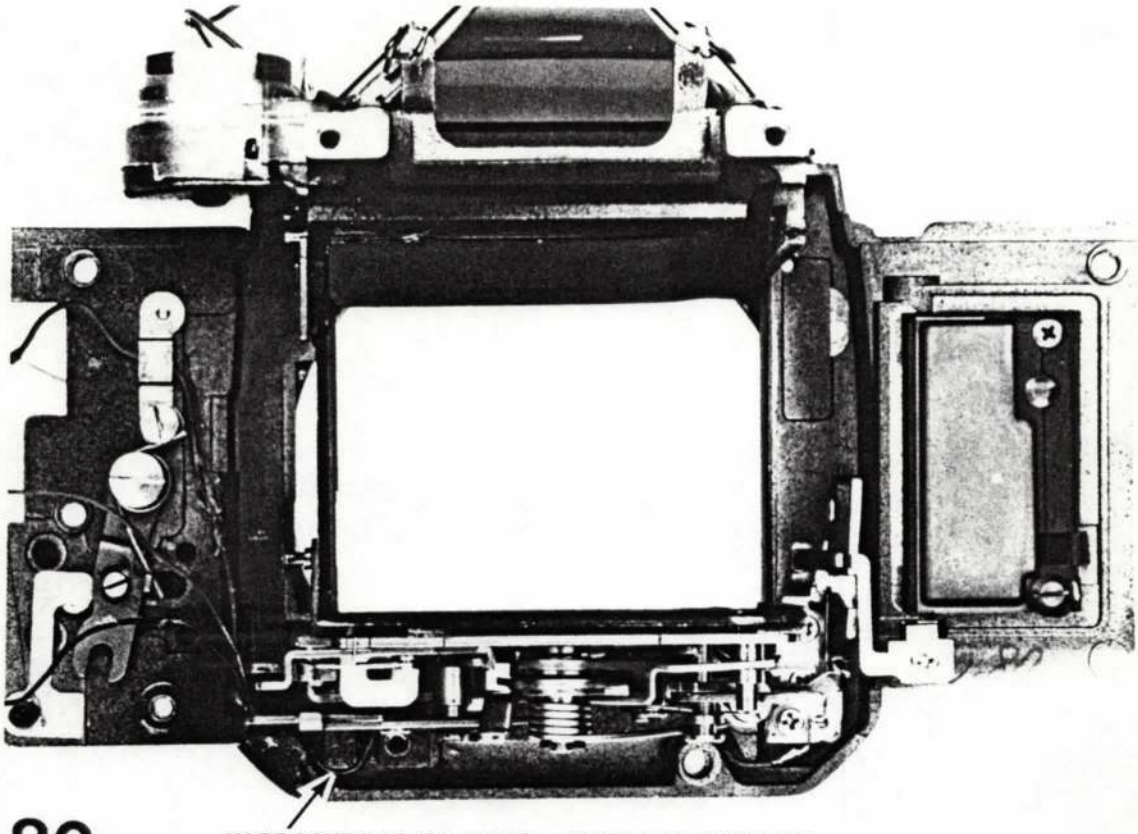
BACK OF AUTO-CONTROL MECHANISM


REMOVE CEMENTED
PLATE UNDER DIAPHRAGM-
CLOSING LEVER
MAXIMUM-APERTURE
CORRECTION PIN

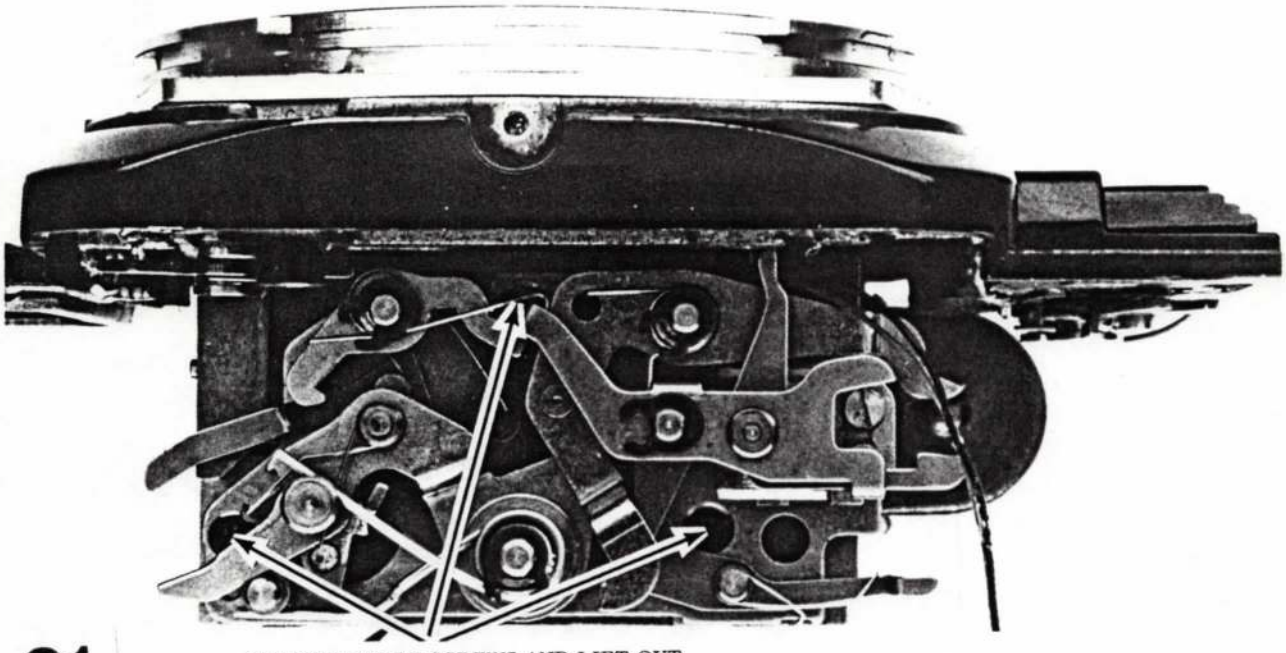
78



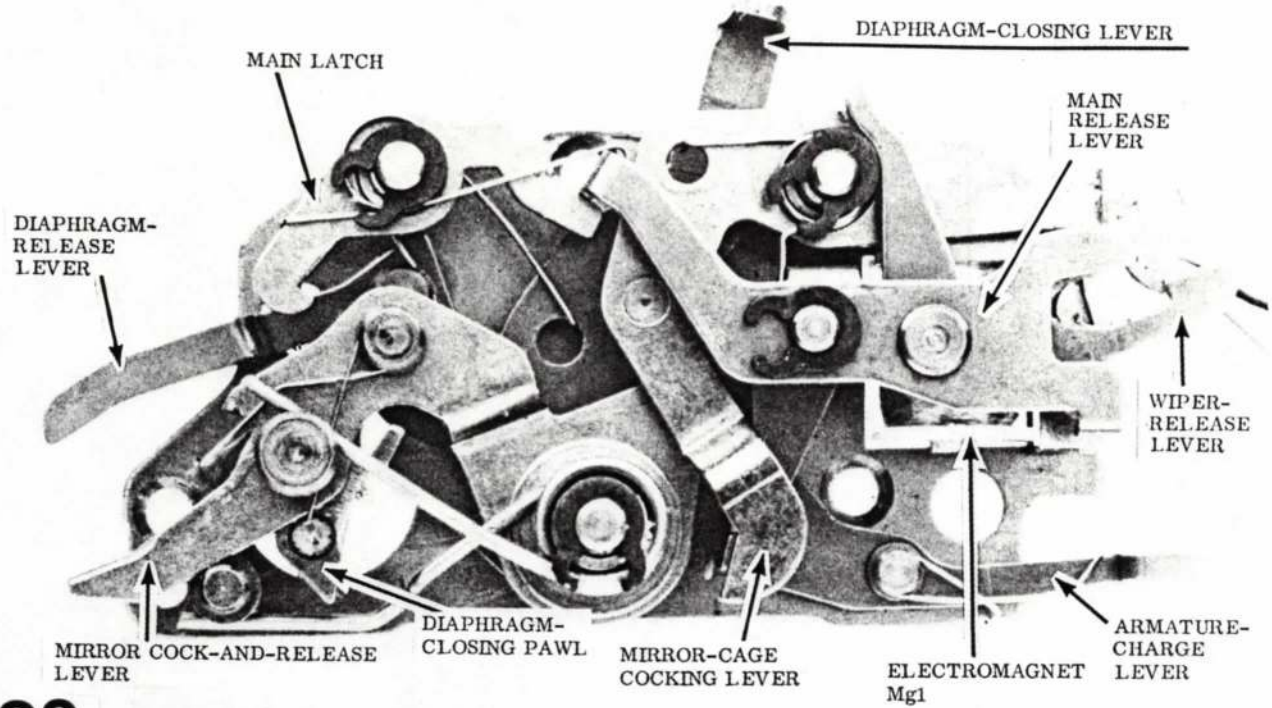
79 NOTE: YOU'LL FIND IT EASIER TO FREE AND REROUTE THE Mg1 WIRES IF YOU FIRST REMOVE THE STOP-DOWN SLIDE BY TAKING OUT THESE TWO SCREWS. HOWEVER, THIS STEP IS NOT NECESSARY.



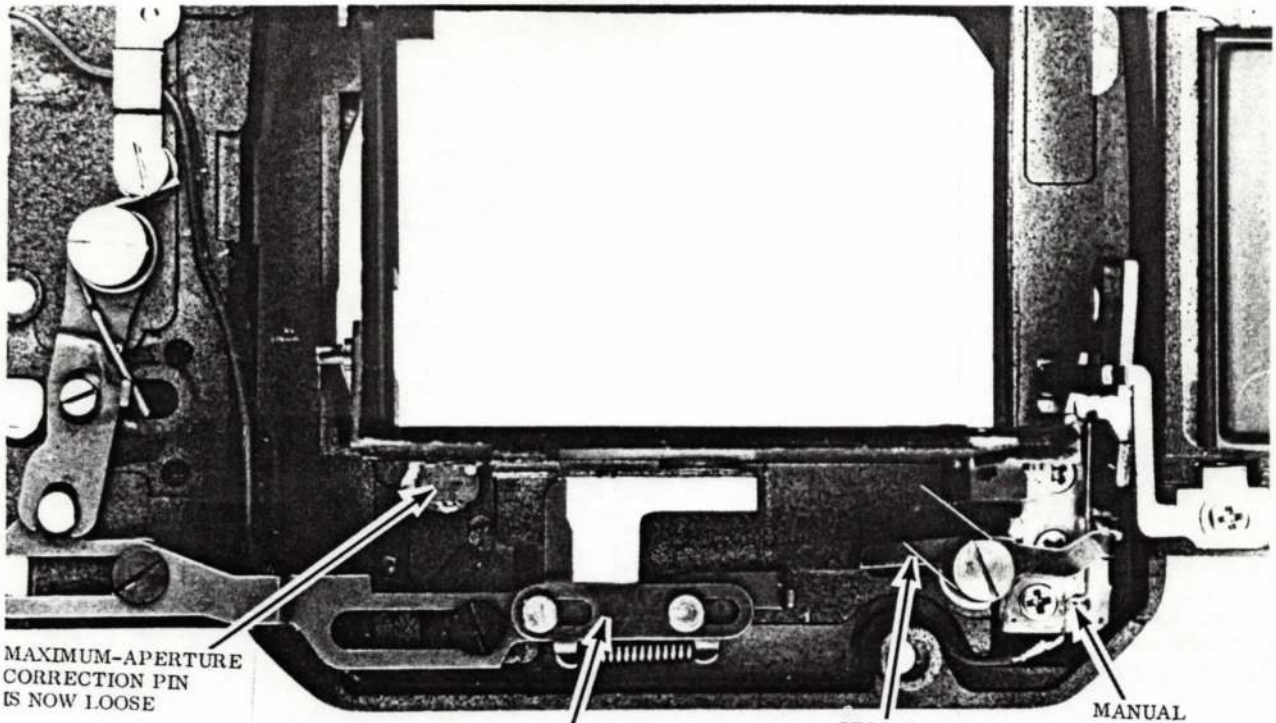
80 NOTE ROUTE OF Mg1 WIRES — WIRES ARE CEMENTED IN POSITION



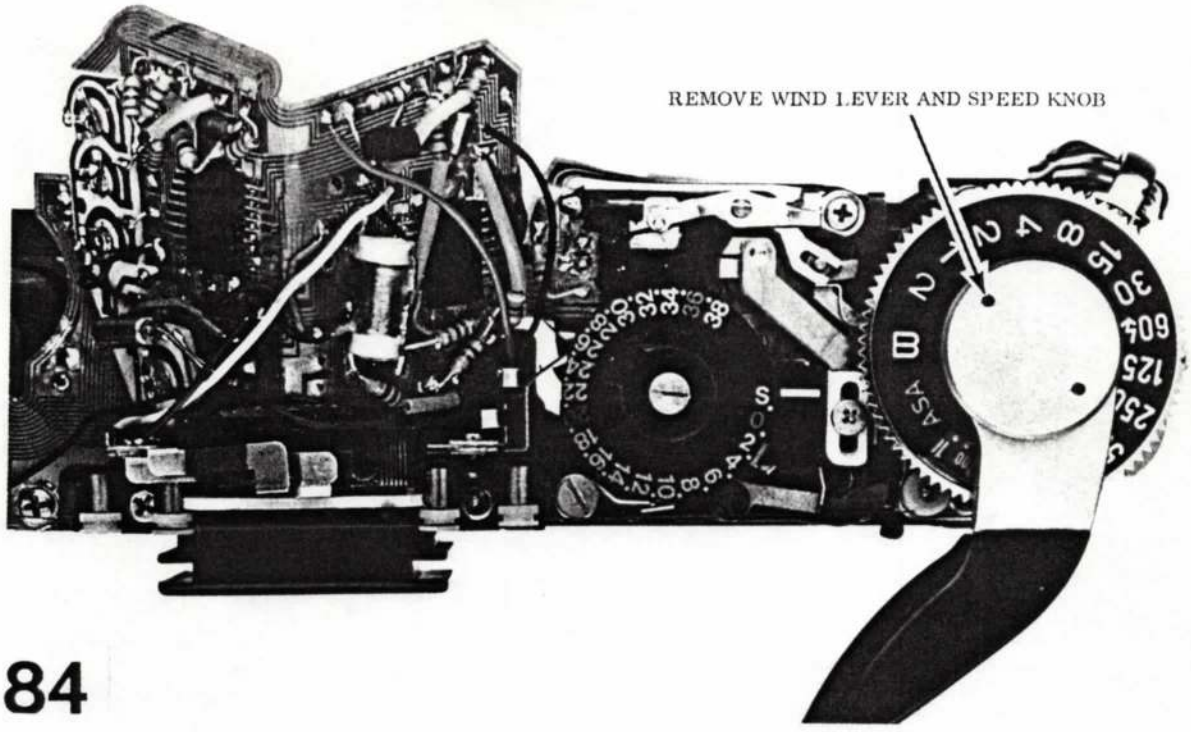
81 REMOVE THREE SCREWS AND LIFT OUT DIAPHRAGM-CONTROL MECHANISM

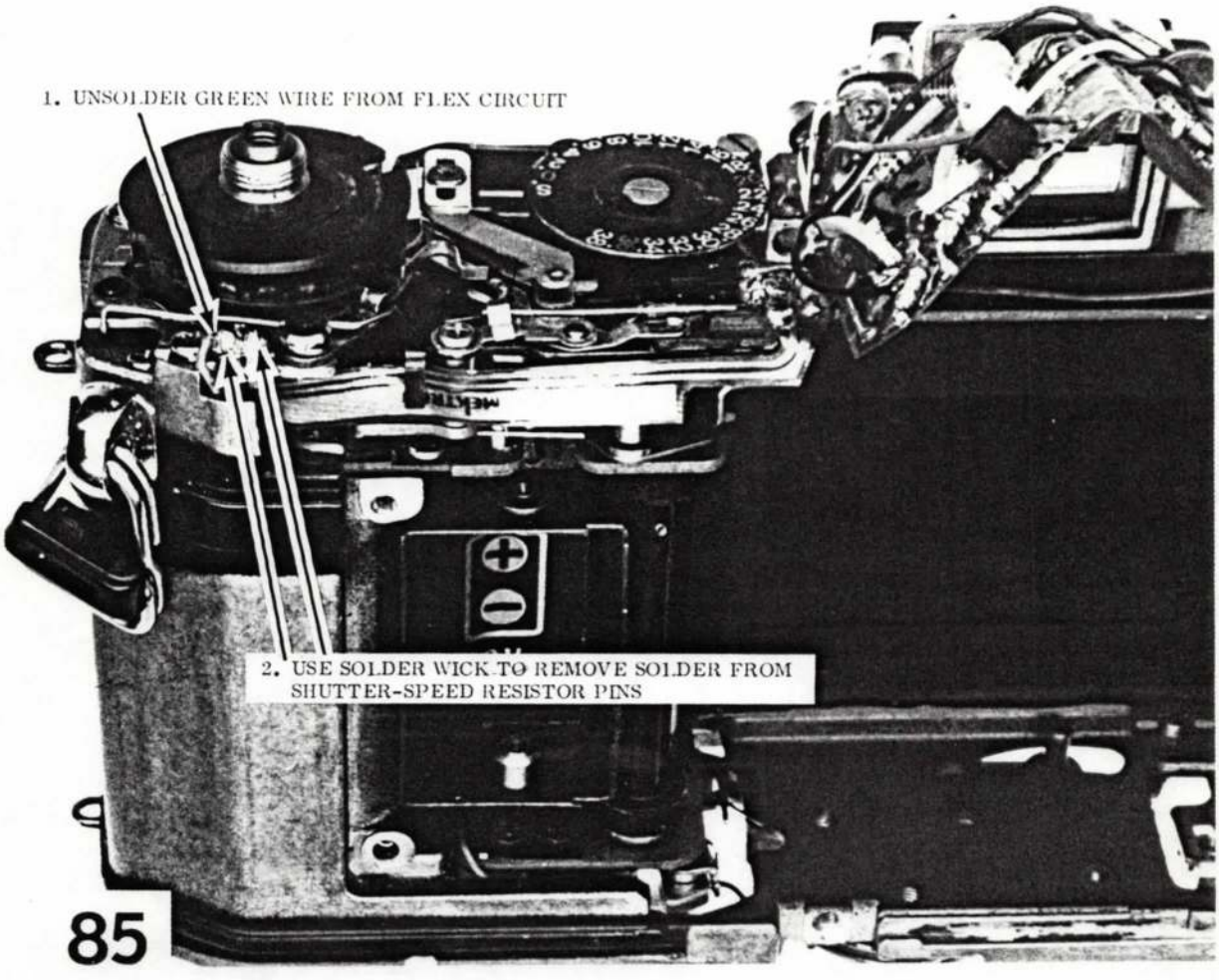


82 DIAPHRAGM-CONTROL MECHANISM

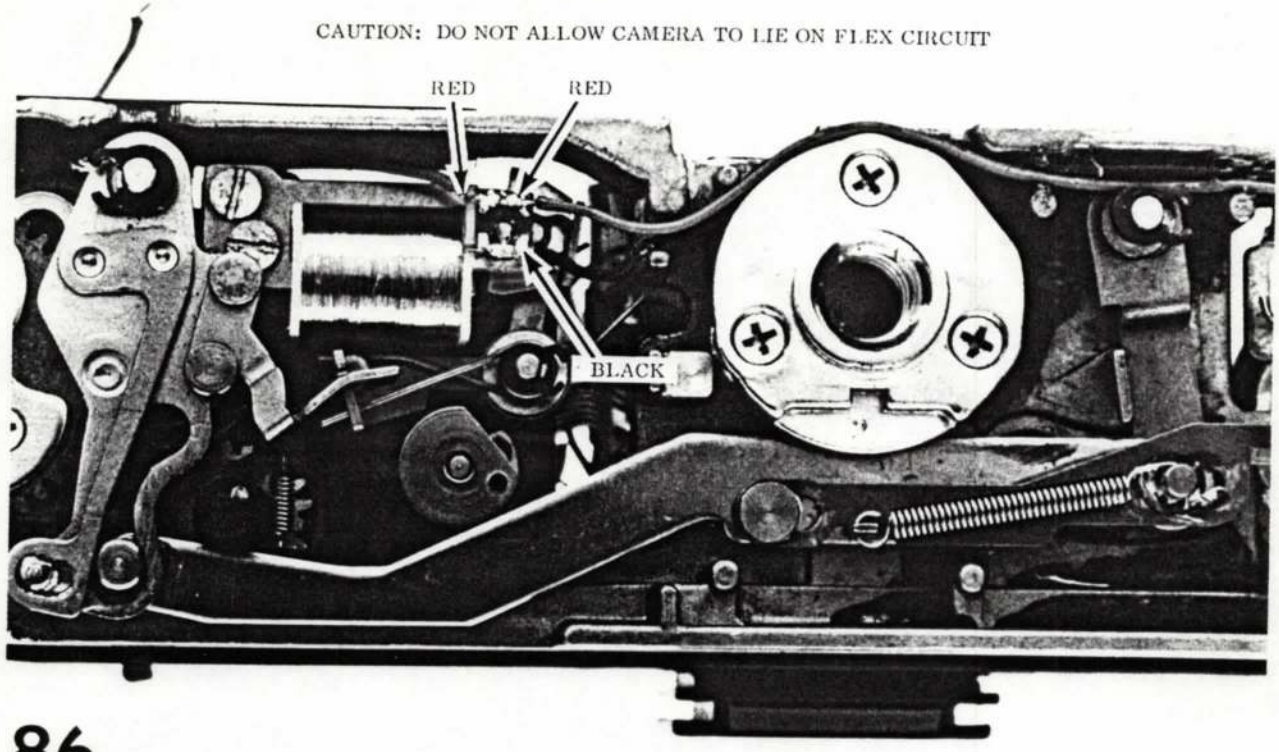

MAXIMUM-APERTURE
CORRECTION PIN
IS NOW LOOSE
STOP-DOWN SLIDE
STOP-DOWN
BLOCKING
LEVER
MANUAL
SWITCH
SW11

83

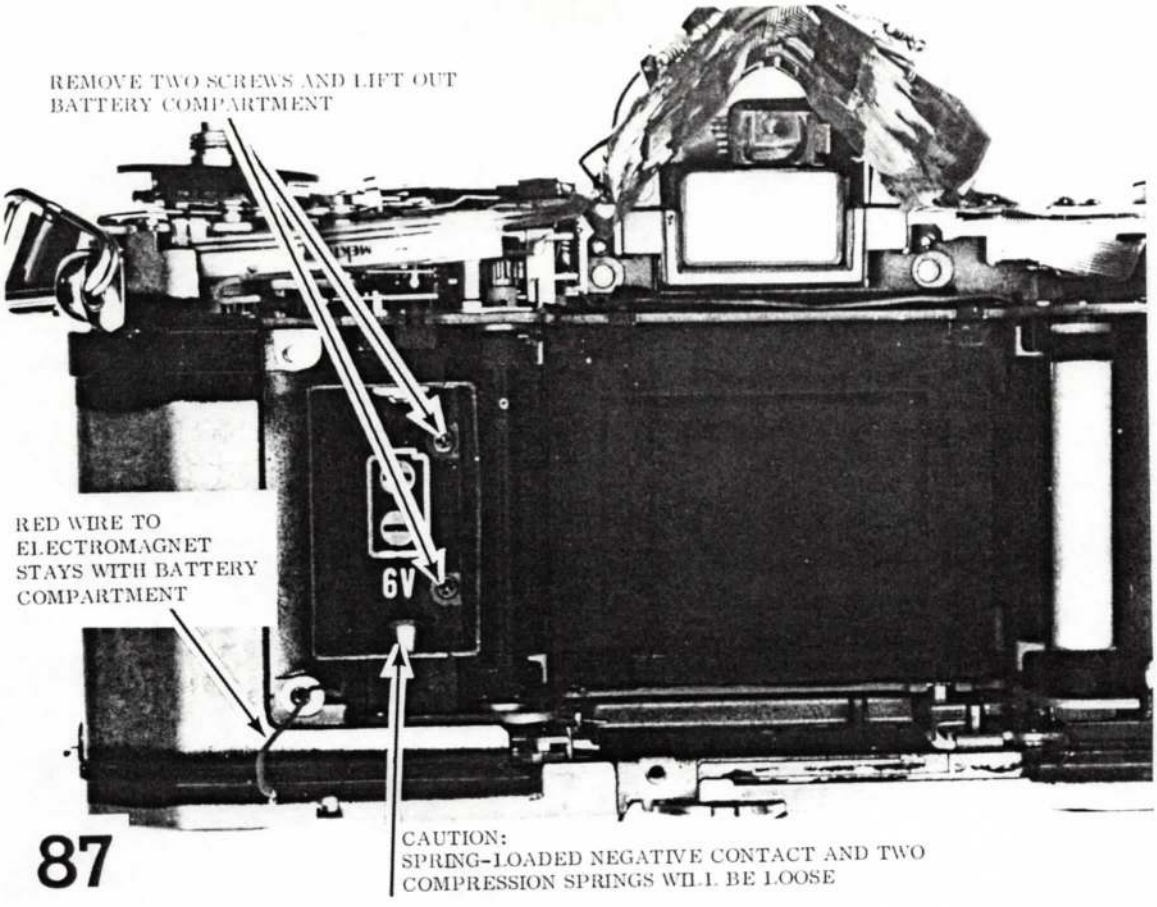

REMOVE WIND LEVER AND SPEED KNOB


1. UNSOLDER GREEN WIRE FROM FLEX CIRCUIT
2. USE SOLDER WICK TO REMOVE SOLDER FROM SHUTTER-SPEED RESISTOR PINS
85

CAUTION: DO NOT ALLOW CAMERA TO LIE ON FLEX CIRCUIT



86 UNSOLDER WIRES FROM CLOSING-CURTAIN MAGNET Mg3

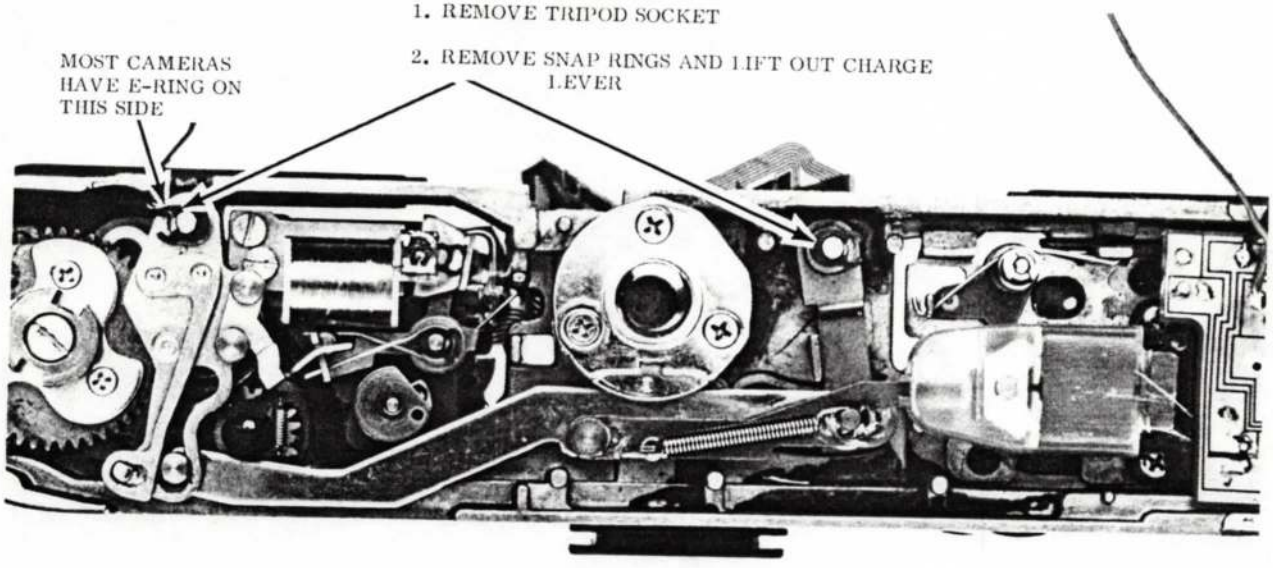

REMOVE TWO SCREWS AND LIFT OUT
BATTERY COMPARTMENT
RED WIRE TO
ELECTROMAGNET
STAYS WITH BATTERY
COMPARTMENT
6V
CAUTION:
SPRING-LOADED NEGATIVE CONTACT AND TWO
COMPRESSION SPRINGS WILL BE LOOSE

87

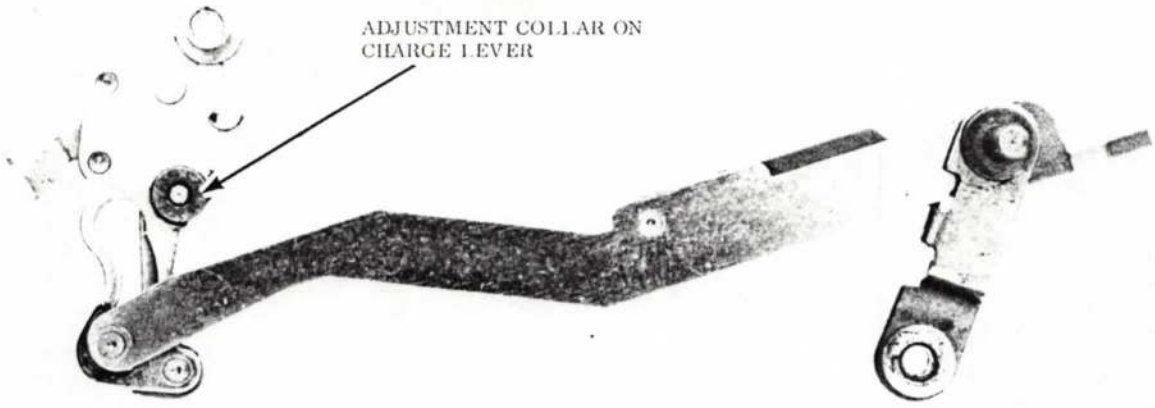
1. REMOVE TRIPOD SOCKET

2. REMOVE SNAP RINGS AND LIFT OUT CHARGE LEVER

MOST CAMERAS HAVE E-RING ON THIS SIDE



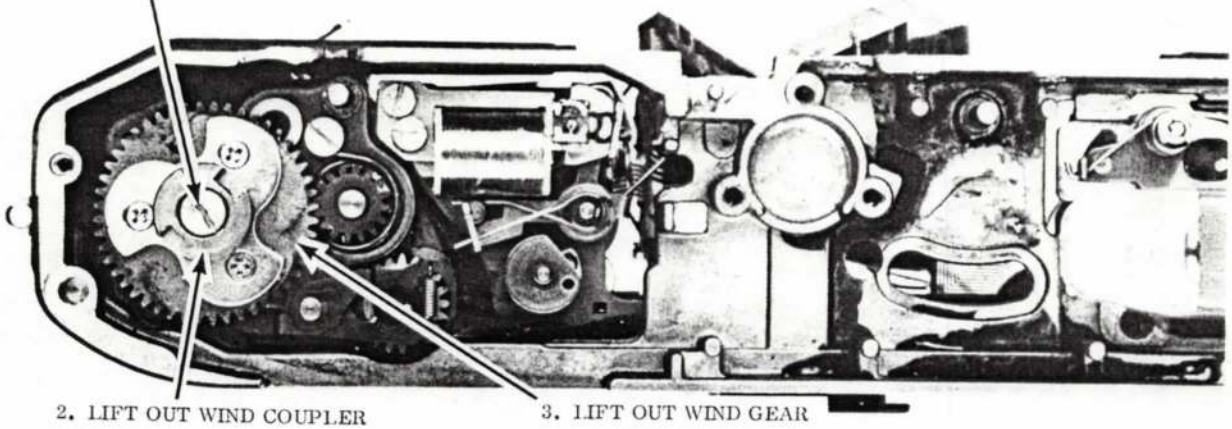
88 CAUTION: ADJUSTMENT COLLAR ON UNDERSIDE OF CHARGE LEVER IS LOOSE



ADJUSTMENT COLLAR DIAMETERS:

3.4mm
3.6mm
3.8mm
4.0mm
4.2mm

1. REMOVE SCREW



2. LIFT OUT WIND COUPLER

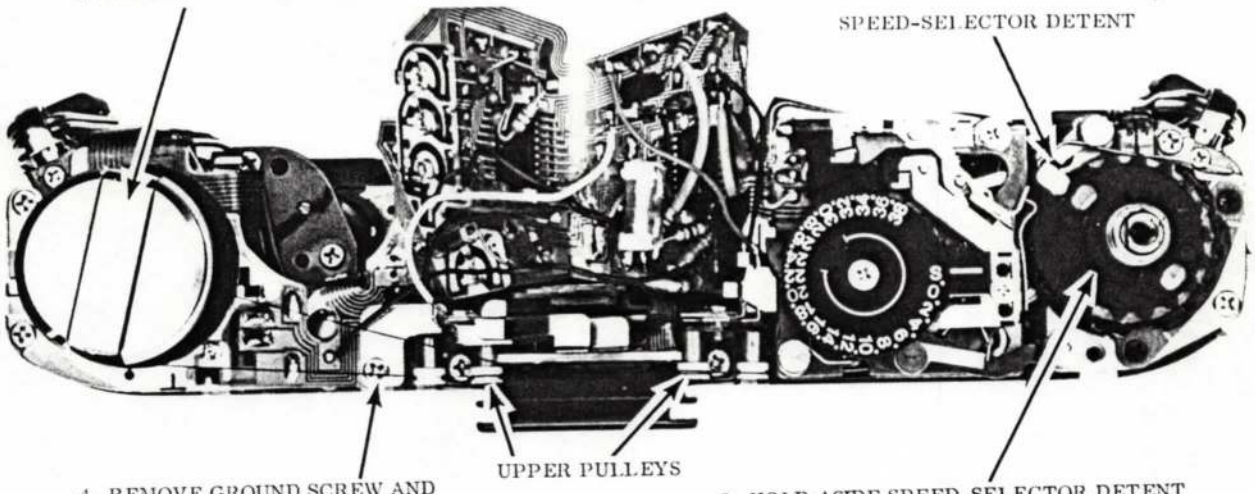
3. LIFT OUT WIND GEAR

90 NOTE TIMING OF CHARGE CAM

1. LIFT OFF SPEED-KNOB COUPLER WITHOUT LOSING INITIAL TENSION ON FUNCTIONAL RESISTOR

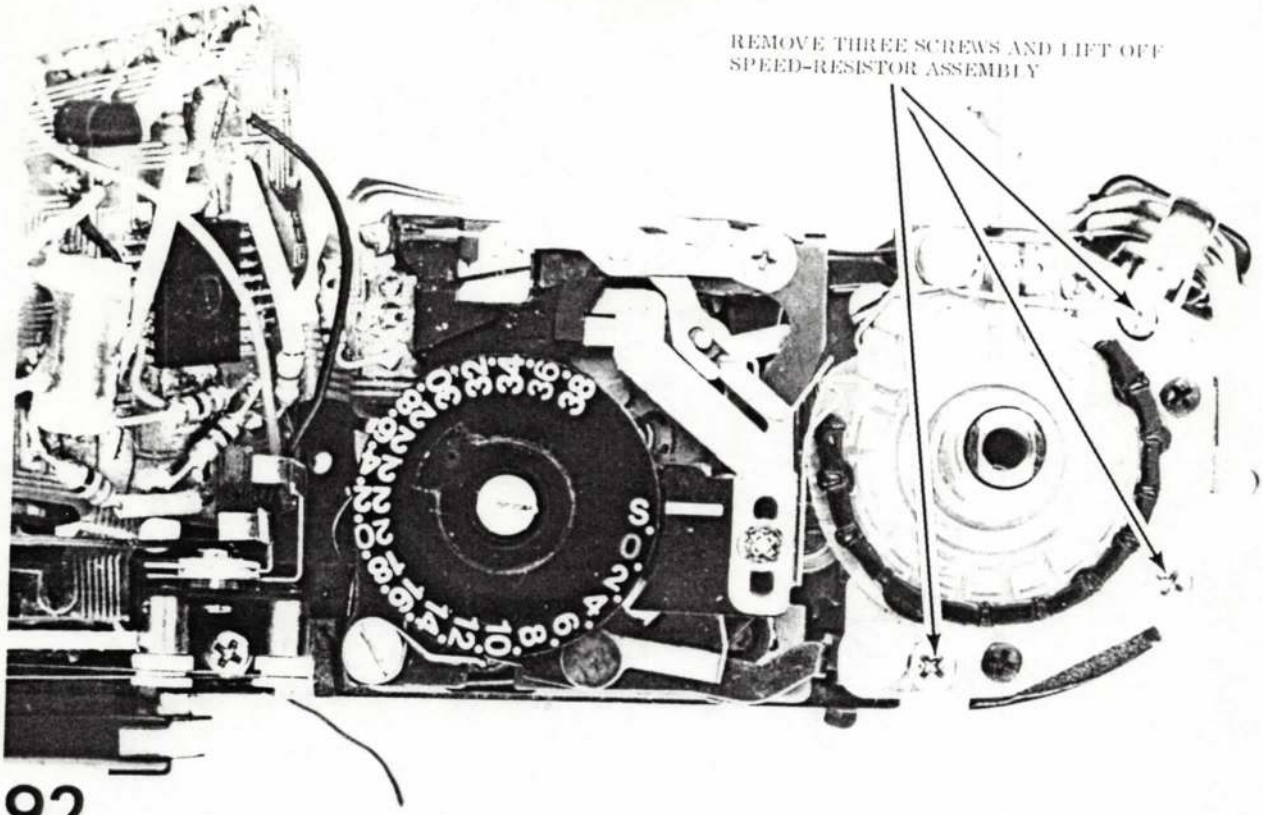
2. ROUTE TUNGSTEN WIRE OVER TOP OF UPPER PULLEYS -- PLACE SPEED-KNOB COUPLER OVER REWIND-SHAFT HOUSING

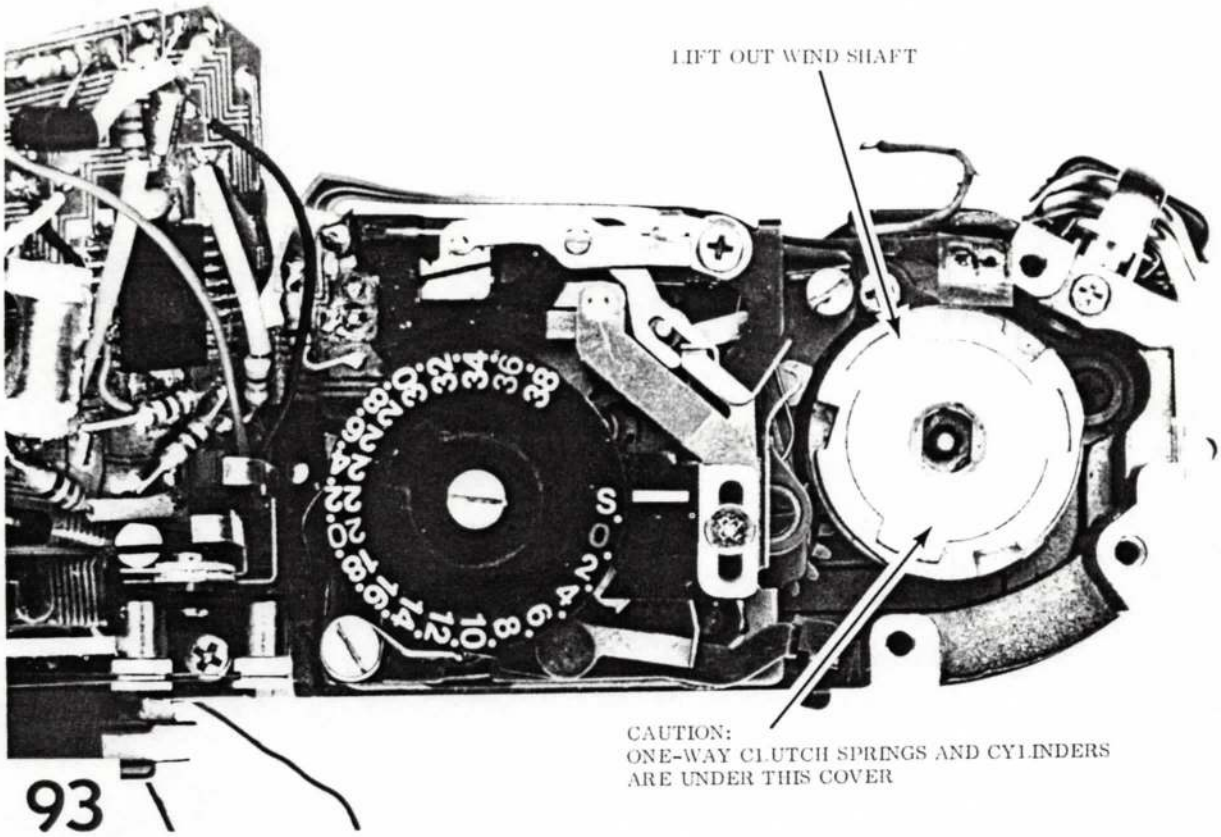
3. REPLACE REWIND KNOB TO HOLD SPEED-KNOB COUPLER IN PLACE



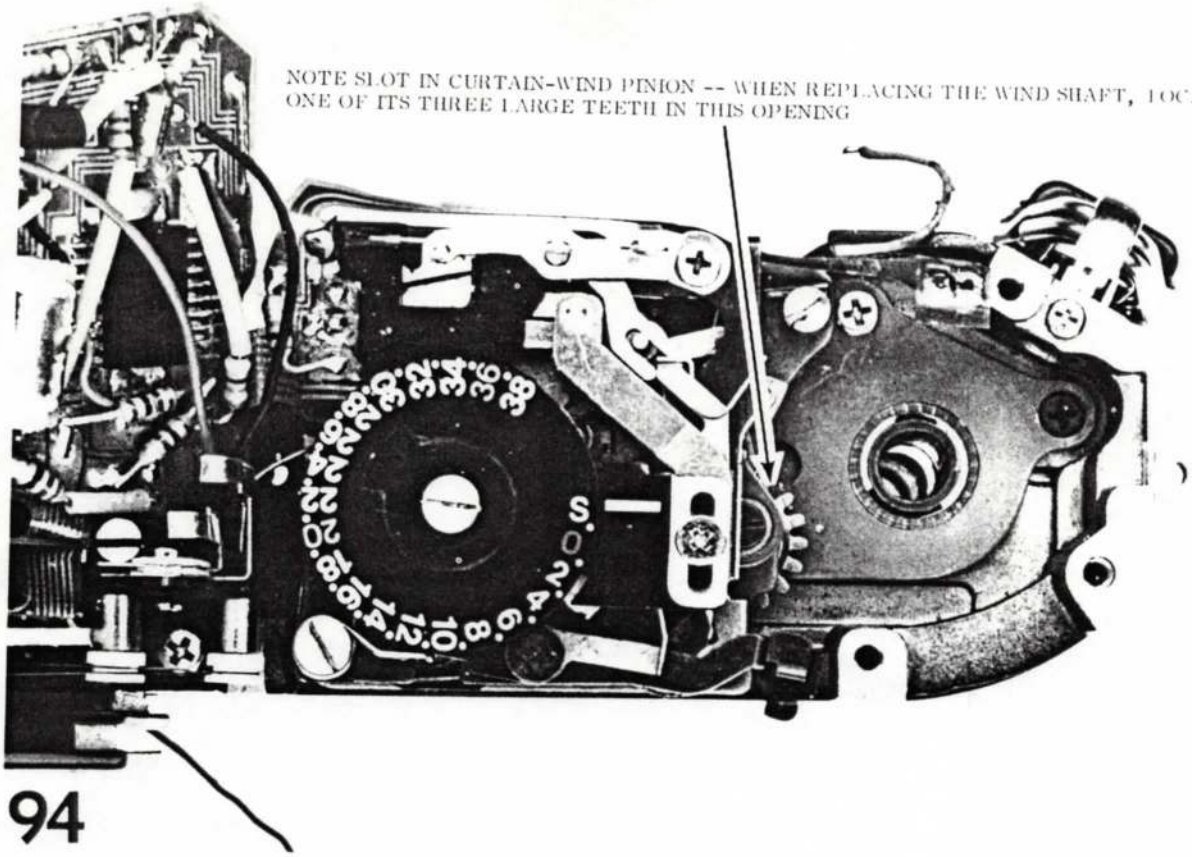
4. REMOVE GROUND SCREW AND GROUND PLATE (IF INSTALLED)

5. HOLD ASIDE SPEED-SELECTOR DETENT AND LIFT OUT SPEED SELECTOR


REMOVE THREE SCREWS AND LIFT OFF
SPEED-RESISTOR ASSEMBLY

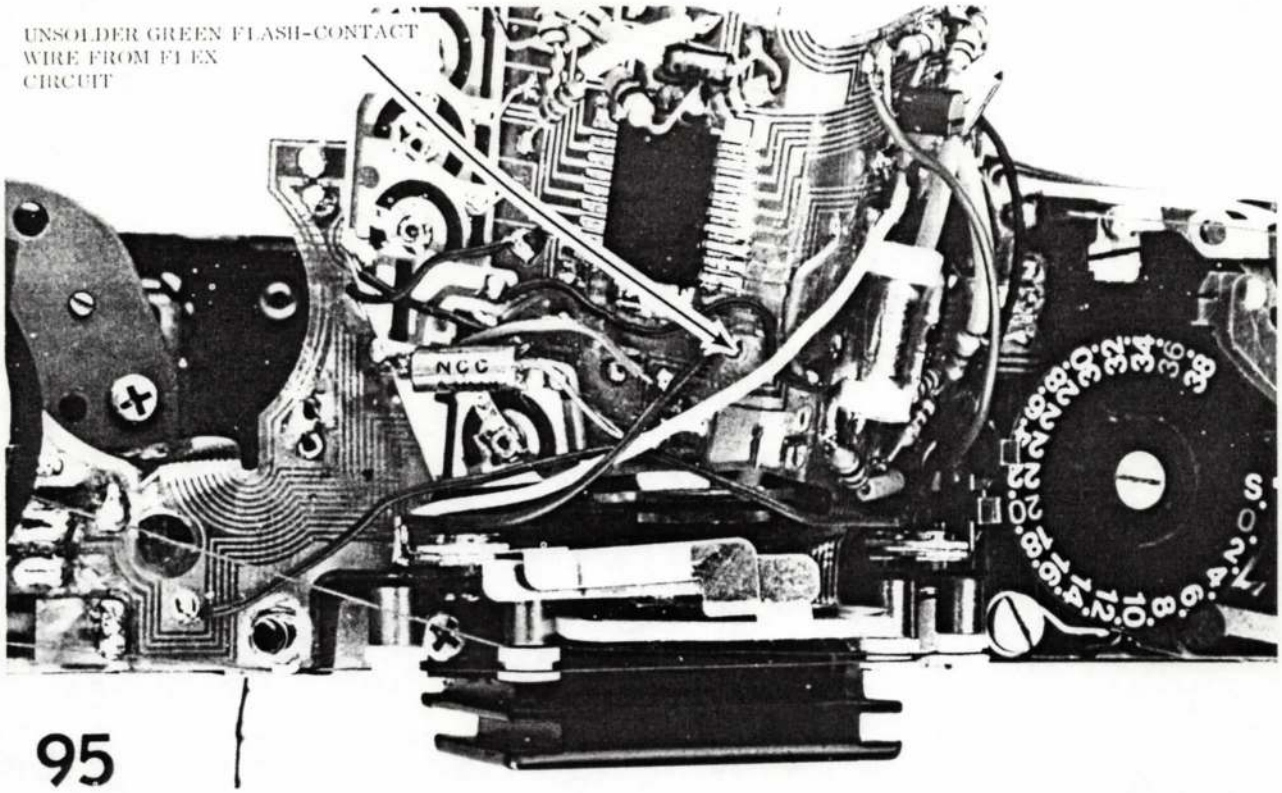

LIFT OUT WIND SHAFT
CAUTION:
ONE-WAY CLUTCH SPRINGS AND CYLINDERS
ARE UNDER THIS COVER

93

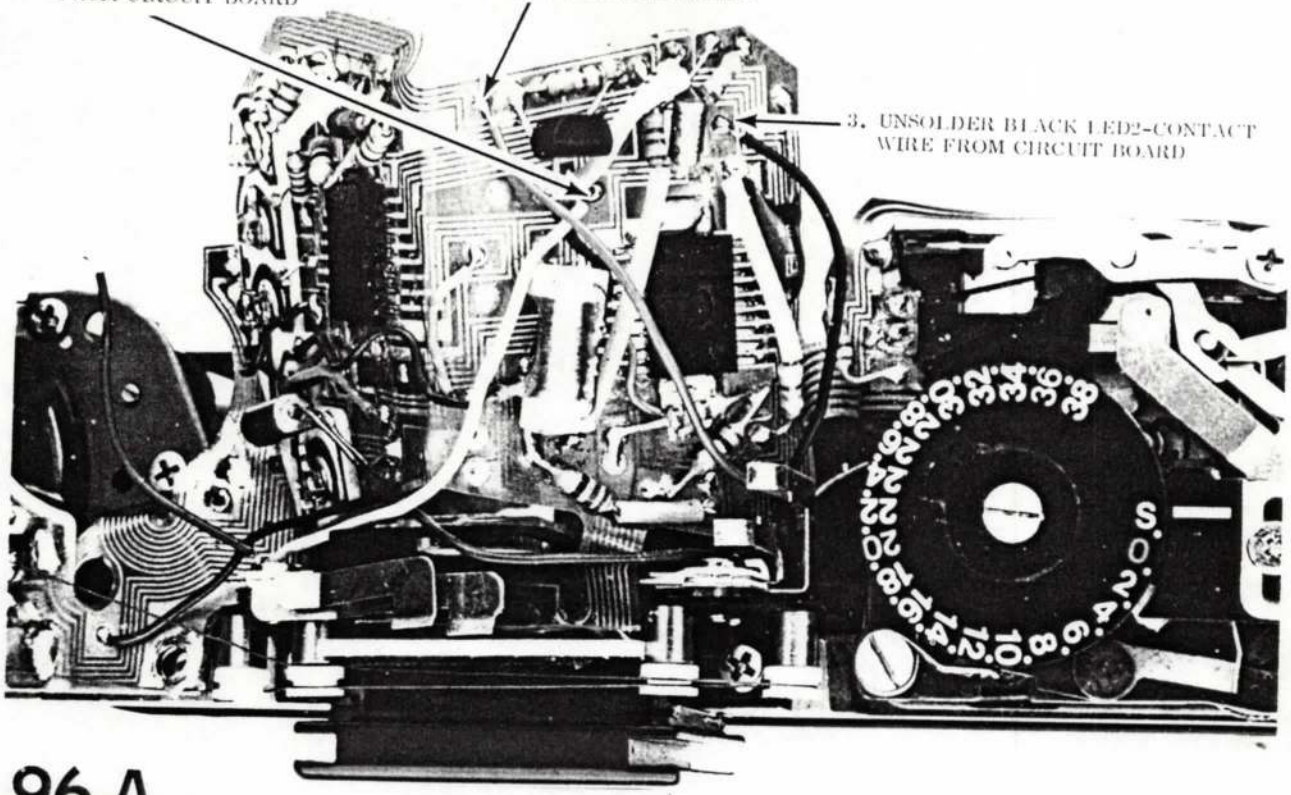


NOTE SLOT IN CURTAIN-WIND PINION -- WHEN REPLACING THE WIND SHAFT, LOCATE ONE OF ITS THREE LARGE TEETH IN THIS OPENING

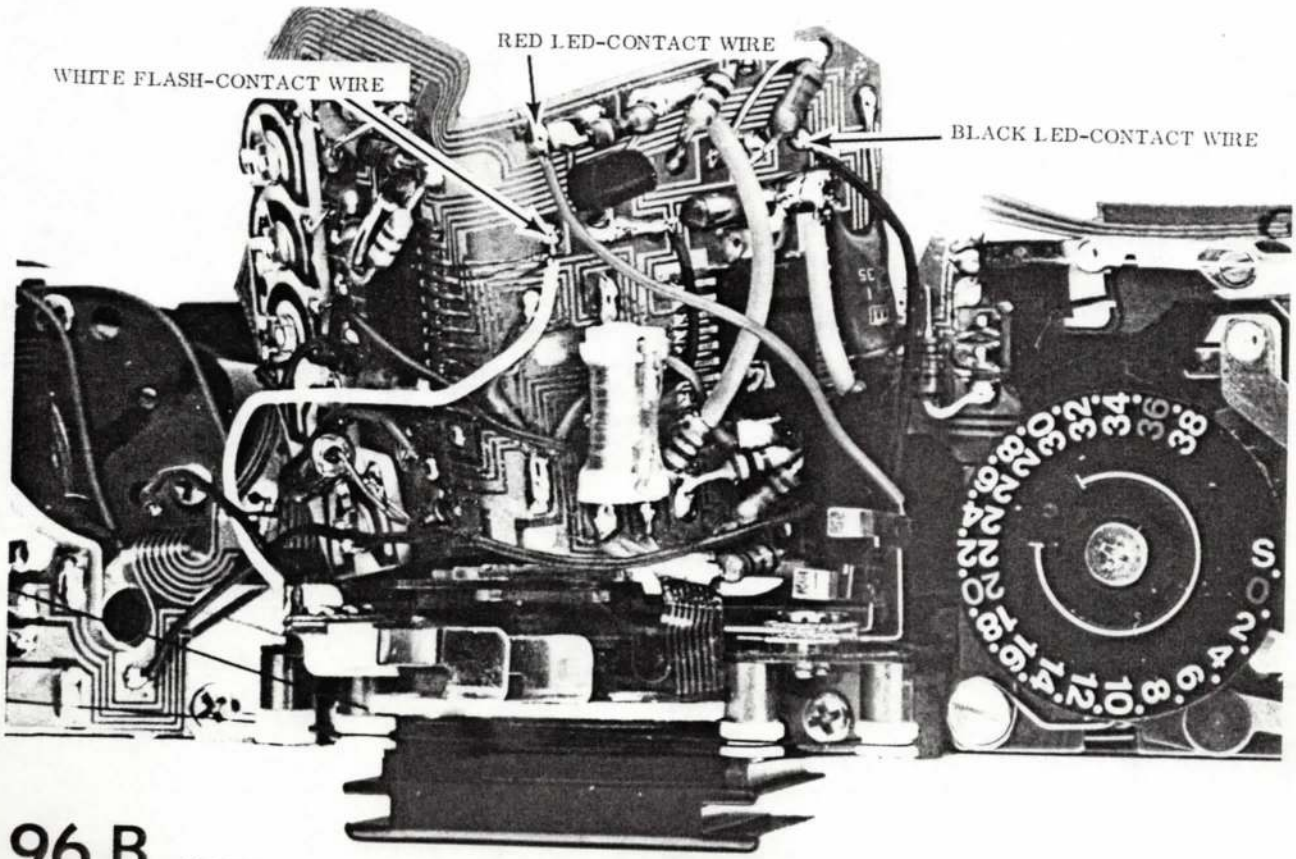
UNSOLDER GREEN FLASH-CONTACT WIRE FROM FLEX CIRCUIT



95



96 A ORIGINAL CIRCUIT BOARD



96 B MODIFIED CIRCUIT BOARD