THE COPAL NO. O SHUTTER

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THE COPAL LEAF-TYPE SHUTTER

Among the most popular of the leaf-type shutters are the several Copal models. Copal, a manufacturer in Japan, produces a variety of modular shutters -- both leaf-type and focal-plane.

Most of the leaf-type models bear a strong resemblance to the Gauthier family of Germany. In particular, the design of the main-lever/leaf-lever assembly, Fig. 1, is nearly identical to that you've seen in the Prontor and Vario shutters.

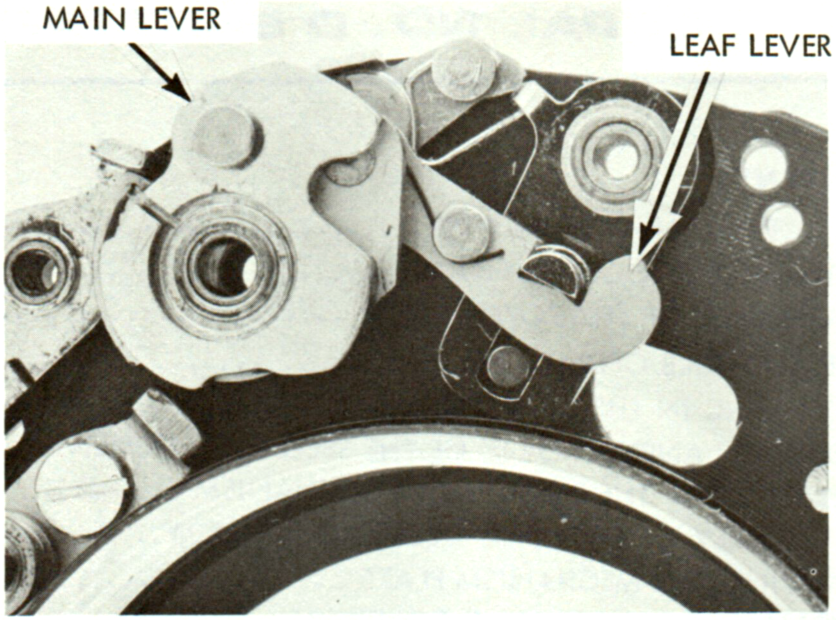


FIGURE 1 COPAL NO. 0

Notice in Fig. 2 how closely the 00-size Copal resembles the Gauthier design. The most apparent variation is in the sync-delay mechanism.

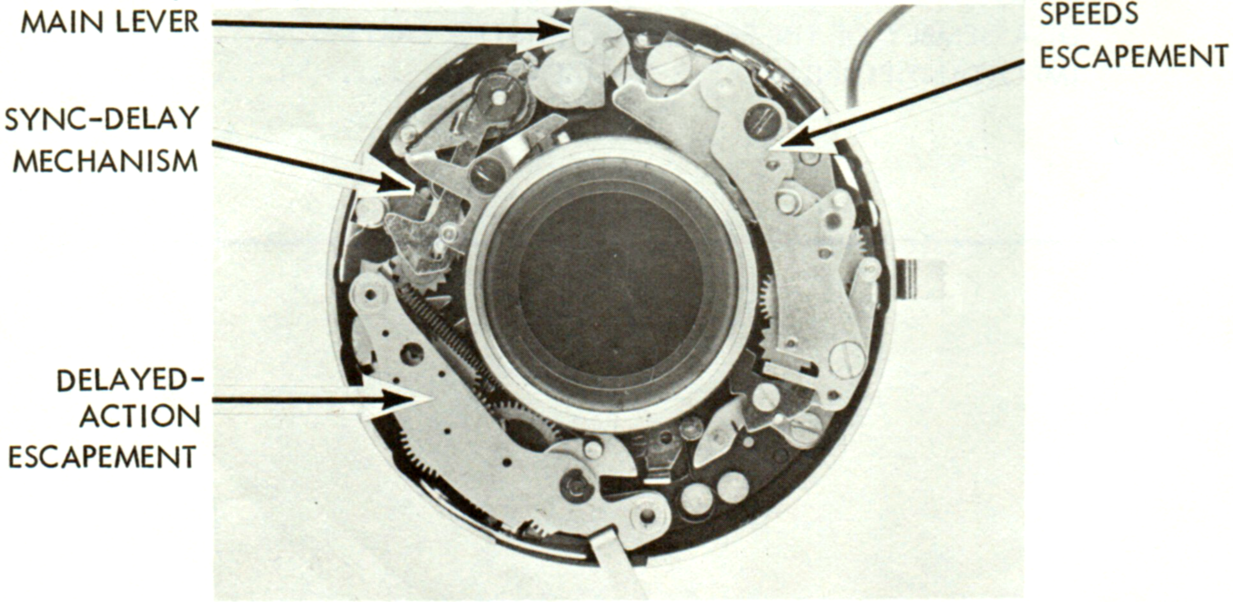


FIGURE 2 00-SIZE COPAL SV

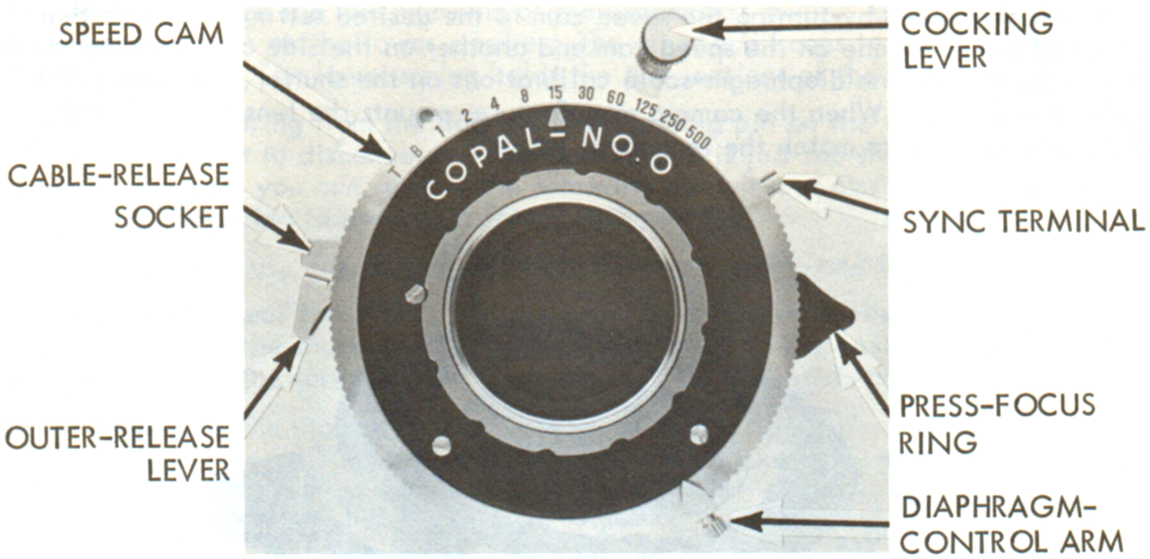


FIGURE 3

The 0-size model, Fig. 3, is a little more unique -- and more complex. So for our study of the Copal shutter, we'll cover the complete disassembly and operation of the 0-size version. Then, we'll discuss the variations in the 00-size Copal.

FEATURES OF THE COPAL NO. 0

You'll encounter the 0-size Copal on several professional-quality cameras in the large and medium film formats. As you'll recall, such cameras frequently provide a means of opening the shutter blades for ground-glass focusing.

Open the blades by turning the PRESS-FOCUS RING, Fig. 3, in a counterclockwise direction -- the shutter may be either cocked or released when using the press-focus feature. With the blades open, you'll find that you cannot depress the outer-release lever; an internal lever blocks the outer-release lever in case the shutter is cocked. Close the shutter blades by returning the press-focus ring in a clockwise direction.

Cock the shutter and notice that the cocking lever returns to its "rest" position. Rather than being an extension of the main lever, the cocking lever is a separate, spring-loaded part.

Other operating features are pretty straightforward. Select the sync-delay setting by moving the SYNC-CONTROL LEVER, Fig. 4, to either "M" or "X." There are two sets of internal sync contacts -- one set for "X" and one set for "M." The position of the sync-control lever decides whether or not the M-sync contacts close during the shutter cycle.

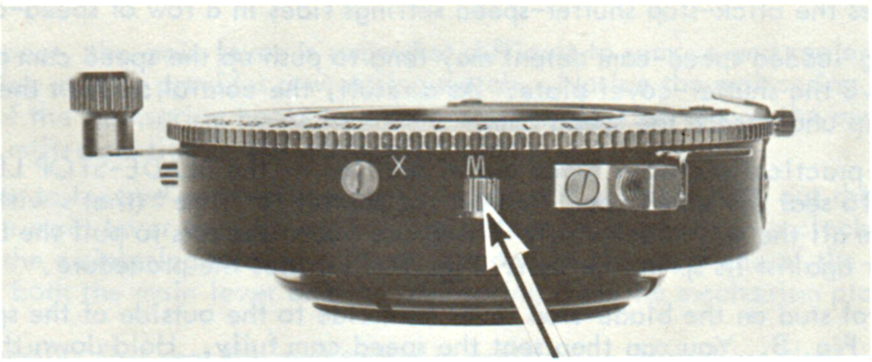
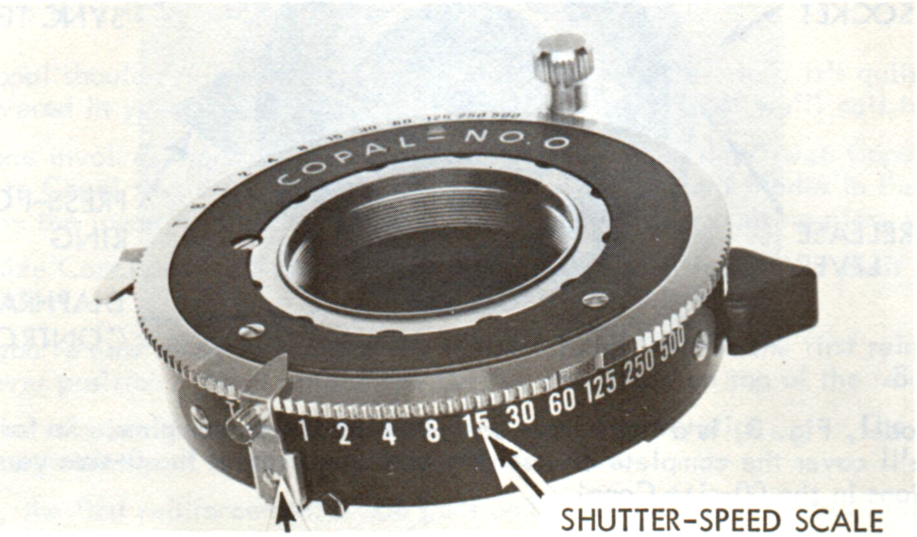


FIGURE 4

Select the shutter speed by turning the speed cam to the desired setting. Notice that there're two shutter-speed scales -- one on the speed cam and another on the side of the shutter housing, Fig. 5. However, there're no diaphragm-scale calibrations on the shutter illustrated; this is how Copal supplies the shutter. When the camera manufacturer mounts the lens to the shutter, he adds the calibrated diaphragm scale to match the lens focal length.



SHUTTER-SPEED SCALE

FIGURE 5 DIAPHRAGM-CONTROL ARM

DISASSEMBLY OF THE COPAL NO. 0

NOTE: The disassembly illustrations begin on page 19 of this ServiSheet. To keep the illustrations handy for reference, separate the picture section from the text section.

Remove the shutter-cover plate by first turning the lock screw, Fig. 6, to clear the scalloped retaining ring. As with similar designs, the scalloped retaining ring determines the tension of the speed cam. Rotate the speed cam to note the "feel." Then, unscrew the scalloped retaining ring and lift off the shutter-cover plate.

On reassembly, tighten the scalloped retaining ring until the speed cam has the same amount of tension as you noted prior to disassembly.

A hole in the back of the shutter-cover plate keys over the locating pin in the shutter, Fig. 7. The detent which provides the click-stop shutter-speed settings rides in a row of speed-cam notches.

The spring-loaded speed-cam detent may tend to push up the speed cam once you remove the shutter-cover plate. As a result, the control studs in the shutter slip underneath the speed cam.

One part practically always jumps out of position -- the BLADE-STOP LEVER, Fig. 7. To seat the speed cam, first set the shutter to "time" (that's with the speed cam all the way clockwise). Then, use your tweezers to pull the blade-stop lever against its spring tension. Fig. 8 illustrates the procedure.

The control stud on the blade-stop lever must ride to the outside of the speed-cam slot, Fig. 8. You can then seat the speed cam fully. Hold down the speed cam as you select the various shutter speeds.

Fig. 9 points out the parts controlled by the speed cam. There are three levers on the speeds escapement riding against the cam surfaces:

1. the retard lever
2. the pallet-control lever
3. the GEAR-TRAIN SHIFT LEVER

The gear-train shift lever carries two gears in the speeds escapement -- the third gear and the HIGH GEAR. Only one of the two gears may be engaged at a time. Engaging the third gear provides a LOW RANGE; engaging the high gear provides a HIGH RANGE. In other words, the speed cam "shifts" the speeds escapement to select the gearing range.

On high range, the gear-train shift lever moves toward the shutter housing. Then, the high gear connects the second escapement gear to the star wheel. Simultaneously, the third gear swings out of engagement. The high gear provides a direct drive from the second gear to the star wheel.

Pushing the gear-train shift lever toward the center of the shutter selects the low range. The high gear moves out of engagement. At the same time, the third gear moves into the gear train. In effect, the gear-train shift lever decides the length of the gear train -- whether or not there's a stepped-up gearing ratio between the second gear and the star wheel.

Low range includes the shutter speeds of 1/60 second, 1/4 second, 1/2 second, 1 second, "bulb," and "time." In fact, the only difference between 1/60 second and 1/125 second is the position of the gear-train shift lever -- at 1/125 second, the third gear moves out of engagement to provide less retard.

The pallet engages the star wheel at speeds of 1 second through 1/30 second. And the retard lever engages the main lever at all speeds (in varying amounts) except 1/500 second.

Another lever controlled by the speed cam is the previously mentioned blade-stop lever, Fig. 9. At 1/250 second, the control stud on the blade-stop lever drops into a cutout in the speed cam, Fig. 10. At 1/500 second, the speed cam pushes the control stud toward the outside of the shutter, Fig. 11.

At 1/500 second, the blade-stop lever is in the path of a stud on the blade-operating ring. Then, when the blades reach the full-open position, the blade-operating-ring stud strikes the blade-stop lever. The blade-stop lever thus restricts the overtravel of the blade-operating ring.

At 1/250 second, the blade-stop lever clears the blade-operating-ring stud. So the blade-operating ring has a slight additional overtravel in the opening direction. The additional overtravel means that the shutter speed is a little slower -- around 15% slower than when the blade-stop lever restricts the overtravel.

The two remaining levers controlled by the speed cam are the BULB LEVER and the TIME LATCH, Fig. 9. Turn the speed cam all the way clockwise to the "time" setting, Fig. 9. Both levers are now free to move.

When you release the shutter at the "time" setting, the bulb lever arrests the main lever. Allowing the outer-release lever to return to its rest position swings the time latch against the bulb lever. So the time latch holds the bulb lever engaged with the main lever.

Depressing the outer-release lever a second time pushes the time latch out of engagement with the bulb lever. The main lever then completes its cycle to close the blades.

At "bulb," the speed cam holds the time latch out of action. So the bulb lever releases the main lever as soon as the outer-release lever returns to its "rest" position. You'll be able to see the time-bulb action more clearly after removing the speed cam.

Lift off the speed cam -- you'll have to tilt the speed cam slightly to clear the diaphragm-control arm. Now, locate the speed-cam detent, Fig. 12. The speed-cam detent sits on top of a compression spring within a tube on the mechanism plate. Lift out both the speed-cam detent and the compression spring.

> REASSEMBLY: Replace the speed cam at the 1/15-second setting, Fig. 13 -- the cutout in the speed cam then clears the control stud on the gear-train shift lever. Next, turn the speed cam all the way clockwise to the "time" setting; here, the control studs of the time latch and the bulb lever drop into their respective cutouts.
>
> You'll now have to pull the control stud of the blade-stop lever toward the outside of the shutter, Fig. 8. Hold the blade-stop lever as shown and seat the speed cam fully.

TIME AND BULB OPERATION

Operating the shutter with the speed cam removed provides "time" action. Locate the upward-projecting BULB TAB pointed out in Fig. 14 -- this tab is on the outer-release lever. When you depress the outer-release lever, the bulb tab swings against a downward-projecting tab on the bulb lever, Fig. 15; thus, the outer-release lever holds the bulb lever engaged with the main lever.

Allowing the outer-release lever to return to its "rest" position frees the bulb lever. If the shutter were set to "bulb," the main lever would push the bulb lever aside and close the blades. But on "time" operation, the time latch moves against the bulb-lever tab, Fig. 16.

So the time latch locks the bulb lever to keep the blades open. Depressing the outer-release lever a second time moves the TIME ACTUATOR, Fig. 17, against the time latch. The time actuator then pushes the time latch away from the bulb lever. And the main lever pushes the bulb lever aside to close the blades.

As you operate the shutter, examine the pivoting action of the time actuator. The outer-release lever strikes the time actuator only during the second stroke -- the stroke that closes the blades. To analyze the control of the time actuator, let's start again with the shutter in the released position.

> With the shutter released, there's a reversal of roles -- now, the bulb lever latches the time latch, Fig. 18.

Notice in Fig. 18 that the downward-projecting tab on the bulb lever holds the time latch against its spring tension. The bulb lever, in turn, is held against its spring tension by the main lever.

Cocking the shutter allows the bulb lever to swing counterclockwise -- into position to catch the main lever. As a result, the bulb lever releases the time latch.

The spring-loaded time latch then swings clockwise. And the time actuator, mounted to one end of the time latch, moves toward the outside of the shutter. The sloped surface of the time actuator finally strikes the brass screwhead shown in Fig. 19.

Now, the time actuator is in its "inactive" position -- it's held against its spring tension by the screw on the mechanism plate. Consequently, when you depress the outer-release lever, the RELEASE TAB, Fig. 19, misses the time actuator.

Instead, the RELEASE TAB on the outer-release lever comes against the side of the time latch, Fig. 20. So the outer-release lever pushes the time latch into position to catch the bulb lever.

Allow the outer-release lever to return slowly to its "rest" position. You can then observe how the end of the time latch engages the downward-projecting tab on the bulb lever. The time latch now holds the bulb lever engaged with the main lever; and the shutter blades remain open, Fig. 21.

But examine the position of the time acutator in Fig. 21. While returning to the "rest" position, the outer-release lever allowed the spring-loaded time actuator to pivot as shown. Remember, the time latch is now engaged with the bulb lever. So the time latch cannot swing far enough clockwise for the brass screw to disengage the time actuator.

The important point is that the notch in the time actuator now faces the release tab on the outer-release lever. The next time you depress the outer-release lever, the release tab strikes the notch in the time actuator, Fig. 17. Consequently, the outer-release lever pushes the time actuator against a tab on the time latch. And the time actuator pushes the time latch out of engagement with the bulb lever.

Both the time latch and the bulb lever have control studs riding against the speed cam. At the "bulb" setting, the speed cam holds the time latch out of action. At instantaneous speeds, the speed cam also blocks the bulb lever.

FLASH SYNC IN THE COPAL NO. 0

As you cock the shutter, notice how the edge of the cocking lever comes against a stud on the main lever, Fig. 22. The cocking lever thus carries the main lever to the cocked position.

At the same time, a lug on the cocking lever strikes the end of the SYNC-DRIVE LEVER, Fig. 22. So the cocking lever moves the sync-drive lever from the position shown in Fig. 23 to that shown in Fig. 24.

In the cocked position, the inner-release lever holds both the main lever and the sync-drive lever. You can see one end of the inner-release lever in Fig. 24 -- this is the end that engages the main lever. The other end of the inner-release lever engages the downward-projecting tab on the sync-drive lever.

That same downward-projecting tab also holds the spring-loaded movable M-sync contact away from the fixed M-sync contact, Fig. 24. Compare Fig. 23 (shutter released) with Fig. 24 (shutter cocked). In the shutter-released position, the RETARD-DRIVE CAM (on top of the main lever) holds the movable M-sync contact away from the fixed M-sync contact.

Cocking the shutter rotates the main lever and frees the movable M-sync contact. So the movable M-sync contact swings toward the fixed M-sync contact. But the downward-projecting tab of the sync-drive lever intercepts the movable M-sync contact before contact is made, Fig. 24.

Remember, the inner-release lever now holds both the main lever and the sync-drive lever. In turn, the inner-release lever is held by the INTERMEDIATE-RELEASE LEVER -- you can just see the intermediate-release lever sitting close to the mechanism plate in Fig. 24.

When you release the shutter, a stud on the outer-release lever strikes one end of the intermediate-release lever. The intermediate-release lever then frees the inner-release lever. So the inner-release lever swings counterclockwise, disengaging the sync-drive lever.

But the inner-release lever does not move far enough to release the main lever. Instead, the RELEASE-LEVER LATCH intercepts the inner-release lever. The release-lever latch is visible in the shutter-released position, Fig. 23.

The sync-drive lever, powered by the sync-drive spring, now swings counterclockwise. The sync retard, Fig. 24, slows down the sync-drive lever during this travel -- a downward-projecting stud on the sync-drive lever feeds through a slot in the first-gear segment of the sync retard.

As the sync-drive lever starts its release journey, its downward-projecting tab frees the movable M-sync contact. The movable M-sync contact then swings against the fixed M-sync contact (if the sync-control lever is set to "M").

Toward the end of its travel, the downward-projecting tab on the sync-drive lever strikes the release-lever latch, Fig. 23. Thus, the sync-drive lever kicks the release-lever latch out of engagement with the inner-release lever. Now, the main lever pushes the inner-release lever aside and completes the release rotation.

Note that the M-sync contacts close before the main lever is released.

Switching the sync-control lever to "X" does only one thing: it prevents the movable M-sync from touching the fixed M-sync contact. Locate the screw on the sync-control lever, Fig. 23. At "X," the screwhead comes against a tab at the bottom of the movable M-sync contact, Fig. 25.

At "X," the X-sync contacts fire the flash. The X-sync contacts are barely visible at this time -- they're adjacent to the main lever, Fig. 25. Later in the disassembly, you'll be able to see exactly how the X-sync contacts work. For now, just remember that the X-sync contacts always close when the shutter blades are fully open.

> In summary, the M-sync delay results from using the sync-delay mechanism to release the shutter. That is, depressing the outer-release lever releases the sync-delay mechanism. The sync-delay mechanism then fires the flashbulb before disengaging the main lever.
>
> The sync-delay mechanism always goes through its complete cycle -- regardless of the sync setting. On "X," however, the M-sync contacts cannot close. Instead, the X-sync contacts fire the flash when the blades are fully open.

OPERATION AND REMOVAL OF THE SPEEDS ESCAPEMENT

While operating the shutter, you may have noticed that you're not getting a full retard. The reason is that the speeds escapement shifts to high range with the speed cam removed. Remember, the gear-train shift lever provides the two gearing ranges.

Removing the speed cam allows the gear-train shift lever to move toward the outside of the shutter, Fig. 26. So the high gear connects the second gear to the star wheel -- direct drive, or high range.

Try pushing the control stud of the gear-train shift lever toward the center of the shutter, Fig. 27; that brings the third gear into engagement. Now, while holding the gear-train shift lever, release the shutter -- you should get full retard, the low range.

Other features of the speeds escapement are pretty standard. The hooked section of the retard-drive cam, Fig. 28, strikes the retard lever at all speeds except 1/500 second. Changing the speed setting varies the depth of engagement between the retard lever and the retard-drive cam.

Note in particular how the pallet-control lever hooks behind a stud on the blade-operating ring, Fig. 28. When the blade-operating ring rotates to close the blades, it kicks the pallet out of engagement with the star wheel. Do you remember the reason? As with similar designs, disengaging the pallet allows the retard lever to return easily to its "rest" position.

> On reassembly, make sure the pallet-control lever hooks to the outside of the blade-operating-ring stud.

To remove the speeds escapement, first cock the shutter. Remove the two screws pointed out in Fig. 29. Now, holding the cocking lever aside, lift out the speeds escapement.

Two spacers sit underneath the speeds escapement. Fig. 30 shows the positions of the spacers. (If your shutter doesn't have the spacers as shown in Fig. 30, check to see if the spacers are stuck to the underside of the speeds escapement.)

Notice that the larger spacer has two holes -- one hole fits over a post on the mechanism plate and the other hole clears the screw hole. The smaller spacer has one hole fitting over the screw hole in the mechanism plate. After noting the proper positions, lift out both spacers.

You can now examine the Prontor-styled leaf lever. Cock the shutter and hold the cocking lever against its spring tension, Fig. 31. Notice that the leaf lever does not hook to a stud on the blade-operating ring -- instead, the leaf lever hooks to a stud on the BLADE-RING LEVER. And a slot in the blade-ring lever fits over the stud on the blade-operating ring.

OPERATION OF THE PRESS-FOCUS MECHANISM

The press-focus ring encircles the back of the shutter. Three tabs on the press-focus ring extend around the edge of the mechanism plate to engage shutter parts.

One tab on the press-focus ring passes through the forked tab of the LEAF-LEVER CAM, Fig. 31. When you turn the press-focus ring to open the blades, the tab turns the leaf-lever cam against the leaf lever, Fig. 32. The leaf-lever cam then pushes the leaf lever away from the stud on the blade-ring lever. Disengaging the leaf lever frees the blade-operating ring for the opening rotation.

Another tab on the press-focus ring controls the BLADE-OPENING LEVER, Fig. 32. One end of the blade-operating-ring spring hooks to the stud on the blade-operating ring -- the other end hooks to the blade-opening lever.

Normally, the tab on the press-focus ring holds the blade-opening lever at the position shown in Fig. 33. So when the leaf lever opens the blades, the blade-operating ring tensions the blade-operating-ring spring.

But turning the press-focus ring counterclockwise drives the blade-opening lever against the blade-operating-ring stud, Fig. 34. The blade-opening lever then turns the blade-operating ring to the open position. Since one end of the blade-operating-ring spring hooks to the blade-opening lever, there's no spring tension acting against the blade-operating ring.

The blade-operating-ring spring takes charge when you close the blades. Turning the press-focus ring clockwise moves the blade-opening lever away from the blade-operating-ring stud -- and, at the same time, tensions the blade-operating-ring spring. So the blade-operating-ring spring closes the shutter blades.

There's a third tab on the press-focus ring -- this one controls the RELEASE-LEVER LOCK, Fig. 34. Moving the press-focus ring to open the blades swings the release-lever lock to the position shown in

Fig. 34. Now, the release-lever lock is in the path of a downward-projecting pin on the outer-release lever. Consequently, you cannot depress the outer-release lever to release the main lever.

Returning the press-focus ring in a clockwise direction frees the release-lever lock. The spring-loaded release-lever lock then moves away from the outer-release lever.

DISASSEMBLY OF THE SYNC-DELAY MECHANISM

> It's possible to remove the mechanism plate without taking apart the sync-delay mechanism. And in many actual repairs, you'll probably leave the sync-delay mechanism assembled. But it's a little difficult to see exactly how the sync-delay mechanism operates without taking it apart.
>
> So for your lesson requirements (if you received a Copal No. 0 as practice equipment) you'll want to disassemble the sync-delay mechanism. This way, you'll be able to examine all the parts and draw a complete cycle-of-operations.

→ The first step in disassembly is to disconnect the sync-drive spring. Notice in Fig. 35 that the upper end of the sync-drive spring hooks at one of the notches in the sync-drive lever. The particular notch which hooks the sync-drive spring determines the spring tension.

> You can adjust the M-sync delay by changing the hooking point of the sync-drive spring. As shown in Fig. 35, the sync-drive spring is hooked for maximum tension -- and the shortest M-sync delay. The greater the tension, the faster the sync-drive lever runs through its cycle. By varying the spring-hooking point, you set the M-sync delay from approximately 13 milliseconds to 18 milliseconds.

Note which notch hooks the sync-drive spring. Then, disconnect the end of the sync-drive spring from the sync-drive lever.

The screw holding the sync-drive lever has a LEFT-HAND THREAD, Fig. 35. Remove the sync-drive-lever screw by turning it in a clockwise direction. Next, lift off the sync-drive lever.

You can now see the slot in the first-gear segment of the sync retard, Fig. 36. On reassembly, the downward-projecting stud of the sync-drive lever must pass into this hole.

→ There's one spring now exposed that can be a troublemaker -- the bulb-lever spring, Fig. 36. The bulb-lever spring curls around the largest diameter of the shouldered brass bushing. There are two shoulders on the bushing: one shoulder serves as a bearing for the sync-drive lever and the other for the bulb lever.

Chances are the bulb-lever spring won't fly out of the shutter when you remove the bushing. But as a safety precaution, you might use two tweezers -- hold the bulb-lever spring with one pair of tweezers and lift the bushing straight up with the other pair. It's during reassembly, as we'll describe a little later, that the bulb-lever spring can be troublesome.

You can now take a closer look at the brass bushing; notice that the two shoulders are different in length. The longer shoulder goes down, passing through a hole in the bulb lever. Lift out the bulb lever, Fig. 37, and the sync-drive spring, Fig. 38.

> NOTE: Fig. 37 and Fig. 38 show the shutter in the cocked position. The shutter does not have to be cocked to remove the bulb lever. However, you'll find it easier to replace the bulb lever if you'll first cock the shutter.

To operate the shutter at this stage of disassembly, first cock the main lever -- notice how the intermediate-release lever swings to the position shown in Fig. 39. The intermediate-release lever then engages a stud on the underside of the inner-release lever.

Now, depress the outer-release lever. The outer-release lever pushes the intermediate-release lever out of engagement with the inner-release lever. So the inner-release lever swings counterclockwise until it comes against the release-lever latch, Fig. 40.

Remember, the initial movement of the inner-release lever frees the sync-drive lever. But the main lever still remains latched. It's now up to the sync-drive sector to disengage the release-lever latch and free the main lever.

Use your tweezers to disengage the release-lever latch as shown in Fig. 41. The main lever then pushes aside the inner-release lever and completes the release rotation.

> NOTE: By now, you've probably noticed a rather unique trait of the Copal No. 0 -- this is a trait demonstrated by both the bulb lever and the inner-release lever. That is, neither lever actually latches the main lever; each must be held in engagement by another part.

To remove the sync retard, first cock the shutter. The release-lever latch then pivots clockwise and provides the clearance you need to lift out the sync retard. Next, remove the two screws indicated in Fig. 41. DO NOT remove the remaining screw at the top of the sync retard -- this screw, normally sealed with a locking agent, holds the upper plate of the sync retard in place. Now, lift out the sync retard.

You can still release the shutter as previously described -- just depress the outer-release lever and disengage the release-lever latch. But the next time you cock the shutter, you'll find that the inner-release lever will not disengage the main lever.

Here's what happens. With the sync retard removed, the intermediate-release lever travels beyond its normal distance, Fig. 42. So the latching end of the intermediate-release lever moves past the pin on the underside of the inner-release lever. Instead, the pin on the underside of the inner-release lever sits above the intermediate-release lever.

When you disengage the release-lever latch, the intermediate-release lever blocks the inner-release lever. Thus, the shutter cannot release.

To release the shutter, first hold the cocking lever fully advanced. Then, push the left-hand end of the intermediate-release lever toward the center of the shutter, Fig. 43. While holding the intermediate-release lever in position, allow the cocking lever to return to its rest position. The latching end of the intermediate-release lever is now to the left of the pin under the inner-release lever, Fig. 44. So you can release the shutter by disengaging the release-lever latch.

REMOVING THE MECHANISM PLATE

There's only one lever remaining on the mechanism plate you'll have to remove: the sync-control lever. The sync-control lever passes through a slot in the side of the shutter housing.

To remove the sync-control lever, take out the screw shown in Fig. 44. Remember, this screw serves to hold the movable M-sync contact disengaged at the "X" setting. In addition, the screw holds the sync-control lever to a mounting lever on the mechanism plate.

After removing the screw, slide out the sync-control lever (toward the outside of the shutter). The U-shaped cutout in the sync-control lever, Fig. 45, slips around a post on the mechanism plate. And the two notches in the sync-control lever work together with a detent spring to provide the two click-stop settings. The detent spring remains in the shutter, Fig. 44. ←

In Fig. 46, you can see the mounting lever for the sync-control lever. The mounting lever now floats freely on the mechanism plate.

> Push the mounting lever as far as it can go in a counterclockwise direction. Then, the mounting lever won't catch on the fixed M-sync contact as you separate the mechanism plate from the shutter housing.

→ There's only one spring that hooks to the shutter housing: the movable M-sync contact spring, Fig. 46. Disconnect the spring as shown in Fig. 47. You can leave the M-sync contact spring in the shutter.

Also, you'll find that the remaining parts are a little easier to handle without the diaphragm-control arm in your way. So remove the screw shown in Fig. 48 and slide the diaphragm-control arm toward the top of the shutter.

Now, turn over the shutter. Remove the three screws holding the diaphragm-setting-ring retainer, Fig. 49. Lift off the diaphragm-setting-ring retainer.

The two holes in the diaphragm-setting ring, Fig. 50, fit over two pins on the diaphragm-control ring. Lift off the diaphragm-setting ring and locate the diaphragm-control ring pins, Fig. 51. On reassembly, you must make sure the holes in the diaphragm-setting ring slip over these pins.

Four screws retain the press-focus ring, Fig. 51. One screw -- the one passing through a slot in the outer edge of the press-focus ring -- is a shoulder screw. The shoulder screw limits the rotation of the press-focus ring.

Remove the four screws shown in Fig. 51. Now lift off the press-focus ring. Also, lift out the press-focus-ring detent, Fig. 52.

Taking off the press-focus ring reveals the four mechanism-plate screws, Fig. 52. Remove all four mechanism-plate screws. You cannot, however, lift the shutter housing straight up. Try gently lifting the shutter housing -- you'll find that something is catching.

Two parts may catch on the shutter housing: the leaf-lever cam and the nut which threads to the lower end of the cocking-lever screw, Fig. 52. The leaf-lever cam, you'll recall, sits on the mechanism plate adjacent to the leaf lever.

Here's one trick you can use to lift off the shutter housing. First, locate the sync terminal on the shutter housing, Fig. 52. Lift the side of the shutter housing opposite the sync terminal -- make sure you lift the shutter housing far enough to clear the nut at the bottom of the cocking-lever screw. Now, slide off the shutter housing in the direction that the sync terminal is pointing.

> You can now see the five shutter blades on the back of the mechanism plate, Fig. 53. One trait common to Copal shutters is the use of REINFORCEMENT BLADES above and below the shutter blades. In the Copal No. 0, there is one reinforcement blade sitting at the pin position on top of the last shutter blade installed, Fig. 53. The other reinforcement blades sit underneath the shutter blades.

Lift off the reinforcement blade shown in Fig. 53. Then, remove the five shutter blades. Notice that the reinforcement blades underneath the shutter blades provide two of the blade-mounting pins, Fig. 54. The slots in the lower reinforcement blades fit over posts on the mechanism plate; and the holes in the lower reinforcement blades fit over the pins on the blade-operating ring. The three holes in each shutter blade then fit over the two pins on a particular reinforcement blade and a pin on the blade-operating ring.

Remove the five lower reinforcement blades. You'll find, however, that you cannot remove the blade-operating ring without further disassembly of the mechanism-plate parts. Notice the half-moon cutouts in the outer edge of the blade-operating ring, Fig. 55. For removal, the blade-operating ring must rotate counterclockwise until the five cutouts face the five retaining washers.

Try holding the leaf lever disengaged from the blade-operating-ring stud; then, rotate the blade-operating ring as far as it can go in the blade-opening direction. You'll discover that you cannot rotate the blade-operating ring far enough to align the cutouts with the spacers.

Two parts on the mechanism plate prevent the blade-operating ring from rotating fully in a counterclockwise direction: the blade-ring lever and the blade-stop lever. Both parts must be removed to take out the blade-operating ring.

> For your lesson requirements, you won't have to remove the blade-operating ring; you've now gone far enough in the disassembly to understand the shutter operation. But in the event you receive a repair job that does require further disassembly, we'll later describe the procedure.

OPERATION OF THE X-SYNC CONTACTS

We held off on an explanation of the X-sync contacts because it was formerly difficult to see the parts involved. But now, with the mechanism plate removed, we can more clearly illustrate the operation.

In Fig. 56 we have turned the leaf-lever cam in a clockwise direction -- you can now see how the movable X-sync contact rides against the edge of the blade-ring lever. Notice that one end of the X-contact spring hooks to a downward-projecting tab on the blade-ring lever, Fig. 56.

The blade-ring lever moves in a counterclockwise direction to open the shutter blades; this movement tensions the spring on the movable X-sync contact. Consequently, the movable X-sync contact swings in a clockwise direction.

As the shutter blades open, the end of the movable X-sync contact shown in Fig. 57 moves toward the shutter housing. Finally, the movable X-sync contact strikes the fixed X-sync contact. The fixed X-sync contact remains with the shutter housing, Fig. 58.

Closing the X-sync contacts fires the flash when the blades are fully open. Then, as the blade-ring lever moves to close the blades, it drives the movable X-sync contact counterclockwise -- away from the fixed X-sync contact.

Remember that the X-sync contacts always close during the shutter cycle -- regardless of the sync-control setting. On "M" sync, the M-sync contacts fire the flash before the blades start to open. Thus, by the time the X-sync contacts close, the flash has already fired.

If necessary, you can adjust the X-sync delay by simply reforming the fixed X-sync contact.

REPLACING THE MECHANISM PLATE

Replacing the mechanism plate is largely a matter of reversing your disassembly procedure -- with one new complication. Notice that the spring-loaded release-lever lock now extends beyond the mechanism plate, Fig. 59. When you replace the mechanism plate, you must push the release-lever lock against its spring tension; that is, the portion of the release-lever lock visible in Fig. 59 must be to the inside of the shutter housing.

> NOTE: Sometimes the long end of the release-lever-lock spring comes loose from the spring-hooking post. The spring should hook to the inside of the spring-hooking post -- that is, the side of the spring-hooking post nearest the lens flange. If the spring comes loose, first hold the outer-release lever depressed. Then, lift the free end of the spring up and over the spring-hooking post.

Begin reassembly by replacing the five lower reinforcement blades on the blade-operating ring (remember, the blade-mounting pins must be toward you). Now, install the first shutter blade over the reinforcement blade nearest the main-lever position. Replace the other four shutter blades in clockwise rotation. Finally, install the upper reinforcement blade -- the one without any pins -- on top of the last shutter blade you replaced.

Start the sync-terminal side of the shutter housing into position first. Then, lower the shutter housing over the mechanism plate -- make sure the nut at the bottom of the cocking-lever screw passes through the hole in the shutter housing.

Now, reach underneath the shutter housing with your tweezers and pull the release-lever lock against its spring tension. While holding the release-lever lock out of the way, you should be able to fully seat the mechanism plate within the shutter housing. Then, replace the four mechanism-plate screws.

> Test your assembly by first turning the leaf-lever cam to the position shown in Fig. 60. You've just disengaged the leaf lever; now, you can check the freedom of the blade-operating ring. Push the blade-operating-ring stud in a clockwise direction to open the blades; and push the blade-operating-ring stud in a counterclockwise direction to close the blades. Make certain that the blade-operating ring turns freely as the blades open and close.

Leave the leaf-lever cam as shown in Fig. 60 to replace the press-focus ring. You'll then be able to see the fork in the leaf-lever cam from the other side of the shutter.

Turn over the shutter and seat the press-focus-ring detent, Fig. 61. Now, locate the two notches on the inside circumference of the press-focus ring -- these two notches must be above the press-focus-ring detent. Seat the press-focus ring as shown in Fig. 62; make sure that the tab on the press-focus ring passes through the fork in the leaf-lever cam.

The press-focus-ring detent is now sitting underneath the press-focus ring. However, the rounded section of the detent must ride against the inside circumference of the press-focus ring to engage the two notches. So insert a pair of closed tweezers into the hole through the press-focus-ring detent, Fig. 63. Then, pull the press-focus-ring detent toward the center of the shutter while pushing down the press-focus ring.

Hold down the press-focus ring while testing the operation. Turn the press-focus ring to each of its two click-stop positions. The shutter blades should open at one position and close at the other.

Continue to hold down the press-focus ring as you replace its retaining screws. Replace the shoulder screw first -- remember, the shoulder screw goes through the slot in the outer circumference of the press-focus ring. Then, replace the remaining three screws.

The trick in replacing the diaphragm-setting ring is to key its two holes over the two pins on the diaphragm-control ring. As you may have discovered, both pins of the diaphragm-control ring must turn equally and simultaneously -- otherwise, the diaphragm leaves may be twisted out of position.

Start with the diaphragm-control ring in the full-open position (all the way clockwise). Remember to turn both diaphragm-control-ring pins at the same time. Now, locate the shutter-speed scale on the shutter housing and the large tab on the diaphragm-setting ring. Align the tab on the diaphragm-setting ring with the "12" digits of the "125" calibration on the shutter-speed scale, Fig. 64. The holes in the diaphragm-setting ring should then slip over the pins on the diaphragm-control ring.

> Test your assembly by turning the diaphragm-setting ring in a counterclockwise direction to close the blades. Make certain that the aperture stops down evenly and smoothly. Uneven leaf movement means that one of the diaphragm-control-ring pins is not seated.

Now, replace the diaphragm-ring retainer with its three screws. You may replace the diaphragm-control arm either at this time or wait until you've completed the shutter reassembly.

REASSEMBLY OF THE SYNC-DELAY MECHANISM

You're now ready to replace the mechanism-plate parts. Begin by hooking the spring for the movable M-sync contact to the cutout in the shutter housing, Fig. 65.

Next, turn the mounting lever until its screw hole points to the slot in the shutter housing. Slip the sync-control lever through the slot. The U-shaped cutout in the sync-control lever must fit around the post on the mechanism plate (the same post that acts as a bearing post for the mounting lever).

Working through the screw hole in the sync-control lever, align this hole with the threaded hole in the mounting lever. Then, replace the screw which retains the sync-control lever. Switch the sync-control lever back and forth between the "X" and "M" settings -- if the sync-control lever is properly seated, you'll feel the two click-stop positions.

You'll find that it's easiest to replace the sync retard in the shutter-cocked position. So first hold the left-hand end of the intermediate-release lever toward the center of the shutter and cock the main lever. The release-lever latch now moves away from the upper screw hole for the sync retard.

Seat the sync retard in position and replace its two screws.

> Test the operation at this stage by first depressing the outer-release lever -- the intermediate-release lever should then disengage. Now, push the release-lever latch away from the inner-release lever to disengage the main lever.

Cock the shutter once again to replace the remaining parts. Then, seat the sync-drive spring over its post on the mechanism plate.

Next, seat the bulb lever over the same post. Make sure that the downward-projecting tab on the bulb lever is between the lower end of the time latch and the lens flange.

Remember that the bushing for the bulb lever has two shoulders. Replace the bushing with the longer of its two shoulders passing through the hole in the bulb lever.

> Probably the trickiest part of reassembly involves replacing the bulb-lever spring. The spring must coil around the outside diameter of the brass bushing. If the spring coil slips underneath the bushing -- between the bushing and the bulb lever -- the parts will bind.

Start the bulb-lever spring into position as shown in Fig. 66. Now, push the two ends of the spring against the lens flange until you can seat the coil over the brass bushing.

You can use one finger to both hold down the bushing and to help seat the spring. Once you've seated the spring, continue to hold down the bushing. Otherwise, the spring coil may slip between the bushing and the bulb lever.

Still holding down the bushing, use your tweezers to connect the hooked end of the bulb-lever spring to the side of the bulb lever, Fig. 67.

Now comes the touch-and-go part -- holding down the bushing while replacing the sync-drive lever. If you're lucky, the bulb-lever spring will stay in position -- that makes matters easy. But if you find that the spring won't remain in place, you'll have to continue holding down the bushing. Here's one reassembly technique you can try:

> Start by positioning the first-gear segment in the sync retard as shown in Fig. 67; notice the position of the slot that receives the downward-projecting stud on the sync-drive lever. Also, set the sync-control lever to "X" -- that holds the movable M-sync contact away from the fixed M-sync contact.
>
> Hold down the brass bushing with your tweezers as shown in Fig. 67. Now, place the sync-drive lever on top of the bulb lever, Fig. 68.
>
> Still holding down the bushing with one pair of tweezers, insert a second pair of tweezers through the hole in the sync-drive lever -- use the second pair of tweezers to hold down the bushing, Fig. 69. Then, swing the sync-drive lever in a clockwise direction until you can feed its downward-projecting stud through the slot in the first-gear segment of the sync retard. At the same time, seat the hole in the sync-drive lever over the upper shoulder of the brass bushing.

The sync-drive lever should now be positioned as shown in Fig. 70. Here, we're using the tweezers to hold down the sync-drive lever; in turn, the sync-drive lever is holding down the bushing. You can now replace the left-hand screw which secures the sync-drive lever.

> Test the operation by first depressing the outer-release lever. Then, move the sync-drive lever in a counterclockwise direction until it releases the shutter -- the sync-drive lever must turn freely.
>
> The bulb lever should now be holding the shutter open. When you depress the outer-release lever a second time, the bulb lever should free the main lever. If the bulb lever does not function as described, most likely the bulb-lever spring slipped underneath the brass bushing.

With the shutter in the released position, locate the free (upper) end of the sync-drive spring. Grasp the end of the spring with your tweezers. Now, pull the end of the sync-drive spring in a clockwise direction (against its tension) until you can hook the spring to the sync-drive lever. Remember to hook the end of the sync-drive spring in the same notch as you noted prior to disassembly.

> Now, cock the shutter. Release the shutter by depressing the outer-release lever. The sync-delay mechanism should run through its cycle and release the main lever.

REMOVING THE OUTER-RELEASE LEVER

As we mentioned, you normally won't have to remove the outer-release lever. In fact, you've already satisfied your lesson requirements in the disassembly of the Copal No. 0 shutter. However, in the event you have to replace a part in an actual repair, we'll describe the disassembly procedure.

Keep in mind that the bulb-lever spring is typical of the springs in this shutter. That's the reason for leaving the outer-release lever installed. Most of the springs in the Copal No. 0 are not attached to their respective levers. Unless you're very careful, you may find that the springs tend to go where they want rather than where you want.

> NOTE: Handling elusive springs in any shutter requires extreme care -- if the spring gets away, it may travel quite a distance through space before making a landing. A trick you can usually apply is to hold one finger over the spring coils. Then, use your tweezers to disconnect one end of the

spring. Your finger should keep the spring from getting away and sailing off to parts unknown.

To disassemble the outer-release lever, first disconnect the time-actuator spring. The time-actuator spring hooks against the time-latch bushing, Fig. 71. You don't have to completely remove the spring -- it remains on the time actuator. But if you don't disconnect the long end of the spring, it may catch under the time-latch screw during reassembly.

Next, disconnect the time-latch spring from the mechanism-plate spring-hooking post, Fig. 72. Notice that the short end of the spring hooks to the upward-projecting tab on the time latch.

Remove the time-latch screw, Fig. 72, and lift out the time-latch spring. Lift off the time latch together with the time actuator.

You can now see the outer-release-lever spring, Fig. 73; this spring normally coils around a brass bushing attached to the underside of the time latch. When replacing the time latch, you must make certain that the bushing passes through the outer-release-lever spring. If the bushing sits on top of one of the spring's coils, the time latch will bind.

Disconnect the outer-release-lever spring from the spring-hooking post. Notice that the other end of the spring hooks against the side of the outer-release lever, Fig. 73. Slide the outer-release-lever spring toward the hooking post until you can disengage its hooked end from the outer-release lever. Then, lift off the outer-release-lever spring.

If you haven't removed the bulb lever, cock the shutter -- the bulb lever then moves away from the outer-release lever. Now, lift out the outer-release lever.

Before removing the release-lock lever, Fig. 74, examine the spring position. The release-lock-lever spring sits underneath the release-lock lever. One end of the spring -- the short end -- hooks against the inside edge of the release-lock lever. The long end of the spring rests against the base of the spring-hooking post, Fig. 74.

Let off most of the spring tension by lifting the long end of the release-lock-lever spring up and over the spring-hooking post -- allow the long end to rest against the side of the shutter housing. Now, remove the screw holding the release-lock lever. Lift off the release-lock lever and its spring.

> Replacing the release-lock lever is probably the trickiest area in the reassembly of the outer-release lever. Again, it helps to use two pairs of tweezers.
>
> First, seat the release-lock-lever spring over the mechanism-plate post. Allow the long end of the spring to rest against the side of the shutter housing.
>
> Now, use one pair of tweezers to pull the hooked end of the release-lock-lever spring in a counterclockwise direction (against the spring tension). Make sure that the spring coils do not ride above the shoulder of the mechanism-plate post. While holding the spring, seat the release-lock lever. Hold down the release-lock lever and hook the short end of the release-lock-lever spring.
>
> Finally, replace the release-lock-lever screw. Then, lift the long end of the release-lock-lever spring up and over the spring-hooking post, Fig. 74.

DISASSEMBLY OF THE REMAINING SHUTTER PARTS

We'll now discuss the complete disassembly of the Copal No. 0 shutter. Thorough disassembly may be necessary if the shutter is extremely dirty or if you have to replace a part. But again, you do not have to complete the disassembly of your practice shutter.

For discussion purposes, let's assume that you've disassembled the shutter as far as previously described. You then discover that further disassembly is necessary -- perhaps the blade-operating ring is bent or the mainspring is fatigued.

To remove the cocking lever, unscrew the nut shown in Fig. 75 (notice that you can reach this nut without removing the shutter housing, Fig. 52). Then, turn over the mechanism plate and unscrew the cocking-lever screw, Fig. 76; CAUTION: There's a small spring under the cocking lever. Lift off the cocking lever, the cocking-lever spring, and the shoulder bushing, Fig. 77.

One end of the cocking-lever spring extends horizontally from the spring coils -- this end hooks within the slot at the top of the main lever, Fig. 77. The other end extends vertically from the spring coils -- this end passes into the hole in the cocking lever.

The shoulder bushing sits on top of the main lever. Notice that the shoulder goes up, away from the main lever. The cocking lever then sits over the shoulder.

> It's probably easiest to reassemble the cocking lever with the main lever in the cocked position. First, seat the bushing -- shoulder up -- on top of the main lever, Fig. 77. Then, seat the cocking-lever spring around the bushing; make sure the long, horizontal end of the spring is within the main-lever slot, Fig. 77.
>
> Now, slip the small hole in the cocking lever over the vertically projecting end of the cocking-lever spring. Slide the cocking lever until you can seat its bearing hole over the shoulder in the bushing. Then, while holding the cocking lever in position, replace the cocking-lever screw.

There's another separate bushing inside the movable M-sync contact. Remove the screw, Fig. 77, and lift out the movable M-sync contact with its spring. Be careful of the bushing which may now be loose.

The spring on the inner-release lever is one of the few springs in the shutter that remains with the part it operates. Notice that the hooked end of the spring attaches to the inside edge of the inner-release lever; the long end of the spring hooks against the post on the mechanism plate, Fig. 78 (the post that supports the bulb lever).

Remove the inner-release lever by lifting it straight up from its support post. On reassembly, you'll have to hold the long end of the inner-release-lever spring against its tension (toward the inner-release lever). Then, you can hook the long end of the spring to the outside edge of the mechanism-plate post.

Now, examine the position of the spring on the release latch, Fig. 78. The release-latch spring coils around the shoulder screw that holds the release latch. One end of the spring hooks to the release latch and the other end lies against the lens flange.

Disconnect the hooked end of the spring from the release latch. Then, remove the shoulder screw and the release latch with its spring. Also, lift out the washer that sits underneath the release latch.

The spring for the intermediate-release lever is also underneath the lever. However, the intermediate-release-lever spring coils around a lip on the support post. So, when you remove the intermediate-release lever, the spring should stay in place.

Lift the intermediate-release lever high enough to clear the shoulder on the support post. Then, slide the intermediate-release lever toward the edge of the mechanism plate.

The intermediate-release-lever spring remains under the lip of the support post, Fig. 79. Grasp the hooked end of the spring with your tweezers -- then, lift the spring over the lip and out of the shutter.

Next, locate the hooked end of the blade-operating-ring spring, Fig. 80. The hooked end of the spring engages a downward-projecting tab on the blade-opening lever; the other end of the spring lies against the post on the blade-operating ring.

Disconnect the hooked end of the blade-operating-ring spring from the blade-opening lever. Then, remove the screw which secures the blade-opening lever, Fig. 80. Lift out the blade-opening lever and the blade-operating-ring spring.

Removing and replacing the blade-stop lever can be a painstaking procedure. But it's a procedure that's necessary if you're going to remove the blade-operating ring. The blade-stop lever is actually an assembly -- two separate levers, each with its own spring.

The upper member of the blade-stop lever acts as the CONTROL MEMBER -- it contains the control stud that rides against the speed cam. The lower member acts against the post on the blade-operating ring. Remember, the blade-operating ring strikes the lower member to restrict the overtravel at 1/500 second.

First, locate the spring on the control member of the blade-stop lever, Fig. 81; the short end of the spring hooks to the control stud and the long end lies against the lens flange. Also, examine the position of the spring between the two members of the blade-stop lever. One end of the spring hooks to the upward-projecting pin on the lower member; the other end hooks to the downward-projecting pin on the control member. The lower spring holds the two sections of the blade-stop lever together.

Disconnect the lower spring from the downward-projecting pin on the control member. The upper spring, however, is difficult to disconnect -- the hooked end is just too short to lift over the control stud. But if you're careful, you can remove the retaining nut without disconnecting the spring. Just hold your finger over the spring to prevent it from getting away.

Unscrew the retaining nut, Fig. 81, and lift off the upper spring and the control member.

> On reassembly, seat the upper spring in position before replacing the retaining nut. Make sure the short end of the spring is hooked to the control stud, Fig. 81. Then, hold the spring in position and screw on the retaining nut.

The control member of the blade-stop lever sits on the shoulder of the bushing shown in Fig. 82. Lift out the lower spring, the bushing, and the lower member of the blade-stop lever. Also, remove the washer sitting next to the mechanism plate.

> Locate the short end of the lower spring in Fig. 82 -- this end of the the spring hooks to the downward-projecting pin of the control member. The way the lower spring is now positioned, you'd have trouble hooking it on reassembly. So -- before you replace the control member -- hook the short end of the lower spring to the upward-projecting pin of the lower member. That is, the long end of the spring hooks to one side of the pin -- hook the short end of the spring to the opposite side.
>
> Then, after replacing the retaining nut, you can reach the short end of the lower spring. Hook the short end of the lower spring to the downward-projecting pin of the control member.

Now, take another look at the spring on the movable X-sync contact, Fig. 83. Remember, one end of the spring hooks to a stud on the movable X-sync contact -- the other end hooks to a tab on the blade-ring lever.

Disconnect the short end of the spring first (the end that hooks to the movable X-sync contact). Then, remove the LEFT-HAND SCREW holding the movable X-sync contact, Fig. 83. Lift out the spring, the movable X-sync contact, and the washer sitting next to the mechanism plate.

It's possible to remove the blade-operating ring without removing the main lever. Just remove the screw holding the leaf-lever cam, Fig. 83. Next, hold the leaf lever away from the blade-ring lever. And turn the blade-ring lever as far as it can go in the blade-opening direction. With a little manipulation, you can now lift out the blade-ring lever.

Finally, turn the blade-operating ring as far as it can go in a counterclockwise direction (as seen from the bottom of the mechanism plate). The cutouts in the blade-operating ring then clear the retaining washers.

As you might expect, the main lever is somewhat difficult to remove and replace. The powerful torsion-type mainspring usually provides a wrestling match. Notice the mainspring hooking points in Fig. 84 -- one end of the mainspring hooks to a downward-projecting pin on the main lever; the other end hooks to a milled section in the mechanism plate.

It's a little easier to remove and replace the main lever if you first take out the main-lever STOP-PLATE, Fig. 83. The main lever then travels a little further than normal in a clockwise direction -- that lets off some of the mainspring tension. Next, disconnect the short end of the mainspring from the main lever. Lift both the main lever and the mainspring from the mechanism plate.

> On reassembly, first seat the mainspring in position -- remember, the lower, straight end of the mainspring hooks within a milled section of the mechanism plate. Then, try hooking a wire with a loop in one end to the short end of the mainspring -- the technique described in your lesson, "SIMPLE ESCAPEMENT RETARD SHUTTER."

Next, seat the main lever in position. Using the looped wire, pull the short end of the mainspring in a counterclockwise direction -- against the force of the mainspring. You should then be able to hook the short end of the mainspring to the downward-projecting pin of the main lever. Finally, turn the main lever in a counterclockwise direction to replace the stop plate.

IMPORTANT POINTS IN THE 00-SIZE COPAL

The 00-size Copal shouldn't give you much trouble -- as we mentioned, it's quite similar to the Gauthier design covered in your lessons. There're just a couple of points we'll call to your attention.

Point number one involves the shutter blades. As you've seen in the 0-size Copal, reinforcement blades are common to Copal shutters. The positions of the reinforcement blades in the 0-size version are pretty obvious -- the lower reinforcement blades carry the blade-mounting pins.

But in the 00-size Copal, all five reinforcement blades are identical. Yet their positions are different -- and critical.

Let's say that you're now ready to replace the shutter blades. Place the first reinforcement blade nearest the main-lever position. Next, place the first shutter blade on top of the reinforcement blade.

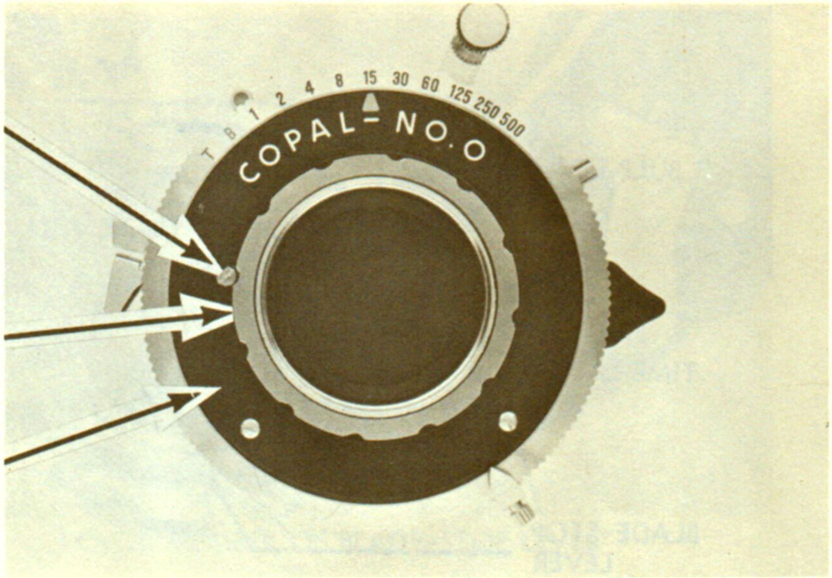
Now, install the remaining four shutter blades in clockwise rotation. The remaining four reinforcement blades go on top of their respective shutter blades.

In other words, the first reinforcement blade goes underneath the first shutter blade. And the other four reinforcement blades go on top of the other four shutter blades.

The other point we want to mention regards the M-sync adjustment. If you look underneath the sync-drive lever, Fig. 85, you can spot a brass disc -- this disc is an ECCENTRIC BUSHING for the sync-drive lever, Fig. 86. Notice that the eccentric bushing has a series of notches in its outer circumference; these notches allow you to turn the eccentric bushing.

Turning the eccentric bushing changes the depth of engagement between the sync-drive lever and the main lever. On the release cycle, the main lever has to push the sync-drive lever out of its way. The length of time it takes for the main lever to get past the sync-drive lever determines the M-sync delay.

So, by changing the depth of engagement, you can vary the M-sync delay. Make the adjustment by first loosening the slotted nut that holds the sync-drive lever, Fig. 86. Then, rotate the eccentric collar to set the depth of engagement between the sync-drive lever and the main lever -- the deeper the sync-drive lever engages the main lever, the longer the sync delay. By rotating the eccentric collar, you can vary the M-sync delay from approximately 10 milliseconds to 35 milliseconds.

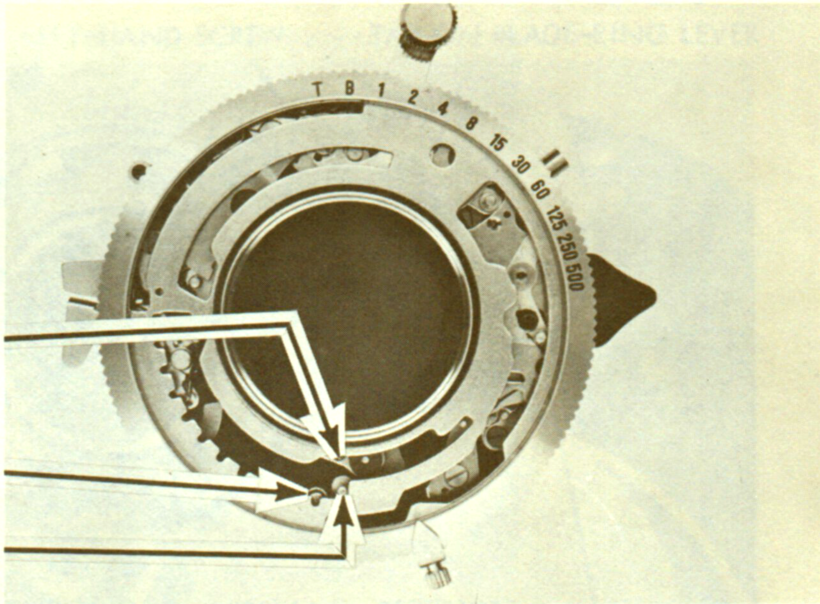


LOCK SCREW

SCALLOPED RETAINING RING

SHUTTER-COVER PLATE

FIGURE 6

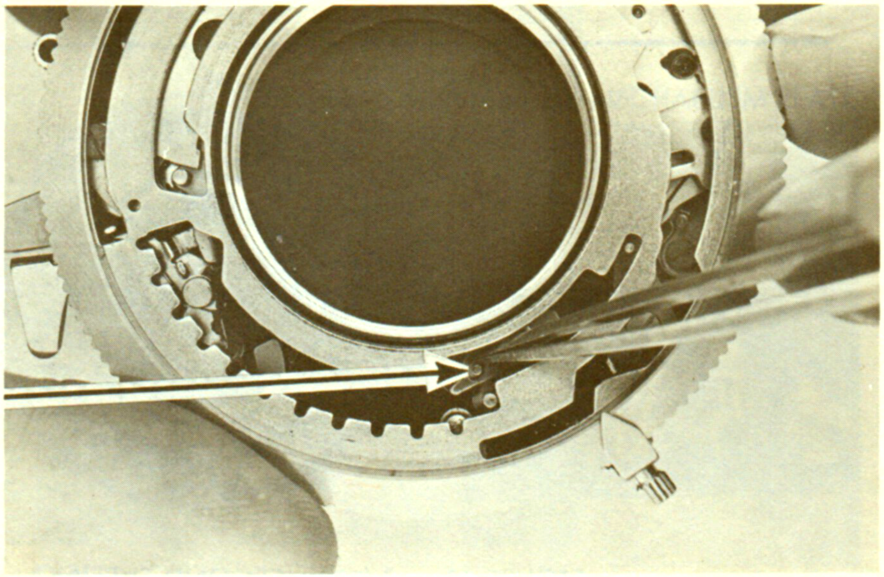


BLADE-STOP LEVER

SPEED-CAM DETENT

LOCATING PIN

FIGURE 7



CONTROL STUD ON BLADE-STOP LEVER

FIGURE 8

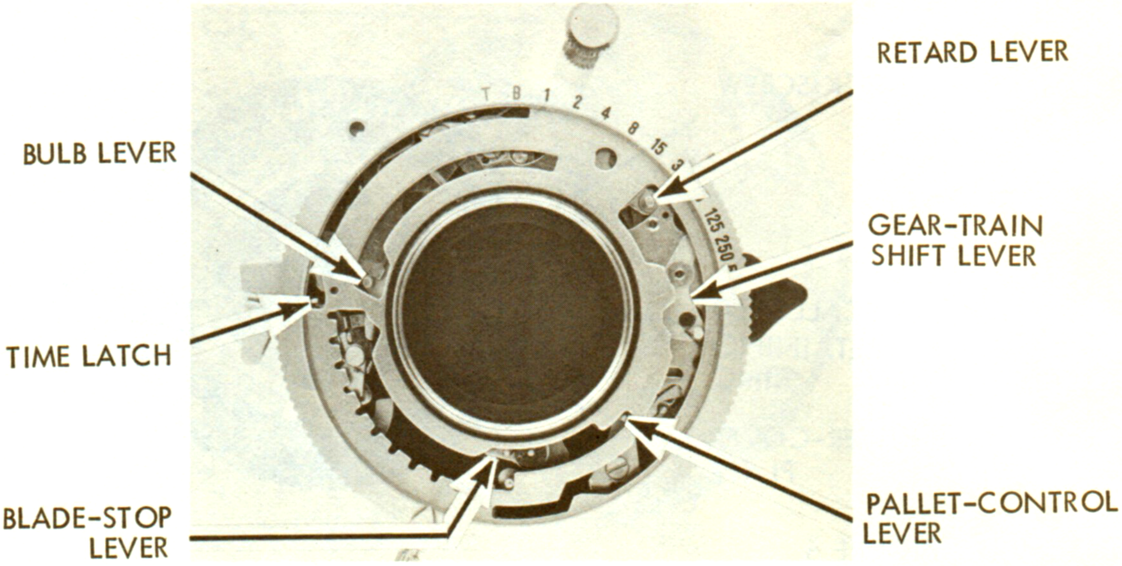


FIGURE 9 "TIME" SETTING

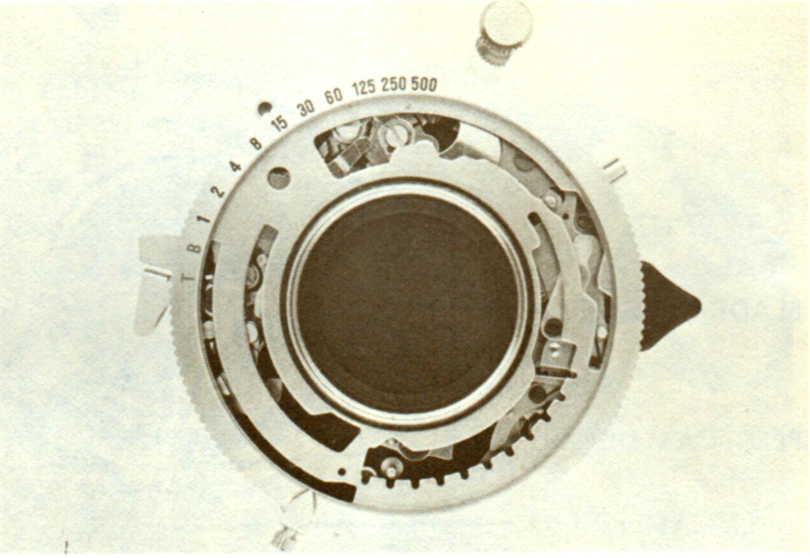


FIGURE 10 1/250 - SECOND SETTING

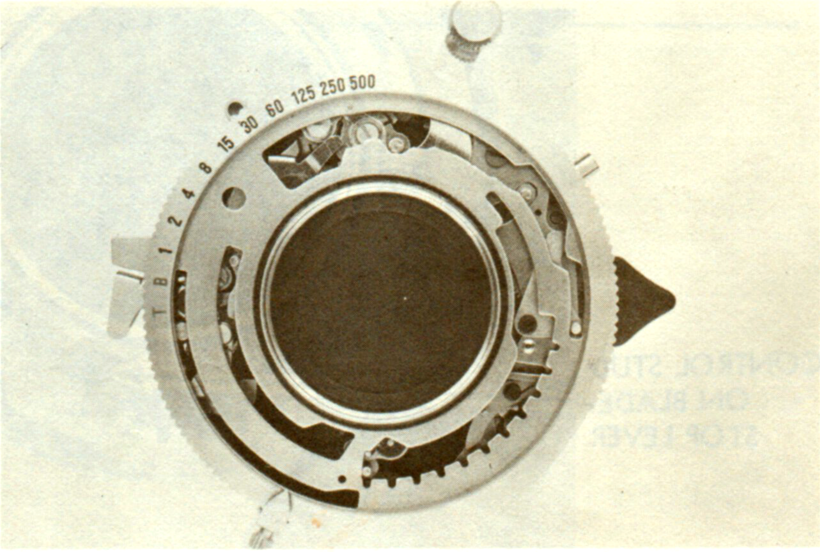


FIGURE 11 1/500 - SECOND SETTING

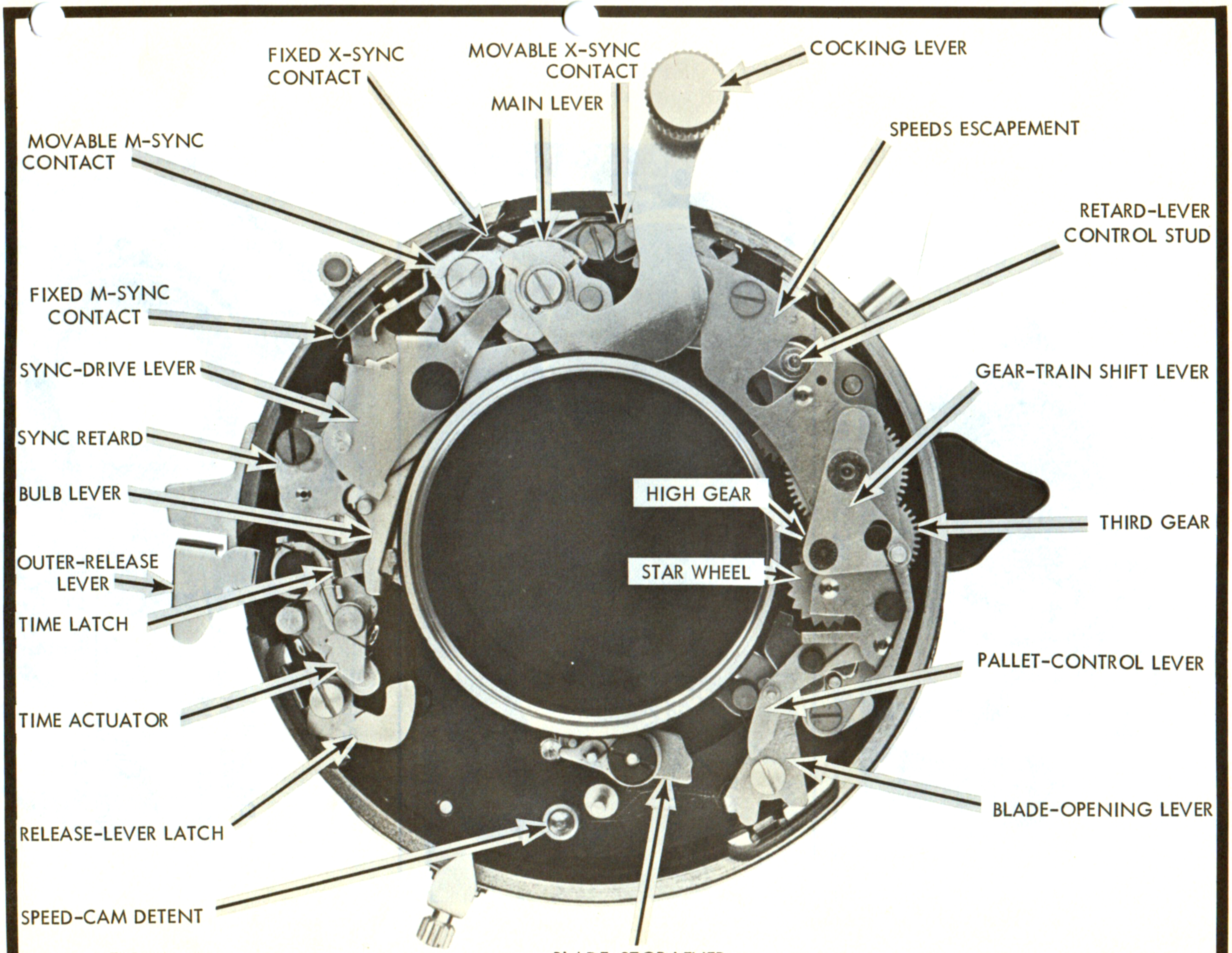

FIXED X-SYNC CONTACT
MOVABLE X-SYNC CONTACT
COCKING LEVER
MAIN LEVER
MOVABLE M-SYNC CONTACT
SPEEDS ESCAPEMENT
RETARD-LEVER CONTROL STUD
FIXED M-SYNC CONTACT
SYNC-DRIVE LEVER
GEAR-TRAIN SHIFT LEVER
SYNC RETARD
BULB LEVER
HIGH GEAR
THIRD GEAR
OUTER-RELEASE LEVER
STAR WHEEL
TIME LATCH
PALLET-CONTROL LEVER
TIME ACTUATOR
BLADE-OPENING LEVER
RELEASE-LEVER LATCH
SPEED-CAM DETENT
BLADE-STOP LEVER

FIGURE 12

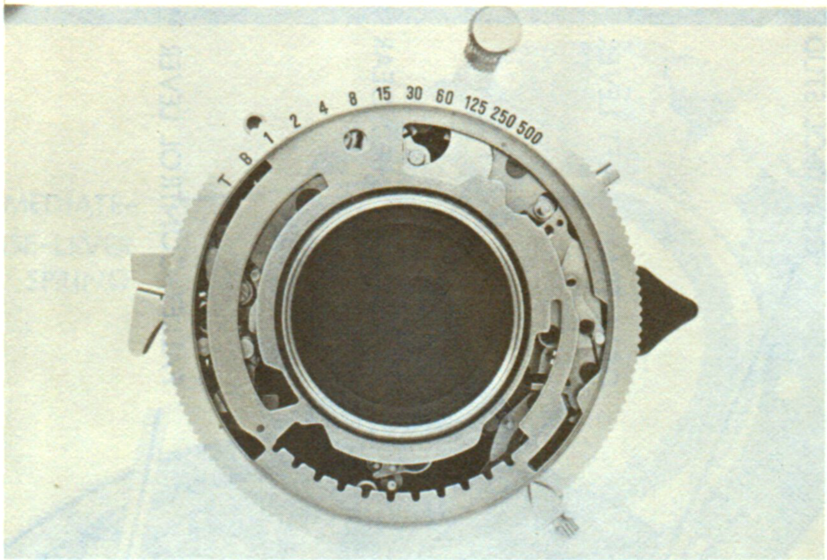
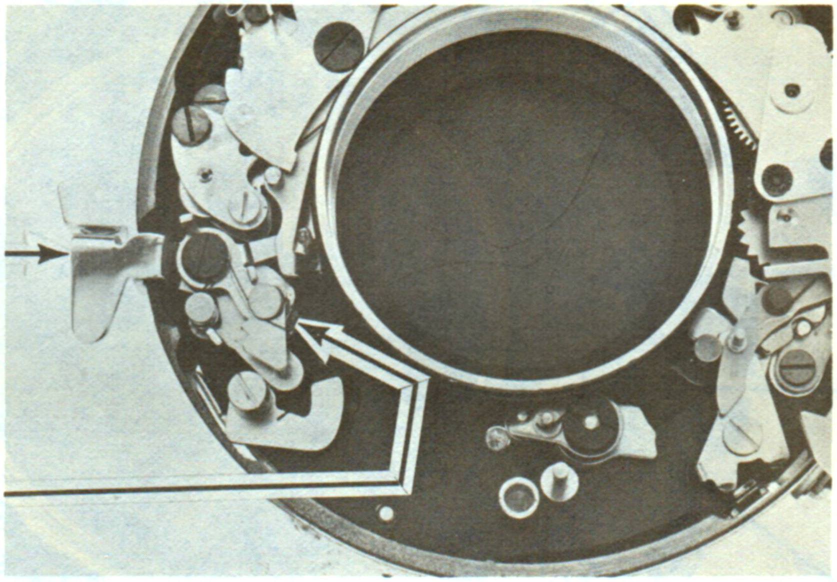


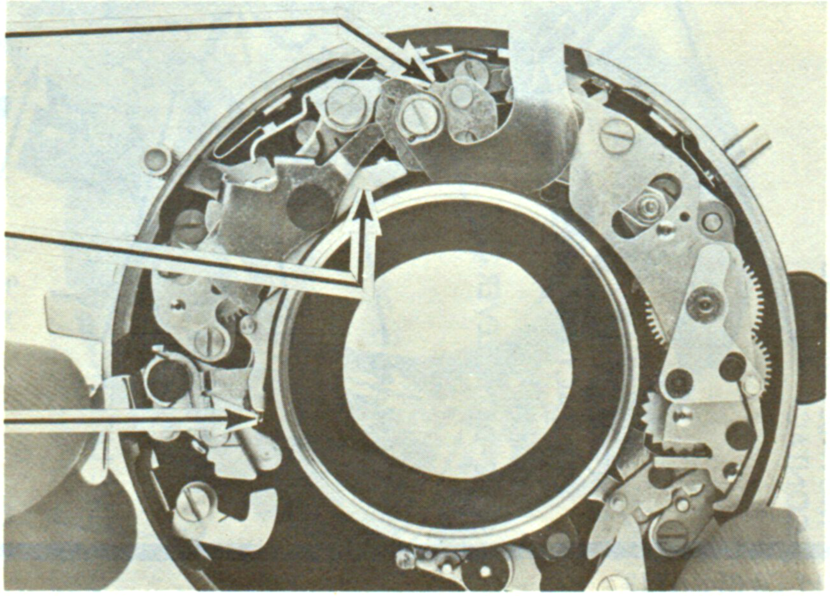
FIGURE 13 1/15 - SECOND SETTING



OUTER-RELEASE LEVER

BULB TAB

FIGURE 14



MAIN LEVER

END OF BULB LEVER THAT ENGAGES MAIN LEVER

BULB TAB ENGAGED WITH BULB LEVER

FIGURE 15

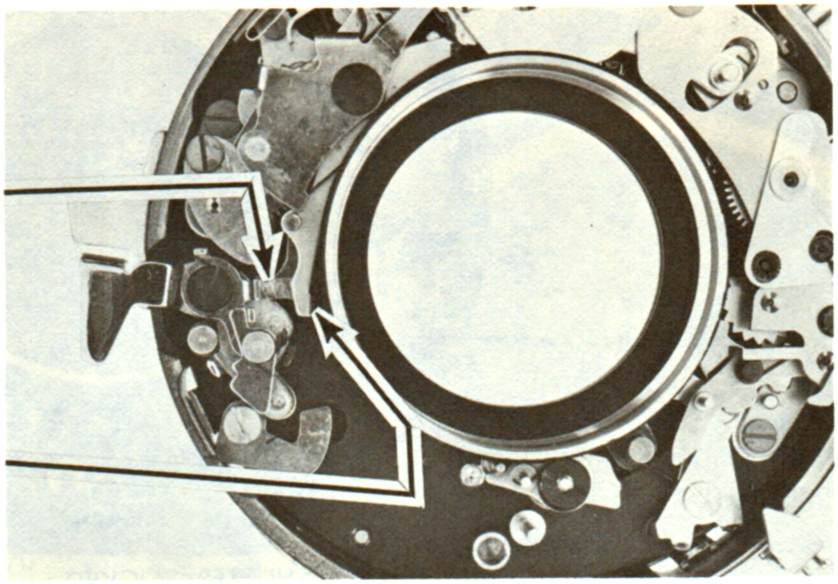


FIGURE 16 SHUTTER HELD OPEN ON "TIME"

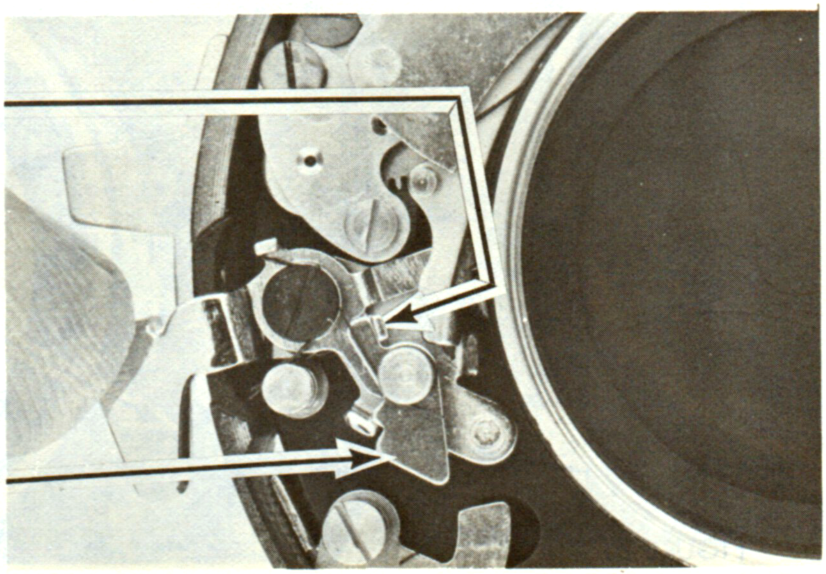


FIGURE 17

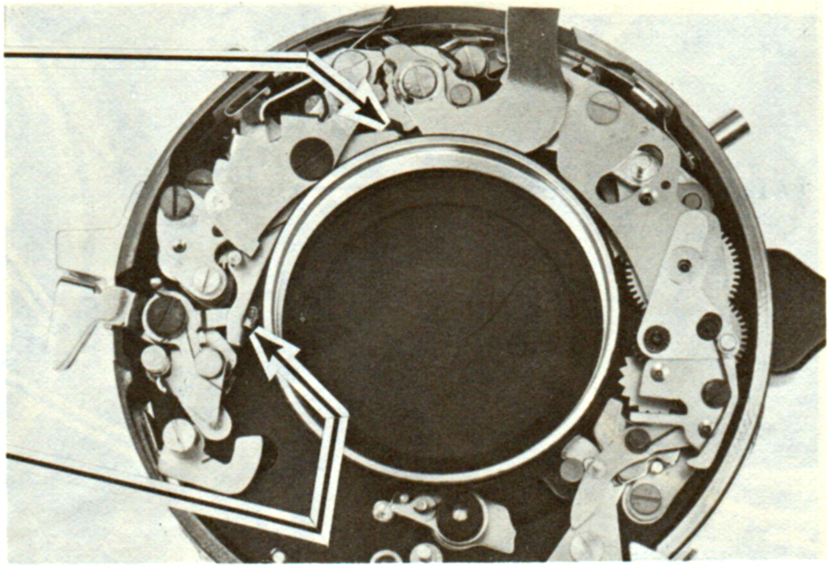
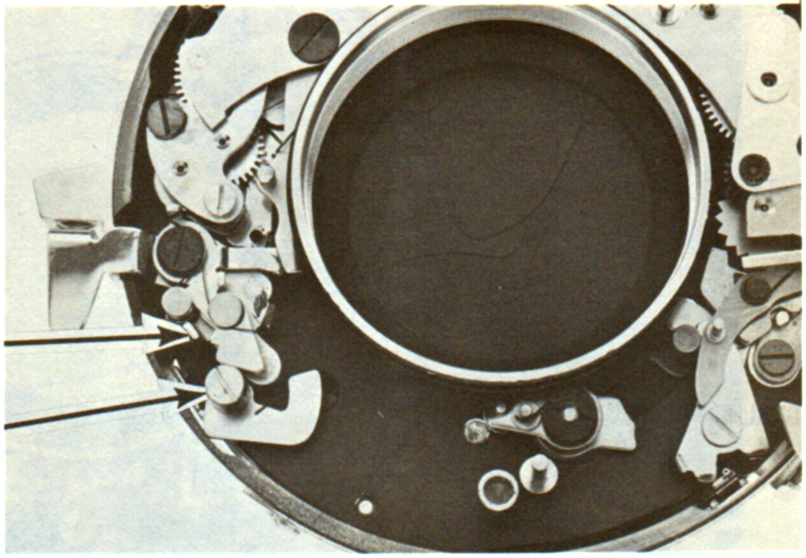
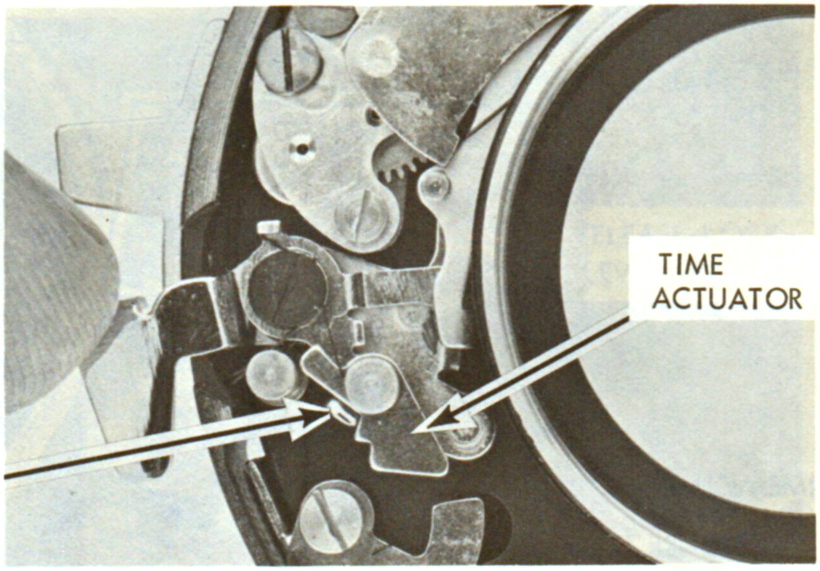


FIGURE 18


RELEASE TAB

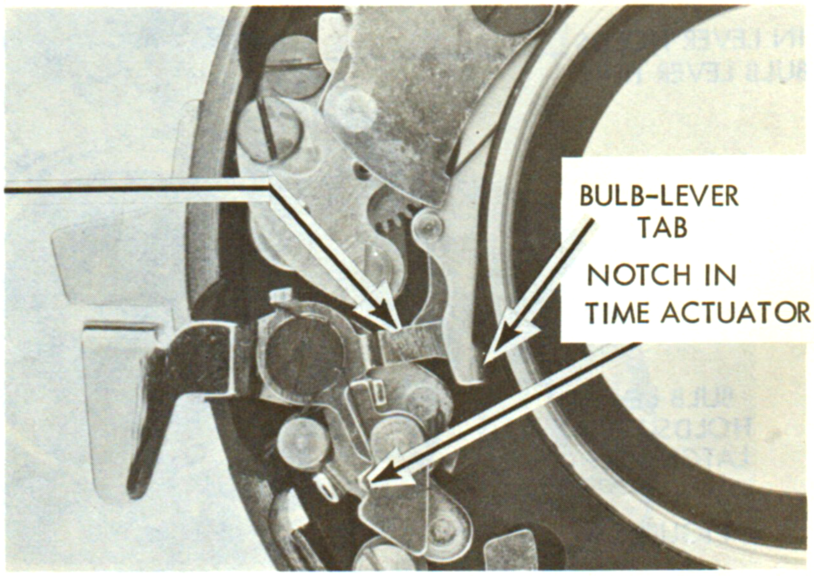
BRASS SCREW
THAT POSITIONS
TIME ACTUATOR

FIGURE 19 SHUTTER COCKED


TIME
ACTUATOR

RELEASE TAB

FIGURE 20


LATCHING END
OF TIME LATCH

BULB-LEVER
TAB

NOTCH IN
TIME ACTUATOR

FIGURE 21

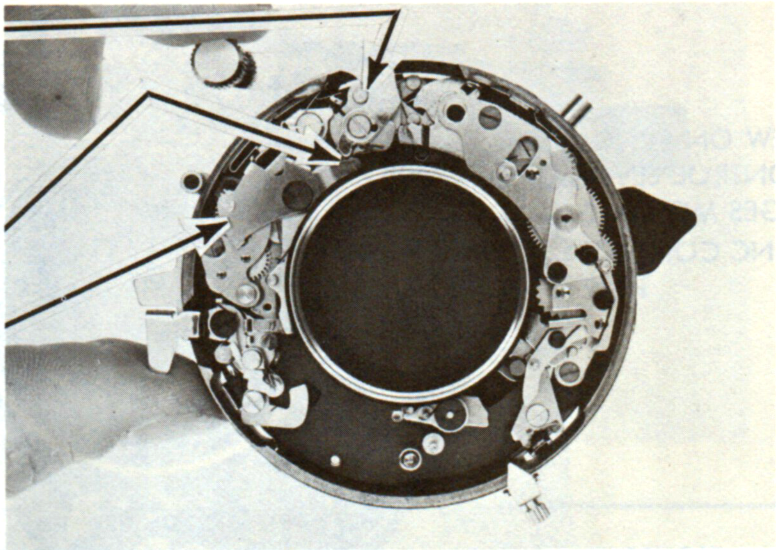


FIGURE 22

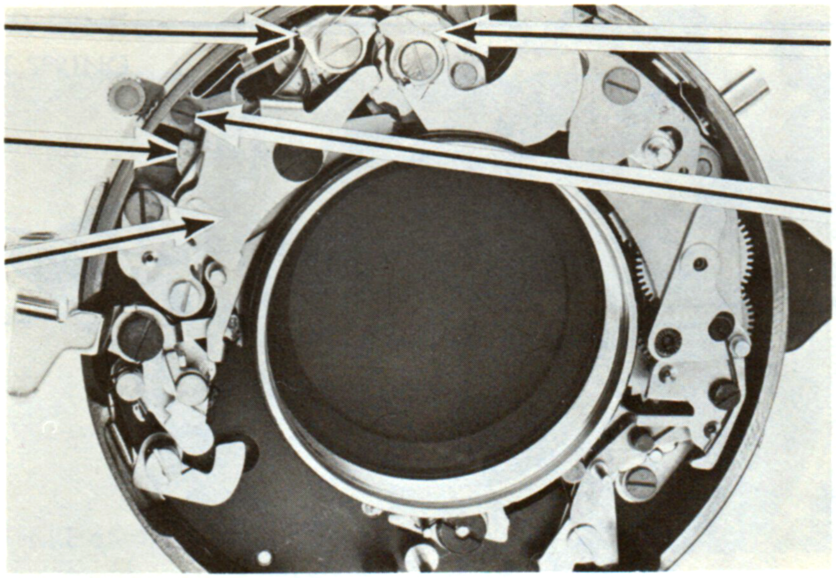


FIGURE 23 SHUTTER RELEASED

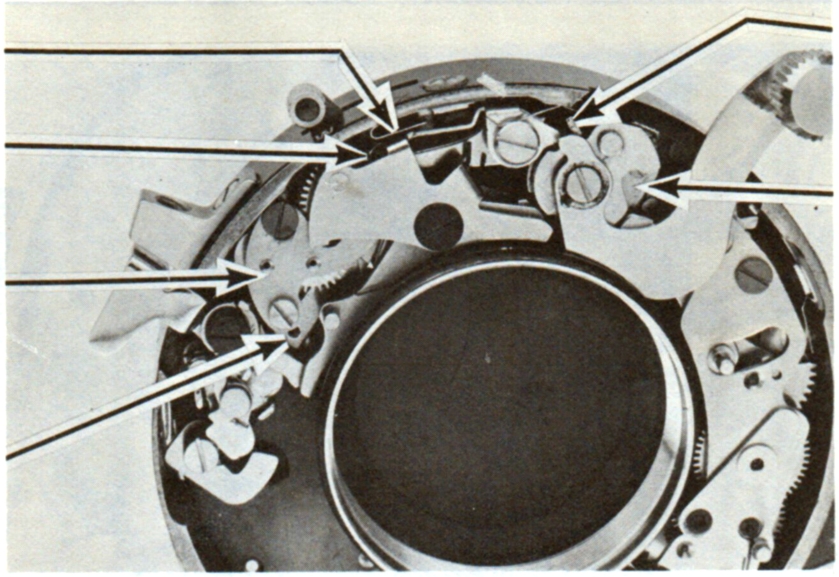


FIGURE 24 SHUTTER COCKED

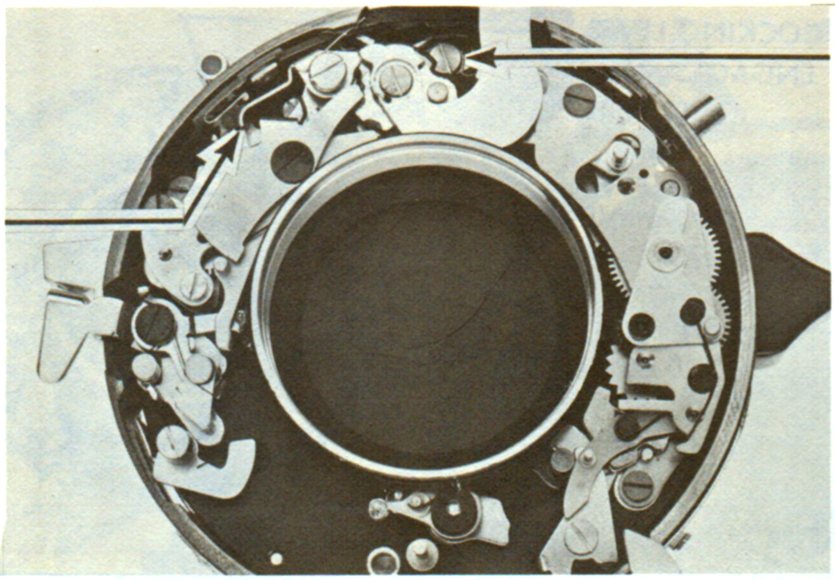


FIGURE 25

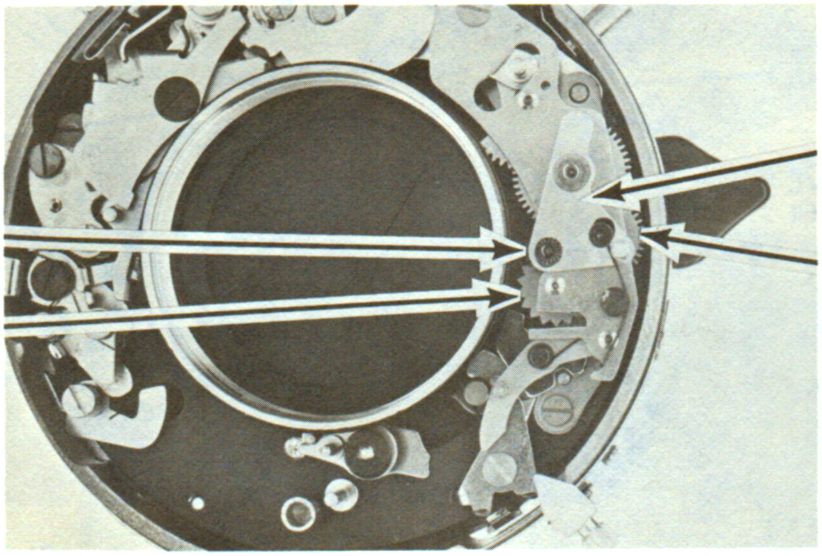


FIGURE 26

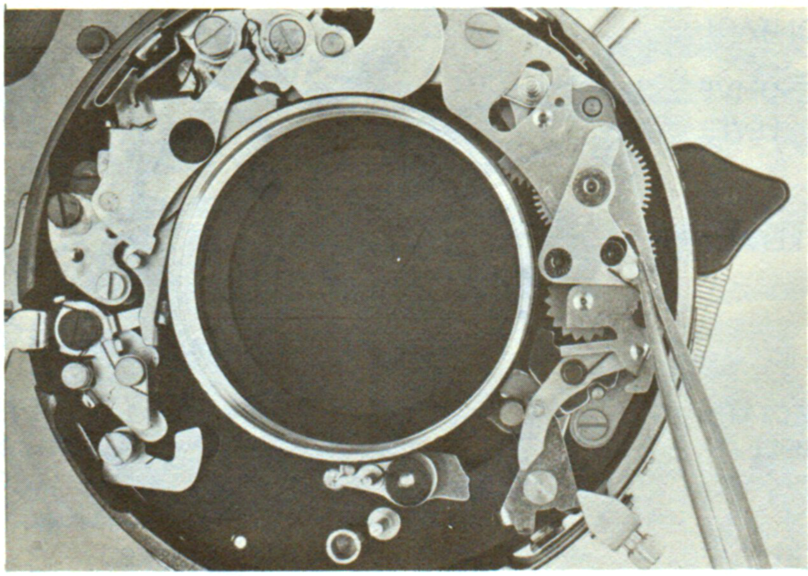


FIGURE 27

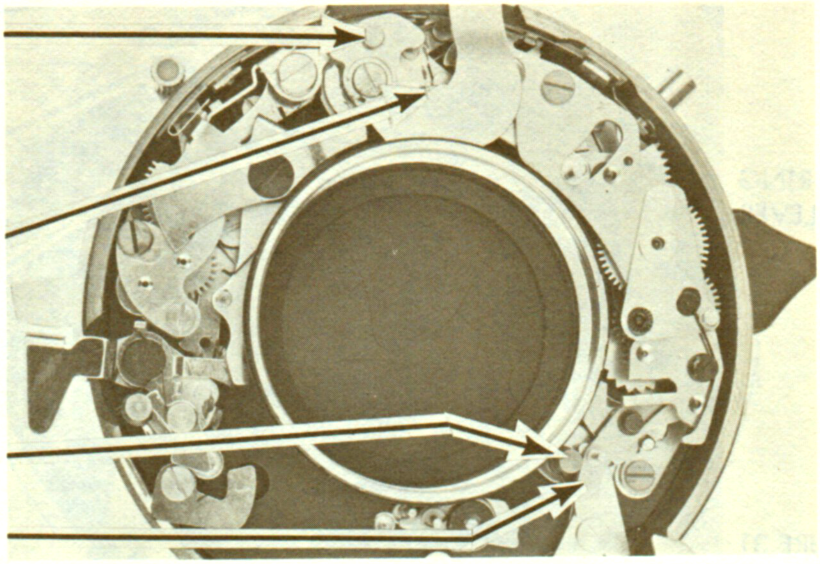


FIGURE 28

SHUTTER COCKED

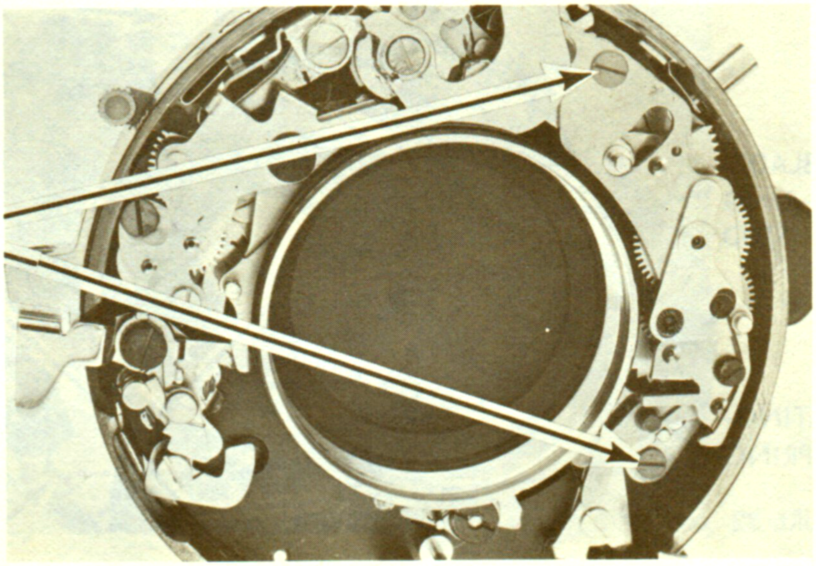


FIGURE 29

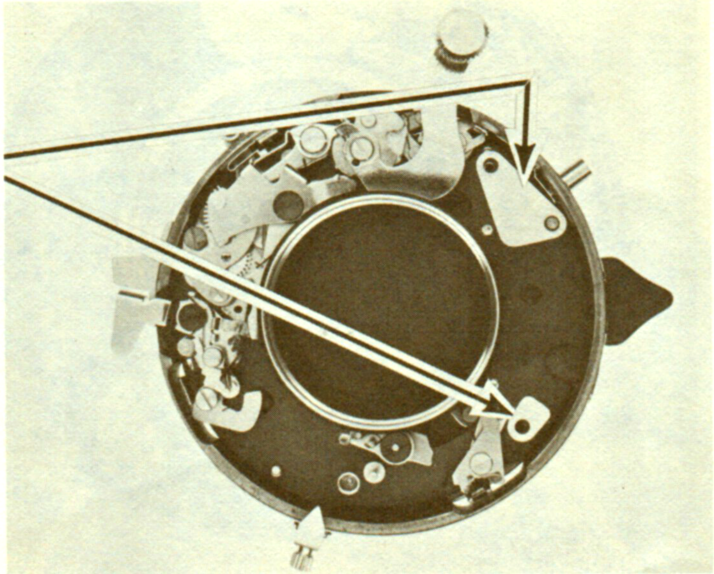


FIGURE 30

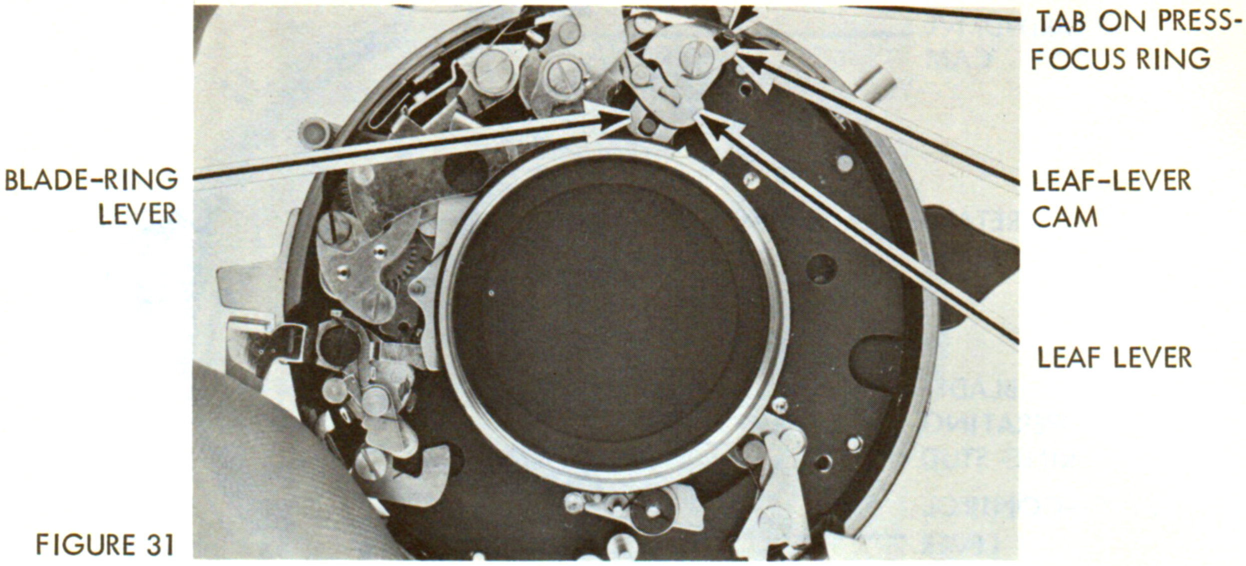


FIGURE 31

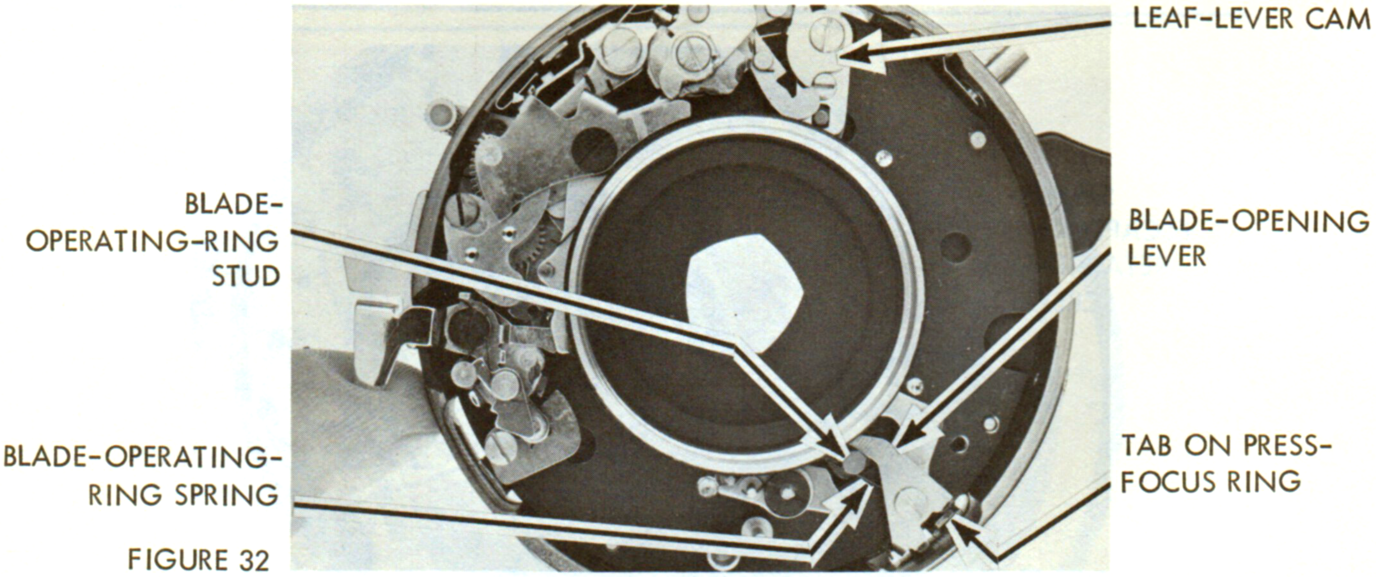


FIGURE 32

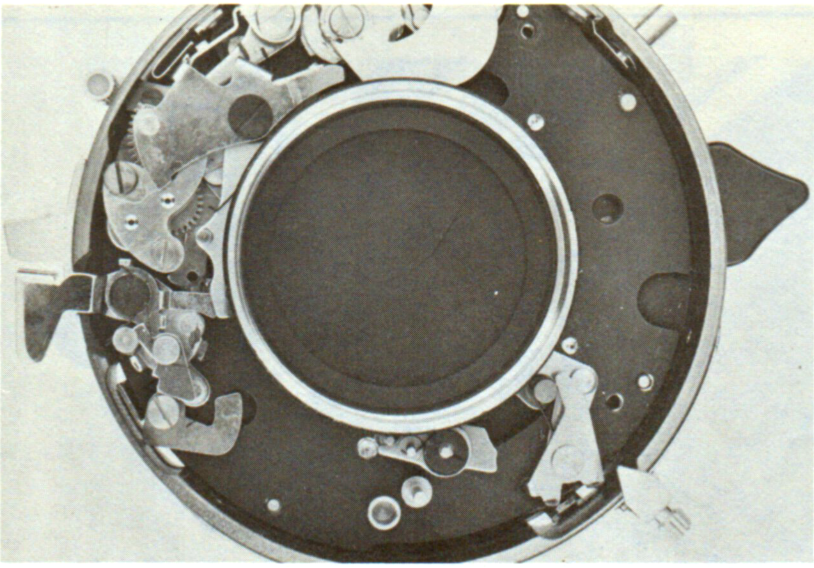


FIGURE 33

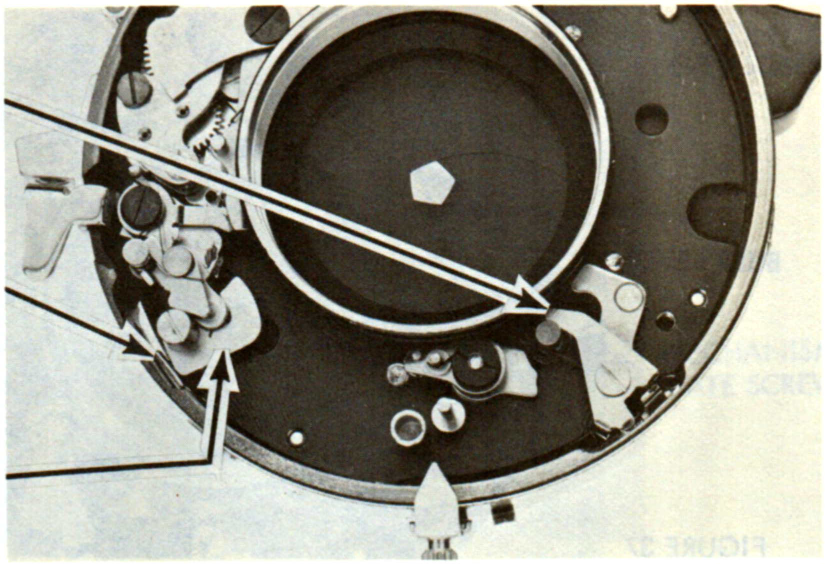


FIGURE 34

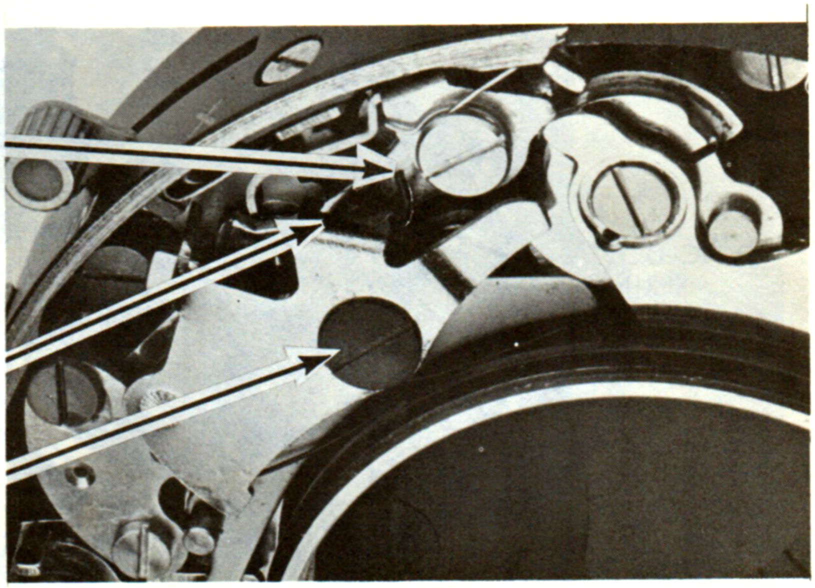


FIGURE 35

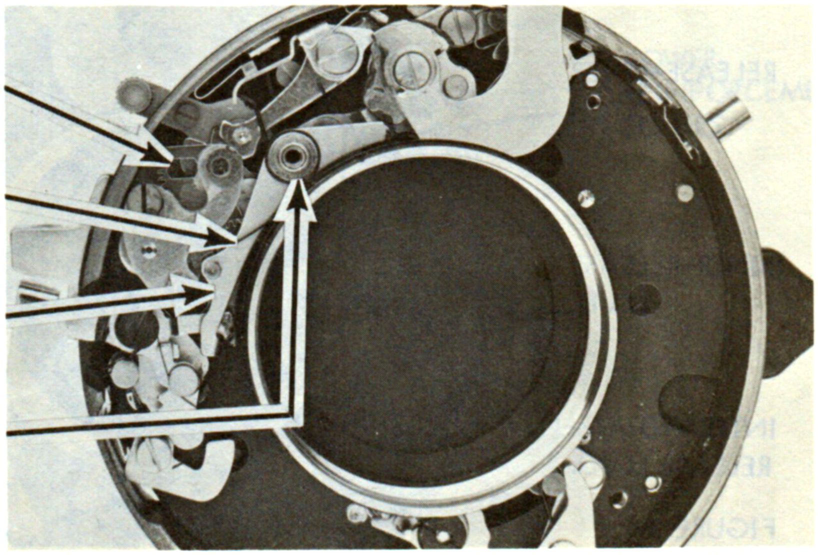


FIGURE 36

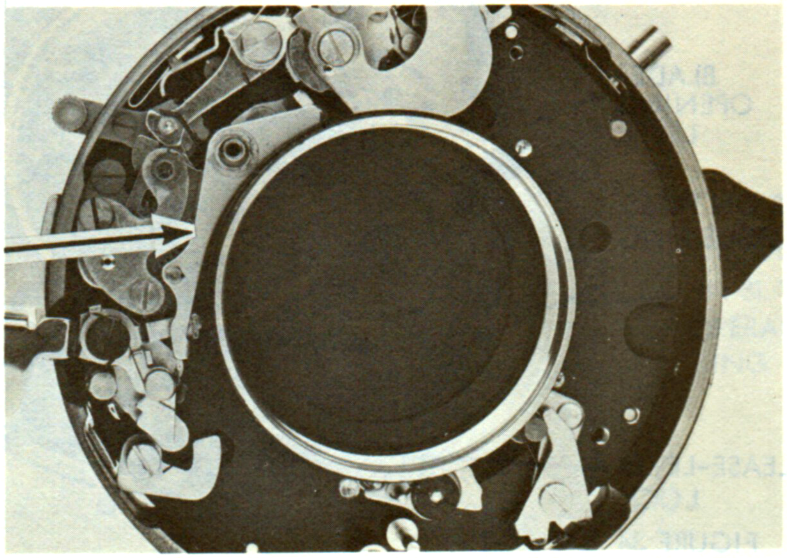


FIGURE 37

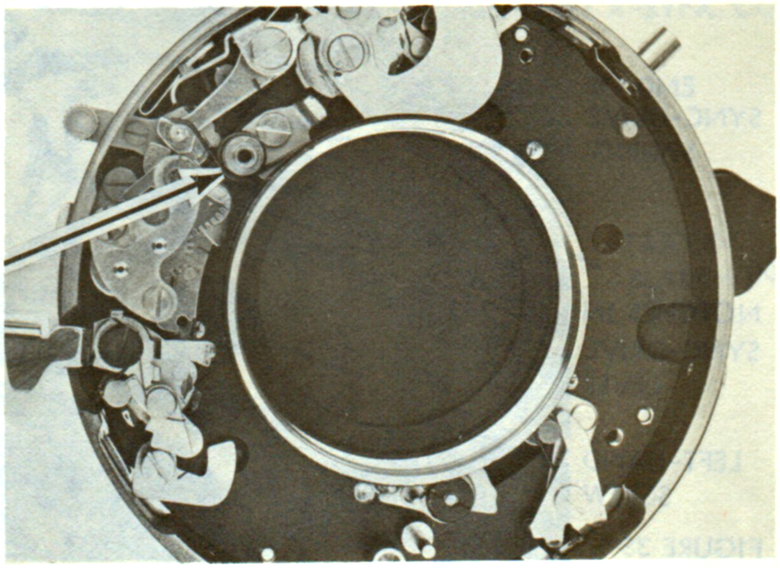


FIGURE 38

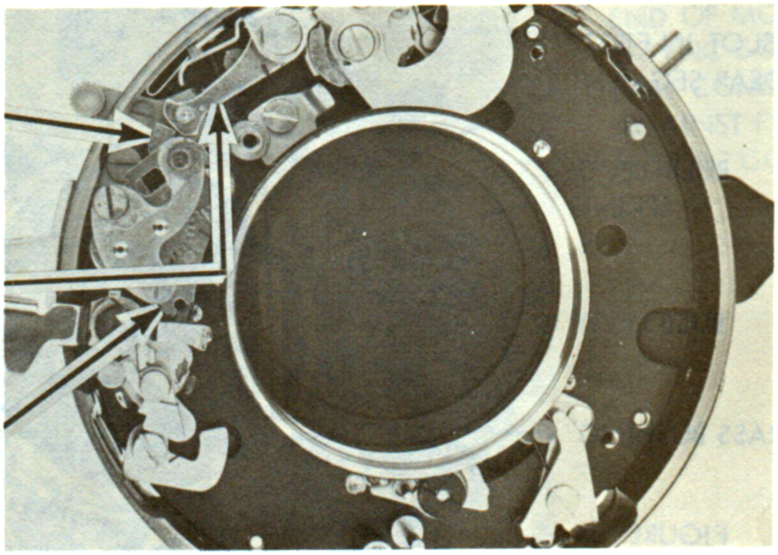


FIGURE 39

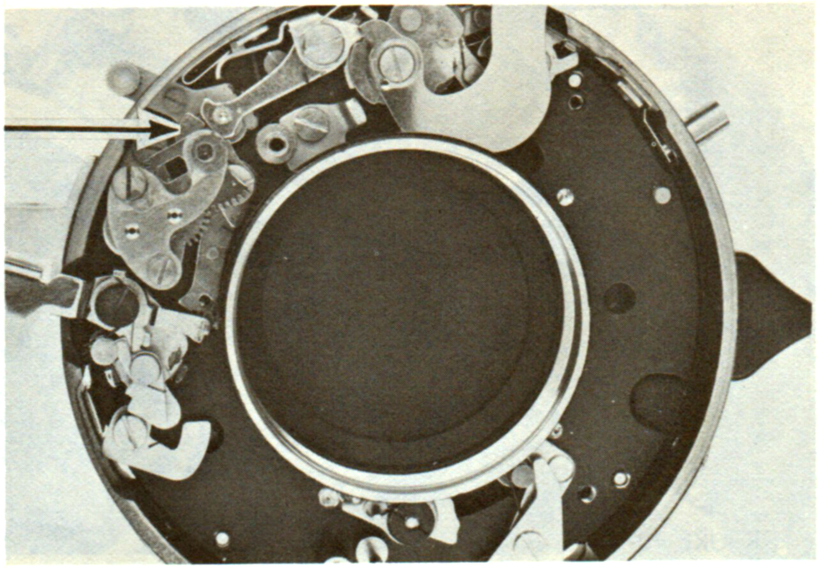


FIGURE 40

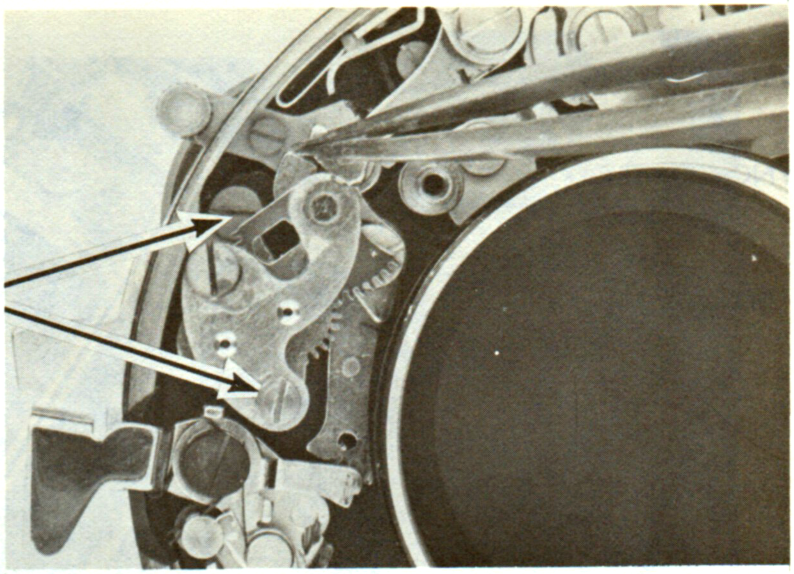


FIGURE 41

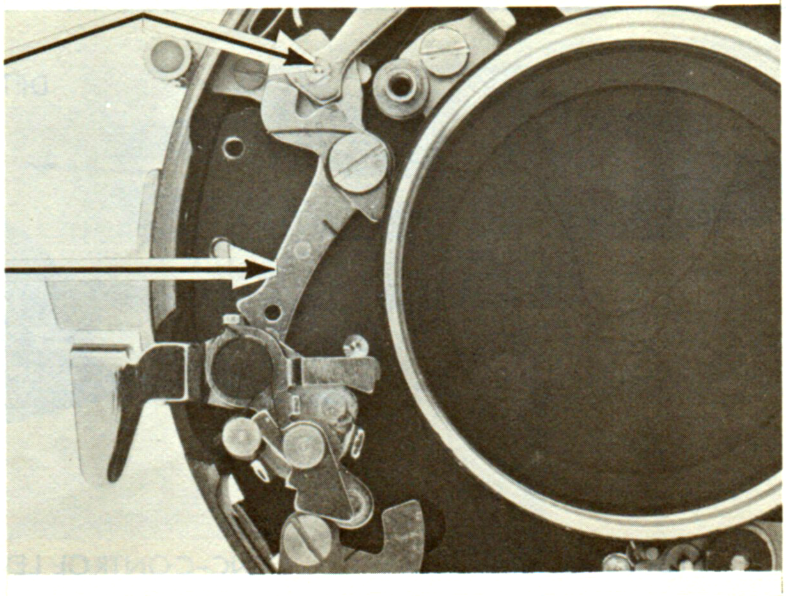


FIGURE 42

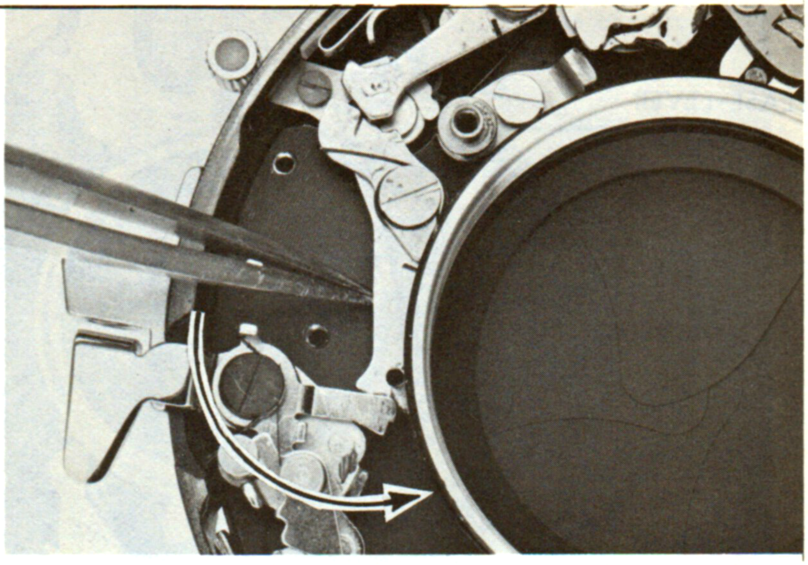


FIGURE 43

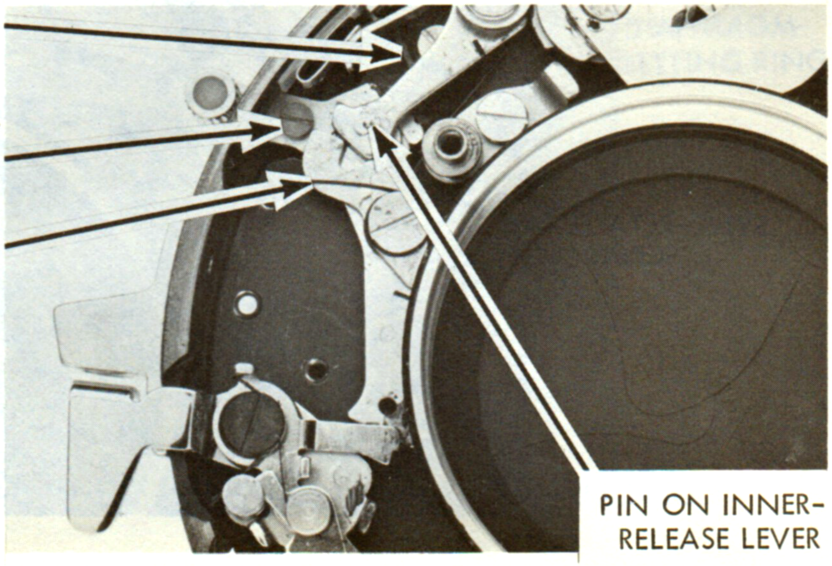


FIGURE 44

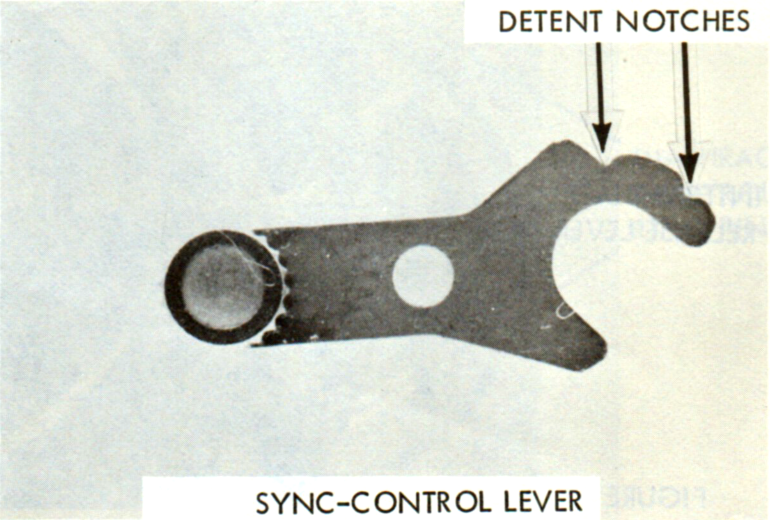


FIGURE 45 SYNC-CONTROL LEVER

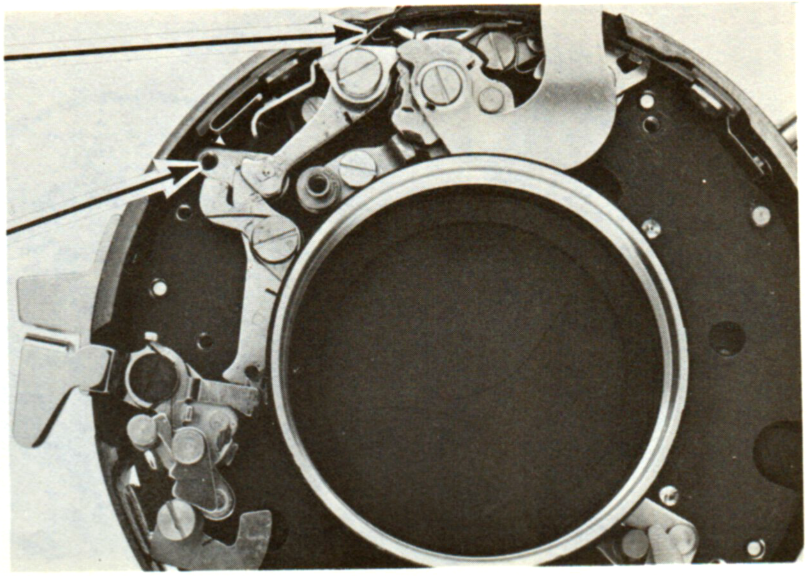


FIGURE 46

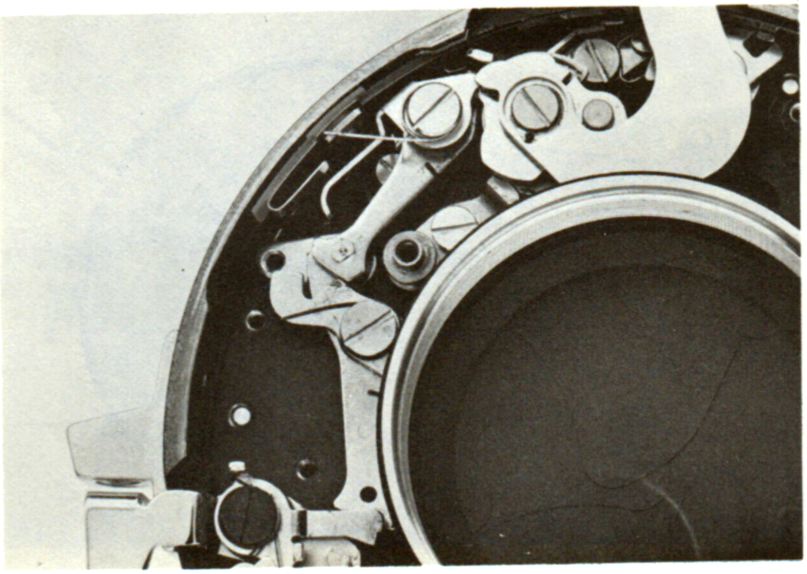


FIGURE 47

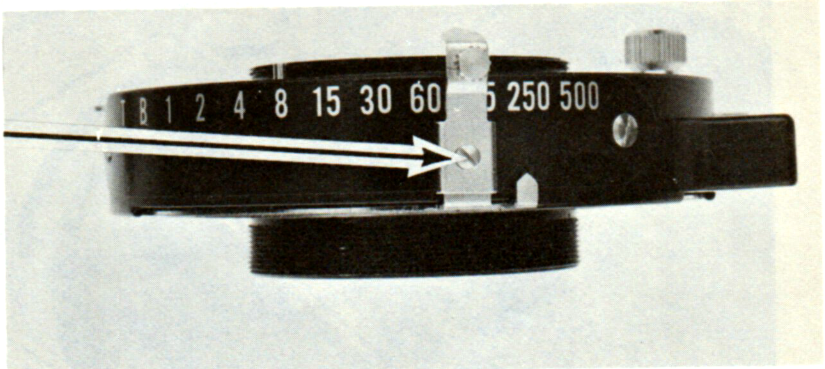


FIGURE 48

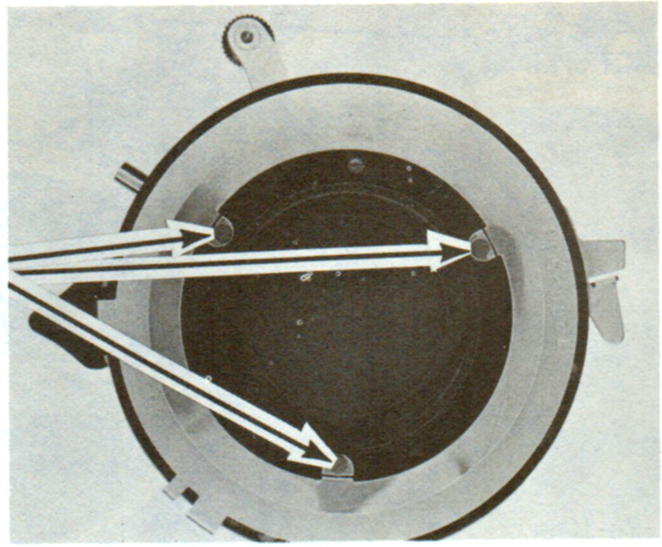


FIGURE 49

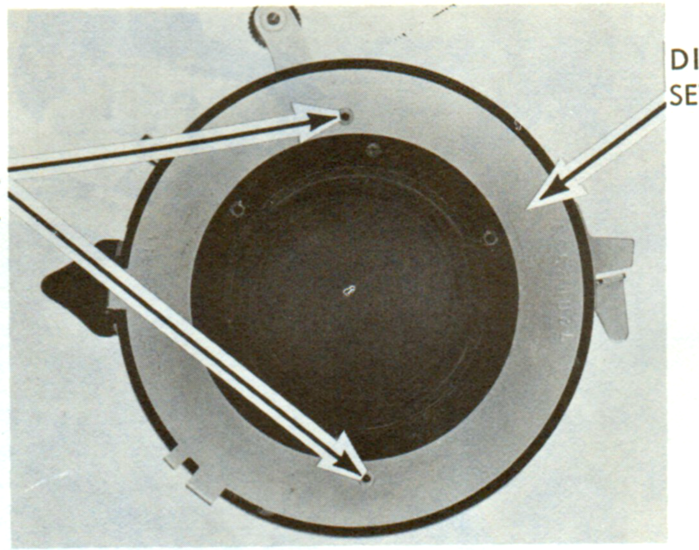


FIGURE 50

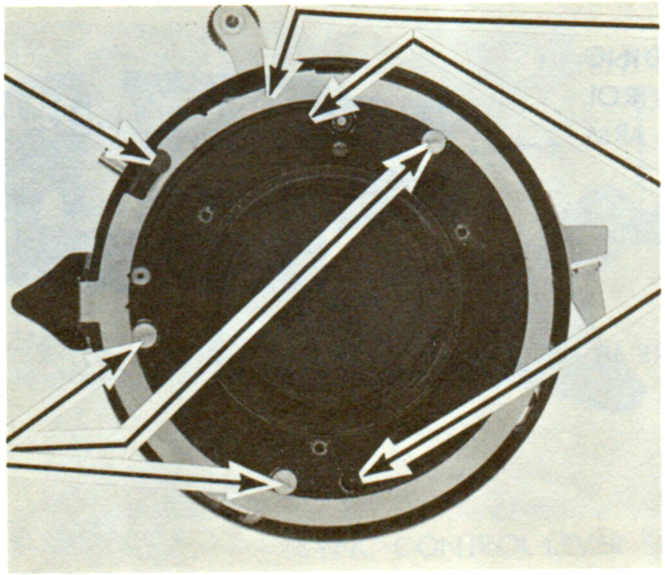


FIGURE 51

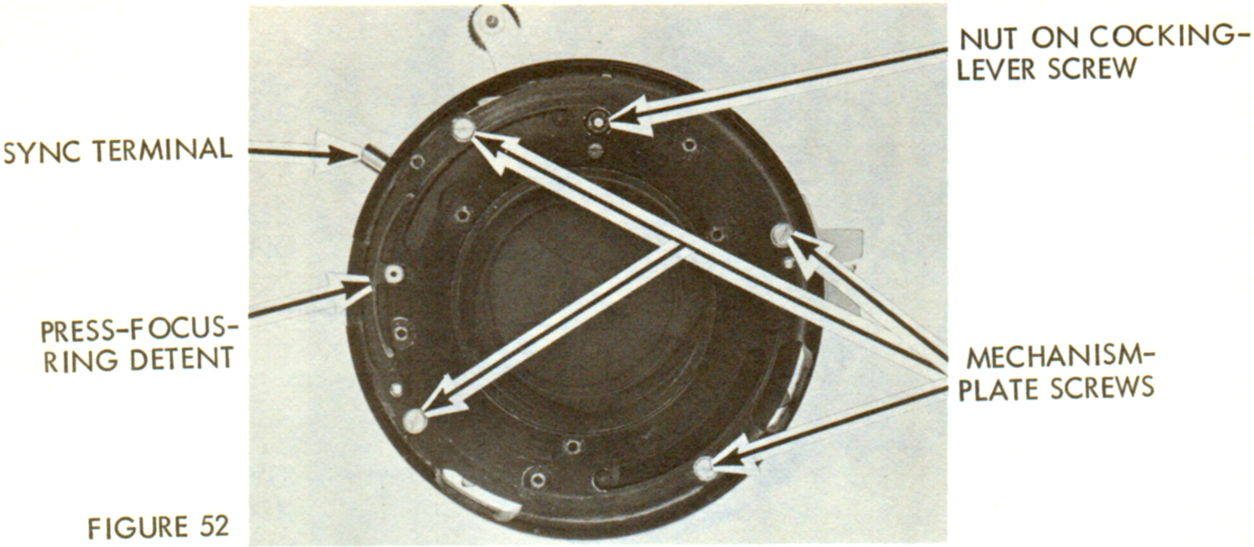


FIGURE 52

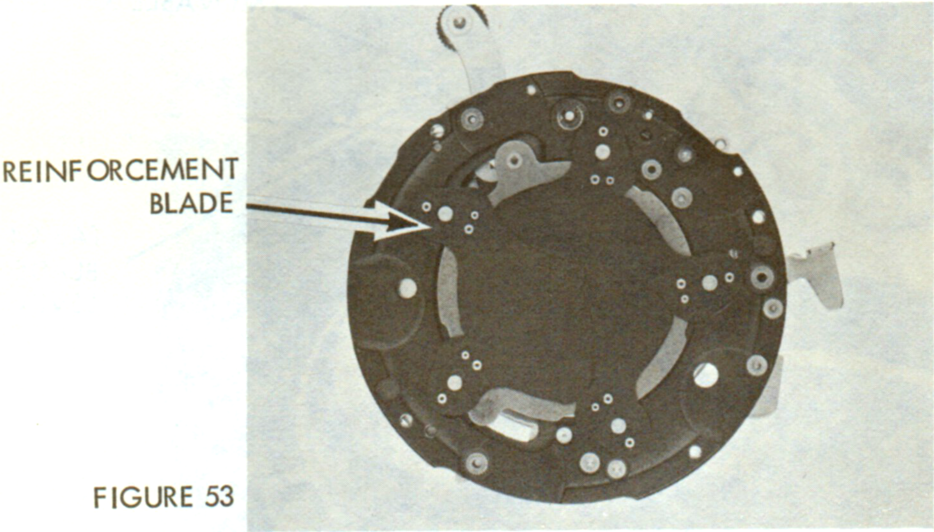


FIGURE 53

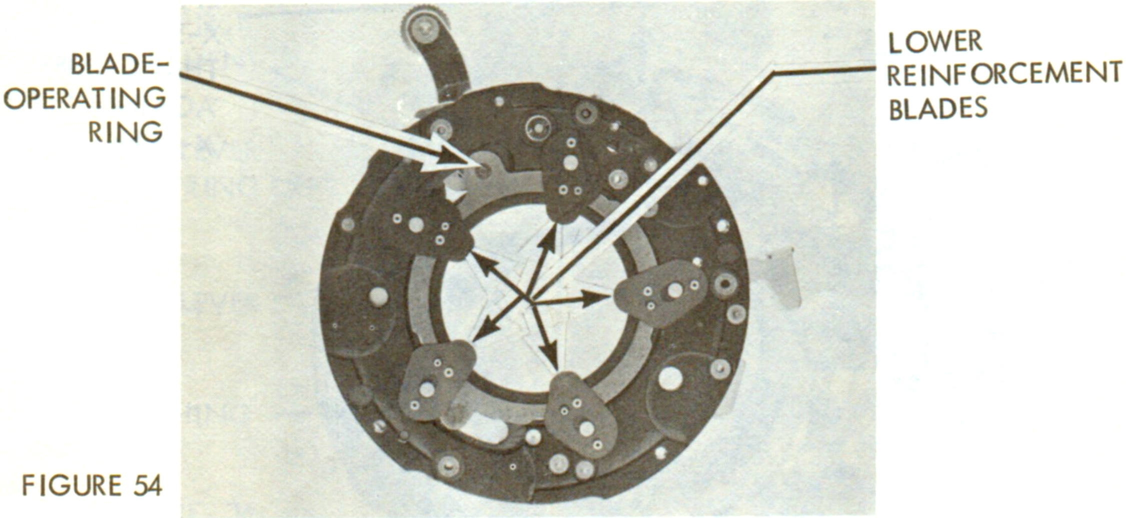


FIGURE 54

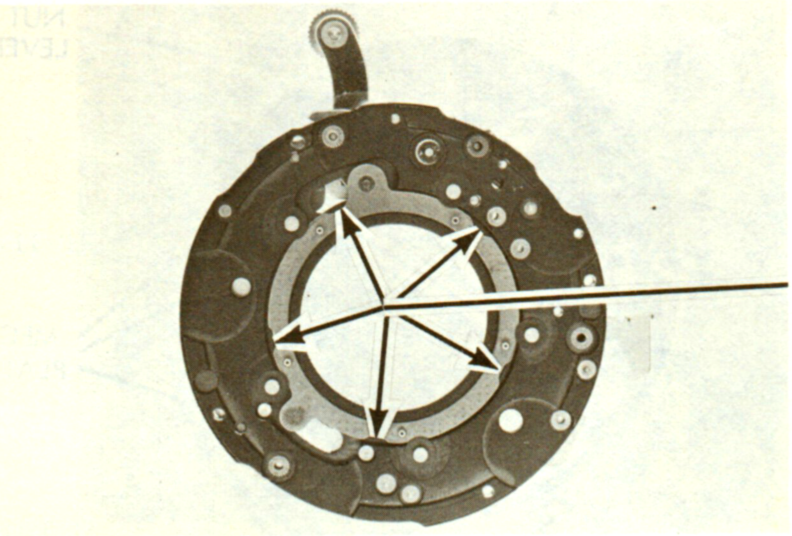


FIGURE 55

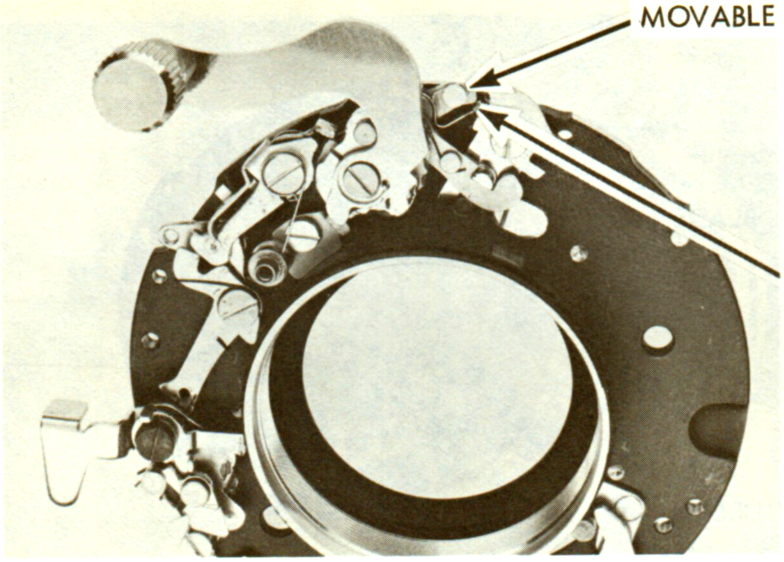


FIGURE 56

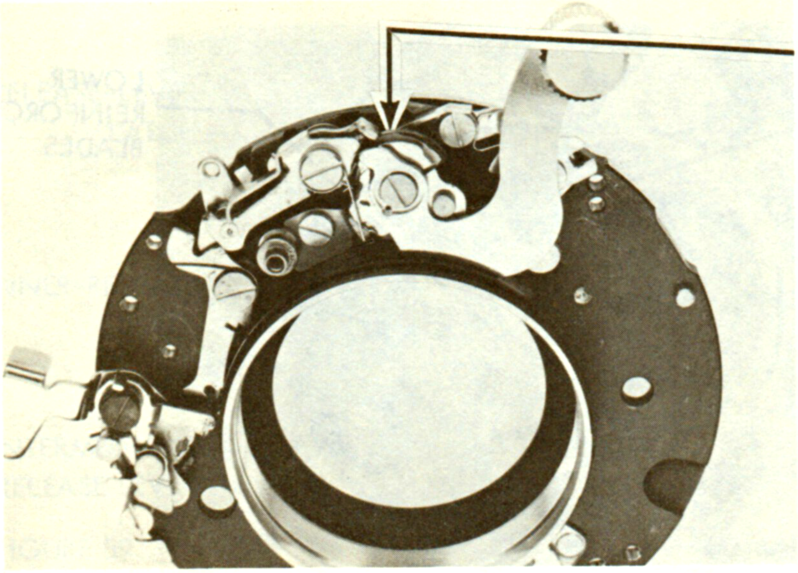


FIGURE 57

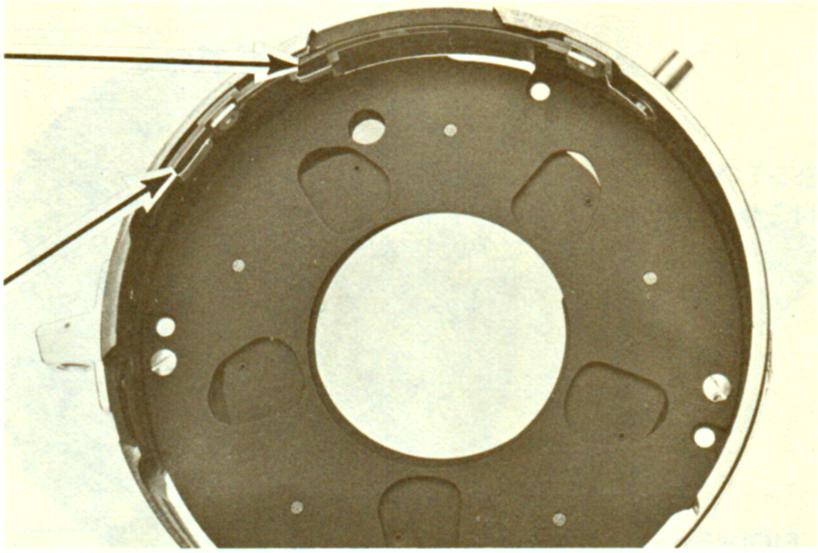


FIGURE 58

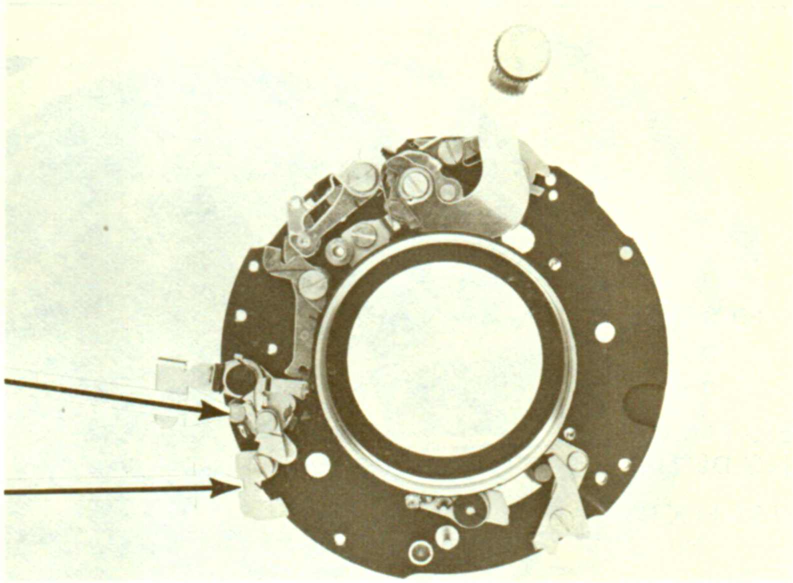


FIGURE 59

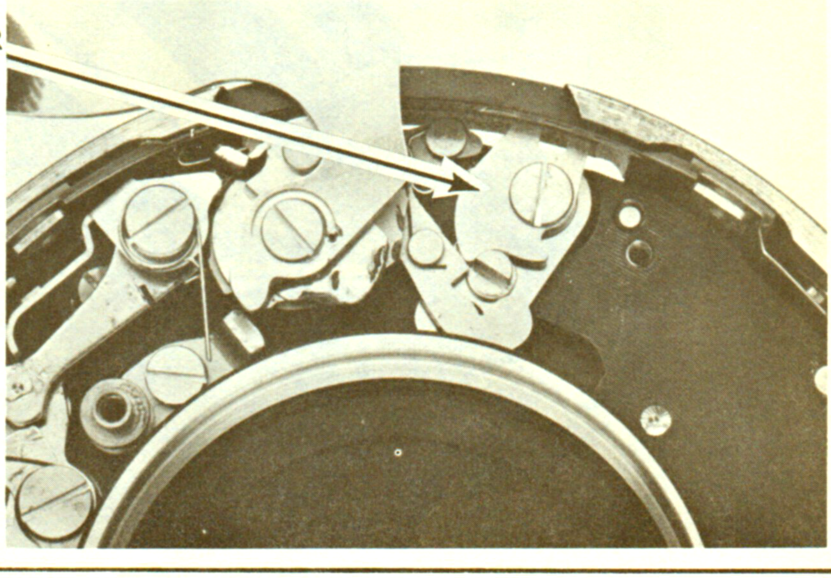


FIGURE 60

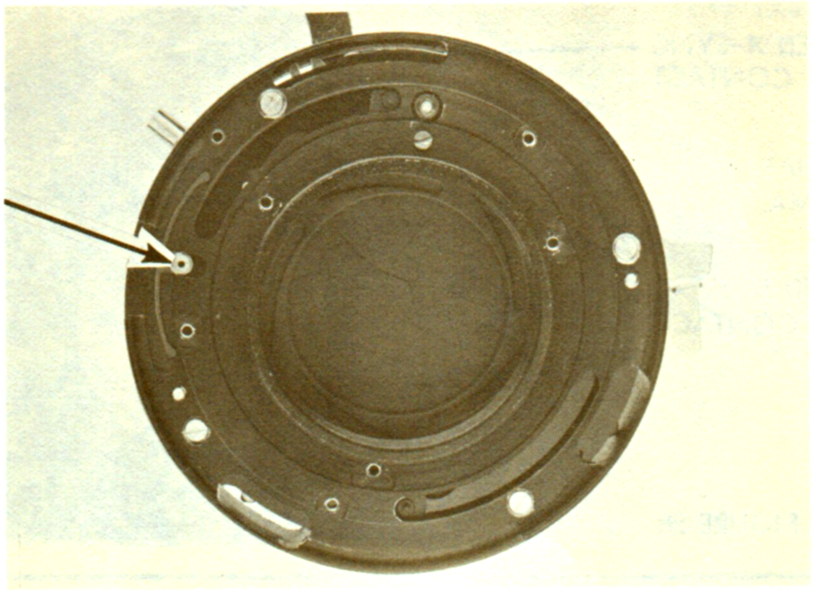


FIGURE 61

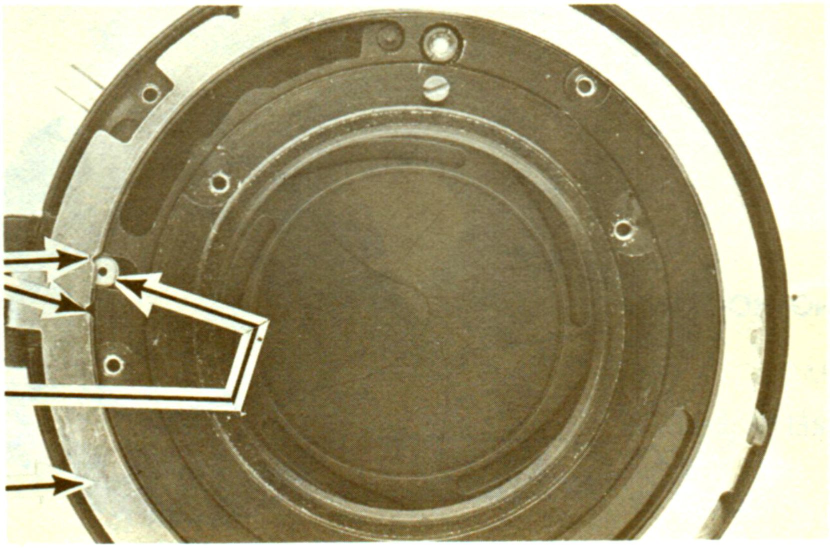


FIGURE 62

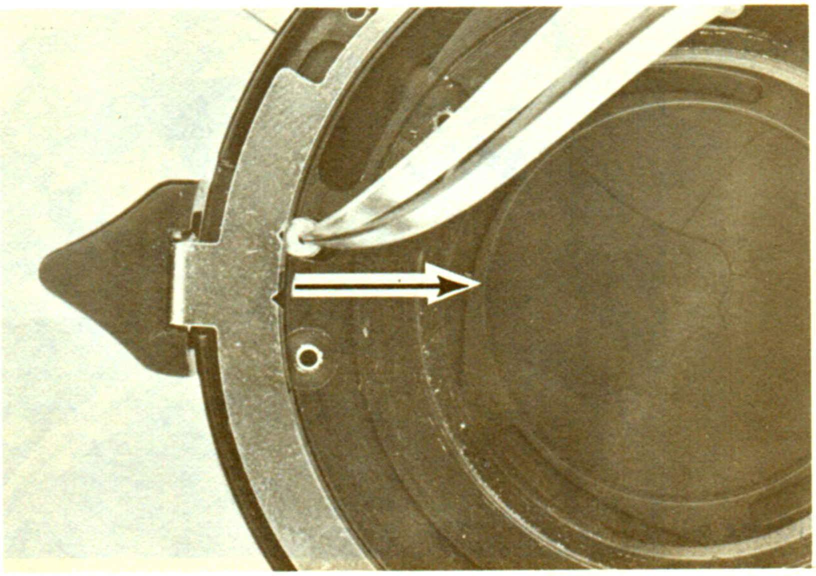
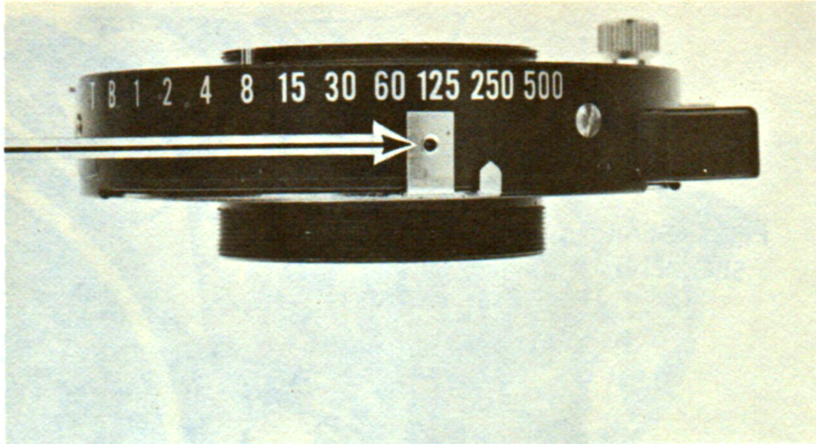
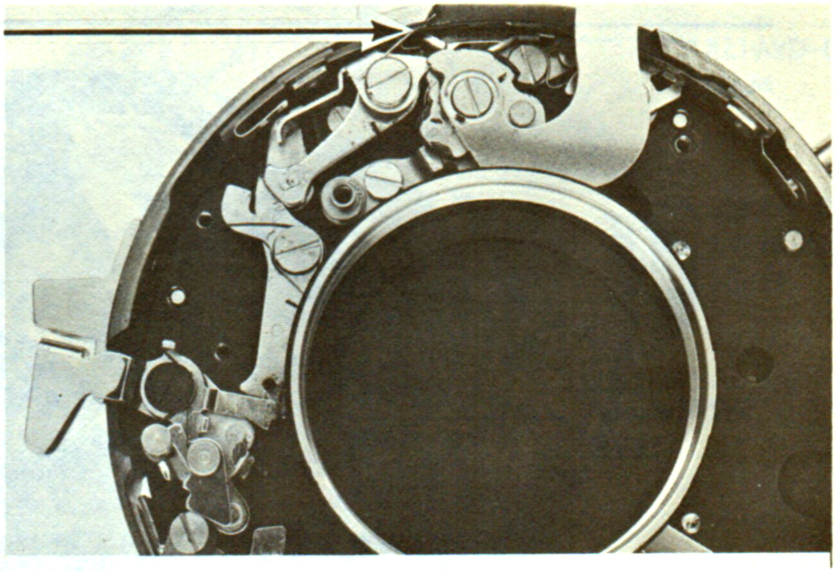


FIGURE 63



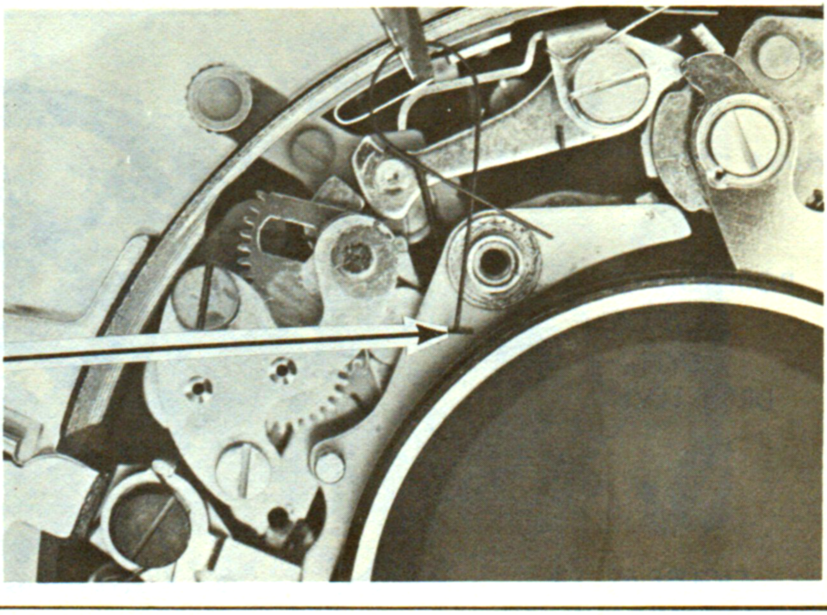
DIAPHRAGM-SETTING-RING TAB

FIGURE 64



MOVABLE M-SYNC CONTACT SPRING

FIGURE 65



HOOKED END OF BULB-LEVER SPRING

FIGURE 66

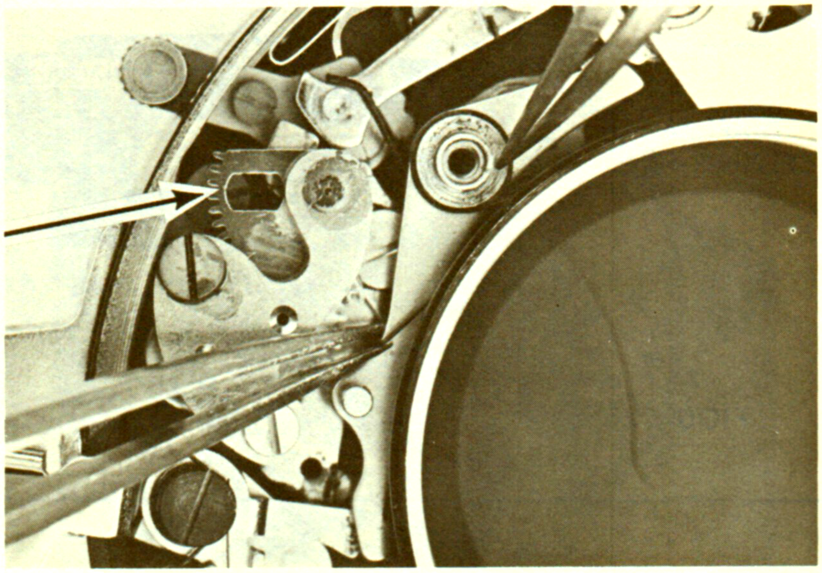


FIGURE 67

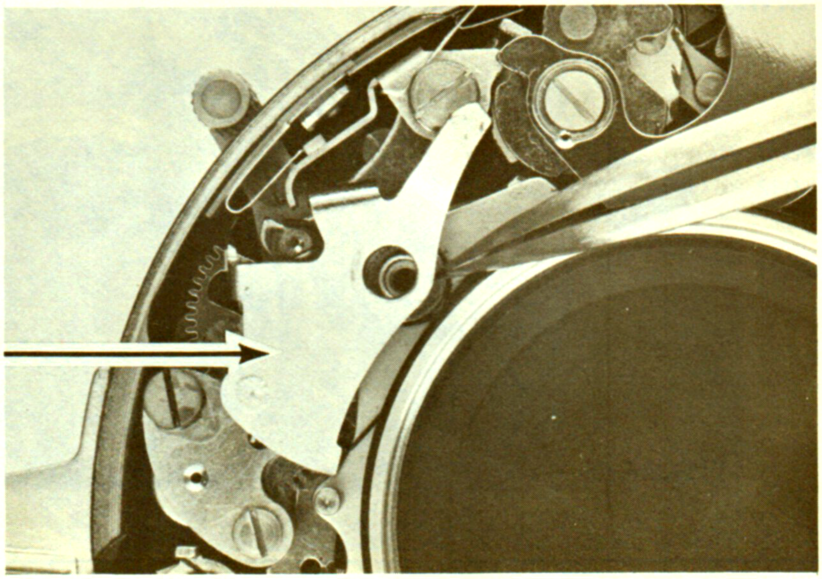


FIGURE 68

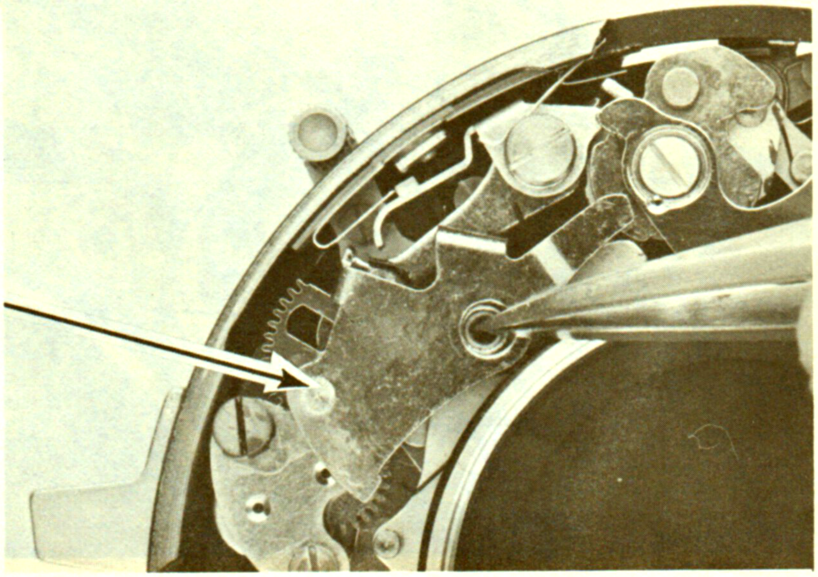


FIGURE 69

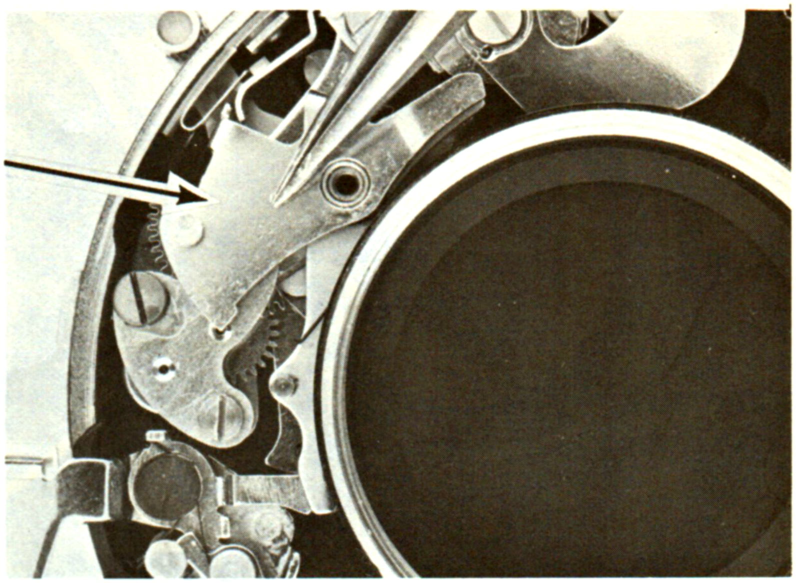


FIGURE 70

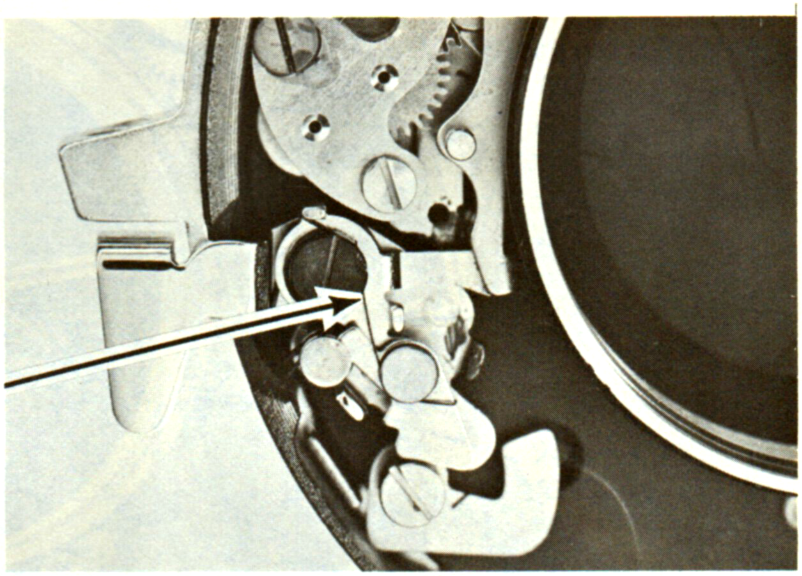


FIGURE 71

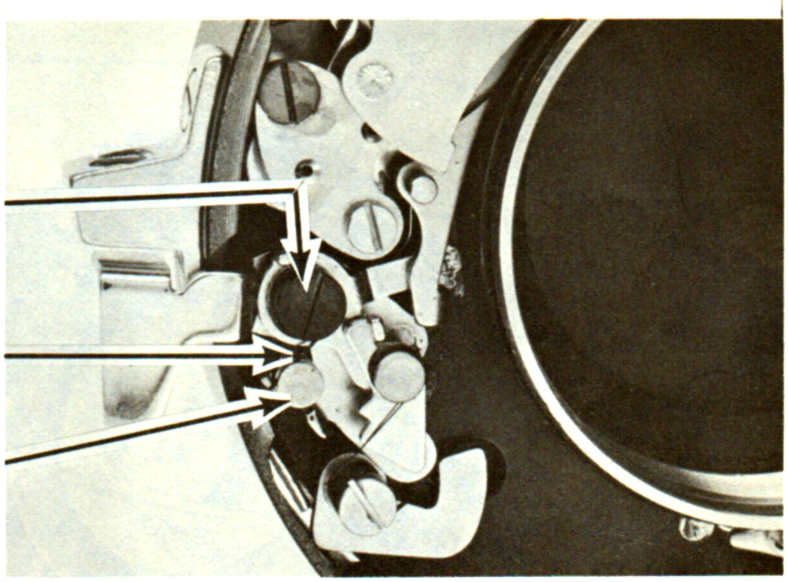


FIGURE 72

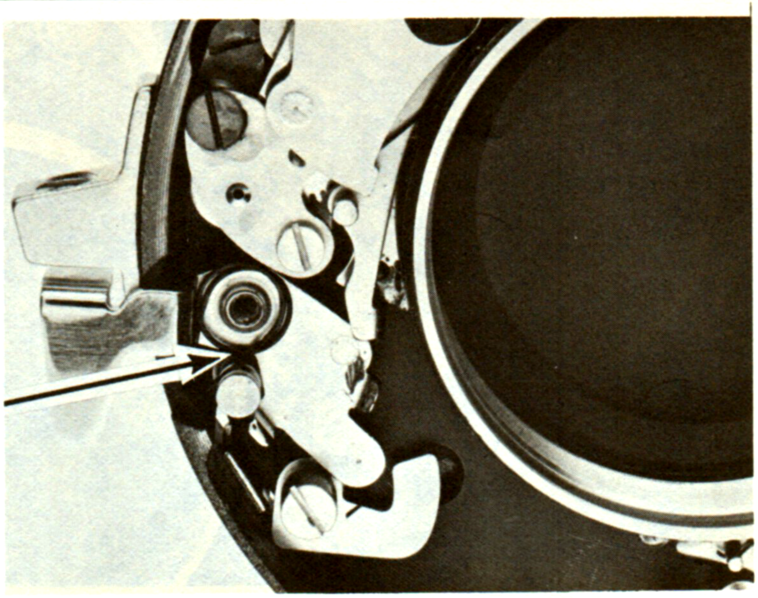


FIGURE 73

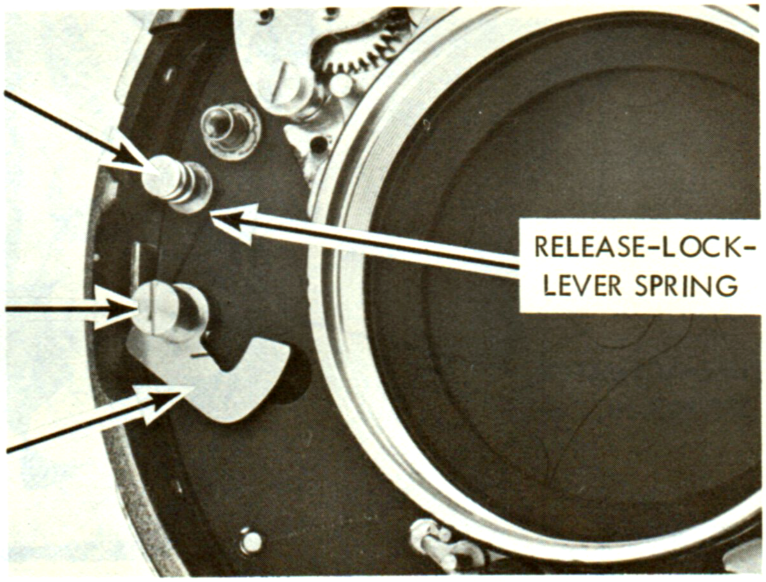


FIGURE 74

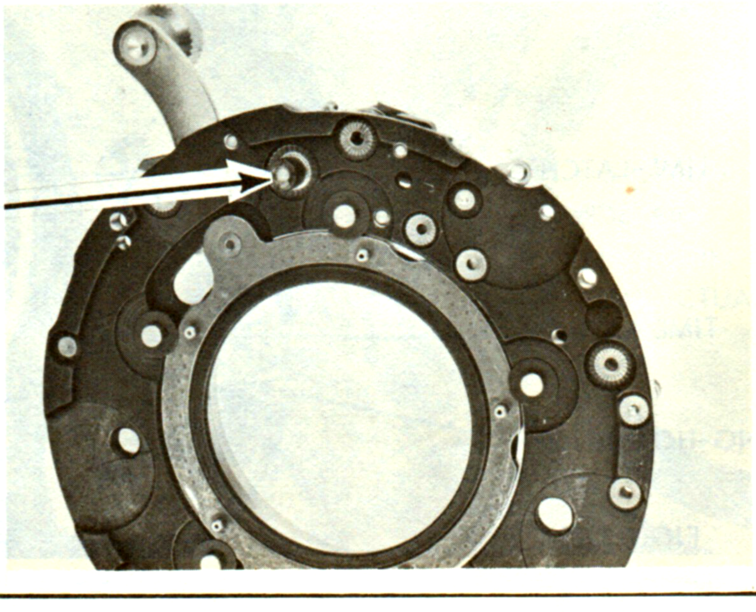


FIGURE 75

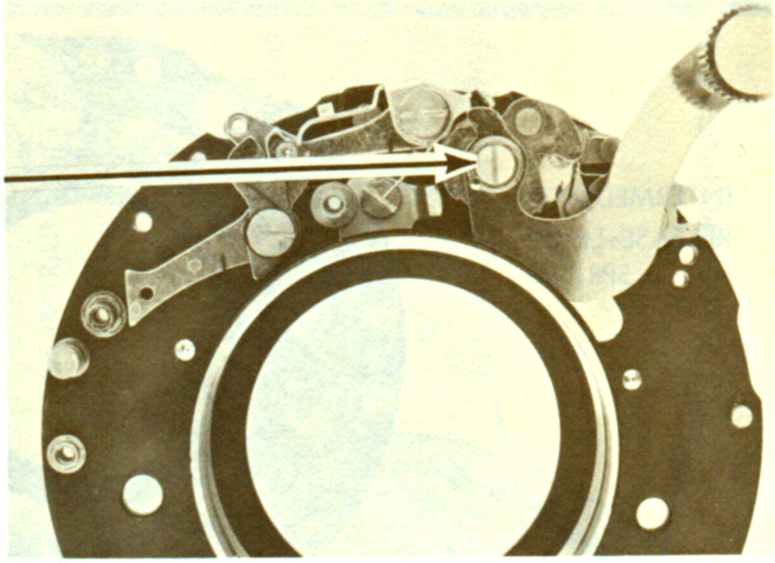


FIGURE 76

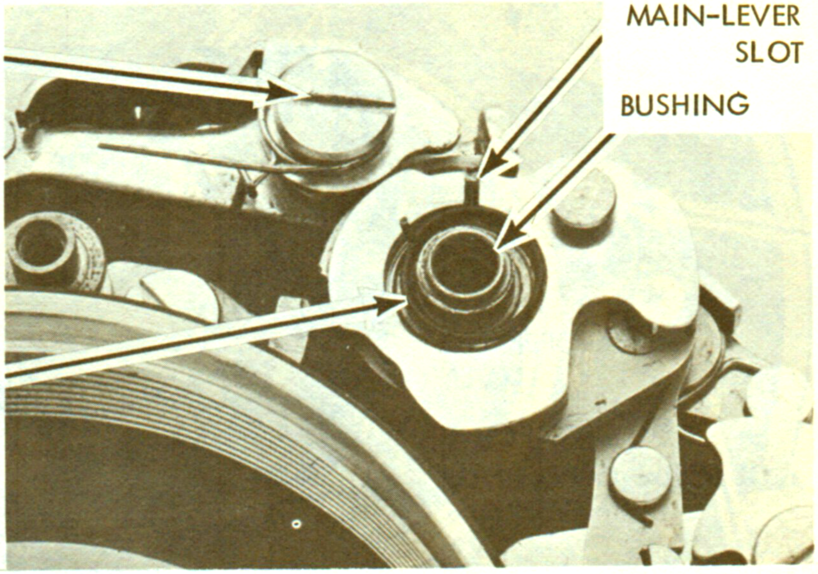


FIGURE 77

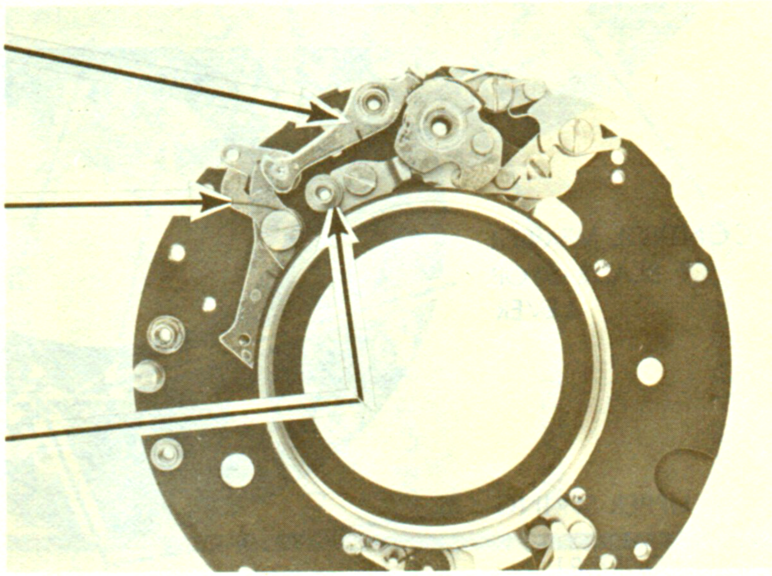


FIGURE 78

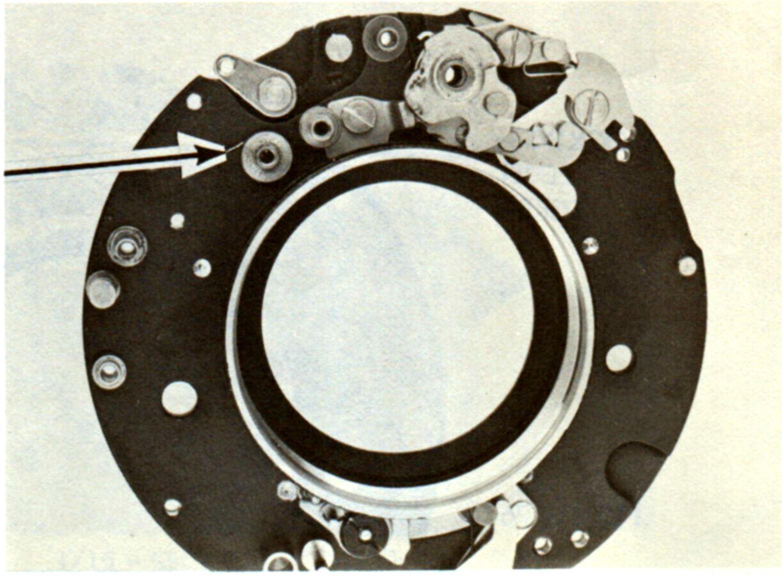
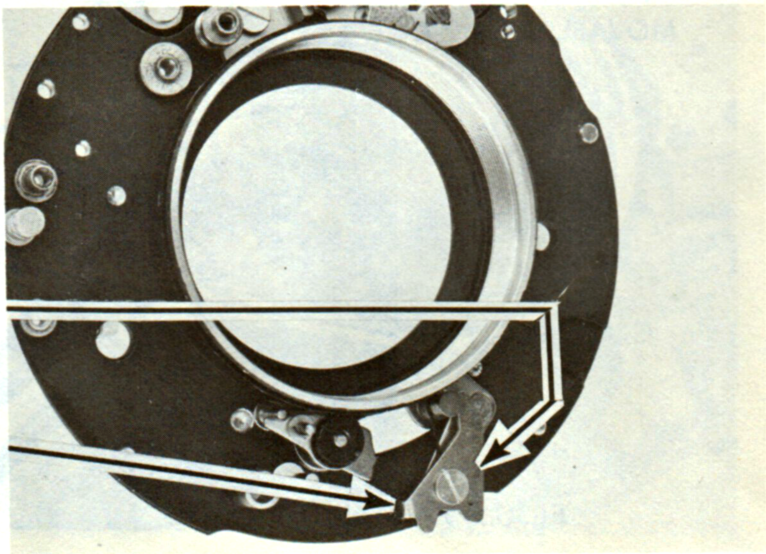
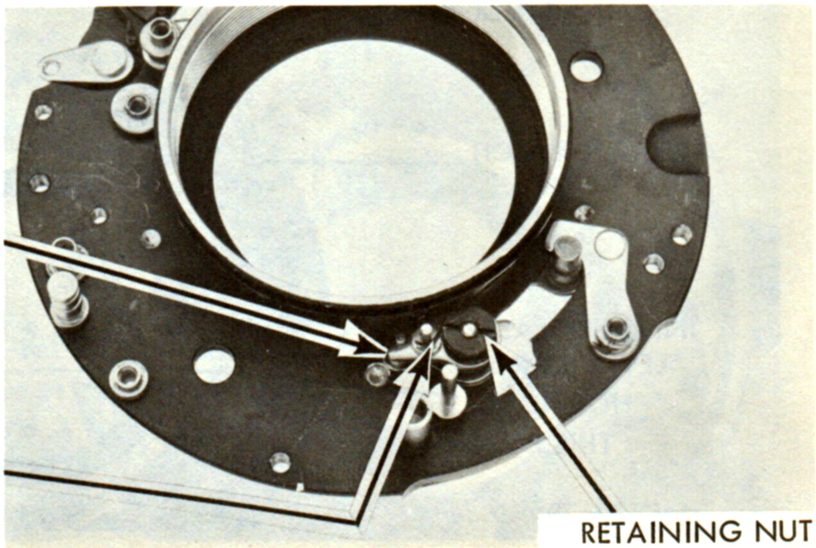

INTERMEDIATE-RELEASE-LEVER SPRING

FIGURE 79


BLADE-OPENING LEVER

HOOKING POINT OF BLADE-OPERATING-RING SPRING

FIGURE 80


CONTROL MEMBER OF BLADE-STOP LEVER

UPPER SPRING

RETAINING NUT

FIGURE 81

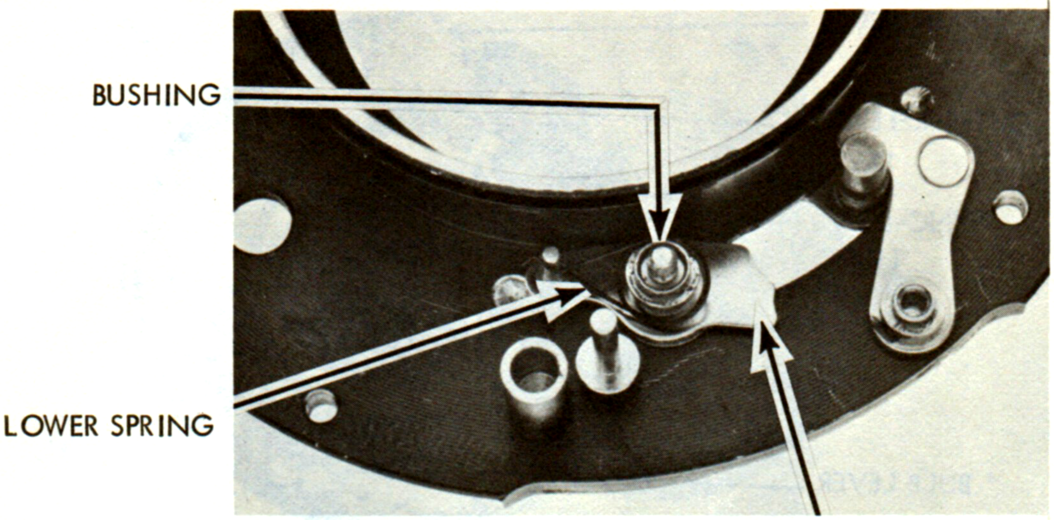


FIGURE 82

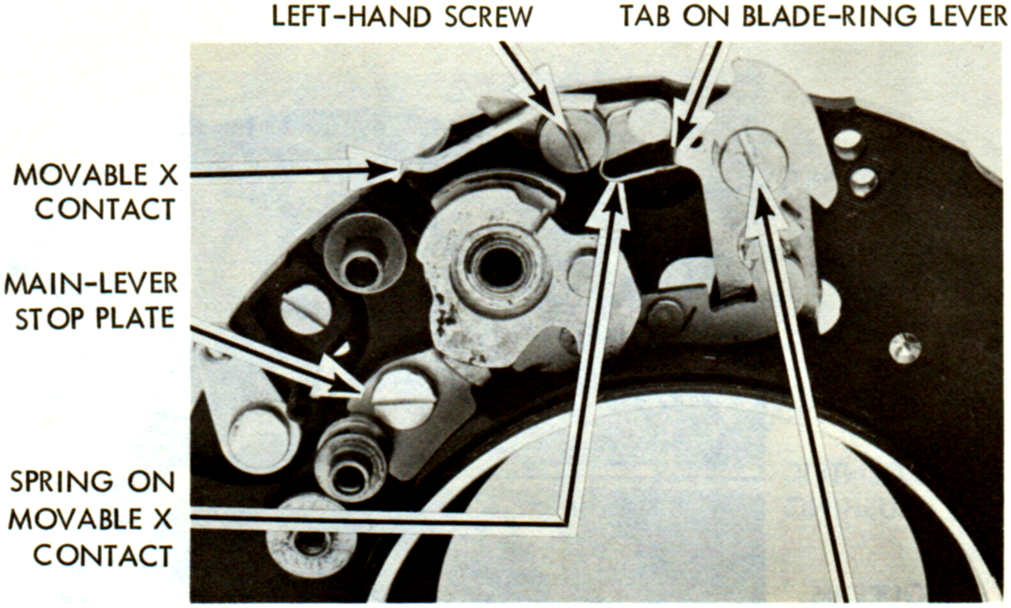


FIGURE 83

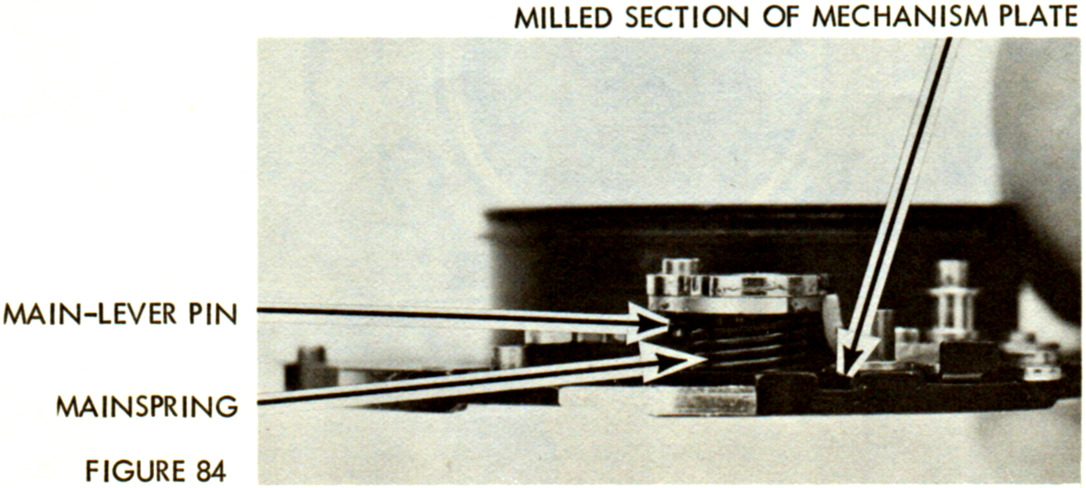


FIGURE 84

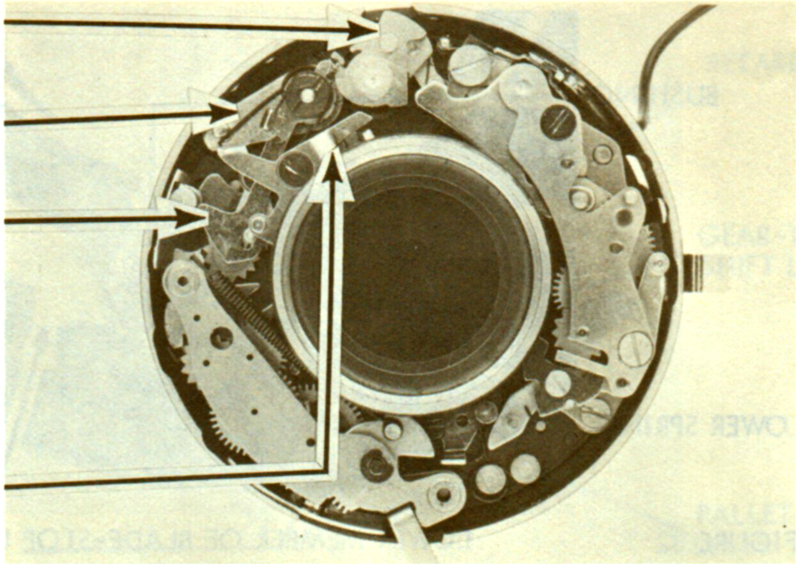


FIGURE 85 SHUTTER COCKED

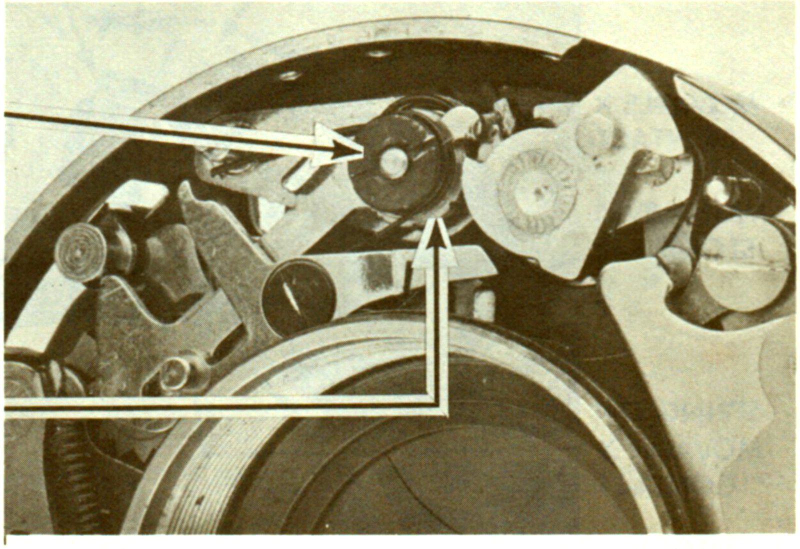


FIGURE 86