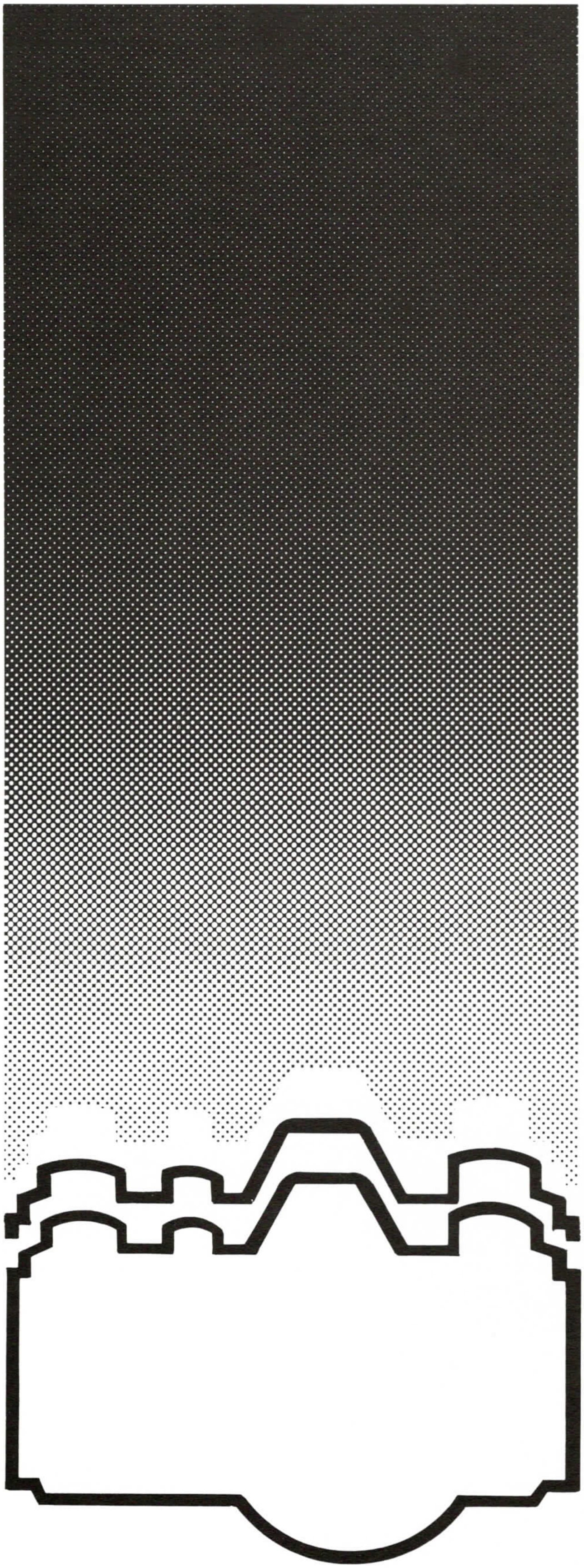
Camera Design Characteristics



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Camera Design Characteristics

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1074

National Camera, Inc.
Technical Training Division

35MM TRANSPORT SYSTEMS

You've already studied a typical camera-body mechanism for cocking the shutter. The camera-body mechanism has an additional duty -- it also advances the film. In 35mm cameras, the film-transport and film-metering systems follow some standard guidelines (they have to, since they all use the same film).

Fig. 1 shows a section of 35mm film. Notice that there are four perforations along each side of a single frame. By moving the film four perforations between each exposure, the camera brings a new area of film into position.

A **single-frame** (also called "half-frame") 35mm camera uses a section of film covering four perforation holes for each frame, Fig. 1. So does a 35mm motion-picture camera. But most 35mm still cameras use a **double-frame** (also called "full-frame") format. A double-frame format has eight perforations along each film frame.

Those film perforations make it convenient to accurately measure the film required for each exposure. So we'll first look at the typical film-transport, film-metering, and timing features of 35mm cameras.

NOTE; NORMALLY CALLED SINGLE FRAME OR HALF FRAME FORMAT

PERFORATIONS 4 EACH SIDE

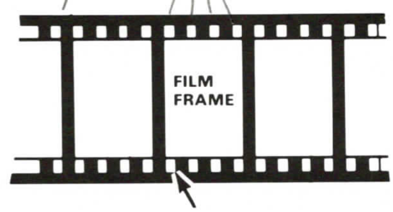

Figure 1

NOTE, MOST 35MM CAMERAS USE FULL FRAME OR DOUBLE FRAME FORMAT (USES 8 PERFORATIONS)

THE SPROCKET AND TAKE-UP SPOOL

At the back of the camera, locate the sprocket and the take-up spool, Fig. 2. One end of the film attaches to the take-up spool. And the film perforations engage the sprocket.

Both the sprocket and the take-up spool rotate as you advance the wind lever. The film then wraps around the take-up spool. The sprocket turns the same amount for each wind-lever stroke.

The sprocket then stops. A mechanical stop inside the camera determines that the sprocket has turned the right amount. So the film also stops. A new frame of film now sits in the focal-plane aperture.

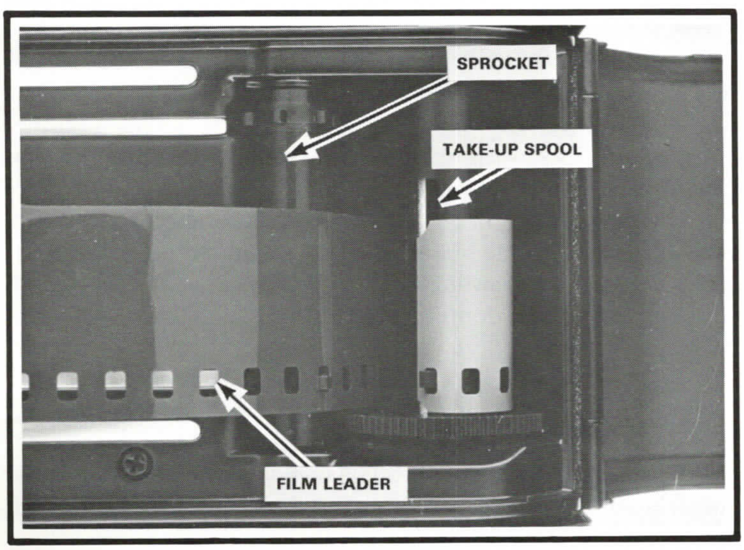

Figure 2

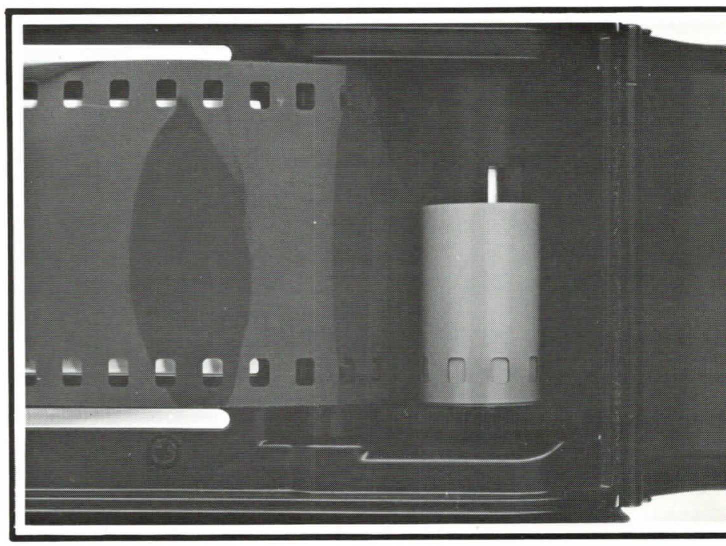
Figure 3

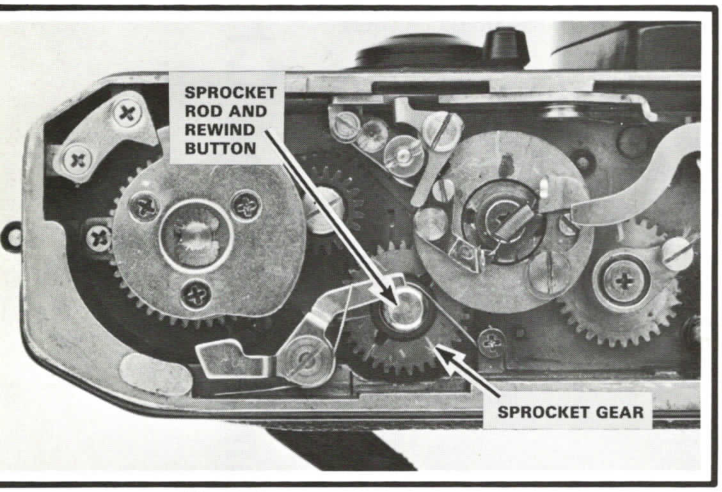

Figure 4

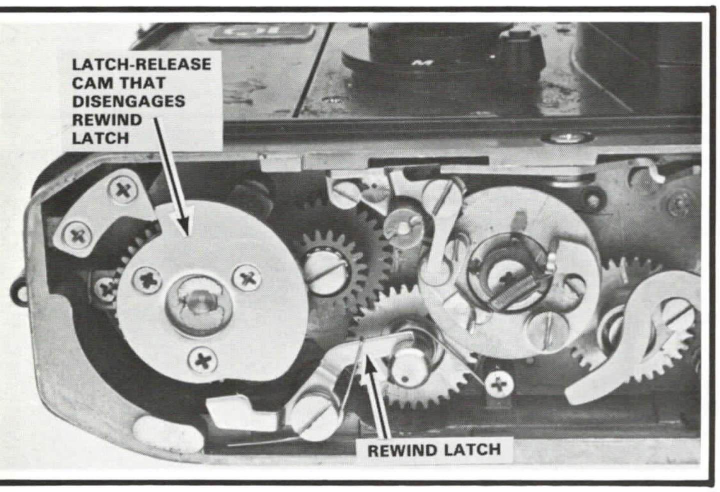

Figure 5

NOTE FILM TAKE-UP ON SIMPLER CAMERAS

It may seem that you wouldn't really need the sprocket. Why not just turn the take-up spool a fixed amount during the wind stroke? Some of the simpler 35mm cameras do indeed use such a system. But these cameras produce negatives which aren't evenly spaced along the roll.

Why? Because one turn of the take-up spool doesn't wind the film a constant amount. As the take-up spool turns, it winds on the film. And, as more and more film winds on, the diameter of the take-up spool increases.

Providing even spacing between the film frames requires a film-metering part in actual contact with the film. In some types of cameras, such as the cartridge-loads, the film-metering part simply senses how far the film has moved. When the film has advanced the right distance, the film-metering part signals an internal mechanism to block the wind lever. But in 35mm cameras, the film-metering part -- the sprocket -- actually advances the film a fixed amount.

NOTE

Again, the sprocket always turns the same distance -- it's geared directly to the wind mechanism. Yet, with film in the camera, the take-up spool rotates a different amount each time. So the take-up spool doesn't gear directly to the wind mechanism. Rather, a **slip spring** carries the take-up spool.

The slip spring always tries to turn the take-up spool with the wind shaft. However, if you hold the take-up spool, you can still advance the wind lever. The slip spring then "slips" around the wind shaft -- it allows the wind shaft to move even though the take-up spool stays put.

There's one other characteristic of the 35mm film-transport system -- pushing the rewind button disengages the sprocket. Then, the sprocket turns freely as you rewind the film. And, thanks to the slip spring, the take-up spool can also turn in the rewind direction.

Notice the rod passing through the sprocket gear, Fig. 4. The **sprocket rod** couples the sprocket to the sprocket gear. In action, the transport mechanism turns the sprocket gear, the sprocket gear turns the sprocket rod, and the sprocket rod turns the sprocket.

NOTE

The lower end of the sprocket rod also serves as the rewind button. Pushing in the rewind button moves the sprocket rod toward the top of the camera -- that disengages the sprocket rod from the sprocket gear. Now, the sprocket can turn freely in either direction.

With most 35mm cameras, depressing the rewind button allows a spring-loaded latch to engage a notch in the sprocket rod, Fig. 5. The **rewind latch** then holds the sprocket rod disengaged. So you don't have to hold down the rewind button as you rewind the film.

Also, most 35mm cameras automatically disengage the rewind latch the next time you advance the wind lever. In Fig. 5, a cam attached to the wind shaft strikes the end of the rewind latch during the wind stroke. The cam then disengages the rewind latch. And a spring returns the sprocket rod to its normal position -- engaged with the sprocket gear.

Check the action by pushing in the rewind button -- make sure the sprocket turns freely in both directions. Then, advance the wind lever. The rewind button should disengage. And the sprocket should turn in only one direction -- the direction that advances the film.

TIMING POINT - NOTE

SPROCKET TIMING

You'll rarely have to disturb the timing of the sprocket. However, if you disengage the film-transport gears, you may lose the sprocket timing. So it's a good idea to note the sprocket position before you disturb any timing points.

The actual sprocket position may vary from camera to camera. But there's a general rule that applies to many 35mm cameras:

With the shutter fully cocked or fully released, a pair of sprocket teeth -- one tooth on top and one tooth on bottom -- should point directly to the back of the camera. Fig. 6 shows the typical timing. Notice that one upper sprocket tooth and one lower sprocket tooth point to the back of the camera.

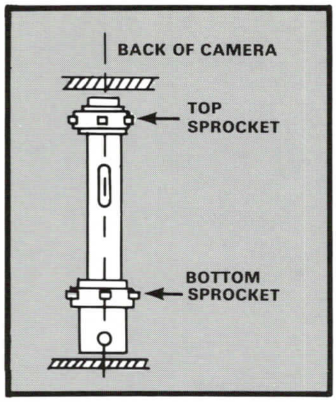

Figure 6

NOTE

The sprocket timing provides proper film registration. Once the film has been processed, the space between film frames should also be between sprocket holes, Fig. 1. Some types of slide mounts depend on the perforation holes for holding the film. In that case, the position of the sprocket holes with respect to the film frames may be important.

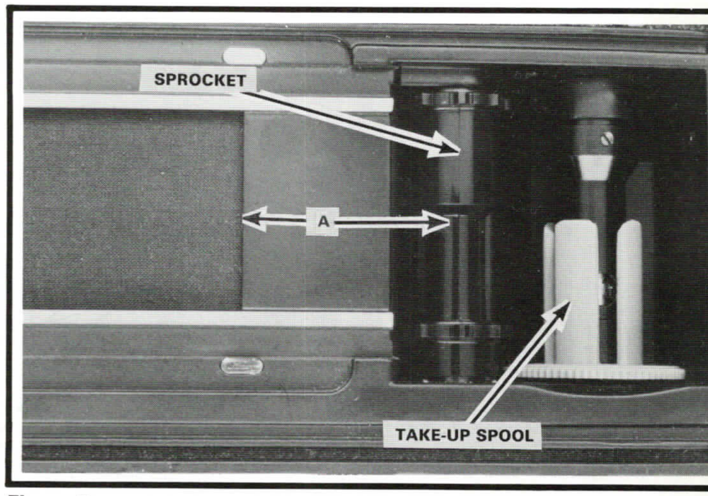

Figure 7

As with every general rule, though, you'll find exceptions -- especially with this rule. The proper position of the sprocket depends on distance "A" in Fig. 7; this distance varies in different cameras. That's why you should note the sprocket position before disassembling the transport gears. Also, it helps to scribe gear positions before disturbing the timing. Scribing gears can be a most valuable time-saver on reassembly.

MARK GEAR TIMING

USE SCRIBE LINES

WHEN TO SCRIBE

How do you know when to scribe a gear? You can often tell by the gear's function -- and by the gear's shape.

Whenever a gear has a special lug or projection, you can be certain the timing is critical. For example, consider the gear shown in Fig. 8. The post on top of the gear tells you that the gear's timing is critical. Don't disengage the gear until you note its timing. And the easiest, fastest way to note gear timing is to use scribe lines.

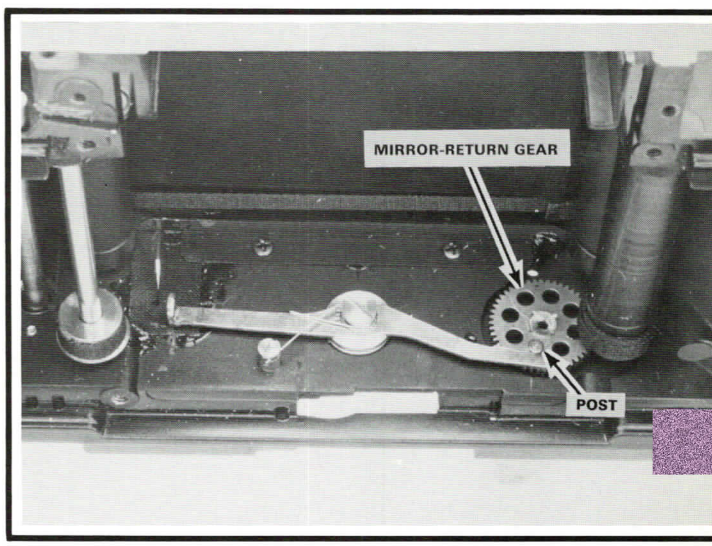

Figure 8

NOTE; SHUTTER COCKED OR RELEASED?

How can you scribe the gear shown in Fig. 8? Just make two scribe lines -- one on the gear and one on the bottom of the camera's body casting. When you replace the gear, align your scribe marks.

But there's one other consideration -- did you scribe the gear with the shutter cocked or with the shutter released? If the gear is part of the transport or shutter mechanism, you must be careful. The gear shown in Fig. 8 doesn't make a full revolution when you cock the shutter.

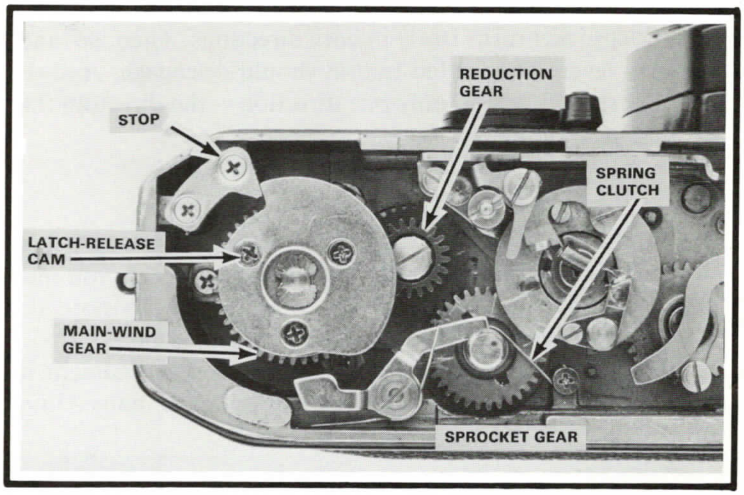

Figure 9

In many cases, it doesn't matter whether the shutter is cocked or released. But in other cases, it makes a big difference. So, if you're in doubt, make a note -- note whether the shutter was cocked or released when you made your scribe.

A sprocket gear, Fig. 9, does make a full revolution during the cocking cycle. Consequently, you can scribe the gear in either the shutter-cocked or the shutter-released position.

It's not always necessary to scribe gear timing; sometimes, the position of the gear makes no difference. A gear that's symmetrical in shape often has no timing considerations. Still, you can save yourself a lot of trouble if you follow a basic rule:

NOTE

When in doubt, scribe.

TEST-YOURSELF QUIZ #1

1. What part assures that the film advances the same amount for each wind-lever stroke? SPROCKET ________.

2. As the film wraps around the take-up spool, the diameter of the take-up spool increases. Consequently, the amount that the take-up spool must turn is different with each wind stroke. What allows the take-up spool to turn different amounts as the film advances? SLIP SPRING ON THE TAKEUP SPOOL ________.

3. Pushing in the rewind button disengages the

   A. sprocket

   B. take-up spool

4. Proper film registration is provided by the timing of the

   A. sprocket

   B. take-up spool

A TYPICAL TRANSPORT SYSTEM

You've seen what's necessary for transporting and metering 35mm film. Now, we can look at the disassembly, adjustments, and timing in a typical system. The camera we used earlier as a representative, Fig. 9, also provides a good example here.

Remember the function of the latch-release cam, Fig. 9 --it disengages the rewind latch as you start advancing the wind lever. But the latch-release cam serves a second purpose. When you allow the wind lever to return, the latch-release cam comes against the stop shown in Fig. 9. The stop holds the wind shaft in the proper position for the next cocking cycle.

The latch-release cam attaches to the bottom of the wind shaft. Since the wind lever attaches to the upper end of the wind shaft, the latch-release cam always turns with the wind lever -- clockwise during the winding stroke and counterclockwise as you allow the wind lever to return to its rest position.

During the wind stroke, the main-wind gear also turns clockwise. You can just see the teeth of the main-wind gear under the latch-release cam, Fig. 9. But the main-wind gear doesn't attach directly to the wind shaft. Rather, a **one-way clutch** (under the latch-release cam) turns the main-wind gear clockwise.

NOTE 1-WAY CLUTCH.

Why the one-way clutch? Because the main-wind gear turns only in the clockwise direction. The one-way clutch allows the wind shaft to return in a clockwise direction without moving the main-wind gear. A little later in this text, we'll examine different types of one-way clutches.

WIND SHAFT FUNCTION

The main-wind gear engages the upper section of the two-piece **reduction gear,** Fig. 9. And the lower section of the two-piece reduction gear engages the sprocket gear. So, during the wind stroke, the two-piece reduction gear turns counterclockwise. That motion drives the sprocket gear in a clockwise direction.

GEAR REDUCTION

A two-piece gear such as the one shown in Fig. 9 transfers a certain amount of rotation to a different amount of rotation. The end result -- the sprocket gear turns one full turn. And the sprocket gear drives the sprocket one full turn.

The lower section of the two-piece reduction gear also drives the take-up spool. You can't as yet see the take-up spool gear -- it's underneath the main-wind gear. But the take-up spool gear also turns one full turn during the cocking cycle.

NOTE

However, the take-up spool doesn't attach directly to the take-up spool gear. As you'll recall, the take-up spool turns different amounts according to how much film has been advanced. Yet the take-up spool gear always turns one turn.

Fig. 10 shows how the take-up spool works. Here, we've removed the take-up spool shaft (the take-up spool gear is part of the shaft) and the take-up spool. The take-up spool seats over the slip-spring collar, Fig. 10. Two tabs on the slip-spring collar engage two slots on the bottom of the take-up spool.

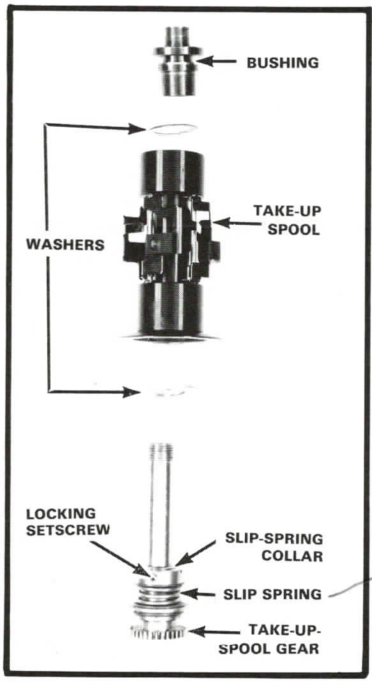

Figure 10

CANON "QUICK LOAD" QL

SLIP SPRING ALLOWS-REVERSE MOVEMENT ALSO (FILM REWIND)

The slip-spring collar turns with the shaft of the take-up spool. However, the two parts aren't directly connected. Rather, the slip spring, Fig. 10, applies downward pressure on the slip-spring collar. That downward pressure tends to hold the slip-spring collar against a shoulder on the take-up spool shaft.

So, if you hold the take-up-spool shaft, you can still turn the slip-spring collar. The slip-spring collar then ''slips'' on the shoulder of the take-up-spool shaft.

SLIP SPRING ADJ. NOTE

How easily does the slip-spring collar turn? It depends on the pressure applied by the slip spring. The more pressure the slip spring applies, the more difficult it is for the slip-spring collar to turn. Most 35mm cameras provide an adjustment for the amount of slip-spring pressure.

In Fig. 10, the adjustment collar provides the adjustment point. The adjustment collar screws onto the take-up-spool shaft. After loosening the locking setscrew, Fig. 10, you can turn the adjustment collar in either direction. Turning the adjustment collar in a clockwise direction (as seen from the top) screws the adjustment collar further onto the take-up-spool shaft. And that increases the pressure applied by the slip spring.

SERVICE NOTE

CUSTOMER PROBLEM

If there's too little slip-spring pressure, the film may not wrap properly around the take-up spool. And if there's too much pressure, the take-up spool may not slip as its diameter increases. In that case, the take-up spool attempts to keep advancing the film after the sprocket has stopped. The sprocket may then tear the film along the perforation holes.

How much pressure should the take-up spool have? Factory service manuals often specify the proper torque -- how much pressure should cause the take-up spool to turn. However, it's nearly impossible to measure this torque without special gages.

ADJ. PROCEDURE

But you can check the slip spring by feel. Hold the take-up spool with your finger as you advance the wind lever. Or, cock the shutter and then turn the take-up spool with your thumb. The take-up spool should turn, smoothly but with noticeable resistance.

Try this test on the cameras you encounter -- you'll then get an idea as to the proper ''feel.'' Chances are the slip-spring adjustments will be correct; it's rare to have a problem in the slip-spring mechanism (that's fortunate, because reaching the slip-spring adjustment normally requires quite a bit of disassembly).

TEST-YOURSELF QUIZ #2

1. You're about to remove a gear from the transport mechanism. You note that the gear has a pin on its top surface. Is the timing of this gear critical? YES

2. Consider that you're about to remove a gear, and you aren't sure whether or not the timing is critical. What technique can you use to assure that you replace the gear in the same position? SCRIBE GEAR + BODY CASTING

3. The main transport-wind gear in a transport mechanism normally doesn't connect directly to the wind shaft. Rather, a ONE-WAY CLUTCH connects the wind shaft to the first gear of the transport system.

4. Suppose that a customer brings in a 35mm camera with this complaint: "The camera tears the film." What part would you check first? TENSION OF SLIP SPRING ON THE TAKE UP SPOOL

ONE-WAY CLUTCHES

Earlier, we mentioned an application for a one-way clutch (allowing the wind lever to return to the ready position). You'll encounter several types of one-way clutches in transport systems. But they all do the same thing -- they allow free rotation in one turning direction while blocking rotation in the opposite turning direction.

For example, consider again the camera shown in Fig. 9. This camera uses a focal-plane shutter with horizontally traveling curtains. As you cock the shutter, you're pulling the shutter curtains against their spring tensions.

IMPORTANT

The curtains latch in the fully cocked position. But what if you let go of the wind lever part way through the wind cycle --before the curtains have latched? The curtains then try to return to their rest positions. And that turns the entire transport gear train in the wrong direction.

So the transport system includes a one-way clutch. The one-way clutch allows the transport gears to turn freely in the shutter-cocking direction. Yet it prevents the gears from turning in the opposite direction.

Our example camera in Fig. 9 uses the simplest type of one-way clutch -- a **spring-type clutch.** The spring seated over the sprocket rod, Fig. 9, provides the clutching action. As you advance the wind lever, the sprocket rod turns within the clutch spring. Turning in a clockwise direction -- the direction that advances the film -- the sprocket rod rotates freely. The one-way clutch spring has no effect.

SPRING TYPE
1 WAY CLUTCH

But the clutch spring won't allow the sprocket rod to turn in a counterclockwise direction. Suppose that you release the wind lever before the shutter's fully cocked. The curtains then try to pull the transport gears in the wrong direction. When the sprocket rod tries to turn counterclockwise, the clutch spring goes to work -- it tightens on the sprocket rod, preventing reverse rotation.

You can check the operation of the clutch spring by simply watching the action. Partially cock the shutter. Then, let go of the wind lever. The sprocket gear should turn slightly in a counterclockwise direction. But it should then stop as the clutch spring seizes the sprocket rod.

RATCHET CLUTCH

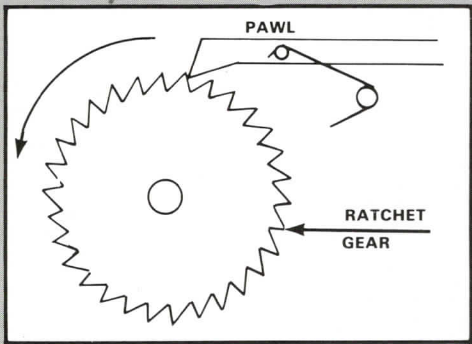

Figure 11

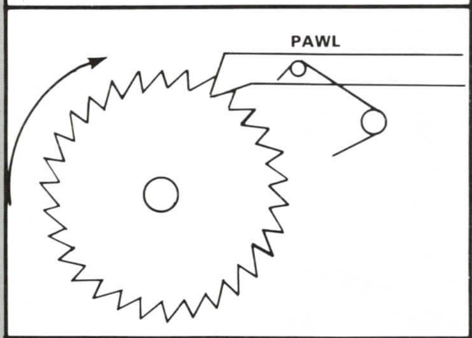

Figure 12

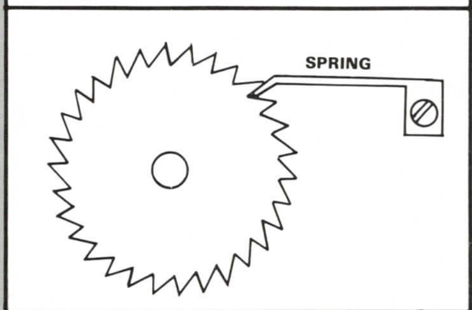

Figure 13

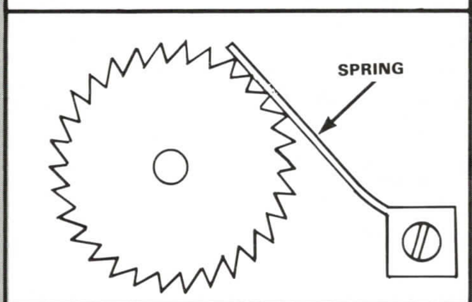

Figure 14

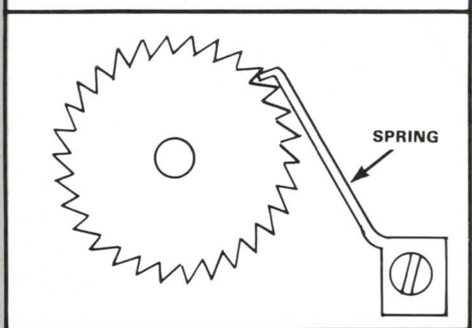

Figure 15

CUSTOMER COMPLAINT?

What if the clutch spring is defective? Then, the curtains may return completely -- all the way to their rest positions. By advancing the wind lever in short strokes, it's possible you'd never get the shutter cocked -- the curtains would return each time you allowed the wind lever to return.

The solution? Replace the clutch spring. It's very difficult -- and time-consuming -- to reform the worn spring properly. You may encounter a similar problem if someone has oiled the clutch spring. A technician may try to cure a rough wind stroke by placing a drop of oil inside the spring coils. That oil may help smooth the wind stroke. But it may also defeat the purpose of the one-way clutch.

IMPORTANT NOTE

As a general rule, never lubricate a one-way clutch.

Another type of one-way clutch -- the **ratchet clutch** -- provides a more positive action. Fig. 11 shows a typical design. The ratchet gear turns as you cock the shutter. And the spring-loaded pawl rides against the ratchet-gear teeth.

As the ratchet gear turns counterclockwise, the pawl rides against the sloped sides of the teeth. The sloped sides simply push the pawl out of the way. So the ratchet gear turns freely in a counterclockwise direction.

Fig. 12 shows what happens when the ratchet gear tries to turn in the opposite direction. Here, the straight side of a tooth comes against the pawl. And the pawl prevents the ratchet gear from turning any further.

The ratchet clutch shown in Fig. 12 rarely presents a problem. If the clutch fails, you'll normally spot the problem immediately -- it's most likely a broken, weak, or disconnected pawl spring. Excessive wear on the pawl or the ratchet teeth could also allow reverse rotation.

SERVICE NOTE

But some of the simplified versions of the ratchet clutch can be frequent problems. In Fig. 13, the "pawl" is simply a spring which rides against the ratchet gear. Here, it's not uncommon for the end of the spring to break. The ratchet gear can then turn in the reverse direction, causing the same malfunction we described earlier.

Fig. 14 shows a simpler version yet -- a type of clutch sometimes used in inexpensive cameras. Notice that the side of the spring (rather than the tip of the spring) rides against the ratchet gear. If the spring doesn't place enough pressure against the ratchet gear, the one-way clutch will fail. That's a common problem caused by spring fatigue.

PROBLEM SOLVER

Some technicians simply reform the spring to increase its pressure. That works fine for a while. But the problem may reappear in a short time. So other technicians reform the spring as shown in Fig. 15. Here, the tip of the spring actually engages the ratchet teeth for a more positive action.

You'll find many versions of the ratchet clutch used in transport systems. But there's another common application for this type of clutch -- in the counter mechanism. Here, the ratchet gear turns one tooth as you advance the wind lever. The counter dial then advances to the next film-frame calibration. And a pawl drops into engagement, preventing the spring-loaded ratchet gear from returning.

In a typical counter mechanism, Fig. 16, the counter dial mounts to the top of the ratchet gear (we've removed the counter dial in Fig. 16). Notice the two pawls in Fig. 16 -- the **advance pawl** and the **latching pawl.** A spring-loaded counter-return lever engages the advance pawl.

The counter-return lever extends through a slot in the camera body. One end of the counter-return lever engages the camera back. Opening the camera back allows the counter-return lever to move away from the counter dial, Fig. 17. The counter-return lever then pulls the two pawls away from the ratchet gear. That allows the spring-loaded ratchet gear to rotate counterclockwise, returning the counter dial to its starting position.

Closing the camera back allows the two pawls to engage the ratchet gear, Fig. 16. The camera back pushes the counter-return lever toward the counter mechanism. Both pawls then engage the ratchet gear.

As you now advance the wind lever, the advance pawl moves the ratchet gear one tooth in a clockwise direction. And the latching pawl drops into engagement with the next gear tooth to hold the ratchet gear.

So the ratchet gear advances one tooth at a time. But there's one tooth missing in the ratchet gear. When the counter dial reaches its last film-frame calibration, the cutaway section of the ratchet gear faces the advance pawl. Consequently, the advance pawl can't turn the ratchet gear as you cock the shutter.

NOTE

We've described one-way clutches used in transport systems and in counter mechanisms. How about that one-way clutch which allows the wind lever to return? Here again, you'll frequently encounter ratchet clutches. However, quality cameras often use **roller clutches** for their satin-smooth operation.

The roller clutch for the camera shown in Fig. 9 sits under the latch-release cam. In Fig. 18, we've removed the latch-release cam to show the roller clutch.

The three-lobed cam, Fig. 18, is part of the wind shaft. So the wind-shaft cam always turns with the wind lever -- both directions. But the main wind gear simply fits around the wind shaft; there's no direct connection. That's because the main wind gear must only turn as you advance the wind lever. It must not rotate in the reverse direction as the wind lever returns.

Notice that each cutout in the wind-shaft cam, Fig. 18, contains a roller. And each of the three rollers has its own compression spring. The compression springs push the rollers toward the narrower ends of the cam slots.

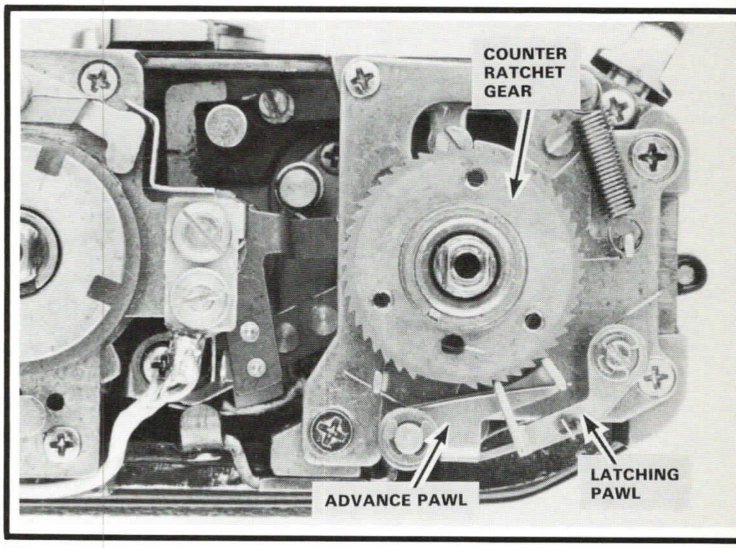

Figure 16 Canon FTb

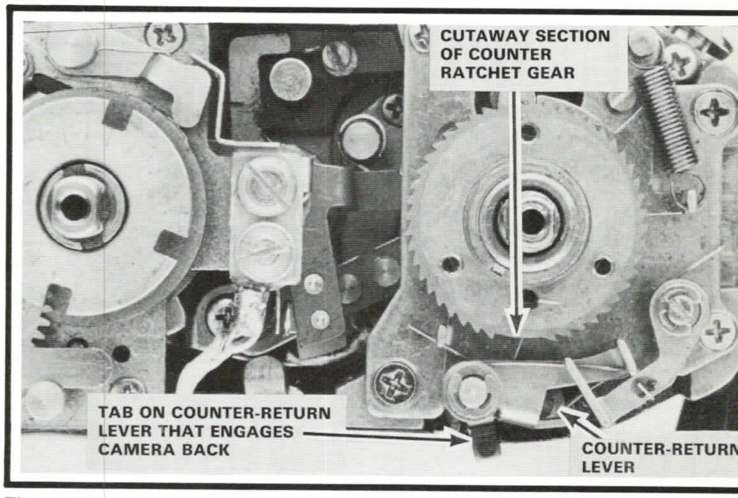

Figure 17

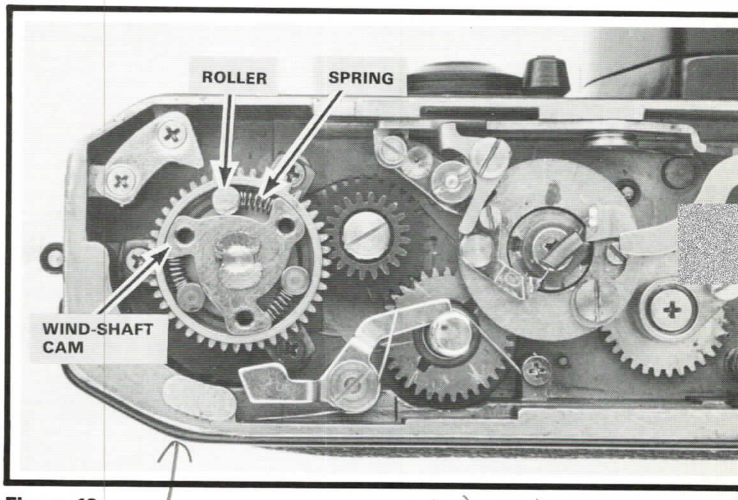

Figure 18

ROLLER CLUTCH

USED IN HIGH QUALITY CAMERAS

As you advance the wind lever, the wind-shaft cam turns clockwise, Fig. 18. Turning clockwise, the narrower ends of the cam slots tend to wedge the rollers against the main wind gear. Consequently, the rollers carry the main wind gear in the same direction.

The wind shaft turns in a counterclockwise direction when you allow the wind lever to return. But the main wind gear can't turn counterclockwise -- the clutch spring on the sprocket rod prevents reverse rotation. Still, the roller clutch permits the counterclockwise rotation of the wind shaft.

Why? As the wind-shaft cam turns counterclockwise, the narrower ends of the slots no longer force the rollers against the main wind gear. The narrower ends of the slots are now moving away from the rollers. The rollers then "roll" along the inside surface of the main wind gear.

SERVICE NOTE

The roller clutch is exceptionally reliable -- it has to be extremely dirty before it'll fail. But roller clutches do cause problems in disassembly. Once you've removed the cover over the roller clutch, those springs and rollers like to pop out --especially if you try operating the mechanism without the cover. It's no great task to reassemble the roller clutch. Yet it can be quite a task to find the springs and rollers.

So, whenever you're working around the wind shaft, keep in mind that you may uncover a roller clutch. If you do, remove the springs and rollers (before they decide to remove themselves). For reassembly reference, note that the compression springs fit between the flat surfaces of the wind-shaft cam and the rollers. And the springs push the rollers toward the narrower ends of the cam slots.

In fact, with any type of one-way clutch, you can quickly decide the proper method of assembly -- just recognize the type of clutch, the direction of motion desired, and other factors which are individually simple. Let's review the three types of clutches we've discussed:

1. In the spring-type clutch, the shaft tends to tighten the spring upon itself when turned in one direction -- and loosens the spring when turned in the opposite direction.
2. In the ratchet-type clutch, the spring pawl will pass freely over the ratchet teeth in one direction --but it will jam in the teeth in the other direction.
3. In the roller-type clutch, the shaft will turn freely within the clutch when the shaft moves the rollers toward the wide ends of the recesses. But when the shaft rotation forces the rollers to the narrow ends of the recesses, the rollers will bind. So both the shaft and the gear or disc driven by the clutch must turn together.

SERVICE NOTES

REPLACING THE SPROCKET AND TAKE-UP SPOOL

It's not uncommon to have to replace a sprocket or take-up spool. These parts are usually plastic. And they do sometimes break.

Replacing either part can be an easy repair. But it can also be a time-consuming repair. Depending on the particular camera, quite a bit of disassembly may be required to remove either the take-up spool or the sprocket.

As you study complete cameras, you'll see some specific procedures. So in this text, we'll stick to general principles you can apply to most 35mm cameras.

REMOVING THE SPROCKET

Sprocket-drive mechanisms are usually quite similar. So once you remove one sprocket, you'll pretty well know the procedure for other 35mm cameras. The variations are in how many parts you must remove to reach the sprocket **support bushing,** Fig. 19.

The support bushing serves as a pivot for the upper end of the sprocket. And it provides a bearing for the sprocket rod. In most cases, you must remove the support bushing before you can take out the sprocket. The support bushing simply screws into the body casting. In the camera illustrated, you can reach the support bushing once you pull the top cover. Unfortunately, it's not always so easy. You often have to remove several parts covering the support bushing.

SERVICE NOTES

To remove the sprocket, first take out the sprocket rod. Normally, a long screw passes through the sprocket rod, Fig. 20. A slot in the bottom of the sprocket fits over the screwhead.

So turn the sprocket until you can see the screwhead. Then, remove the screw and lift out the sprocket rod, Fig. 21. There's usually a compression spring inside the sprocket that pushes down the sprocket rod. The spring may stay in place or it may be loose at some state of the disassembly, depending on the design.

With the sprocket rod removed, the sprocket seems free. But you'll have to unscrew the support bushing, Fig. 19, before there's enough clearance to remove the sprocket. Then, lift out the sprocket from the back of the camera. That's all there is to replacing a sprocket.

All this disassembly has no effect on the sprocket timing. As yet, you haven't disturbed the timing of the sprocket gear.

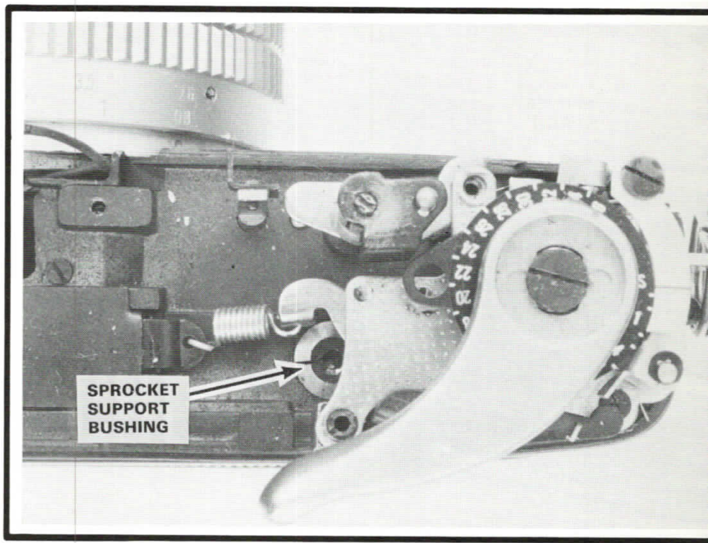

Figure 19

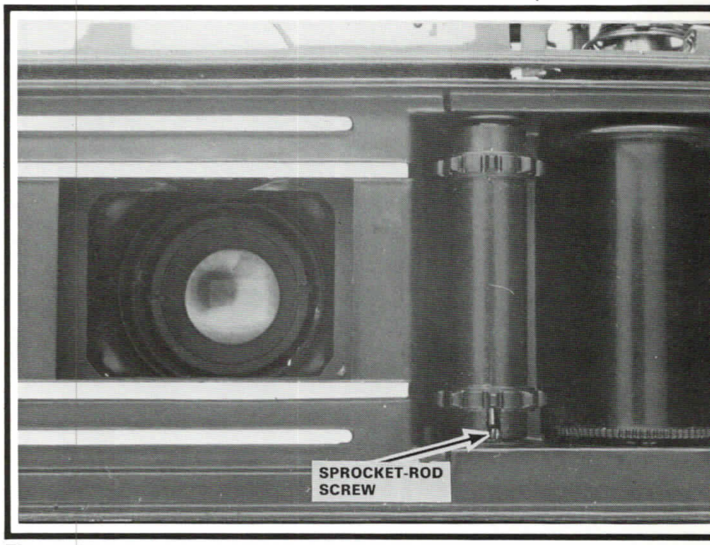

Figure 20

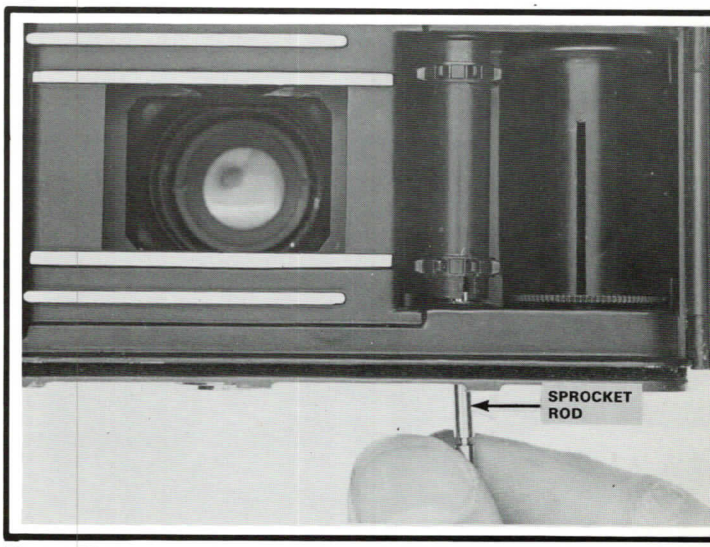

Figure 21

OPERATION OF SPROCKET + ROD FIG 22-23-24 SHOWING REWIND MODE

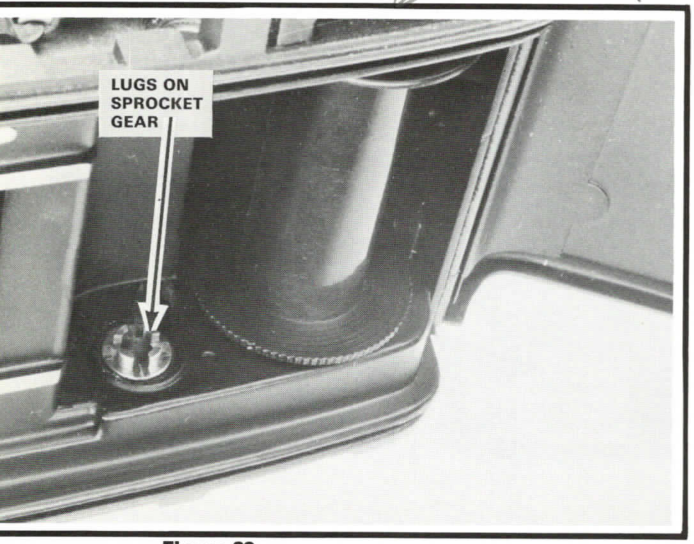

Figure 22

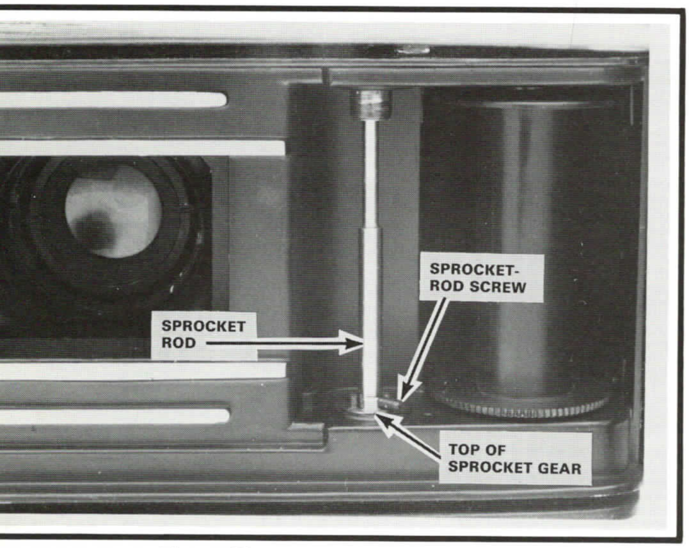

Figure 23

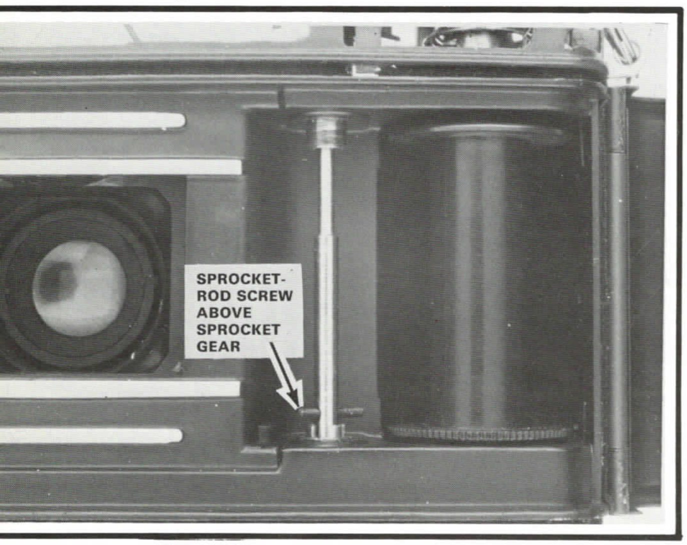

Figure 24

You can see the top of the sprocket gear in Fig. 22. Notice the four slots. The screw passing through the sprocket rod fits through a pair of these slots.

In Fig. 23, we've replaced the sprocket rod without the sprocket. Here, you can see how the sprocket rod couples to the sprocket gear. Since the screw engages the slots, turning the sprocket gear also turns the sprocket rod. And the sprocket rod turns the sprocket -- remember, the screwhead engages a slot at the bottom of the sprocket, Fig. 20.

OPERATIONAL INFO

Pushing in the sprocket rod to rewind the film moves the screw up and out of the sprocket-gear slots, Fig. 24. Now, the sprocket rod and the sprocket gear can turn in either direction. The rewind latch, you'll recall engages a slot in the sprocket rod. So the sprocket rod stays in the raised position.

As you start advancing the wind lever, though, the rewind latch disengages. The compression spring inside the sprocket then pushes down the sprocket rod. And the screw once again engages the sprocket-gear slots, Fig. 23.

REMOVING THE TAKE-UP SPOOL

To replace a take-up spool, you'll have to remove the wind shaft. And here you'll encounter a lot of variations, depending on the particular camera.

But plan on removing the wind assembly at the top of the wind shaft, Fig. 25. The wind assembly often comes out as a modular unit. With the camera shown in Fig. 25, the counter mechanism is part of the wind assembly -- that's also typical.

The spring which returns the wind lever often comes out with the modular wind assembly, Fig. 26. In many cases, you don't have to unwind the spring -- it stays in place.

You'll normally have to do some additional disassembly at the bottom of the wind shaft. It's usually necessary to remove the main cocking gear of the transport mechanism. In Fig. 27, a single screw holds the main cocking gear to the bottom of the wind shaft -- the one-way clutch is at the top of the wind shaft, Fig. 28. And with the camera shown in Fig. 18, you must disassemble the one-way clutch to reach the main wind gear.

NOTE

Remember, when removing transport gears you may be disturbing critical timing. So use scribe lines.

Most wind shafts come out from the top of the camera. Yet you still may be unable to pull the take-up spool. Like the sprocket, the take-up spool normally has a support bushing. You'll then have to unscrew the support bushing to remove the take-up spool.

With the design shown in Fig. 29, the support bushing is part of the wind shaft. Both the support bushing and the take-up-spool gear, Fig. 30, have spanner holes. So you need two spanner-type wrenches to remove the wind shaft. Use one spanner wrench to prevent the wind-shaft gear, Fig. 30, from turning. And use the second spanner wrench to unscrew the support bushing, Fig. 29.

TOOLS
2 SPANNERS REQ'D.

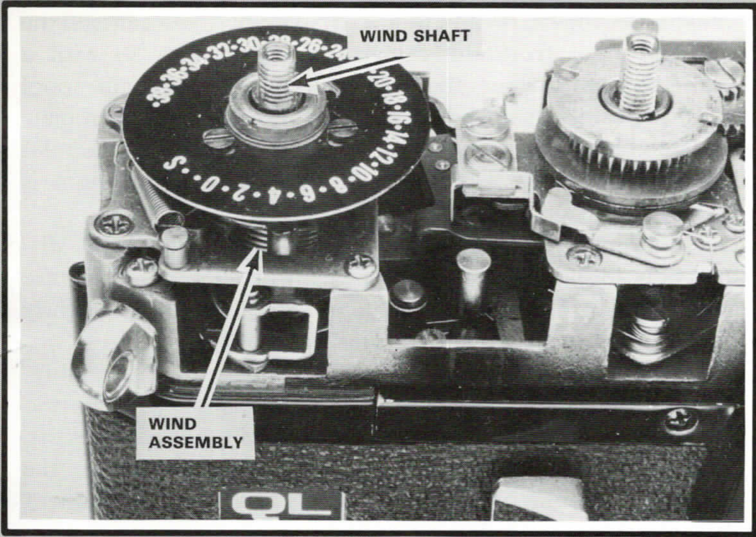

Figure 25

Figure 26

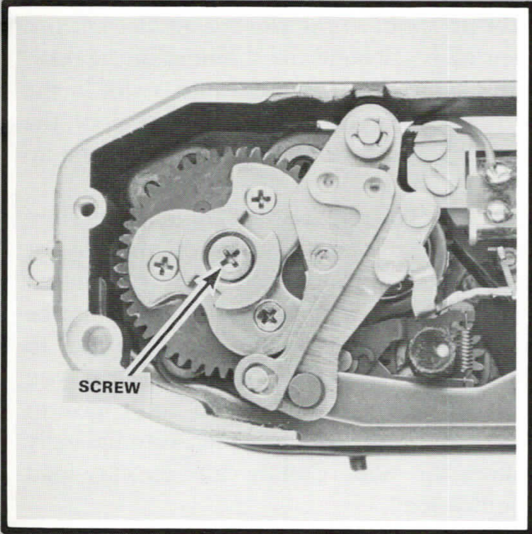

Figure 27 Canon AE-1

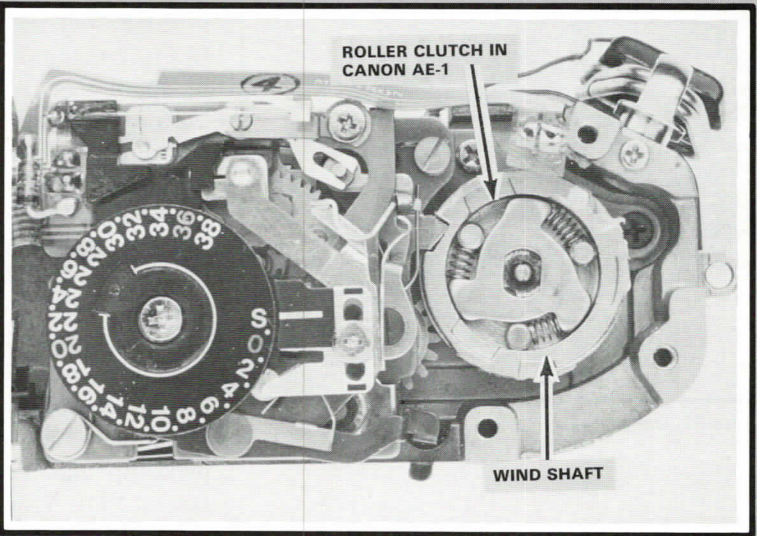

Figure 28

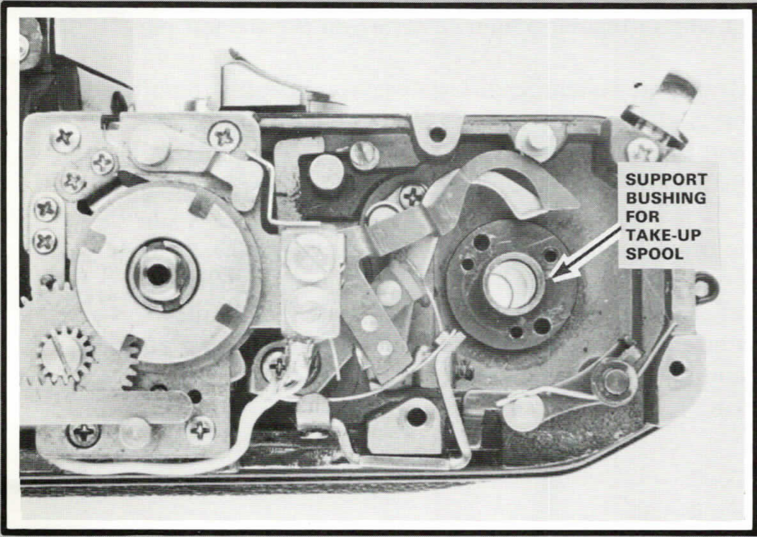

Figure 29 Top of Camera

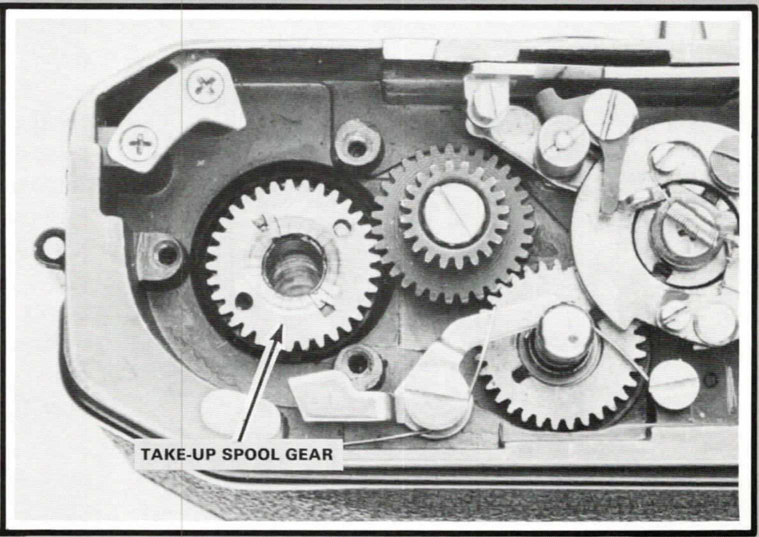

Figure 30

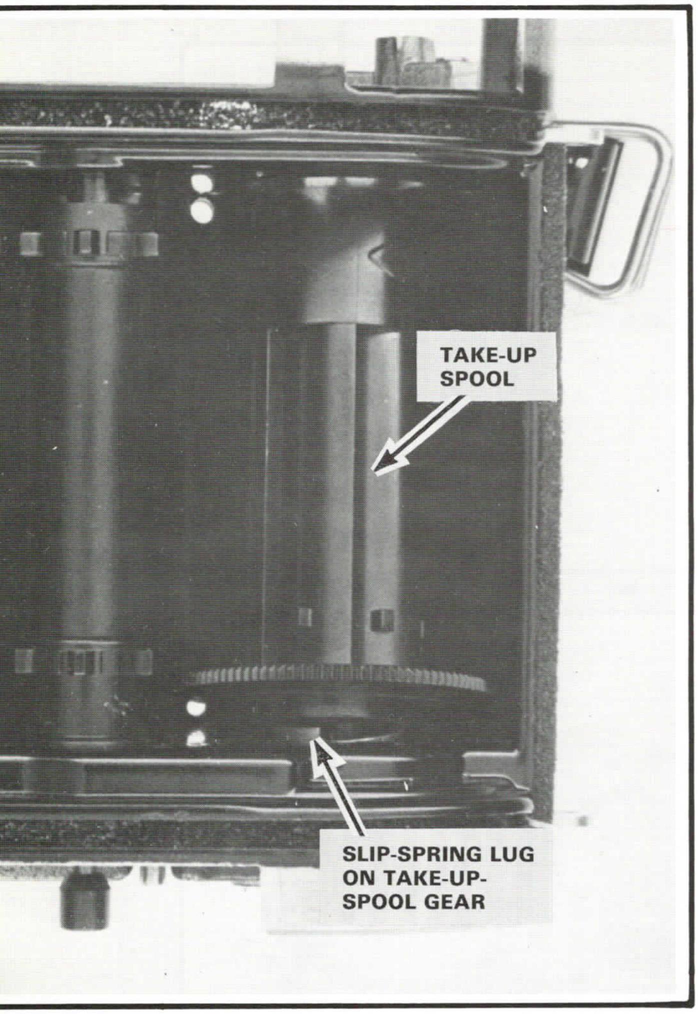

Figure 31 Canon AE-1

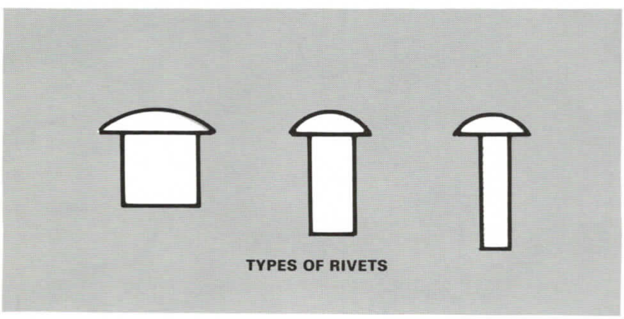

Figure 32

Again, disassembly procedures vary considerably from camera to camera. As an example of extremes, you can pull the take-up spool from the camera shown in Fig. 30 with a minimum of disassembly. Yet removing the take-up spool from the camera shown in Fig. 27 requires almost a complete disassembly -- you even have to remove the shutter module! That's because the support pivot for the take-up spool is riveted to the shutter's mechanism plate.

NOTE ON CANON AE-1

So you often have to "feel your way" through the disassembly. Still, there are some general precautions which are pretty typical. For one, *watch for washers.* You'll frequently find washers at the ends of the take-up spool.

Keep the washers in the proper sequence for reassembly. These washer positions vary in different cameras (and even in the same camera models). Manufacturers often use washers to take up end play in individual parts. Consequently, the number, sizes, and positions of washers may vary from camera to camera.

NOTE WASHERS

Here's another precaution: on reassembly, you must normally *key the take-up spool to the slip-spring mechanism.* In Fig. 31, the slip spring fits around the shoulder of the take-up-spool gear. A tab on the slip spring fits into a slot in the bottom of the take-up spool. As you seat the take-up spool, the slot must fit over the slip-spring tab -- otherwise, the take-up spool will bind.

NOTE SERVICE

And finally, make sure you replace the take-up spool right side up. With most designs, it's pretty obvious -- the slot for hooking the film leader goes toward the bottom of the camera. Yet with other designs, the take-up-spool position may not be so obvious. For example, the take-up spool shown in Fig. 10 doesn't have film-hooking slots or tabs. With this design, you just lay the leader on the take-up spool -- you don't have to hook the leader to a slot. The take-up spool then automatically picks up and advances the film. Canon calls its easy-load system "QL" for "quick load."

Whenever you replace a take-up spool, check the feel of the slip spring. You should also test the operation with a dummy roll of film (a regular 35mm cassette you use for test purposes).

SERVICE NOTE

The transport-system repairs we've covered apply to both focal-plane and leaf-type cameras. Later, you'll study complete cameras in both categories. But before you do, there are some other general repair techniques with which you should be familiar.

Quite often, transport repairs involve riveting (or "staking"). Rivets, Fig. 32, may hold the wind gears. Such rivets aren't limited to inexpensive cameras. Nor are they limited to transport mechanisms. So we'll cover the riveting process and other common techniques normally associated with the transport system.

TEST-YOURSELF QUIZ #3

1. Should you lubricate a one-way clutch? NO

2. What type of one-way clutch is used in the Canon counter mechanism?

   A . slip-spring

   B . ratchet-type

   C . roller-type

3. You're reassembling a roller clutch. The compression springs should push the rollers toward the NARROW (narrow, wide) ends of the cam slots.

4. When removing a sprocket, you discover a loose compression spring. This spring goes inside the sprocket where it pushes down the SPROCKET ROD.

5. The slip-spring assembly in a 35mm transport assembly keys to the TAKE UP SPOOL.

RIVETING AND STAKING

Rivets may hold the various parts to the camera body. Or, the part itself may include a rivet. In that case, you'll have to use a riveting operation to replace the part.

For example, consider the mechanism plate from a leaf-type shutter such as you've already studied. All the support posts are riveted -- or "staked" -- to the mechanism plate. Each support post simply fits through a mechanism-plate hole. The manufacturer then stakes (flattens) the end of the support post against the other side of the mechanism plate.

In other cases, a rivet may hold two parts together. Each part then has a hole to accept the shank of the rivet. As shown in Fig. 33, the rivet fits snugly through the holes.

Replacing such a part then requires removing the rivet. It's pretty tough to remove a metal rivet without destroying it. Normally, you must cut away one end of the rivet to remove the part. And use a new rivet for reassembly.

Fig. 34 illustrates a conventional riveting operation. Once you insert the rivet, you must form a second head on the other end. Put the end which already has a head on an anvil. Then, use a ball-peen hammer to distort the end of the rivet as shown in Fig. 35. Partially flatten this end. Finally, use repeated strokes of the hammer's ball end to round the rivet's second head.

Don't strike the rivet at any set pattern. Rather, vary the angle from which you swing the hammer. That way, you can shape the head into a semi-round shape.

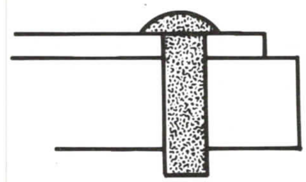

Figure 33

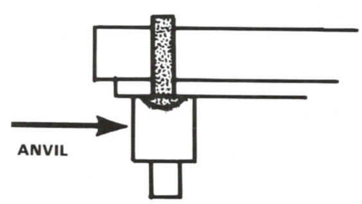

Figure 34

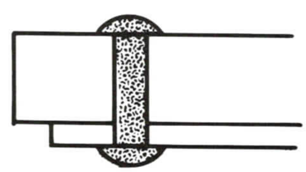

Figure 35

"Staking" normally differs from riveting in that you don't actually form a second head. One end of a part to be staked may have a concave end as shown in Fig. 36. To stake the part, first use a round-nose punch, Fig. 37 -- that flares the concave end over the support part. Then, use a flat-nose punch, Fig. 38, to flatten the flare.

TOOL

A watchmaker's staking tool, Fig. 39, has some applications in camera repair. For example, it's useful when you're restaking a post to a mechanism plate, Fig. 40. Sometimes these posts work loose. And all you really need to do is tighten the stake.

The staking tool includes a series of punches and a series of stumps. So you have a wide selection for the right size and shape of punch. Select a stump which has a hole large enough to accept the shaft of the post you're staking, Fig. 40. Here, you're using the stump to support the post by its shoulder.

TOOL

Then, insert a punch into the staking tool, Fig. 40. Start with a round-end punch to flare the end of the post. And finish the job with a flat-end punch. Notice in Fig. 40 that we're using a brass hammer. Using a brass hammer prevents damage to the punch.

You may not encounter enough riveting or staking jobs to justify the expense of a special tool. However, you can accomplish the same thing using your bench block and an assortment of punches. Select the hole in your bench block which will properly support the post.

With inexpensive cameras, though, you'll often encounter plastic rivets. Here, a hammer or a staking tool won't do you any good. One end of the plastic rivet may be cemented in place. Or, the manufacturer may use heat -- a "heat seal" -- to spread one end of the rivet.

SERVICE

It's sometimes possible to reuse a heat-sealed rivet. Suppose you have a heat-sealed rivet holding a gear to a mechanism plate. And you want to replace the gear. Touch your soldering iron to the heat-sealed end of the rivet. Then, pull out the rivet to free the gear.

If you're careful, you may be able to pull the rivet without burning away too much of the heat-sealed end. Enough of the end must remain to form a new heat seal. After replacing the plastic rivet, touch your soldering iron to the heat-sealed end. The plastic should then flow over the supporting part to hold the connection.

OTHER PLASTIC PARTS

Although plastic rivets can be a problem, you won't face the problem too often. But there's one situation where plastic parts cause frequent headaches. That's when the camera uses a plastic body housing or some other part that accepts metal screws.

Why's that a problem? It's very easy to strip the plastic screw threads. A stripped screw isn't much of a problem -- you

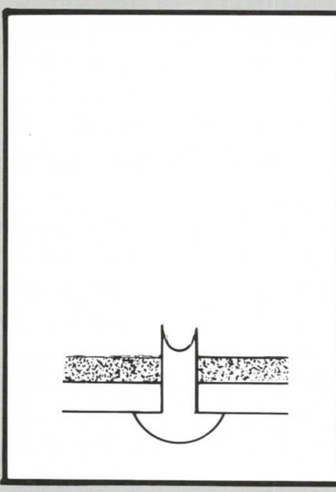

Figure 36

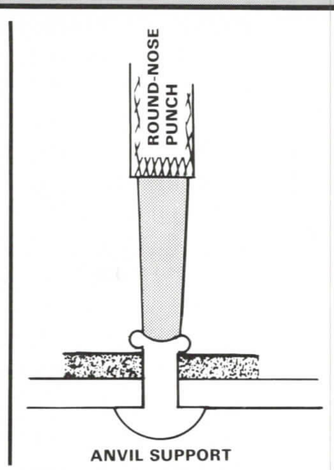

Figure 37

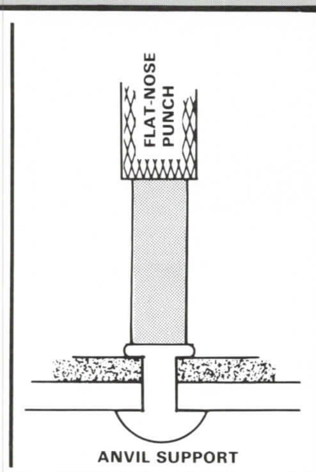

Figure 38

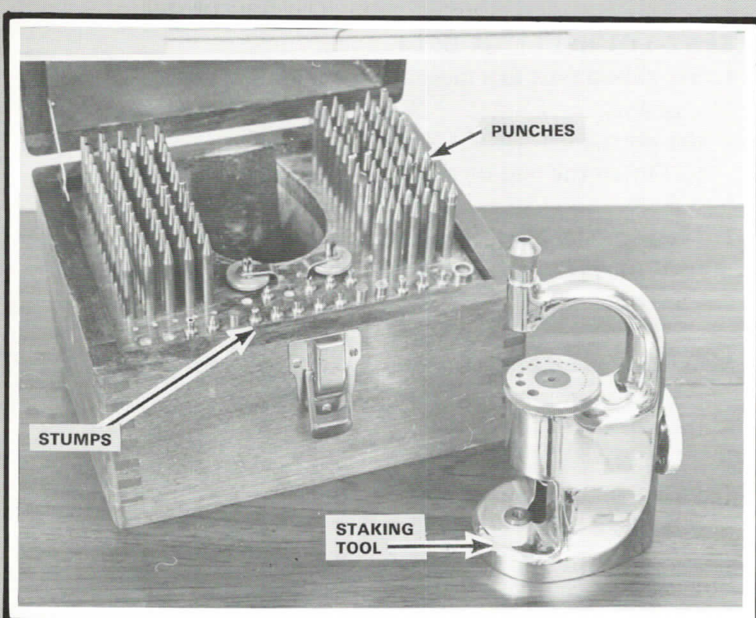

Figure 39

TOOL

Figure 40

Figure 41 Plastic Repair Kit

USEFUL ON PLASTIC PARTS!

can always replace the screw. But what about stripped threads in a plastic body casting?

If you're careful, you can usually avoid the problem. Just use caution when you're working with plastic-body cameras. Say you're just starting the screw into position. Make sure that you've started the screw correctly -- a cross-threaded screw will tear out the plastic threads.

Here's one trick you can use: *As you start the screw, try turning it slightly in a counterclockwise direction -- opposite the direction you'd turn the screw to tighten it.* You should "feel" the threads click into place. You then know that the screw has started properly.

And be careful you don't overtighten the screw. Tighten the screw until it's snug. But if you put any extra pressure on the screw, you may very well strip the plastic threads.

Even careful technicians do occasionally strip a plastic thread. Fortunately, you don't have to throw away the camera body -- you can make a repair. One technique is to use Plas-T-Pair, a plastic repair kit, Fig. 41. Using Plas-T-Pair, you can fill in the plastic threads. Then, when the Plas-T-Pair dries, use the screw to cut new threads.

TEST-YOURSELF QUIZ #4

1. To stake a post to a mechanism plate, first use a ROUND NOSE punch to spread the concave end of the post; then use a FLAT NOSE punch to flatten the end of the post over the mechanism plate.

2. Many modern cameras use plastic rivets. What is normally used to spread and flatten the end of the rivet? HEAT SEAL

3. When a metal screw threads into a plastic piece, you must be very careful to avoid STRIPPING the plastic threads.

4. Name the two things that normally cause stripped plastic threads.

   1. CROSS THREADING the screw.

   2. OVER TIGHTENING the screw.

LOCKING AGENTS

We've discussed the problems involved in removing sealed parts (screws, retaining rings, etc.). Manufacturers frequently use locking agents on threaded parts. And there's a good reason -- vibrations can cause threaded parts to work loose.

Also, certain camera parts move quickly and stop suddenly. The normal camera action may then cause the screws

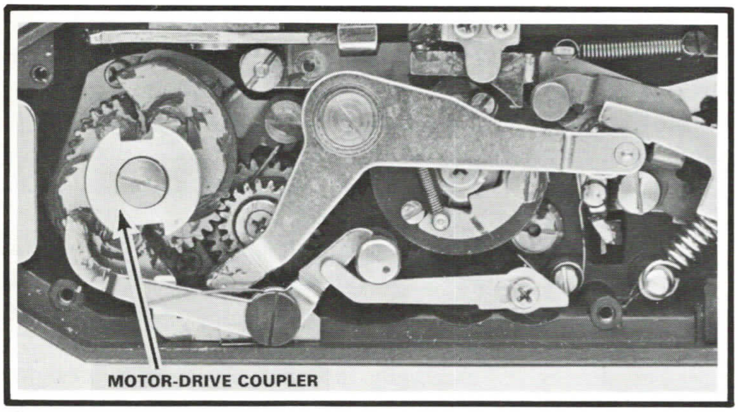

Figure 42 Canon F-1

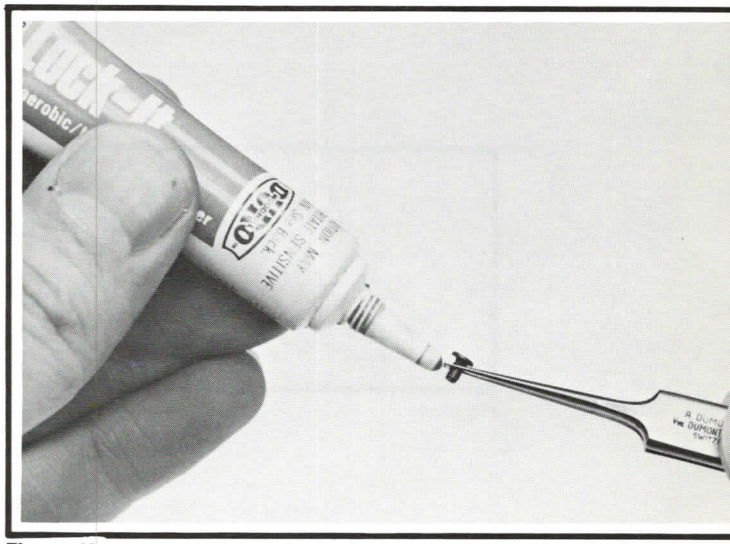

Figure 43

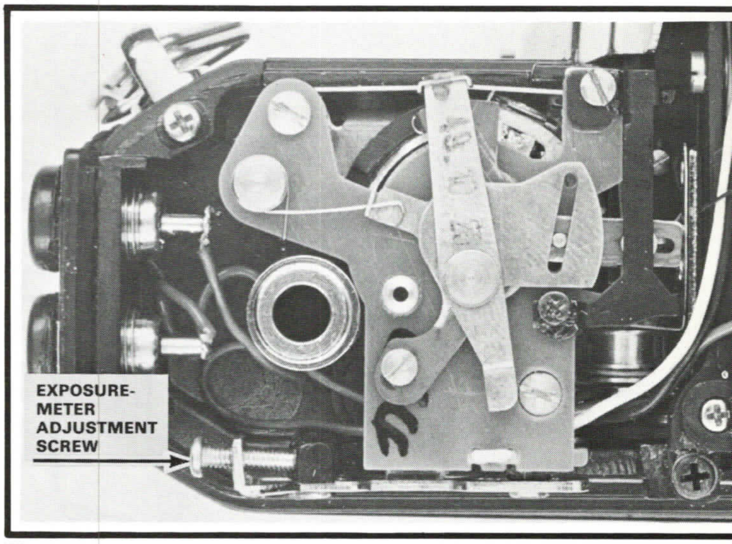

Figure 44

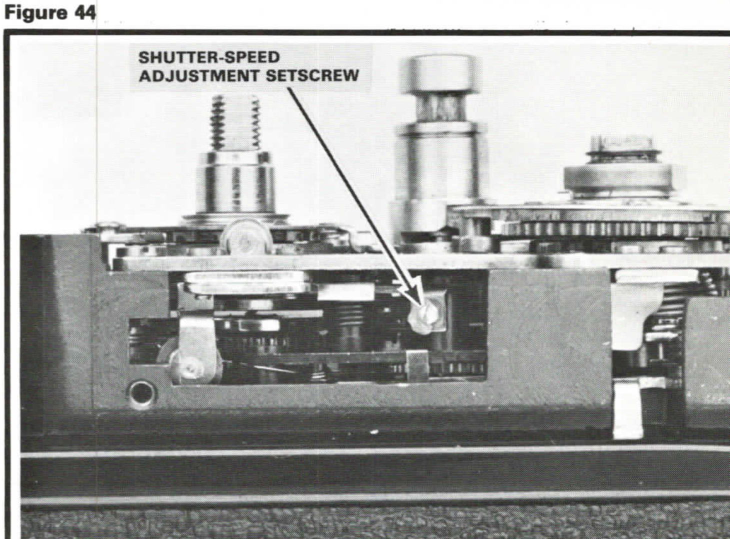

Figure 45

SERVICES

holding these parts to work loose. How about those external parts, like wind-lever cover screws? It sometimes seems manufacturers lock these parts just to prevent owners from disassembling their own cameras.

In many cases, it's good practice to relock such parts --especially those under heavy stress. For example, suppose you're replacing the screw that holds the motor-drive coupler in Fig. 42. The motor drive engages this coupler to cock the shutter and advance the film. And a motor drive puts a lot of stress on the parts. So you should relock the screw.

LOCKING AGENT

There are several locking agents you can use. Some technicians use purple glyptol. Others use commercial locking compounds such as Loctite. In either case, *apply the locking agent to the threads of the screw* (or the threads of a retaining ring), Fig. 43. Then, install the screw. If you try applying the locking agent after installing the screw, it won't work -- the locking agent won't harden.

GOOD POINT

But many technicians use lacquer to lock parts -- or even fingernail polish. A drop of fingernail polish on the screwhead will lock the screw in place. In some ways, it's preferable to lock the screwhead rather than the threads. That way, you can replace the screw and check the operation before applying a locking agent.

WATCH FOR IT!

You'll also see lacquer used to lock adjusting screws, Fig. 44 and Fig. 45. Here, manufacturers often use red lacquer. The red lacquer serves both to hold the adjustment and to warn the technician -- it tells you at a glance that turning the screw will affect an adjustment.

When you do make an adjustment, though, you should relock the screw. Again, fingernail polish works well. You want to make sure the adjustment doesn't change after the camera has been returned to the owner.

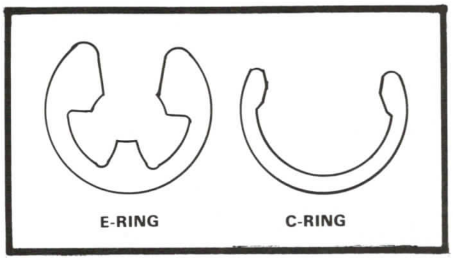

Figure 46

METAL FASTENERS -- E-RINGS AND SNAP RINGS

Besides using screws and rivets, camera mechanisms often use metal fasteners -- or "clips"--to hold parts in position. Fig. 46 shows two types of fasteners -- the E-ring and C-ring. You'll often hear the terms "E-ring" and "C-ring" used interchangeably. But, as you can see in Fig. 46, there's a slight design difference.

Metal fasteners rely on their spring-clipping action to hold parts. Installing the metal fastener forces the sides to spread apart. Once in place (normally in a slot, Fig. 47), the metal fastener springs back to its original shape.

The E-ring is especially popular in camera designs (popular with manufacturers, not so popular with technicians). Normally, the E-ring secures a rotating or pivoted part. Or it may hold a spring in position. The part, such as a lever or the compression spring in Fig. 47, fits over a post. A groove cut around the post then receives the E-ring. That leaves the part free to pivot or rotate between the E-ring and the base or shoulder of the post.

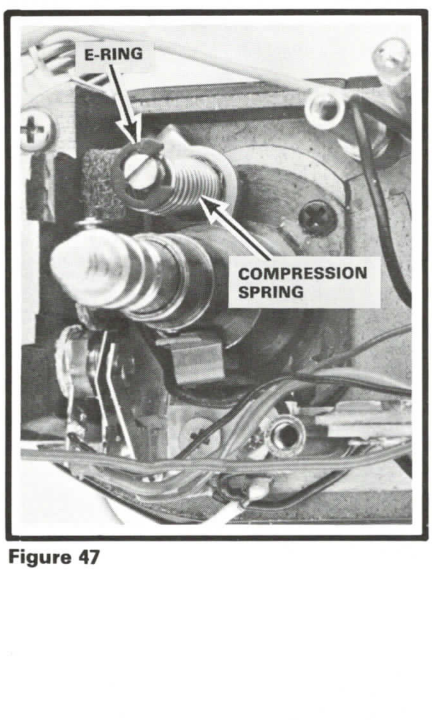

Figure 47

There's a good reason technicians aren't overly fond of E-rings -- it's easy to lose the tiny E-rings during disassembly and reassembly. You must use some pressure to remove or replace an E-ring. And, if you're not careful, the E-ring may go flying across the room.

It may take a little practice before you can handle E-rings with confidence. However, even experienced technicians often find themselves on the floor searching for an elusive E-ring. So most technicians keep an E-ring assortment on hand, Fig. 48. It takes less time to simply install a new E-ring than it does to find the old one.

There are special tools available for removing and replacing E-rings. These tools may be valuable if you do find the E-rings difficult to handle. But you can remove and replace E-rings using a screwdriver. Insert the tip of the screwdriver into the E-ring as shown in Fig. 49. Then, pull the E-ring off the post. Here's one tip to avoid losing the E-ring -- *keep your finger over the E-ring during removal.*

To replace the E-ring, start the open end over the groove. Then, use your screwdriver blade to snap the E-ring into place, Fig. 50. Again, keep your finger over the E-ring to prevent loss.

Although the E-ring provides a simple, inexpensive fastener, it has one design drawback. Remember, the E-ring clips into a groove or slot. So there may be excessive endplay between the E-ring and the part which must pivot or rotate. Manufacturers often use spacer washers under the E-ring to take up endplay.

Another type of fastener -- the **snap ring** -- often eliminates the need for endplay washers. The snap ring, Fig. 51, clamps onto the post with a viselike grip. Consequently, there may not be a groove in the post; the manufacturer can adjust the endplay simply by positioning the snap ring.

Figure 48 E-ring Assortment

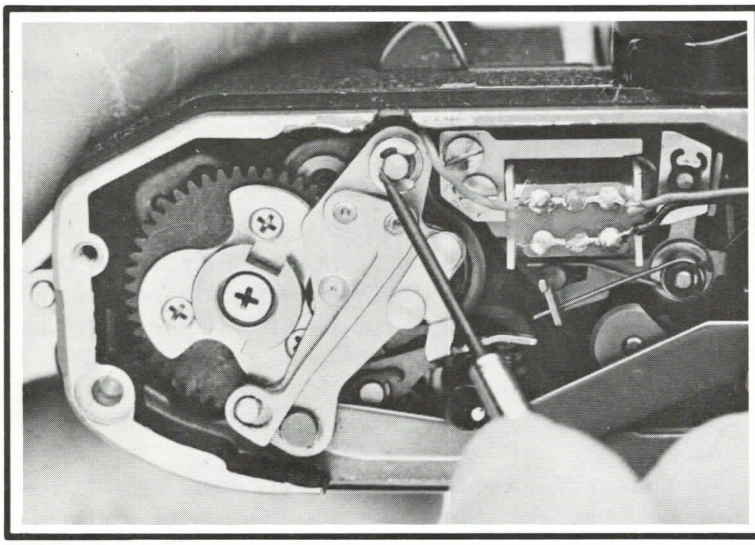

Figure 49 Removing E-ring

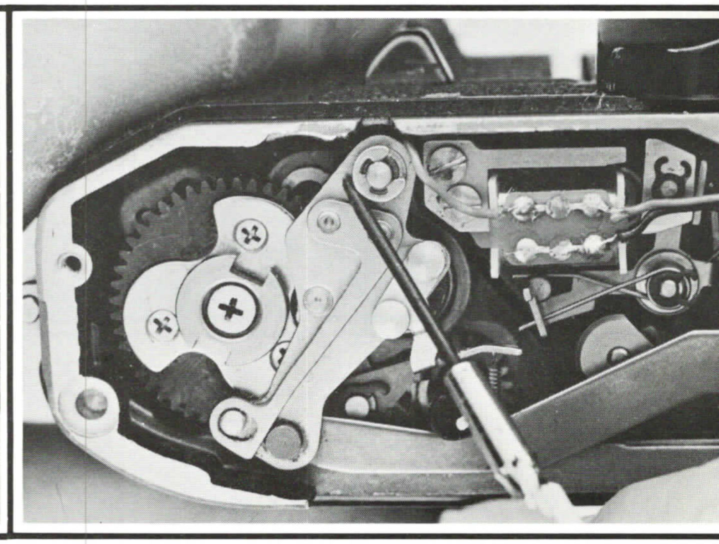

Figure 50 Replacing E-ring

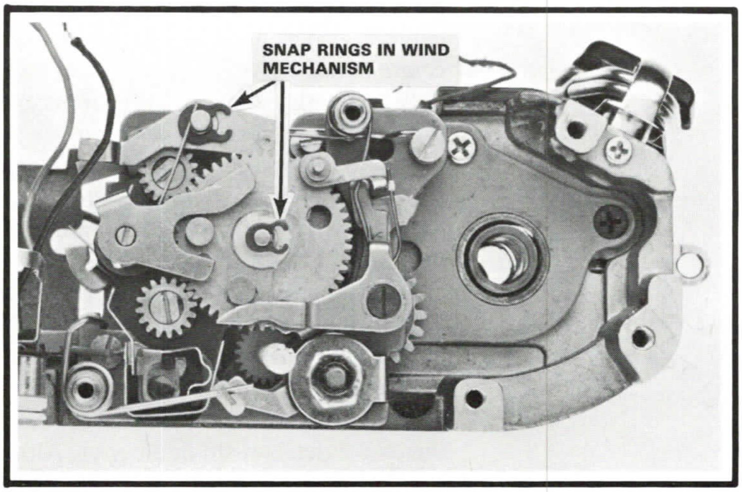

Figure 51

TOOL

But snap rings can be tougher to remove than E-rings. You may be able to pry off the snap ring using a screwdriver blade. However, that'll probably distort the snap ring. So it's best to use a special snap-ring plier, Fig. 52.

Just insert the tips of the snap-ring plier into the snap-ring ends. Then, squeeze the snap-ring plier to slightly spread the snap ring. You can now lift the snap ring up and off the post.

Be careful to avoid spreading the snap ring any more than necessary. If you spread the snap ring too much, the snap ring won't spring back to its original shape. You must then use a new snap ring on reassembly. Some snap-ring pliers have an adjustable stop screw which limits how far the pliers can open. Properly adjusting the stop screw eliminates the chance of damage.

As you replace the snap ring, you can adjust the endplay of the part (such as the lever and gear in Fig. 51). Seat the snap ring against the part. Then, move up the snap ring a slight amount -- until the part rotates or pivots freely.

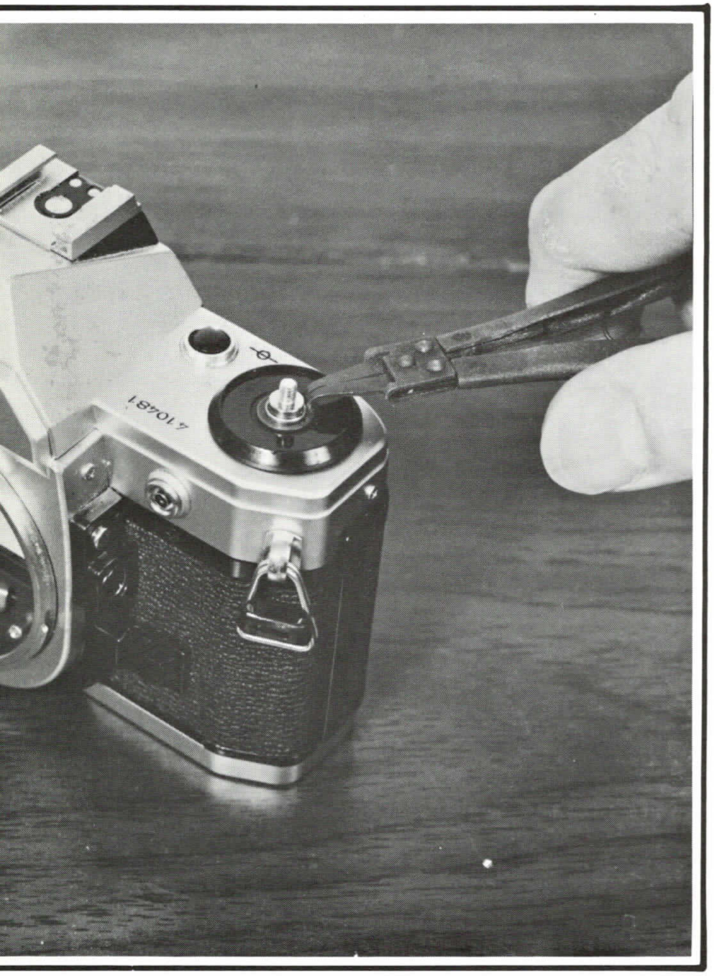

Figure 52

WATER-DAMAGED CAMERAS

Rust can quickly destroy a camera. What do you tell someone who has dropped a camera in water? The best advice -- bring in the camera as soon as possible. If you can get to the mechanism right away, you might be able to salvage the camera.

Salt water causes more damage than does fresh water. So if a camera has had a salt-water bath, use fresh water to flush it out. Bathe the camera in fresh water before disassembly.

Then, you may have to put other work aside to give immediate attention to the water-damaged camera. With a minimum amount of disassembly, you can check the extent of the water damage. What's the first step? Right -- pull the bottom cover.

You can then see how much effect the water has had. How bad is the rust? Can you brush it away? Or has it eaten its way into the metal parts?

The question isn't really whether or not you can repair the camera -- it's whether or not you can repair the camera *economically.* Even with extensive rust damage, you can probably repair the camera. Yet you may have to charge more than the camera's worth.

Why? Because you'll have to remove virtually every part. You can then use a glass brush to scrape away the rust. Or soak the individual parts in a rust-removing solution. Sure, you can do it. But it takes a lot of time.

If the rust damage doesn't appear excessive, you may be able to make an economical repair. Again, you can tell most quickly by looking at the bottom of the camera.

SERVICE NOTE

Your first step -- get the water out of the mechanism before it can cause more damage. A fast technique is to bathe the entire mechanism in alcohol. Alcohol drinks up the water. Yet the alcohol dries on its own without leaving a residue.

You'll still have to remove certain parts. For example, don't bathe the lens elements in the alcohol -- that can damage the optics. Rather, use a lens-cleaning solution and clean the optics separately. But, after removing the lens elements, you can place the entire lens mechanism -- including the diaphragm -- in the alcohol bath.

Also, don't put plastic parts in alcohol. The alcohol will eat up plastic parts such as windows and focusing screens.

After the alcohol bath, proceed with the disassembly. Here, you may have to disassemble the camera no further than with an ordinary cleaning job (how far is that? -- you'll cover this subject when you study complete camera mechanisms).

LOOK FOR LESSON

Some technicians don't offer a warranty for water-damaged cameras. Others tell the customer he can expect to bring back the camera at least once during the warranty period. That warning does have merit. The customer may not have to bring back the camera for additional work. But if he does, he isn't likely to be unhappy -- you've given him fair warning.

TELL THE CUSTOMER

TEST-YOURSELF QUIZ #5

1. When using Loctite on a screw, apply the locking agent to

   A . the screwhead

   B. the threads

2. When you see a screw locked by red lacquer, be careful --turning the screw may disturb ADJUSTMENTS

3. Which type of metal fastener clips to a groove or slot in a post?

   A. the E-ring

   B . the snap ring

4. A glass scratch brush is used to remove RUST.

5. You have a leaf-type shutter which has water damage. The diaphragm-setting ring of the shutter has two plastic lugs. Would it be necessary to remove the diaphragm-setting ring before soaking the shutter in alcohol? YES

SUMMARY

SUMMARY

The main emphasis in this assignment has been on 35mm film-metering systems. In particular, you've studied the two key parts -- the sprocket and the take-up spool.

Remember that the sprocket both advances and meters the film. The take-up spool simply wraps on the film advanced by the sprocket. Pushing the rewind button disengages the sprocket from the transport mechanism. The sprocket may then turn in the reverse direction as you rewind the film.

As the film winds on the take-up spool, the diameter of the take-up spool increases. Consequently, the take-up spool must have a slipping action. A slip-spring mechanism normally carries the take-up spool.

READ OVER

You've also learned the importance of using scribe lines before removing gears. Taking the time to scribe a gear's position pays off in the long run -- it can save you a lot of time on reassembly.

The three common types of one-way clutches covered in this assignment are the slip-spring clutch, the roller clutch, and the ratchet clutch. The slip-spring clutch normally causes the most problems, and the roller clutch is normally the most reliable.

Some of the common repair procedures you've covered include riveting and staking. Put particular emphasis on the portions of your assignment covering the procedures and precautions for plastic parts. More and more cameras are using plastic bodies and other plastic parts. It's easy to strip plastic threads if you're not extremely careful.

Threaded parts which are under heavy stress -- or subjected to sudden stops and starts -- should normally be locked with a locking agent. But be cautious when you see red lacquer used to lock a screw -- that red lacquer often signals an adjusted part. Turning the screw may disturb a critical adjustment.

Many cameras, regardless of cost or quality, use E-rings or snap rings. E-rings can cause a lot of grief to camera repair technicians. Since the E-rings are under tension, they're easy to lose. Remember to keep your finger over an E-ring as you're removing or replacing it. Special snap-ring pliers are desirable when removing or replacing a snap ring. Without the special pliers, you may spread or deform the snap ring.

Finally, you've covered what to do about a water-damaged camera. A water-damaged camera can normally be repaired. But can it be repaired economically? At first, this may be difficult to determine -- you may find yourself completely disassembling a water-damaged camera before deciding it's uneconomical to repair. But with experience you'll be able to judge the extent of water damage after pulling the bottom cover.

ANSWERS TO TEST-YOURSELF QUIZZES

QUIZ #1

1. The **sprocket** meters the film, assuring that the film advances the same amount for each wind-lever stroke.

2. A **slip-spring mechanism** allows the take-up spool to slip more as its diameter increases.

3. Pushing the rewind button disengages the **sprocket (A).**

4. The **sprocket** provides proper film registration.

QUIZ #2

1. Chances are **the timing is critical.** The pin probably has to be in a precise location.

2. To note the gear timing, **use scribe lines.**

3. A **one-way clutch** normally connects the main-wind gear in the transport to the wind shaft.

4. Check the **slipping action of the take-up spool.** If the take-up spool isn't slipping, it continues to advance the film after the sprocket has stopped.

QUIZ #3

1. Normally you **should not lubricate** a one-way clutch.

2. The Canon counter mechanism uses a **ratchet-type clutch (B).**

3. The compression springs should push the rollers toward the **narrow** ends of the cam slots.

4. The compression spring pushes down the **sprocket rod.**

5. The slip-spring assembly keys to the **take-up spool.**

QUIZ #4

1. First use a **round-nose punch** to spread the stake; then use a **flat-nose punch** to secure the stake.

2. A **heat seal** normally holds plastic rivets.

3. Be careful to avoid **stripping** plastic threads with the metal screw.

4. Two things that often cause stripped plastic threads are **overtightening the screw** and **cross-threading the screw.**

QUIZ#5

1. Apply the locking agent to the **threads** of the screw.

2. Turning a screw marked with red lacquer may disturb an **adjustment.**

3. The **E-ring (A)** clips to a groove in a post. The snap ring normally doesn't require a groove.

4. Use the glass scratch brush to remove **rust.**

5. **Yes,** remove the diaphragm-setting ring. The bath in alcohol could ruin the plastic lugs.