THE CYCLE-OF-OPERATION

THE BASIC PRINCIPLES OF CYCLE CONSTRUCTION AND HINTS FOR IMPROVING THE COMPLEX CYCLE

One of the techniques that will be used to evaluate your understanding of complex mechanisms is the cycle-of-operations. This is a schematic means of showing the operational relationship between parts.

Instead of concentrating on the physical location of parts, you will now be relating the action and forces that make the shutter work.

Let's start by developing a cycle-of-operations for a simple multiple-blade shutter. The shutter will be single-action design. With variable main lever/leaf lever engagement. It's suggested that you review the following sections in the text "Introduction To Shutters": (1) Charting the Shutter's Operational Sequence, (2) The Complex Multiple-Blade Shutter, and (3) The Simple Multiple-Blade Shutter.

1. All action starts or is actuated by the FINGER. Begin the cycle with the FINGER boxed at the top of the page.
   a. The FINGER operates the RELEASE LEVER, so the RELEASE LEVER should be added under the Finger with a connecting arrow between them indicating the direction of control. Also include the spring which returns the RELEASE LEVER to its rest position - use an $\boxed{S}$ to represent the spring and an $\boxed{H}$ to indicate the shutter housing, mechanism plate, stud or other non-moving part. The double ended arrow $\longleftrightarrow$ is used to indicate spring action only.

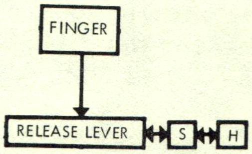
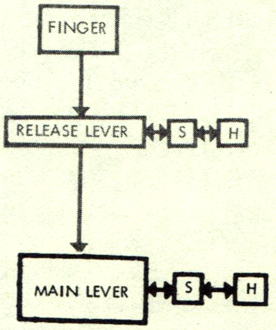


Figure 1



   b. Ask yourself which part in the main shutter action is operated by the RELEASE LEVER. If it is the MAIN LEVER in the particular shutter you are cycling, add the MAIN LEVER (with its spring) to the cycle.

Figure 2

c. You should then add all of the additional parts (and springs) of the main shutter action which are operated by the MAIN LEVER and are used to control the SHUTTER BLADES. Your cycle at this stage should look like the example shown. (Some shutters may not have all the parts or springs shown; others may have additional parts.)

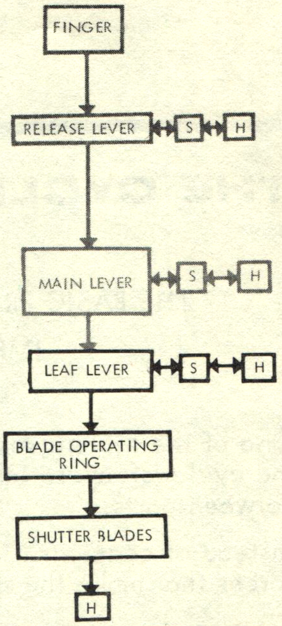


Figure 3

2. Having established the main action of the shutter, your next step will be to add the speed-control system.

   a. Start with the SPEED-CONTROL LEVER (or cam) which is operated by the FINGER. Then add the TIME and BULB LEVERS and spring (some shutters may have separate springs for the time and bulb levers -- others may eliminate the time action altogether).
   Draw in the connecting arrows showing the direction of movement or control between the FINGER, SPEED-CONTROL LEVER and TIME AND BULB LEVERS.

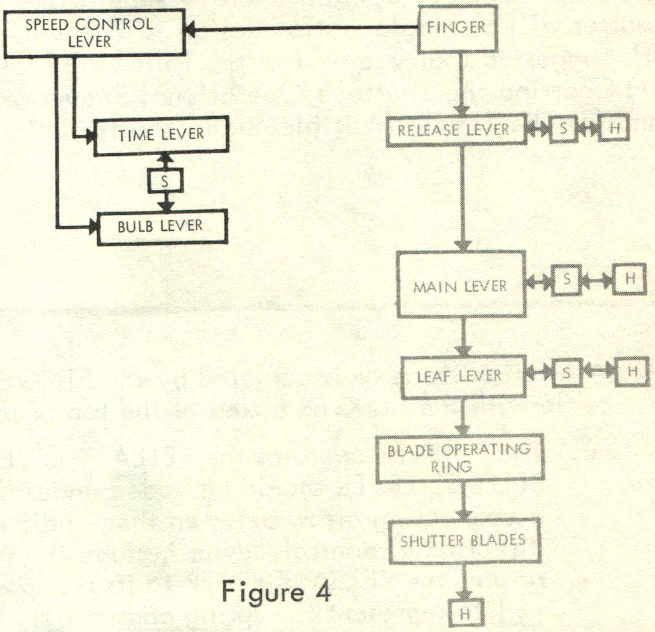


Figure 4

   b. Ask yourself what parts the TIME and BULB LEVERS act on and which parts act on the TIME AND BULB LEVERS. In this example, both the TIME AND BULB LEVERS act on the MAIN LEVER to intercept its movement when the SHUTTER BLADES are wide open. Both are acted on by the RELEASE LEVER to disengage them from the MAIN LEVER. Add the connecting lines and arrows showing this movement on the cycle.

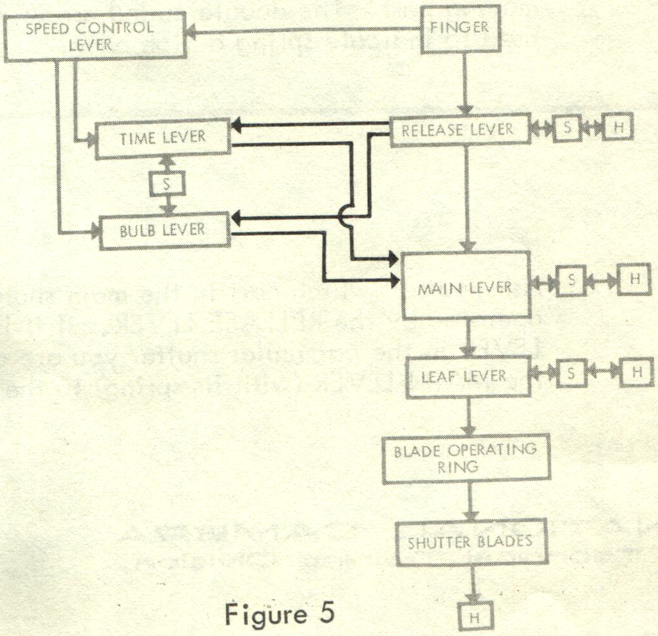


Figure 5

c. How are the instantaneous speeds controlled? There are several methods used in simple multiple-speed shutters. The MAIN LEVER may be controlled directly as shown in this example, or perhaps the SPEED-CONTROL LEVER could vary the mainspring tension. Add those parts to the cycle and draw in the connecting arrows to indicate the direction of control.

Does the shutter have a RETARD WEIGHT? If it does, add it to the cycle. Use opposing arrows (⇄) to connect it to the part which sets it in motion. The opposing arrows are always used to indicate a retarding or governing type action.

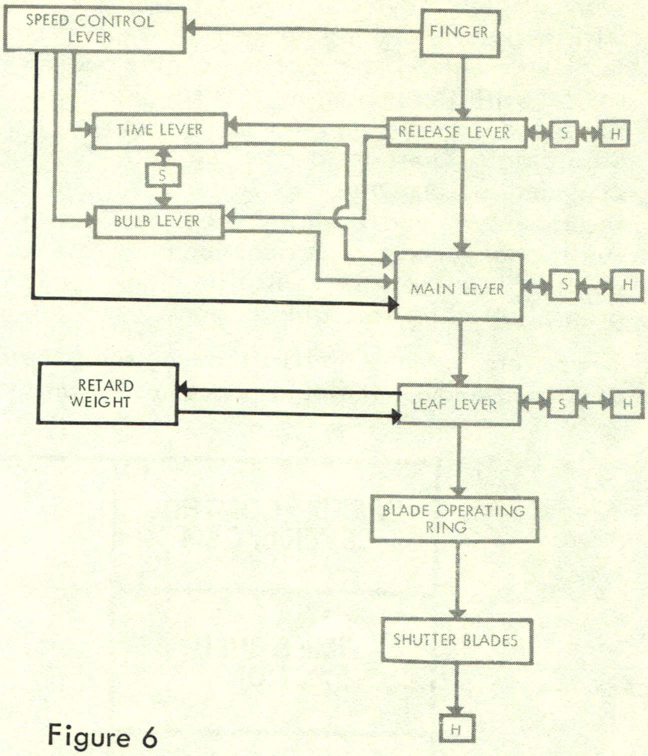


Figure 6

3. In the cycle for a simple multiple-speed shutter we have one more section to add -- the diaphragm. The diaphragm section usually consists of a DIAPHRAGM CONTROL RING which is initially operated by the FINGER from the outside of the shutter. The resulting rotational movement of the DIAPHRAGM CONTROL RING is translated to a pivotal action of each DIAPHRAGM BLADE against the housing. Add the diaphragm parts and connecting lines and arrows to the cycle.

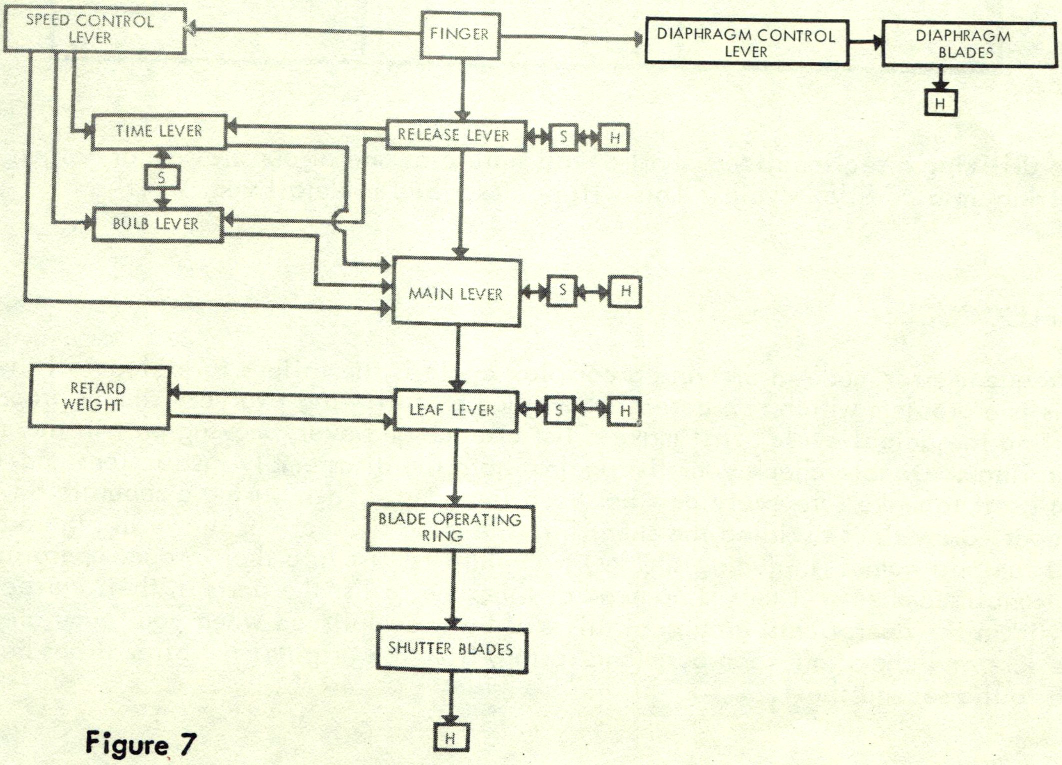


Figure 7

Our completed cycle (Figure 7) reveals a basic orientation of shutter parts and operations which will be used in making up even the most complex of cycles. Let's examine that orientation for just a moment. Note that the center column is devoted exclusively to the main action of the shutter with the remaining secondary actions shown to both the right and left of the center column. The speed-controlling parts of the secondary action (Speed-Control Lever, T & B Levers and Retarding Action) are on the left with the diaphragm-controlling parts on the right. There is a considerable amount of space remaining on the right side which can be used for diagramming the flash sync and/or delayed action mechanisms employed in the more complex designs. Additional secondary actions such as Press Focus, would also be shown in this area when applicable. Parts for controlling high-speed action may be diagrammed on the left in the same area allotted for retarding action.

If we were to make a chart showing the general orientation of each of the operating sections described above, it would appear as shown in Figure 8.

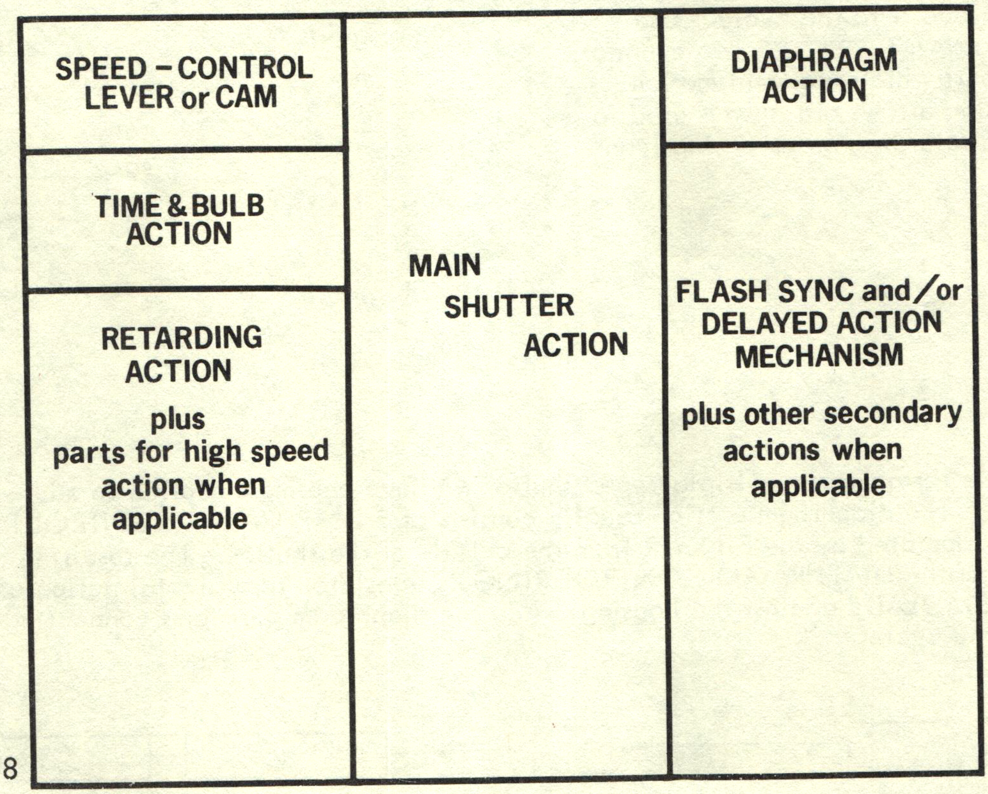


Figure 8

We will be utilizing a sectionalized chart of this nature as one of our preliminary organizational steps in setting up a complex cycle. This will be described in detail very shortly.

THE COMPLEX CYCLE

The most frequent error made in drawing a complex cycle is the failure to include all the necessary parts. This is a problem which can be easily avoided by following two very simple preparatory steps. Before starting the actual cycle, first make a list of each and every moving part in the mechanism including springs. Double check your list against both the disassembly instructions and/or the mechanism itself to make sure every part has been included. Then, using a separate 8 1/2" x 11" sheet of paper, draw lines dividing the sheet into the same six sections shown in Figure 8. Next, transfer all the part names (including springs) from the first list into their proper operational groups on the sectionalized sheet. There is no need at this time to list the parts in their correct sequence of action within the operational groups -- this will be accomplished when you formulate the actual cycle. Be sure and check off each part (and spring) from the original list after it has been transferred to the second sheet.

Once the sectionalized list has been completed, you will have a complete and organized grouping of part names from which you can formulate your actual cycle-of-operations. To see how this works in actual practice, let's take a typical complex escapement retard shutter such as the vintage Supermatic and follow through all the procedural steps for making a complete cycle, including the two preliminary steps we have just discussed. (Even though a Supermatic shutter is used in the example steps that follow, the technique described can be applied to any leaf-type shutter regardless of its complexity.)

Step #1. Make a list of the part names.

PARTS LIST - SUPERMATIC SHUTTER

RELEASE LEVER
RELEASE LEVER SPRING
BULB LEVER
BULB LEVER SPRING
TIME LEVER
TIME LEVER SPRING
SPEED CAM
MAIN LEVER
MAIN LEVER SPRING
SETTING LEVER
SETTING LEVER SPRING
RETARD LEVER
RETARD LEVER SPRING
PALLET CONTROL LEVER
PALLET CONTROL LEVER SPRING
PALLET
FIRST GEAR SEGMENT
SECOND GEAR
THIRD GEAR
STAR WHEEL
DIAPHRAGM CONTROL RING
DIAPHRAGM BLADES

BLADE OPERATING RING
SHUTTER BLADES
LEAF LEVER
LEAF LEVER SPRING
HIGH SPEED SPRING
HIGH-SPEED CAM
DELAYED ACTION RELEASE LEVER
DELAYED ACTION RELEASE LEVER SPRING
DELAYED ACTION SETTING LEVER
DELAYED ACTION LOCK LEVER
DELAYED ACTION LOCK LEVER SPRING
FIRST GEAR (D.A.)
FIRST GEAR SPRING (D.A.)
SECOND GEAR AND ONE WAY CLUTCH (D.A.)
THIRD GEAR (D.A.)
FOURTH GEAR (D.A.)
FIFTH GEAR (D.A.)
STAR WHEEL (D.A.)
PALLET (D.A.)

Figure 9

Step #2. Transfer the part names to the sectionalized sheet. (Don't forget to check off names from your original list as they are transferred.)

SPEED CAM

BULB LEVER
BULB LEVER SPRING
TIME LEVER
TIME LEVER SPRING

RETARD LEVER
RETARD LEVER SPRING
PALLET CONTROL LEVER
PALLET CONTROL LEVER SPRING
PALLET
FIRST GEAR SEGMENT
SECOND GEAR
THIRD GEAR
STAR WHEEL
HIGH SPEED SPRING
HIGH SPEED CAM

RELEASE LEVER
RELEASE LEVER SPRING
MAIN LEVER
MAIN LEVER SPRING
SETTING LEVER
SETTING LEVER SPRING
BLADE OPERATING RING
SHUTTER BLADES
LEAF LEVER
LEAF LEVER SPRING

DIAPHRAGM CONTROL RING
DIAPHRAGM BLADES

DELAYED ACTION RELEASE LEVER
DELAYED ACTION RELEASE LEVER SPRING
DELAYED ACTION SETTING LEVER
DELAYED ACTION LOCK LEVER
DELAYED ACTION LOCK LEVER SPRING
FIRST GEAR
FIRST GEAR SPRING
SECOND GEAR AND ONE WAY CLUTCH
THIRD GEAR
FOURTH GEAR
FIFTH GEAR
STAR WHEEL
PALLET

Figure 10

Step #3. Using your sectionalized list (Figure 10) as a guide and check list, organize the parts from the center operational group (main shutter action) into their correct sequence of action on a third sheet of paper. Box in the names and add connecting lines and arrows showing proper direction of control. Don't forget to check off the parts from the sectionalized list after they have been transferred to the cycle sheet.

Since this is a set and release shutter design, the SETTING LEVER is included as part of the main shutter action.

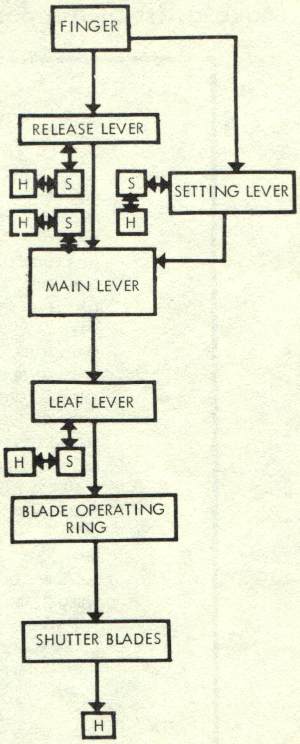
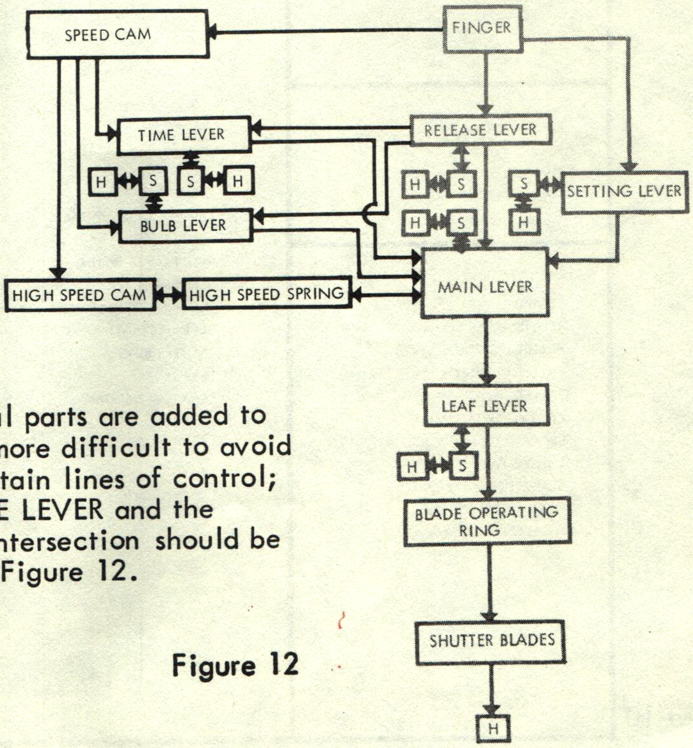


Figure 11

Step #4. Next, add the SPEED CAM, TIME AND BULB LEVERS and springs, HIGH-SPEED CAM and HIGH-SPEED SPRING plus their connecting lines and arrows.

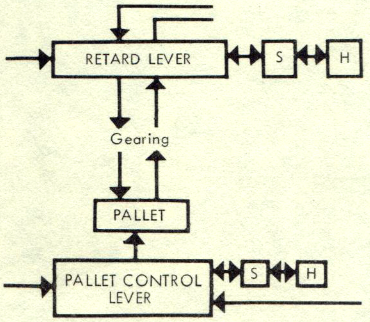


Note that as additional parts are added to the cycle it becomes more difficult to avoid the intersecting of certain lines of control; i.e. between the TIME LEVER and the MAIN LEVER -- the intersection should be drawn as indicated in Figure 12.

Figure 12

Step #5. Now add the retard mechanism, connecting lines and arrows. Don't forget the opposing arrows to indicate the retarding action of the escapement mechanism.

Although we are including all the moving parts of the retard mechanism in our example cycle, it is permissable to simplify the construction by substituting the word "gearing" for the individual gears of the escapement:



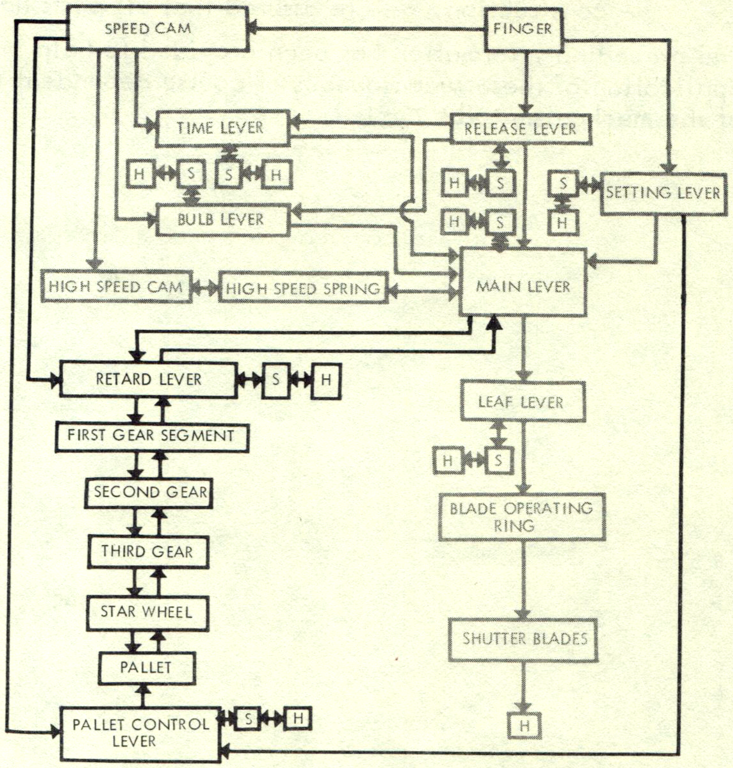


Figure 13

Step #6. As our final step, we will add the diaphragm and delayed-action mechanism, connecting lines and arrows. Since the delayed action mechanism is an escapement, its retarding action against the DELAYED-ACTION SETTING LEVER is shown with opposing arrows. Two-way action such as the movement and control between the RELEASE LEVER and the DELAYED-ACTION RELEASE LEVER, may also be indicated with opposing arrows, one broken and one solid as shown in Figure 14.

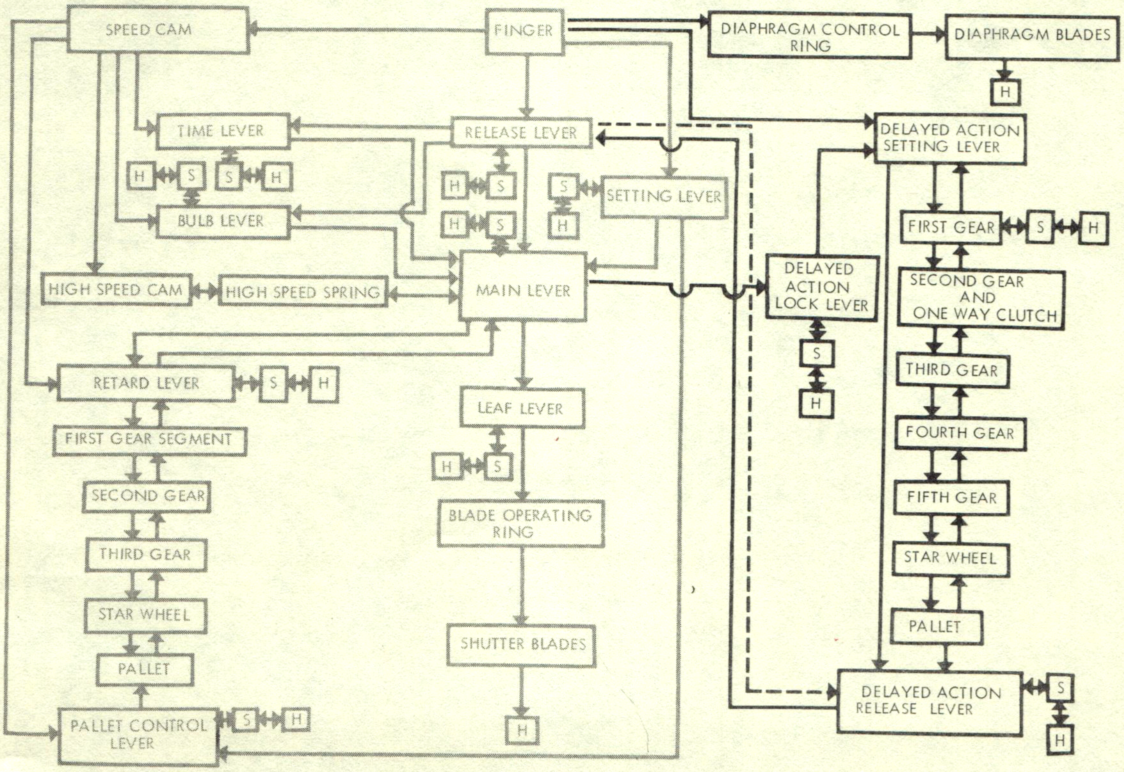


Figure 14

Our cycle is now complete. And, because of the systematic approach used in its construction, we are assured that all parts have been included.

The preceding information has been provided to help improve your construction techniques. Proper application of these techniques is of course dependent on your thorough operational comprehension of the mechanism to be cycled.