The film transport mechanisms of Ciné-Kodak movie cameras

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ABSTRACT AND INTRODUCTION

In 1923, Eastman Kodak Company introduced 16 mm motion picture film and a camera, the Ciné-Kodak, to use it. This brought to the general public the possibility of making their own motion pictures. The cost of this art form was further reduced when Kodak, in 1932, introduced 8 mm motion picture film and a camera, the Ciné-Kodak Eight, to use it. This article describes the film transport mechanisms of those pivotal cameras and later ones of the same "dynasty".

Cameras discussed (all made by Kodak) include: the original Ciné-Kodak (later called the Ciné-Kodak Model A); Ciné-Kodak Model B; Ciné-Kodak Model K; Magazine Ciné-Kodak Eight Model 20/25/60; the Magazine Ciné-Kodak; Ciné-Kodak Magazine 16; Ciné-Kodak Royal Magazine; Magazine Ciné-Kodak Eight Model 90; Ciné-Kodak Magazine Eight; Ciné-Kodak Special; Ciné-Kodak Special II; and Ciné-Kodak K-100.

1. COMPANION ARTICLE

The context within the cameras whose film transport mechanisms are described in this article is described in further detail in this article, by the same author: "The film and cameras that made 'home movies' possible".

2. CONCEPTS OF THE FILM TRANSPORT MECHANISMS

2.1 Functions

The film transport mechanism of a motion picture (henceforth "movie") camera is usually charged with three primary functions.

2.1.1 *From the supply spool*

The film must be withdrawn from the supply spool in a disciplined (usually steady) way and led to the *exposure gate*, where the actual photography takes place.

2.1.2 *At the exposure gate*

At the *exposure gate*, the film must be moved in an intermittent fashion, frame by frame. At each frame location, the film must remain

stationary while that frame is exposed, after which the film must be moved to the next frame position. In the cameras being discussed (and in most, but not all, movie cameras) this intermittent motion is done by a *pulldown claw*. One or more teeth on this claw engage sprocket holes (often called *perforations*) in the film and then "drag it" to the next frame position, during the interval between frame exposures. This movement is necessarily in the downward direction, thus the name of the component. Then the claw moves back to its starting position, and then engages the film for the next stroke.

The gate typically consists of two primary members. An *aperture plate*, nearest the lens, with the film just behind it, defines the plane in which the film will lie, and contains an aperture that defines the scope of exposure of the frame. Behind the film is a pressure plate, which serves to keep the film in contact with the aperture plate. One or the other of these (which one differing between different designs) is spring loaded against the other.

Cooperating with the intermittent mechanism is almost invariably a shutter, rotating or reciprocating, synchronized with the pulldown operation. It opens the path from the lens to the film while the film is stationary for the exposure of a frame, and closes that path while the film is moving between frame positions.

2.1.3 *To the takeup spool and onto it*

The film must then be conveyed in a disciplined (usually steady) way to the takeup spool, where, under the influence of a controlled torque on the spool, the spool winds up the exposed film.

2.2 The need for two "loops"

With the film being led from the supply spool toward the exposure gate at a steady pace, and from the gate toward the takeup spool at a steady pace, but moving intermittently, frame by frame, through the gate, we recognize that there must be some slack in the film before and after the gate to let this happen. The slack is ordinarily substantial, such that it forms into what is called a "loop" in each of these regions. We will regularly hear about these loops as the different mechanisms are described.

3. THE EVOLUTION OF "HOME MOVIES"–16 mm CINEMATOGRAPHY

3.1 16 mm motion picture film and the first camera for it

In the United States, amateur cinematography (which we may, somewhat incompletely, refer to as "home movies") became technically and economically practical when, in 1923, Eastman Kodak

Company introduced (black and white) 16 mm reversal safety motion picture film and a camera to use it.

3.1.1 *The camera*

The first "home movie" camera, introduced by Kodak in 1923, for use with the first 16 mm motion picture film, was called the Ciné-Kodak camera. (After the introduction of the successor model, the Ciné-Kodak Model B, this camera was called the Ciné-Kodak Model A.) We see in figure 1 a typical variety of it. As with each of the camera "models" I will discuss here, the design and exact features varied over the years of production.

Figure 1. Kodak Ciné-Kodak 16 mm camera

The camera was housed in an robust die cast aluminum case. It weighed (loaded with 100 feet of film) about 7.5 lbs. The dimensions were approximately 8.0 in. high, 8.5 in. long, and 4.5 in thick.

This camera had no motor of any sort, and, just as for the studio cameras of the time, needed to be hand cranked ("Two revolutions per second, please") for the duration of a shot. This made working on a tripod (a substantial one, in fact) essentially mandatory.

3.1.2 *Its transport mechanism*

The film transport system of the Ciné-Kodak Model A (as we will call it) is straightforward. In figure 2 we see a typical Ciné-Kodak Model A with the loading door (the left side of the housing) removed.

Figure 2. Ciné-Kodak Model A, loading door open

Annotations have been applied to facilitate reference in this discussion.

We see the film supply spool, S, at the top right. In this case, this is a 100 foot roll. A 50 foot roll could also be used.

The business end of the camera is the exposure gate, G. The film is pressed by a spring loaded pressure plate toward the lens against the aperture plate itself, which is fixed.

An intermittent mechanism, using a reciprocating “pulldown claw”, pulls the film down one frame for every cycle of the mechanism. Here we actually have a *dual claw*, with two “teeth”, which simultaneously engage perforations on both edges of the film. This reduces the force on the teeth and thus on the film itself, minimizing wear during the transport of the film.

This also eliminates the fact that the force of the pulldown claw, if only engaging the film on one side, would tend to twist the film in its plane, requiring more authoritarian lateral film guidance arrangements.

The pulldown claw is moved up and down, and in and out of the gate, by two cams mounted behind the shutter and on its shaft.

The film is drawn from the supply spool by a sprocket, P, which the film engages (the first time) at its top. The film is held in engagement with the sprocket by a clamp, x, (the term used in the official literature) term), which can be unlatched and moved a bit away from the sprocket so the film can be put in place during threading.

After the film has passed though the exposure gate, it is regulated in its movement onto the takeup spool, T, by a second engagement with the same sprocket, now at its bottom. Again there is a movable clamp, y, to hold the film in engagement with the sprocket.

The takeup spool is turned through a friction arrangement providing a controlled torque. It will wind the film as fast as it is "metered" by its second engagement with the sprocket.

So that the film, which is moving at constant velocity through the each engagement with the sprocket, can nevertheless move intermittently through the gate (as done by the pulldown claw), there is slack in the film at points UL and LL, the "upper loop" and "lower loop". To help the operator remember to do this and to suggest about how big the loops should be, there are white loop patterns on the mechanism backplate. (Whoever threaded this beauty apparently didn't pay quite enough attention to that guidance with regard to the upper loop!)

Between the lens and the aperture is a rotary shutter, H.[1] It blocks any light from the lens from reaching the film during the time that the film is moving from one frame to the next. The shutter is fully open about half the time. Thus, with a frame rate of 16 fr/s, the exposure time for each frame is about 1/32 s.

We note in passing that in the serious 16 mm cameras of many other manufacturers, two separate sprockets are used for the "from the supply spool" and "toward the takeup spool" duties of the transport mechanism.

Each sprocket clamp has two rollers to hold the film in proper contact with the sprocket. The profile of these rollers is such that they only actually contact the film along its very edges (outside the sprocket teeth). This avoids any possibility that the rollers would scuff the film in its active area, especially important since the rollers contact the photosensitive (emulsion) face of the film.

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[1] Look fat for a shutter? Well, it has a very heavy rim, so it can serve as the flywheel to keep the mechanism running smoothly.

When we go to thread the film around the sprocket, we open the clamp by pulling outward on a locking plunger with a knurled knob on its exposed end and, with that knob, swing the moving part of the clamp (which carries the rollers) outward. This moves both rollers clear of the sprocket, one of them then clearing the sprocket by more than the other one.

3.2 The Ciné Kodak Model B camera

3.2.1 *The camera*

Kodak's next move was the introduction, in 1926, of the Ciné-Kodak Model B camera, which also used 16 mm film, spool loaded. This camera was smaller, lighter, and more convenient to use than the Ciné-Kodak Model A.

In figure 3 we see an early Model B (from our collection).

Figure 3. Kodak Ciné-Kodak Model B (1928)

The biggest convenience factor of the Model B was that it had a motor drive, using a spring motor. The motor was wound with a crank, and one winding was sufficient for a little less than one minute of shot time. As with its predecessor, it could be loaded with either a 50 foot or 100 foot spool of film. The unique layout of the film transport system allowed the housing to be more compact than that of the Model A while still accommodating the 100 foot supply spool and the matching takeup spool.

3.2.2 *Its transport mechanism*

The camera can use film provided on either 50 foot or 100 foot spools. So that the camera did not have to have the height and/or length to accommodate both the supply and takeup spools in the 100 foot size "in the same plane" (as is the case with the Ciné-Kodak [Model A), in this camera the two spools are mounted "face to face", on essentially the same axis (although separated by a "partition"). This does not increase the thickness of the camera; it needed to be thick enough anyway (at least for part of its length) to accommodate the spring drive motor.

In figure 4 we see the interior of the camera's film transport area).

Figure 4. Ciné-Kodak Model B—Film transport area

The right hand portion of the "back wall" of this area is actually a door, which we see opened in figure 5 (it is normally held closed by a small spring latch at the bottom).

Figure 5. Ciné-Kodak Model B—Interior door open

This exposes the “back room” compartment where the supply spool will go. The light colored finger is used to feel the film on that spool to operate a “film remaining” indicator on the top of the camera. It can be moved aside (using a small knob at its top) to allow the supply spool to be put in place (or the empty one to be removed).

In figure 6 we see an illustrative supply spool in place (this one actually empty).

Figure 6. Ciné-Kodak Model B—Empty supply spool in place

In figure 7, we see the interior door closed and an illustrative takeup spool in place.

Figure 7. Ciné-Kodak Model B—Empty supply spool in place

In figure 8, we see the camera actually loaded and threaded.

Figure 8. Ciné-Kodak Model B—Loaded and threaded

We see the film coming from the supply spool (in the "back room") along a twisted path into the main mechanism compartment (guided by a flanged roller, which we can see most clearly in figure 6).

As to the transport mechanism itself, we see that there is a single sprocket of modest diameter. The film coming from the supply spool engages that sprocket at its top; it is held against the sprocket by an openable "clamp". The film having passed through the exposure "gate" then engages the sprocket at its bottom (again held in place by an openable clamp.

The aperture plate itself, which contains the exposure aperture, is held against the film, which is in turn supported by a fixed pressure plate.[2]

In the gate the film is moved intermittently, one frame at a time, by a reciprocating claw, which engages one sprocket hole after another.[3] So that there will be no tension on the film to interfere with this intermittent motion, it is necessary that there be a slack in the film (a "loop") between the supply-side sprocket engagement and the gate and between the gate and the takeup-side sprocket engagement. White line paths in the camera remind the user to establish these loops when threading and gives guidance as to their approximate size.

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[2] We might expect that, in the interest of greatest accuracy of focus, the aperture plate would be fixed and the pressure plate spring loaded against the film from the back (as in the Model A), but not so here for various practical reasons.

[3] It is actually a "dual claw" which engages the sprocket holes on both sides of the film. This minimizes wear on the sprocket holes and makes guidance of the film easier.

A rotary shutter in front of the aperture plate (not visible here) obscures the film during the time it is moving. The film actually spends about half the time moving and half the time being exposed while stationary, one frame at a time. Thus the exposure time for each frame is approximately 1/32 second.

A spring belt driven by a small pulley at the base of the sprocket passes over a slightly larger pulley at the base of the takeup spool spindle (seen clearly in figure 4). The belt is crossed so as to turn the driven pulley in the proper direction. The pulley ratio is such that if the takeup spool were free to rotate it would turn at a rate slightly greater than is needed to wind the arriving film when the film "pack" is at its smallest diameter (at the beginning of operation).

But the takeup spool can only turn as fast as allowed by the incoming film, considering the current diameter of the "film pack". Thus the belt slips (on the driving pulley, in fact) as needed, maintaining a relatively constant torque on the takeup spool spindle.

The film traveling from its second engagement with the sprocket to the takeup spool passes around an angled "bail". The purpose of this is obscure but very clever.

If the film were to pass directly from its second engagement with the sprocket to the takeup spool, then, depending on the exact location of the takeup spool along its axis, the film might rub on one flange of the spool or the other (with considerable force).

But here the bail forces a twist in the film, allowing it to more readily move laterally as needed to enter the takeup spool. In fact, as the effective width of the film is now less than its actual width, with the spool in any position it is likely to take, both film edges will have clearance from the adjacent spool flange. Then, as the film settles against the film already on the spool, it flattens out, gracefully nestling between the flanges of the spool.

The sprocket clamps in this camera are ornate mechanisms in their own right. Each has two rollers to hold the film in proper contact with the sprocket. The profile of these rollers is such that they only actually contact the film along its very edges (outside the sprocket teeth). This avoids any possibility that the rollers would scuff the film in its active area, especially important since the rollers contact the photosensitive (emulsion) face of the film.

To open the clamps so the film can be threaded around the sprocket, we, using a tab on the moving part of the clamp. move the rollers both out from the sprocket a significance difference. Both rollers move clear by the same amount (a difference from the "swinging" clamps

used on the Model A). After the film has been put into place, the moving part of the clamp is moved back toward the sprocket, moving the rollers into running position.

A detent holds the moving part of the clamp in either its “open” or “running” position.

If we neglect to return both sprocket clamps to their closed positions when we are (we think) done with the threading process, we get a reminder when we try and replace the loading door. There is a post on that door for each sprocket retailer, which will strike the operating tab of the clamp is it is in its open position. Thus the door will not seat properly, our warning that things are not yet right in the mechanism. Yes, we often see on antique Model B cameras one or both sprocket clamp operating tabs bent from their proper positions. How do you think that might have happened?

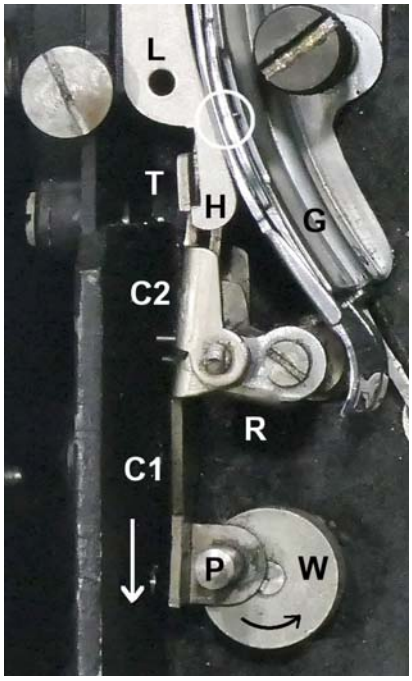

Figure 9. Model B pulldown claw

I will return now to the pulldown claw. We see it in a closer view in figure 9.

The claw is moved by the claw crank wheel, W, which rotates counterclockwise, one revolution per frame time. In this picture it is in its position where the claw is about halfway through its down stroke.

The claw proper comprises two components, C1 and C2, but for the moment consider it to be a single rigid part. It is supported partway along its length by one end of the radius arm R, which pivots at its other end on a fixed post (we see the slit in its head).

As the crank wheel rotates, if the claw were really a single part, and was in free air, the claw tooth would describe a sort of elliptical path.

But the claw is in fact made of two parts, C1 and C2, joined by a pivot (which happens to also be the pivot on which the claw is supported by the radius arm). This "elbow" in the claw has limited motion; the upper part cannot pivot to the right with respect to the lower part more than to a certain position. And this elbow is forced toward this position by a spring.

The bottom line of all this is that when the claw mechanism moves to pull the claw tooth out of the film, it can do so absolutely (by way of the "stiff elbow"). But when it moved to push the claw tooth into the film, it is dependent on the elbow spring for the force to do so. In this picture, the claw tooth is in the area of the white circle; we can see its little tip slightly projecting though the gate pressure plate.

The reason for the "yielding elbow" arrangement is that when the claw tooth head toward the film, if the film is not positioned where it should be—with a sprocket hole in exactly the location needed to gladly receive the advancing claw tooth (and thus might well be the case after the camera had just been loaded and the mechanism is started for the first time). In this case, the claw just yields at its elbow, and the claw tooth is able to just drag along the film proper until it encounter a sprocket hole, into which it then drops.

Now, we will consider the matter of threading the film through the gate during loading. With the camera stopped (and assuming that the motor spring is wound some), the claw is in the position where it is engaged with the film and at the bottom of its stroke (and the shutter is closed, although just about to open.)

Thus, when we load the camera, and are about to thread the film through the gate, the claw teeth would interfere with the entry of the film into the gate.

Removing this problem is the job of loading lever, L. When we commence to load the camera, we move that lever clockwise (by moving the tab at its top to the right), where it is held by a detent.

The lower tip of the lever moves to the left and pushes against a tab, T, on the claw's "forearm", pushing the claw out of the gate so it will not interfere with the entry of the film.

If we forget to move the lever to this "loading" position before we go to thread the film through the gate, we get a rude reminder by the lever, which in its "running position" blocks (in a very visible way) the entry path into the gate.

With the lever in its loading position, if we should inadvertently try to start the camera, as soon as the mechanism starts to move, a hook, H, on the lower portion of the loading lever will catch the claw by its tab at the top of its next downstroke, stalling the mechanism (and still holding the claw out of the gate).

When the film has been properly inserted into the gate, we move the lever back to its normal, "running", position (where it is again held by the detent). It will then turn loose of the claw, which settles back into its normal situation.

Should we forget to return the lever to its running position when we are done loading the camera, if we try and run the mechanism with the loading door still off (to verify that the film as we have threaded it will move properly), it will not run (owing to the threading lever's ability to "catch" the claw).

If we have not restored the lever to its running position and try to replace the loading door, a post on the loading door will strike the operating tab of the loading lever and prevent the door from being seated. Yes, we often see on antique Model B cameras the loading lever operating tab bent from its proper position. How do you think that might have happened?

Referring to figure 4, we see below the position for the takeup spool a black lever. We see two projections from the interior door on which the lever (which is spring loaded upward) can be "parked", and the corresponding lever positions are labeled by the prominent markings on the door "100" and "50".

The tip of this lever has a V-shaped projection that will contact the film when the takeup spool is almost full. The purpose of this lever is to produce a light drag on the film during this phase of operation. This is so that, after all the film has run through the camera onto the takeup spool, leaving the trailing end of the film free, the film will not unwind from the spool.

Thus when the operator opens the camera to remove the exposed film, it will be tightly wound onto the takeup spool, ensuring that light cannot leak into the outermost layers of the film.

The reason that there are two positions in which the lever can be "parked" is so it will contact the film when the takeup spool is nearly filled when 100 foot or 50 foot film rolls are being used.

3.3 The Ciné-Kodak Model K

Over the next some years, Kodak introduced several new 16 mm cameras that descended directly from the Model B. These differed in

the size of film spools they would accommodate (some with smaller housings could only take 50 foot spools), the type of mount if they took interchangeable lenses, and so forth.

Perhaps the most prominent (and long-lived) of these was the Ciné-Kodak Model K, which was manufactured from 1930 through 1946. It was much like the Model B but was lighter and smaller. It also handled up to 100 foot film spools.

Figure 10 shows a typical Model K (from our collection).

Figure 10. Kodak Ciné-Kodak Model K

The transport mechanism of the Model K is almost the same as that of the Model B with a few exceptions, including:

• The sprocket clamps open by swinging out (like the ones in the Model A) rather than sliding out. This in fact comes to be the most common situation in future ciné cameras from various manufacturers.

• The Model K does not have a “loading lever” to hold the pulldown claw clear of the gate when the film is being threaded into the gate. Rather, there is a tab on the claw that the user can use to directly retract the claw, which is then held in the retracted position by a spring latch. When the camera is started and the claw moves up to engage a fresh perforation, the claw comes free from that latch so it can drop into its normal operating situation and engage the film.

In figure 11 we see the Model K film transport area.

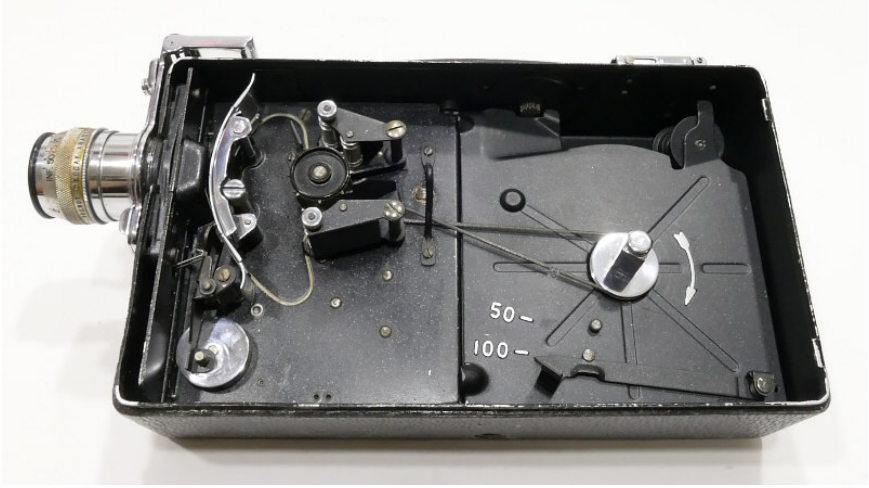

Figure 11. Ciné-Kodak Model K film transport area

We see, however, that the overall arrangement is almost identical to that of the Model B. There is just less “wasted space” in various regions.

In figure 11 the sprocket clamps, a bit different from those of the Model B, are shown open.

Figure 12. Ciné-Kodak Model K—Interior door open

A convenience compared to the Model B is that when the interior door is opened for access to the supply spool position, the “film remaining” finger is automatically drawn clear of the area where the supply spool will be placed. We see that in figure 12.

In figure 13 we see a two closeups of the pulldown claw system of the Model K.

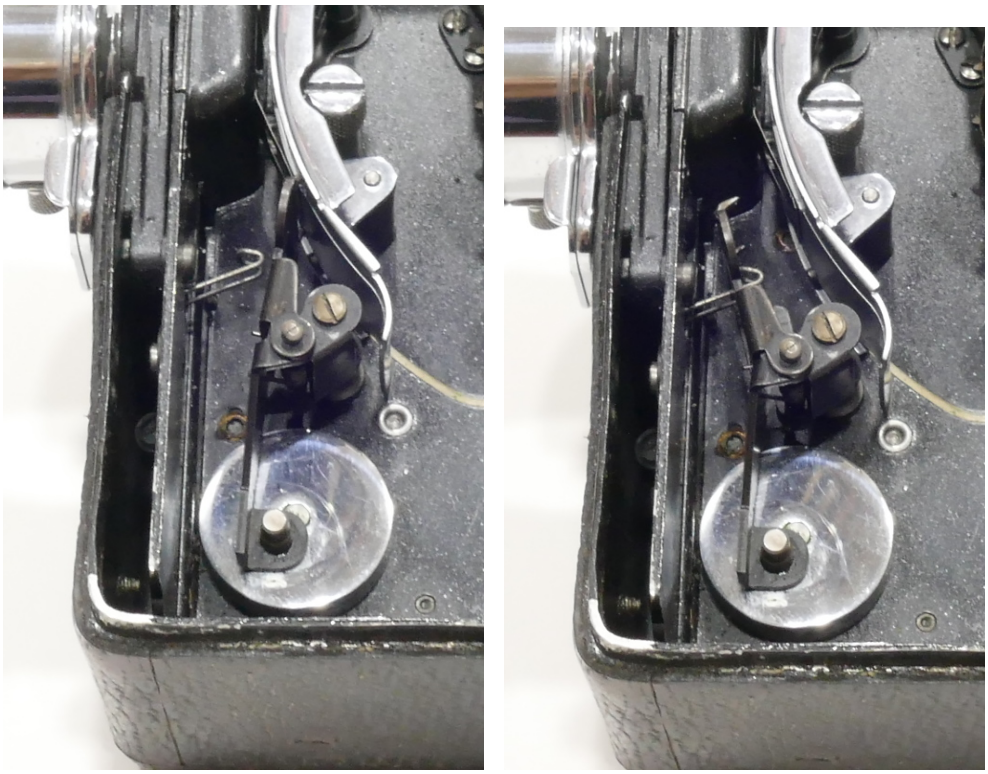

Figure 13. Ciné-Kodak Model K pulldown claw system

In the left panel, we see the claw in its operating situation, at the bottom of its stroke. We note that the arrangement is essentially identical to that of the Model B. A difference is that there is no loading lever. Rather, when the operator is about to thread the film into the gate, she pushes the claw to the left, using a tab near its tip. It is caught in that position by a spring hook. We see the claw thus held back in the right panel of the picture.

When the camera is next started, as the claw moves upward, it disengages from the spring hook and resumes its normal operation.

4. THE SECOND WAVE–8 mm CINEMATOGRAPHY

4.1 8 mm motion picture film and the first camera for it

The next stage of the "home movie" revolution came in 1932, when Eastman Kodak introduced 8 mm motion picture film and a lovely small spring wound camera to use it, the Ciné-Kodak Eight. This combination resulted in lower cost, weight, and size for a camera of given capabilities, and significantly lower cost for film and processing. It actually required this event to bring home movies to "Everyman"

4.1.1 *The film*

Largely to be able to take advantage of film production machinery and portions of film processing machinery developed for 16 mm motion picture film, the Ciné-Kodak 8 camera used the "double 8 mm"

system. Here the film as supplied had an actual width of 16 mm, but the sprocket holes on each side were at half the pitch they would have had on film to be used in 16 mm cameras.

The film was run once through the camera, during which the frames, with about half the linear dimensions of the frames in 16 mm cinematography) would be laid down on one side of the film centerline. When this "pass" was done, the film (now on the takeup reel) was removed and replaced in its original "supply spool" position, other side up. It was then run through the camera again, the frames being laid down opposite those from the first pass.

At the processing laboratory, the film was developed intact. Then the film was slit lengthwise, giving two lengths of actual 8 mm wide film. These were spliced end to end and returned to the user on a reel, ready for projection.

The most common film "package" in this mode had 25 feet of film (plus some extra on each end to be used for threading and to protect the roll from the intrusion of light during handling). Thus the result for the user was a 50 foot movie, with a running time of a little over four minutes.

4.1.2 *The camera*

The Ciné-Kodak Eight was initially produced in two variants, the Ciné-Kodak Eight Model 20 and the Ciné-Kodak Eight Model 25, differing only in the lens with which they were equipped.

In 1932, the Ciné-Kodak Eight Model 60 was introduced. It offered interchangeable lenses. Its mechanism was essentially identical to that of the Model 20 and Model 25.

4.1.3 *Its transport scheme*

In figure 14 we see a Ciné-Kodak Eight Model 25 camera (from our collection) with the loading door (left side of the housing) removed. Annotations have been applied to facilitate reference in this discussion. The film transport scheme a bit unique.

In this photo we see the interior of the camera with the loading door removed. A prominent feature of the transport scheme is the single rather large sprocket (S). The film coming from the supply spool (A) engages this sprocket for a short distance at C; it is held against the sprocket by an openable clamp, c. The film heading toward the takeup spool (B) engages this sprocket for a short distance at D (again with an openable clamp, d). Thus the movement of the film through the mechanism is well controlled.

Figure 14. Ciné-Kodak Eight Model 25 open

In between these two interactions with the sprocket, the film passes through the exposure "gate" (E). The aperture plate itself, which contains the exposure aperture, is held by spring pressure against the film, which is in turn supported by a fixed pressure plate.[4]

In the gate the film is moved intermittently, one frame at a time, by a reciprocating pulldown claw (at F, but not really visible here), which engages one sprocket hole after another. So that there will be no tension on the film to interfere with this, it is necessary that there be slack in the film (a "loop") between the supply-side sprocket engagement (C) and the gate and between the gate and the takeup-side sprocket engagement (D). White line paths in the camera remind the user to establish these loops when threading and suggest an appropriate size for them.

A reciprocating shutter in front of the aperture plate (at G, but not visible here) obscures the film during the time it is moving. The film actually spends about half the time moving and half the time being exposed, one frame at a time. Thus the exposure time for each frame is approximately 1/30 second.

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[4] We might expect that, in the interest of greatest accuracy of focus, the aperture plate would be fixed and the pressure plate spring loaded against the film from the back, but not so here for various practical reasons.

An indicator moved by a spring-loaded finger (H) lying against the film on the supply spool shows the amount of usable film remaining, in feet.

The large single sprocket configuration used in this camera family is rather unique. Some “professional” ciné cameras use separate small sprockets at the feed and takeup ends of the film travel. More commonly, a single sprocket is used for both purposes (the film engaging it twice), but it is typically much smaller then we see here. We do not know what were the design objectives of the large-diameter sprocket used in this camera. In any case, this arrangement sure makes it crowded inside the film transport area.

We note that the sprocket clamps are of the type that open by swinging rather than by sliding (a return to the basic concept of the clamps in the Model A, and in fact consistent with common practice among ciné cameras from many manufacturers). Unlike the clamps in Model A, these are not provided with rollers to contact the film. Rather they have curved polished metal surfaces that contact the film only outside the image area.

As an aside, in later “consumer” 8 mm cameras, there were often no sprockets whatsoever. The intermittent advance of the film in the gate pulled the film from the supply spool (whose inertia caused a very small “loop” to be briefly formed there).

The takeup spool (operating, in the usual way, with a low torque applied by a slip clutch) did not pull the film with enough force to cause it to move in the gate other then as it was propelled by the pulldown claw. When the claw quickly advanced the film by one frame, the film was free to move, briefly forming a small loop on the way to the takeup spool before the takeup spool, with its considerable inertia, “caught up”. This is of course a “cost engineered” design.

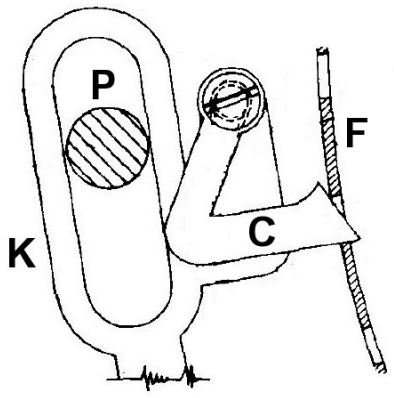

Figure 15. Ciné-Kodak Eight claw assembly

We note that in this camera the pulldown claw is not explicitly retracted from the current sprocket hole by the mechanism (as we saw for the Model B) so the claw can move up to then be dropped into the next sprocket hole.

Rather, here the claw is in the nature of a pawl, still spring-loaded against the film. We see it in Figure 15.

The claw, C, is borne by an oscillating claw carrier K. It is guided in linear motion by guide post P. Not shown is a spring that urges the claw in the direction toward the film.

We see the claw engaging a sprocket hole of the film, F.

After its downstroke is finished, the carrier moves up and the claw cams out of the current sprocket hole. Its tip drags up along the film until it reaches the next sprocket hole (actually a little bit further). Then as its downstroke begins, it fully enters that next sprocket hole so the claw can then move the film down one more frame location.

Although this motion seems simple, the mechanism that produces it (and, separately, operates the vertically oscillating shutter) is intricate and ingenious. One of its achievements is that the claw moves downward in a shorter period than that in which it moves upward. Thus the film is stationary (and ready to be exposed) for more than half of the frame time, thus giving a greater exposure time for any given frame rate. The movement of the shutter cooperates in this.

5. LATER 16 mm CAMERAS

5.1 The Ciné-Kodak Special series

5.1.1 *The cameras*

The Ciné-Kodak Special, introduced in 1933, was an elaborate professional camera using 16 mm roll film. In the Special, the film was carried in a replaceable film magazine, which was actually half the camera. (In fact, except during the first few years of this series' life, Kodak called these *film magazines*, since by then *magazine* had come into use with a different meaning. I will nevertheless consistently refer to them as magazines.)

There were two types, one that accommodated a 100 foot film spool and another (giving the camera the iconic "movie camera" profile) that accommodated a 200 foot film spool.

In 1948, the original Ciné-Kodak Special was superseded by the Ciné-Kodak Special II. A major difference was in the details of the two-lens turret and the type of lens mount used. There was no consequential change in the transport mechanism.

In Figure 16 we see a typical Ciné-Kodak Special with the 100 foot capacity film magazine.

Figure 16. Ciné-Kodak Special with 100 foot film magazine

5.1.2 *The turret*

The camera's turret system is of course not part of the film transport system, but it has some special mechanical features, so I will discuss it briefly here.

In the original Ciné-Kodak Special, the turret was basically a flat slab of aluminum. It sat against the front plate of the camera, essentially another flat slab or aluminum. The lens mount system holds the lenses in place with their axes perpendicular to the turret "face". Thus, the axes of the two mounted lenses were parallel.

But if both lenses flowered at their fronts into large-diameter hoods, the two lenses might physically interfere with each other.

Or, if one lens had a wide field of view, and the other lens (perhaps a telephoto) were physically long, the second lens might some into the field of view of the first lens.

As a result, for example, there is in the manual for that camera an elaborate table showing what combinations of the Kodak ciné lenses considered suitable for use with this camera would actually be compatible, mechanically and optically.

This was a serious limitation to many users (or potential users) of the Ciné-Kodak Special camera.

To alleviate this problem, in the Ciné-Kodak Special the turret has a "roof" shaped face, with the "ridge" outermost. The front plate of the camera proper is canted at an angle. The overall result was that the axes of the two mounted lenses diverge but the axis of the "active" lens iss still parallel to the camera axis.

We can see the situation in figure 17, adapted from a drawing in the patent for this scheme:

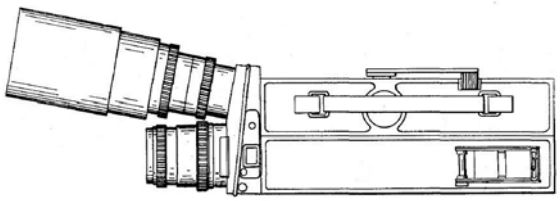

Figure 17. Ciné-Kodak Special II—Turret geometry

One challenge of this arrangement is that, as the turret rotates, lenses that have a substantial projection behind the mounting plane can come into interference with the camera front plate. To avert this, the turret cannot be rotated continuously, but only 180° degrees. The turret has prominent arrows that, with it in either of its two operating positions, show in which direction it can be rotated to get to the other position.

5.1.3 *The film magazine—general*

Unlike earlier 16 mm Ciné-Kodak cameras, the Special cameras can use "single perforation" film, allowing the possibility of adding a magnetic sound track to the developed film. Among other things this means that the intermittent pulldown claw only has a tooth on one side, and the sprocket only has teeth on one side.

In this camera (both versions), the entire film transport mechanism, including the exposure gate and the intermittent pulldown system, is in the removable film magazine. With the magazine in place, a drive wheel on the camera body proper engages, with two pins on its face, a mating wheel (with two holes) on the magazine.[5] This is the "motor input" to the film magazine. The drive rotates once per frame of camera operation.

An important consideration is that this camera can be run both forward and backward. Backward motion is not under "spring motor" power, but rather is done with a special crank inserted into one of two openings on the camera's "control panel". We see this "hand winding crank" in place in one of those locations on figure 16.

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[5] The two pins are not symmetrically located, thus the two mating wheels can only engage in one orientation.

Backward winding is used for such special effects as dissolves and double exposures, in which the film is exposed once for a “scene”, then wound back by hand, then exposed again.

One consequence of this is that that the pulldown claw also has to be able to “pull up”. Thus the claw cannot be of the “pawl” nature, where after pulling the frame down one fame the claw. moving upward to grab the next perforation, just cams out of the existing perforation and slides along the film until it finds the next perforation.

Rather in these film magazines, the claw is driven in an “absolute” way. During forward operation, the path of the claw tooth is rather an oval, with it engaging the film during the downward portion but free of it during the upward portion. During backward operation, the claw mechanism just works in the opposite way, the claw tooth engaging the film during the upward portion of its path but being free of the film during the downward portion.

The movement of the claw into the film is “permissive” (with a yield spring): If the claw strikes the film, the claw yields rather than punching through the film.

This is of course not a new concept for the pulldown claw. The claws in almost all early Ciné-Kodak cameras worked in that way (but of course was not called upon to move the film “backward”).

A further imperative is that the takeup process must now be workable both when the film is taken up on the takeup spool (in normal operation) or on the supply spool (in backward operation.

This is accomplished by having a belt, driven by the gear train in the magazine, drive pulleys associated with both supply and takeup spool shafts. There is a one-way clutch between each of these pulleys and the associated shaft, oppositely oriented for the two shafts.

Thus, when the mechanism is operating in the normal, forward direction, a torque is applied by the belt to the takeup spool shaft; when the mechanism is operating in the backward direction, a torque is applied by the belt to the supply spool shaft. The belt will slip on the pulleys as needed to allow the driven shaft to turn at only the speed needed to wind the film.

5.1.4 *The 100 foot magazine*

In figure 18 we see the 100 foot capacity film magazine, open.

Figure 18. 100 foot magazine on a Ciné-Kodak Special II, with loading door open

Here the supply spool is at the right (an empty spool is in that spot here) and the takeup spool to the left. Again a single sprocket is used to meter the film movements in both phases of its passage. But here, both those engagements are on the same side of the sprocket (an arrangement we saw earlier in the 16 mm film magazine).

The shiny lever on the right, when the loading door is closed, lies on the film in the supply spool. It operates the "footage remaining" indicator on the magazine. It rides on the film at one edge, so there is no concern about it scuffing the picture area of the film.

The shiny lever whose tip we see near the takeup spool pulley lies on the film in the takeup spool once the film pack builds up substantially. Its purpose is, when all the film had been run through and the tail of the film is free, to keep the tail wound snugly around the film pack until we grasp the spool to remove it, making sure that there is no exposure to light onto the latter layers of "active" film

This is a different strategy than in the Model B and Model K, where the drag lever does not contact the film until the takeup spool is almost full. Here, as in the case of the film measuring lever, this lever rides on the film at one edge, so there is no concern about it scuffing the picture area of the film.

Figure 19 shows the film path when the magazine is threaded (adapted from a figure in the manual).

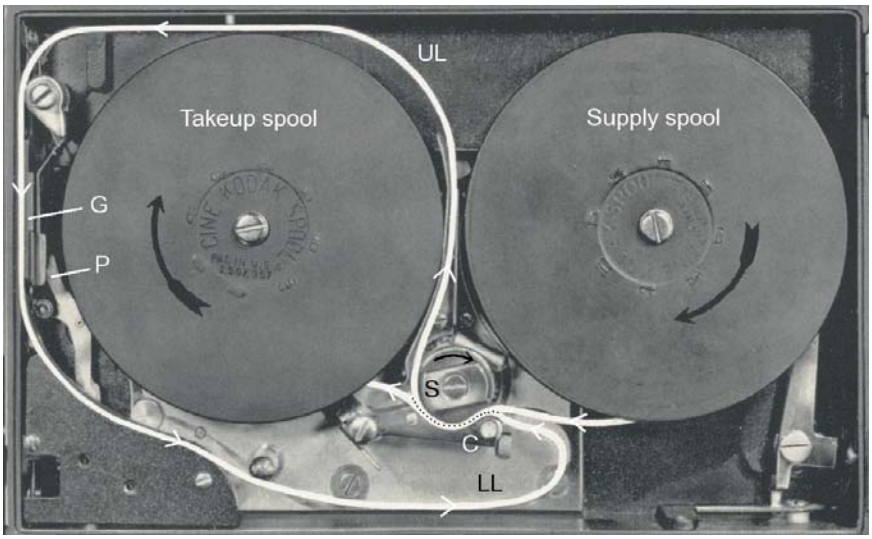

Figure 19. Film path of the 100 foot magazine.

There is a single sprocket, which serves to meter the film movement from the supply spool and also its movement toward the takeup spool. A pivoting sprocket clamp. C, serves to hold the film in proper engagement with the sprocket. It can be swung slightly aside, after releasing a latch by pushing on a small knob (just to the right of the label "C"), in order to insert the film.

The clamp engages the film through two rollers. Their profile is such that they only touch the film in the sprocket area so there is no risk that they will scuff the film in the image area.

The sprocket only has teeth on one edge of the film (the edge away from us). In the case of "single perforated" film (used when a magnetic sound track is to be laid on the developed film) there are only perforations on that edge.

After the film passes around the sprocket, under the two rollers of the clamp, it is led up through a narrow channel between two polished metal plates. From there. as the upper loop, UL, it goes to our left under the "roof" of the magazine, and then turns down to go into the exposure gate, G.

In the gate, the film is moved by the pulldown claw, P, which has a tooth that engages a single film perforation. The claw moves down to move the film down by one frame distance, then is withdrawn from the film, then moves up to where the next perforation is, then moves into that perforation, and then again moves down.

Leaving the gate, the film travels down a polished "chute" to the floor of the magazine, then along the floor (as the lower loop, LL) until it is below and to the right of the sprocket. Then it turns back and passes

through the sprocket a second time, now lying in contact with the film passing through the sprocket on its way from the supply spool.

Figure 20 is a sketch that makes more clear this situation at the sprocket.

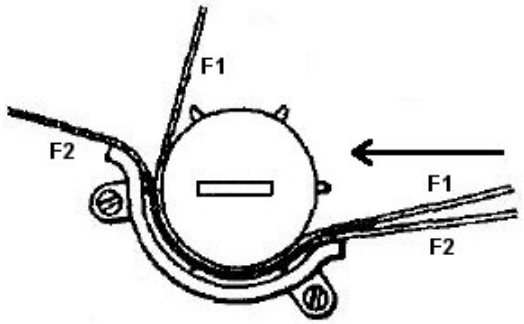

Figure 20. Double layer of film around sprocket

We see that in this layout the upper and lower loops are rather spread out, unlike the situation in typical motion picture cameras, where the loops are formed "in thin air" over a short distance from the sprocket to the gate.

In fact, here the film will likely slide along the "ceiling" and the "floor" of the magazine. These surfaces are not provided with polished shiny metal surfaces for the film to touch. They are however nicely smoothed. And they have a slightly curved surface (like a shallow trough) so that the film gliding along these surfaces will only touch them at the film edges, where we are not concerned with possible scuffing.

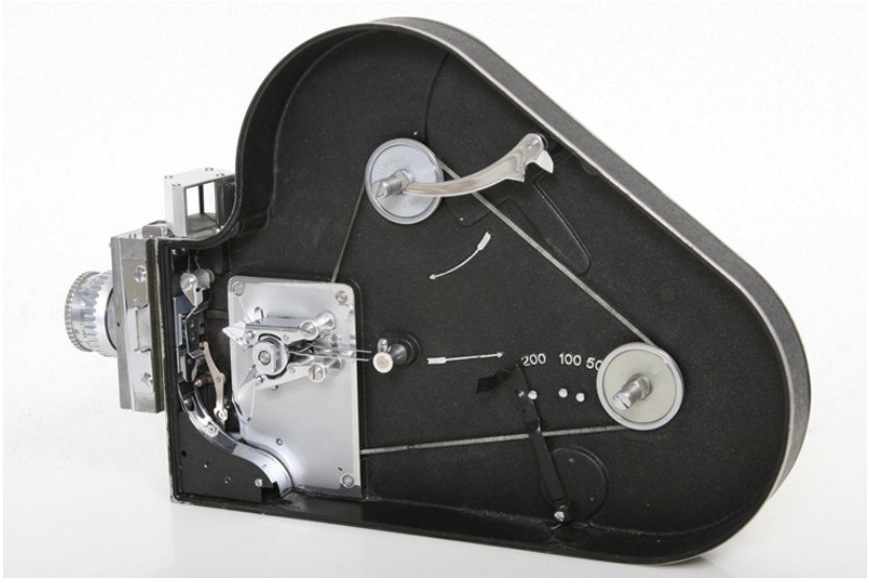

Figure 21. Ciné-Kodak Special–200 foot film magazine, open

5.1.5 *The 200 foot film magazine*

In figure 21 we see the interior of the 200 foot capacity film magazine, showing the basic layout of the film transport system. The overall principles of the film transport are the same as in the 100 foot magazine, but the arrangement is rather different. The relative positions of the supply and takeup spools are (more or less) reversed from the situation in the 100 foot magazine.

We see the takeup spool shaft and the takeup drag lever, here in the same style as on the Model B and Model K, in this case with parking positions for 200 foot, 100 foot, or 50 foot rolls.

The light colored lever resting on the supply spool spindle lies on the surface of the supply roll with the magazine loaded. It operates the "film remaining" indicator, which is on the right face of the film magazine. It rides on the film at one edge, so there is no concern about it scuffing the picture area of the film.

We see the film path in the 200 foot magazine in figure 22 (adapted from a figure in the manual).

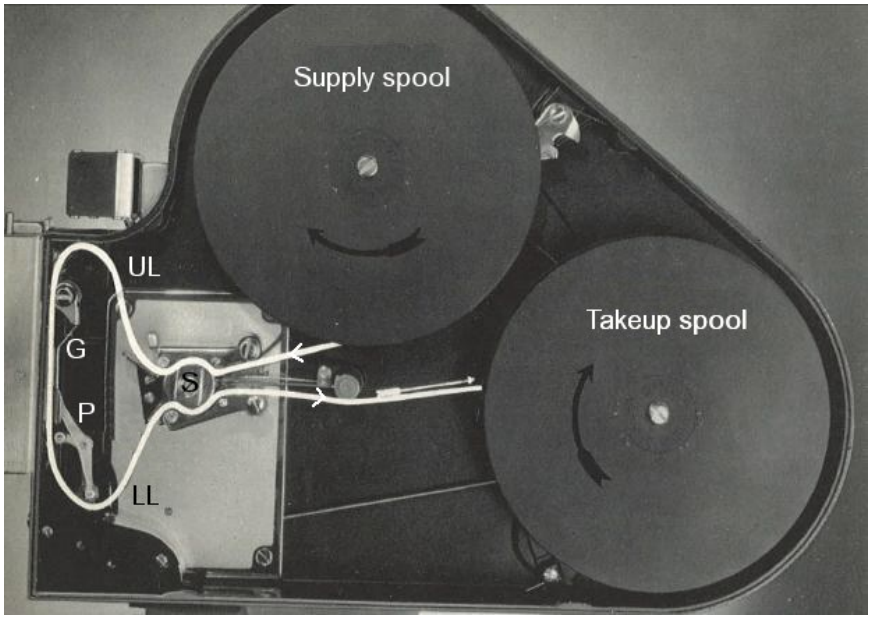

Figure 22. Film path of 200 foot magazine.

Although a single sprocket is again used, the film paths from the supply spool and to the takeup spool here utilize opposite sides of the sprocket, rather than traveling though the same part of the sprocket "piggy back" as in the 100 foot magazine.

In this arrangement, the upper and lower loops are more "conventional" than in the 100 foot magazine, short and "hanging in thin air" (as in most other cameras)

5.1.6 *Aperture axial positioning*

The gate assembly (which includes the aperture plate), part of the magazine, floats in an axial direction, urged toward the lens by a spring.

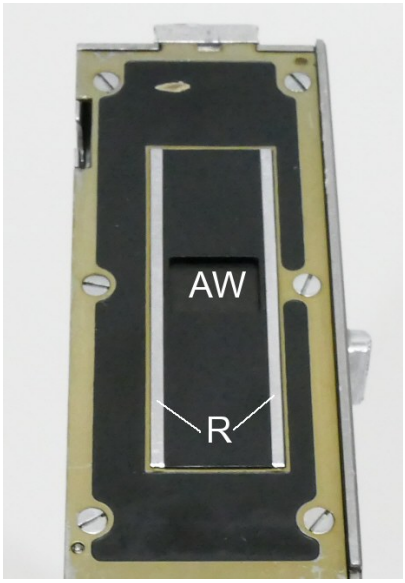

Figure 23. Ciné-Kodak Special—front face of 100 foot film magazine

In figure 24 we see part of the front face of the film magazine.

AW is the aperture window, now closed with the dark slide. The gate presents itself as two rails, R, which protrude slightly from the front face of the magazine.

Figure 24. Back of camera front plate

In figure 24 we see the left part of the back side of the camera front plate, against which the front face of the magazine fits closely.

When the magazine is put in place, the two rails on the gate, R, press against this surface, driving the gate back into the magazine as needed to precisely locate the gate axially, so that focus will be proper (especially if focus has been set precisely with the reflex viewfinder). We can in fact see four little scuff marks where the tips of the rails have pressed on this surface over the years.

5.2 The Ciné-Kodak K-100

5.2.1 *The cameras*

In 1955, Kodak introduced the Ciné Kodak K-100, an elegant spool loading 16 mm camera, in its single lens form, and in 1956 it was joined by a three lens turret version (known formally as the Ciné-Kodak K-100 Turret. Figure 25 shows the turret version. (This is not our personal specimen.)

Figure 25. Kodak Ciné-Kodak K-100, turret version

This interchangeable lens camera, which we might describe as intended for the advanced amateur/semi-professional, has several of the advanced features of the Ciné Kodak Special family but in a “less industrial” aesthetic design. It accommodates up to 100 foot rolls of 16 mm film and, like the Special, can use “single perforation” film, as might be used if a magnetic sound track were later to be laid onto the film.

This is, for all practical purposes, the last Ciné-Kodak camera.

5.2.2 *The turret*

Paralleling the situation in the Ciné-Kodak Special II, the face of the turret is “dished” (convex outward) so that the axes of the mounted lenses will diverge, avoiding mechanical or optical incompatibility between lenses.

We also note on the turret three small-diameter lenses. These are the front lenses for the internal viewfinder. Their focal lengths are chosen so as to give the viewfinder the same view as the camera has with the currently active “taking” lens.

5.2.3 *The film transport system*

In figure 26, we see the film transport area of the K-100.

A single sprocket is used in the familiar way, with the film engaging it twice, once on the top and once on the bottom. The sprocket, by the way, only has teeth on the “back side”, thus allowing the camera to use film stock perforated only along one edge. This may be encountered when it is contemplated, after the film is exposed and developed, to lay a magnetic sound track on it so that sound can be laid in during post-production.

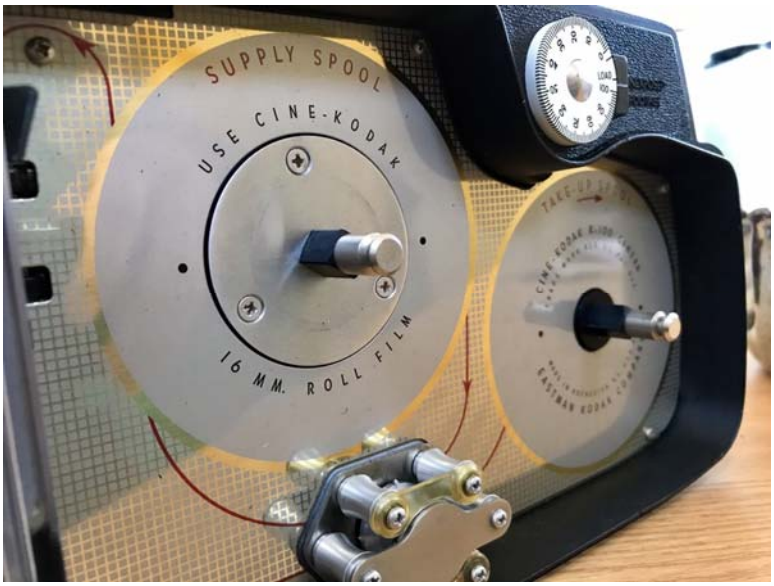

Figure 26. Ciné-Kodak A-100, open

Here, the sprocket clamps are not openable. They each have a pair of rollers. In addition, there are two more rollers, at 3 o’clock and 6 o’clock, which serve to “strip” the film from the sprocket when it is time for it to leave its engagement with the sprocket and go on with its journey.

The profile of these rollers is such that the film can be slipped into place on the sprockets without anything opening.

The plastic “dog bones” joining each of the two pairs of roller spindles and the plate with two ears comprise a “fence” to keep the film in place. The film is put in place through the slots left open between the fence parts. The slot is not located where it would be handy for the film to slip out through it. But, just to make sure, when the loading door is put in place a spring-loaded ring on the door is pressed against the face of the sprocket assembly and blocks that slot.

In figure 27, we get a more complete look at the sprocket and its surroundings, and as well a look at the gate.

We see the “gate back”, the black rectangle with two light-colored buttons. On the face of the back there is a spring loaded pressure plate, an arrangement paralleling that on the back of a typical 35 mm film camera. (The rivet heads we see are part of the support arrangement for the pressure plate.)

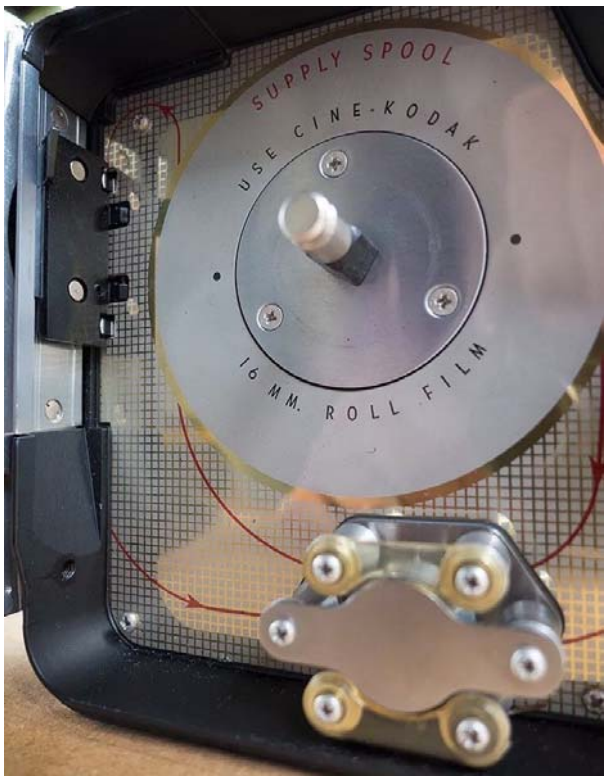

Figure 27. Ciné-Kodak A-100—sprocket and gate

The gate back can be easily opened on a hinge (there is a “toggle spring” arrangement to hold it open, or closed) to allow the aperture plate, pressure plate, and film guide channel to be easily cleaned. This is a gigantically more convenient situation that we previous had on any of the Kodak ciné cameras.

In figure 28 we see the gate opened.

Figure 28. Ciné-Kodak A-100—gate open

We see the pressure plate. It has several polished ribs to hold the film flat in the region of the aperture.

Inside the white squares we see spring edge guides, which hold the film against a guide wall on the opposite side so its lateral position will be precisely controlled.

The pulldown claw (in the white circle) has a single tooth (consistent with the possible use of single-perforated film) and is explicitly pulled from the film for its upstroke.

The claw is driven in and out, and up and down, by two cams on the hub of the rotary shutter.

6. MAGAZINE LOADING

Loading these cameras involved “threading” the film through the transport mechanism, a slightly tedious process that was not attractive to the user. The process was more difficult in the 8 mm cameras than the 16 mm cameras because the film path was more “congested” in the 8 mm camera (largely a result of the slightly bizarre

"really big sprocket" design in those cameras). Overall, the prospect of having to thread the film kept many people away from adopting this new art form. But help was on the way.

6.1 The Ciné-Kodak Magazine 16

6.1.1 *The camera*

To mitigate this problem, Eastman Kodak, in 1936, introduced the Magazine Ciné-Kodak, a camera that utilized 16 mm film that was preloaded in a light-tight magazine (also introduced at that time). Loading the camera was now as simple as just placing a fresh magazine in the camera and closing the loading door. We see in figure 29 a typical Magazine Ciné-Kodak.

Figure 29. Kodak Magazine Ciné-Kodak (16 mm)

The standard magazine held 50 feet of 16 mm film, for a total shot time of a little over two minutes.

This model was made until 1945. It was then superseded by the almost indistinguishable Ciné-Kodak Magazine 16, made through 1950. In 1950 Kodak introduced the "third generation" 16 mm magazine camera, the Ciné-Kodak Royal Magazine camera. We see in figure 30 a typical camera of this model.

We see that is had received some substantial design and styling changes, one of which was that the viewfinder was now enclosed.

Figure 30. Kodak Ciné-Kodak Royal Magazine

It is believed that it was this model that was used by Princess Elizabeth of Great Britain, not long before she became Queen Elizabeth II, to make the precious movies of her children that have recently been presented by the BBC. We might wonder whether the interesting name of this model had anything to do with that.

Figure 31. Kodak 16 mm magazine

6.1.2 *The 16 mm magazine*

In these cameras, the entire film transport system (except for the pulldown claw, but including the exposure gate) is in the preloaded magazine. Thus, the film transport story centers on the magazine.

In figure 31 we see a typical Kodak 16 mm magazine.

I note that in that photo, the two screws that hold the cover on the magazine have been removed, as has been the sealing tape we will see later.

In figure 32 we see a typical 16 mm magazine with the cover removed. It has been annotated to facilitate reference.

Figure 32. 16 mm magazine, open

We note that, since there is no “drag brake” on the supply spool, even with the magazine not in a camera, the film has somewhat unrolled.

As in typical 16 mm camera (and early 8 mm camera) design principles, the transport scheme here involves a sprocket (S), which, as its first task, draws the film from the supply spool (so the pulldown claw won’t have to do that) and, as its second task, “meters” the movement of the film onto the takeup spool (so the torque on that spool does not try to give the pulldown claw help it doesn’t want).

As in typical 16 mm camera (and early 8 mm camera) design principles, the transport scheme here involves a sprocket (S), which, as its first task, draws the film from the supply spool, A (so the pulldown claw won’t have to do that) and, as its second task, “meters” the movement of the film onto the takeup spool, B (so the torque on that spool does not try to give the pulldown claw help it doesn’t want).

Before I proceed, let's look at the back of the magazine, seen in figure 33.

At the bottom we see a reddish "pinion". With the magazine in the camera, this will engage with internal teeth on a drive hub rotated by the camera mechanism when the camera is running. The pinion drives the mechanism of the magazine.

Figure 33. Kodak 16 mm film magazine–rear

The drive hub is arranged so it can float a bit laterally so it can engage the magazine pinion regardless of small variations in the pinion position (it is on a "stalk"). The drive hub is also able to retreat from its normal position in case the exact alignment of the teeth of the two mating members is such that engagement can't be immediately accomplished. As soon as the drive hub begins to rotate, it will quickly be able to "pop out" into engagement with the pinion.

Now, back to figure 32. The pinion on the magazine is directly connected to the sprocket, which thus will turn as the camera mechanism runs. The path of the film to engage the single sprocket twice is rather novel (although in fact it is precisely paralleled by the arrangement used in the 100 foot film magazine of the Ciné-Kodak Special cameras).

Leaving the supply "spool" (again actually only a hub) the film engages the sprocket at its bottom (as we see it in the picture). The film then travels to the top of the magazine (past the area labeled "UL", as this is part of the upper loop), goes over the takeup spool, and them passes down through the gate, G, (propelled there, as usual, by a pulldown claw in the camera itself).

Leaving the gate, the film drops to the bottom of the magazine and travels under the takeup spool. It goes under the sprocket arrangement and then doubles back (at the area labeled "LL", as this is

part of the lower loop), then engaging the sprocket in the very area where the film, coming from the supply spool, already engaged it. Thus, the two film runs lie in intimate contact. That situation is shown in figure 34.

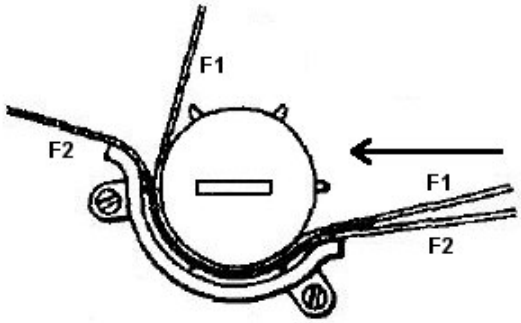

Figure 34. Film passing twice over the same part of the sprocket

F1 is the film passing through the sprocket on its way from the supply spool. F2 is the film passing thorough the sprocket on its way to the takeup spool.

The sprocket is driven by a shaft in the camera body that engages with the magazine sprocket shaft when the magazine is put in place.

In figure 35 we see how tension is put on the takeup spool.

Figure 35. Takeup drive

A gear, t, on the sprocket (which is rotating continuously when the camera is running) drives an idler gear T, which drives a gear (not visible) below the takeup hub, B. That gear is coupled to the hub itself through a slip clutch. Thus, a controlled torque is applied to the takeup

hub so it will wind up the film as it comes off its (second) engagement with the sprocket.

In this picture, flap F has been moved from its typical operating position, perhaps so as to give the best view of idler gear T.

In figure 36 we see the “nose” of a magazine, the end that goes against a wall in the camera, toward the lens.

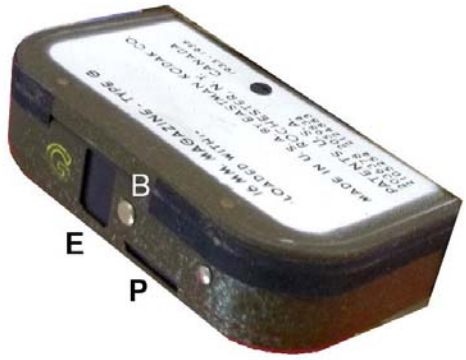

Figure 36. 16 mm magazine “nose”

Button B bears against a button on that wall to properly locate the magazine (and thus the exposure gate) longitudinally). To finish that story, the magazine is located in the proper plane by its back surface lying against three buttons on the side wall of the magazine case. It is properly located vertically in that its “lower” side lies against two buttons on the bottom of the magazine compartment. Various springs (some on the loading door) force the magazine into contact with all these locating features.

We see on the magazine nose the window through which the film will be exposed (E), and the slot through which the pulldown claw will engage the film (P). With the magazine not in a camera (as in this picture) these are both covered by a flexible thin metal shutter with a black finish just inside the magazine outer wall.

Referring again to figure 32, that shutter runs around the “upper right” corner of the magazine (as we see it) between the magazine outer wall and an inner wall (IW). On it is a post (P) that protrudes through the outer wall through a slot. We see the post and the slot in figure 37.

The inner wall blocks any light through the slot from entering the magazine interior.

Figure 37. Shutter control post

The way that post is moved can be seen in figure 38, which shows a Ciné-Kodak Magazine 16.

Figure 38. Ciné-Kodak Magazine 16, open

When the magazine is put in place in the camera, that post engages a sliding fork in the camera, F, part of the loading door locking slide, whose operating tab is labeled as S. When the loading door is closed and the slide is moved from “Open” through “Locked” to “Run”, the fork moves to the upper right (in the figure), pulling the post and thus pulling the flexible shutter in the magazine clear of the exposure window and pulldown claw slot.

If we remove the magazine (even if only partly used), when the loading door locking slide is moved to “open”, the fork pushes the flexible shutter back into place, preventing any light leak into the magazine when the door is opened. As the tip of the shutter moves to close the pulldown claw slot, it cams the claw out of the way by way of its inclined upper surface.

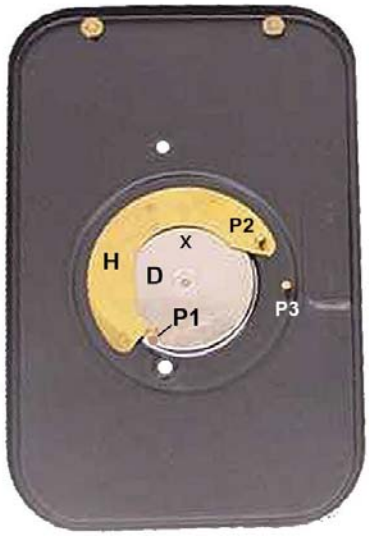

Figure 39. Cover underside showing footage indicator

The magazine has on its cover a footage remaining indicator (seen on figure 31, a little green window). We see its mechanism from the underside on figure 39.

The pointer is moved by a disk, D, which has a post, P1, that will contact the supply roll of film at its edge (in the sprocket hole area, so there is no concern of the post scuffing the film in the image area), urged by a hairspring under disk D.

When the magazine has been loaded and it is time to put the cover on, the operator can move the indicator to the position where the post is well clear of the film roll (perhaps at point “x” and keeping in place with a finger on the slotted head in the center of the indicator as the cover is put in pace.

One final feature is seen on this figure, the fixed posts P2 and P3. With the cover in place, they is in a position to assure that the film, leaving the sprocket in its first trip, is forced to head upward so it will successful begin its journey to the upper loop. They only contact the film near one edge.

In the first cameras that used this type of magazine (the Magazine Ciné-Kodak, the Ciné-Kodak Magazine 16, and the Ciné-Kodak Royal Magazine), the pulldown claw, as in the Ciné-Kodak Eight cameras, is

not explicitly retracted from the current sprocket hole by the mechanism so the claw can move up to then be dropped into the next sprocket hole.

Rather, the claw is in the nature of a pawl. The principle of its operation is described in section 4.1.3 .

To wrap up with a small detail, on the pressure plate there is a small tooth that acts like a ratchet on the perforations and prevents the film from moving backward through the gate (which I suppose could happen if somebody was "playing" after opening the magazine shutter).

In addition, there is some spring mechanism (I'm not sure just how it works) that prevents the sprocket from being turned in the reverse direction.

At one time the magazine when sold had on it a label indicating the type of film it contained. Figure 40 shows two versions of thoset (the earliest form at the top)..

Figure 40. Film labels on 16 mm film magazines

More recently, that was given up (perhaps in the interest of Kodak being most flexibly able to reuse returned magazines) and instead the magazine labeling became more generic (as we see in figure 31) and the type of film was printed on the tape used to seal the cover on the magazine. We see that in figure 37.

This magazine was widely use by the U.S. Military during World War II, often in "gun cameras". In that context it was known as the "type G" film magazine.

6.2 The Magazine Ciné Kodak Eight Model 90

6.2.1 *The camera*

Moving this new convenience to a wider pool of prospective users, Eastman Kodak, in 1940, introduced the 8 mm film magazine and with it a camera to use it, the Magazine Ciné-Kodak Eight Model 90, seen in figure 41 (this from our collection).

Figure 41. Magazine Ciné-Kodak Eight Model 90

Again, this used an easily loaded preloaded magazine. Following the lead of the earlier spool loaded 8 mm cameras, this magazine used the double 8 mm scheme.

The magazine contained 25 feet of double 8 mm film. It was inserted in the camera and the loading door closed. After all 25 feet of usable film had been exposed in its “first pass”, the camera was opened, the magazine removed and then replaced the other way two, and the door closed. The camera was then ready to give the film its second pass.

This camera was produced until 1946, when it was replaced by the almost indistinguishable Ciné-Kodak Magazine Eight, which was made until 1955.

The “Model 90” in the name of this camera seems odd. My suspicion is that this camera was initially seen as the “magazine loading” version of the Ciné-Kodak Eight family, which in its roll loading form had versions known as Models 20, 25, and 60.

6.2.2 *The magazine*

As in the 16 mm magazine, the entire film transport system (except for the pulldown claw, but including the exposure gate) is in the preloaded magazine. Thus again the film transport story focuses on the magazine.

In Figure 42 we see a typical 8 mm film magazine.

Figure 42. Typical 8 mm film magazine

With the magazine not in a camera, an internal rotary shutter in the magazine blocks the windows through which the film will be exposed and through which the pulldown claw will engage the film perforations (I say "windows" since there are two, one to be used during each "pass" of the film.)

In figure 43 we see the "face" of the magazine, the part that will lie against a wall of the camera toward the lens. It has been annotated for convenience in reference.

Figure 43. 8 mm film magazine—"face"

When the magazine is placed in the camera, a small square shaft with a pointed end (S), emerging from the center of the front face of the magazine, enters a matching opening on a small wheel in the camera body, accurately locating the magazine (most importantly, the gate) with respect to the lens, laterally.

Four small posts on the wall of the camera body enter matching holes (G) on the face of the magazine, where they press on the gate assembly, which is in its entirety spring loaded toward the face of the magazine. This action serves to accurately locate the gate (and thus the film plane) at the proper spot along the optical axis. The resulting small inward movement of the entire gate also, ingeniously, frees the blocking shutter so it could be rotated.

In fact, the square guide pin we heard of earlier is actually the shaft of the blocking shutter. When the loading door is closed, a tab on it operates a lever in the camera body which rotates the wheel into which that shaft now extends by 90°, in turn rotating the blocking shutter in the magazine so as to open the path to the exposure aperture (and for the pulldown claw) that will be used on this pass. (It also opens the path to the other exposure aperture, but that one is blocked by a resilient pad on the camera wall, sort of an "eye patch".[6])

In figure 44, we see the magazine with the windows opened.

Figure 44. 8 mm film magazine—"face", windows opened

We can in fact see sprocket holes through the portions of the windows in which the pulldown claw will operate. (Do not be confused by the colors we see through the four little holes—this is not film, just the color of the near portion of the gate assembly.)

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[6] Which, however, is missing in the specimen shown in the photo. Hey, I bought it for $19.00, and it's 77 years old.

In figure 45 we see the interior of the magazine.

We see that this is a “sprocketless” film transport system, as found on later simpler 8 mm movie cameras. We can see that as the takeup “spool” (actually, a flangeless core) fills up, it will eventually intrude into space where film on the supply “spool” had been, but is no longer.

Figure 45. 8 mm film magazine—interior

When the magazine is not in a camera, small spring brakes inside the spindles on which the spools run provide a drag to prevent the film from unwinding as the magazine is handled. When the magazine is placed in the camera, a post on the wall against which the magazine lies pushes on the brake “plunger” for the supply spool, releasing its drag on the spool. When the loading door is closed, a post on it does the same thing to the brake plunger for the takeup spool. Thus both spools are free to rotate without any brake drag.

When the magazine in inserted in the camera, the hub of the takeup spool, which carries a protruding tab, lies against a rotating wheel, with two tabs, on the camera wall. When the camera runs, this disk is turned by a slip clutch (the wheel itself is one of the clutch plates), and through the engagement of a tab on the wheel with the tab on the magazine spool hub, a modest torque is applied to the takeup spool.

At the gate, a coil spring presses the pressure plate against the aperture plate (the film being trapped between) so as to ensure that the film lies against the aperture plate. This in turn presses the entire gate assembly toward the magazine wall so that it will rest on the four

posts coming from the camera wall, thus assuring proper positioning of the film at the focal plane of the optical system.

Because the supply spool is free to turn (it must be so that the film can be easily drawn from it by the action of the pulldown claw, throwing a small “loop” of slack in the process), it is possible that the outermost turn of film could contact the film being wound onto the takeup spool. This would bring the emulsion (sensitive) faces of the two film runs into contact, and they are moving in opposite directions, so this could result in “scuffing” of one the emulation, damaging the image.

To avert this, a jockey roller, supported by a freely swinging frame, intervenes to keep the two film runs out of contact. The jockey roller itself only contacts the film runs near their edges, in the sprocket hole area, so there is no chance that the jockey roller itself could scuff the emulsion in the active area.

We note that in this magazine the film is would on the supply “spool” with the emulsion (sensitive) side out, the opposite arrangement from that used for cine film on spools generally.

As with the 16 mm film magazine, at one time the 8 mm magazine when purchased had on it a label indicating the type of film it contained. More recently, that was given up (perhaps in the interest of being most flexibly able to reuse returned magazines) and instead the type of film was printed on the black tape used to seal the cover on the magazine.

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