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Portable camera and recorder for News reel work

"Seeing" Motion Pictures is due to Persistence of Vision

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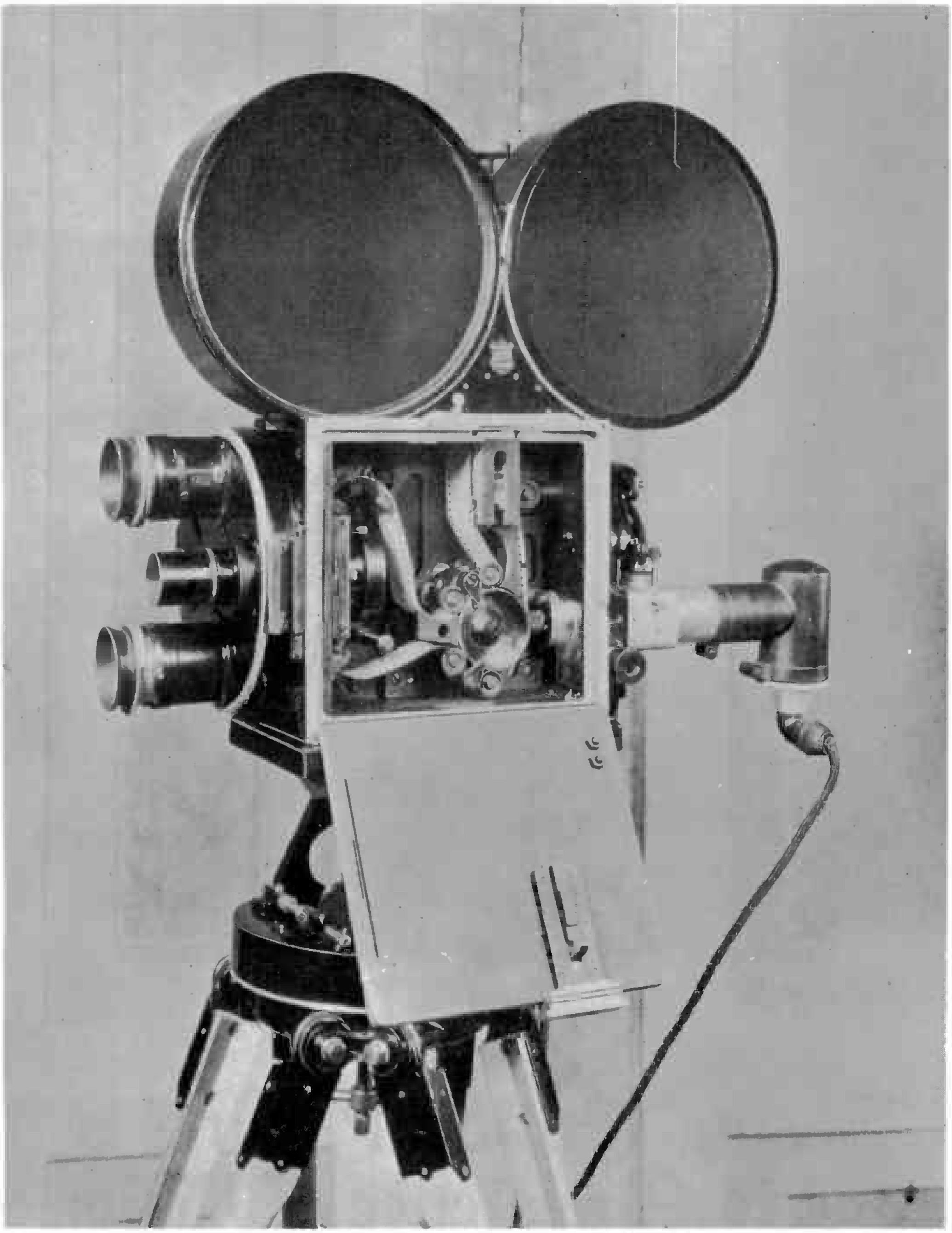

Sound picture camera using Aeo light method of sound recording.

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"SEEING" MOTION PICTURES IS DUE TO PERSISTENCE OF VISION

PERSISTENCE OF VISION

Did you ever stop to consider that the illusion of motion which we get when looking at a moving picture on a screen is possible only because our eyes possess the peculiar faculty of being able to "see" an object for a fraction of a second after the object has been removed from view? We are able to test this property of the eye in many ways, some of which are so common in our experience that we do not even question the causes which bring about certain effects. For instance, most of us can recall having seen a boy in the act of rapidly whirling a tin can or "firepot" filled with small pieces of lighted wood. This fast movement causes the air to rush through holes punched in the can and fan the lighted wood into a roaring flame. Now the thing about this action that holds our attention is the fact that as the pot of fire is whirled in a circle we do not actually see the can and burning wood,but instead it appears like a continuous circle of brilliant flame or smoke,and the outline of the can seems very indefinite. Figure 1 shows how the flaming circle would naturally appear to the eye due to the property of persistence of vision. If it were not for this property of the eye we could clearly see the pot with its burning wood at any particular point as it moved in the circle.

Another familiar demonstration of the principle of persistence of vision is a propeller in rapid motion. As shown in the picture drawing in Figure 2, the propeller appears to be a hazy, transparent disc instead of a set of long narrow blades. The action of persistence of vision in the case of either the whirling firepot or the revolving propeller blades, of course, is to cause the eye to continue seeing the object in one position for a short time even after it has passed to a new position, and to blend these impressions into a whole figure.

A simple experiment to test the effect of persistence of vision is to look at any object for a moment and then quickly close your eyes. You will find that an image of the object looked at still remains with you for a fraction of a second after shutting your eyes. It has been definitely decided that this natural function called persistence of vision takes place not in the eye, but in the nerves which convey visual impressions to the brain, or in the brain itself.

Whether or not the ancient people on our earth possessed any knowledge concerning motion pictures probably will never be known,because the records of man's activities so many years back have thus far been lost to us, but we do learn that as early as the year A. D. 130 a Greek geographer and astronomer, named Ptolemy, demonstrated the phenomenon of persistence of vision by means of a simple piece of apparatus consisting of a disc with spots on it, which was made to revolve. The first record of anything suggesting the general scheme of modern pictures is found in the Zoëtrope or Wheel of Life, patented by W. G. Horner in 1833. His device consisted of a hollow cylinder which turned on a vertical shaft. On the inside of the cylinder there was an arrangement of slots, which permitted a series of pictures to be inserted in a certain sequence so that each pic-

Figure 1

ture would show a successive stage in some movement, for example, a horse in the act of galloping. As one looked through a hole in the cylinder the picture on the inside of the cylinder directly opposite the hole came into view, and as the cylinder continued its rotation successive holes and consequently new pictures rapidly followed one another. Persistence of vision caused these individual pictures to blend together and produce the effect of a horse in motion. Figure 3 gives a general idea of the appearance of a Zeotrope. At first the Zeotrope pictures were drawn by hand but later photography was used to produce them.

You may have seen the application of the Zoetrope principle in a very simple form which was merely a small booklet or tablet of blank paper on the pages of which were drawn a series of pictures, each one being slightly different from the other and in proper sequence, so as to depict some action. When thumbing through the book the pages would follow one another in quick succession and if approximately 16 pictures per second were flashed before your eyes, persistence of vision would come into play and cause the pictures to blend into one picture giving a fairly clear effect of the object in motion. This method of showing a moving picture was used by Leonardo da Vinci, the great artist and inventor, to amuse the people of his time.

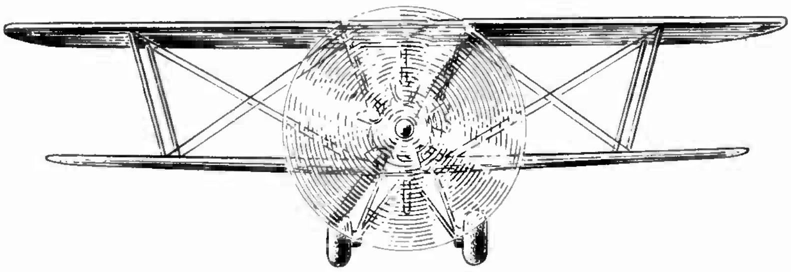

Figure 2

The pictures used in early attempts to produce the illusion of motion pictures were merely sketches or drawings made by an artist and even to this day we have "comics" in the movies, or animated pictures of cats and other animals that are made up of a series of drawings. However, regardless of whether the pictures are drawn or are actual photographs, so long as each succeeding one is slightly different from the preceding one and in correct sequence; and the series is flashed before your eyes at the proper speed; the effect of "seeing" the picture in motion is always due to your "persistence of vision."

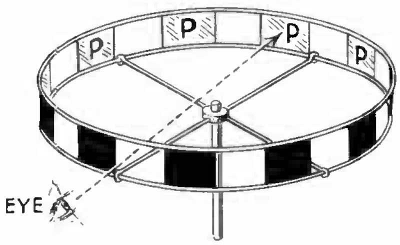

Figure 3

EARLY ATTEMPTS AT PHOTOGRAPHY

The first attempt to produce successive pictures of an action by photographic means was made in the year 1872 by an Englishman named Edward Muybridge. He made these photographs at the request of several race-horse owners who had come to a heated discussion regarding the gait of their favorite horse. At this time wet collodion plates were used in photography. Muybridge set up twenty-four cameras in a row at the side of a race track and stretched a thread from the shutter of each camera across the track so that the horse, when running, would break each thread in turn and open and close the shutter of each camera in succession. With this arrangement 24 separate pictures were taken with each one showing the horse in a position slightly in advance of the preceding picture.

The first attempt to obtain photographs of a galloping horse was not a success because the wet collodion plates were not sensitive enough to get a fully exposed photograph in the short time required for the horse to pass by the lens of each camera. The problem connected with obtaining a good picture of an object in motion when using a short exposure time was greater then than it is today, because of the older types of lenses and shutters in use at that time.

EXPOSURE TIME

If we carefully consider how a camera operates it is easy to understand that if an object should move while actually being photographed then the image of this object focused on the plate in the camera will also move. This fact makes it rather difficult to obtain a sharp picture of a moving object at any particular instant unless the proper exposure is made as we will explain.

Let us consider an extreme case where an object moves across the field of vision of a camera lens from the extreme right to the extreme left and, likewise, the image of this object moves across the sensitized plate from left to right because we assume the shutter of the camera is left open during this time. We can be sure that the silver salts of the emulsion will be affected in every portion of the plate by the light rays of the image as the rays pass over the emulsion on their journey across the plate and upon development a blurred outline of the image will show up extending clear across the plate making it unfit for use as a negative. To avoid this difficulty in photography we must do something that will give the effect of "stopping" the motion momentarily. By the expression "stop motion" in photography we mean that the light image reaching the plate from a moving object should be permitted to remain on the emulsion for only an extremely short time, or a small fraction of a second, so that for all practical purposes a sharply defined image will be obtained in one place on the negative after development.

It is quite plain that strictly speaking there is no such thing as "stopping the motion" of an image on the plate if the object is actually moving. Therefore, regardless how short may be the time allowed for light from an object being photographed to pass through a lens, if the object moves in that time the image will also move a certain distance on the plate, as already explained.

The best we can hope to do in trying to cope with a situation of this kind is to allow light to come through the lens for only a small fraction of a second so that although the image may have moved a little during this short exposure, yet the movement is relatively so small that the developed image on the negative will appear to be sharp and clear.

Then, in order to "stop motion" on the plate only a very short exposure time should be used. The part of a camera that controls the time of exposure is called the "shutter." It is made of an opaque material, for example sheet metal of some kind, and is mechanically arranged to open and close the path of the light rays through the lens in varying amounts of time; certain types of shutters can be

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regulated to provide an exposure as fast as 1/10,000th part of a second. It is important that with a short exposure time there must be a sufficient amount of light allowed to enter the lens to focus on the plate or film to fully expose or act on the silver bromide in the emulsion.

According to the limitations just outlined for photographing any object in motion a simple line of reasoning tells us that in order to take photographs with very short exposures it is necessary to provide any one of certain conditions as follows:

(1) There should be a great deal of reflected light from the subject to be photographed, or

(2) A very large lens in proportion to the size of the plate should be provided so that a large amount of light may enter and strike the plate, or

(3) An emulsion should be used that requires very little light to become fully exposed. An emulsion made for this purpose is said to be a "fast" emulsion, whereas, one that requires a strong light for proper exposure is called "slow."

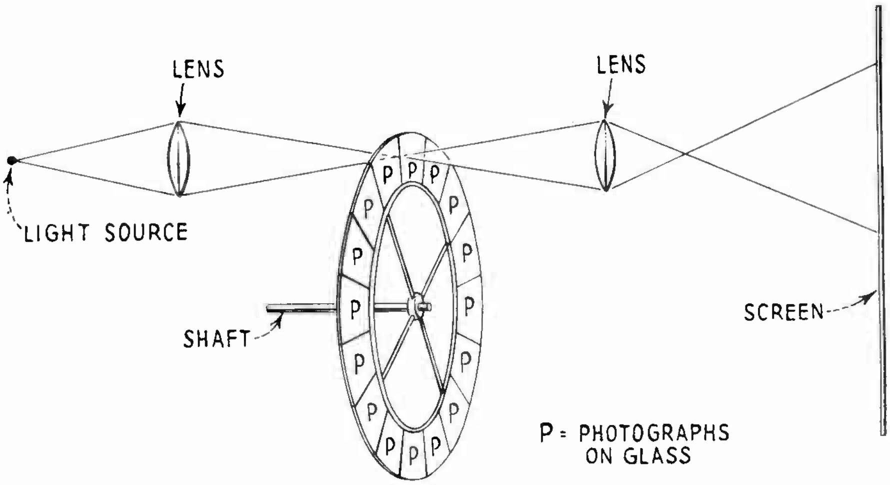


Figure 4

Now that you understand what "stopping motion" means and the need for proper values of time and light for a given exposure, let us return to the race track discussion where Muybridge had his cameras set up to take 24 separate and slightly different views of a horse in motion. He found after developing his wet collodion plates they were too "slow" to produce a good image, so he conceived the idea that the amount of light falling on the plates could be increased if the legs of the horses were painted white. He was sure the white would reflect more of the brilliant sunlight which shone upon the horse, and in turn more light rays would enter the lens to properly expose the emulsion.

After obtaining a good set of 24 photographs taken by this method

Muybridge proceeded to build a machine for projecting them on to a screen to give the illusion of motion. He called the apparatus a Zoopraxoscope, probably because it was the customary thing in those days to make scientific names sound as impressive as possible. The machine consisted of a large glass disc that revolved in a vertical plane with 24 photographs set in proper sequence along its outer edge. A limelight was set up with a lens that projected the pictures on to the screen and so, when the wheel was revolved each picture came into view for a moment and was quickly replaced by another. With this crude method the photographs projected on the screen were quite blurred, nevertheless they gave the effect of a horse in motion, and all because of that quality which the human eye possesses — persistence of vision. This was the first time moving pictures were ever produced on a screen. Figure 4 is a drawing of Muybridge's Zoopraxoscope.

INTRODUCTION OF THE SHUTTER

As just explained, the images on the screen were so blurred by the movement of the photographs as they passed in front of the light beam it was necessary for Muybridge to devise a shutter that allowed light to pass through the photograph only for a very short interval of time,or precisely at the moment the photograph came into place before the lens. This shutter eliminated the blurred effect and the same principle is still in use today as you will learn. When the shutter on a modern motion picture projector gets out of adjustment you instantly see the same blurring effect in the form of white lines racing up the screen.

It is interesting to note that the idea of "talking pictures" was in Muybridge's mind as early as the year 1888 for at that time he went to Thomas A Edison who had invented the phonograph and asked whether the Zoopraxoscope could be connected in some way to Edison's phonograph so as to make it appear that the people shown on the screen were speaking or singing as the case may be. Mr. Edison would not consider the project because the phonograph at that time was not loud enough to be heard by a large audience. In 1893 at the Chicago World's Fair, Muybridge, due to his efforts in this field, won recognition as the father of Motion Pictures. The thing that was holding back the practical development of motion pictures however, was the difficulty experienced in obtaining satisfactory photographs on glass plates when the exposures had to be taken in quick succession.

For years scientists and inventors in various countries continued to struggle with the problem presented by the use of glass plates. The most successful of these workers was a man named Donisthorpe who patented a mechanism for taking photographs on plates at the rate of 8 per second. These photographs were printed on a continuous strip of paper which was used in the Zoopraxoscope, and with this improvement the movements of persons, animals, etc., could be reproduced on the screen with more lifelike effect to the eye of the observer than had heretofore been possible. Donisthorpe made a very entertaining moving picture by taking a series of photographs of buds opening into flowers, with long intervals between each picture, and then by showing these photographs in rapid succession he produced in a matter of seconds the effect of buds unfolding into flowers.

CELLULOID FILM MADE MOTION PICTURES PRACTICAL

Dr. Marey who was carrying on experiments in Paris was the first to use flexible sheet celluloid for taking a series of photographs. At the same time two men in England were using paper film for a similar purpose and, also, Thomas Edison in America began work on the production of motion pictures. In fact these inventors and many others bent their efforts toward producing moving pictures, not for projection on a screen, however, but particularly for use in coin operated machines where only one person could view a picture at a time. Some of these machines still survive in the "penny arcades" of today.

It is probable that the first public showing of a motion picture was given by C. Francis Jenkins in 1894. The mechanism which he used to take the photographs can be said to be the first camera employing methods corresponding to present day motion picture photography. A significant fact in this connection is that Jenkins used the same machine for both photographing and projecting his pictures. When taking a picture the film was fed from a roll or reel mounted on a ratchet-rotated drum which drew one picture at a time past the lens opening where it was exposed, and from there the film was rewound on another reel ready for the development room. To show or project the picture an oil lamp was so placed that its light passed through the film and then through the lens which focused it on the screen.

THE "GATE" AND "INTERMITTENT"

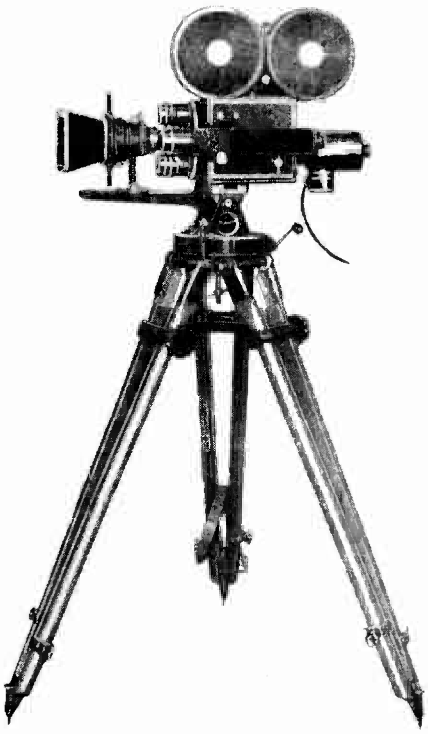
In the foregoing paragraphs we covered some of the principles of motion picture photography with descriptions of the first attempts to produce moving pictures, and now we will pass on to present day practices of the motion picture industry with particular reference to the "gate" and "intermittent" mechanism of a motion picture camera.

Figure 5 is a photograph of a modern silenced motion picture camera of the type used in sound picture work. It has a felt and leather padded hood which encloses the working parts in a sound proof chamber and is different in several ways from the old type cameras used in taking silent "movies". The main difference is in the internal construction, where working parts that were sources of noises in old machines are now made to run so silently that the cameras may be located quite close to the microphone without any danger of running sounds being picked up, or vibration sounds being recorded on the sound track.

Figure 6 is an illustration of a widely used non-silenced type of camera made by Bell and Howell for use in motion picture work where sound is not to be recorded. A comparison between the silenced and non-silenced cameras in Figures 5 and 6 respectively shows that the main difference so far as external appearance is concerned is the addition of the padded hood on the silenced camera for sound picture work. The circular metal housings on top are for the feed reel and the take-up reel. Before a machine is ready for service the operator must place a reel of fresh, unexposed film in the feed reel housing and thread it through the camera mechanism to be rewound on a reel in the take-up housing. The schematic view in Figure 7 shows the interior of the camera pictured in Figure 6, where "A" is the feed reel and "B" the take-up reel.

Figure 5

While in operation the film is pulled from the feed reel by a large sprocket wheel which revolves in a counter-clockwise direction, and then through an arrangement of gears and sprockets the film is fed to the "gate" which holds it firmly in place in front of the lens. Associated with this part of the machine is a mechanism known as the "intermittent movement". It consists of a claw-like arrangement which pulls down the film three-quarters of an inch at a time, allows it to rest in front of the lens opening "C" for a fraction of a second, and then repeats the operation by pulling the film down the same distance to allow the next unexposed section of it to come into place before the lens. The film then passes to the lower portion of the sprocket wheel and is fed by it to the "take-up" reel, which rewinds the exposed film preparing it for the development room.



Courtesy Bell & Howell Co.

Figure 6

Refer to Figure 7. The following paragraphs give the sequence of operations within the machine when photographing just one of the pictures on the film during the taking of a movie scene. We will start out with the assumption that this is to be a "silent picture", that is, without sound, and the photographs are to be taken by the camera at the rate of 16 per second. This rate is standard for silent film and is based on the duration of our persistence of vision. From experience it has been determined that at least 16 separate images must be projected on a screen each second in order to have them blend into an illusion of a continuous picture in motion. To begin the explanation suppose the film is threaded into place in the camera and at this particular instant the intermittent movement has just ceased to move. The image of the scene being photographed will then pass through the lens in the form of light rays which focus on the sensitized film only for this instant, or while the film is stationary before the lens opening. As in the taking of any photograph the light rays of the focused image strike upon the silver bromide of the emulsion with which the film is coated and prepare it for the action of the developer which is used later in making the negative. After this exposure the intermittent movement starts operation and with a swift downward motion it pulls the film three-quarters of an inch by means of claws or sprocket teeth.

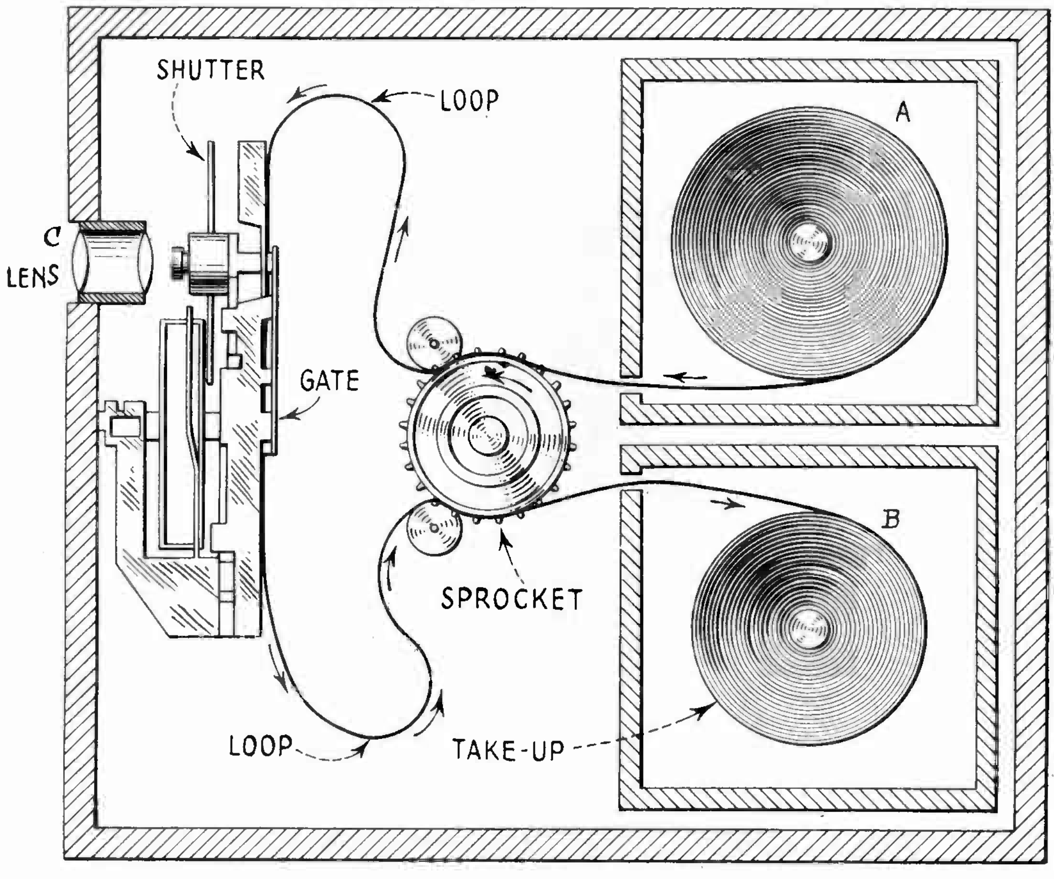


Figure 7

While the film is in motion it is necessary to shut off the light rays coming through the lens so that the image will not then be focused on the film and obviously, the emulsion will not be affected. We know the light rays must be cut off at the proper moment that is, before they are allowed to move to any great extent, or otherwise a blurred negative will result. A very ingenious shutter arrangement is used to cut off the light from the film while it is in motion. As Figure 8 shows, the shutter is in the form of a circular disc with a segment cut out, thus leaving a large opening in one portion of it; a shutter of this general type is also used on the projector when the picture is shown in the theatre.

By referring again to Figure 7 it can be seen that the shutter is located between the lens and the gate. This is the end view of the shutter, the front view of the same shutter being shown in Figure 8. During the running of the machine the shutter revolves continuously making one complete revolution for each picture taken. It is to be understood, of course, that the cut-away portion of the shutter comes in front of the lens only while the film is at rest. This allows the light from the object being photographed to pass first through the lens, next through the opening in the shutter, and then to the emulsion on the film. In this manner one picture is "taken" or, as we say, one exposure is made. After this exposure the intermittent starts to pull the film down and in another fraction of a second a fresh, unexposed portion of the film is pulled into place before the lens ready for the next picture or exposure to be recorded.

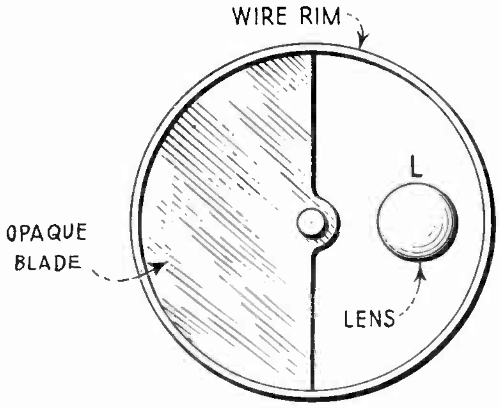


Figure 8

At the instant the intermittent starts to move the film the shutter begins to turn, its cut-away portion is taken away from the lens, and the solid or opaque part comes into place before the lens to cut off the light while the film is in motion. When the intermittent ceases its movement the film remains stationary before the open segment of the lens for a fraction of a second and during this moment another exposure is taken. This sequence of operations continues at the rate of 16 per second so long as the camera crank is turned, or in the case of a motor-driven camera so long as the current is turned on.

The normal operating speed for silent picture photography is 16 pictures per second, for sound pictures 24 per second, but as many as 200 pictures per second can be taken with most standard cameras by means of special adjustments provided. The size of each separate picture taken with a standard motion picture camera is 1 inch by 3/4 inch. Figure 9 shows a strip of film with dimensions indicated.

Figure 10 is a section of film illustrating a simple form of motion. A man is shown in the act of raising his arm from one position to another. As will be observed each succeeding picture shows his arm slightly higher than the preceding one so when these pictures are projected on a screen in rapid succession our persistence of vision causes a blending of each picture with the next to produce the effect of continuous motion. The action of a motion picture camera, after all, is to "break up" the moving object being photographed into a series of pictures where each one shows the action taking place a 24th of a second later than the preceding one.

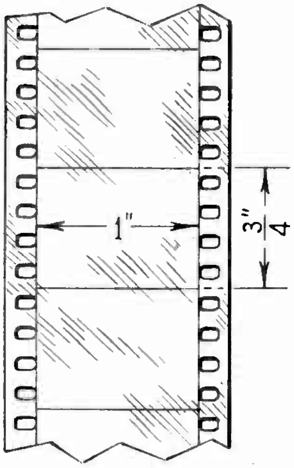


Figure 9

FAST AND SLOW MOTION.

We have already mentioned how a motion picture camera is capable of producing effects which cannot be seen with the unaided eye. Two of these effects may be produced either by taking the pictures very slowly or very quickly. An illusion of a very slow movement in actual life that is speeded up for a moving picture is the blossoming of a bud. On the movie screen, before one's very eyes, we see a series of pictures run off in a matter of minutes that actually were taken at the rate of a few pictures a day. To obtain such a picture the camera is placed before the bud and left there for the required time with an exposure being made at the rate of one per hour or at even longer intervals. When the completed strip of pictures is thrown on the screen the viewing of all the pictures that took days to record is over in several minutes and in this manner any slow motion can be speeded up tremendously.

The other extreme is the case where it is desired to produce a motion picture of an action too fast for the unaided eye to follow. For instance, an action as fast as the flight of a bullet has been successfully photographed. When reproduced on the screen every opportunity was presented to observe the bullet as it floated gracefully across the field of vision and struck objects which were placed in its path. The method of producing such an illusion is just the opposite as in the case of the blossoming bud.

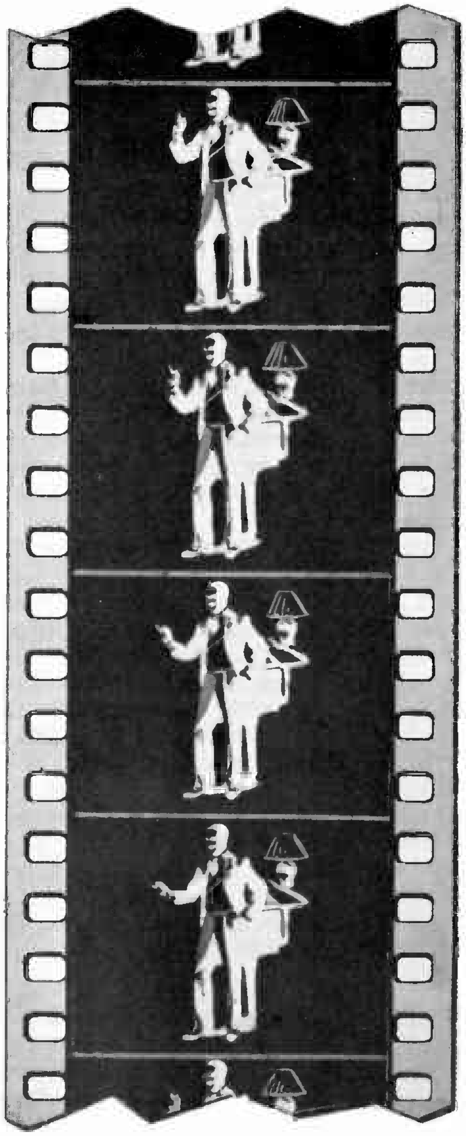


Figure 10

As many as 200 pictures per second may be taken by the standard camera to produce this "slow motion" effect and special cameras have been designed which will take thousands of pictures per second. Suppose the successive photographs of the bullet in flight were taken at very short intervals, say 1/2000th of a second, then when they are reproduced on the screen at the rate of 24 per second the bullet will appear to move across the field of vision at only about 1/83rd of its actual speed, or in other words the actual speed of the bullet is 83 times greater than it appears on the screen.

From your study of exposures and emulsions it is easy to understand that a difficult problem arises in special cases to get enough light to the emulsion for proper exposure at terrific high speed and extremely short exposure time. This problem is solved by a combination of a "fast" emulsion and a "fast" lens. "Speed" in an emulsion means its sensitivity to light and "speed" in a lens is its ability to pass a large amount of light to the film in a short space of time.

HOW THE FILM RUNS THROUGH THE CAMERA.

A standard motion picture film is perforated with holes equally spaced along each edge so that the claws and sprockets in either a camera or projector may have something to catch hold of in the process of moving the film through the machine and pulling it down into place to expose succeeding "frames" of the film.

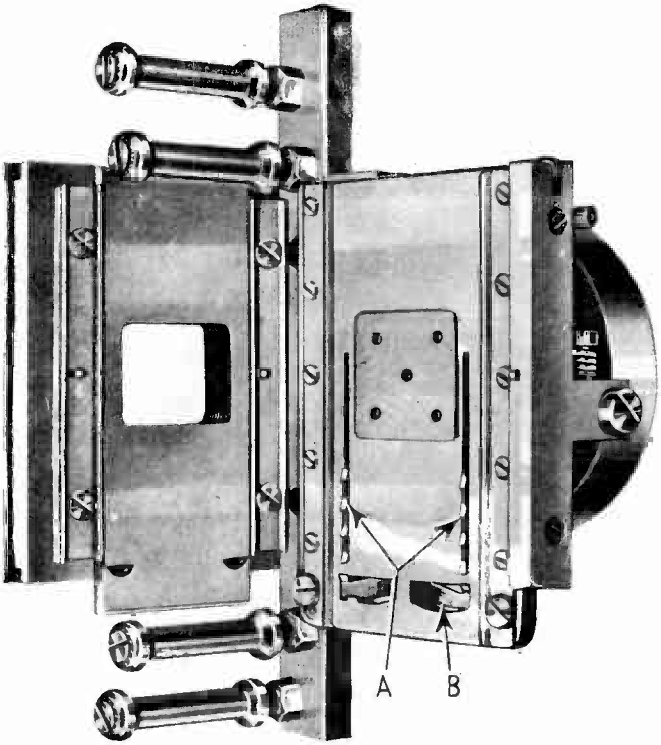
It was explained in the first part of this lesson that the film is held tightly against the aperture in front of the lens by friction springs shaped like tiny sled runners. These flat, thin springs press the film up against the opening before the lens but exert pressure on the edges only where the sprocket holes are located. This serves to keep the film flat and in the proper place for a sharply focused image of the light rays from the object or movie scene.

While the camera is in operation the film is pulled downward in short, sharp jerks by means of the claws, which engage the sprocket holes in their action of pulling successive frames in place before the aperture. To prevent the claws from tearing the sprocket holes out by the suddenness of this jerking action against the friction of the steel springs, a well-designed camera will have a set of 4 claws on each side of the aperture plate which engage 8 sprocket holes in the film at one time. The 8-claw movement in Figure 11, known as super-speed film movement, has two sets of claws, marked "A," sunk in the gate. The gate is shown open as it actually would be if a film were being threaded through the machine. The film would go between the two top rollers and down past the aperture, which is the oblong hole through which light passes to expose the film, and then through the lower rollers back to the take-up reel.

During operation the claws, which are shown at the bottom of the stroke in the illustration, sink into the guide slots, and after rising to the top of the slots they come forward and engage with the sprocket holes in the film. After this the claws move downward with a quick motion pulling the film with them and thus a fresh section or frame of film is placed before the aperture; this action is repeated over and over again. In Figure 11 the part marked "B" is called the "check pawl." When the film comes to rest this part moves out of its slot and engages with the two sprocket holes, which causes the film to be held firmly in place during exposure and while the 8-claw movement is rising to engage a new set of sprocket holes.

Of course, when the film is in place and these operations are in progress the two halves of the mechanism, shown in Figure 11, are closed together like a book thus providing a pathway through which the film passes during operation of the camera. If the shutter were mounted in place in this photograph it would be located just on the other side of the aperture and beyond that would appear the lens system.

A more detailed view of a standard camera is seen in Figure 12 where the film can be traced coming from the reel at the left, passing down to the sprocket wheel which engages the sprocket holes of the film,



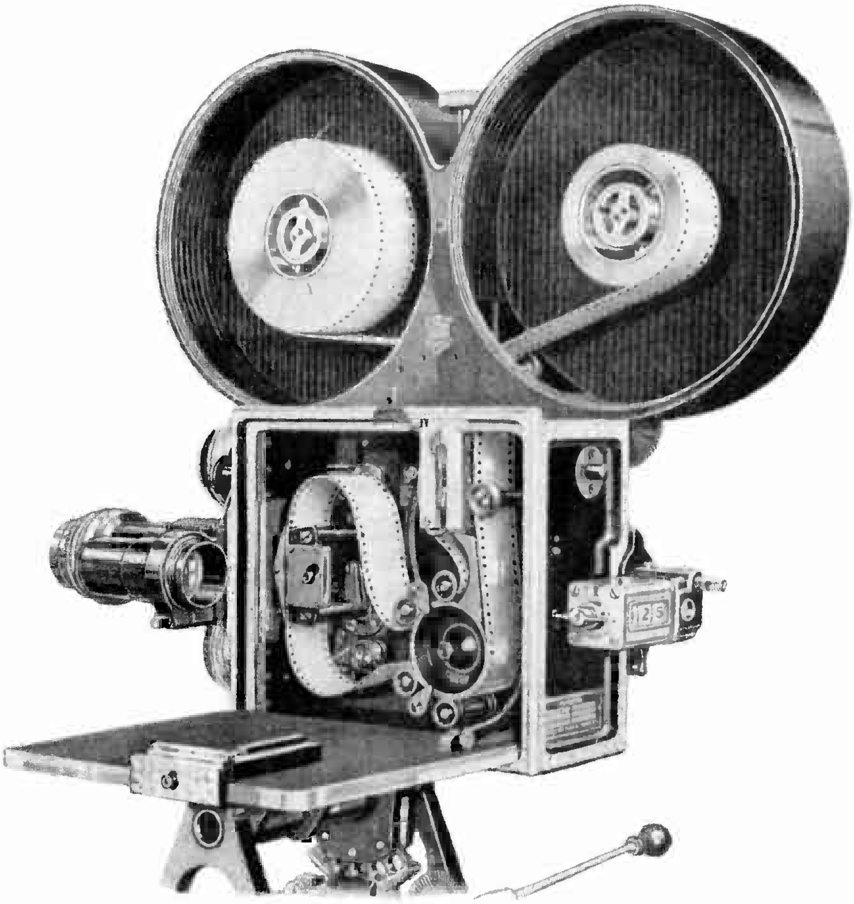
Courtesy of Bell & Howell Co.

Figure 11

then to the gate where it passes before the aperture and lens, and thence to the bottom of the sprocket wheel and back to the take-up reel which is shown at the right. The four small rollers pressing the film up against the sprocket wheel cause the sprocket teeth to make a positive engagement with the sprocket wheel.

As viewed in Figure 12 a modern motion picture camera is seen to consist of first; a lens (a number of lenses are shown on a revolving mount at the left which is the front of the camera); second, a revolving shutter which cannot be seen in this photograph but which is mounted between the lens and aperture, and third; a gate which includes the aperture and intermittent movement.

The sprocket wheel is simply a device for feeding in and taking away film from the gate. The two reels at the top are provided for storing two films, one for unexposed film and the other for exposed film. The feed reel at the left requires no driving power to actuate it because this reel simply unwinds when the film on it is pulled by the sprocket wheel. However, the take-up reel at the right is driven by a slipping clutch arrangement that enables it to take up the exposed film as fast as it is fed by the sprocket wheel. We know that all



Courtesy of Bell & Howell Co.

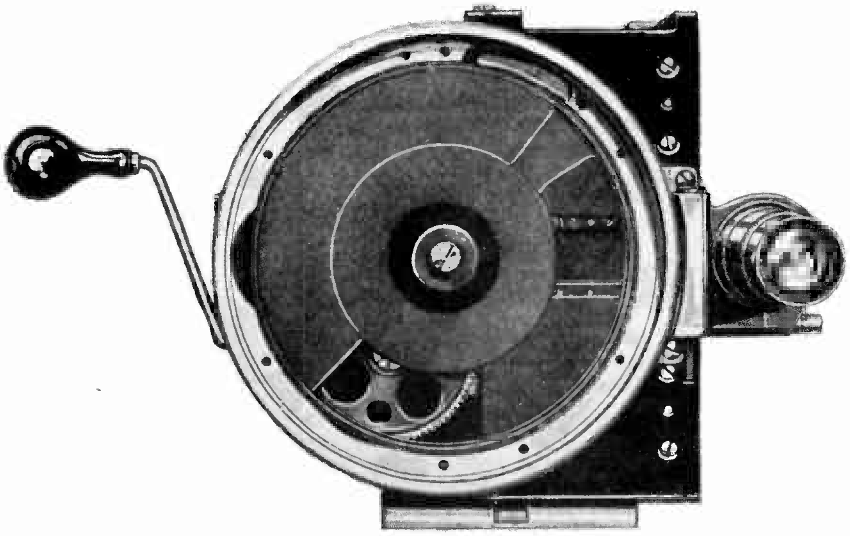
Figure 12

the film is fed evenly to the intermittent movement by the sprocket wheel yet the film moves through the gate in quick jerks of 3/4" sections to expose the frames one at a time. To allow the intermittent enough free film so that the film may be jerked down freely when in operation it is necessary to provide a certain amount of slack film in two loops, one over and one below the gate.

Figure 13 is a front view of the camera with the turret plate removed to show the shutter and aperture. The shutter on this model is semicircular in shape and in the illustration it occupies the position it takes just before it closes off the light from the aperture or oblong opening seen at the right of the circular shutter housing.

The lens barrel at the right is the "finder" or "viewing lens" by means of which the cameraman is able to see the scene exactly as its image appears on the film. Looking through the finder from the rear he is able to follow the action of the scene perfectly so that he knows at all times just what is being photographed on the film. This finder serves the same purpose as the finder found on ordinary cameras with which you are doubtless familiar.

On modern motion picture cameras there is a device known as the "dissolve mechanism." This is an additional shutter about the same size as the regular shutter and is so constructed that it allows the opening in the circular shutter to be closed gradually, thus slowly cut-



Courtesy of Bell & Howell Co.

Figure 13

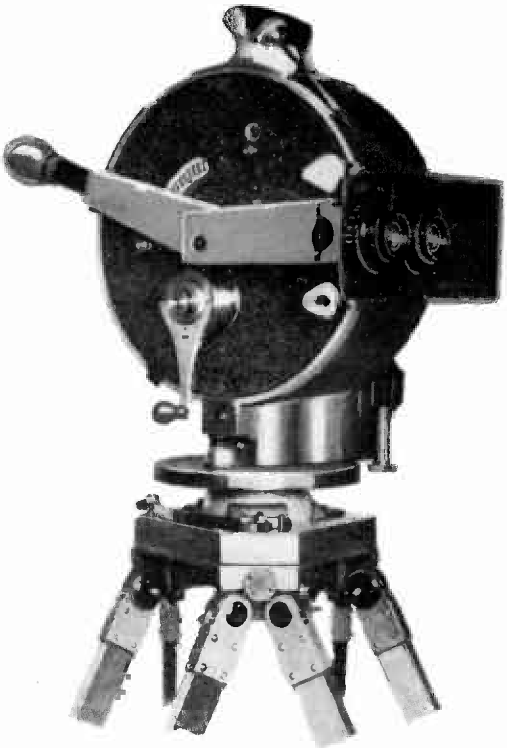
ting off all light entering the camera. This shutter can be made to operate automatically by the cameraman so that if it is desired the amount of light entering the camera may be cut down from maximum to no light by the time 5 feet of film have passed through the camera. A dissolving shutter will close the opening in the regular shutter from 170 degrees (nearly half the circle) to zero, or completely closed. This gradual closing off of the light through the lens gives the effect of the scene gradually fading out of view when shown on the screen in the theatre. By reversing the process a scene may be made to come slowly into view.

CAMERAS FOR SPECIAL PURPOSES.

Generally speaking the internal mechanism of various types of cameras are of such design that they perform similar functions in the taking of a film. The Akeley camera, in Figure 14, is ruggedly built for the use of explorers and hunters. Another type, the Mitchell camera in Figure 15, is made for studio and location work. The term "on location" is used in motion picture work to designate the photographing of scenes away from the studio, for instance in canyons, deserts or places where the natural scenery is used for background instead of using studio "props."

On the front of cameras used in "studio" and "location" work there are a number of lens barrels mounted on a vertically revolving table or mount which permits various types of lenses to be selected and placed before the aperture of the camera. Each lens combination has a distinct quality which makes it most suitable for photographing a certain subject or scene. For instance, the situation is frequently met where a "close-up" of the subject to be photographed is desired as in the case where a person's face is to fill a whole picture; a close-up of this kind requires a certain lens combination.

On the other hand, for the opposite extreme condition or one where an object is located at a great distance and appears as a small speck with an ordinary lens, we must enlarge or bring the object closer by using a "telephoto" lens. This lens combination acts on the image



Courtesy of Akeley Camera Co.

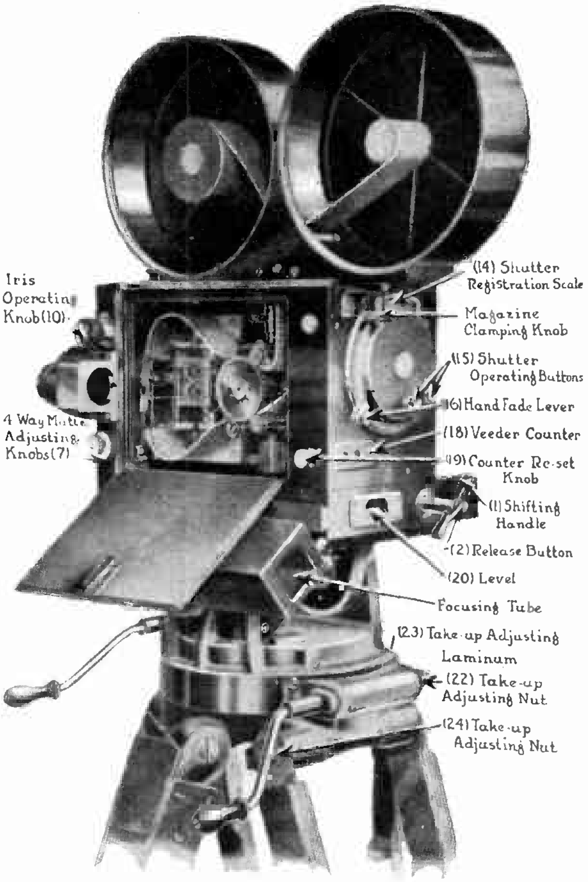
Figure 14

that it focuses on the film in the same way a telescope acts on an image to bring it close to the eye, that is, a distant object is made larger and appears as being much closer when using either a telescope or a telephoto lens.

The set of lenses in Figure 16, made for the Akeley camera in Figure 14, includes a much greater range of lenses than is used on cameras with the revolving lens mount. This range is provided for meeting the unusual conditions encountered by explorers and big game hunters who at times must take pictures under adverse conditions where light-ing and distance cannot be arranged as in studio and location work. Alongside of each lens barrel is seen a small tube containing the "finder" through which the cameraman can see any scene exactly as it is being photographed on the film as already explained. A more complete discussion about lenses and their properties is given in another lesson.

DEVELOPING AND FIXING OF FILM.

After a film has been "exposed" it is taken to the laboratory for development and fixing, and the "negative" thus produced is used later for printing "positives."



Courtesy Mitchell Camera

Figure 15

To obtain good photographs, cameramen must be sure to obtain the correct exposure time which is determined by the lens and emulsion used and the light conditions. The principles volved in the development and printing of films are similar but in the matter of the apparatus required for this work we meet various types used by the different companies engaged in this work. For example in some plants the film, after exposure, is wound upon round wooden racks which are immersed in large tanks of developing solution for the required length of time.

A rack with its film would next be transferred to a tank of water for washing off the developer and from there it would go to a tank of "fixing" solution, usually hyposulphite of soda, which acts to definitely stop the development process and "fix" the images on the film.

After succeeding processes of washing and drying of a film it is ready for the film "editor" and the cutters who take the different parts of the complete picture and cut and splice them into a continuous reel of negative from which are printed the final "positives" that are distributed to the theatres.

Another laboratory method employed for finishing a film makes use of an automatic developing plant. This machinery carries the film over rollers that cause it to dip in and out of a tank of developer; from there the film is run through a tank of water, next through the fixing solution and then through another tank of water where it gets the final wash; after which it is wound on racks for drying.

Courtesy of Akeley Camera Co.

Figure 16

A continuous printing machine is used to make a positive. A machine of this kind feeds the exposed positive film and the finished negative together past the light source in such a way that the proper amount of light will pass through the negative to the positive which

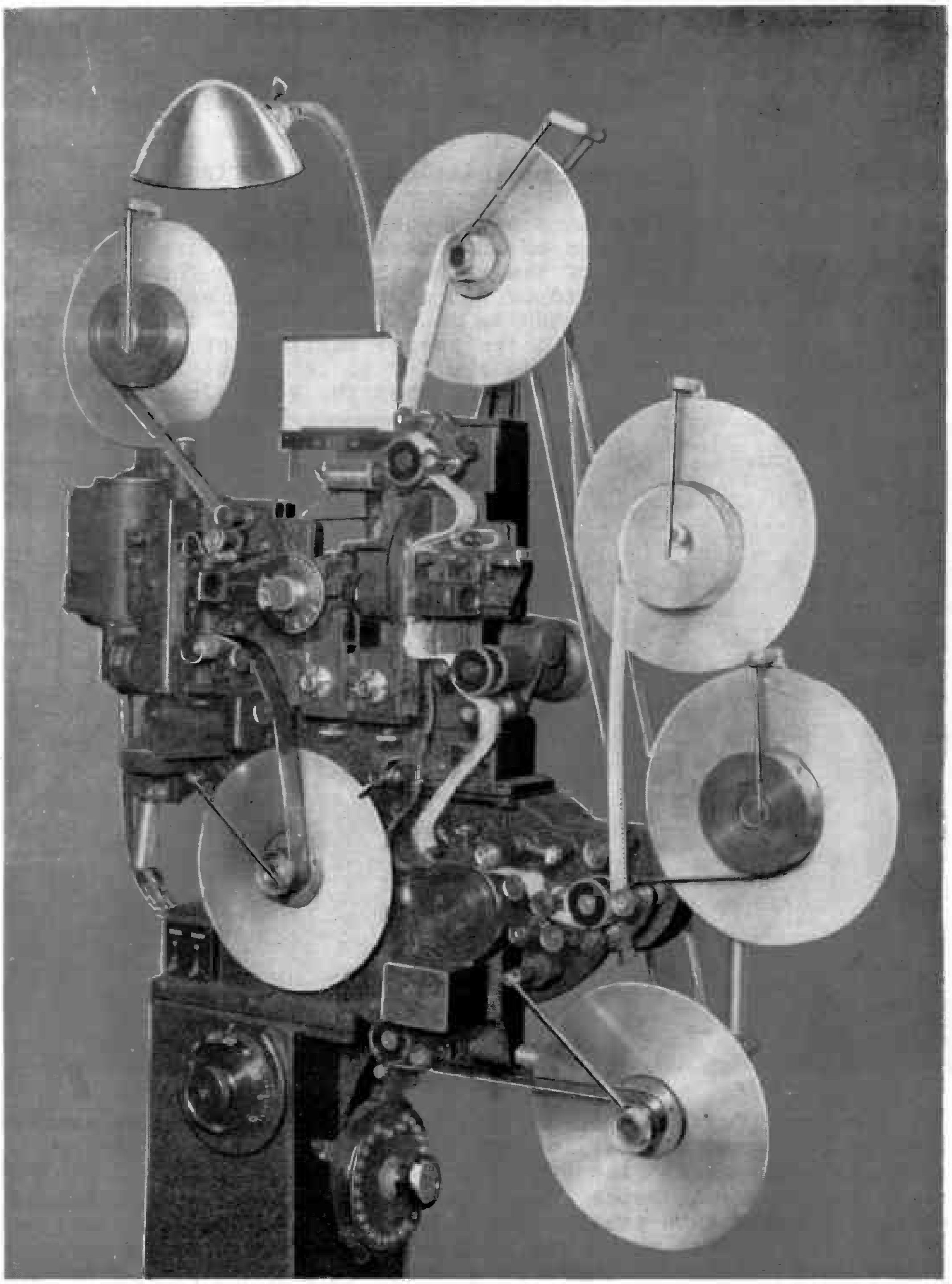


Figure 17

is run underneath. Both films during the process are run in close contact with each other in the oblong opening where the light is focused. After the positive film has been exposed to the light by this method it is developed and fixed in much the same manner as was the negative film from which it was made. A modern printing machine which prints the sound track simultaneously with the picture shown in Figure 17.

A close-up of an intermittent movement is shown in Figure 18.

A late type portable Photophone sound picture machine is shown in Figure 19. A special feature of this machine is the fire shutter which is mounted as a part of the revolving shutter. The fire shutter has openings and solid or opaque parts which are like the revolving shutter and the mechanism is so constructed that when the film is running at normal speed the opaque portions of both shutters are in line and act like a single shutter to let light through and cut off light periodically. However, when the film slows down or

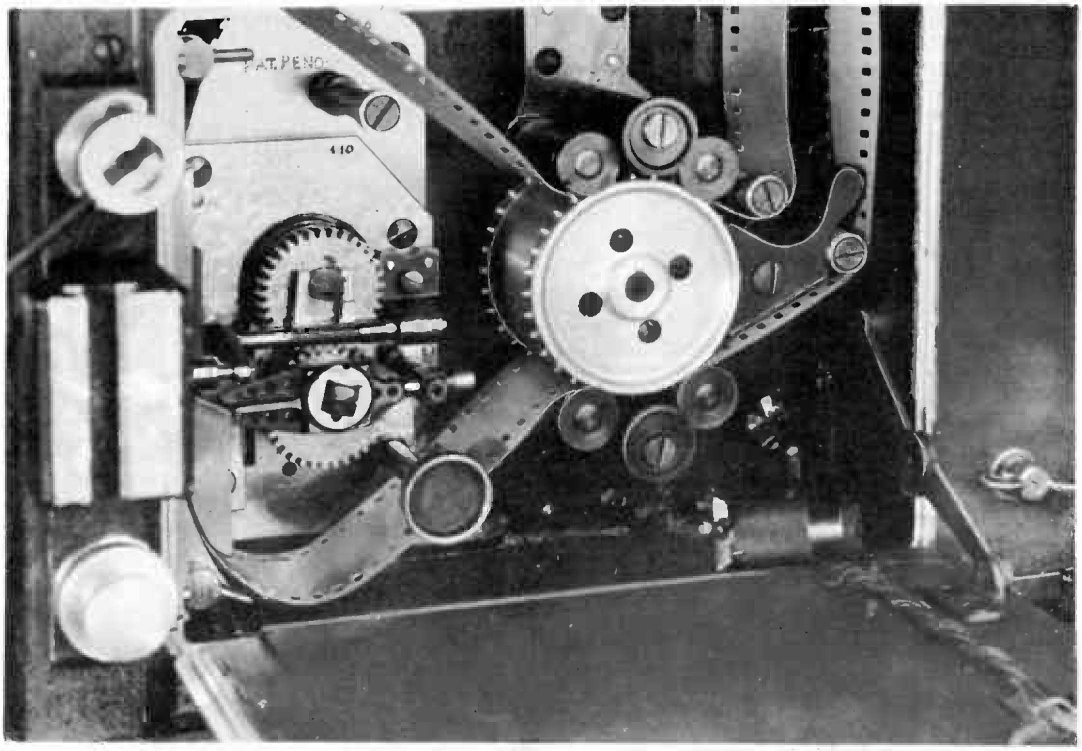


Figure 18

stops the centrifugal action on the fire shutter causes this shutter to change its speed and fall out of alignment with the revolving shutter with the result the opaque portions of both shutters do not line up together and, hence, are like a solid disc with no openings presented for light to pass to the film. Also, in this machine the gate is fixed through which the film is threaded and, therefore, does not open and small shoes press the film against the aperture. A 1000-watt incandescent prefocused lamp is used as the light source. The term "prefocus" means that the plane of the filament is parallel to the plane of the condenser lens when the lamp is inserted in the socket. It has a reflector and condenser lens.

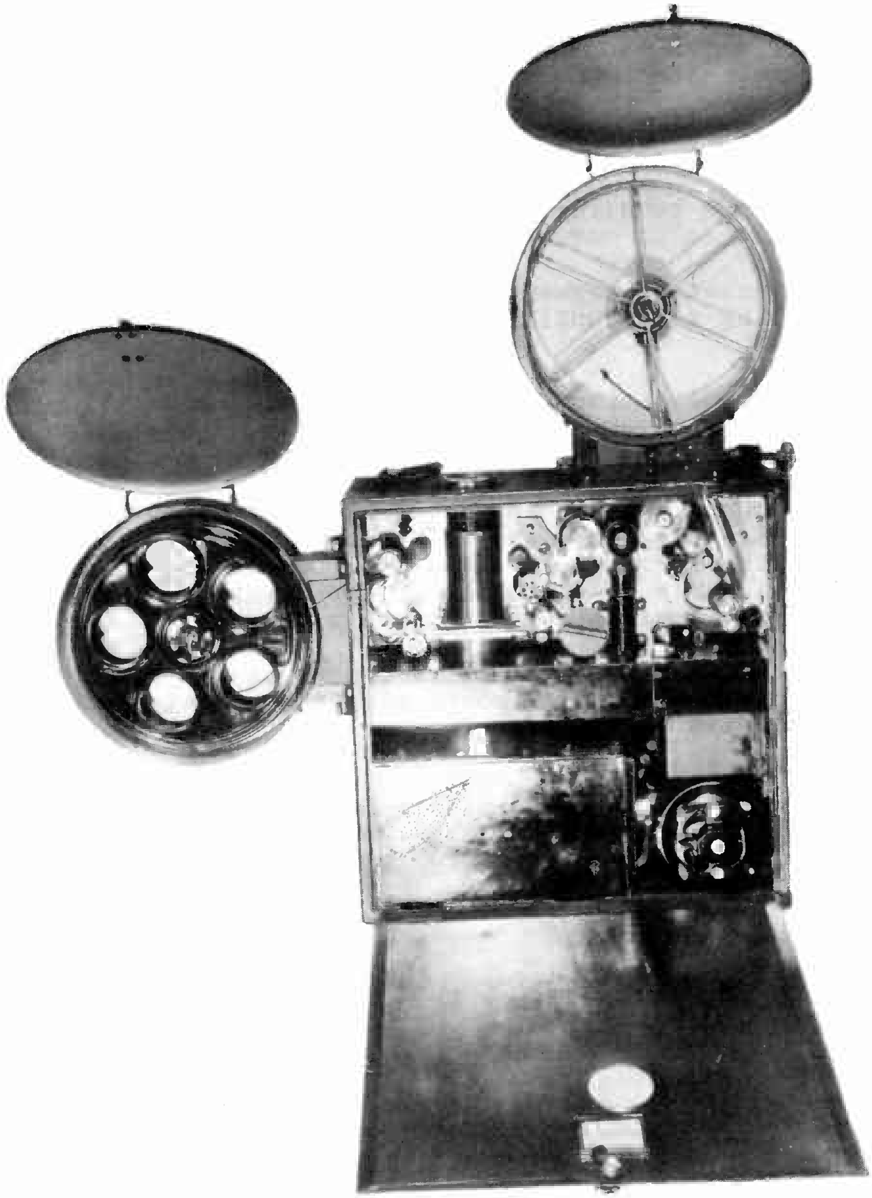


Figure 19

EXAMINATION QUESTIONS

1. What are the dimensions of a single picture or frame on a motion picture film?

2. Is the picture taken by a motion picture camera a "negative" or a "positive?"

3. What piece of mechanism in a motion picture camera moves the film into place before the lens and how does it function?

4. What piece of apparatus cuts off the light while the film is in motion?

5. Explain about the peculiar property of the human eye upon which the illusion of motion pictures depends.

6. Give the sequence of operations of a film from the time the picture is being taken until the film becomes a finished "positive."

7. While taking sound motion pictures a film will pass through the camera at the rate of 90 feet per minute. How many pictures are taken per second?

8. Suppose pictures are taken of an object which is moving too fast for the eye to follow and by means of motion pictures we can see this object in flight on the screen. Explain whether the pictures are taken or projected at the greater speed to make them visible on the screen.

9. An important change in motion picture cameras was brought about by the introduction of sound pictures. What was the change and why was it necessary?

10. Is there any limit as to the number of "negatives" and "positives" that can be taken with a motion picture camera of a given production or scene? Explain.

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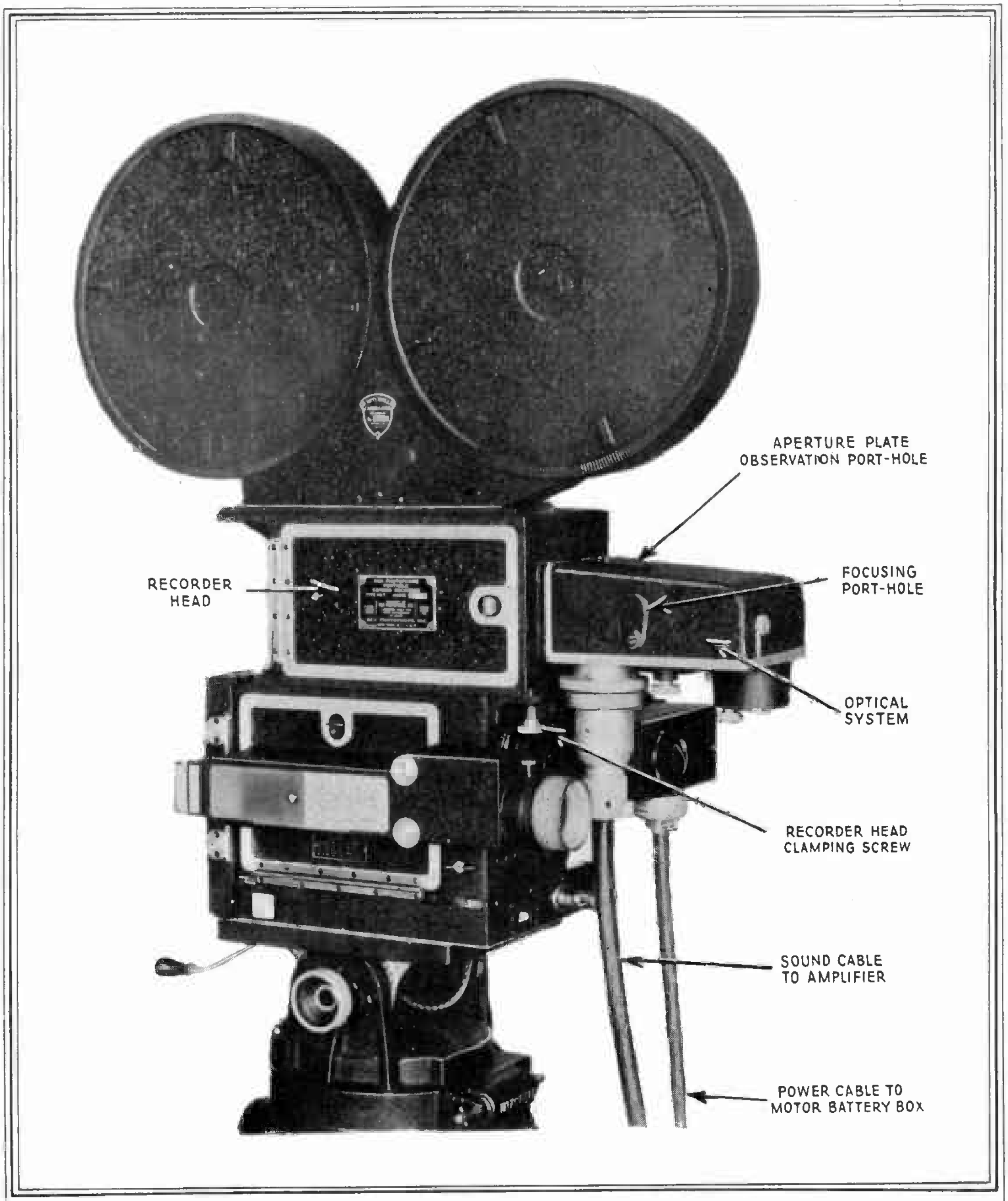

Sound picture camera with recording head.

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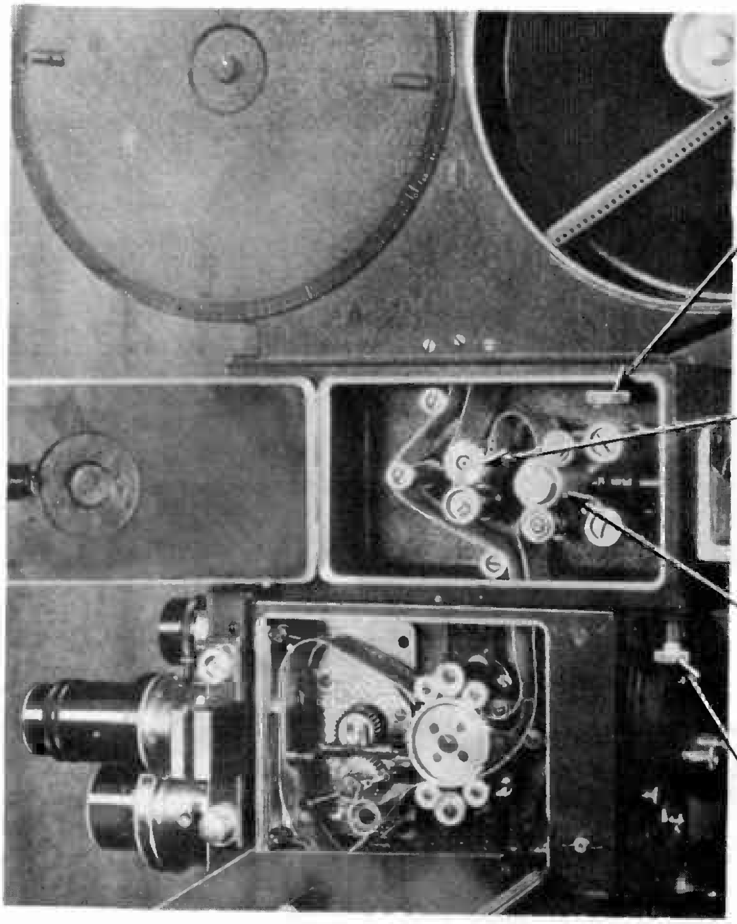

Interior of sound picture camera and recording head.

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