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THE SIGNAL SCHOOL
FORT MONMOUTH, NEW JERSEY
ENLISTED DEPARTMENT

REPAIR OF AERIAL EQUIPMENT—SUBCOURSE 773

TRAINING MEMORANDUM NO. 1

K-20 AIRCRAFT CAMERA

NOTE: The material in the following paragraphs comprises essential supplementary instructional material and is provided pending availability of official Department of the Army publication.

1. GENERAL.

a. Aerial photography was used extensively by military and civilian agencies prior to 1940. But its value was reemphasized by World War II, when it provided the photo-maps and photographs of enemy disposition, camouflage, etc. so invaluable to our photo-interpreters.

b. The making of aerial photos can be a hazardous and expensive operation and the success or failure of an entire campaign may hinge on whether or not those photos are good. Since so much may be at stake, the Camera Repairman must be sure that the equipment used is in tip-top condition and that all adjustments have been made with precision.

c. This memorandum is designed to provide the necessary instructions for Operating, Maintaining, and Servicing the type K-20 Aircraft Camera. It is intended, however, only for those already skilled in the field of Camera Repair.

2. GENERAL DESCRIPTION.

a. The K-20 is a manually operated aerial camera used to make oblique photographs for reconnaissance purposes. Its light weight (11¾ pounds when loaded) and compact dimensions (9½ inches x 7½″ x 11″) make it ideal for hand-held operation from standard military aircraft. It is especially convenient for use from the lighter planes where weight and space are such important considerations.

b. The camera makes 50-4 x 5 inch negatives with a half-inch space between each on a 20′ roll of 5¼″ film. This film has an opaque leader and trailer of 3½′ each to permit daylight loading. The shutter release and film transport mechanisms are interlocked to prevent double exposures and skipped frames, and have their controls located in the operating handle of the camera. The film is held flat during the exposure by a vacuum back and pressure plate.

c. The lens used in the K-20 is prefocused and has a focal length of 6⅜″ with aperture openings from f/4.5 to f/.22. The between-the-lens shutter in which the lens is mounted has speeds of 1/125, 1/250, and 1/500 second. The control knobs for both of these may be adjusted through openings in the front of the camera cone.

d. An oblique viewfinder, an exposure counter, a data-recording device, a film loading guide and a wall bracket for securing the camera to the fuselage of the plane when not in use, are provided.

e. The K-20 camera is made of metal (largely aluminum alloys). When using an ordinary press camera for aerial work, the high velocity of the wind is apt to damage the bellows or cause the bellows to shield a portion of the picture area. This possibility is eliminated by the metal lens cone of the K-20.

3. DETAILED DESCRIPTION.

a. The Type K-20 camera combines in one unit, all of its components; body, lens, shutter, magazine, film transport mechanism, vacuum back, operating controls exposure counter, recording device, viewfinder, and means for attaching it to the fuselage when not in use.

b. The references "right," "left," "top," etc., in this Memorandum are based on the camera being held in the operating position.

(1) Camera Body

(a) The camera body is of cast aluminum alloy. The front part, containing the lens and shutter, in the cone, to which is attached the fixed handle, the wind and trip coupling shafts and the viewfinder. The rear of the body contains the film transport, vacuum system, and other mechanisms; the operating handle is attached to its right side in front of the exposure counter. This rear part of the camera is enclosed in the removable magazine cover.

(2) Lens and Shutter

(a) The shutter is mounted in the cone of the camera so that the lens will be protected even when the camera is placed nose down on a flat surface for loading.

(b) The front cell of the lens has a diameter of 44.5mm (1¾ inches) and also has 3 studs to accommodate filters in special bayonet mounts.

(c) The movements that cock and release the shutter are transmitted from the operating handle by coupling shafts, inside the cone, that connects with the shutter from the rear.

(d) The diaphragm and shutter speed knobs may be rotated in either direction to bring the desired setting under the reference line which is scribed in the cone. No attempts should be made to force these knobs past the stops at either end of the scales. Also, it should be remembered that intermediate settings of the shutter will not give intermediate speeds.

(3) Film Transport Mechanism

(a) The film transport mechanism is a series of gears, cams and levers in the rear of the camera. It is actuated by a forward thrust of the operating handle. A special device disengages the film transport when 4½ inches of film has traveled past the metering mechanism.

(4) Vacuum Back

(a) The vacuum back consists of a retractable pressure plate and a vacuum piston whose movements are synchronized with the film transport and shutter release. Its function is to hold the film flat in the film plane while the exposure is being made.

(5) Operating Handle

(a) The operating handle on the right side of the camera is pivoted near its upper end. Rotating this handle fully forward advances the film 4½ inches and moves the exposure counter one graduation. Returning the handle to its original position lowers the pressure plate against the film, sets the vacuum piston, cocks the shutter, and locks the film transport mechanism.

(b) Pressure on the trigger releases the vacuum piston so that the film is drawn back flat against the pressure plate; starts the mechanism which releases the shutter; then releases the pressure plate so that it withdraws from the film, freeing it for the next cycle.

(c) The shutter cannot be tripped until the film is advanced, and the film cannot be advanced, until the shutter is tripped.

(6) Exposure Counter

(a) The exposure counter is a dial, on the right side of the camera, divided into 50 graduations. The return movements of the operating handle actuates the gears which move this counter forward one graduation before each picture is made.

(7) Recorder

(a) The recorder provides a means for photographing data in an area approximately ¼ x 3 inches on the long side of the negative, the data being written with a soft pencil on the transparent card attached to the metal recorder handle. A slot is provided in the magazine cover to receive the recording device. The cover cannot be attached or removed with the recording device inserted.

(8) Viewfinder

(a) The optical (Newtonian) oblique viewfinder is located on the upper rear section of the lens cone. Depressing the small block leaf spring protruding from the right front of the base permits the lens to be raised or lowered. The rear sight positions itself automati-

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cally. When the photographer sights through the viewfinder, with the ball of the rear sight in line with the red lines scribed in the finder lens, the area visible through the finder corresponds to the area covered by the negative.

(9) Accessories

(a) Film Loading Guide

The film loading guide is a sheet of hard rubber with a metal handle. It is inserted in the focal plane slot during the threading of the film to prevent the leader from curling down into the body and preventing passage of the film.

(b) K-20 Spools

The film spools for the K-20 are all metal and will accommodate 20 feet of film with the leader and trailer (3½ ft. each) attached .

(c) Lens Cap

The lens caps is a felt-lined metal cap that is kept on the lens, at all times that the camera is not in actual use, it protects the lens from dirt and damage.

(d) Filters

1. The filters for the K-20 are in bayonet mounts, with three spring clips engaging studs on the lens mount. Two filters, one red and one yellow, are provided with the unit.

2. To attach a filter, place it on the lens mount so that the studs on the lens mount engage the spring clips, then turn it clockwise until the projections on the springs pass over the studs and snap into place, securing the filter. Reverse this procedure to remove filter.

(*a*) *CAUTION*: Filters must be treated as carefully as lenses. When handling them, touch only the mount so that the glass will not be smudged or scratched.

(e) Wall Bracket

1. The wall bracket is attached to the fuselage of the plane with three No. 10-32 round-head screws. The camera should be attached to it when in the plane and not in use, so that it cannot be accidentally dislodged.

2. To attach the camera to the wall bracket: close the viewfinder, hold camera by both handles with lens down and viewfinder towards bracket, slip the pins that form the end of the viewfinder into the two hooks of the bracket, press the stud (camera support hook) against the bracket-spring and lower the camera until stud is engaged in the slot and spring has forced the stud into the countersunk receptacle of the bracket.

3. To remove camera, press the camera back against the spring, lifting it up and away from the wall.

(f) Carrying Case

1. The case is made of fiber and accommodates the camera with all its accessories, plus two spare rolls of film.

2. The camera should be placed in the case with the recorder inserted, name plate up, and its back to the partition i. e., with operating handle next to the hinge. The filters are kept in their compartment at the right rear corner of the case. (Make sure the cover is snapped shut.) The block inside the lid will exert a slight pressure on the magazine cover to hold the camera securely when case is closed. The compartment at the left end of the case is for film and the film loading guide.

3. To remove camera from the case, grasp it by both handles and lift *straight* up.

4. PREPARATION FOR USE.

a. Caution

(1) *Do not operate the camera with nothing in the focal plane channel,* because the vacuum back is not designed to operate undamped. If it should be necessary to operate unloaded, insert the film-loading guide, or a piece of paper or old film under the pressure plate to check the free movement of the vacuum piston DO NOT FORCE ANY PART OR MOVEMENT. Difficulty indicates that something is wrong so check your previous adjustments before proceeding. ALWAYS RELEASE SHUTTER BEFORE PUTTING CAMERA ASIDE. When the mechanism and shutter are tripped and the cover is removed, DO NOT PRESS DOWN ON THE VACUUM PISTON.

This will upset the operating cycle and require disassembly of both the camera and the shutter mechanism for repairs to restore correct operation.

b. Opening and closing Camera

(1) To open the camera, stand it on its nose with the viewfinder away from you, remove the recorder, unscrew the knurled cover screw knob on the left side of the cover. Now slide the cover to the left and off the camera. There is a retaining clip inside the cover which prevents loss of the cover screw knob.

(2) To close the camera slide cover onto back of camera, making sure that grooves and ridges of light-trap are properly engaged and recorder is not inserted DO NOT FORCE A FIT. Difficulty indicates that cover is not properly placed on the body. Secure the cover by inserting the cover screw in its socket and setting it up hand-tight. Insert the recorder as instructed in Paragraph 4 below.

c. Loading the Camera

(1) With the camera on its nose and the cover removed, see that the camera is tripped, so that the pressure plate is raised to permit introduction of the film under it. If it is necessary to trip the mechanism, check the motion of the piston with a finger, to prevent its hammering, making sure the finger is not caught under a crosspiece as the piston rises.

CAUTION: DO NOT TURN THE TAKE-UP KNOB UNLESS THE MECHANISM IS TRIPPED!

(2) As the film is somewhat protected by its leader, it may be loaded in subdued light. Place an empty spool in the take-up end (the side toward the viewfinder), making sure that the crosspiece on the drive shaft engages the slot in the spool flange and pin on the far left hand spring is in the hole in the other flange.

(3) Place a full film spool in the supply end in such a way that the tongue of the leader points up when it is toward you, which will cause the film to unwind from the bottom of the roll. Break the seal and withdraw about 10" of leader.

(4) Insert the film-loading guide in the focal plane slot, making sure that the pressure plate is raised.

(5) Pass the tongue down, around and forward under the black guide roller and through the focal plane slot above the loading guide. Next turn the camera around so that the take-up spool faces you. Bring the leader up and back between the metering roller (bottom) and the two rubber pressure rollers, lifting the pressure rollers to facilitate passage.

(6) Remove the film-loading guide.

(7) Insert the tongue in the lateral slot of the empty take-up spool and make sure that the leader is centered between the flanges and feeds straight. Then wind two complete turns of film on the spool with the take-up knob. If this knob will not turn, wind and trip the mechanism with the operating handle.

(8) Replace the magazine cover and recorder.

(9) Wind and trip the mechanism eight times to bring the sensitized film into the focal plane. Be sure the trigger is tripped after the last preliminary winding.

(10) Set the exposure counter at 50 (zero), and the camera is ready for operation.

CAUTION: CARE MUST BE TAKEN TO PREVENT THE FILM FROM UNROLLING AND BEING FOGGED DURING LOADING.

d. Inserting the Recorder

(1) The recorder consists of a sheet of matte-surfaced cellulose-acetate secured to a metal handle and is carried in slot in the magazine cover. Wind the mechanism and insert the recorder in the slot on the bottom of the magazine cover in such a way that the matte surface is toward the film. The words "Top—REMOVE SLIDE BEFORE COVER" should face the operator when the camera is in operating position.

(2) Information can be written in the three rectangular clear areas on the matte surface of the acetate with a soft lead pencil. To facilitate writing, place the recorder on a

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flat surface so that the handle curves over the edge.

(a) CAUTION: When inserting and removing the recorder, be sure to push it straight in and out. Twisting is apt to tear the acetate from the handle.

e. Opening and closing the Viewfinder

(1) To open and close the viewfinder, depress the black leaf spring on the right front of the finder and raise the finder frame to the vertical. The rear sight is automatically brought to the proper position by a torsion spring on its shaft and the whole finder is maintained in operating position by the leaf and torsion springs.

(2) To close the finder, depress the leaf spring and push back the top of the finder frame until it snaps into the folded position.

5. OPERATION.

a. Remove camera from carrying case or wall bracket.

b. Load the camera

c. Remove lens cap

d. Make sure lens is clean

e. Attach filter, if one is to be used

f. Write desired data on recorder and insert in slot.

g. Raise the viewfinder

h. Setting the Lens and Shutter

(1) Determine the shutter speed and diaphragm opening to be used and set the diaphragm and shutter accordingly.

i. Checking the Exposure Counter

(1) To keep track of the amount of film remaining in the camera, check the exposure counter.

j. Holding the Camera

(1) The camera is held with the fixed handle in the left hand and the operating handle in the right hand. The right index finger lies on the trigger, the back of the magazine rests against the chest. Keep the elbows close to the body and do not allow any part of the camera to contact the plane lest the pictures be blurred by vibration.

k. Making Pictures

(1) Holding the camera as directed in the above paragraph, sight through the viewfinder at the area to be photographed. When the ball of the rear sight is in line with the etched cross-lines on the finder lens, the area seen in the finder will appear on the negative.

(2) Rotate the handle fully forward and return it. This advances the film, cocks the shutter, sets the vacuum mechanism, and advances the exposure counter.

(3) To make the exposure, squeeze the trigger gently and steadily to avoid jarring the camera.

(4) Move operating handle fully forward and return to prepare the camera for the next exposure.

(5) Refer to the exposure counter from time to time and when 50 exposures have been made, unload as follows:

l. Unloading

(1) When all film is exposed, operate the camera 10 or 12 times, until its freer movement indicates that all the trailer has passed onto the take-up spool.

(2) Open the back and remove the full spool, reseal it. This should be done in subdued light.

(3) Replace magazine cover or reload.

m. Storage

(1) When camera is not in use, keep it on the wall bracket or in the case.

6. SERVICE INSPECTION, MAINTENANCE AND LUBRICATION.

a. Inspection

(1) In spite of its rugged construction, the K-20 and its accessories are precision instruments and must be cared for as such.

(2) As with other equipment, when a unit is disassembled, make a rough sketch of the relationship of parts or witness mark them if there is a possibility of replacing them incorrectly.

(3) Inspect all parts for wear, dirt, scratches, deformities or any damage, which might cause malfunction.

b. Shutter

(1) The shutter of each K-20 is a standard unit, and is interchangeable with other shutters. However the focusing posts on the back of the housing are machined for the particular lens and *must never be interchanged.*

c. Maintenance

(1) Removing the lens

(a) Unloosen screw and rotate lens lock cam free.

(b) If it is necessary to remove the rear lens element from the shutter, the shellac sealing it must be softened.

1. Place one drop of grain alcohol at any point of the joint between the lens and the shutter; it will spread all the way around. After two or three minutes, the element may be unscrewed with the fingers.

2. After cleaning and replacing the element, reseal it by placing on the joint, one drop of a mixture of 7 parts grain alcohol and one drop orange shellac.

d. Removing Shutter

(1) Wind and trip the camera.

(2) To remove the shutter, take out the three large fillister-head screws and lift same out carefully. After this has been done, extreme care should be exercised not to disturb the trip coupling and upper spring cup on the shutter, or the operating handle on the camera, in order to reassemble the shutter to the camera body correctly.

(3) If the above are disturbed, it will be necessary to retime the shutter.

(4) In some cases the shutter may fit so snugly that a special means of firmly grasping same is necessary to extricate it. A shutter removal plate can be quickly made up by cutting a flat piece of ¼ inch thick wood or metal to a 7 inch square. Three ¼ inch holes spaced 3½ inches apart, in the form of an equal-sided triangle should be centered and drilled in the plate three 8-32 round-head screws, 3 inches long, having a thread length of at least 2 inches, and three washers and nuts are needed.

(a) Remove the six screws on the front of the shutter. The three larger ones hold the shutter and the three smaller ones hold on the shutter cover.

(b) Screw the nuts all the way up on the 3-inch long removal screws, add washers, and insert the screws through the shutter removal plate and thread them carefully into the seating holes of the smaller shutter cover screws.

(c) Turn down the nuts on the three removal screws, taking care to keep them equalized.

(d) While lifting out the shutter the first part of the way in this manner, check occasionally to see if it becomes free enough to raise it out of the remainder of the way by gently pulling on the removal plate.

e. Replacing Shutter

(1) Before replacing the shutter, make certain that the position of the wind and trip couplings and the wind and trip coupling shafts have not been disturbed. If they have, it is necessary to retime the shutter. (Refer to par. 2. *d.*, this sec.)

(2) When ready to replace the shutter, guide same into position carefully using a long pin inserted into one of the shutter screw holes as a locating device.

f. Timing Shutter

(1) Should the shutter be removed for lubrication, the following procedure must be observed in installing the shutter to time same correctly. Set retard knob at 1/500th of a second.

(2) With the aid of a screw driver inserted into the trip coupling on the shutter, rotate same slowly in both clockwise and counter-clockwise directions. If spring is tensioned, distinct clicks will be heard. Continue rotating until clicks cease and then turn same to extreme counterclockwise position and allow same to remain in that position.

(3) With the aid of a screw driver inserted into the upper spring cup, turn same

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slowly in a counter-clockwise direction while observing the shutter opening and closing, until a distinct click is heard, and it is impossible to reverse the direction of the rotation. This constitutes one-eighth turn initial tension.

(4) Wind and trip the camera and begin to wind the camera again, but stop exactly when operating handle is at the end of the forward stroke. (Do not complete the winding cycle which normally would consist of a forward and backward twist of the operating handle.)

(5) Set camera down with cone facing upwards.

(6) Insert trip coupling shaft (long) spring end toward magazine.

(7) Insert wind coupling shaft (short) spring end towards magazine. If the pin on the shutter end of the wind coupling shaft is not in correct alignment to receive the slotted end of the upper spring cup on the shutter, hold operating handle to prevent it from moving and then turn the wind coupling shaft clockwise until it is in alignment. This can be easily determined by noting that the pins in both trip and wind shaft should approximately parallel each other.

g. Lubrication

(1) Shutter

(a) The K-20 aircraft camera contains a high-speed rapid-action shutter which is a standard unit that can be interchanged with other cameras, and which, for efficient operation, depends largely upon proper lubrication and the absence of corrosion, rust, and particles of sand or dust in the mechanism. The shutter requires more frequent lubrication than the slower speed type; therefore, the procedure outlined in the following paragraphs will be adhered to. The lens shutter should be lubricated every 6 months, or after approximately every 5,000 operations.

(b) For lubrication and inspection of the shutter mechanism, the following method is prescribed for removing the front cover from the shutter without lifting the entire shutter assembly from the camera.

1. Obtain three 10/32 fillister-head screws and turn down the heads to a diameter of .247. This will provide clearance for the shutter cover holes.

(c) Remove the three shutter retaining screws (fig. 7) taking them out one at a time, and, after removing each screw, replace it with one of the screws described in the preceding paragraph, (a). The shutter retaining screws may be identified by the larger fillister heads.

(d) Set shutter speed knob midway between the 1/125th and the 1/250th; remove the three cover retaining screws, and lift off the shutter cover to expose the mechanism.

(e) If the entire shutter assembly is removed from the camera, the shutter will have to be retimed.

(f) A fraction of a drop of oil should be carefully applied to the teeth of the retard segment. Also, a thin film of grease should be applied to the maindrive bushing, release-lever, trip lever, snubber, stop segment and retard segment. When applying lubricants, use them sparingly, removing any excess.

(g) The mechanism should be kept clean and free of all corrosion and rust. Should any corrosion or grease be detected, it should be rubbed off with a slightly oiled cloth; however, if the deposit is deep, it should be removed by using a piece of fine emery paper, making certain to clean the mechanism thoroughly after this operation.

(h) All grit, sand, or any other particle of foreign matter should be carefully removed from the mechanism particular attention being given the tripping parts.

(i) To replace the shutter cover, set the speed knob midway between the 1/125th and 1/250th marks; set the diaphragm knob at f4.5, and open the diaphragm to its largest diameter aperture. The cover may then be put in place and fastened with the three cover screws. Before tightening the cover screws, make certain that the cover is fully seated by turning both the speed knob and the diaphragm knob slightly back and forth to make proper

engagement with the diaphragm and retard mechanism. Remove the three special small head shutter-retaining screws, one at a time; and as each one is removed, replace it with a regular screw and lock washer.

NOTE: Do not use the special small head screws when operating the camera normally. They are designed only for holding the shutter securely in place while the cover is being removed, the purpose being to prevent possible disengagement of the wind and trip rods from their couplings.

(j) To lubricate the leaf center, remove the S pin and the three leaf center retaining screws. Lift out leaf center and put a fraction of a drop of oil (oil, lubricating, general purpose, low temperature) on the five shutter leaf pivots, and wipe off all superfluous oil immediately. The leaf center must not be dismantled.

(2) Camera Body

(a) The lubrication given the camera body mechanism at the time of manufacture should be sufficient to last indefinitely.

(b) Should unusual conditions require the mechanism to be relubricated, the teeth of gears and cams should receive a very thin film of grease. Where they are carried in the casting, a fraction of a drop of oil should be applied to the film roller bearing pins, the film metering pinion, and to the two ends of the pressure roller shaft. The vacuum back piston rod should receive one small drop of oil (oil, lubricating, general purpose, low temperature).

(c) No lubrication should be applied to the vacuum back piston edge or to the vacuum back cylinder wall.

7. DISASSEMBLY, INSPECTION, REPAIR, REASSEMBLY, AND FINAL TEST.

a. Disassembly

(1) For the proper order of disassembly of any particular unit, the reverse order of assembly should be followed as given in this section under the heading of "Reassembly." The reassembly instructions are detailed enough to require no particular disassembly instructions.

(2) During disassembly of any or all parts of the camera, a careful inspection of each part should be made and any replacement or repair that is necessary must be noted and recorded.

b. Inspection

(1) If upon disassembly, inspection reveals that a part is in need of replacement which is a piece of an assembly or subassembly that is held together by a taper pin, the whole assembly should be replaced, even though only a single detail part of same may be in need of replacement. This procedure is necessary due to the fact that in taper pinned assemblies, only the dimensional relationships of individual parts are held on shafts, etc., in exact correlation and only complete assemblies are interchangeable. Individual detail parts are not interchangeable from one assembly or subassembly to the other, if they are a definite part of a taper pinned assembly or subassembly; because, of the fact that in regulation manufacturing practice, fixtures, and jigs control only the exact dimensional positions of parts of assemblies for taper pinning. The locations of the taper pins themselves are not held in close enough control to allow their being interchangeable on two assemblies or subassemblies of the same kind.

c. Repair

(1) All screw threads and taps should be rethreaded where necessary, and screws, bolts, nuts, and washers replaced if burred or worn, with like parts in kind and size. Loose rivets should be replaced. All moving parts, gears, cams, shafts, bearings, etc., showing excessive wear should be replaced and properly fitted. All parts should be inspected and tested for their assigned tolerances and if found to exceed the allowable figures, these parts must be discarded and new parts installed. The replacements of all screws which originally had shellac applied to them, should be dipped in shellac.

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d. Reassembly

(1) General

(a) In reassembly, the sequence of assembly of details, subassemblies, and assemblies is indicated by the order of their appearance in the text. Timing marks in the form of engraved lines and spot drilled marks are incorporated on all gears, where necessary, for reference in reassembly.

(b) In the system from the operating handle to the shutter winding bevel pinion, a difference in accumulated tolerances may occur, should it be necessary to make any repairs to the mechanism assembly which would require the replacement of worn or broken parts with new ones.

(c) This may necessitate replacing the shutter winding bevel pinion with a new one in which the angle of the location of the lower pin must be determined, the hole drilled, and the pin inserted.

(d) To determine whether or not to replace the shutter winding bevel pinion, it is necessary to check that the angle at which the lower pin positions itself, conforms to a setting of exactly 20 degrees clockwise from the vertical with all backlash removed, when the operating handle is at its stop at the completion of a winding cycle.

(e) This can be checked in the following manner:

1. Trip mechanism assembly by pressing trigger and pushing actuating link down and then moving the operating handle forward and backward through a complete winding cycle.

2. Hold operating handle firmly against its stop in the wound position.

3. To set the shutter winding bevel pinion, in order to determine whether the angle of the location of the lower pin is correct, first ratchet the shutter winding bevel pinion in a clockwise direction until it assumes a position approximately 20 degrees clockwise from the vertical and then turn same counterclockwise as far as possible, which will take up all backlash in the entire system, while still holding the operating handle firmly against its stop in the wound position.

4. At this point the position of the lower pin should be 20 degrees clockwise from a vertical line intersecting the center of the winding bevel pinion which constitutes the proper setting.

5. The vertical line intersecting the center of the winding bevel pinion should be at a right angle to a line parallel with the straight edge of the mounting plate.

(f) Should the angle as determined be within 1 degree plus or minus of the proper setting, the shutter winding bevel pinion can be reused after repairs have been made.

(g) Should the angle as determined be in excess of 1 degree plus or minus of the proper setting, a new undrilled shutter winding bevel pinion must be assembled into the mechanism assembly the backlash removed, the correct angle determined, the lower pin hole properly located and drilled, and the pin inserted.

(h) Means have been provided for making an adjustment on the trip link shaft which resets the shutter on the return stroke of the operating handle. An adjustment of 5 degrees is possible by turning the trip link adjusting stud. The resetting of the shutter must occur between 5 and 11 degrees of the end of the return stroke and can be recognized in the form of an audible click.

(i) To determine whether the reset adjustment of the trip link shaft is correct, it is necessary to check in the following manner:

1. Time shutter and assemble to camera body.

2. Begin to wind camera very slowly moving the operating handle forward and then very slowly, backward. About 1 to 5 degrees before the end of the backward stroke, the shutter should reset, which can be observed by hearing a distinct click. If the distinct click is heard, no adjustment need be made.

3. If, however, no click is heard, (*do not wind camera again as this would cause serious damage*) loosen the washer head screw and turn the trip link adjusting stud until the click is heard.

4. Tighten the washer head screw, trip the camera, and wind the camera again, listening for the reset click which should be heard just before the completion of the return stroke.

(j) Should it be impossible to make the shutter reset by turning the trip link adjusting stud, the shutter should be removed from the camera body and examined for a reason for the failure to reset.

8. CYCLE OF OPERATION (FAIRCHILD SHUTTER).

a. The Fairchild shutter is driven by a powerful coil spring located in the housing on the rear of the shutter. The spring encircles the shaft assembly which rotates the main drive bushing. One end of the spring engages the shaft assembly while the other engages the wind coupling which protrudes from the spring housing. Tension is held on the spring by means of a ratchet pin that engages the wind coupling allowing the coupling to be turned in a clockwise direction only. The tension is released only when the main drive bushing is allowed to rotate. Both the wind coupling and the trip coupling are activated by connecting shafts from the side plate assembly.

b. The main drive bushing is made up of three "layers" or cams on a single shaft. It opens and closes the shutter blades by means of a connecting link extending from an offset stud on the top cam to the blade control ring. This connection link is held by means of a washer and "S" pin on each end.

c. The release lever engages the top cam of the main drive bushing. It is activated by the rounded cut-out on the trip lever which fits around the rounded portion of the release lever, pivoting release lever forward when the shutter is cocked and retracting it to free the main drive bushing when the trigger is depressed.

d. The trip lever has a cam on its bottom side which disengages the stop segment when the shutter is cocked. This allows the main drive bushing to rotate about 1/16″ in a clockwise direction until its top cam engages the release lever. This causes the clicking noise heard just before the end of the winding cycle.

e. When the trigger is depressed, the main drive bushing is released by the release-lever so that it rotates in a clockwise direction, opening and closing the shutter blades. Its speed of rotation is regulated by the retard segment which impedes its movement by engaging the lower cam. The retard segment is positioned by the cam on the speed dial so that it is moved into or out of the path of the main drive bushing to give the various speeds.

f. When the lower cam has moved past the retard segment, it engages the snubber which is positioned by a spring held by a shoulder screw. The raised portion of the snubber bears against the floating stud in the slot of the trip lever. This stud pushes the stop segment into the path of the main drive bushing to stop its rotation. In addition the snubber slows the main drive bushing, reducing the impact with which the middle cam of the main drive bushing strikes the stop segment. Rebound is prevented by the reserve tension on the shutter drive spring.

9. DISASSEMBLE THE SHUTTER ASSEMBLY.

a. Remove the shutter assembly.

(1) Wind and trip the shutter.

(2) Set the camera on the bench with the cone up, remove the three large fillister head screws and lift the shutter assembly from the camera cone.

(3) Remove the wind coupling shaft and the trip coupling shaft from inside the cone.

b. Remove the front and rear lens elements.

(1) Remove the lens locking eccentric and unscrew the lens elements.

c. Remove all tension from the shutter spring.

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(1) Insert the blade of a screwdriver in the trip coupling and turn the coupling back and forth until clicks are no longer heard and the shutter leaves remain open.

d. Remove the shutter case cover.

(1) Set the retard knob halfway between 1/125 and 1/250, set the diaphragm knob at f/4.5. Remove the remaining three fillister head screws and lift out the shutter case cover assembly.

e. Remove the leaf center assembly .

(1) Remove the "S" pin to free the shutter operating link from the shutter operating link pin. Remove the three screws and the leaf center assembly.

(2) Disassemble the leaf center assembly.

(a) Remove the diaphragm assembly.

1. Unfasten the three diaphragm sector screws and remove the diaphragm sector. Remove the twelve diaphragm leaves. Unfasten the four screws and remove the lower plate with the four between plate spacers.

(b) Remove the shutter leaf assembly.

1. Remove the "S" pin and shutter operating link from the No. 5 link drive leaf assembly. Remove the five connecting links. Remove the pivot leaf assemblies in order beginning with No. 5 making sure that each pivot shaft spacer is kept with the correct leaf assembly.

(*a*) The #5 leaf assembly takes the .012 pivot shaft spacer.

(*b*) The #4 leaf assembly takes the .016 pivot shaft spacer.

(*c*) The #3 leaf assembly takes the .020 pivot shaft spacer.

(*d*) The #2 leaf assembly takes the .024 pivot shaft spacer.

(*e*) The #1 leaf assembly takes the .028 pivot shaft spacer.

f. Remove the retard assembly.

(1) Unfasten the "S" pin and lift off the retard pallet. Remove the snubber cam stop and retard segment shaft, the retard segment spring, the spacer, and the retard segment assembly. Remove the other snubber cam stop and retard segment shaft, the shims, the spacers, the trip lever, the shutter cam pawl, the spring pivot screw, the snubber spring, and the snubber assembly.

g. Remove the shutter trip assembly.

(1) Drive out the taper pin and remove the trip coupling from trip shaft. Withdraw the trip shaft assembly from the shutter case. Remove the shutter cam stop pin.

h. Remove the shutter wind assembly.

(1) Remove the four screws from the shutter spring housing. Remove the setscrew, the wind stop pin spring, and the wind stop pin from the housing. Detach the spring clip. Remove the upper spring cup and wind coupling, the shutter spring, and the cam shaft collar. Remove the taper pin, the lower spring cup and the shutter trip cam assembly.

10. REASSEMBLE THE SHUTTER ASSEMBLY.

Replace the shutter wind assembly.

a. Replace the .015″ spacer on the shutter trip cam assembly. Insert the shaft through the cam shaft bushing. Secure the lower spring cup to the shaft with a taper pin. Add the cam shaft collar and the shutter spring. Replace the wind coupling in the spring housing andd secure it with the spacer and spring clip. Place the spring housing over the shaft assembly and fasten it with four screws. Replace the wind stop pin, wind stop pin spring, and the setscrew.

b. Replace the retard assembly and the shutter trip assembly.

(1) In the following order, replace the .005″ spacer, the snubber assembly, the snubber spring, the pivot screw, a .005″ shim, the shutter cam stop pawl, and two .005″ shims. Now insert the trip shaft into the bearing of the housing and replace the trip lever at the same time since these two parts are interlocking. Replace one or more .005″ shims as needed on top of the trip lever to take up the play. Insert the snubber cam stop and retard segment shaft. Secure the trip coupling to the trip shaft with a taper pin. Replace the shutter cam stop

pin in the trip actuating lever. Position the retard segment and .005" shim, the spacer, and the retard segment spring. Then insert the other snubber cam stop and retard segment shaft. Replace the retard pallet and secure it with the washer and "S" pin.

c. Replace the leaf center assembly.

(1) Reassemble the leaf center assembly.

(a) Starting with the #1 leaf assembly and spacer, place the leaf assemblies in order in their correct positions on the lower plate.

1. Place the five connecting links on the lower plate in approximately the right position.

2. Replace the leaf assemblies so that the two studs on the assemblies engage the connecting links.

3. Replace the pivot shaft spacers on the correct leaf assembly. Check each spacer with a micrometer.

(b) Replace the between plate spacers and the upper plate. Secure the two plates with four screws.

(c) Replace the shutter operating link to the #5 leaf assembly and secure with the washer and "S" pin.

(d) Replace the diaphragm assembly.

1. Replace the diaphragm leaves on the lower plate and position on the diaphragm sector on the leaves so that the stud on each of the diaphragm leaves rides in the slot of the diaphragm sector. The diaphragm must be at its full opening when the two index marks on the sector and the diaphragm idler gear line up.

(*a*) Secure the diaphragm sector with three screws.

2. Secure the leaf center assembly with the three screws and lock washers. Secure the free end of the shutter operating link to the shutter trip cam assembly with the washer and "S" pin.

d. Replace initial tension on the shutter spring.

(1) If this initial tension is not wound on this spring, the shutter leaves will not remain closed after the shutter has been tripped. This tension also insures a complete rotation of the shutter cam and complete closing of the shutter leaves.

(2) One full turn of operational tension in addition is placed on this spring by the turning of the wind action of the camera act.

(3) If more than the initial tension is put on this spring and the camera is then wound, a double wind will be placed on the spring, and this will result in either a broken or twisted shutter spring.

(4) Turn the upper spring cup counter clockwise so that the shutter spring will slip into the slot in the upper cup. Now continue turning the coupling until the upper spring cup is latched by the shutter wind stop pin. The initial tension of 135 degrees is now on the shutter spring.

e. Wind and trip the shutter.

(1) Insert a screwdriver in the wind coupling and by turning the coupling one revolution counter clockwise, a full wind is put on the shutter spring. Then place the screwdriver in the trip coupling and turn it first clockwise then counter clockwise.

f. Replace the cover assembly.

(1) Check to see that the retard knob is between 1/125 and 1/250 and that the diaphragm knob is set on f/4.5.

(2) Fasten the cover assembly with the three screws and lock washers.

g. Replace the lens elements .

(1) Secure the elements with the eccentric locks.

h. Replace the shutter assembly in the cone so that the wind and trip coupling engage the wind and trip shafts. Secure the shutter assembly with the three long fillister head screws. Wind and trip the camera to check the operation.

THE TYPE K-20 AIRCRAFT CAMERA, SIDE PLATE ASSEMBLY

11. SIDE PLATE ASSEMBLY PROCEDURE.

a. Disassemble the side plate assembly.

(1) Remove the magazine cover.

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(a) Loosen the cover securing knob on the left side of the cover.

(2) Remove the vacuum back and bridge assembly.

(a) Remove the nut, the actuating link stud, the cotter pin in the vacuum back piston rod, and the four screws (two on each end of the bridge assembly).

(b) Remove the four screws holding the vacuum back assembly.

(c) Remove the two film spool guide rods.

(3) Remove and disassemble the side plate assembly.

(a) Remove the four screws holding the side plate assembly to the cone.

1. Remove the two visible screws when the operating handle is in the normal position.

2. The other two screws may be removed by putting the operating handle in the forward position .

(b) Remove the clutch pawl spring and the metering cam follower arm spring.

(c) Remove the taper pin, the take-up spool shaft knob, the washer, and the take-up spool ratchet assembly from the side plate.

(d) Remove the rear plate assembly.

1. Remove the "S" pin from the stud on the shutter trip shaft assembly, thus freeing the trip actuating link.

2. Remove the three screws near the bottom of the rear plate assembly.

3. When the rear plate assembly is removed, the safety latch, shutter winding clutch spring, and the shutter winding clutch pinion will fall free.

(e) Remove the trigger spring and the taper pin and lift off the winding sector assembly and the actuating disc spacing collar.

(f) Remove the counter actuating arm.

1. Detach the spring clip, remove the arm, and the counter arm return spring.

(g) Remove the actuating disc assembly from the winding handle shaft.

(h) Remove the operating handle from the side plate.

1. Remove the trigger locking screw from the trip shaft.

2. Remove the taper pin from the winding handle shaft.

3. When the operating handle is removed, the operating handle spacer will fall free and the trigger assembly will be free.

4. Remove the trigger handle screw, the trigger screw roller, and the trigger from the operating handle.

b. Reassemble the side plate assembly.

(1) Replace the mechanism assembly.

(a) Replace the trigger in the operating handle and secure it with the trigger screw roller and the trigger handle screw

(b) Place the operating handle against the side plate with the operating handle in place and replace the winding handle shaft through the operating handle. Secure the operating handle with the taper pin. Replace the trigger locking screw in the trigger after the trigger assembly is inserted through the side plate into the operating handle.

(c) Replace the actuating disc assembly on the winding handle shaft.

(d) Replace the counter actuating arm with the counter arm return spring in place. Secure it with the spring clip.

(e) Replace the actuating disc spacing collar.

(f) Replace the winding sector on the winding handle shaft and secure it with a taper pin. Replace the trigger spring. Check to see that the counter actuating arm is riding on the trip lever return spring (located on the winding sector).

(g) Replace the rear plate assembly.

1. Replace the shutter winding clutch pinion, the shutter winding clutch spring, and the safety latch in that order on the winding gear shaft. Hold these parts in place while fitting the rear plate assembly into the proper position. The operating handle should be in the extreme rear position when the rear plate is fitted into place. The marked tooth space on the winding gear should engage the marked tooth on the shutter winding clutch pinion. Secure the rear plate assembly with three screws. Replace the trip actuating link on the stud of the shutter trip shaft assembly and secure it with an "S" pin.

(h) Replace the take up spool ratchet assembly in the side plate. Replace the take up spool shaft knob on the take up spool shaft with the washer in place and secure it with a taper pin.

(2) Check the operation of the side plate assembly.

(a) Apply pressure to the actuating link to simulate the tension normally supplied by the vacuum back piston leaf spring.

(b) Wind and trip the side plate mechanism.

(3) Replace the side plate mechanism on the cone and secure it with the four screws and lock washers.

(a) With the operating handle in the extreme rear position, the two screws just below the operating handle may be inserted. Then push the operating handle forward and insert the remaining two screws.

(4) With the two film spool guide rods in place, replace the vacuum back assembly and secure it with the four screws.

(5) Replace the bridge assembly and secure it with the four screws.

(6) Replace the cotter pin through the piston actuating lever and vacuum back piston rod.

(7) Secure the actuating link to the piston actuating lever with the actuating link stud and nut.

c. Insert the film threading plate, dummy film, or some paper in the focal plane and while winding and tripping the camera, observe the functions of the following parts:

(1) The actuating disc.

(a) Resets the shutter.

(b) Trips the shutter.

(c) Depresses the vacuum back pitson.

(2) The trip lever.

(a) Rotates the actuating disc counter clockwise, on the backward stroke of the wind handle, which resets the shutter and depresses the piston.

(b) Allows the actuating disc to fly clockwise when released from engagement at the time that the trigger is pulled, tripping the shutter.

(c) Locks the handle at the end of the backstroke by a latch.

(d) Releases the latch after the trigger is pulled.

(e) Permits the handle to be moved in one direction only during the wind cycle by means of full stroke pawls.

(3) The guard rail.

(a) Holds the trip lever away from the actuating disc on the forward stroke.

(b) Prevents the camera from being tripped until the shutter is fully wound.

(4) The safety latch.

(a) Locks the operating handle upon the completion of the wind cycle and prevents the forward stroke until the shutter is tripped.

(5) The trip actuating link.

(a) The trip actuating link resets the shutter when the actuating disc is turned counter clockwise.

(b) Trips the shutter when the actuating disc is rotated clockwise by piston action.

(6) The actuating link.

(a) Depresses the piston when the actuating disc is pulled counter clockwise on the backward stroke of the handle.

(b) Rotates the actuating disc clockwise by piston tension when the piston is released.

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(7) The counter actuating arm.

(a) Moves the exposure dial ahead and records each exposure.

(b) Rides on and is actuated by the winding sector.

(8) The cam follower arm.

(a) Engages the slot of the metering cam allowing the ratchet stop spring to engage the film metering ratchet, stopping the film wind when the metering roller has rolled off the correct amount of film.

(9) The winding sector.

(a) Winds the film on the forward stroke of the operating handle by means of the upper part of the sector.

Winds the shutter spring on the backward stroke of the operating handle by use of the lower part of the sector.

(10) The metering ratchet assembly.

(a) Acts as a clutch to stop film wind action when sufficient film has passed across the focal plane.

(b) It is controlled by the cam follower arm.

(11) The metering cam.

(a) Controls the action of the cam follower arm which rides on the cam. One revolution is equivalent to the correct amount of film. It is geared to and rotated by the metering roller over which the film passes.

(12) The shutter winding bevel pinion and shutter winding bevel gear .

(a) Turns the shutter wind shaft which winds the shutter spring.

(13) The wind clutch pinion.

(a) Acts as a clutch slipping backward four teeth over the pin on the shaft on the forward stroke.

(b) Engages with the pin on the backward stroke transmitting power to the shutter spring.

(14) The trip adjusting stud.

(a) Adjusts the position of the shutter reset action.

(15) The non-reverse pawl.

(a) Prevents the take up spool from backing up.

d. Wind and trip the side plate mechanism. Load the magazine with dummy film and replace the magazine cover. Set the camera upside down with the cone pointing up. Replace the trip coupling shaft and the wind coupling shaft.

e. Wind and trip the shutter assembly. Replace the shutter assembly in the cone so that the wind and trip couplings engage the wind and trip shafts. Secure the shutter assembly with the three long fillister head screws. Wind and trip the camera to check operation.

d. Winterization.

(1) When the K-20 should be winterized.

(a) Most cameras designed for operation in normal temperatures will operate satisfactorily without winterization in temperatures down to approximately minus 20 degrees Fahrenheit. However, K-20 cameras which are to be regularly operated at temperatures below plus 20 degrees Fahrenheit, should be winterized. Two K-20 cameras may operate quite differently at low temperatures since the adjustments and fits of parts are not exact. Consequently, the adjustment and fit of parts are of major importance. Well broken in (not worn out) K-20 cameras will not freeze up as quickly as new cameras.

(2) How to winterize the K-20.

(a) The results of a recent low temperature study made of all standard aerial cameras lubricated with new low temperature lubricants indicate that sufficient clearances already exist on almost all camera parts and that past malfunctions at extremely low temperatures have been largely due to the use of improper lubricants. It has been determined that in nearly all cases complete, relubrication alone is sufficient to insure proper low temperature operation. The following general instructions apply for all standard aerial cameras.

1. Each camera, including all sub units and each individual part thereof, should be washed thoroughly by removing every trace of the old lubricant. Dry cleaner's naptha (Federal Spec. No. *P-S-661), acid free

kerosene (Federal Spec. No. VV-K-211), or lead free gasoline should be used.

2. Relubricate sparingly with the grease or oil specified in the applicable Technical Order.

(*a*) Grease is usually specified. All metal parts such as housings, castings, etc., which are subject to rust and corrosion should be wiped with a cloth impregnated with the grease or oil.

(*b*) Exercise care to keep the lens and shutter leaves free from grease, oil, and grit.

(*c*) Oil should be used on counters and similar intricate parts where grease impedes proper operation at extremely low temperatures. Oil is also recommended for shutter leaf pivots to retain indicated shutter speeds.

(*d*) Complete relubrication is recommended twice a year or as frequently as is found necessary, depending upon the operating conditions and the amount of use the equipment receives.

3. The increasing of clearances between shafts, bearings, and other wearing surfaces is definitely discouraged as a means of freeing a camera. With very few exceptions, the normal clearances between running parts will suffice for satisfactory operation at low temperatures.

(3) Low temperature lubricants.

(a) The recommended grease is Spec. AN-G-3a, special for camera use.

1. The nomenclature on the containers of this grease will read as follows: "Grease, lubricating, low temperature, Spec. AN-G-3a, special for camera use."

(b) TG-223 grease has given very satisfactory results at low temperatures. However, due to the low viscosity and flash point of the oil used in this grease, its service life at elevated temperatures is not entirely satisfactory. Continued use of TG-223 grease is recommended only when the new AN-G-3a grease is not available.

(c) The recommended oil is Spec. No. AN-O-6a. This oil has a low evaporation rate and is very satisfactory for low temperature operations.

(d) Fluid, hydraulic, petroleum base, Spec. No. AN-VV-366b, may be used as a substitute. However, this oil has a high evaporation rate and should be reapplied frequently. Also it does not serve as a good corrosive preventive.

(e) Gyro instrument oil, lubricating, aircraft, Spec. No. AN-O-4 is usable when necessary and has good corrosion preventive characteristics, but is not as good as AN-O-6a at low temperatures, hence it is recommended only as an alternate lubricant when AN1O-6a is not available.

(4) Condensation on camera equipment.

(a) K-20 cameras to be used in low temperatures should be kept in low temperature storage, usually a protected outdoor shelf or an unheated room.

(b) Do not bring equipment into warm air just prior to a cold weather mission.

1. Cold equipment brought into warm air will condense moisture from vapor in the warm air. This condensation or "sweating" is harmful to camera equipment and will freeze if the equipment is subjected to freezing temperatures before condensation has completely disappeared.

(5) Shutter speeds.

(a) With the use of camera winter lubricants, winterized between-the-lens shutters of the K-20 will operate in temperatures as low as minus 65 degrees Fahrenheit and at a speed approximately 10% less than they operate at moderate temperatures.

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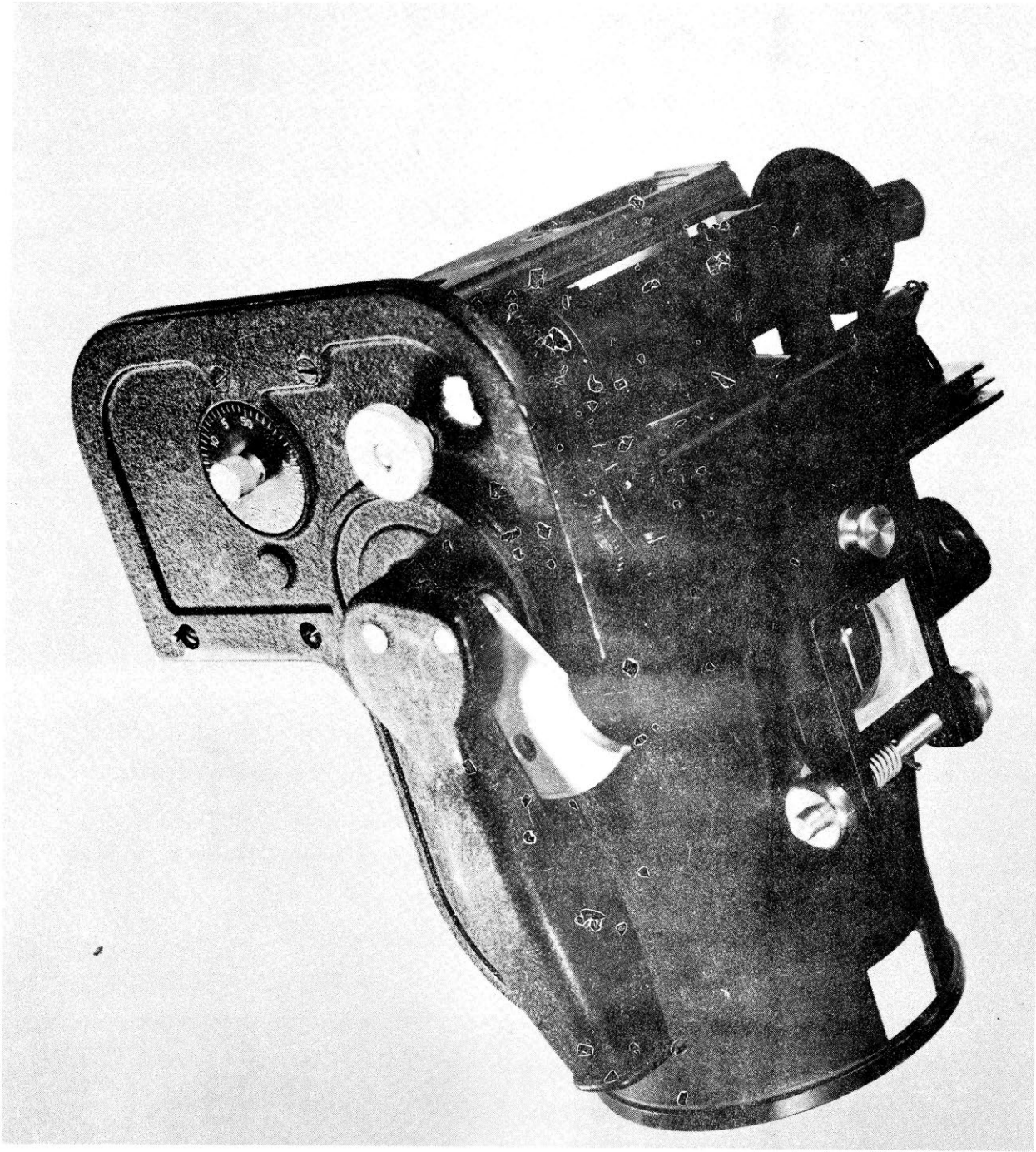
12. TROUBLE, CAUSES AND REMEDIES.

Trouble	Probable Cause	Remedy
Shutter bounces after tripping	Loss of initial tension	Retime camera
	Stretched shutter spring	Replace spring
Faulty negative spacing	Distortion of metering ratchet spring	See film feed adjustment
	Operating camera too rapidly	Keep wind cycle to one second minimum
	Threading film over pressure roller	Rethread film between pressure roller and metering roller
Negative out of focus	Loose lens element (front, rear or both)	Set the lens element securely with lens locking cams
Difficulty in tripping camera	Excessive play in operating handle	Replace and refit new safety latch (clearance should be .010" when fully wound)
Jamming of wind mechanism	Overwinding of shutter operating spring	Remove shutter and check spring; retime camera. Check for proper reset action
Jamming of vacuum back	Vacuum back not traveling evenly	Check vacuum back alignment pins for vertical alignment
	Improper clearance between latch pins on vacuum back cylinder and latch pin stops	Adjust to .002 inch clearance equally on both sides of vacuum back cylinder. When piston and cylinder vacuum back assembly is seated on the film guide. By adding or removing latch pin shims on the latch pin stops before screwing them down.
High shutter speed at all settings	Retard segment sticking	Adjust retard segment. Clean if corroded
Possible to back up operating handle when winding camera	Full stroke pawl not engaging ratchet	Adjust or replace full stroke pawl
Shutter fails to trip	Shutter failing to reset	Adjust screw in trip link shaft until resetting action (denoted by clicking noise) occurs 5 to 11 degrees before end of stroke.

—END—



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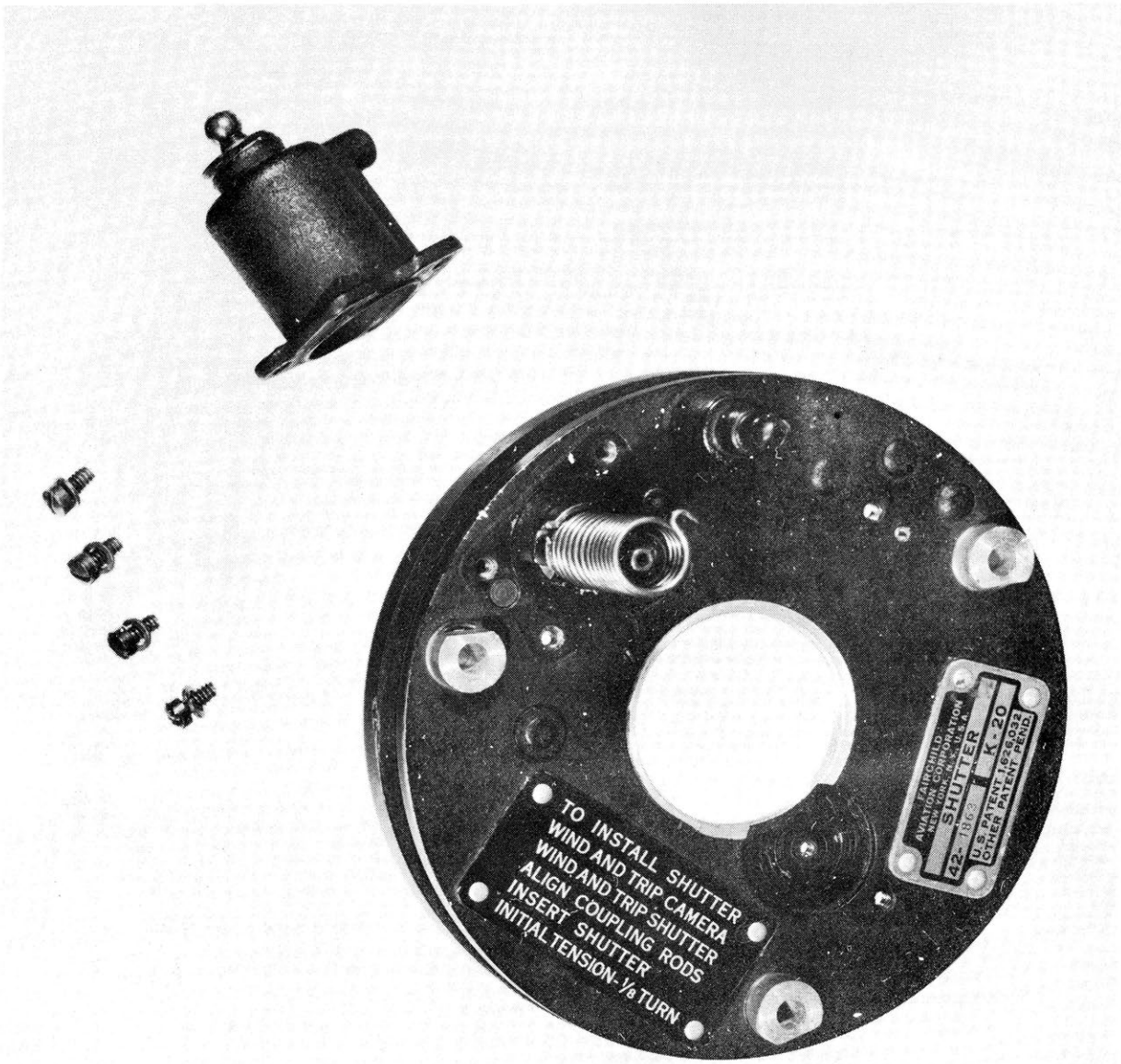
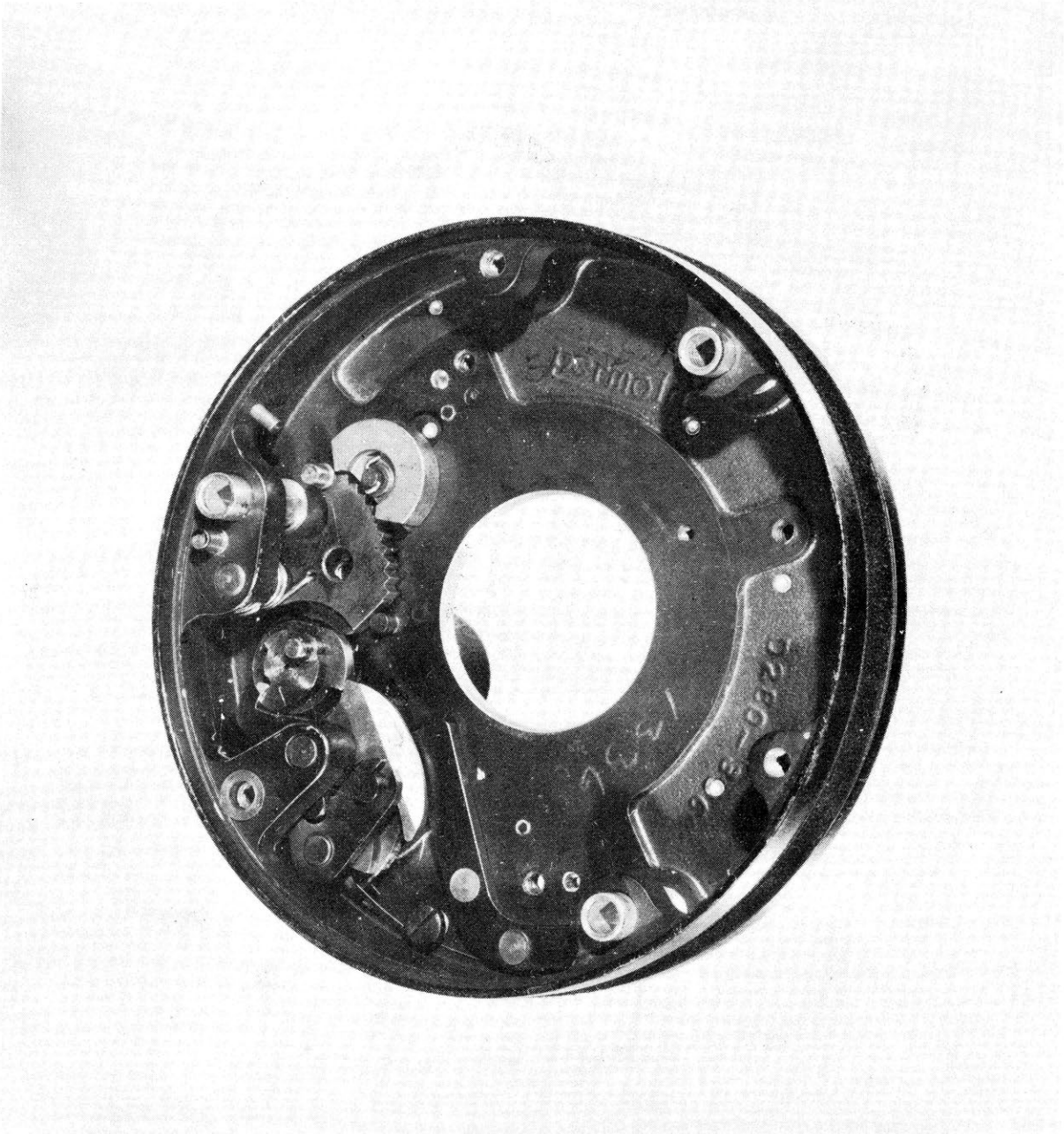

TO INSTALL SHUTTER
WIND AND TRIP CAMERA
WIND AND TRIP SHUTTER
ALIGN COUPLING RODS
INSERT SHUTTER
INITIAL TENSION-1/8 TURN
SHUTTER
K-20
U.S. PATENT 1,626,012
OTHER PATENT PEND.



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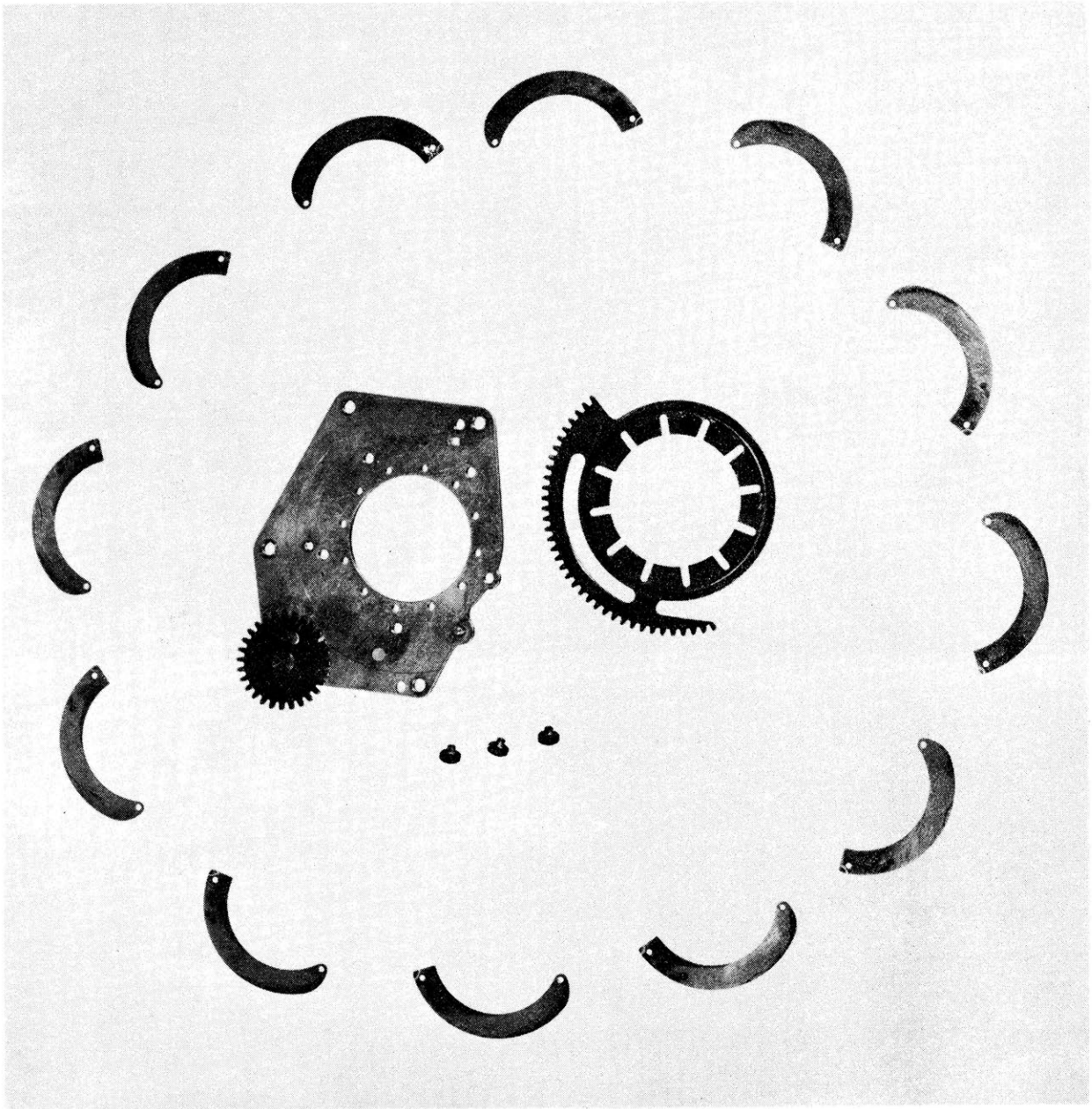

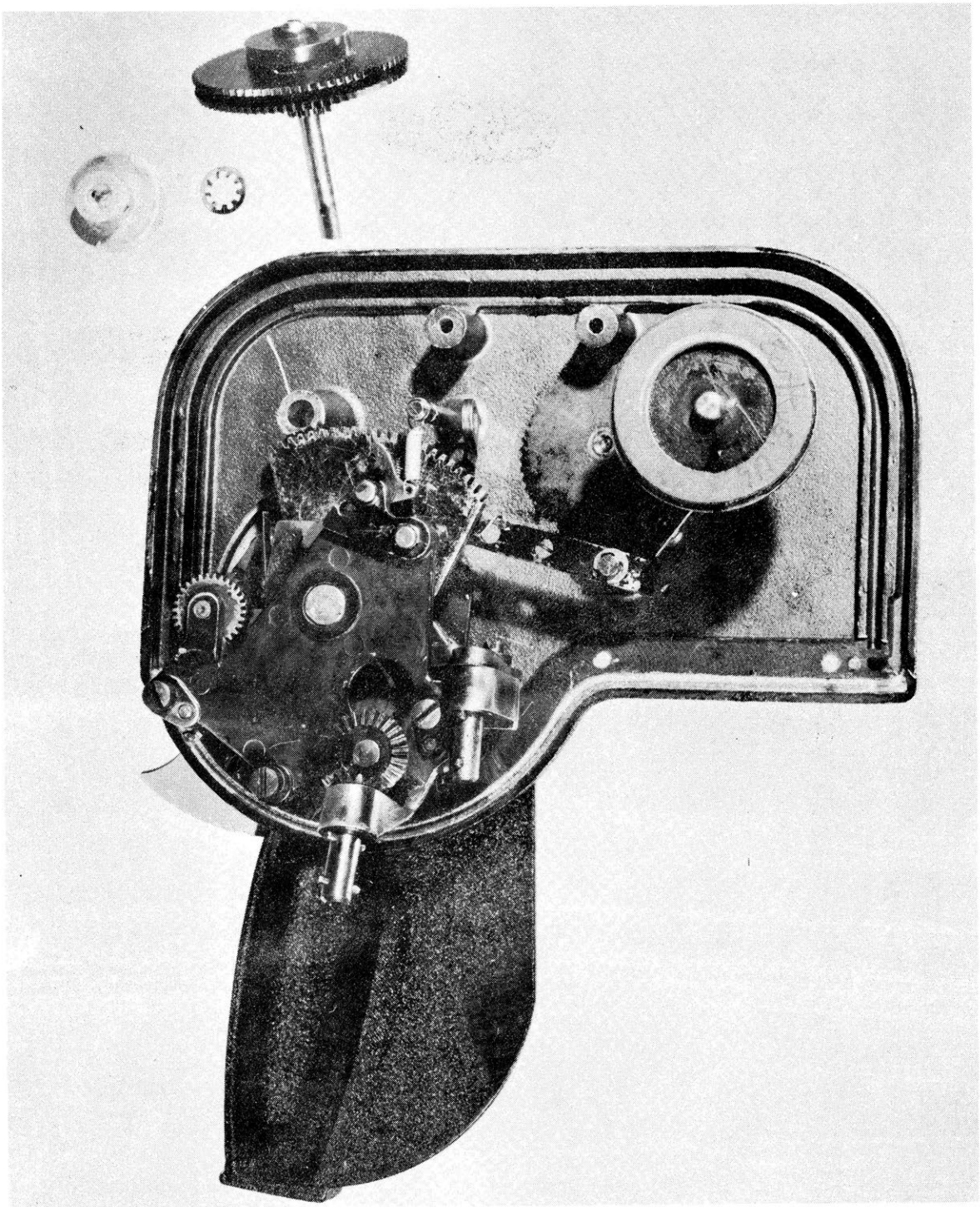

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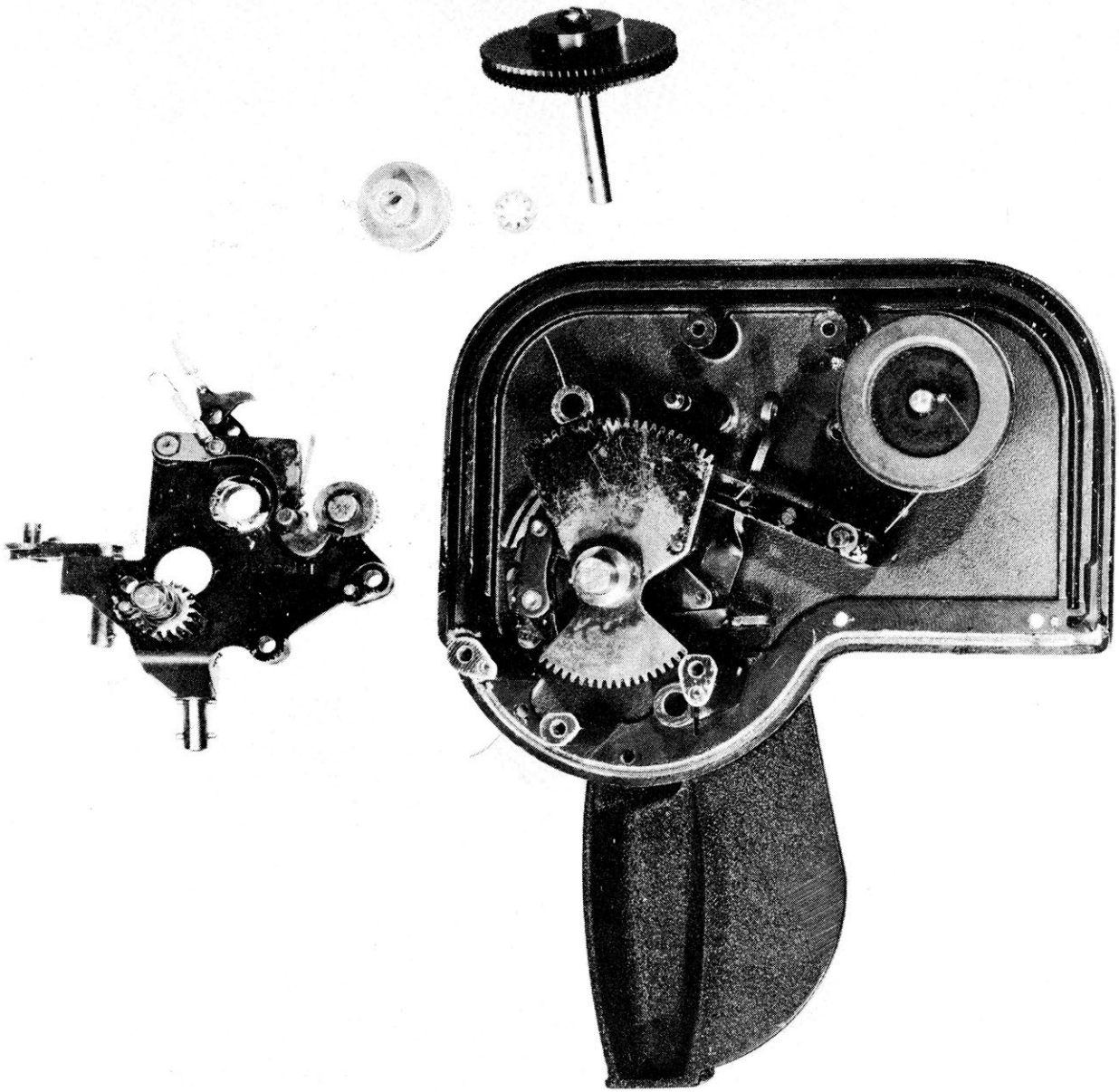

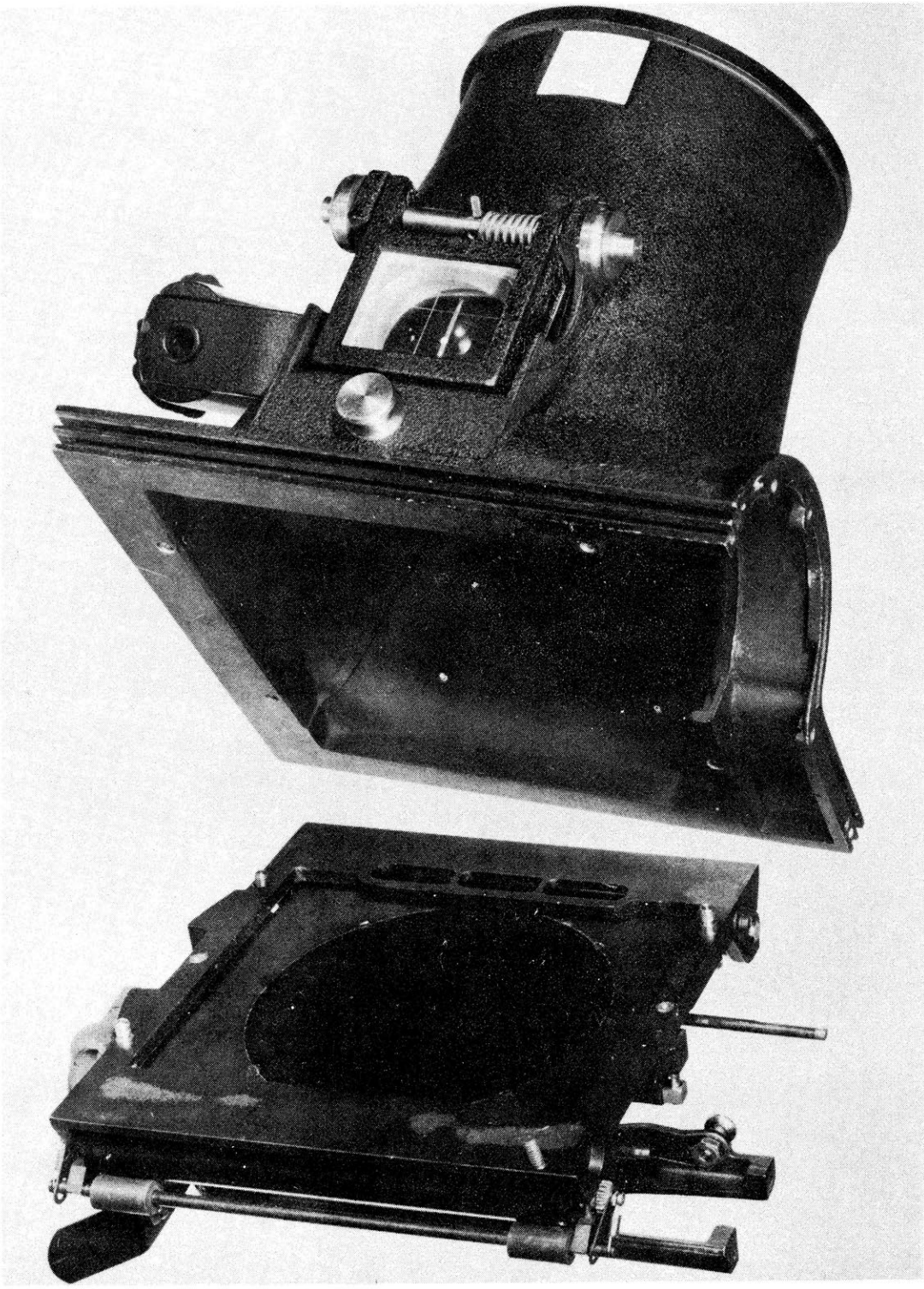

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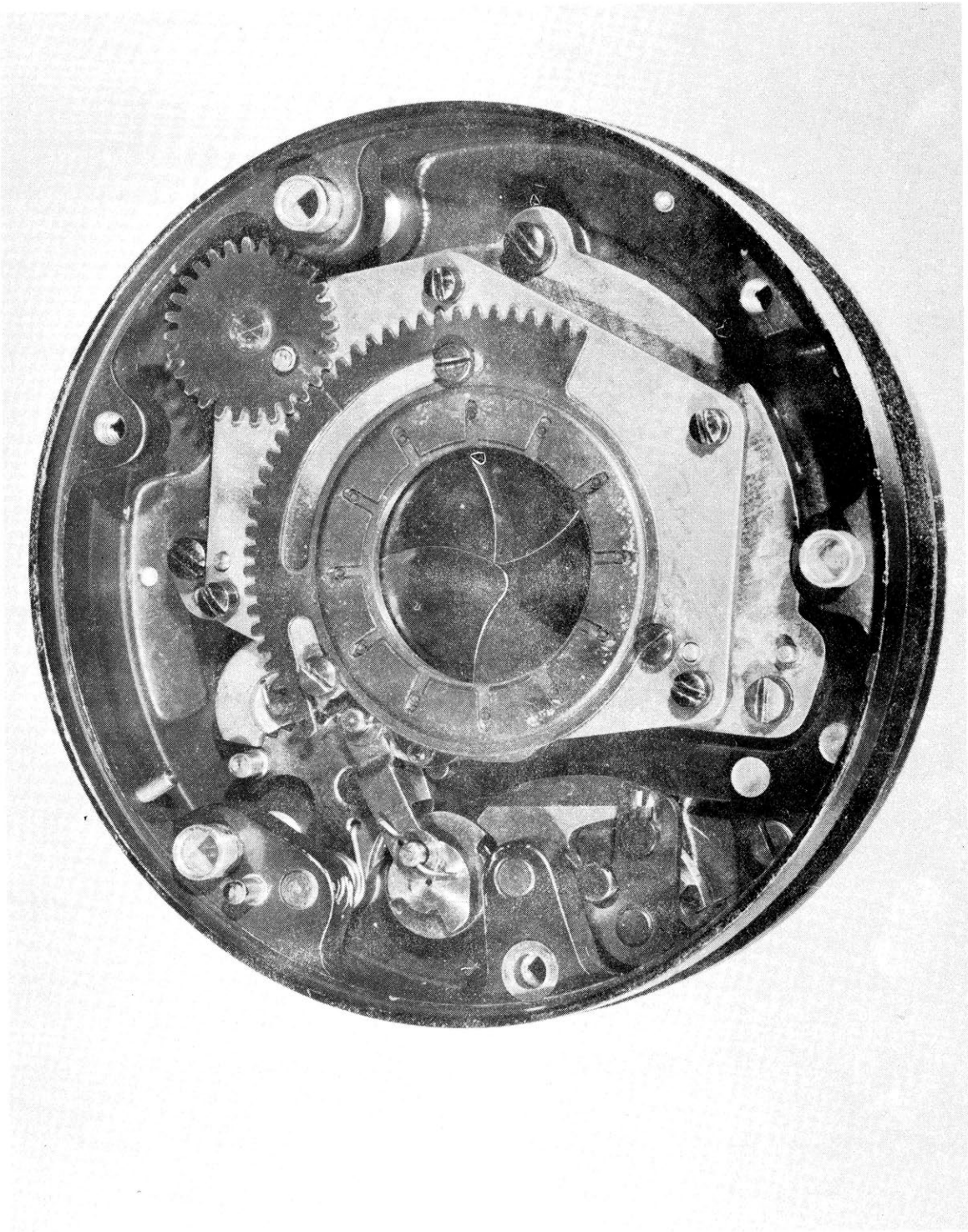

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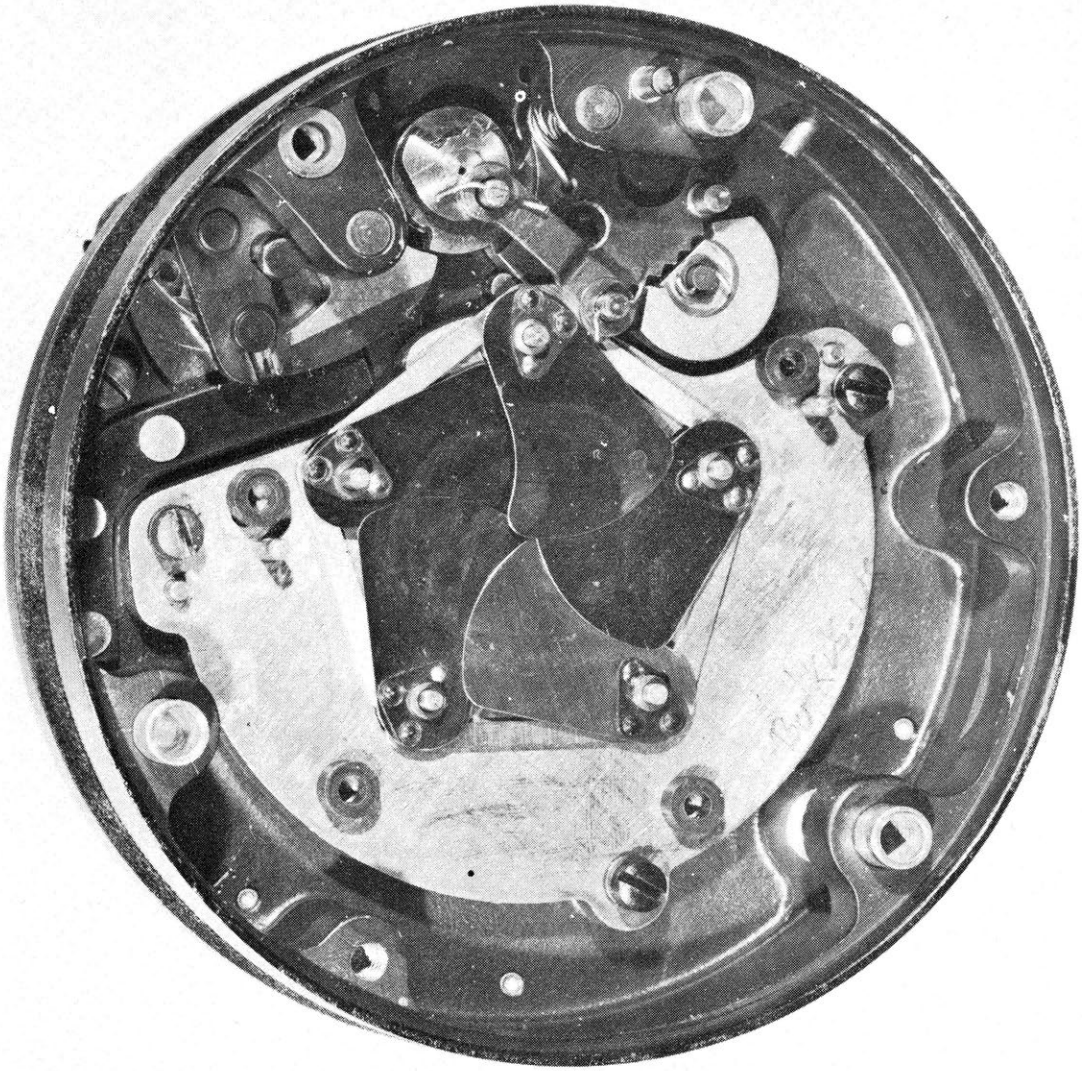

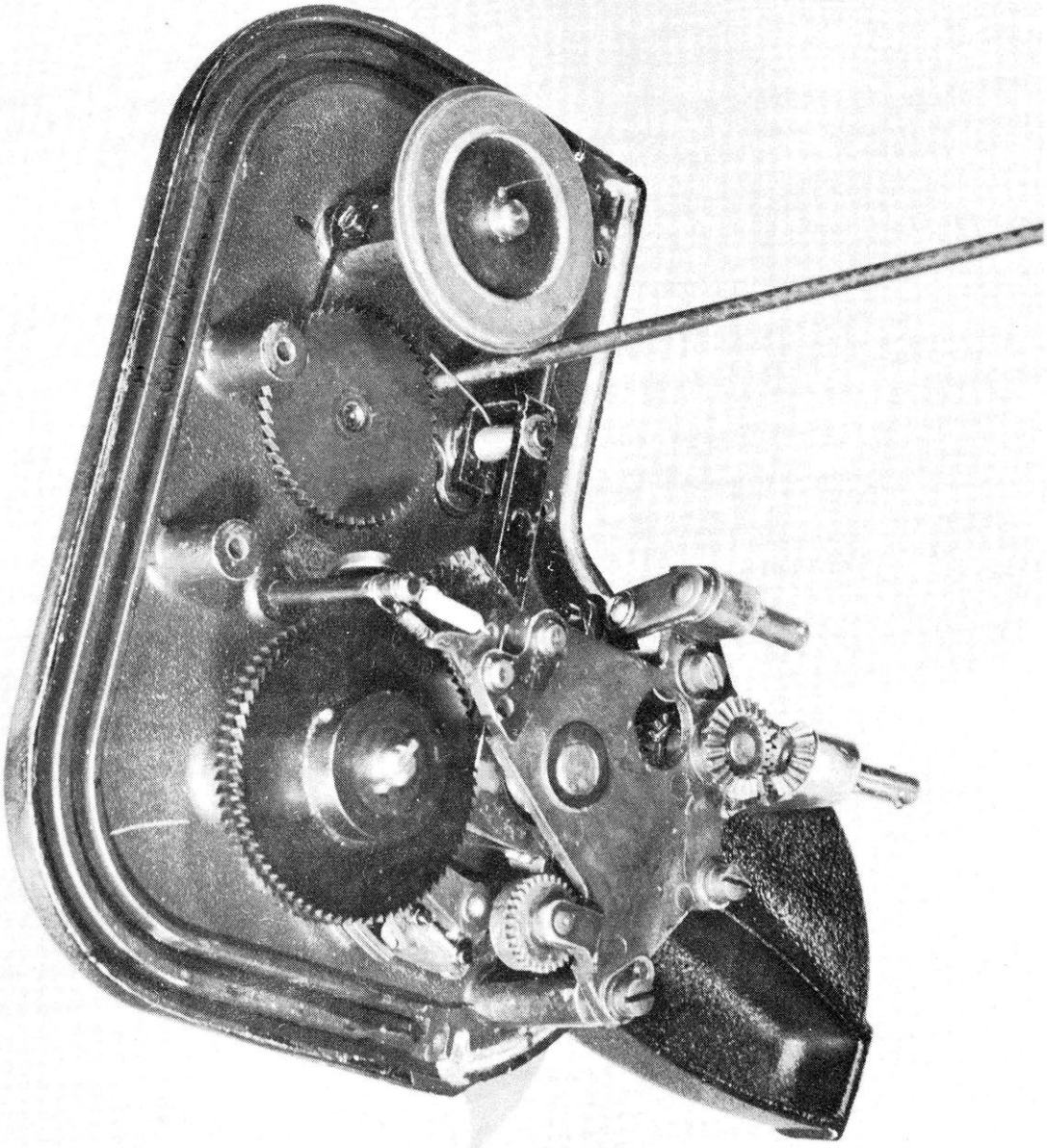

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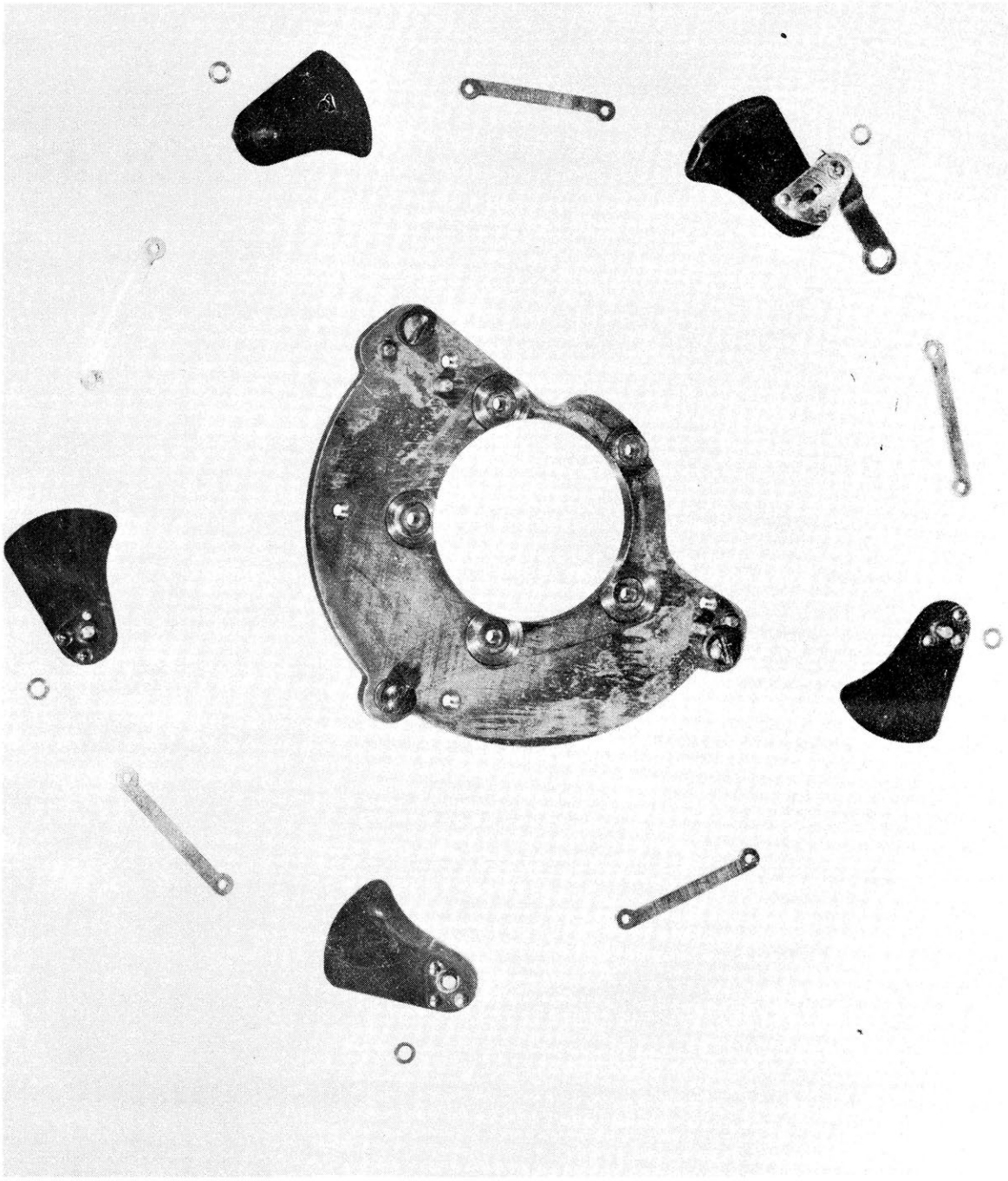

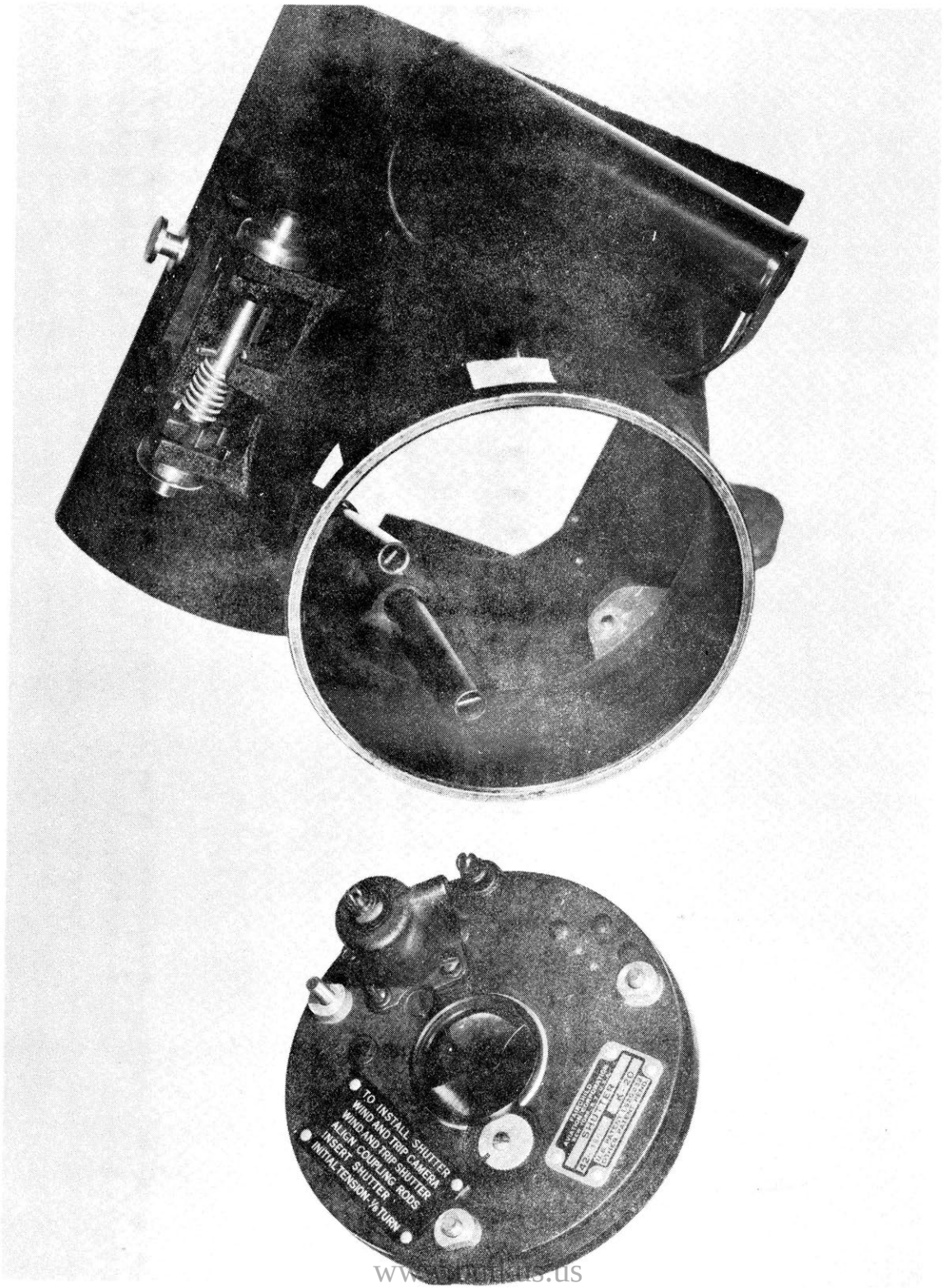
TO INSTALL SHUTTER
WIND AND TRIP CAMERA
WIND AND TRIP SHUTTER
ALIGN COUPLING RODS
INSERT SHUTTER
INITIAL TENSION ¼ TURN

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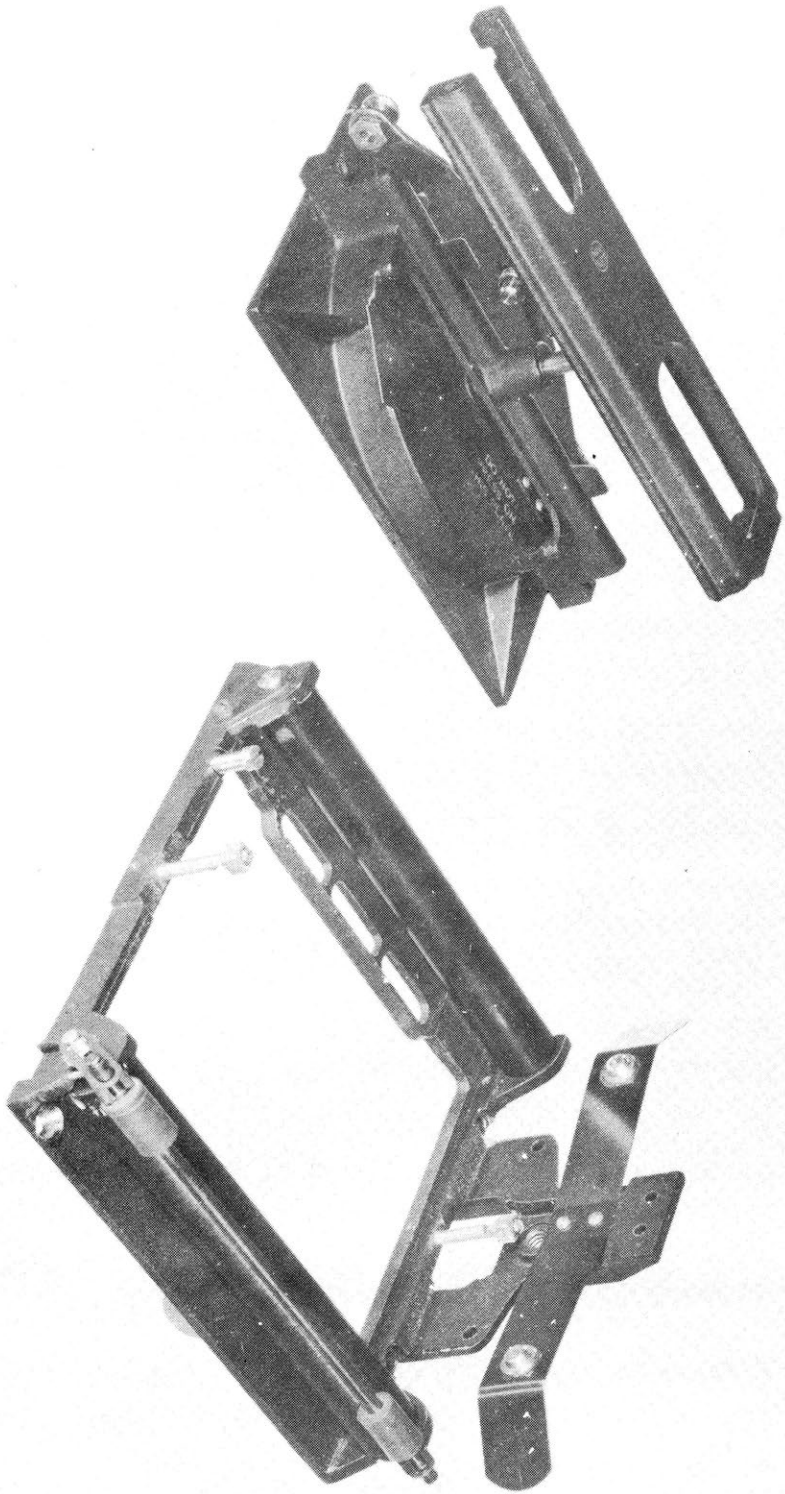

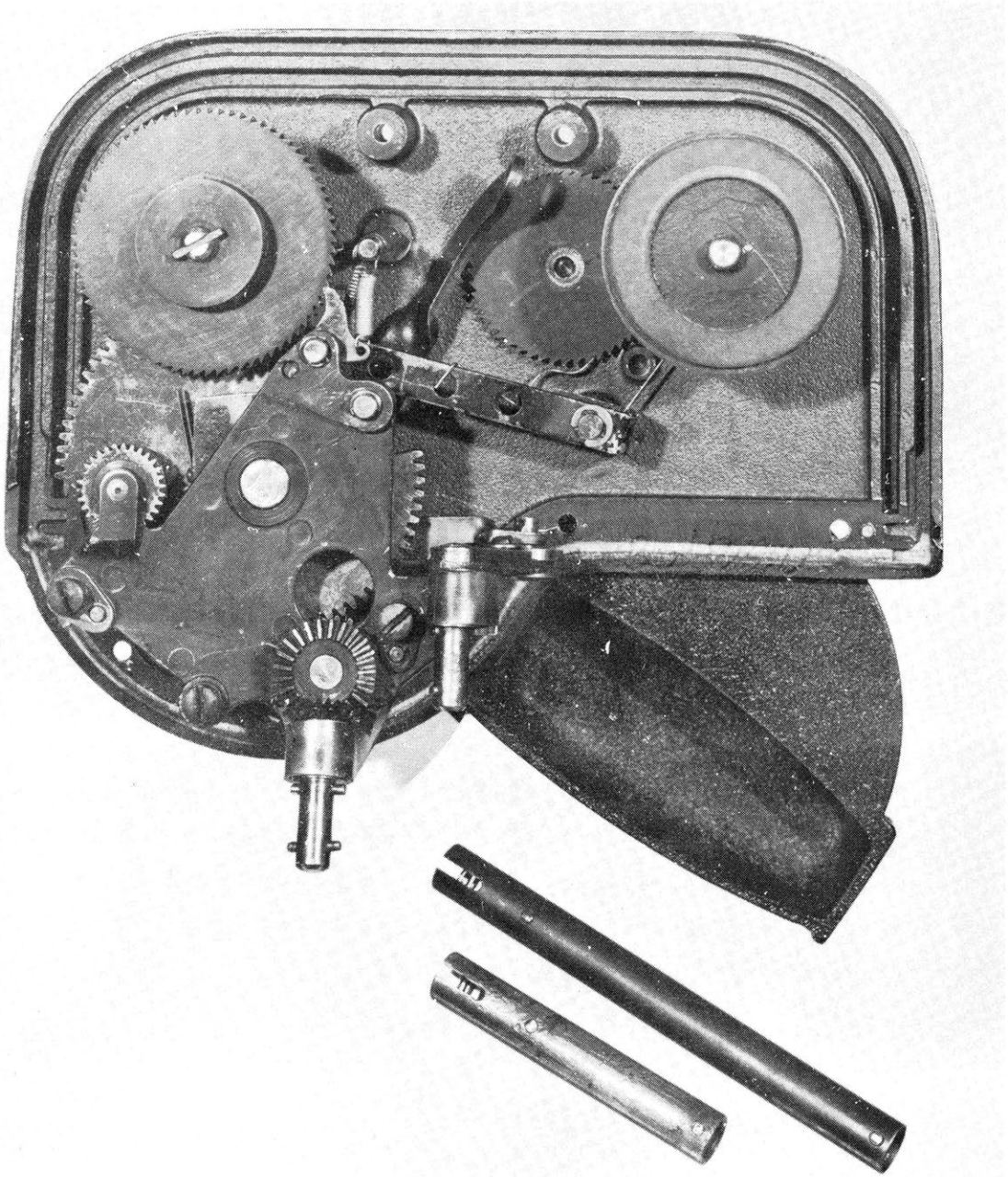

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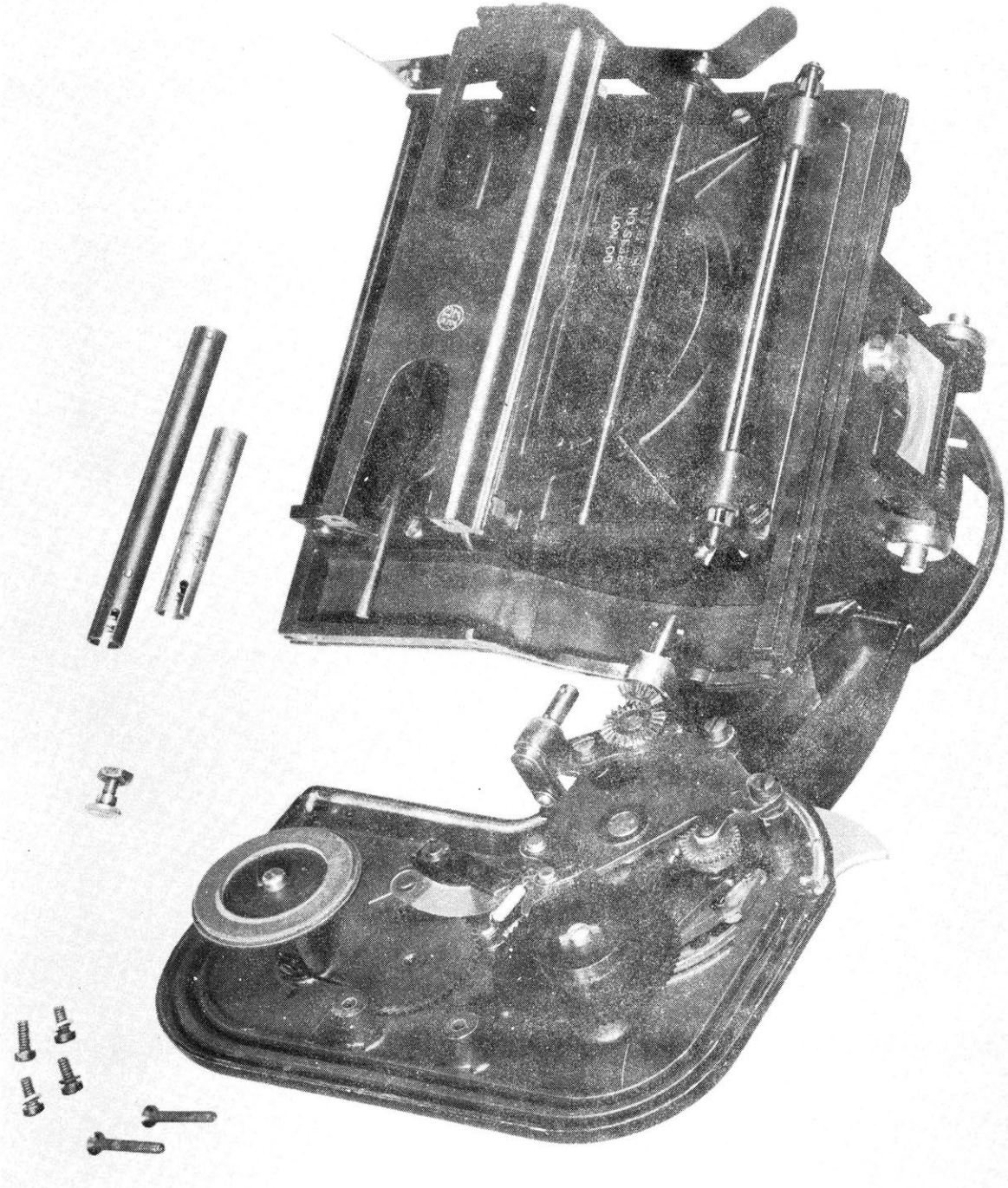
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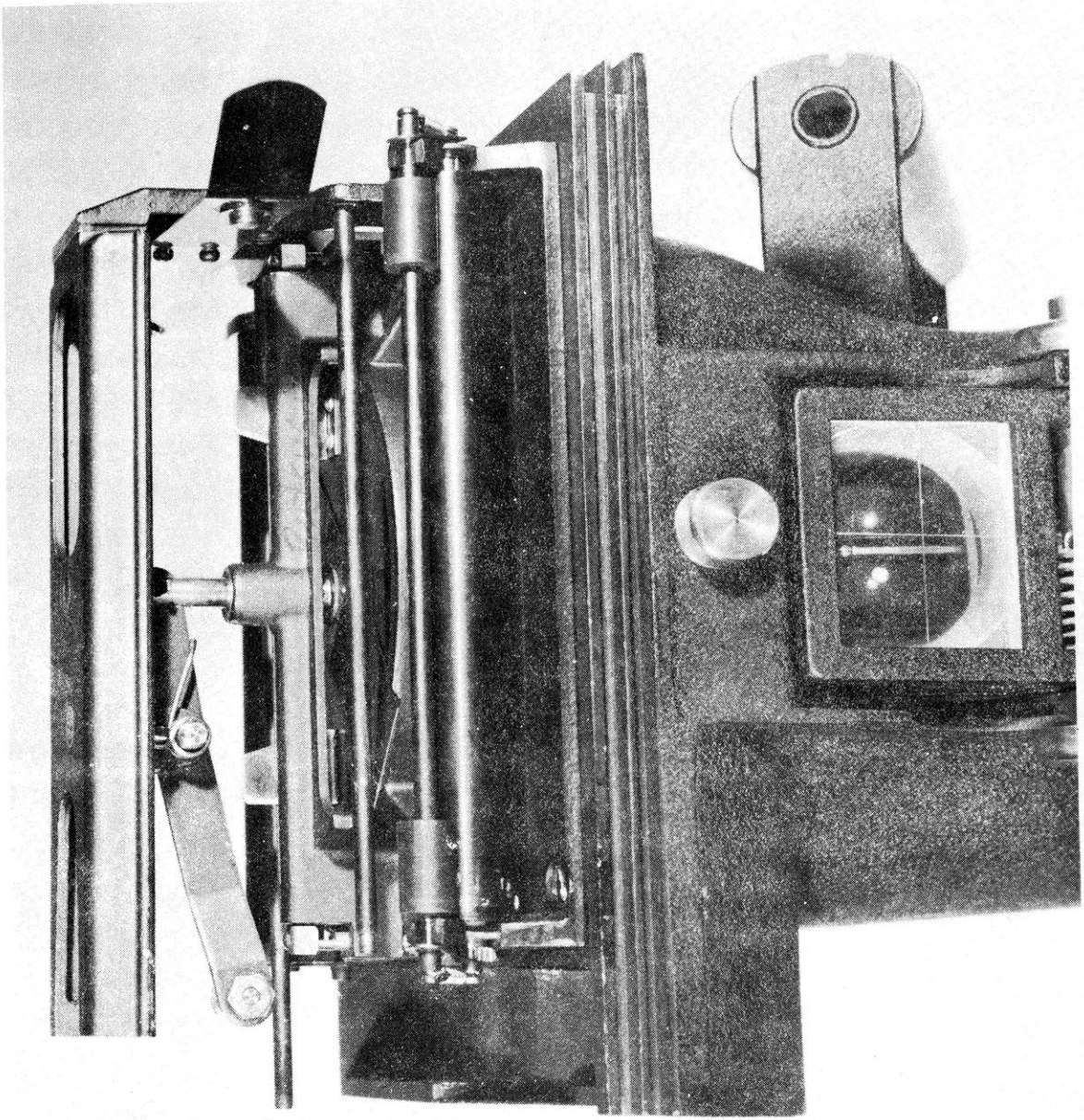

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