

CHAPTER 2

AIRCRAFT CAMERA, TYPE F.24

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Introduction

1. The type F.24 camera is designed on the unit system, permitting a straightforward interchange of units, both to meet particular requirements, and the replacement of defective parts. Exposures may be made singly by using the push switch control, or at regular, pre-determined intervals by the type 35 control. The camera is fully automatic in operation and may be run from either 12 or 24-volt aircraft supplies.

Application

2. *General air reconnaissance.*—In peace-time this camera was used for day reconnaissance with a range of lens cones of from 5 to 20 in. focal length. The range of lenses has been augmented since the war by the 3½ in. extra wide angle. Lenses at present available are given in the Table in para. 15.

3. *Hand-held camera.*—It can be used for hand-held oblique photography with the Type 21 mounting, although this application is now largely met by the American K.20 camera.

4. *Low altitude records.*—With the addition of the mirror attachment and Type 48 control, the camera is used for low altitude attack records, being coupled to operate automatically with the bomb release mechanism.

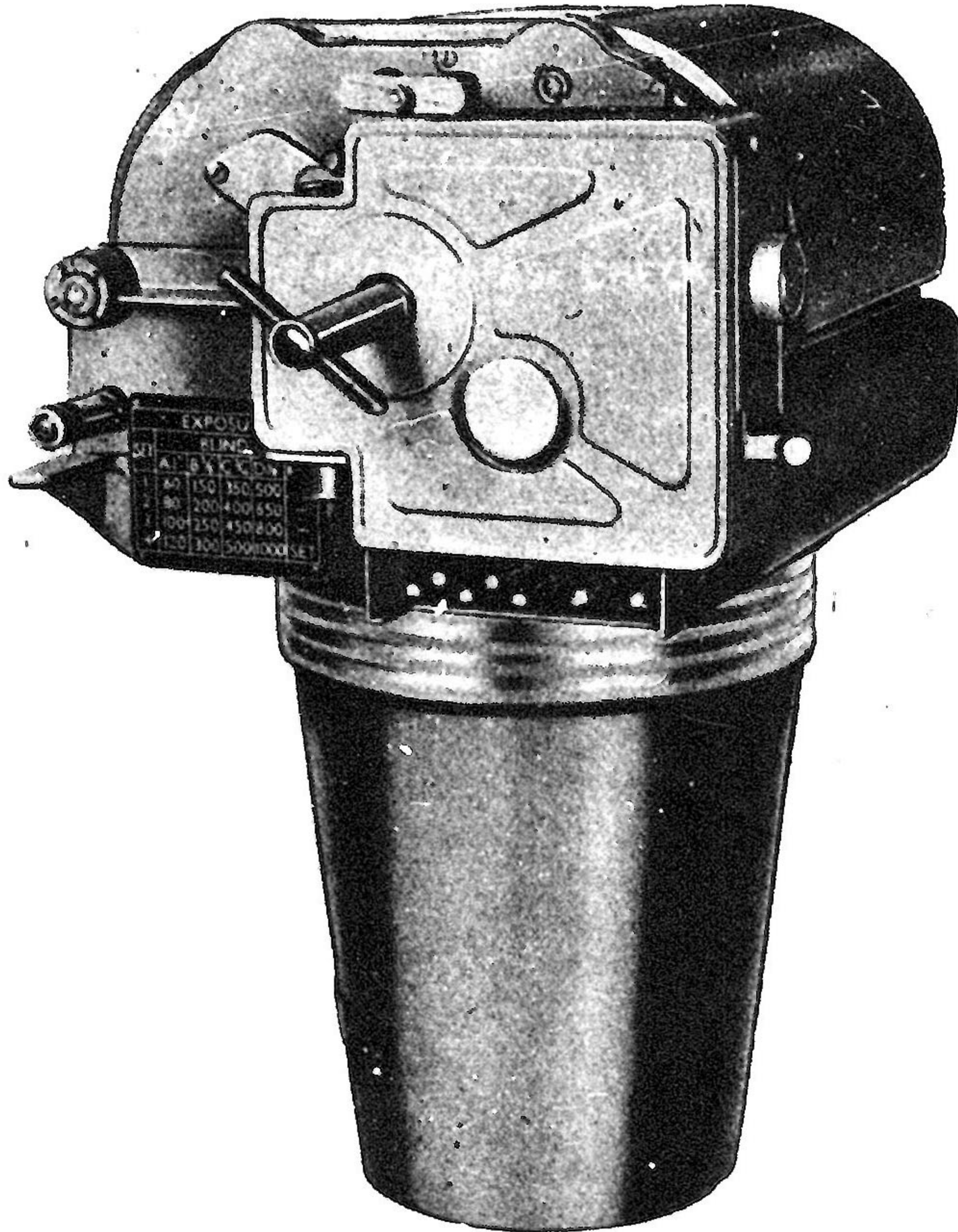


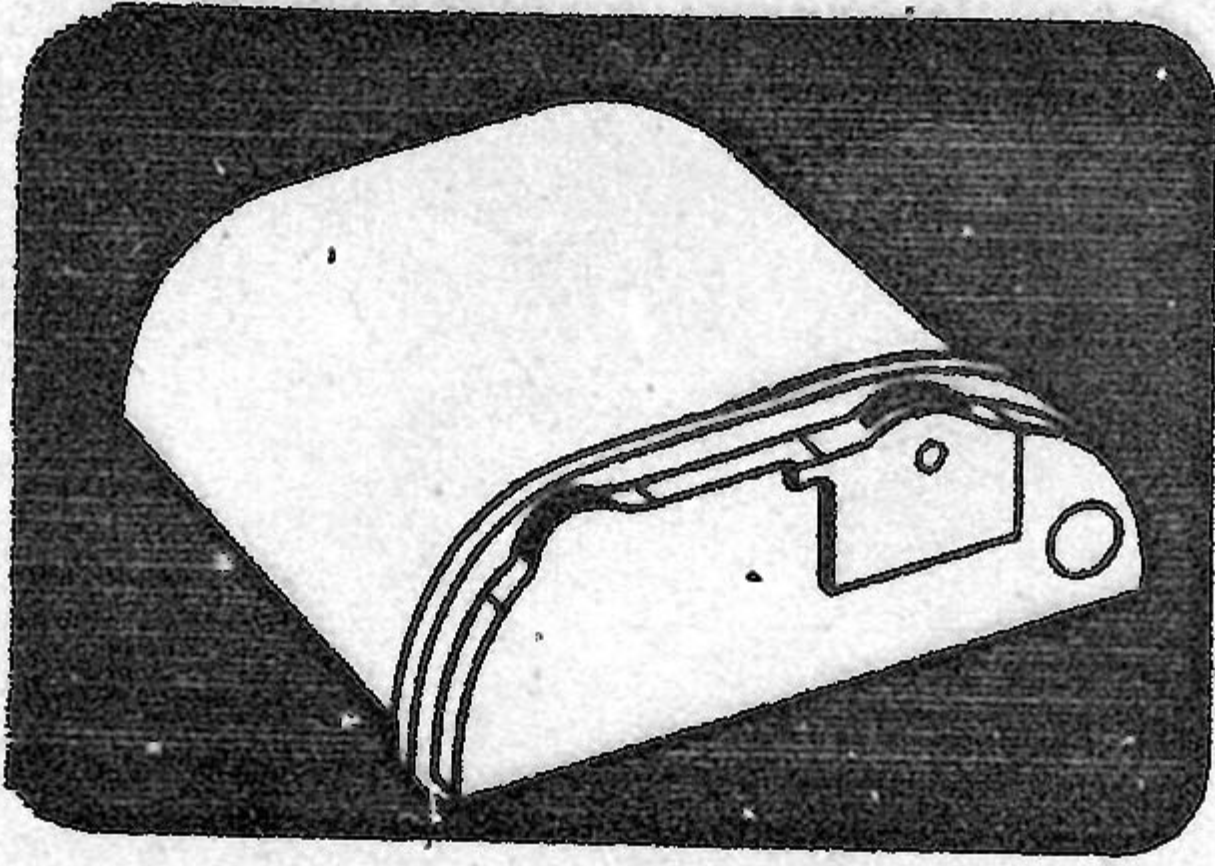
Fig. 1.—Air camera, type F.24

5. *Night photography.*—The camera forms the basis of the night camera and when coupled to the No. 19 or 20 Type 35 control is used for target identification on night bombing raids, the 4.5 in. photographic flash being used as the illuminant (see A.P.2651).

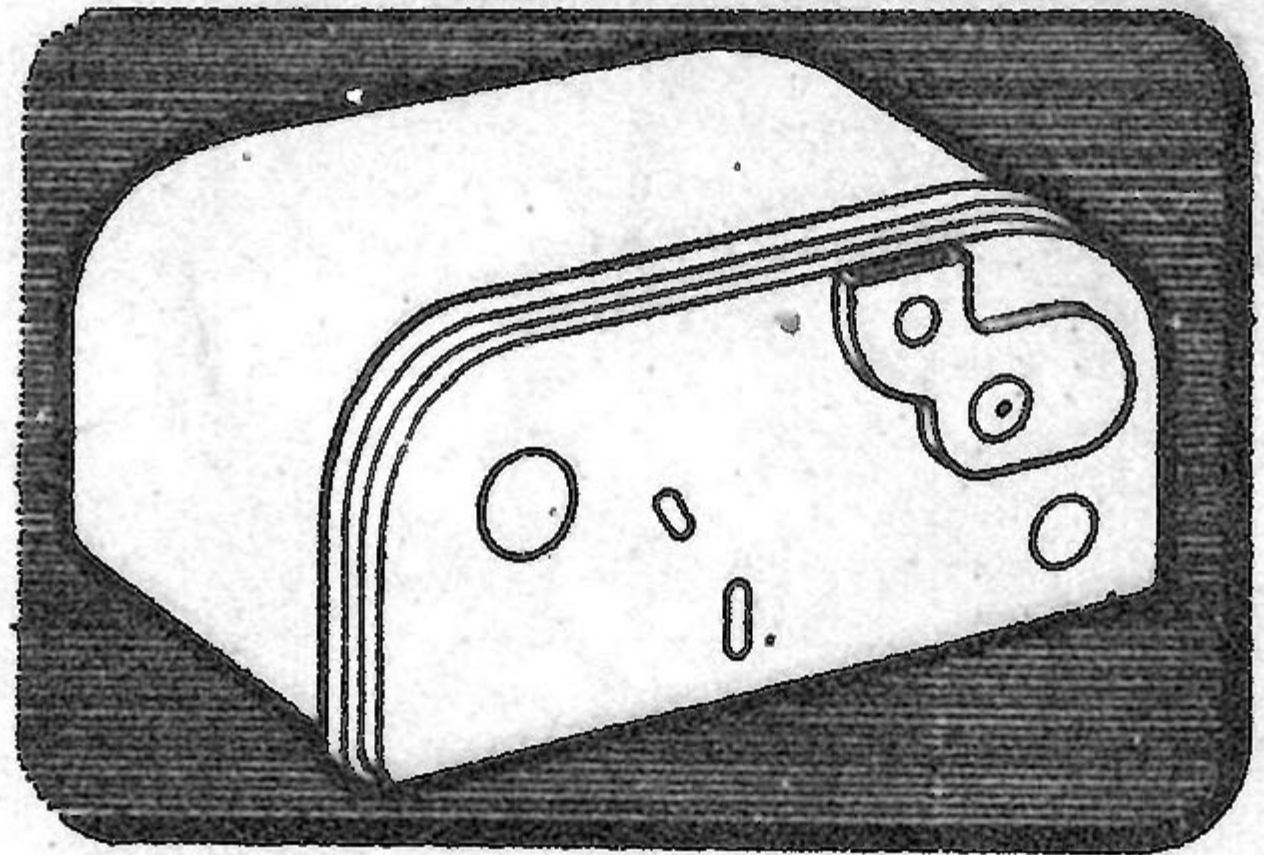
Brief description of units

6. *Magazine, type A.*—This is the standard magazine, taking up to 125 exposures of 5½ in. width unperforated air film. It is divided roughly into two spool chambers—feed and take-up—both of which are friction loaded to allow for changing spool diameters during wind-over. The film is fed through the magazine by the needle measuring roller, which is directly coupled to the gearbox. A visual exposure counter and film wind indicator are incorporated. The metal film spools are slotted to engage with the spool dogs. Correct adjustment of the spool friction loading is extremely important (see para. 31 and 32).

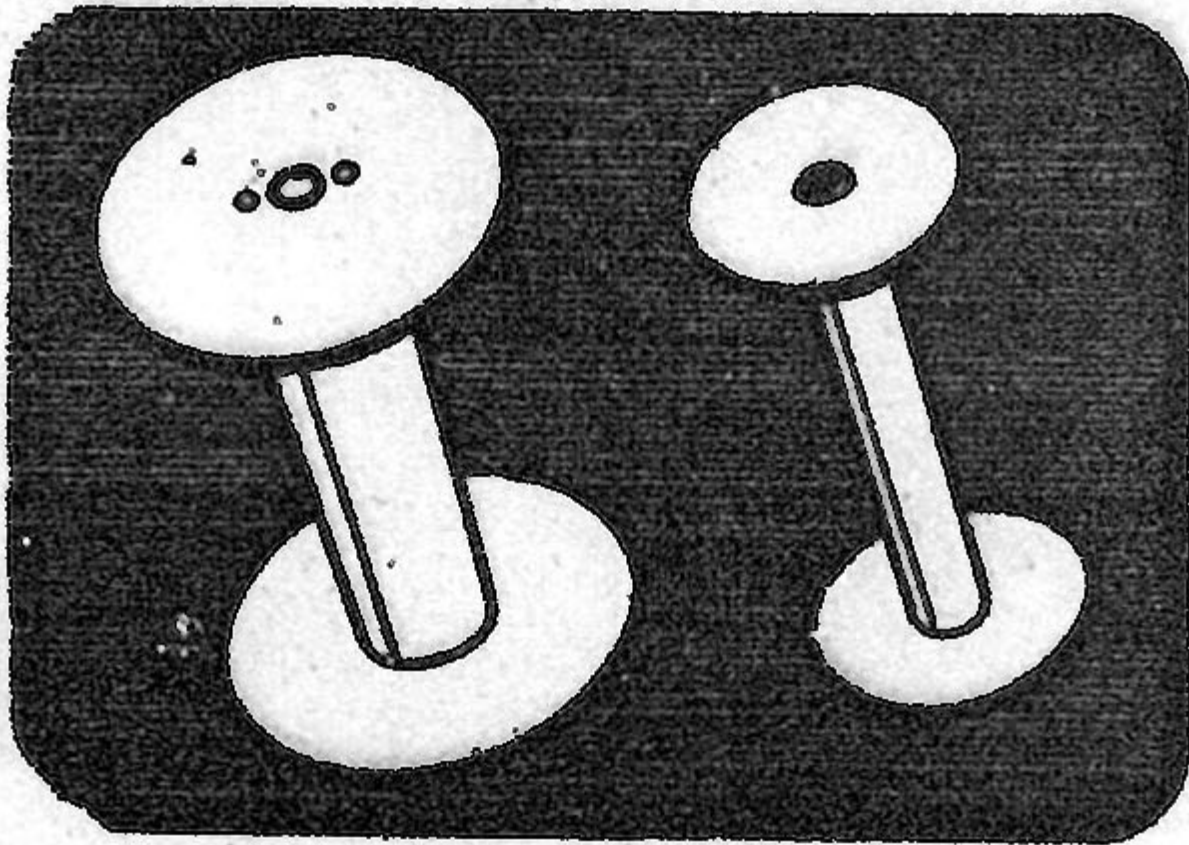
7. *Magazine, Type C.*—This larger capacity magazine takes up to 250 exposures of 5½ in. width air film. It is primarily intended for use in Photographic Reconnaissance Units. It is of similar design to the Type A, with the exception that a toothed measuring roller is normally fitted for winding over perforated air film. A needle measuring roller is supplied as an interchangeable spare for using unperforated film, when perforated is unobtainable.



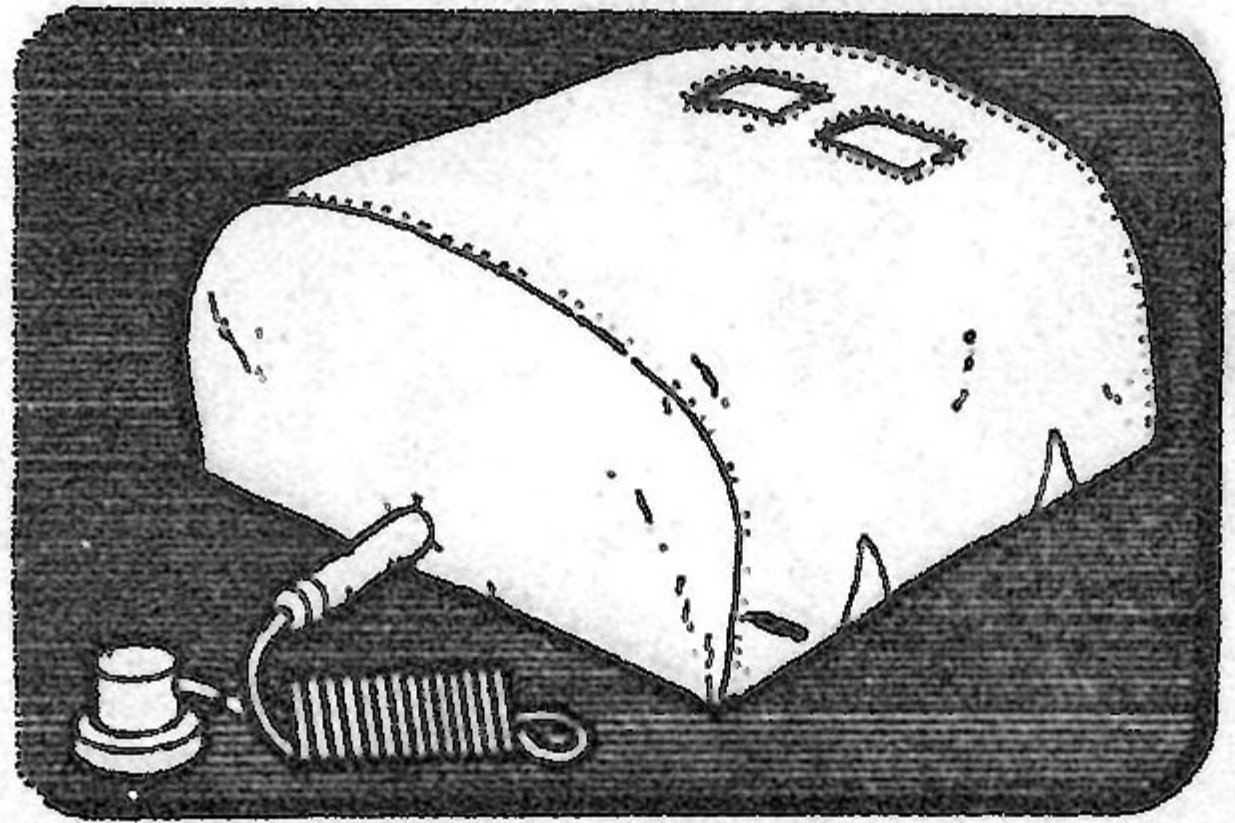
Magazine (type A) taking up to 125 exposures at a loading.



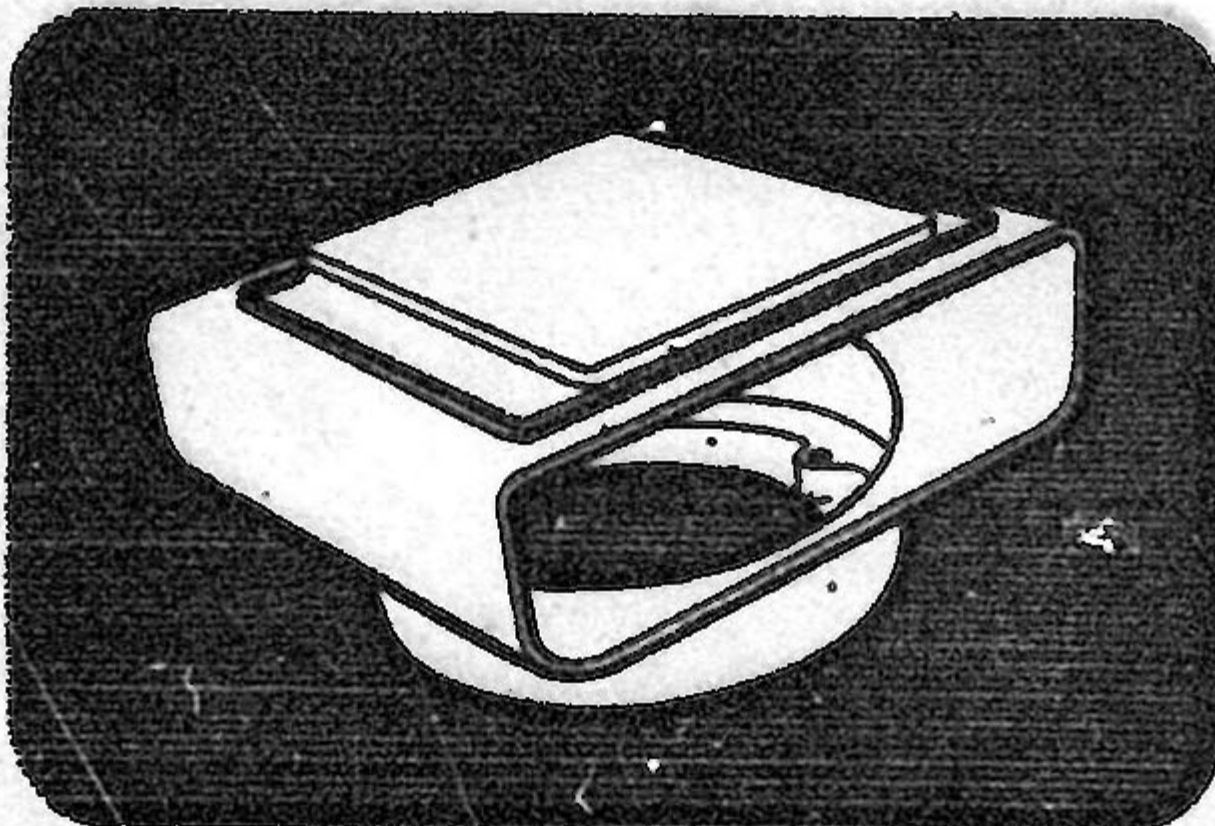
Magazine (type C) for 250 exposures. Sprocket or needle drive for use with perforated or unperforated film respectively.



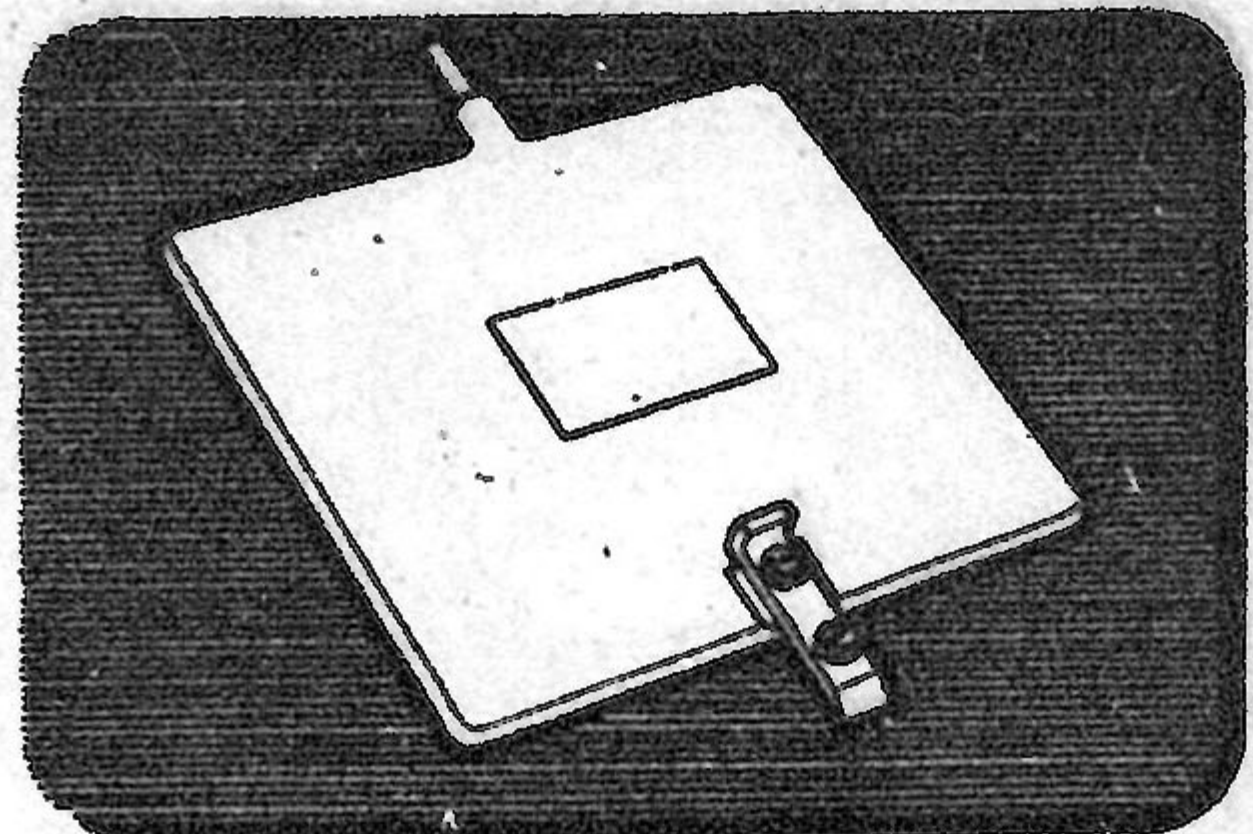
Film spools for 125 and 250 exposure magazines, type A and B respectively.



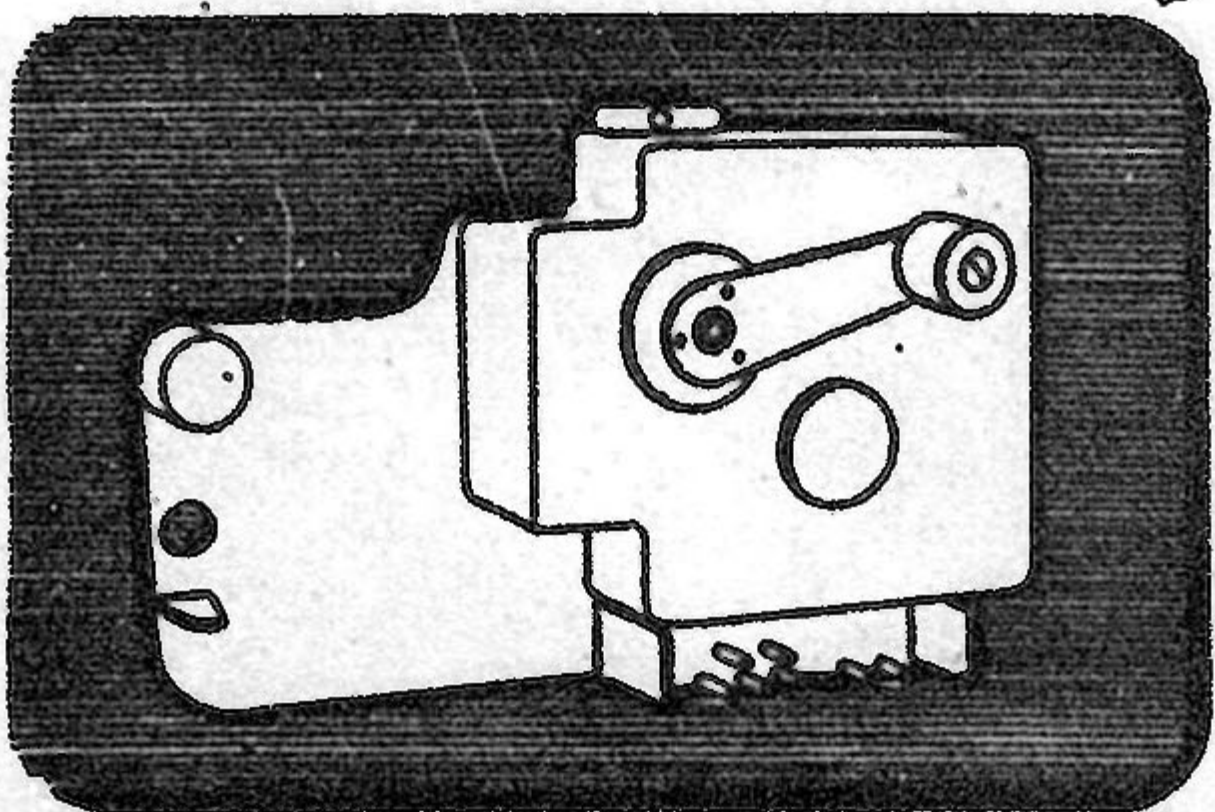
Muff heater 12 or 24 volt required on all aircraft unless ample hot air heating of the aircraft is available.



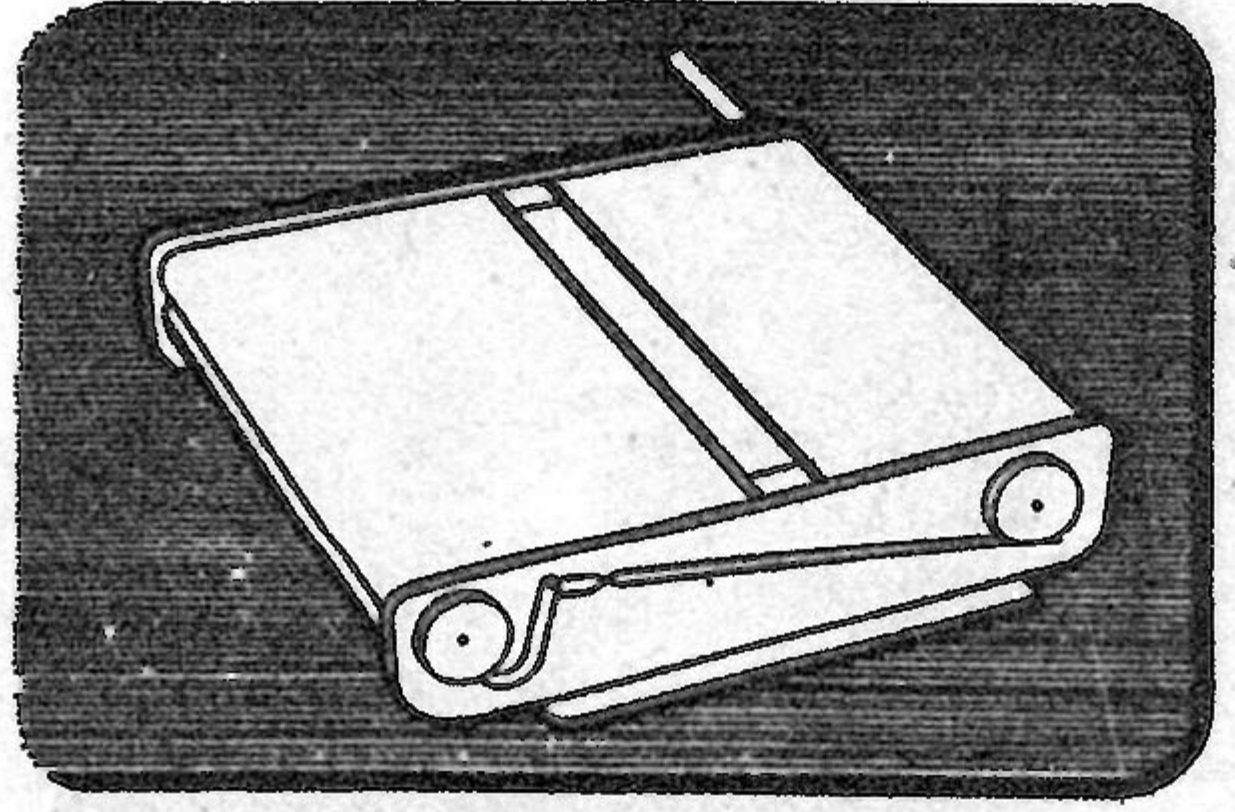
The body, contains the register glass and houses the shutter; it forms the junction for the gearbox, lens cone and magazine.



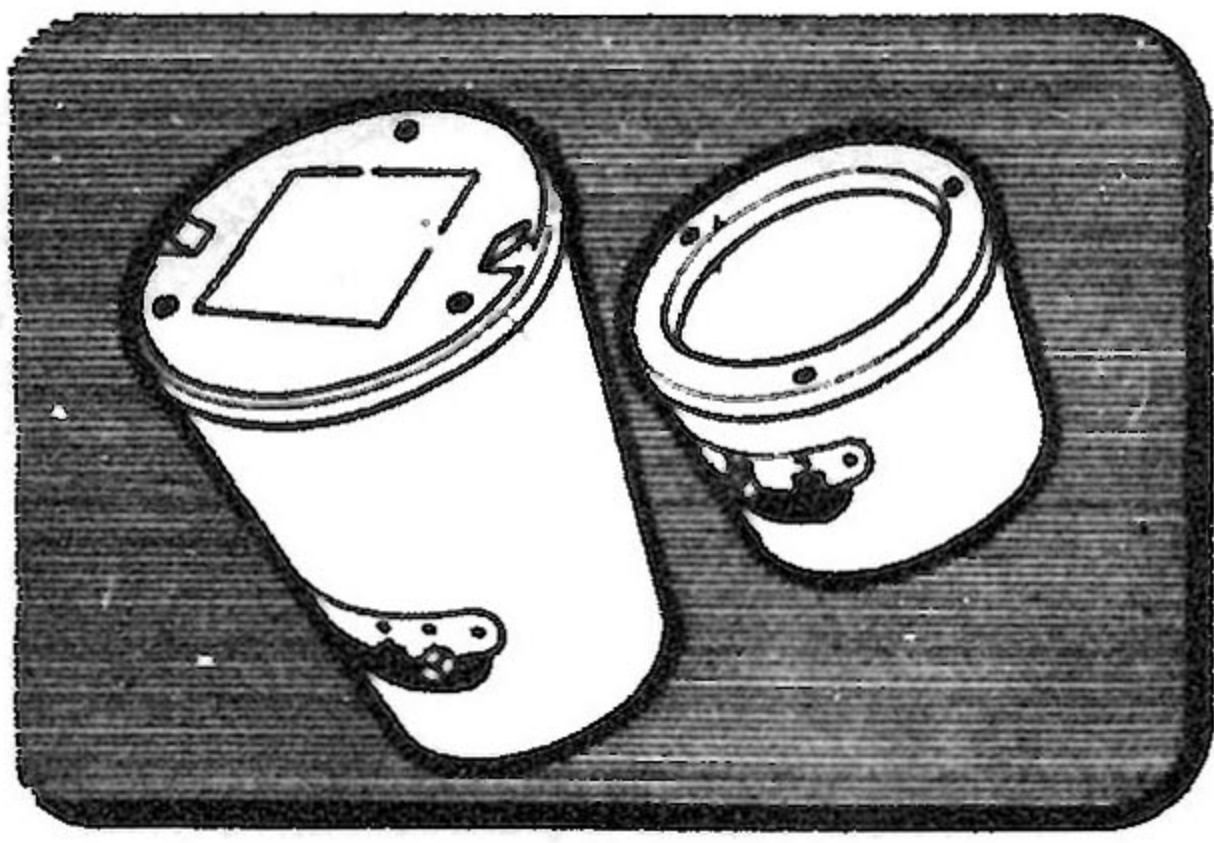
Magazine protective cover to be placed over the register glass whenever the magazine has been removed.



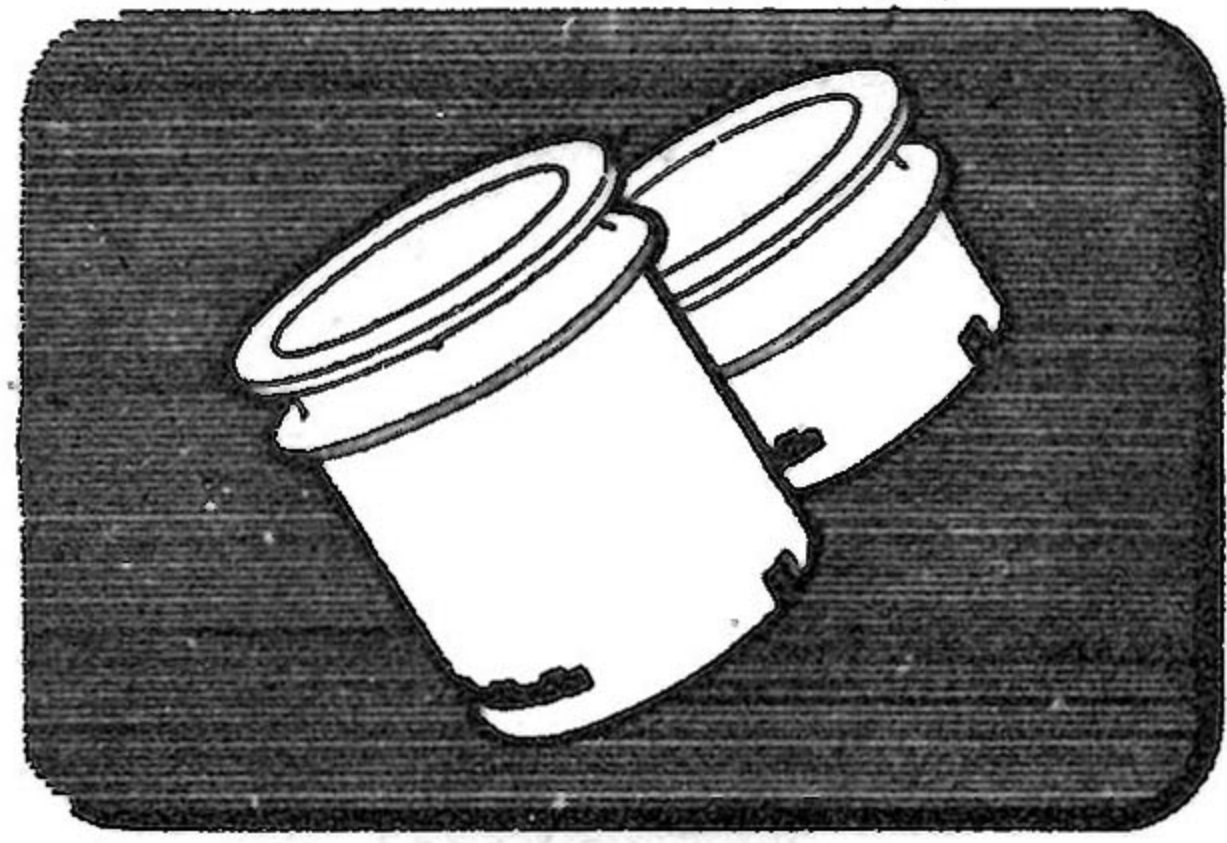
The gearbox contains the mechanism for releasing the shutter, raising the pressure pad and winding on the film. It may be used on 12 or 24 volt aircraft supply.



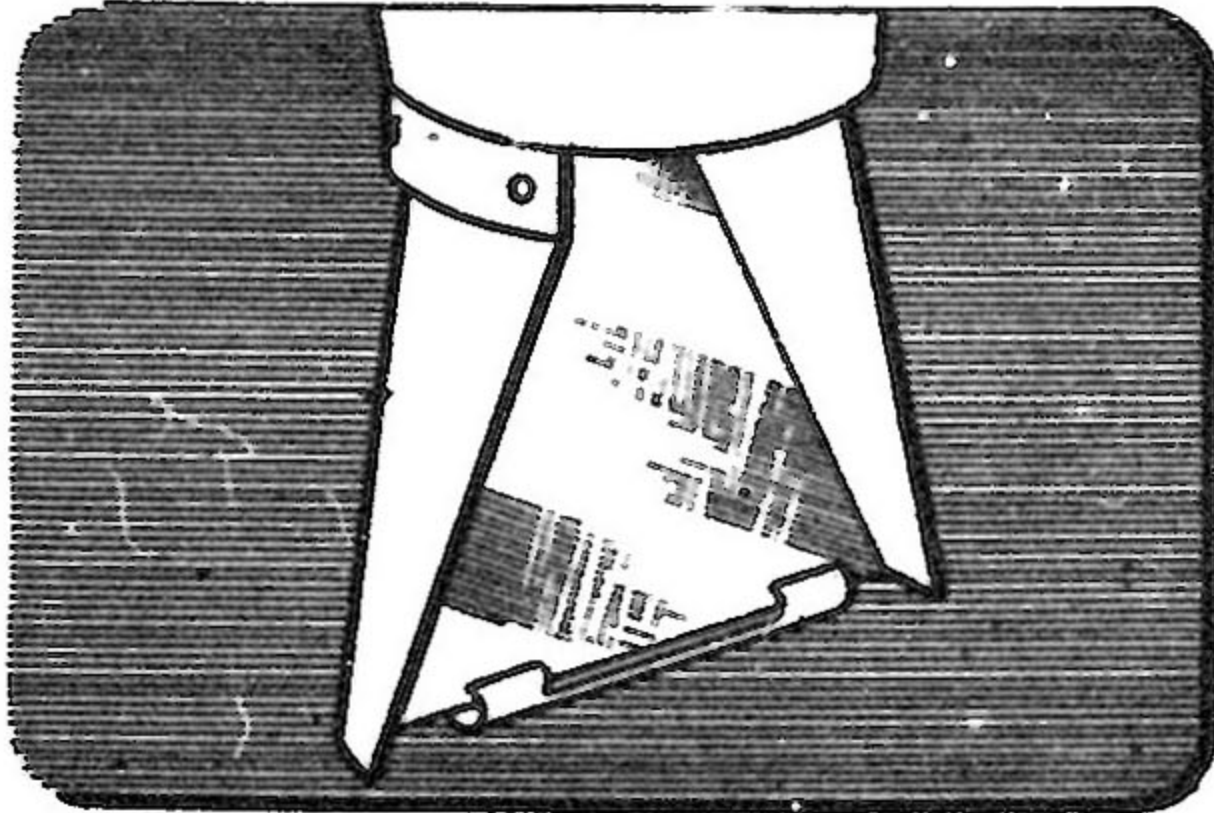
The shutter—a variable tension focal plane type, incorporates the capping blind and the various interchangeable main blinds.



Lens and cones (type A) form a complete unit which is attached to the body by three locking screws.



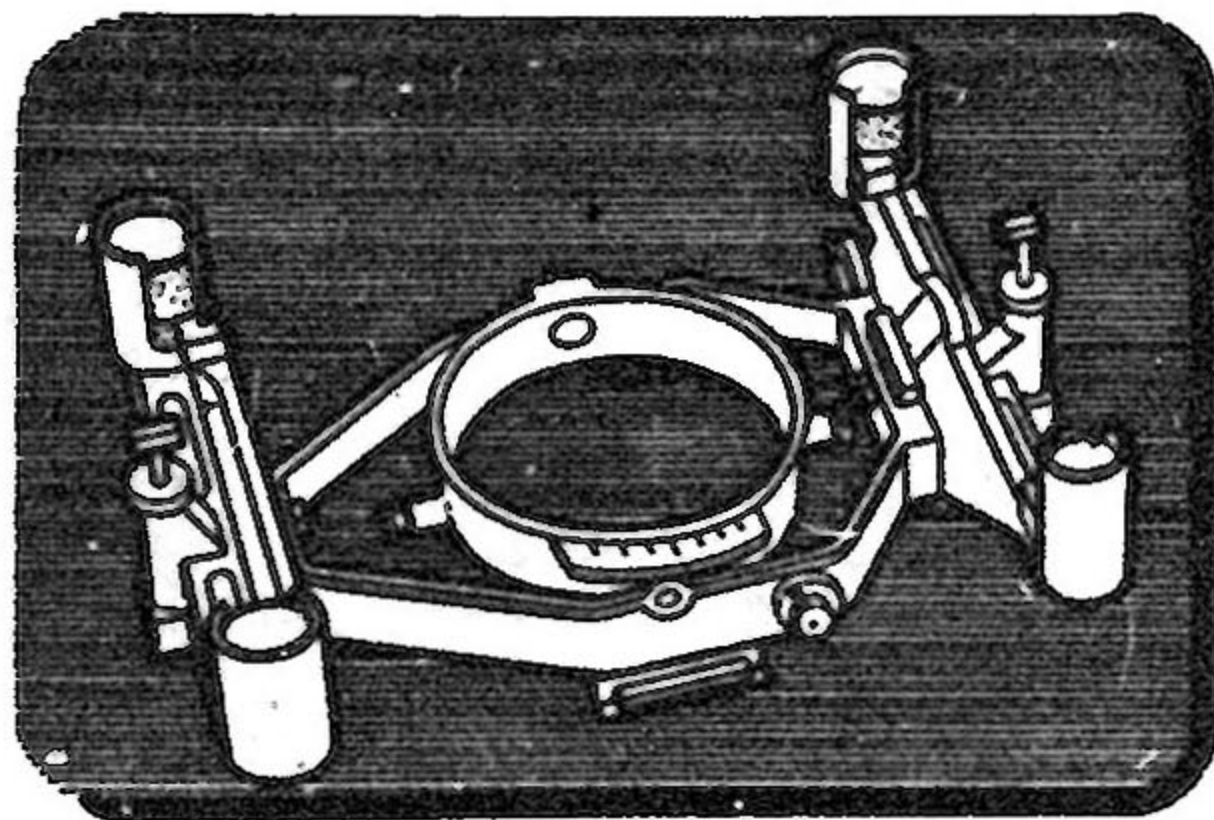
Lens and cones (type B) cut away to accommodate mirror attachment. Die cast. Available for 5 in. and 8 in. lenses.



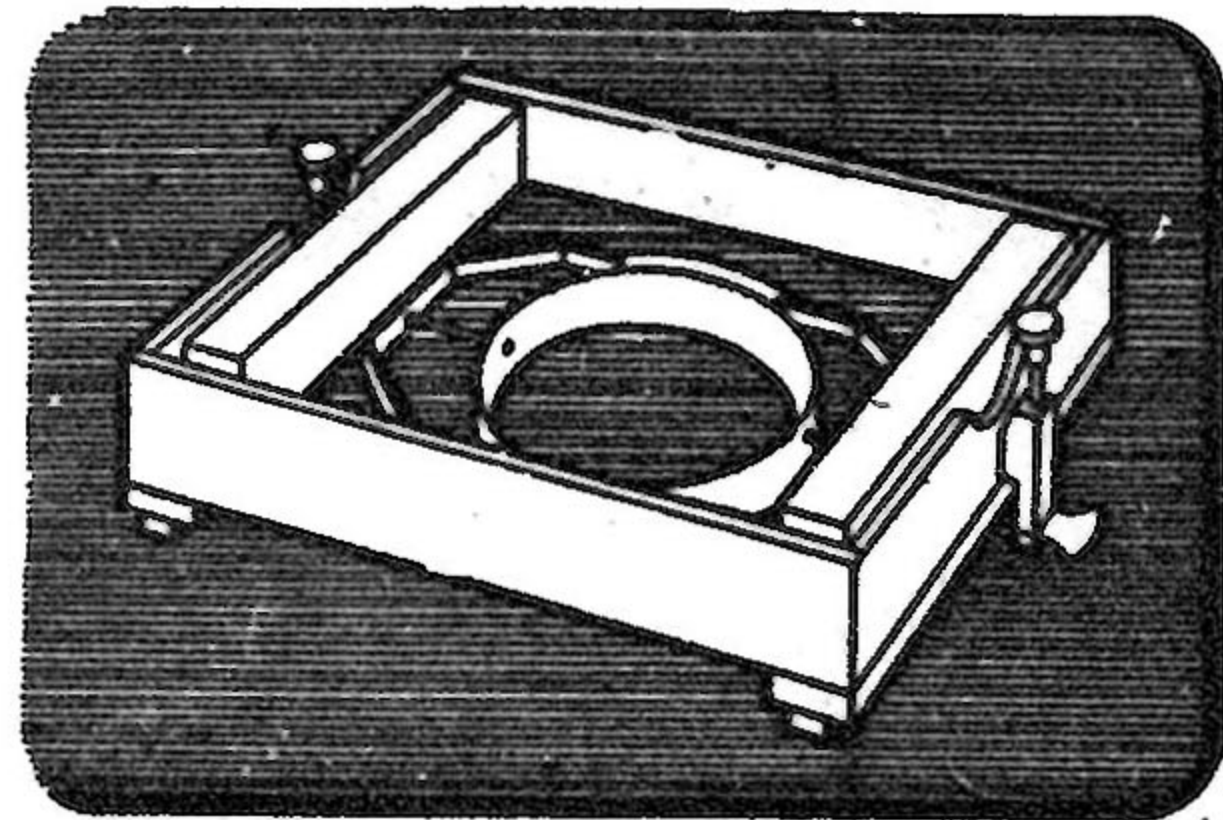
Mirror attachment for type A and B, 5 or 8 in. cones with vertical installations. Enables oblique photographs to be taken.



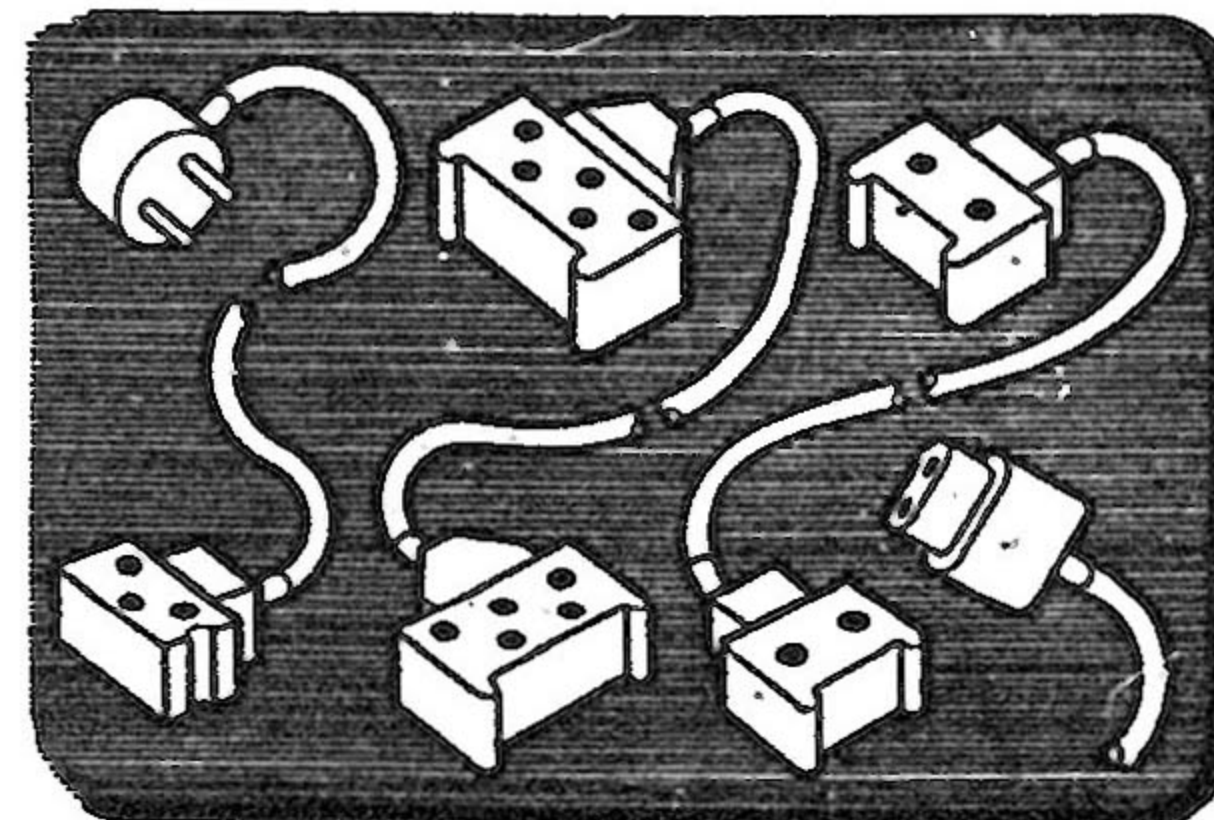
Mirror attachment for type B.2 cones fitted by a bayonet catch.



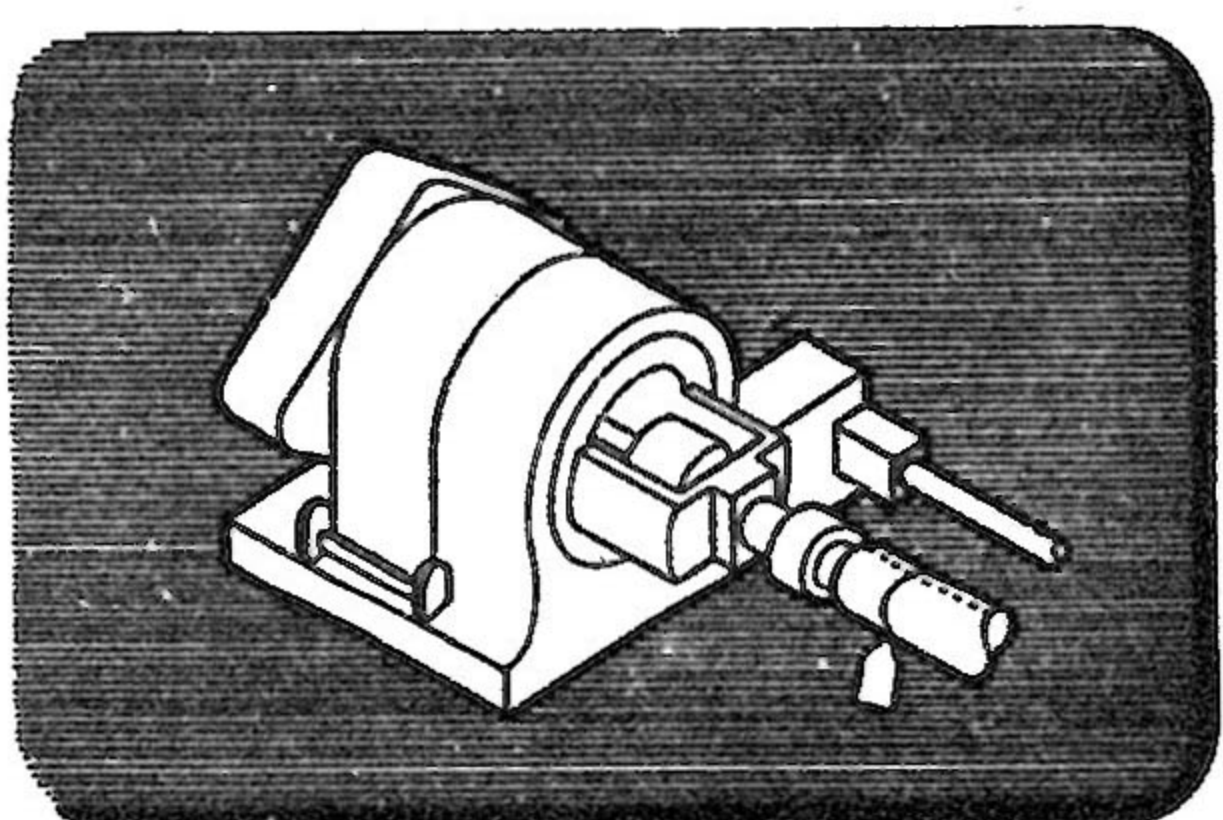
Type 25 mounting for vertical or oblique F.24 camera installations. Other mountings are the types 16, 21, 34 and 45.



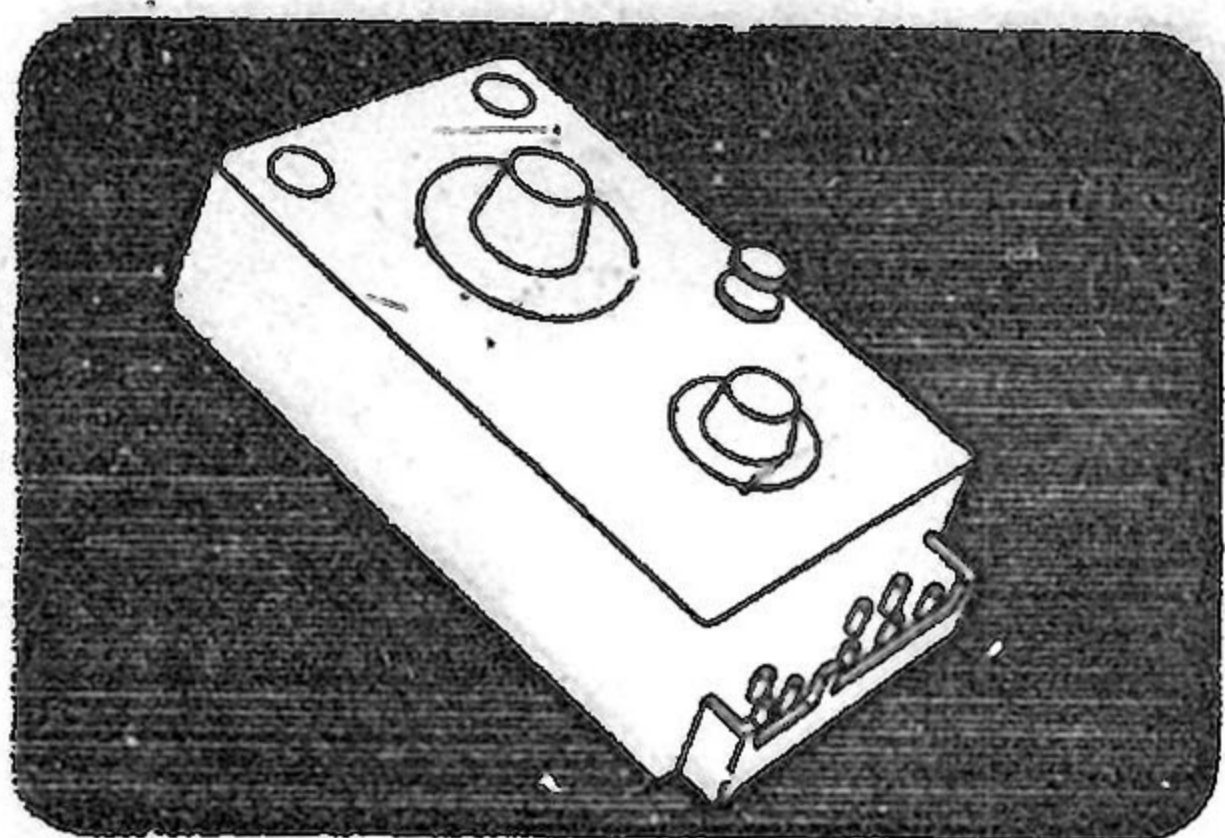
Type 45 mounting for vertical F.24 camera installations; wooden replacement of the type 25 mounting.



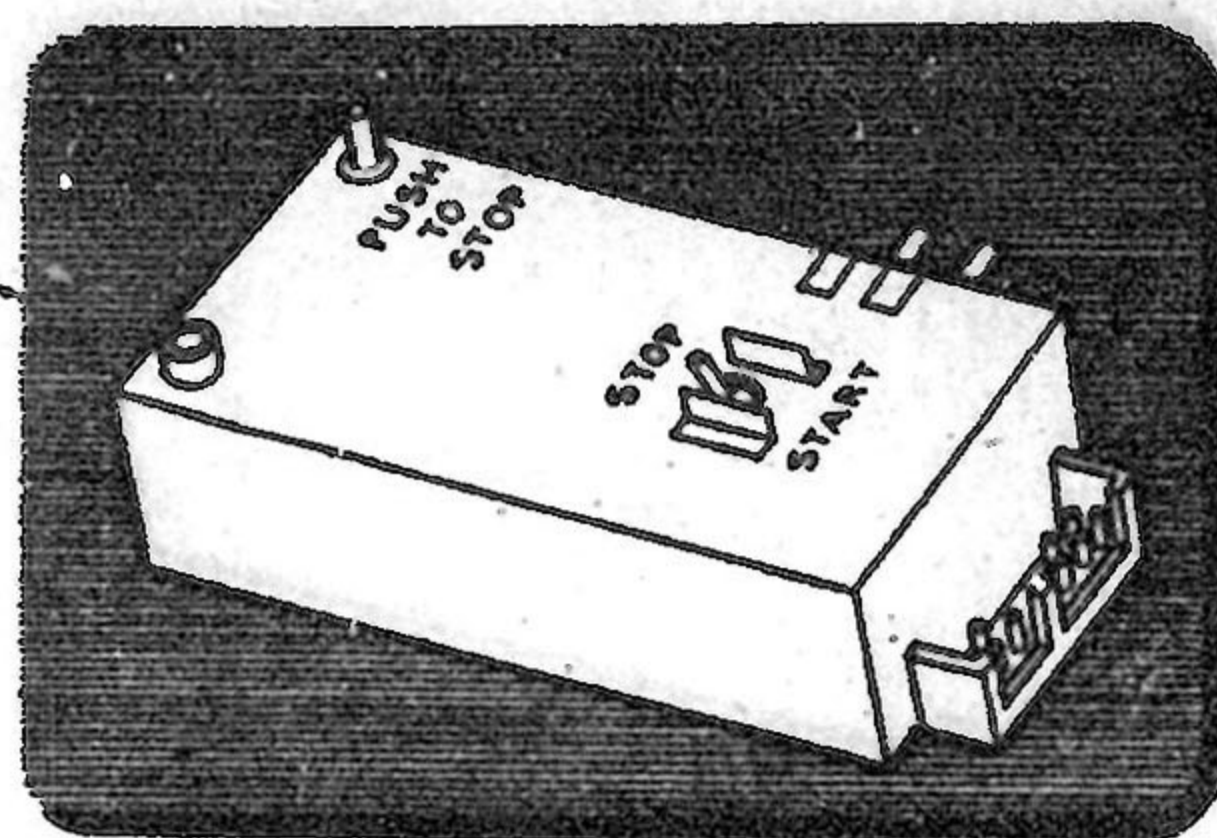
*Leads—
No. 1 a 2-way 3-way (supply lead)
No. 2 a 5-way 5-way (control lead)
No. 4 a 2-way 2 way (motor lead)
No. 3 pilot's indicator light.*



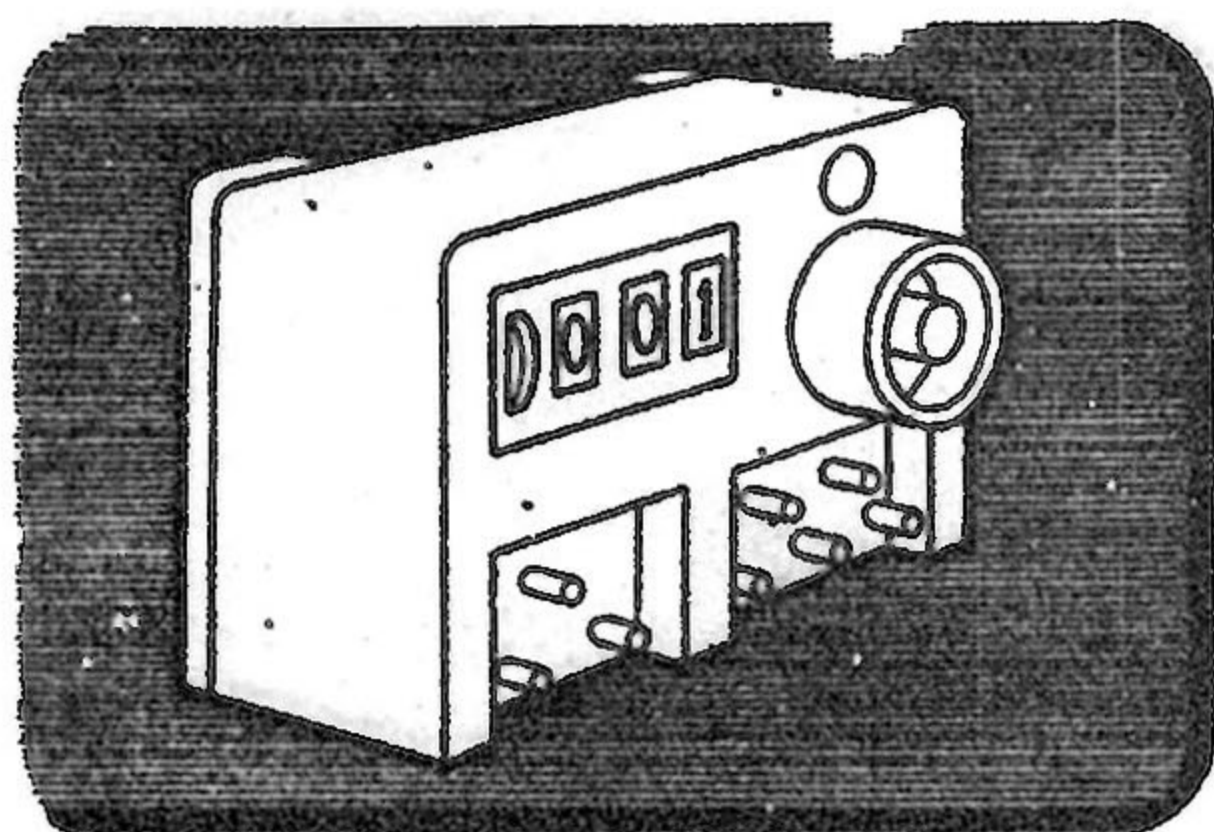
Motors type A and B (12 or 24 volts) for driving camera gearbox with flexible drive.



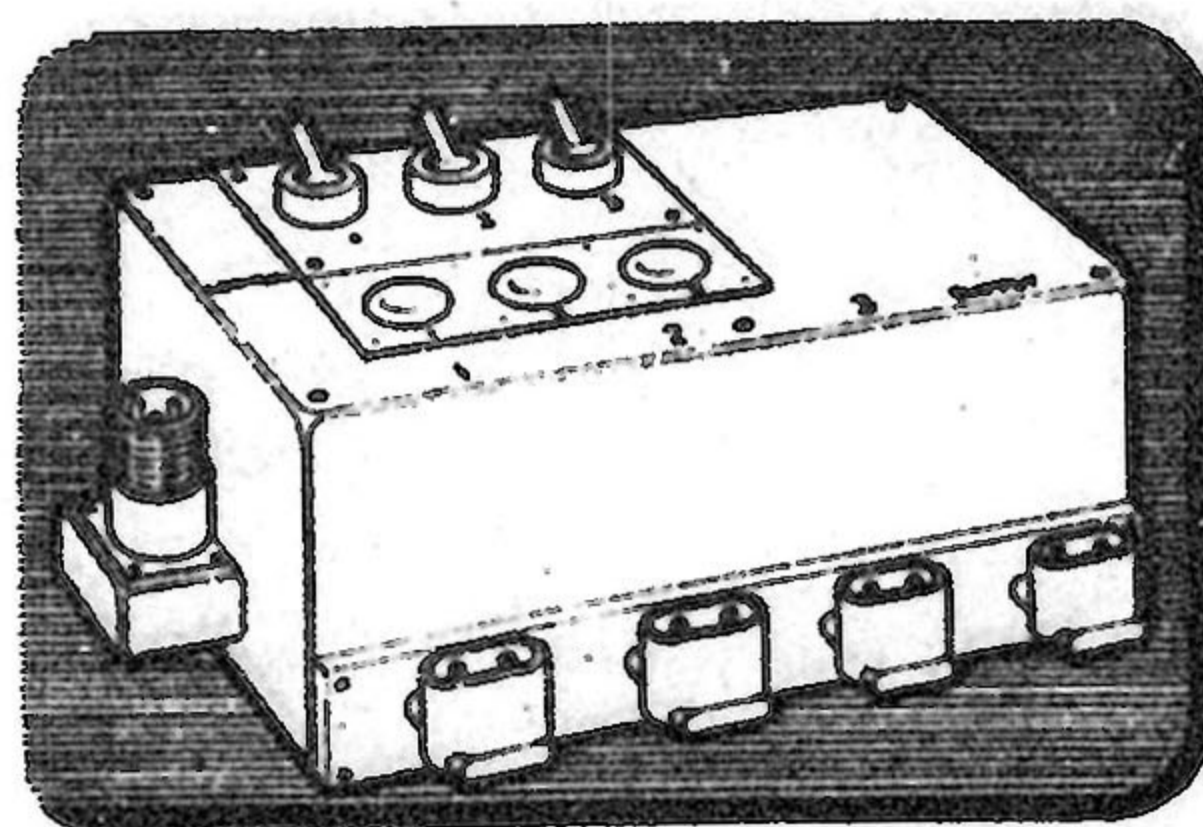
Control type 35 variable delay switch for operating camera at regular pre-determined intervals. Nos. 7, 8, 13, 14, 15 and 16 for day photography and Nos. 19 and 20 for night photography.



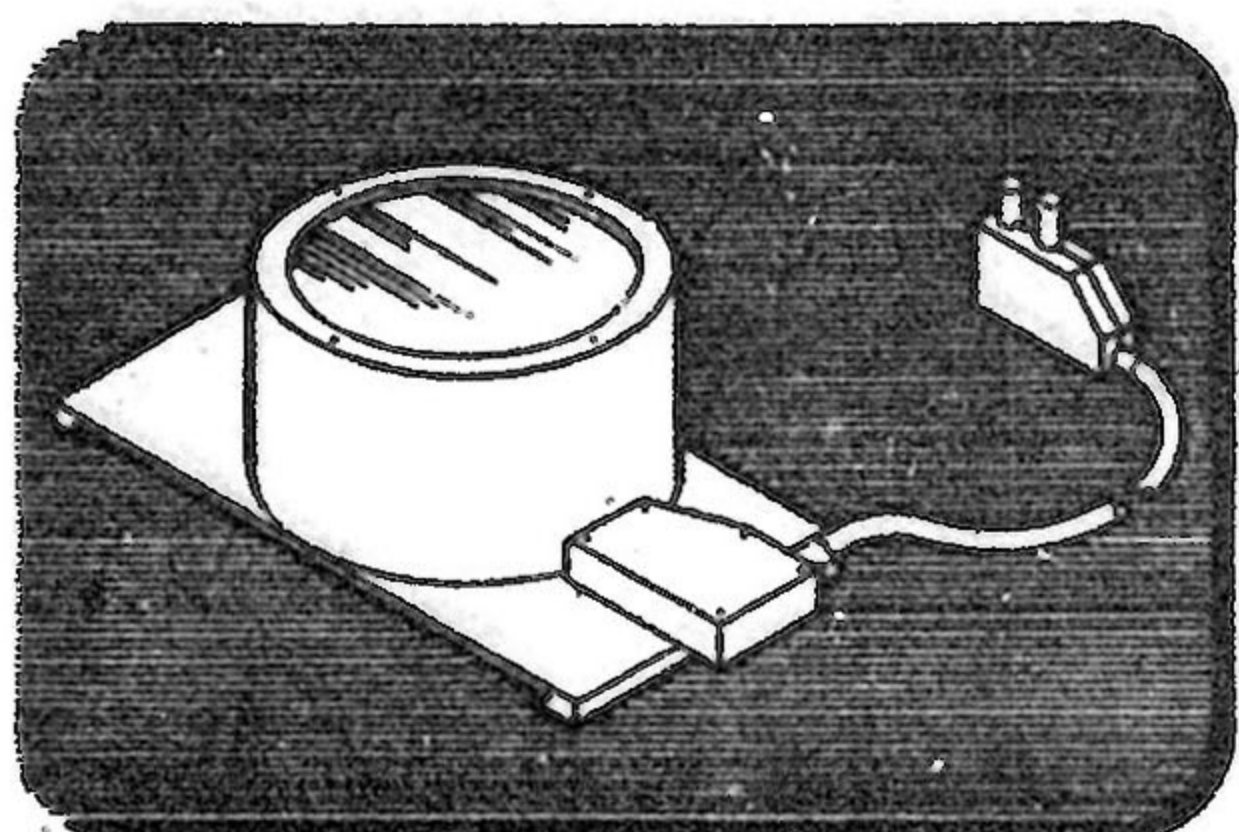
Control type 48 slugged relay delay switch for giving shortest possible time interval between exposures.



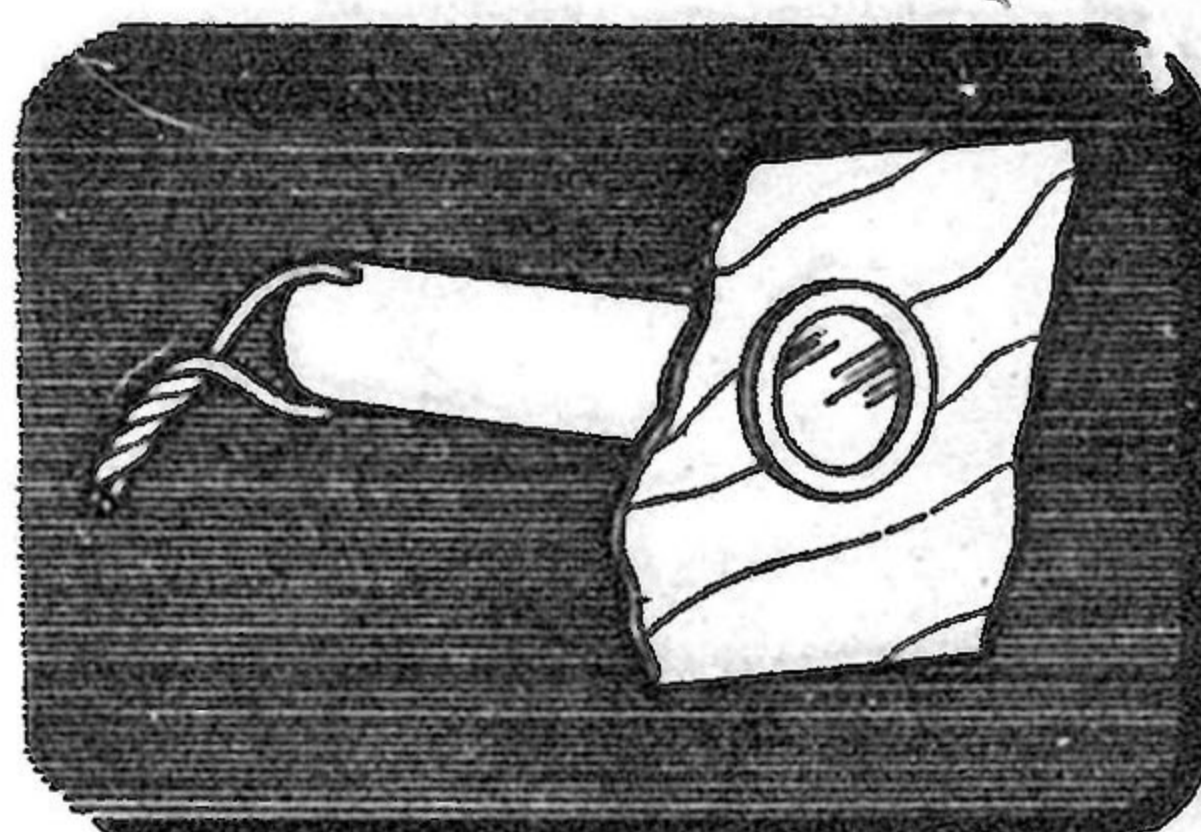
Push switch remote control 12 or 24 volt for making single exposures. Incorporates counter and warning light.



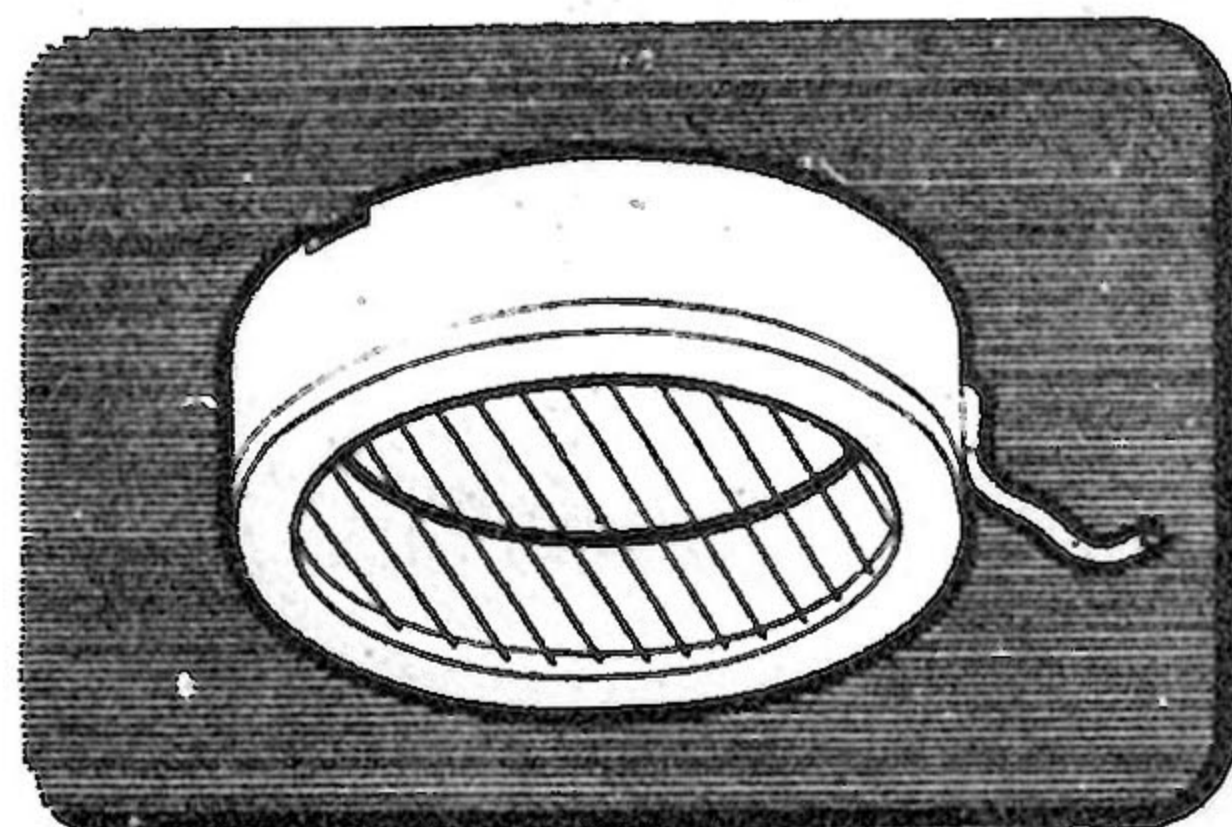
Distribution box types 47 and 48 provides switch and junction box for multiple camera installation with type 35 controls Nos. 15 and 16.



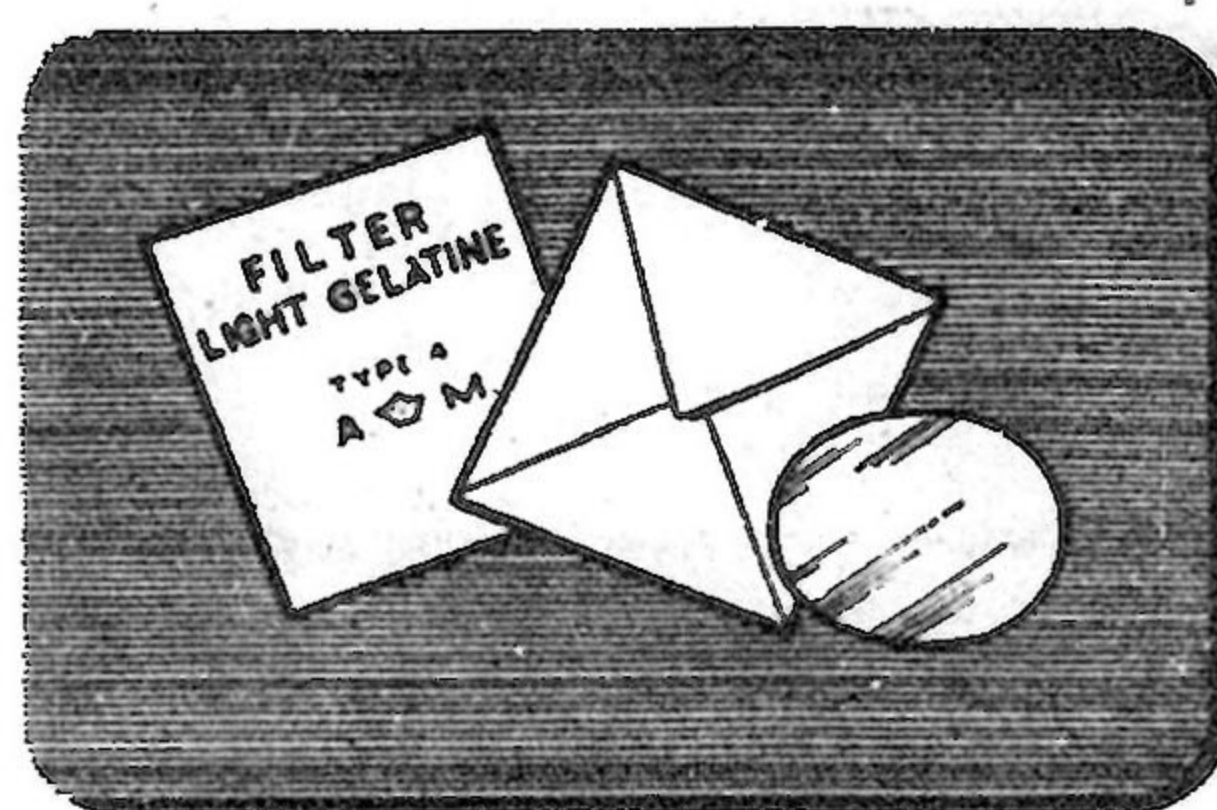
Pilot's indicator light provides an extension light in parallel with the red warning light of the type 35 control.



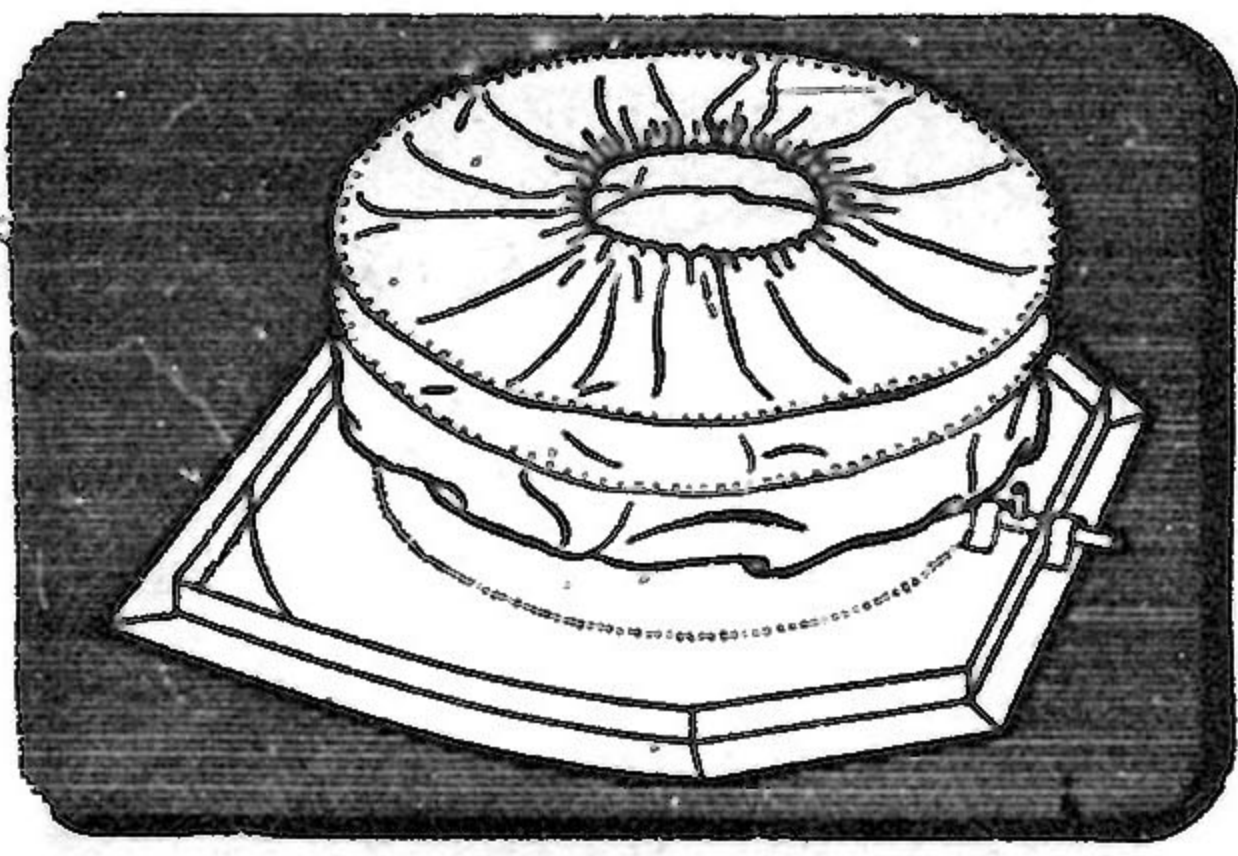
Rotax panel mounted indicator light replaces the pilot's indicator light on future aircraft. It is fitted with a dimming bezel.



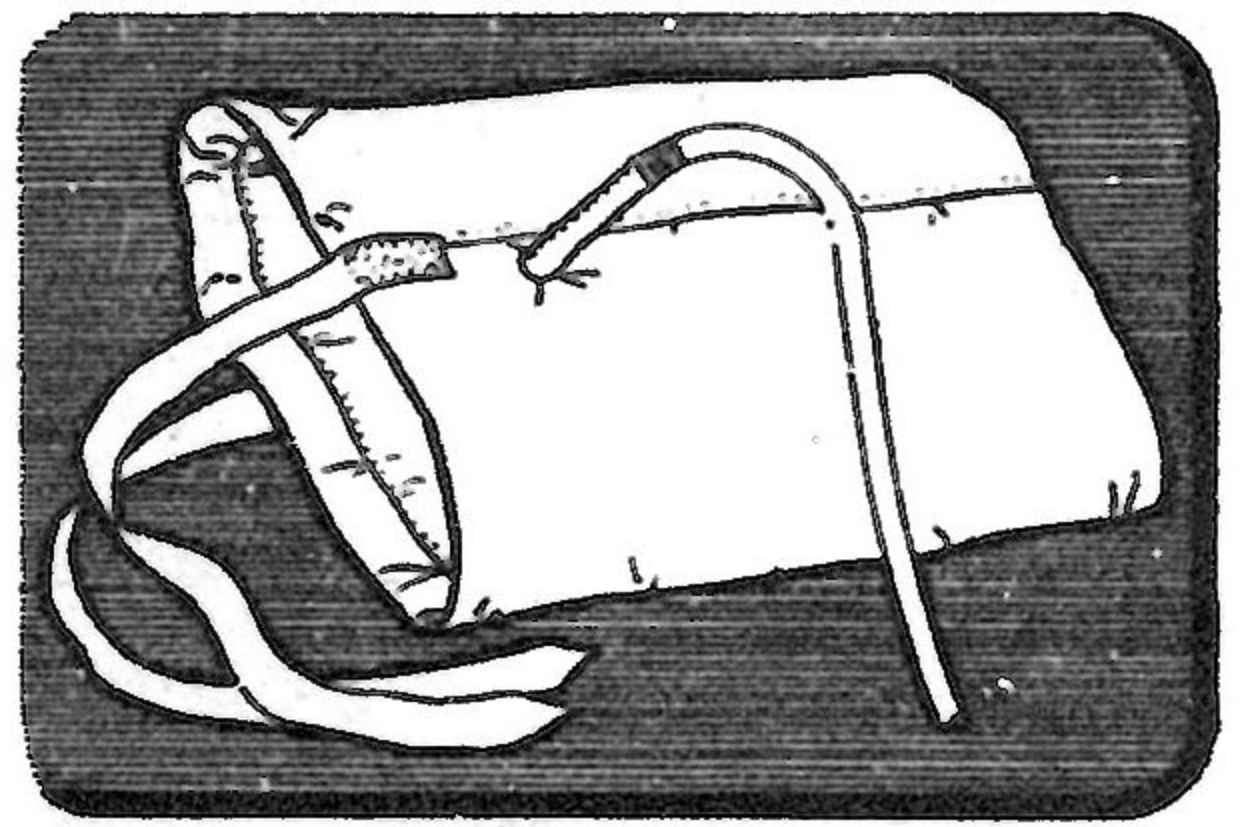
Lens heaters 12 or 24 volt used to prevent condensation on lenses. May be fitted with clear glass or optical filter glass in front of heater wires.



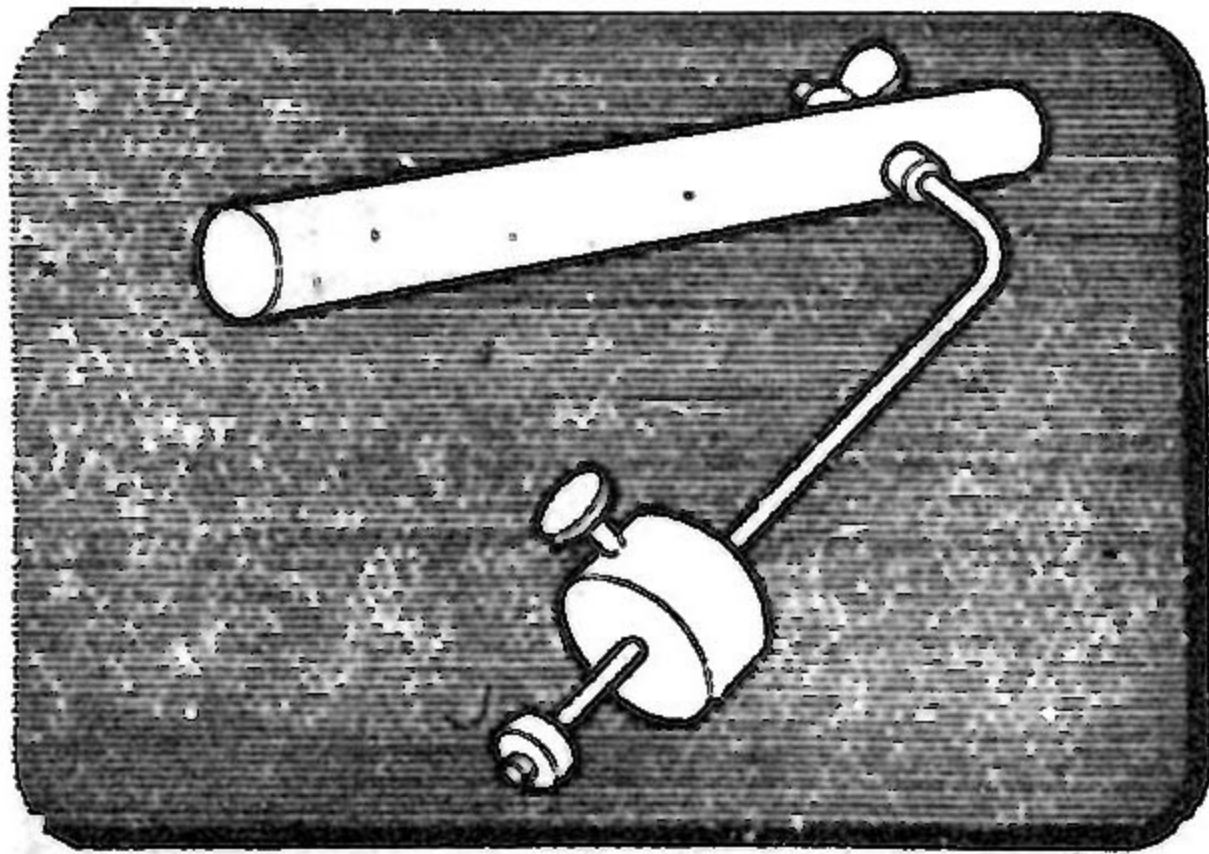
Filters gelatine type packed in envelopes may be cut to size required. Fitted in rear component of lens.



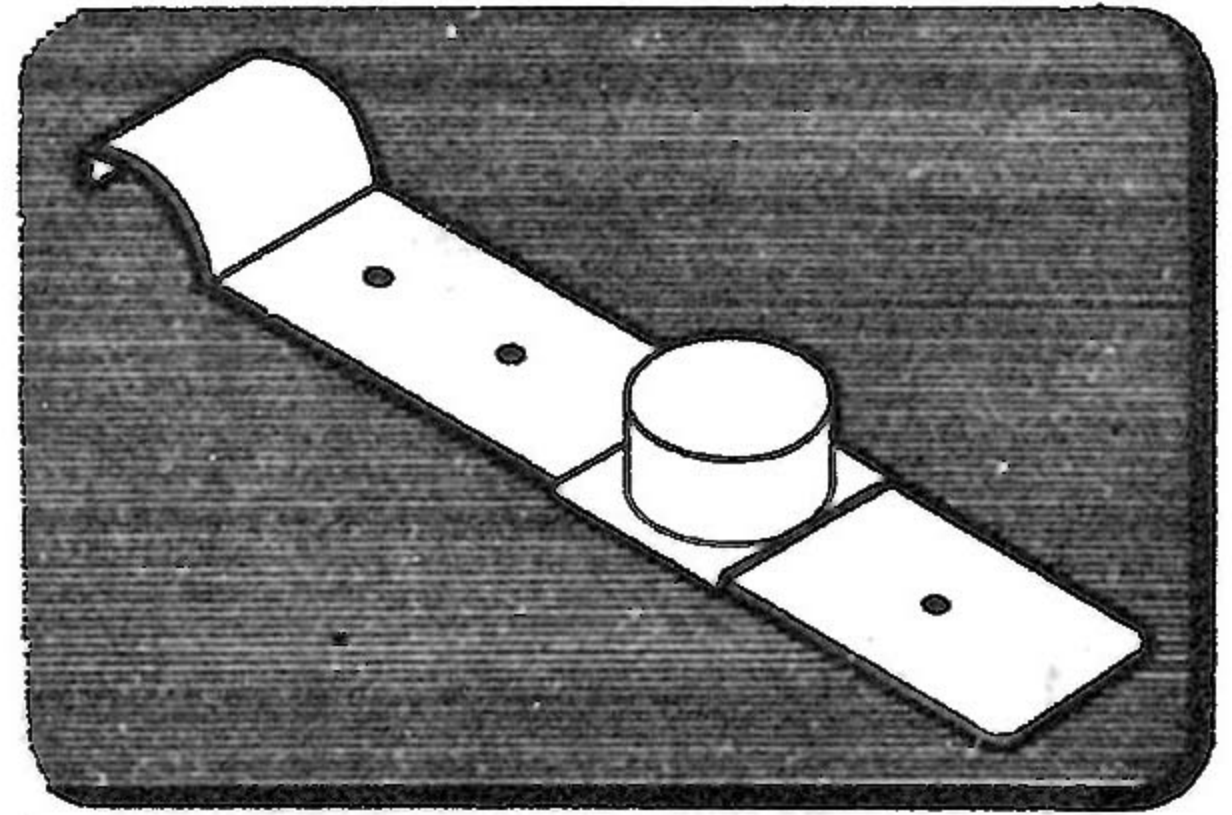
Sealing gland forms a union with the lens cone and plate adaptor.



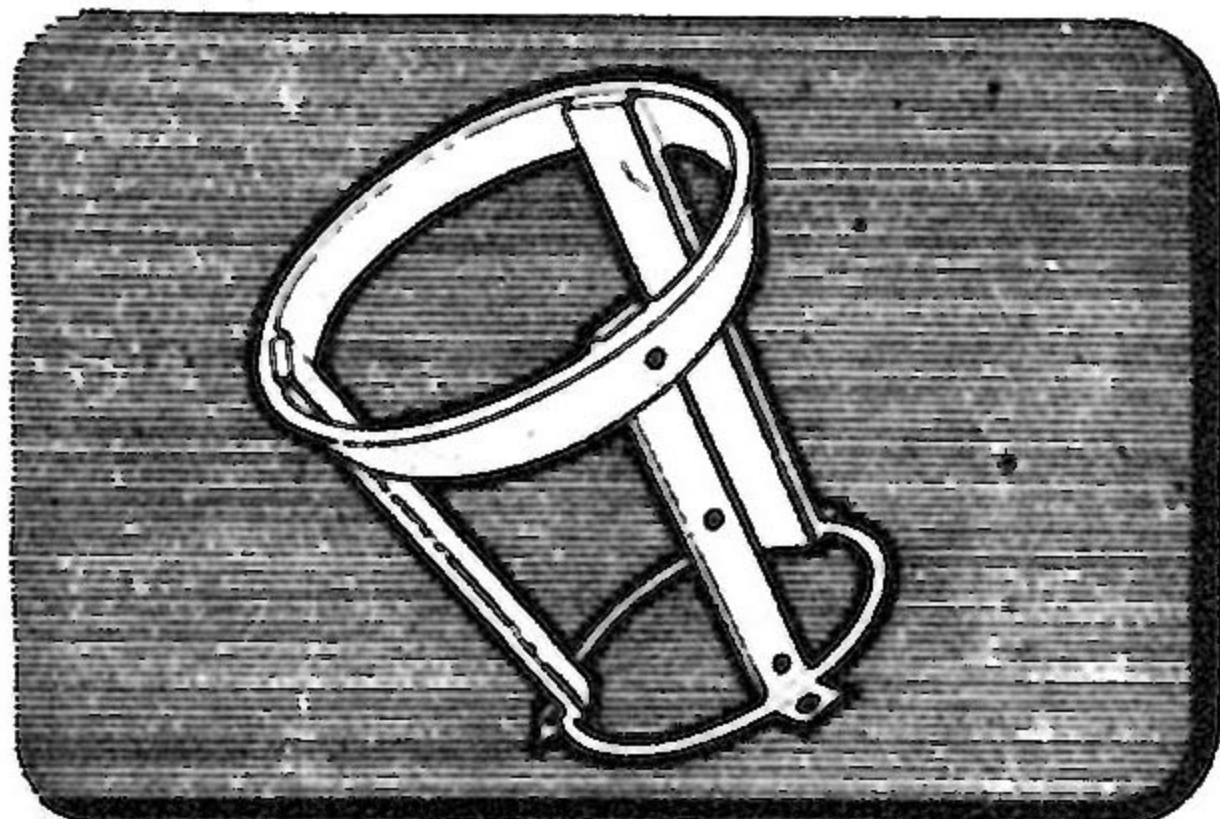
Heater sleeve provides heating for the lens cone. Normally used in conjunction with a muff heater.



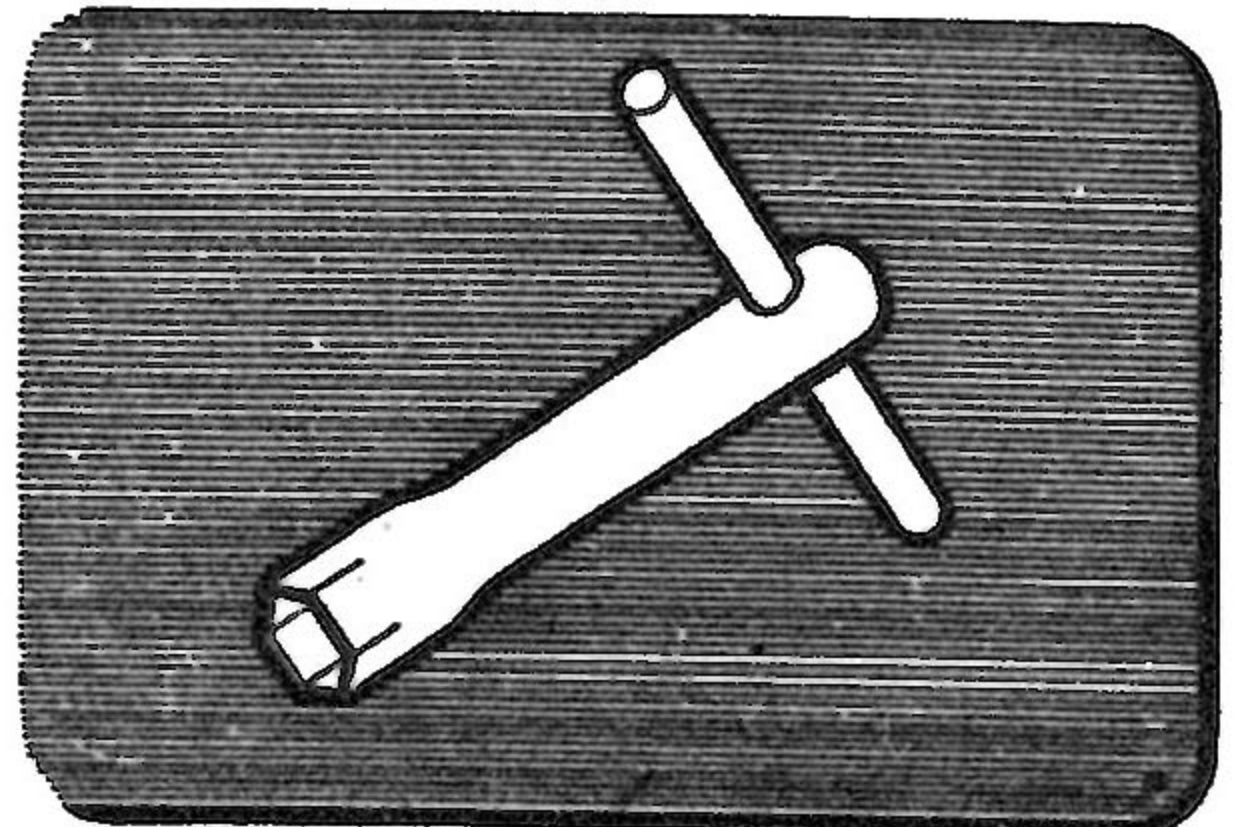
Magazine friction tester for type A magazine. Marked positions for testing of feed and receive spools.



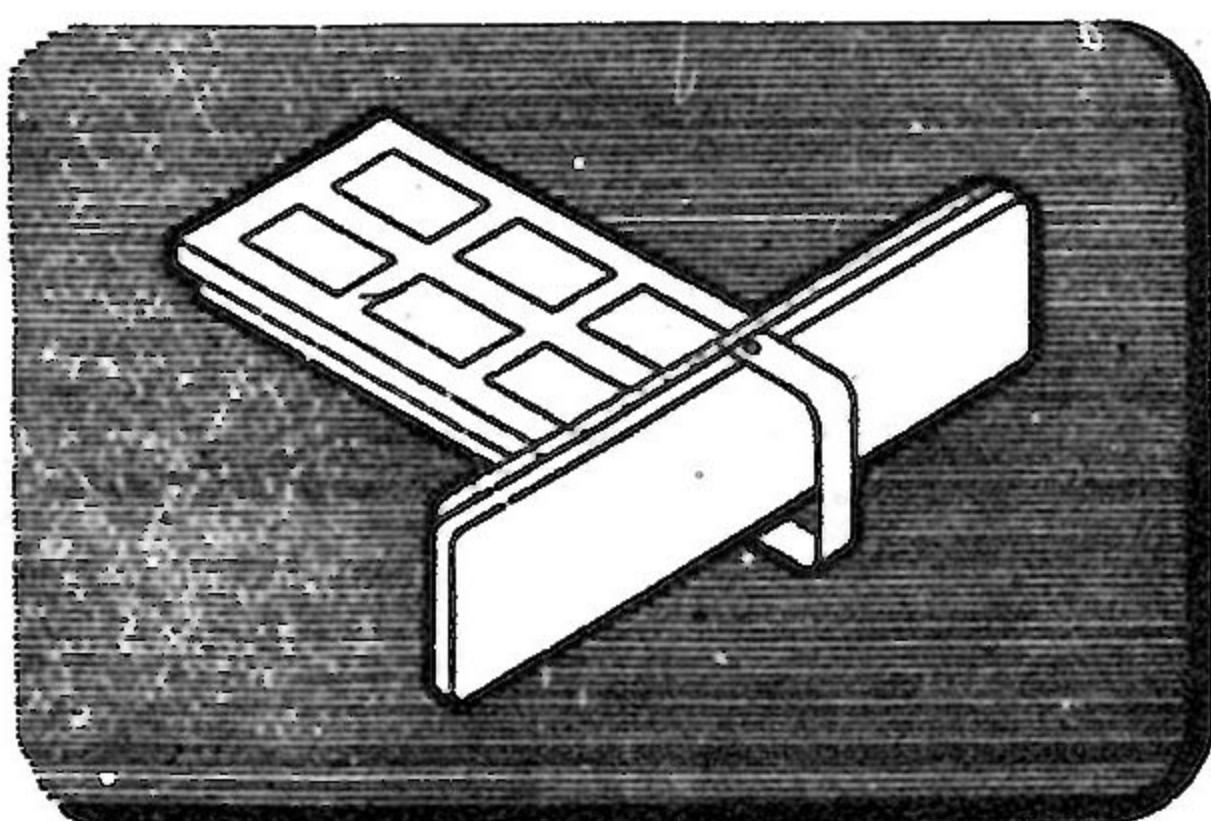
Magazine friction tester for type C magazine. The same instrument is used for aircraft cameras type F.8 Mark II and F.52.



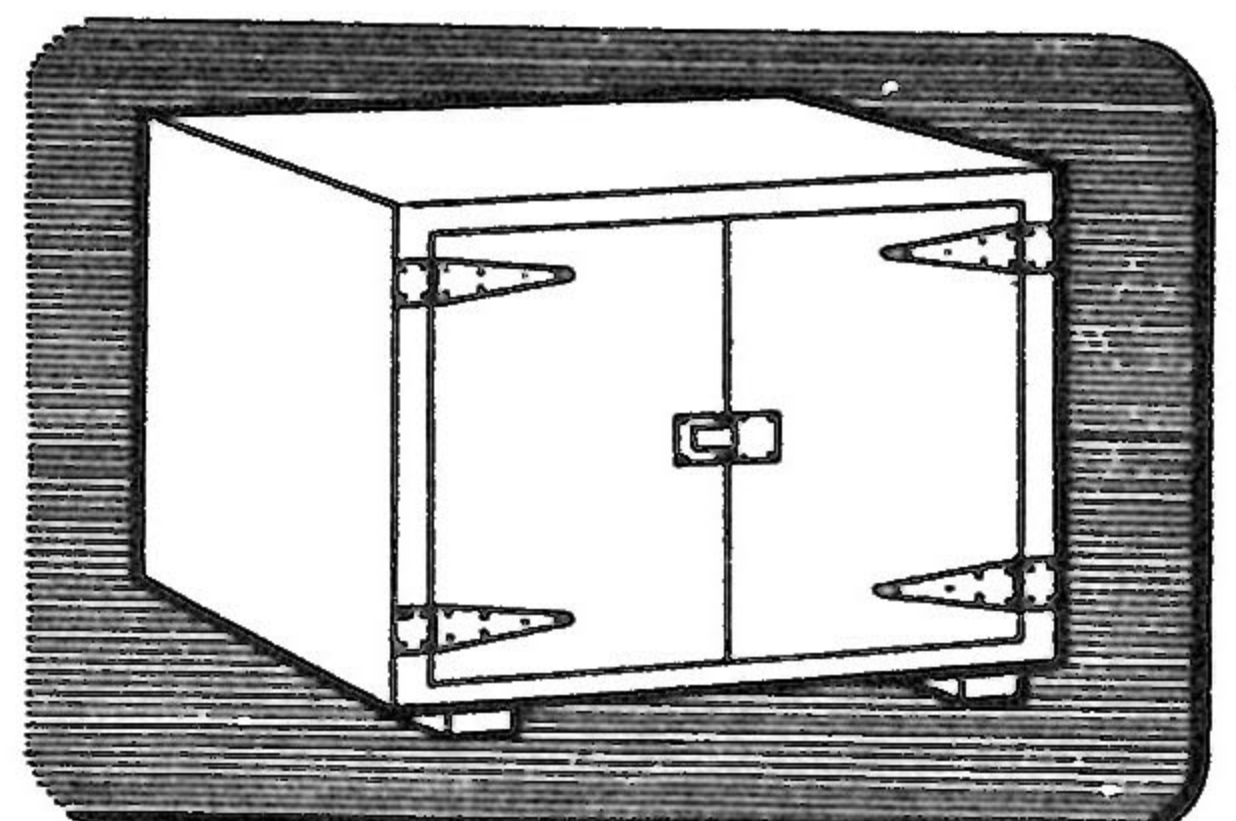
Storage frame for temporary support of the hand held camera when used in flying boats or seaplanes.



Box spanner for changing lens cones and turning over gearbox by hand on F.24 models fitted with the type F gearbox.



Silica gel. tray—dessicator fitted in place of gearbox to prevent moisture condensation in camera body during dispersal of aircraft.



Storage case for storage when the camera is not in use.

Fig. 2.—F.24 units and accessories

8. *Body*.—The body provides the focal register of the camera, being accurately machined at the base where the lens cone is fitted and at the datum surfaces to which the upper face of the register glass is levelled. The distance between the two machined surfaces is constant for all camera bodies, being 4.75 in. \pm 0.0015. The body forms the central unit to which the gearbox, shutter, lens cone and magazine are fitted.

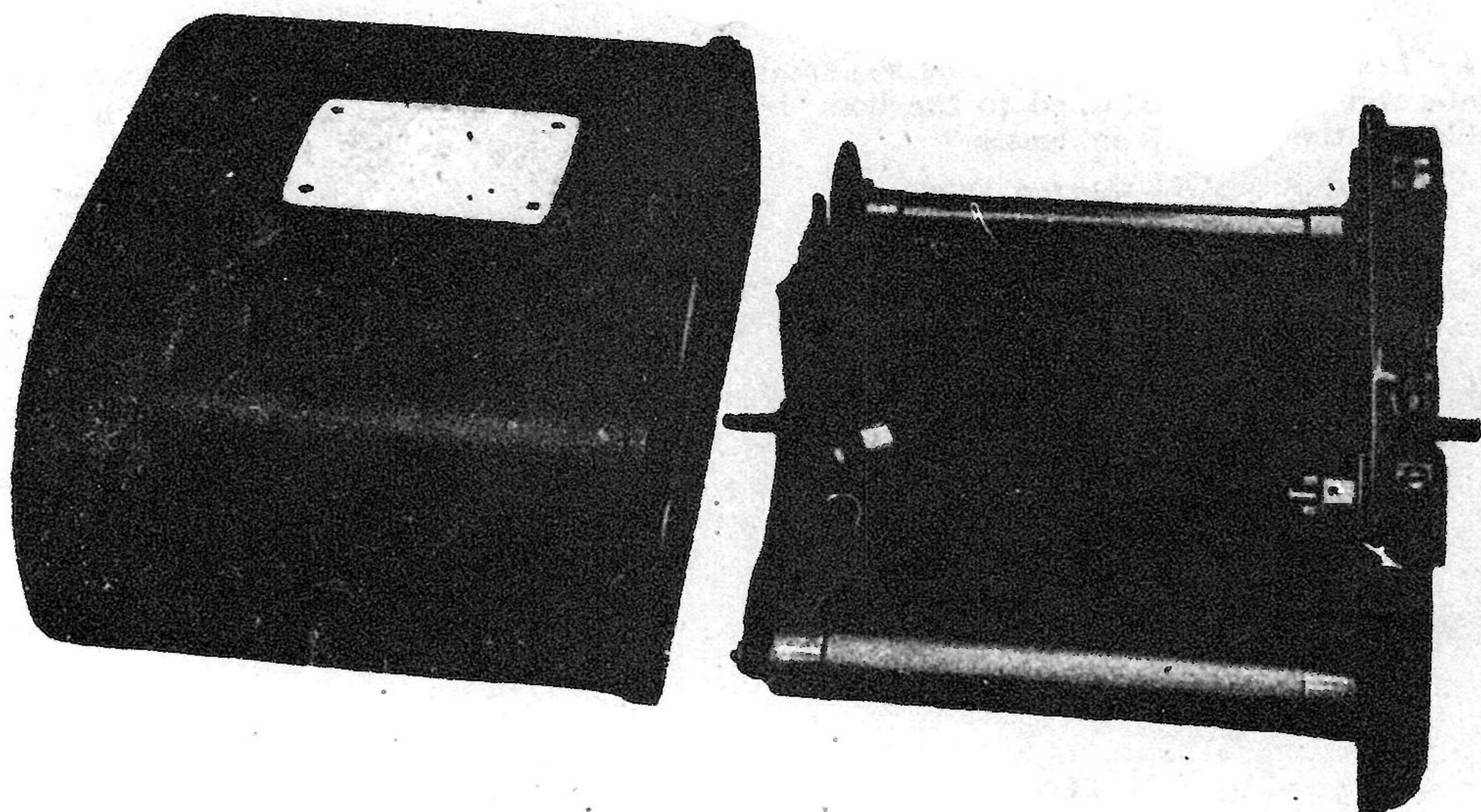


Fig. 3.—Type A magazine

9. *Universal shutter, Mk. I*.—This is a separate unit which is screwed to and operated by the gearbox. It is a variable-tension focal plane shutter with four interchangeable blinds of fixed slit, as follows:—

| Blind | Slit width | Speeds |
|-------|------------------------|---------------------|
| A ... | 1 in. ... | 1/60–1/120th sec. |
| B ... | $\frac{3}{8}$ in. ... | 1/150–1/300th sec. |
| C ... | $\frac{3}{16}$ in. ... | 1/300–1/600th sec. |
| D ... | $\frac{1}{8}$ in. ... | 1/500–1/1000th sec. |

10. A capping blind provides the necessary protection to the film when the main blind is reset. The main blind is coupled to an anti-acceleration brake, which maintains a constant shutter speed across the focal plane. The main blind tension is adjusted by a calibrated adjustment screw which projects through the gearbox casting.

11. *Universal shutter, Mk. II*.—This is of similar construction but is fitted with a light baffle for use with the night camera and Type N blind (see A.P.2651).

12. *Gearbox, Type E*.—The gearbox unit forms the operating mechanism of the camera. A double free-wheel system permits either electrical operation by a driving motor through worm and wheel or manual operation by hand. It may be released manually by means of the release block or by remote electrical control (Type 35 or push switch) through the release solenoid. In order of sequence it performs the following operations:—

- (i) Releases shutter.

- (ii) Re-engages itself to the driving pinion.
- (iii) Winds over capping blind and main blind.
- (iv) Releases capping blind.
- (v) Winds over film.
- (vi) Operates counter in Type 35 control.
- (vii) Disengages itself from driving pinion coming to rest in the set position.

Note.—A detailed description of the cycle of operations is shown in figs. 6 to 10.

13. *Gearbox, Type F.*—This is basically the same as the Type E which it supersedes, but the winding handle is omitted and replaced by an hexagonal sleeve which will accommodate a standard $\frac{1}{4}$ in. B.S.F. box spanner (Stores Ref. No. 14A/728).

14. *Lenses and cones.*—Each lens is mounted in a cone of suitable dimensions and forms a complete unit which is attached to the body by three locking screws. Three types of cones are available for the 5 and 8 in. lenses.

Type A. Old tapered type.

Type B. Parallel reinforced.

Type B2. Similar to Type B but with detachable front and bayonet fitting for mirror attachment or lens baffle for night photography.

15. The following table gives a list of lenses and cones:—

| <i>Lens</i> | <i>Angle of view of diagonal</i> | <i>Scale at 5,000 ft.</i> |
|--|----------------------------------|---------------------------|
| 3½" F5.5 | 94° 24' | $\frac{1}{18400}$ |
| 5" F4 | 70° 24' | $\frac{1}{12000}$ |
| 8" F2.9 8" F5.6 | 46° 24' | $\frac{1}{7500}$ |
| 14" F5.6 14" F4.5 | 28° | $\frac{1}{4286}$ |
| 20" F5.6 Tele 20" F5.3 20" F6.3 Tele | 20° | $\frac{1}{3000}$ |

16. Storage cases are provided as follows:—

| <i>Equipment</i> | <i>Stores Ref. 14A/</i> |
|----------------------------|-------------------------|
| 5 and 8 in. assemblies ... | 722 |
| 5 and 8 in. lenses ... | 727 |
| 14 and 20 in. lenses ... | 826 |
| Type A magazine ... | 779 |
| Type C magazine ... | 2490 |

Note.—Equipment should be kept in these cases when not in use.

Accessories

17. *Mirror attachments.*—A fitment to the 5 and 8 in. lens cones consisting of a holder in which a mirror is held at an angle of 45° in front of and covering the angle of view of the lens. It enables high altitude obliques to be made with a vertical camera installation and, also, fore or aft records of low level bombing attacks. For the latter purpose the camera is coupled to a Type 48 control for obtaining the shortest possible time interval between exposures. (A detailed description of the Type 48 Control will be found in A.P.1355, Part II, Chapter 10.) The following Table gives details of the two fitments:—

| | | |
|-------------------------|-----------|----------------------|
| Mirror attachment 5 in. | 14A/3204. | Cones, Type A and B. |
| Mirror attachment 5 in. | 14A/3365. | Cone, Type B2. |
| Mirror attachment 8 in. | 14A/2687. | Cones, Type A and B. |
| Mirror attachment 8 in. | 14A/3396. | Cone, Type B2. |

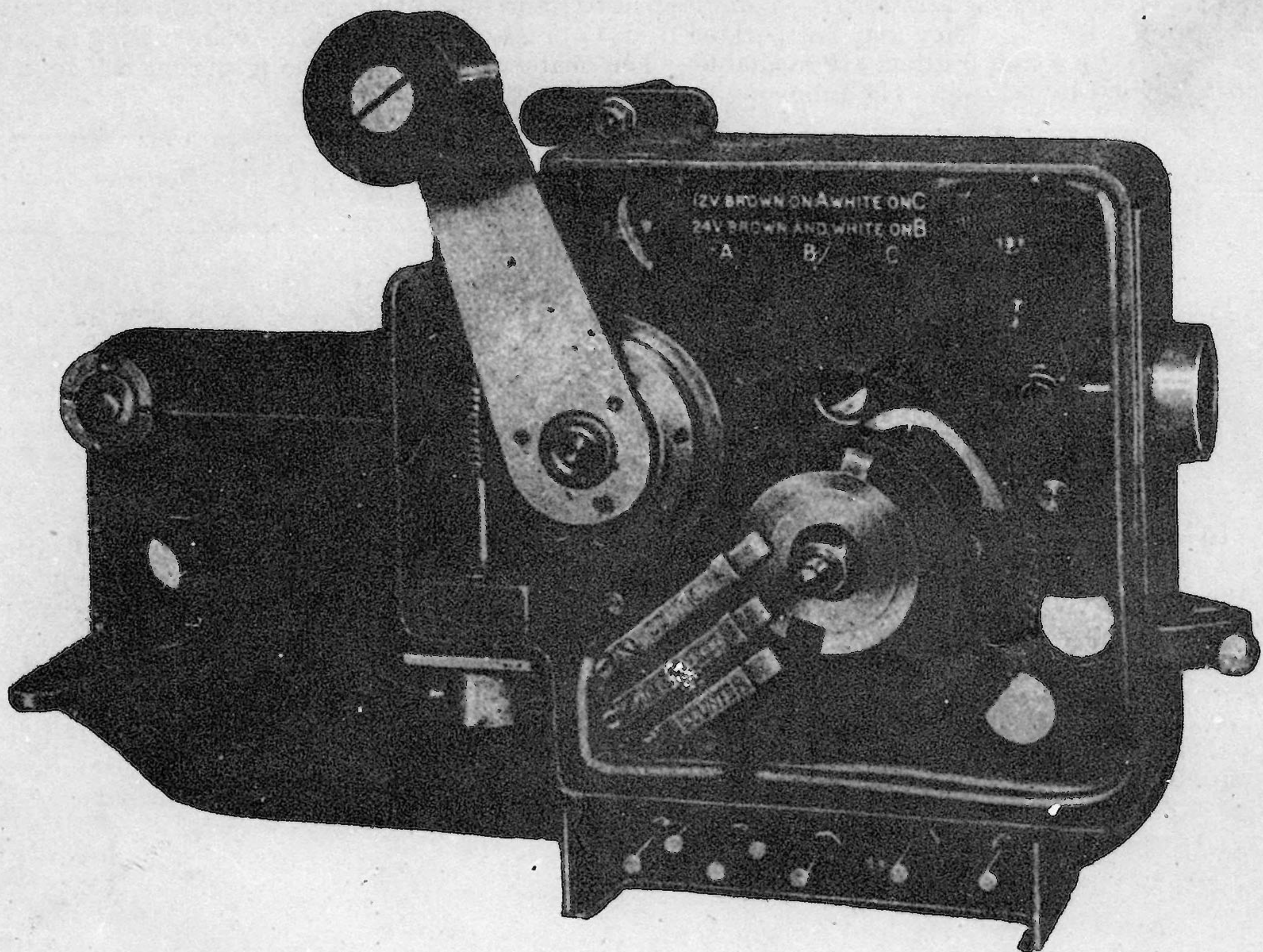


Fig. 4.—Type E gearbox

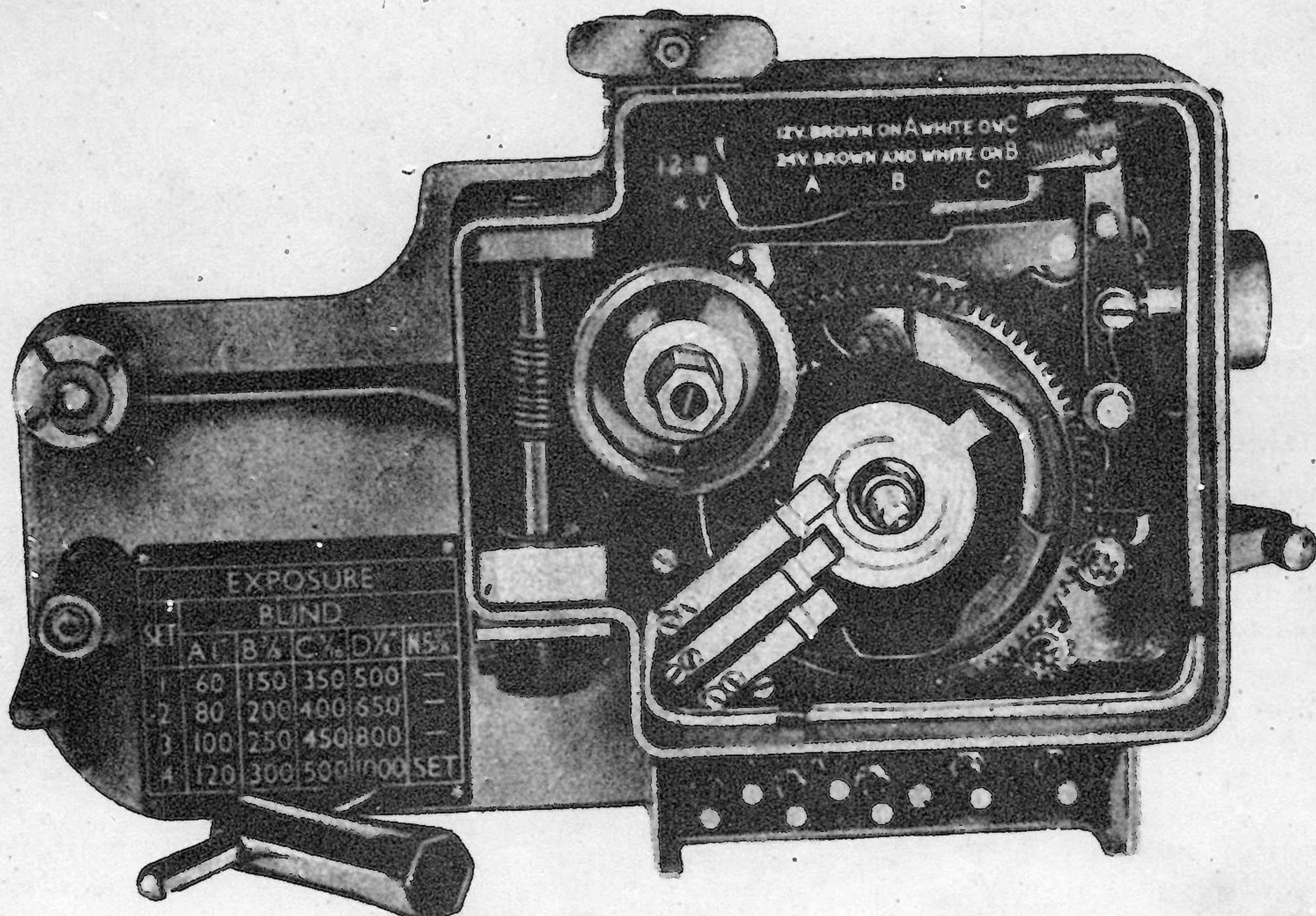


Fig. 5.—Type F gearbox

18. *Camera heating accessories.*—Combined heater and filter attachments are provided for fitting to the front of lenses. They may be operated from 12 or 24-volt aircraft supplies by wiring in parallel or series. Type 4 and 5 filters are available. The heater is secured to the front lens cell by a split band tightened by screws. The following is a list of heaters:—

| <i>Lens heater</i> | <i>Stores Ref. 14A/</i> | <i>Lens</i> | <i>Stores Ref. 14A/</i> | <i>Diameter of filter</i> |
|--------------------|-------------------------|-------------|-------------------------|---------------------------|
| 5" | 2289 | 5" F4 | 843 | 3.10 in. |
| 8" No. 2 | 2303 | 8" F2.9 | 780 | 3.68 in. |
| 8" No. 3 | 2366 | 8" F5.6 | 1727 | 2.85 in. |
| 14" No. 1 | 2298 | 14" F4.5 | 827 | 4.41 in. |
| 14" No. 2 | 2371 | 14" F5.6 | 3254 | 3.68 in. |
| 20" No. 1 | 2299 | 20" F5.6 | 1000 (Dallmeyer) | 4.41 in. |
| 20" No. 2 | 2300 | 20" F5.6 | 1000 (T.T. & H.) | 4.41 in. |
| | — | 20" F6.3 | 3262 (Ross) | |

19. An electrically heated muff is provided to protect the magazine when adequate heating is not available in the aircraft. It is available for 12 or 24 volt supplies. A heated sleeve is provided for the 14 and 20 in. cones and is normally used in conjunction with the muff. A lagging sleeve is provided for the 8 in. cone.

Electrical

20. *Wiring.*—The camera gearbox may be operated on either 12 or 24-volt aircraft supply by adjusting the leads of the solenoid as indicated on the terminal block. Plugs for the motor lead (2-pin) and the control or push switch lead (5-pin) are located at the base of the gearbox. Fig. 11 shows the wiring of the Type E and F gearboxes. Four leads are supplied as accessories.

No. 1. The supply lead to the push switch or Type 35 control.

No. 2. A five-way lead for connecting push switch or Type 35 control to camera gearbox.

No. ~~3~~ 4 A two-way lead for connecting the motor to the camera gearbox.

No. ~~2~~ 3 A two-way lead for connecting the pilot's indicator light to the Type 35 control.

Operating

21. *Loading the magazine.*—Before going into darkness the magazine should be thoroughly dusted out and fitted with a spool in the receive spool chamber. The following operations must be carried out in total darkness:—

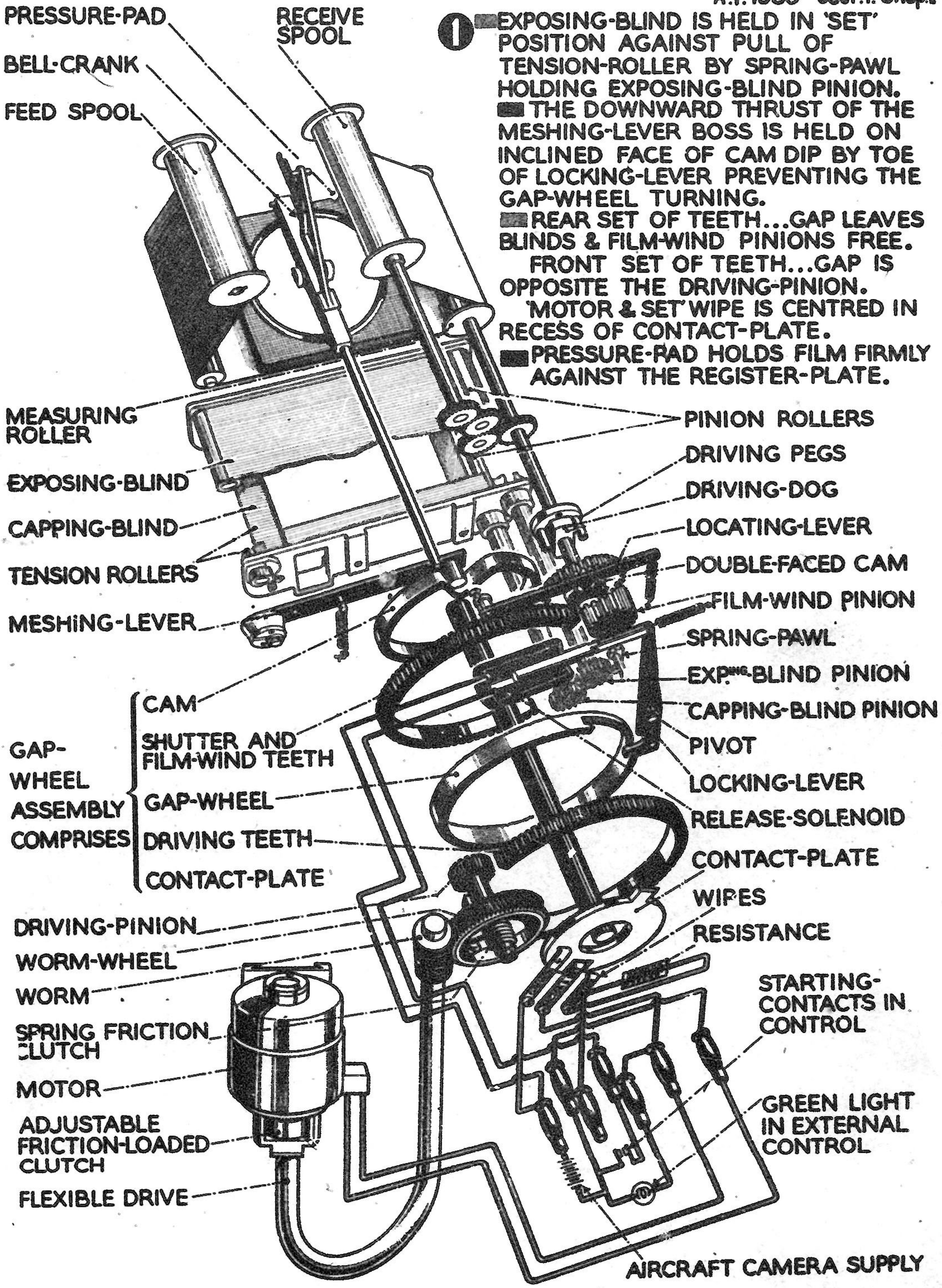
- (i) Fit new spool of film to the dogs of the spool chamber so that the film is drawn away from the pressure pad bridge, emulsion side up.
- (ii) Draw the film over the guide roller, under the pressure pad and over the measuring roller.
- (iii) Secure the film to the slot of the receive spool by drawing it between the spool and the pressure pad and inserting the pennant in the slot.
- (iv) Holding the pennant in position wind up the slack film.
- (v) Replace cover and screw. Test magazine by winding over once with the magazine fitted to the camera. See that the film wind indicator is operating.
- (vi) Set exposure counter to zero.

Note.—The above instructions apply to the Type C magazine except that care must be taken to ensure that the teeth of the measuring roller are engaging with the film perforations.

22. *Adjusting lens and shutter.*—According to the exposure shown to be necessary by the exposure tables, a shutter blind giving a suitable speed range must be fitted to the shutter. Adjustment of the shutter speed is then made by the tension adjustment screw. The lens aperture is adjusted by means of the lever fitted to the lens cell to the appropriate marking on the cone. Final adjustments to the lens and shutter speed should be made when the camera is being installed immediately before flight.

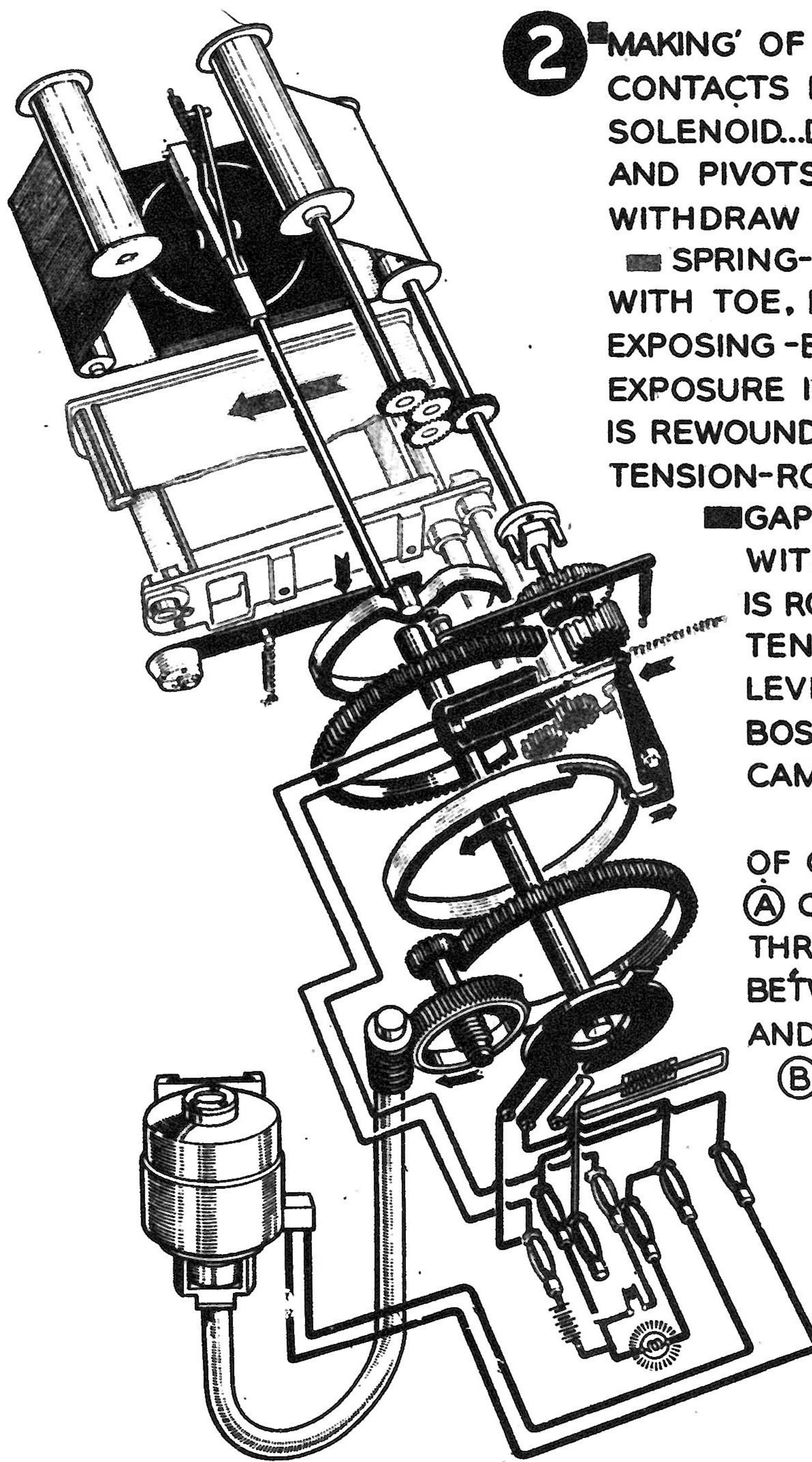
23. *Routine test.*—The camera should be thoroughly examined and tested in the Photographic Section preparatory to use in the air. The following operations should be carried out in the order given:—

- (i) Remove the gearbox and shutter units. Clean both sides of the register glass and lens. If necessary, fit filter to lens, ensuring that the back combination is screwed home.
- (ii) Examine the shutter blind for pinholes and the tapes for wear.



1 EXPOSING-BLIND IS HELD IN 'SET' POSITION AGAINST PULL OF TENSION-ROLLER BY SPRING-PAWL HOLDING EXPOSING-BLIND PINION.
 THE DOWNWARD THRUST OF THE MESHING-LEVER BOSS IS HELD ON INCLINED FACE OF CAM DIP BY TOE OF LOCKING-LEVER PREVENTING THE GAP-WHEEL TURNING.
 REAR SET OF TEETH...GAP LEAVES BLINDS & FILM-WIND PINIONS FREE.
 FRONT SET OF TEETH...GAP IS OPPOSITE THE DRIVING-PINION.
 MOTOR & SET WIPE IS CENTRED IN RECESS OF CONTACT-PLATE.
 PRESSURE-PAD HOLDS FILM FIRMLY AGAINST THE REGISTER-PLATE.

Fig. 6 - The cycle of operations.



2 'MAKING' OF RELEASE-SWITCH CONTACTS ENERGIZES RELEASE-SOLENOID..DRAWS IN ARMATURE, AND PIVOTS LOCKING-LEVER TO WITHDRAW TOE FROM GAP.

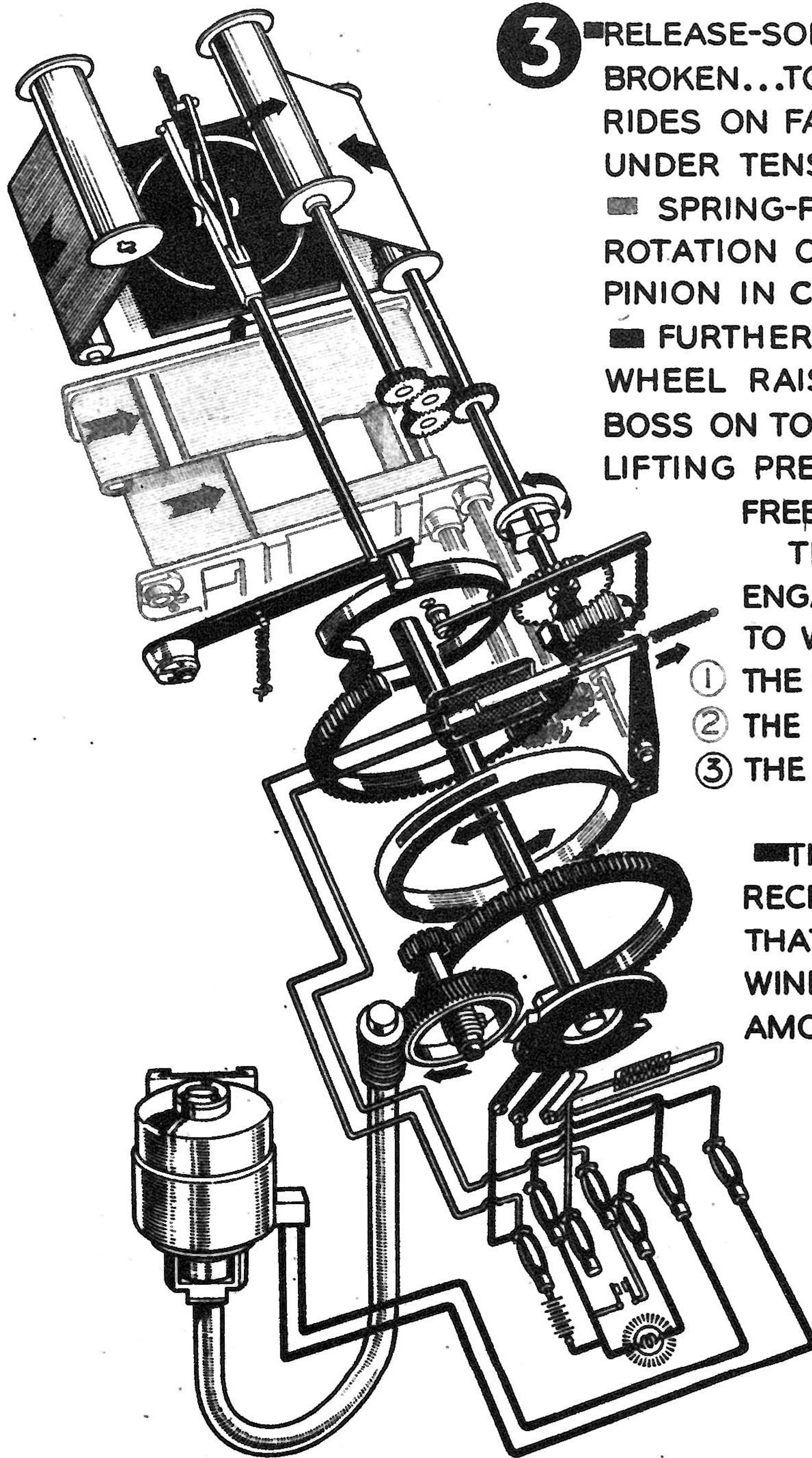
■ SPRING-PAWL, WITHDRAWN WITH TOE, RELEASES THE EXPOSING-BLIND PINION, AND EXPOSURE IS MADE AS BLIND IS REWOUND BY SPRING ON TO TENSION-ROLLER.

■ GAP-WHEEL IS FREED BY WITHDRAWAL OF TOE, AND IS ROTATED $\frac{1}{4}$ " BY THE TENSION OF MESHING-LEVER SPRING PULLING BOSS TO BOTTOM OF CAM DIP.

PARTIAL ROTATION OF GAP-WHEEL HAS...
 (A) COMPLETED CIRCUIT THROUGH CONTACT-PLATE BETWEEN COMMON POSITIVE AND MOTOR-&SET WIPES
 (B) ENGAGED FRONT SET OF TEETH WITH DRIVING-PINION.

MOTOR STARTS TO ROTATE- GAP-WHEEL.
 GREEN LAMP LIGHTS.

Fig. 7 - The cycle of operations.



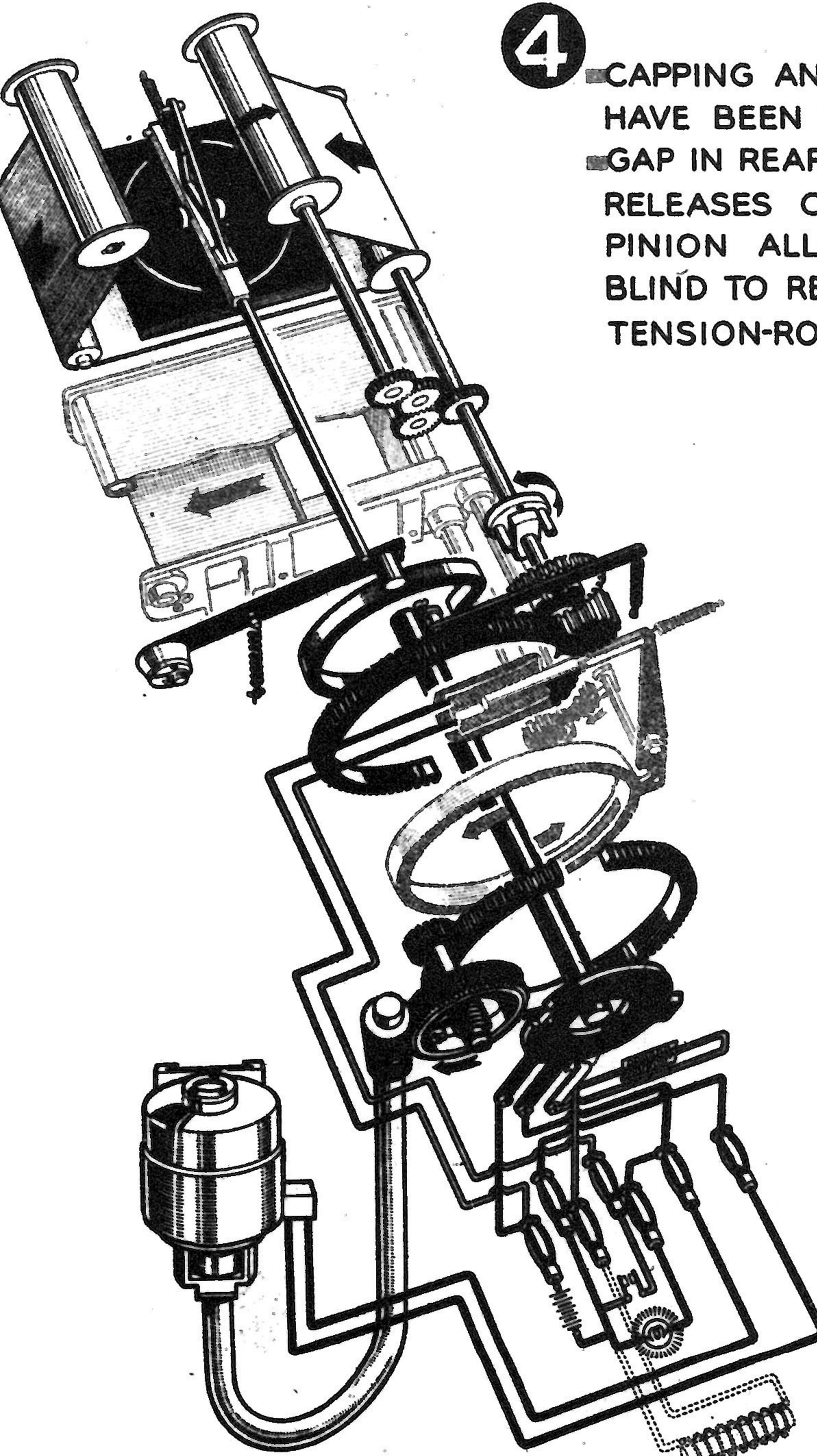
3 ■ RELEASE-SOLENOID CIRCUIT BROKEN...TOE OF LOCKING-LEVER RIDES ON FACE OF GAP-WHEEL UNDER TENSION OF SPRING. ■ SPRING-PAWL ALLOWS FREE ROTATION OF EXPOSING-BLIND PINION IN CLOCKWISE DIRECTION. ■ FURTHER ROTATION OF GAP-WHEEL RAISES MESHING-LEVER BOSS ON TO PERIMETER OF CAM, LIFTING PRESSURE-PAD AND FREEING FILM.

THE REAR SET OF TEETH ENGAGES WITH, AND STARTS TO WIND IN THIS ORDER...

- ① THE CAPPING-BLIND PINION
- ② THE EXPOSING-BLIND PINION
- ③ THE FILM-WIND PINION

■ THE FRICTION-DRIVEN RECEIVE-SPOOL IS SO GEARED THAT IT ENDEAVOURS TO WIND OVER AN EXCESS AMOUNT OF FILM...THE POSITIVELY DRIVEN MEASURING-ROLLER PREVENTS MORE THAN THE REQUIRED $5\frac{1}{4}$ OF FILM BEING PASSED

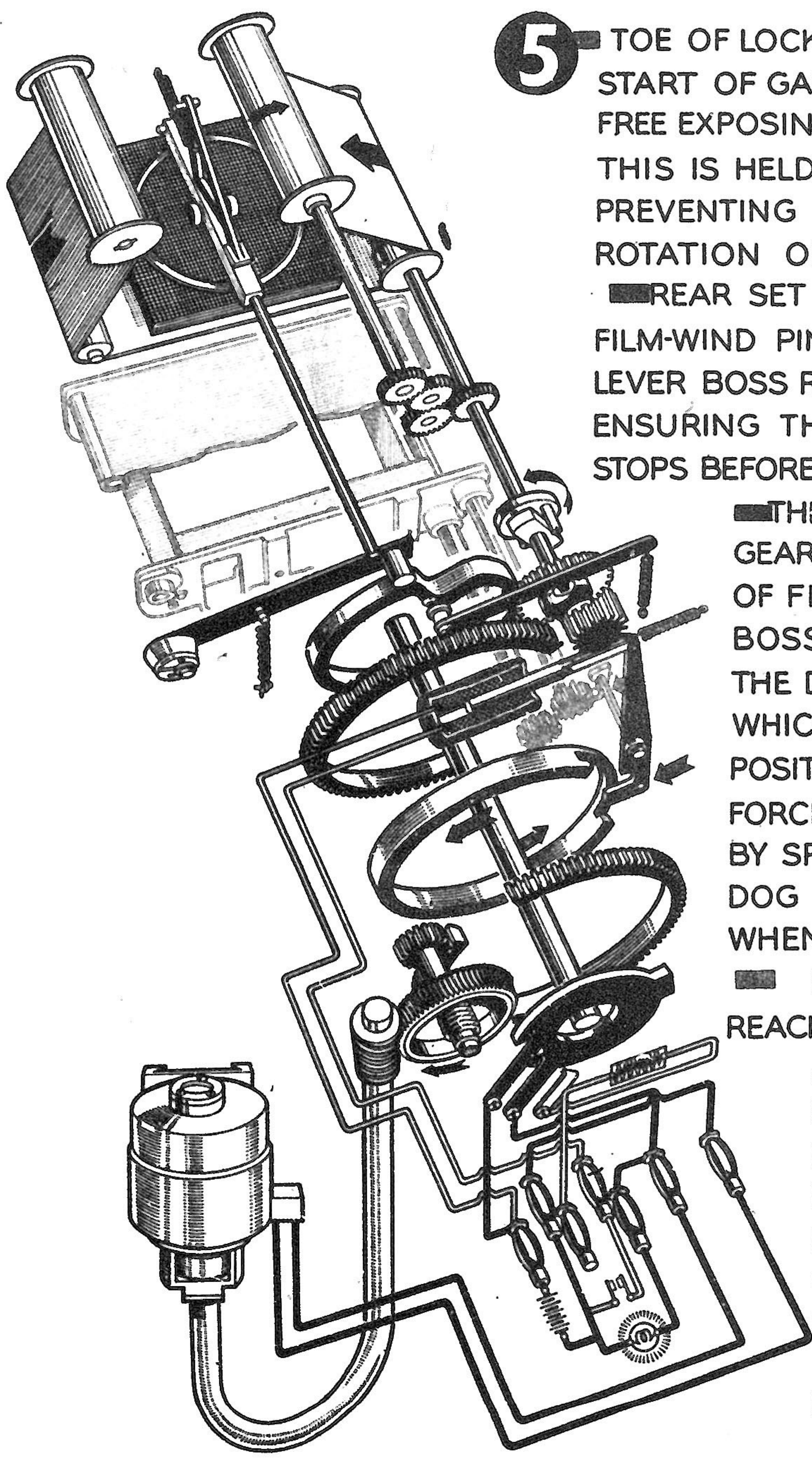
Fig. 8 - The cycle of operations.



- 4** CAPPING AND EXPOSING-BLINDS
HAVE BEEN WOUND OVER...
GAP IN REAR SET OF TEETH
RELEASES CAPPING-BLIND
PINION ALLOWING CAPPING-
BLIND TO RE-WIND ON TO
TENSION-ROLLER

NOTE HALF-WAY
THROUGH THE CYCLE
THE TONGUE ON CONTACT-
PLATE PASSES THE
COUNTER-WIPE, CIRCUIT IS
COMPLETED TO ELECTRO-
MAGNET IN EXTERNAL
CONTROL AND COUNTER
MECHANISM IS ACTUATED
...SEE A.D. 2115 FOR
T.35 CONTROL DETAILS

Fig. 9 - The cycle of operations.



5 TOE OF LOCKING-LEVER DROPS INTO START OF GAP...REAR SET OF TEETH FREE EXPOSING-BLIND PINION BUT THIS IS HELD BY THE SPRING-PAWL PREVENTING ANTI-CLOCKWISE ROTATION OF THE PINION.

■ REAR SET OF TEETH HAS RELEASED FILM-WIND PINION BEFORE MESHING-LEVER BOSS REACHES THE CAM DIP ENSURING THAT FILM WINDING STOPS BEFORE PRESSURE-PAD DESCENDS.

■ THE FILM-WIND SPINDLE IS GEARED TO COMPLETE WINDING OF FILM AS LOCATING-LEVER BOSS STOPS AT A CREST OF THE DOUBLE-FACED CAM DIP, WHICH RETURNS TO HORIZONTAL POSITION AS BOSS IS FORCED TO BOTTOM OF DIP BY SPRING...THUS DRIVING-DOG IS ALWAYS LEFT VERTICAL WHEN CAMERA IS 'SET'.

■ MESHING-LEVER BOSS REACHES START OF CAM DIP AND ATTEMPTS TO DROP UNDER PULL OF SPRING BUT IS HALTED MID-WAY BY THE TOE OF LOCKING-LEVER REACHING END OF GAP AND STOPPING ROTATION OF GAP-WHEEL.

REFER BACK TO FIG.1 FOR 'SET' POSITION

Fig.10 - The cycle of operations.

- (iii) Remove gearbox cover, inspect mechanism and ensure that the brass discs and electrical contacts are clean and free from oil.
- (iv) Test accumulator by means of the No. 1 lead and a voltmeter; this should read 13.2 volts.
- (v) Replace and secure shutter and gearbox units.
- (vi) Connect all leads to components and operate camera to ensure that everything is in working order. Particular attention should be paid to the shutter, noting that it is winding, capping and setting correctly and that it is set at the speed at which it is going to be used in the air.
- (vii) Fit the loaded magazine and operate for three exposures to bring unexposed film into position. Ensure that the magazine operates with the camera.

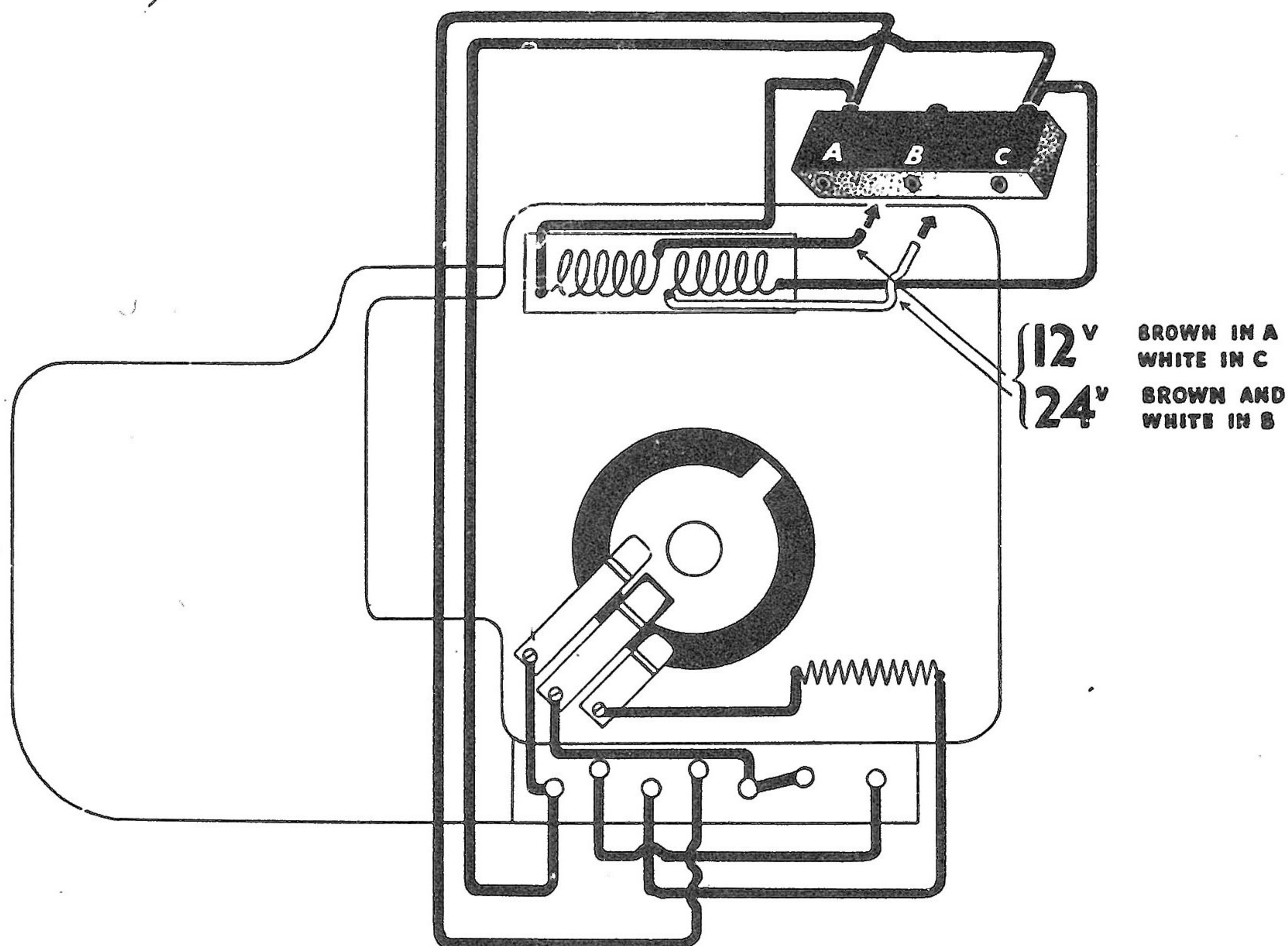


Fig. 11.—Wiring diagram of gearboxes type E and F

24. *Installation.*—The camera is installed in the aircraft by one of the following types of mountings:—

| Mounting | Purpose |
|------------------------|---|
| Type 16 | Seaplane |
| Type 21 | Hand held |
| Type 25 | Vertical and oblique photography |
| Type 26 (now obsolete) | Type 25 with extended cradle |
| Type 34 | Twin cameras |
| Type 45 | Vertical photography, available with extension legs, Type C |

25. The camera leads and accessories will vary according to the type of aircraft and the particular installation. The basic installation shown in fig. 12 will serve as a guide. After the mounting has been fitted, the following procedure should be adopted:—

- (i) Lower the camera into the mounting. Secure the camera by screwing home the two thumb-screws.
- (ii) Attach the motor, push switch or Type 35 control and pilot's indicator lamp to their respective wedge plates.
- (iii) Make the electrical connections, taking No. 1 lead from the supply to the electrical control or push switch, No. 2 lead from the electrical control or push switch to the gearbox, No. 3 lead from the gearbox to the motor, and No. 4 lead from the electrical control to the pilot's indicator lamp (this lead is not employed when the push switch control is used).
- (iv) Loosely coil all spare lengths of lead and tie them securely so that they are free from all flying control cables.
- (v) Operate the camera electrically for three exposures to wind unexposed film into position in the focal plane. Ensure that the film wind indicator is moving.
- (vi) Check the shutter setting and the lens aperture.
- (vii) Set the counter of the Type 35 control to zero and inspect all locking bolts and catches.

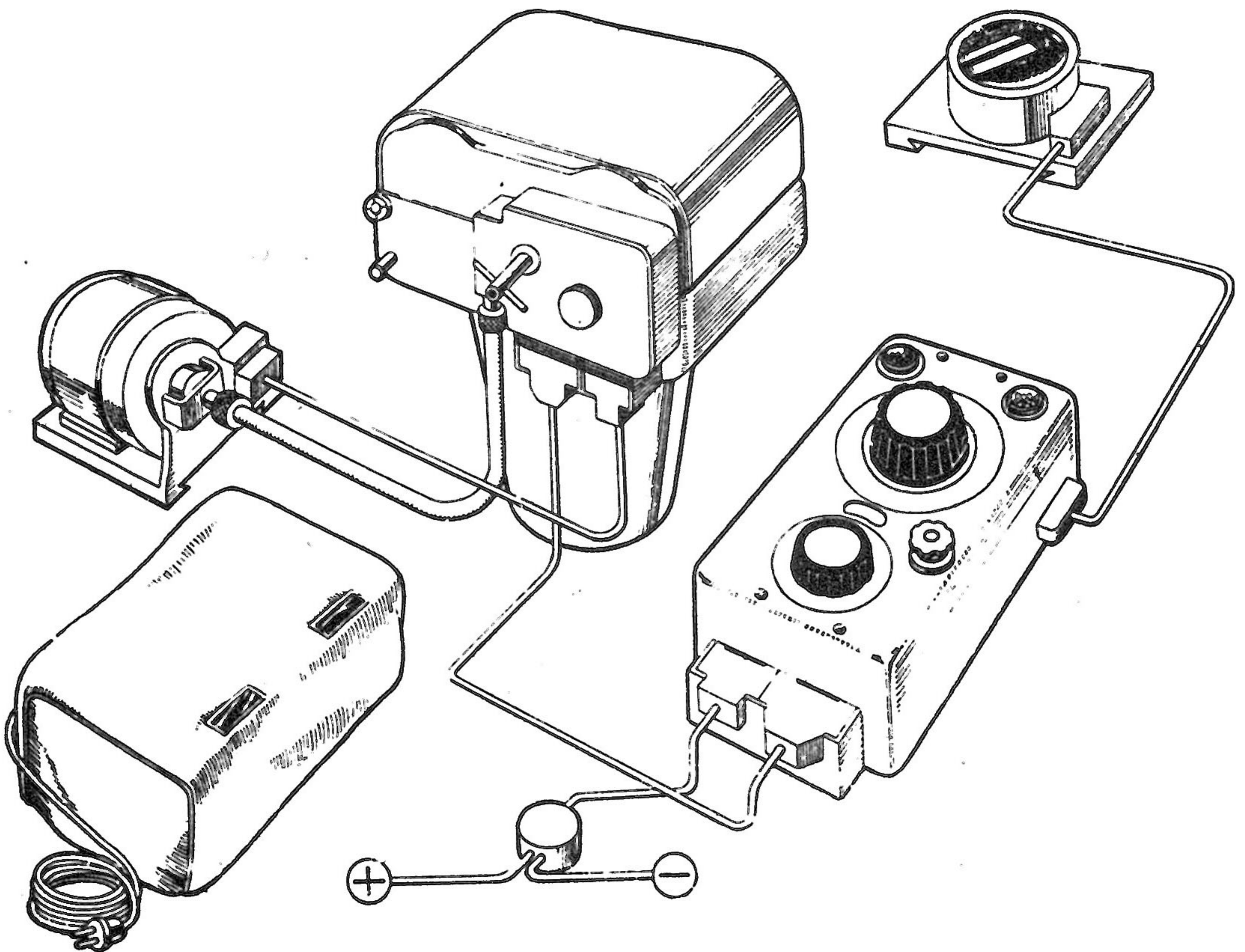


Fig. 12.—A typical aircraft camera installation

26. *Gland sealing.*—As no perspex panel is now used over the camera aperture, a fabric sealing gland is provided to seal off this part of the camera. The gland permits a moderate amount of tilt fore and aft. A bung is provided to seal off the aperture when the camera is not in position.

27. *Heating for low temperature operation.*—If low temperatures are likely to be encountered, an electrically heated muff and cone lagging sleeve should be fitted to the camera.

28. *Camera tilt.*—When the angle of the camera is adjusted on the ground before flight, due allowance must be made for the difference in attitude between level flight at the time of photography and the ground position.

29. *Embodied leads.*—Recent aircraft are installed with numbers 1, 2 and 3 leads, and the Rotax panel-mounted type of indicator light. The wiring is usually completed up to and including the plugs or sockets on the camera control or gearbox.

Routine adjustment

30. *Changing or removing lens cones.*—The following procedure should be adopted:—
- (i) Remove the shutter and gearbox from the camera body.
 - (ii) Place a selvyt cloth on the back of the lens to protect it from damage in the event of a spanner or bolts falling into the cone.
 - (iii) Remove the three hexagonal headed screws and spring washers situated on the inside of the cylindrical base of the camera body, by which the cone is secured to the body. Lift the camera body from the lens cone.
 - (iv) Place the cone to be fitted face downwards on the bench and place a selvyt cloth on the back of the lens. Stand the camera body upon the cone, turning it so that the three holes for the screws are in alignment with the holes in the cone, and the diaphragm lever is to the front of the camera. When the 8 in. cone is being fitted, the metal baffle must be inserted between the cone and camera body and must be located so that its sides are parallel to those of the exposure aperture in the camera body.
 - (v) Ensure that the base of the camera body lies flush with the top of the lens cone. Fit the three screws and spring washers and tighten finger tight with the box spanner provided.
 - (vi) Remove the selvyt cloth.
 - (vii) Clean both sides of the register glass, replace shutter and gearbox.

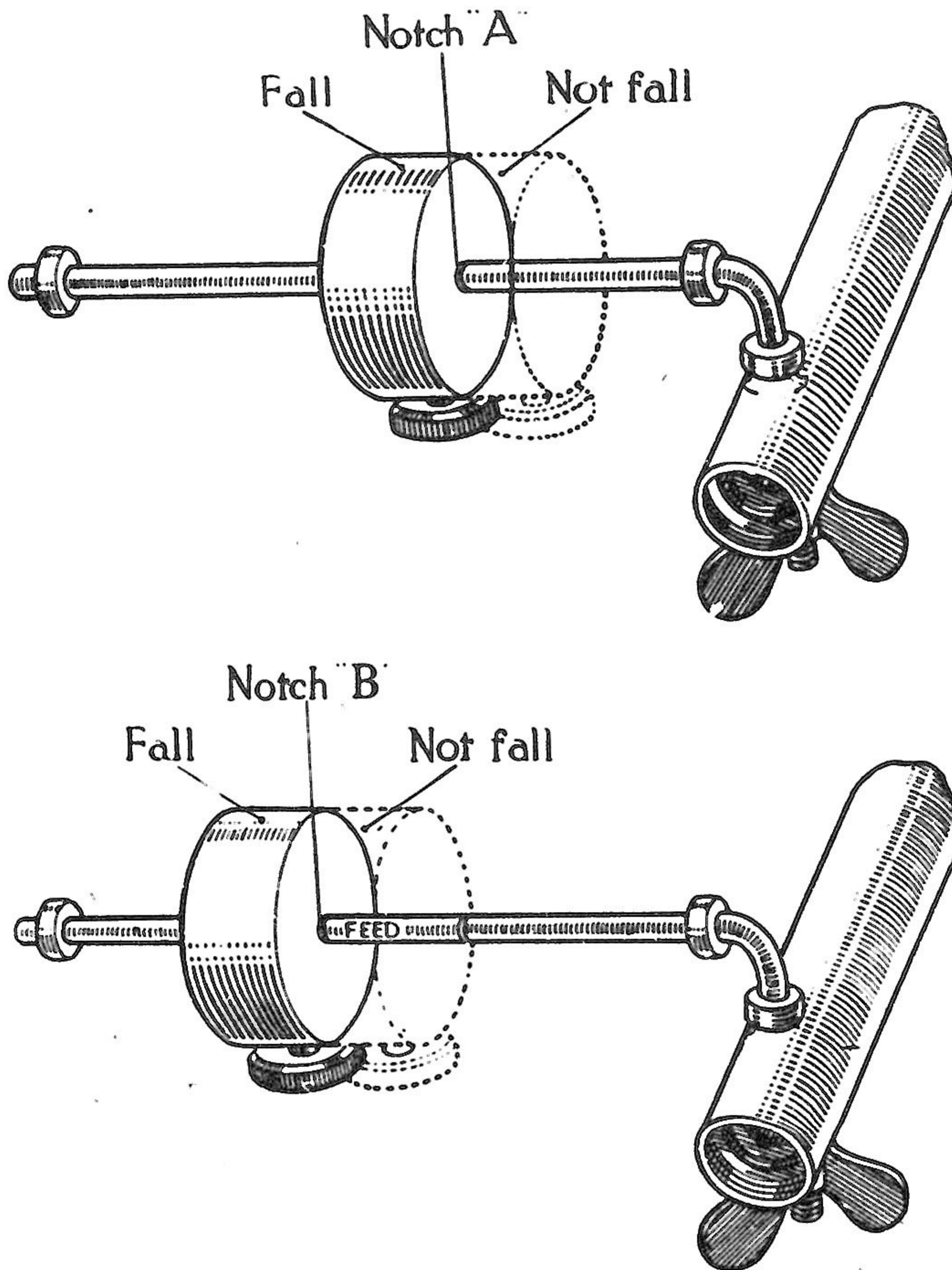


Fig. 13.—Adjustment of friction tester Stores Ref. 14A/731

Servicing

31. *Adjustment to Type A magazine spool friction.*—The adjustment is carried out with the modified friction tester (Stores Ref. 14A/731), as follows:—

- (i) Magazines with the old type "feed" friction washers. Place the friction tester in position on the "feed" side of the magazine, with the outer face of the weight set to the first notch, marked "A", fig. 13, with the arm at right-angles to the support tube, extending away from the magazine. With this setting the arm should remain in the horizontal position when released. Now move the weight so that the inner face coincides with the same notch. When raised to a horizontal position and released, the arm should fall.
- (ii) Magazines with the modified disc type "feed" friction. The test is the same as detailed in the previous sub-para. (i) except that the second notch, marked "B", fig. 13, is to be used for the weight settings.
- (iii) Test for "receive" spool friction for both types of magazine:—
 - (a) Using the magazine test adaptor (Stores Ref. No. 14A/991), place the magazine to be tested on a camera fitted up for electrical operation.
 - (b) Place the friction tester in position on the "receive" side with the extension arm over the bridge of the magazine, with the weight set against the "receive" stop-collar. Raise the arm to the horizontal position, then operate the camera electrically. If the friction is correctly adjusted the arm should maintain its position with the camera running.

Note.—The weight on the extension arm, together with clamping screw, weighs $4\frac{1}{2}$ ozs. (127 grammes), and the distance between its two faces is 0.68 inches.

32. *Adjustment to Type C magazine, spool friction.*—Friction adjustment is carried out by working to the load of the magazine friction tester (Stores Ref. 14A/2562). The friction tester can be adapted for the feed or receive spools by sliding the weight to the appropriate notch. The test is carried out by placing an empty spool in the spool chamber to be tested and fixing the tester into the slot of the spool. Correctly loaded, the tester should slowly descend.

33. If either of the spool chambers needs adjustment, the following procedure should be adopted:—

- (i) Detach the magazine coupling by removing fixing screws.
- (ii) Remove the magazine gear cover.
- (iii) With the friction tester in position loosen the locking nut on the friction bearings and tighten or loosen the adjusting nut as required. The adjustment necessary for this nut will probably not exceed half a turn. Tighten the locking nut and test the friction again as the locking nut may tend to increase the tension.
- (iv) Replace cover and coupling.

34. A sprocket roller is fitted to the F.24, Type C, 250-exposure magazine in place of the needle roller, as follows:—

- (i) Remove cover plate.
- (ii) Remove taper pin fixing the roller pinion to the sprocket roller spindle, then remove pinion.
- (iii) Withdraw the rear guide plate supporting the rollers by removing the five screws holding this part in position.
- (iv) Remove the needle roller complete with spindle.
- (v) The two spacing washers supplied with the sprocket roller must be assembled on the sprocket roller spindle with the thick washer on the sprocket end and the thin washer on the other end.
- (vi) Place sprocket roller complete with spindle and spring washers in position.
- (vii) Replace rear guide plate and retaining screws.
- (viii) Replace roller pinion and taper pin on the roller spindle by using the existing holes in the two parts.
- (ix) Replace cover plate. The friction of the spools will not be altered.

35. *Changing shutter blinds.*—The following procedure should be adopted:—

- (i) Set the shutter tension to position 1.
- (ii) Release the shutter and holding blind by the metal slit, withdraw it away and out from the shutter frame to its full extent.
- (iii) Holding the tension roller underneath to prevent its rotation, draw the tension end of the blind halfway up to the cutaway in the side of the frame. The tension roller is now held.
- (iv) Withdraw the other end of the blind completely, taking care not to turn the roller.

Note.—If the roller has been accidentally turned, before re-inserting the alternative blind, it should be turned until the slot in the roller is opposite the cut-away.

- (v) Insert the alternative blind halfway into the empty roller, title side up and the tension end free.
- (vi) Holding the tension roller again, remove the old blind and insert the alternative blind right home. Care should be taken to ensure that the turned over fabric is kept out of the slot.
- (vii) Push home the other end of the blind and allow the blind to roll up on the tension roller. TEST THE SHUTTER TWO OR THREE TIMES TO SEE THAT IT WORKS CORRECTLY.

Note.—If the tension of the tension roller has been released, it must be rewound according to the instructions already given. 15 turns must be counted from the position at which the tension roller was quite free and these must be made in the direction indicated on the shutter.

36. *Fitting a gelatine filter.*—A gelatine filter is normally fitted to the lens of the F.24 camera, and may be kept permanently in position until it shows signs of fading or a different type is required. It is not necessary to remove the Type 4 gelatine filter when fitting a lens heater of either Type 4 or 5 filter glass since this has no noticeable effect on exposure. If a Type 5 filter is fitted, it must however, be removed for fitting a Type 4 glass filter.

37. The filter is packed with instructions and template for cutting to the size of various lenses. It is inserted in the lens by removing the rear component. The rear component should be replaced and screwed home finger tight only. This operation is most easily accomplished with the cone removed from the body.

38. *Voltage adjustment, gearbox solenoid.*—The release solenoid is provided with two tappings which are connected to the supply in parallel for 12 volts or in series for 24 volts. Instructions for making this adjustment are shown in fig. 14. It is most important when installing the camera to check that the adjustment is correct for the particular aircraft supply.

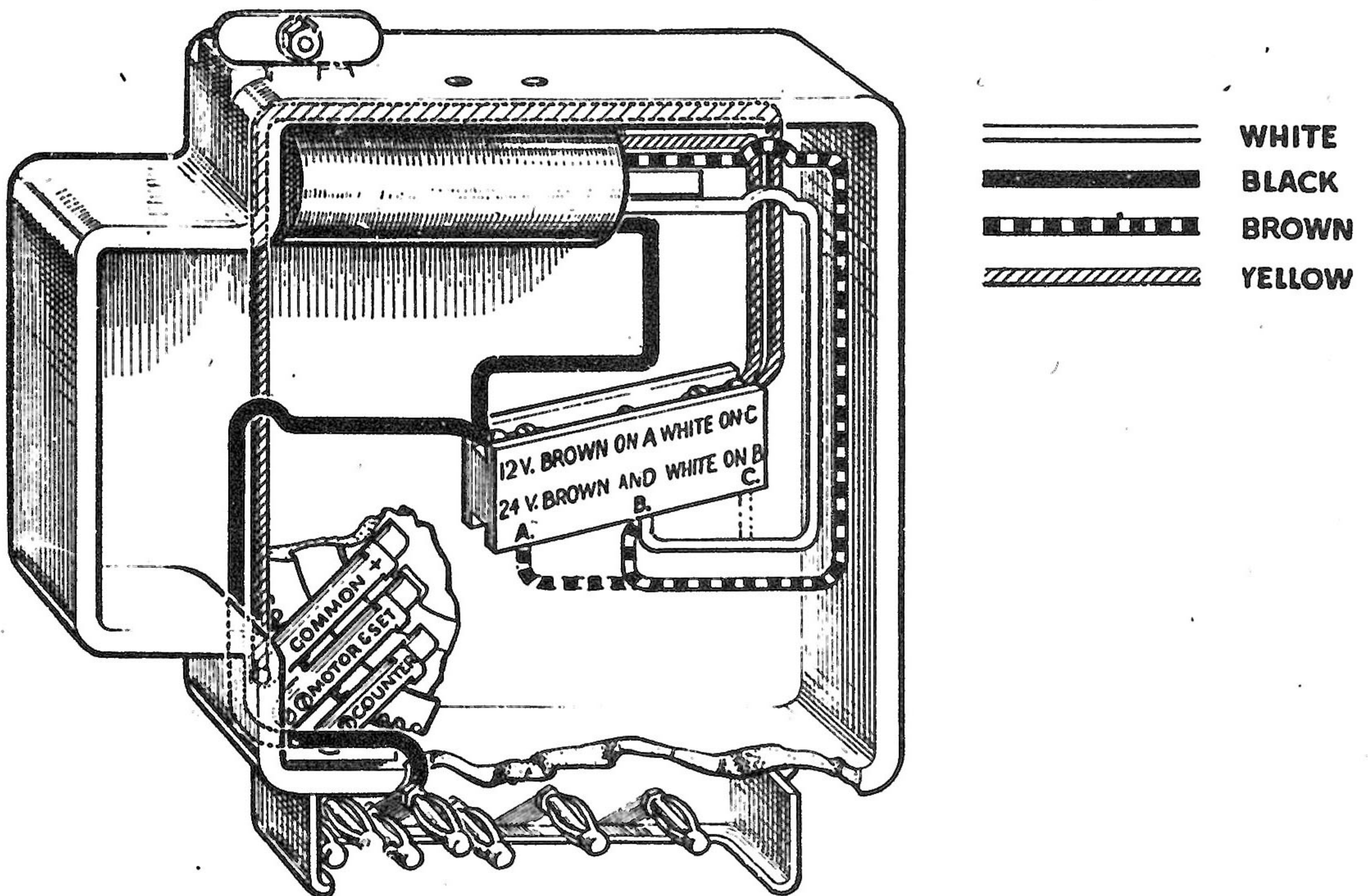


Fig. 14.—Voltage adjustment, gearbox solenoid

Servicing and replacements

39. *General note.*—The following instructions for dismantling and subsequent assembly of the various units of the camera are given to enable replacements to be made on occasions when it is impossible to obtain replacement of the complete unit. Since all failures can be diagnosed without stripping the units concerned, ALL UNNECESSARY DISMANTLING IS TO BE AVOIDED.

40. *Changing the register glass.*—In the event of a register glass being badly scratched or broken a new glass should be obtained. The new glass should be fitted as follows:—

- (i) Remove the four fixing plates and clean the recess free from grit or fragments of glass.
- (ii) Pack up the glass in the recess with the packing shims provided at each of the four corners until the outer surface of the glass is dead level with the datum surfaces. The packing shims are made of laminated sheet brass, each layer being 0.002 in. thick. The layers can be peeled off with the assistance of a penknife blade. By this means it is possible to adjust the register glass to within ± 0.001 in. of the datum surface.

Note.—All register glasses are thinner than the depth of the recess and will therefore require packing. In the absence of the laminated packing shims, good quality paper may be used.

- (iii) The accuracy of the adjustment is best checked by placing the edge of a steel rule across two diagonally opposed datum surfaces and viewing the union of the rule and the glass against the light. Correctly adjusted there should be a just perceptible trace of light between the glass and the rule or, in other words, the glass should be slightly below (if anything) the datum surface. The test should be made with the fixing plates secured in position.

41. *Focus check.*—Assuming the lens to have been correctly focussed with the glass aligned with the datum surface, it will not be necessary to check it. If, however, any doubt exists that the old glass may have been incorrectly fixed (too high or low) the following test should be made:—

- (i) Support the camera, fitted with an 8 in. lens, in a horizontal position directing the lens at a distant object such as a church steeple or telegraph post. Select a piece of clean plain glass (a washed off half-plate will do) and make a fine scratch near the centre. Lay the glass scratch against the register glass and align the scratch with a definite point on the selected object as viewed through the register glass with one eye closed. Still viewing with the one eye only, move the head to the right and left of the scratch. If the lens is correctly focussed the position of the scratch with the object will remain unchanged. If the object is seen to move to the right of the scratch when the head is moved to the right then the lens is too far forward, and conversely. Adjustment, where necessary, must be made to the lens and not to the register glass once the latter has been correctly fitted. When the correct position of the lens has been found, the lens should be taped in position until an instrument maker can re-drill the lens mount and fix it to the cone.

42. *Dismantling shutter unit.*—The universal shutter will allow the main blinds to be withdrawn without dismantling the shutter. The following instructions are based on the previous type of shutter where the main blind is fitted by dismantling the rollers. Apart from this, the instructions may be taken to apply to both types of shutters.

43. The operation should be carried out as follows, with the tension adjustment at the lowest speed:—

- (i) Remove the anti-acceleration lever and brake drum.
- (ii) Remove the anti-acceleration cam and gear wheel as a unit.
- (iii) Remove the split pin from the pinion at the left-hand end of main blind pinion roller spindle and, with a small drift, drive the spindle through the pinion until pinion and spindle can be removed by hand.
- (iv) Remove the pinion and other components from the end of the roller spindle.
- (v) Lift the pinion roller from between the side members of the shutter frame and allow the blind to be wound on to the tension roller.
- (vi) Remove the split pin from the pinion at the left end of the main blind tension roller spindle and, with a small screwdriver, prise the pinion from the end of the spindle. Remove the screws which retain the flange at the base of the tension adjusting sleeve to the side of the shutter frame. Holding the roller, turn the sleeve approximately eight turns in a clockwise direction or until no tension is left on the spindle. Now remove spindle and roller.
- (vii) Slide the blind from the two rollers.
- (viii) Turn the exposure adjusting knob until the reading is at the top speed. Remove the knob and slide the sleeve clear of the end of the spindle.
- (ix) Remove the split pin from the left-hand end of the capping blind pinion roller spindle and withdraw the spindle.
- (x) Remove the pinion and components from the end of the spindle.
- (xi) Slide the blind reinforcement strips from the ends of the roller and slide the blind extension inwards until their wired ends may be withdrawn through the holes in the roller.

- (xii) Remove the setscrew which retains the anchor pin at the right-hand end of tension roller spindle whilst pressing the end of the spindle sideways with the thumb-nail to prevent its flying round as soon as the screw is removed. Remove the anchor pin and release the spindle.
- (xiii) Using a small drift, force the right-hand end of the spindle through its socket and then work the right-hand end of the roller out from between the sides of the shutter frame. Push the spindle back from the left-hand end of the frame so that it projects from the right-hand end of the roller. Gripping the end of the spindle between the fingers, withdraw it still further until the roller can be removed from the shutter frame.
- (xiv) Slide the blind from the roller.

44. *Assembly of the shutter unit.*—

- (i) Screw the sleeve engraved with the shutter settings along the threaded portion of the spindle until its end is flush with the inner end of the threaded portion.
- (ii) Pass the tension adjusting sleeve over the engraved sleeve and turn the squared end of the spindle until the lowest reading is opposite the scribed line in the window. The roller should be held by the adjusting sleeve whilst this is being done and the tension released from time to time.
- (iii) Fit the adjusting knob over the square end of the spindle, place the spring in its bore, and fit the retaining nut and washer to the end of the spindle.
- (iv) Fit the pinions to the main and capping blind pinion roller spindles, as follows:—Pass the following over the end of the spindle:—
 - (a) Friction washer
 - (b) Pinion
 - (c) Friction washer
 - (d) Plain washer
 - (e) Spring washer

Screw home the retaining nut, securing it with a split pin or Simmonds locking nut.

- (v) Place the shutter frame on the bench or table, lower face undermost, and, with the tension roller end on the right-hand side, lay the capping blind on the bench beyond the tension roller end of the frame so that the blind leads towards the frame from the top of the roller.
- (vi) Work the extension strips of the capping blind between the guides in the shutter frame and under both rollers, pulling them through until the leading edge of the blind is located about half-way along the guides.
- (vii) Lay the capping blind pinion roller on the bench beyond the left-hand side of the shutter frame so that the end with the D shaped hole is further away.
- (viii) Slide tape end of capping blind on to roller.
- (ix) Place the capping blind pinion roller between the side members of the shutter frames and slide the spindle home, placing a washer either side of this roller and between the frame as the spindle is passed home. Place a washer over the nearer end of the spindle and then fit a split pin through the end of the spindle, cutting the ends of the pin so that they project about $\frac{1}{8}$ in. through the spindle. Both bearings for the spindle are to be lubricated sparingly with oil before the spindle is fitted.
- (x) Wind the slack of the blind on to the pinion roller and then fit the tension roller, first engaging the nearer end of the spindle in its socket and then the further end. A washer is to be fitted at each end of the spindle next to the roller and this must be sparingly lubricated.
- (xi) Wind the blind back on to the tension roller and when fully wound, turn the spindle through six revolutions in a counter-clockwise direction by the anchor pin; then secure the anchor pin to the shutter frame of the setscrew.
- (xii) Fit the main blind to the roller and, placing the roller between the frame, pass the spindle, with pinions fitted, through frame bearing, inserting a washer between roller and frame on each side of rollers. When spindle is finally home replace pinion and split pin.
- (xiii) Lubricate the bearings for the pinion roller spindle and fit the spindle.
- (xiv) Tap the pinion on to the nearer end of the spindle and secure it with a new split pin. The ends of the pin are to be cut so that they project $\frac{1}{8}$ in. beyond the spindle. Bend the head of the pin up to clear the cam gear wheel.

- (xv) Wind the blind on to the pinion roller, fit a washer over the nearer end of the tension roller spindle, and after lubricating it, insert the nearer end of the spindle into its bearings in the shutter frame. Slide the further end of the spindle home into the slot in the side of the shutter frame.
- (xvi) Set the tension adjustment at the lowest shutter speed and then wind the blind back on to the tension roller by turning the latter through the sleeve of the tension adjustment.
- (xvii) When the blind is fully wound, make sure that there is no loading on the tension spring, and then give the latter ~~eight~~^{five} turns by turning the tension adjusting sleeve in a counter-clockwise direction. Secure the sleeve to the shutter frame with the three countersunk screws and replace stop screw.
- (xviii) Fit the pinion to the nearer end of the spindle and secure it with a split pin. Bend up the head of the split pin to avoid fouling the brake spring drum gear wheel.
- (xix) Fit the anti-acceleration cam and gear wheel, first lubricating the screw about which it rotates. Temporarily, the gear wheel may be meshed in any position with the pinion.
- (xx) Fit the anti-acceleration brake lever, hooked end undermost, also the brake drum. Temporarily, the drum gear wheel may be meshed in any position with the pinion. A washer must be fitted behind the split pin which secures the lever.
- (xxi) Wind the main blind on to the pinion roller until the trailing edge of the slit in the blind is 90° past the top of the roller then alter the meshing of the cam gear wheel so that the toe of the brake lever bears on the root of the cam. Then allow the blind to be wound back on to the tension roller.
- (xxii) Loosen the screw which retains the anti-acceleration brake drum and gear wheel, disengage the gear wheel from the pinion and let down the spring. Tension the spring by turning the gear wheel through thirty teeth in a counter-clockwise direction before re-engaging it with the pinion and tightening the pivot screw. This completes the assembly of the shutter.

45. *Dismantling the gearbox unit.*—

- (i) Remove the sleeve to which the sheath of the flexible drive to the worm is attached, prise off the worm protecting cap and tap out the worm with a brass or copper drift; the bottom ball bearing will come away with the worm. Withdraw the worm from the mechanism casing.
- (ii) Remove the handle and worm wheel, slacken the two screws which retain the handle clutch to the shank of the pinion and, using a shoulder drift, tap the shank of the driving pinion through the clutch (this information applies to Type E gearboxes only). Turn the pinion in the appropriate direction and withdraw it from the worm wheel.
- (iii) Remove the screws which retain the connections to the brush gear, and the screws which retain the brush gear in the mechanism casing, after which lift the brush gear clear.
- (iv) Turn the gap wheel into the locked position, operate the shutter, then release and withdraw the gap wheel from its spindle.
- (v) Disengage the spring from the peg on the meshing lever, remove the split pin from the end of the lever spindle and remove the meshing lever.
- (vi) Remove the guide of the release block.
- (vii) Remove the return spring of the release block and withdraw the block from the mechanism casing.
- (viii) Remove the solenoid return spring.
- (ix) Remove the back of the gearbox, the three screws and the disc which retain the locking lever spindle.
- (x) Remove the split pin that retains the locking lever on its spindle, tap the spindle through the lever and the back of the mechanism casing and remove the lever, solenoid armature, pinion and washer.
- (xi) Remove from the back of the gearbox the screw which retains the locating lever spindle and withdraw the spindle from the lever. If necessary, disengage the spring from the lever and remove the lever.
- (xii) Using a small drift, drive the pin that retains the film wind dog clear of the spindle, drive the spindle through the dog and remove both components.
- (xiii) Unscrew terminal block and attach release solenoid leads. Remove the screws which retain the solenoid and lift component clear.

Note.—There are no bearings on the worm shaft of the Type F gear box and no thrust washer.

46. *Assembling the gearbox.*—

- (i) Fit solenoid and re-attach leads to terminal block.
- (ii) Lubricate the film wind spindle and insert it through its bush and the mechanism casing. Place the film drive dog over the end of the spindle, secure it with a taper pin and file the ends of the pin flush with the sides of the dog.
- (iii) Connect the spring between the end of the locating lever and the peg in the mechanism casing.
- (iv) After lubricating it, insert the locating lever spindle to the end of the lever.
- (v) Engage the roller of the locating lever in one of the hollows of the cam, locate the rear end of the lever over its boss in the mechanism casing and fit, from the back of the gearbox, the screw which retains the spindle.
- (vi) Adjust the setting of the locating lever as follows:—
 - (a) Fit the locking lever spindle temporarily to the casing, ensuring that the centre marks on the flange and casing are adjacent.
 - (b) Pass the washers and film wind pinion over the spindle, drop the gap wheel over its spindle so that the gap is opposite the film wind pinion. Turn the gap wheel slowly in a counter-clockwise direction and note how the spring tooth engages the film wind pinion. The tooth should just miss the top of one of the teeth of the pinion and engage the next tooth correctly. Should it foul the top of the tooth, be depressed by that tooth and pass it with a slight click, the setting of the lever spindle must be altered. The screw by which the spindle is retained to the gearbox is fitted eccentrically to the spindle, and to alter the setting of the latter it is necessary first to loosen the back screw, turn the spindle until correct engagement is obtained and then re-tighten the back screw, taking care that the spindle is not again turned in so doing.
 - (c) Having adjusted the setting of the locating lever spindle, remove the gap wheel and withdraw the locking lever spindle until its end is flush with the top of the film wind pinion.
- (vii) Clean the solenoid armature and insert it (connected through the links to the locking lever) into the solenoid. Position the fulcrum boss of the locking lever over the end of its spindle and, after lubricating the lever, slide the spindle through it. Turn the spindle so that the centre marks on its flange and the gearbox are next to one another, and then fit the three countersunk screws.
- (viii) Place a washer over the end of the locking lever spindle, then fit a split pin through the spindle.
- (ix) Fit the return spring between the hole in the long link pin nearer the solenoid armature and the hole in the web at the top of the front end of the mechanism casing.
- (x) Lubricate the bush for the meshing lever, fit the lever and connect up its spring. If the lever is a replacement, do not yet fit the retaining washer and split pin.
- (xi) Lubricate the bore of the gap wheel, fit the wheel over the gap wheel spindle. The wheel should be turned so that the inner gap is opposite the toe of the locking lever and the latter must be held so that its toe allows the rim of the wheel to drop past it. The meshing lever should next be raised so that the wheel may be slid right home on the spindle. If a new meshing lever, gap wheel or gap wheel cam has been fitted, it may be necessary to alter the setting of the meshing lever bush; the bore of this bush is eccentric to the exterior. To test the necessity of such an adjustment, turn the gap wheel until it is locked by the locking lever and remove the screws that retain the meshing lever bush. Turn the bush in its socket and watch the roller of the meshing lever. If the roller should rise at the side of the cam as the bush is turned, the setting of the bush requires attention. The bush should be positioned so that the roller is maintained at the top of the travel imparted to it by the rotation of the bush. The bush is to be retained in the new position by drilling two fresh holes in the flange and boss for the reception of the screws. Having adjusted the setting of the bush, fit the washer and split pin to the end of the meshing lever spindle.
- (xii) Insert the pawl carrying a portion of the release block (which is to be complete with the loose base plate) through the slot in the front of the mechanism casing and connect the return spring between the peg on the block and the web in the casing.
- (xiii) Fit the guide for the release block.
- (xiv) Fit the brush gear and connect up the wiring. The yellow and striped wires are to be connected to the "Common" brush. The orange wire to the "Motor and Set" brush, and the white wire to the "Counter" brush. A small washer is to be fitted beneath the head of each screw by which the connections are made.

- (xv) Fit the worm wheel and handle to the driving pinion after lubricating its shank. The worm wheel is to be fitted next to the pinion with its ratchet further from the pinion. The shank of the pinion is to be pressed through the handle until it is flush with the outer end of the latter. The two screws in the clutch body must be engaged in the holes in the shank of the pinion and then tightened.
- (xvi) If removed, fit the upper bearing for the worm in its housing.
- (xvii) Fit the handle assembly over the spindle in the gearbox.
- (xviii) Fit the worm complete with the thrust bearing and lower journal bearing into the mechanism casing and secure it with a flanged sleeve which retains the sheath of the flexible drive cable.

47. *Fitting the gearbox to shutter unit.*—Ensure that the locking lever is in the trip position and then secure the shutter to the gearbox with the two screws and spring washers. Turn the handle to operate the mechanism and note if the pinions are correctly meshed to the gap wheel. When the gap in the gear wheel frees the shutter pinions, see that the spring-loaded pawl engages and holds the shutter in the wound position. If the pinions mesh too deeply the fault will be felt when the handle is turned. The remedy for both the above faults is to slacken the two screws which retain the shutter to the gearbox and remove the two components with respect to one another until the correct position is found. Re-tighten the two screws.

48. *Protection and storage.*—The camera with its accessories, should as far as possible, be protected from rain, sand and dust. The regular use of a canvas cover for this purpose is strongly recommended. When not in use the camera must always be stored in the storage case provided. It must never be left with the lens pointing towards the sun.

49. *Cleaning and testing.*—Before every photographic flight, the camera should be tested and cleaned. After use, the camera should be thoroughly inspected and all dust and grease removed. Before the camera is placed in the storage case the exposure tension should be adjusted to the lowest setting and the shutter wound to the set position. Spare shutters that are detached from the gearbox should be similarly stored with the tension at the lowest setting and the main exposing blind wound on to the pinion roller, but held in this position by tying the pinion wheels together with tape.

50. *Weekly inspection.*—When the camera is in regular service, a careful weekly inspection of the mechanism should be carried out. Particular attention must be paid to the following points:—

- (i) Examine the gearbox and note that all electrical connections are perfectly clean and free from grease or oil.
- (ii) Examine the shutter blinds for the presence of pin holes or signs of wear.
- (iii) Examine the register glass and the lens combination, cleaning them when necessary with a selvyt cloth. It is important to ensure that the cloth is perfectly clean and free from dust or dirt that might scratch the surface of the glass. On no account must methylated spirit be used to clean the register glass since this will dissolve the pigment in the collimating marks.

51. *Renewal of register glass tilling strip.*—The black strip on the register glass which is provided to obtain a fair edge on the film suitable for tilling is liable to become chipped and uneven. When this occurs the strip should be cleaned off with aircraft dope solvent and a fresh strip painted on. When the old strip has been removed the glass should be thoroughly cleaned. A strip of black air drying enamel (Stores Ref. 33A/344) should then be applied along the edge next to the gearbox. Care should be taken to see that complete opacity is obtained. The enamel will take about 18 hours to dry. A straightedge must then be obtained and the enamel cut away with a sharp knife to within $\frac{1}{8}$ in. of the edge. Scrape or peel off the surplus enamel to leave a clean, straight edge.

52. *Lubrication.*—In tropical or semi-tropical countries inspection and lubrication must be carried out at more frequent intervals than is otherwise necessary, special care being taken to remove any sand that may have entered the mechanism. Cameras and equipment must not be left in strong sunlight for any long period and magazines should be shielded from the sun when being transported between flights.

53. Figs. 15 and 16 shown the lubrication points in the gearbox and magazine respectively, together with the times at which lubrication is necessary. Oil, lubricating, anti-freezing, type A (Stores Ref. 34A/43) only is to be used. This should be applied sparingly and any superfluous oil wiped off with a dry cloth. Care must be exercised to ensure that the electrical contacts are clean and free from oil.

54. For high altitude photography or when the camera is likely to be exposed to extreme cold, oiling should be kept to the minimum.

Chapter 2

CAMERA ELECTRICAL CONTROL, TYPE 35

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RESTRICTED

'A' LUBRICATE ONCE WEEKLY
 'B' LUBRICATE ONCE MONTHLY
 D — DO NOT LUBRICATE
 OIL — STORES REF. 34A/43
 ONLY TO BE USED

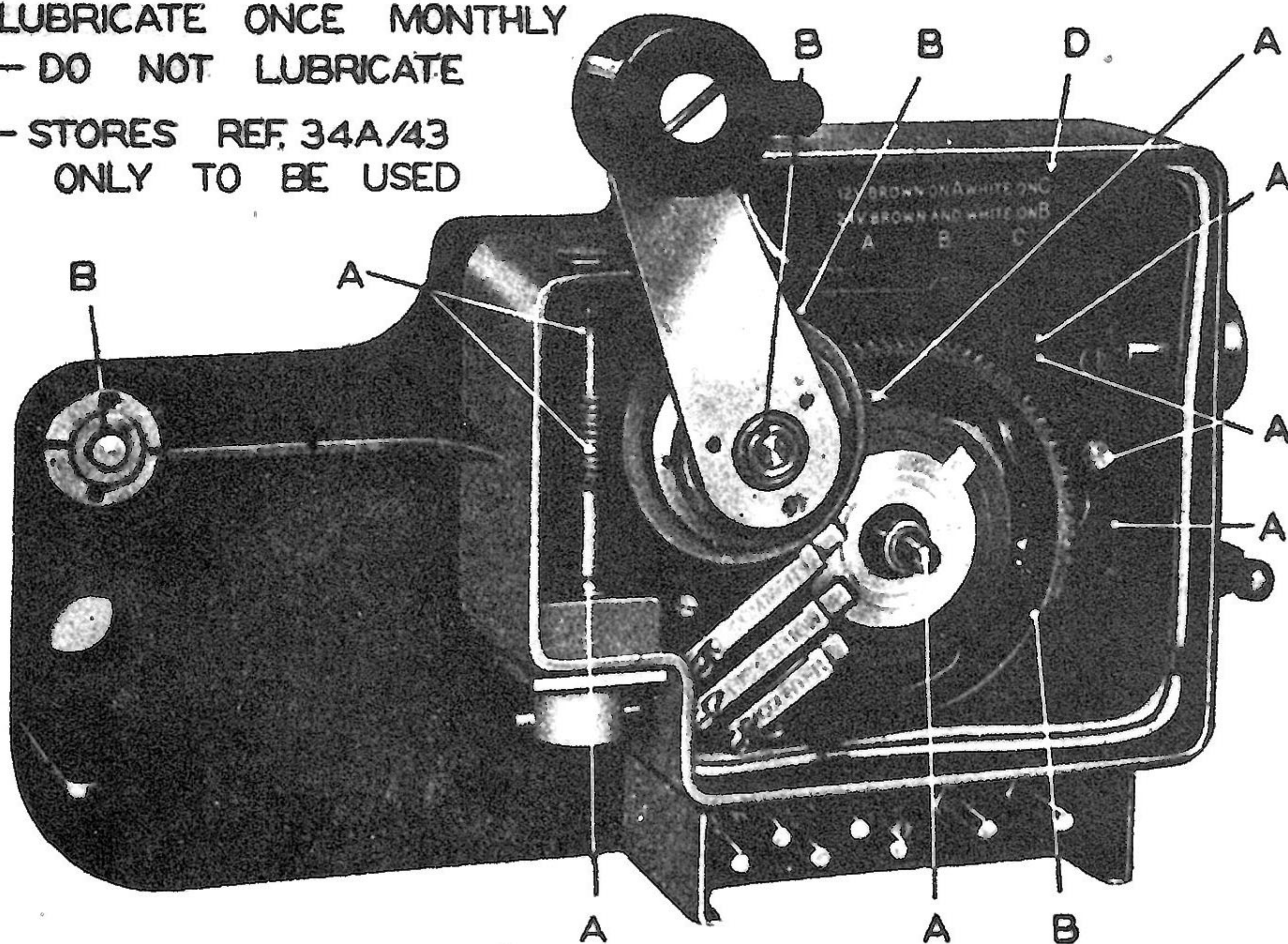
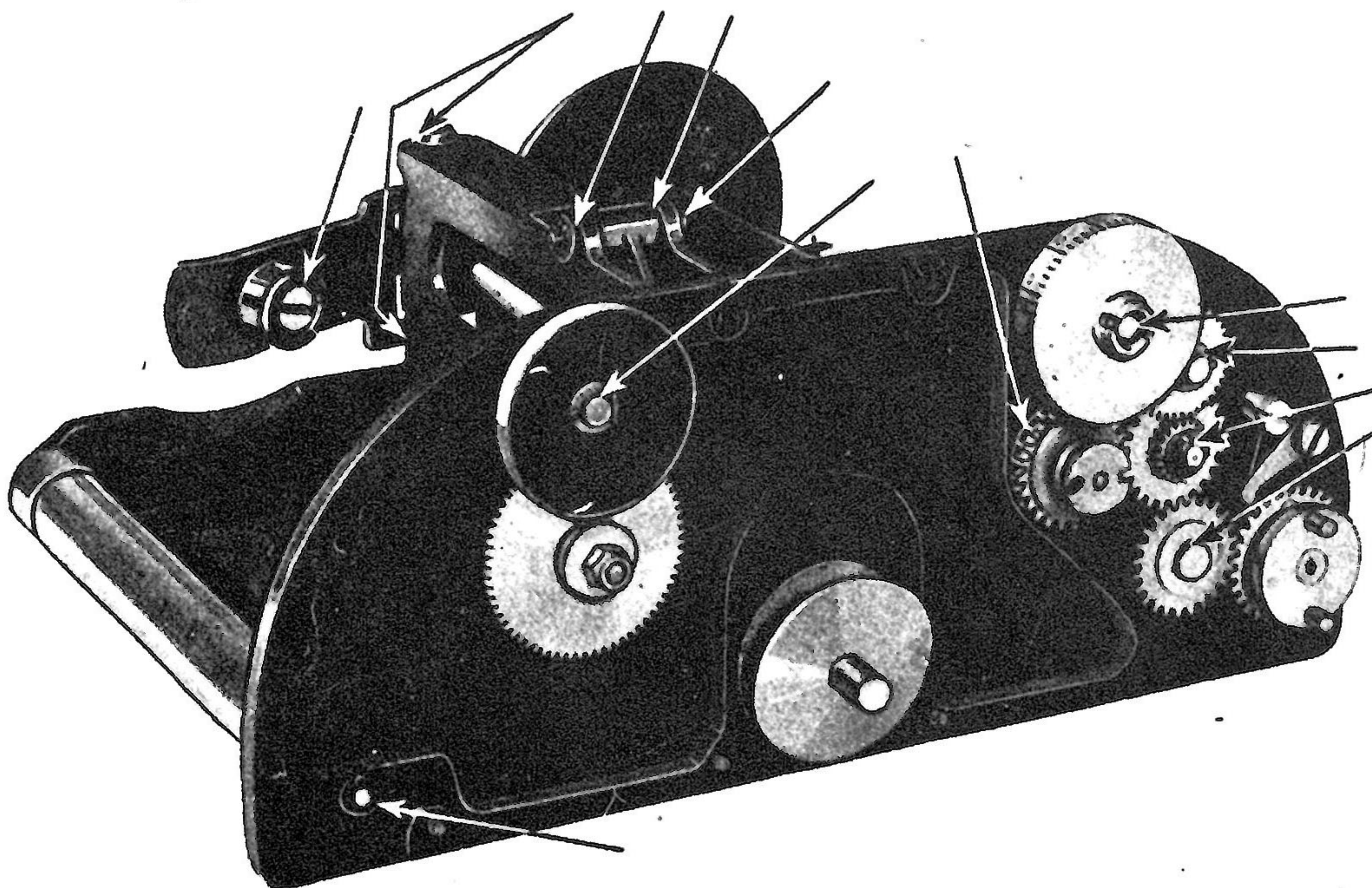


Fig. 15.—Lubrication of the gearbox



OIL ALL PARTS MARKED ← ONCE MONTHLY

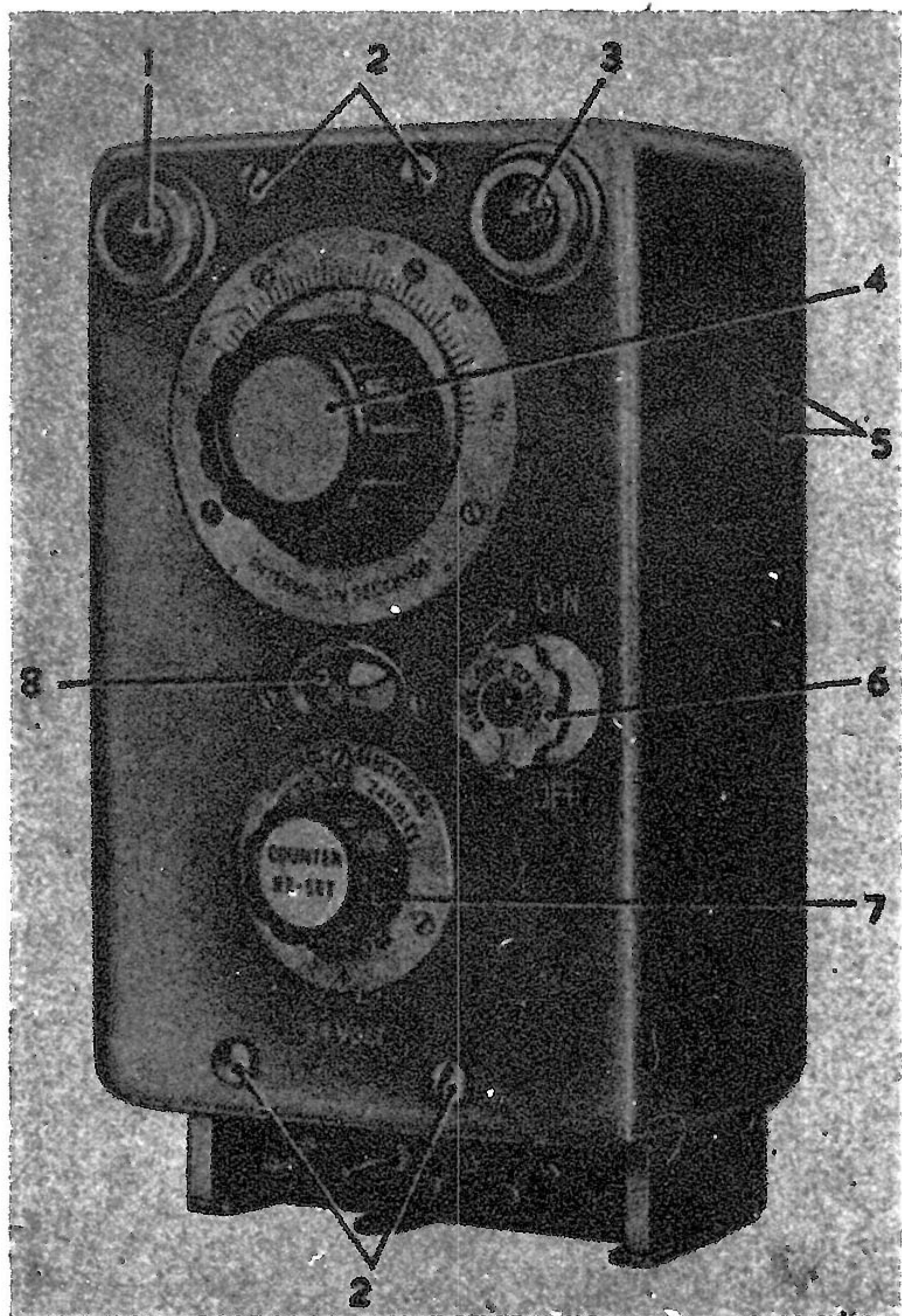
Fig. 16.—Lubrication of the magazine type A

Introduction

1. The camera electrical control, Type 35, is an electrically-driven chronometric switch mechanism which can be set to operate a camera at pre-determined regular intervals by completing the electrical circuit to the camera operating solenoid. The electrical circuit of the camera operating solenoid can also be completed by a manually operated push-switch provided on the control; thus it is possible to operate the camera for single exposures if required.

2. Where the control has been modified from the original design in order to suit it for a particular use, a new serial number has been allocated. A list of the current series of controls, Type 35, is given in Table 1; the odd numbers indicating that the control is suitable for 12-volt d.c. operation and the even numbers that it is suitable for 24-volt d.c. operation. The construction and operation of controls No. 7 and No. 8 is described, but the modified types are described only in so far as they differ from No. 7 and No. 8.

3. A description of a special camera electrical control, Type 48, intended for use during low altitude photography, is given in Chapter 3 of this section.



- | | |
|--------------------------|------------------------------------|
| 1 RED WARNING LIGHT | 5 HOLES FOR SOCKET CONNECTION |
| 2 SCREWS, COVER SECURING | 6 ON-OFF SWITCH CONTROL |
| 3 GREEN INDICATOR LIGHT | 7 EXPOSURE COUNTER RE-SETTING KNOB |
| 4 INTERVAL CONTROL KNOB | 8 WINDOW |

Fig. 1. Camera control, Type 35, No. 8

TABLE I

Concise details of camera controls, Type 35

| Control | Stores Reference including storage case | Voltage | Day or night use | Brief description |
|---------|---|---------|------------------|---|
| 7 | 14A/2209 | 12 | Day | Minimum interval 2 seconds Maximum interval 51 seconds Indicates number of exposures up to 99 |
| 8 | 14A/2210 | 24 | Day | Details as No. 7 |
| 8A | 14A/4020 | 24 | Day | Details as No. 8 but added "hundreds" dial enables number of exposures up to 699 to be indicated |
| 14 | 14A/2988 | 24 | Day | Details as No. 8 but switch includes solenoid; can therefore also be switched on by remote push-switch |
| 16 | 14A/2896 | 24 | Day | For use with distribution boxes Types 47 and 48. Details as No. 8 but wiring modified so that exposure counter circuit is completed by the control instead of by the camera |
| 16A | *14A/4014 | 24 | Day | Details as No. 16 but added "hundreds" dial enables number of exposures up to 699 to be indicated |
| 20A | 14A/3673 | 24 | Night | For bomb strike night photography with photographic flash, up to 25,000 feet. Operates for single cycle only, each time it is started manually or by push-switch. Provides five camera operating pulses during each cycle. Two scales (one for each of two types of fuzes) are calibrated in aircraft height and fuze time. |

* Excluding storage case

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CONTROL TYPE 35, No. 7 AND No. 8**DESCRIPTION**

4. Shown in fig. 1 is a control, Type 35, No. 8 (for 24-volt operation). Control, Type 35, No. 7 is identical but is for 12-volt operation. The control measures approximately $7\frac{7}{8}$ in. \times $4\frac{3}{8}$ in. \times $3\frac{1}{2}$ in. and consists of the following main parts which are described in para. 5 to 16.

- (1) Cover
- (2) Base
- (3) Escapement and interval timing mechanism
- (4) Exposure counter
- (5) Main on-off switch
- (6) Camera contacts unit
- (7) Electrical connections

Cover

5. The mechanism is enclosed by a rectangular box shaped aluminium alloy cover which can be seen in fig. 1, and which is secured to the base by four special long shank screws (2). These screws, which are held captive in the cover by split pins, pass through guide plates to threaded holes in the base plate. A red warning light (1) and a green indicator light (3), a large knob (4) which controls the interval between successive exposures, the exposure counter re-setting knob (7) and the on-off switch control (6) protrude through holes in the cover. A scale, graduated in seconds, surrounds the hole through which the interval control knob protrudes. The details such as the Stores Reference, the nomenclature and the serial number appear on a circular plate which surrounds the hole for the exposure counter re-setting knob. In the centre of the cover is a window (8) through which may be seen a tell-tale disc which rotates when the control is in operation. Two small holes (5) in the side of the cover allow an external socket and lead to be connected to a 2-pin plug fitted to the base of the control.

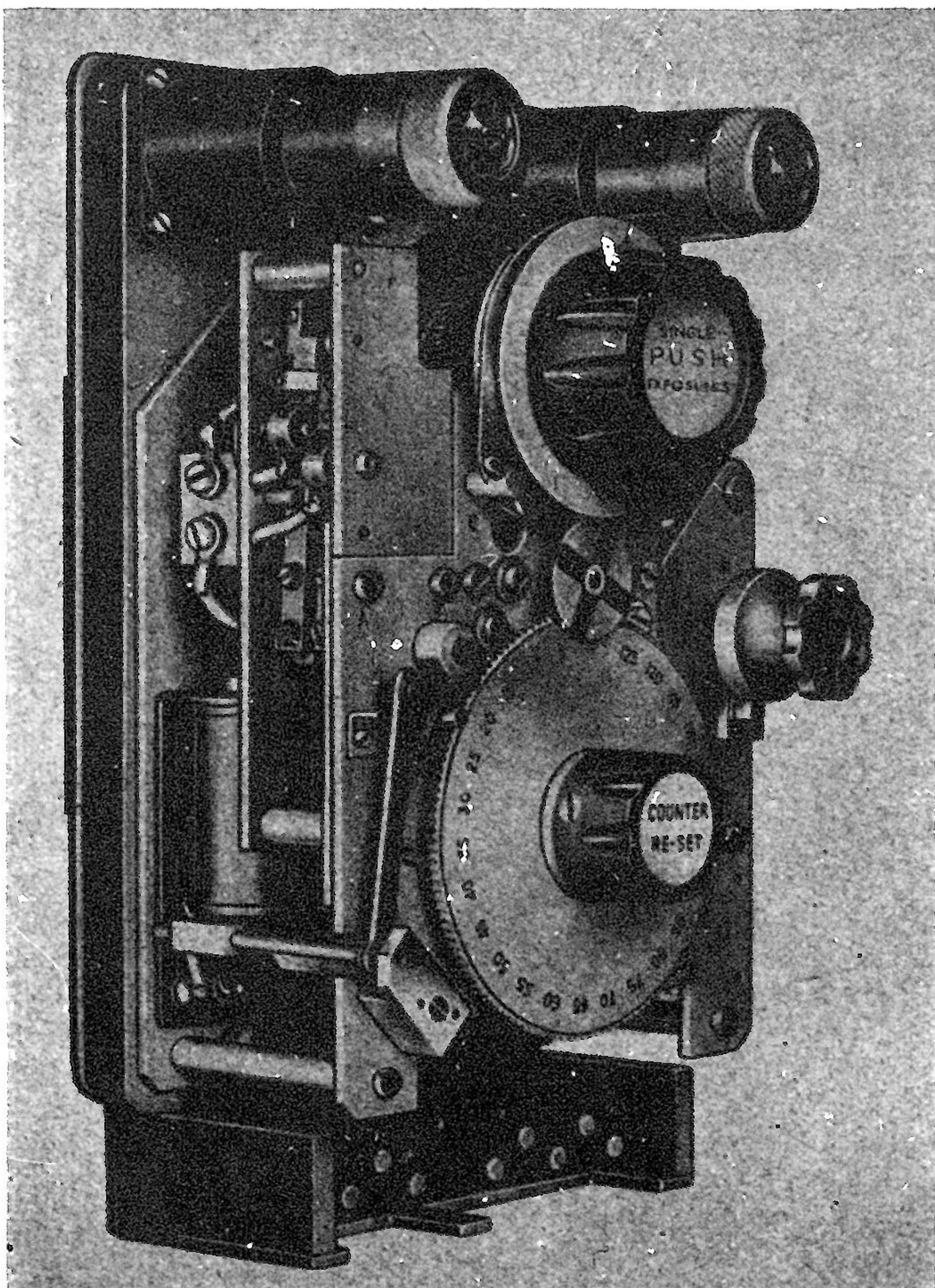


Fig. 2. Camera control, Type 35, No. 8 with cover removed

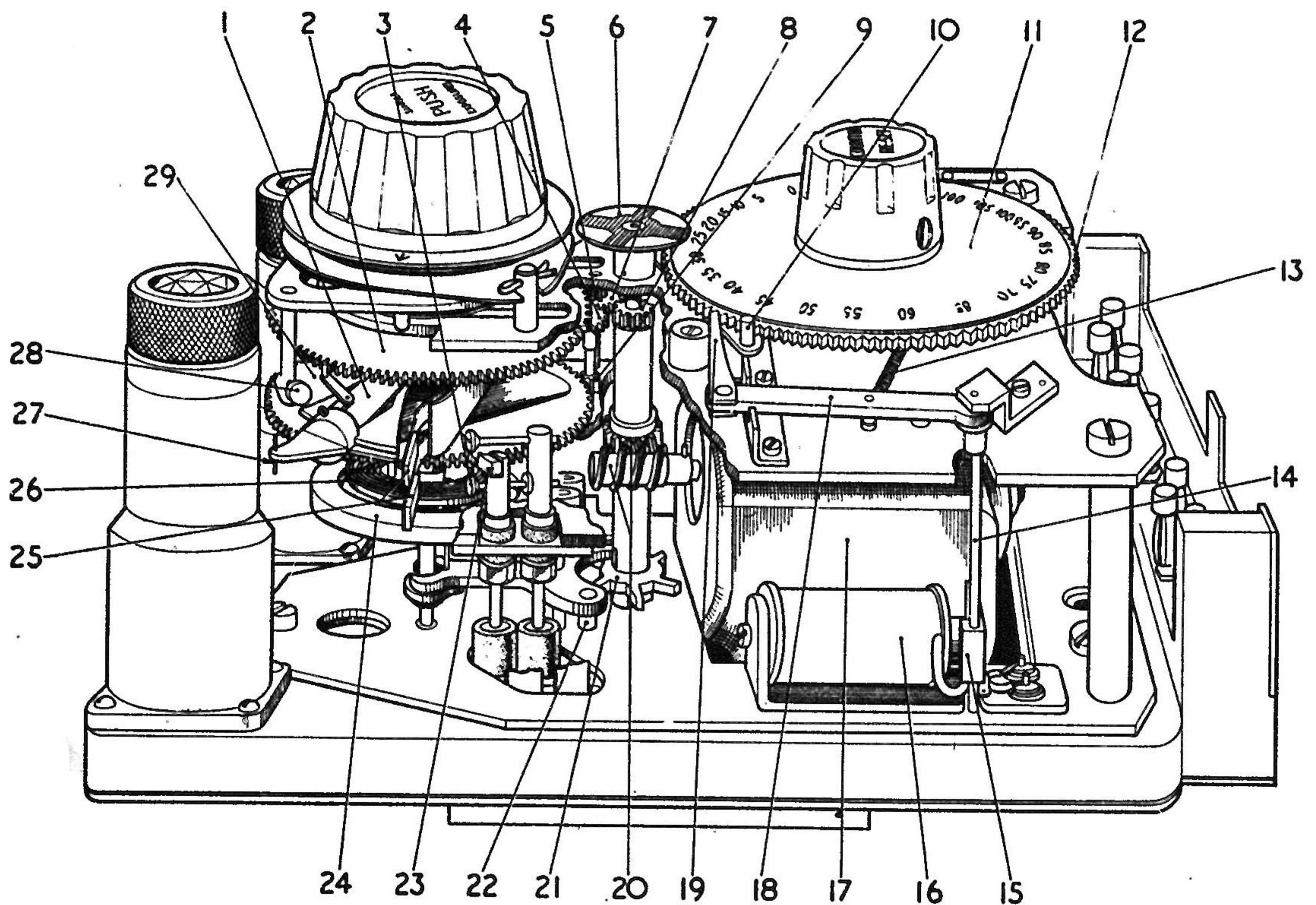
Base:

6. The base on which the mechanism is mounted, is of cast aluminium and is shaped at one end to form a housing for a 3-pin and a 5-pin plug. At the other end of the base are two pillars, one in each corner and each containing a warning light. A flat plate which is secured to the underside of the base casting by six screws, covers the electrical wiring. To enable the control to be secured to the standard wedge plate, a wedge fitting is provided at the back of this plate.

Escapement and interval timing mechanism

7. The mechanism is driven by a 12-volt or 24-volt shunt wound motor which runs

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- | | | | |
|----|---------------------------------|----|---------------------------------|
| 1 | RADIUS ARM | 16 | SOLENOID |
| 2 | LARGE GEAR WHEEL (TIMING WHEEL) | 17 | MOTOR |
| 3 | WARNING LIGHT CONTACTS | 18 | EXPOSURE COUNTER OPERATING ARM |
| 4 | SPUR WHEEL | 19 | PAWL |
| 5 | RELAY PINION | 20 | WORM AND WORM WHEEL |
| 6 | TELL-TALE DISC | 21 | ESCAPE WHEEL |
| 7 | SPUR WHEEL | 22 | PELLETS |
| 8 | PINION | 23 | FIXED STOP |
| 9 | RELAY PINION | 24 | BALANCE WHEEL |
| 10 | SPRING CATCH | 25 | SPRUNG CONTACTS |
| 11 | EXPOSURE COUNTER DIAL | 26 | HAIRSPRING |
| 12 | TOOTHED EXPOSURE COUNTER WHEEL | 27 | WIPING PIN |
| 13 | SPRING | 28 | ADJUSTABLE STOP |
| 14 | TORQUE ROD | 29 | LARGE GEAR WHEEL (TIMING WHEEL) |
| 15 | ARMATURE | | |

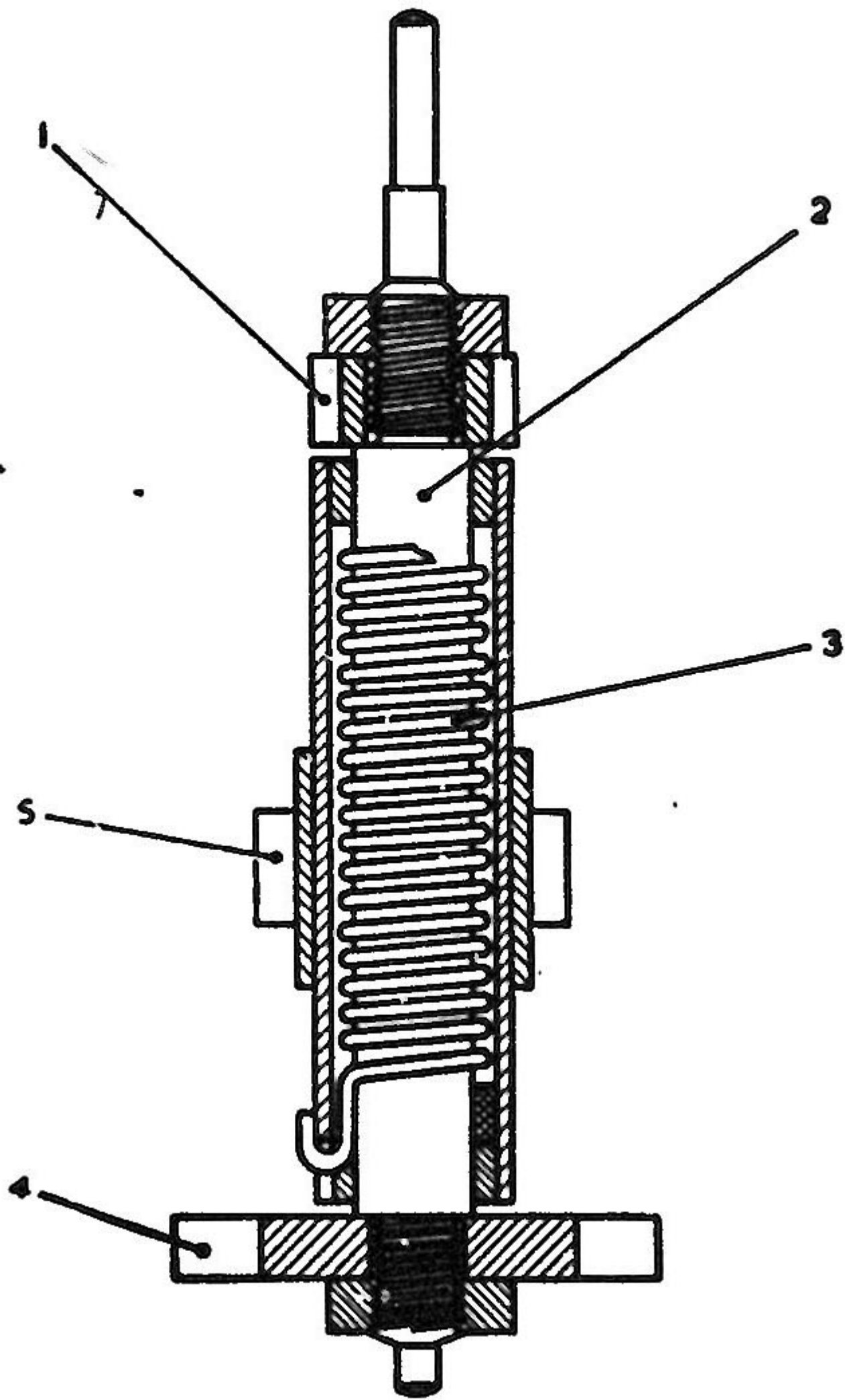
Fig. 3. Camera control, Type 35, cut-away view showing arrangement of mechanism

continuously at approximately 3,500 r.p.m. when the on-off control is turned to the ON position. This motor is coupled by a spring friction drive to an escapement and interval timing mechanism, which at the appropriate time completes the electrical circuit to the camera operating solenoid. The arrangement of the mechanism is shown in fig. 3.

8. The motor (17) is coupled to the external sleeve of a spring friction drive by means of a worm and worm wheel (20) (a sectional view of the spring friction drive is given in fig. 4).

Directly coupled to the internal spindle of the friction drive is an escape wheel (21), which engages with pellets (22) which in turn operate a balance wheel (24). By means of this escapement mechanism, which is designed to give 240 beats a minute, the spindle of the friction drive is prevented from rotating at motor speed and its speed of rotation is regulated to 20 r.p.m., the motor being allowed to overrun by means of the spring clutch. A tell-tale disc (6) is fitted to a collar on the top end of the friction drive spindle. This disc, on which is marked a

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- | | |
|-------------------|----------------|
| 1 PINION | 4 ESCAPE WHEEL |
| 2 CENTRAL SPINDLE | 5 WORMWHEEL |
| 3 SPRING | |

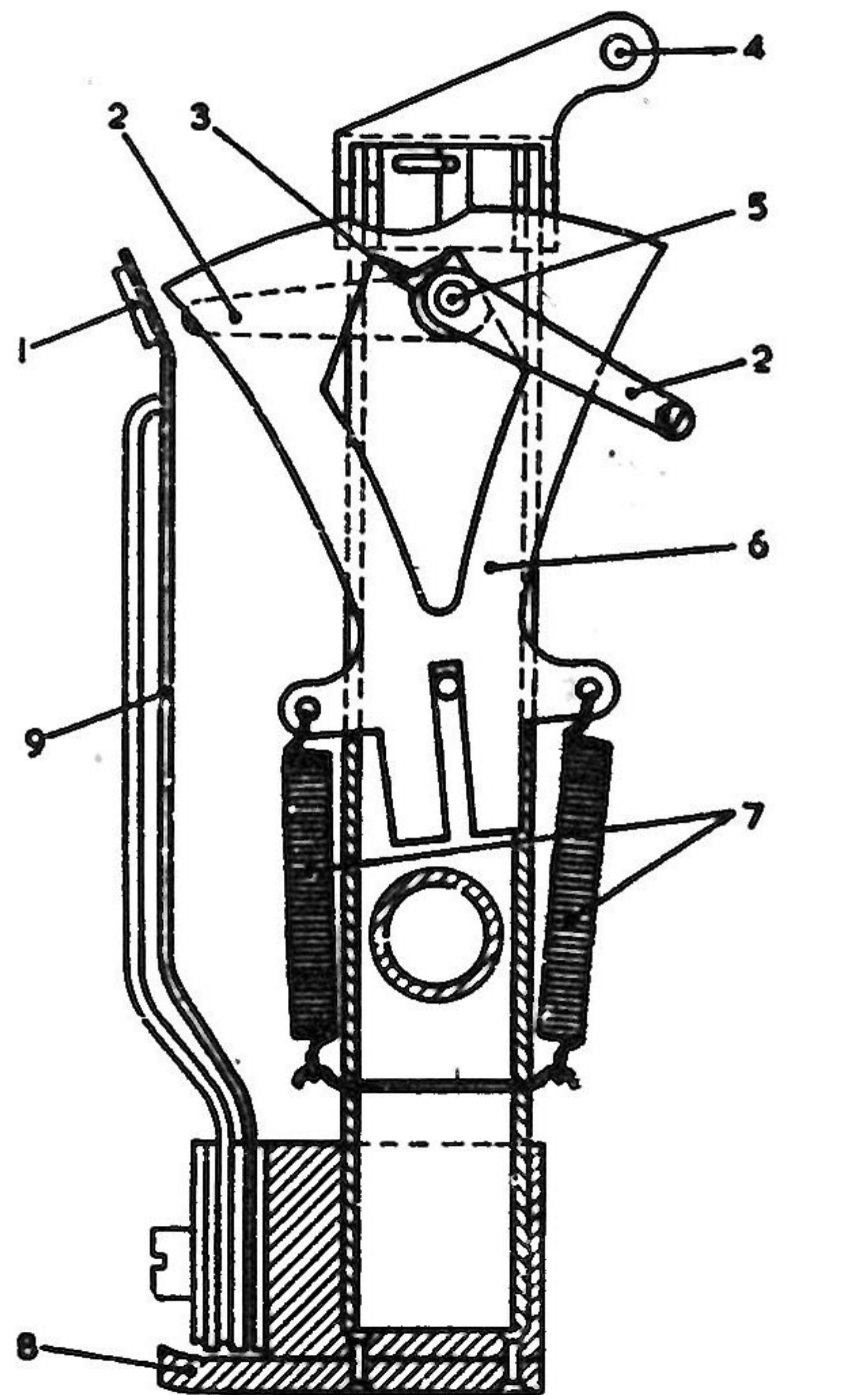
Fig. 4. Spring friction drive, sectional view

black cross, is visible through a window in the cover and indicates when the control is in operation.

9. Mounted on the spindle of the friction drive below the tell-tale disc, is a pinion (8) which drives a spur wheel (7). Above the spur wheel and on the same spindle is a relay pinion (5) which meshes with a large gear wheel (2). The spur wheel (7) also meshes with a second spur wheel (4), the spindle of which has at its lower end a second relay pinion (9). This relay pinion engages with a second large gear wheel (29). The two large gear wheels, known as timing wheels, are driven in opposite directions at constant speed, the upper wheel rotating anti-clockwise and the lower wheel clockwise when looking from the front of the control.

10. Between the timing wheels, and mounted on the same axis, is a radius arm (1) which carries two contacts (25) mounted on a sprung arm at its side and also a small wiping pin (27) at its end. When the radius arm reaches the appropriate positions, the sprung contacts, which are connected

together, complete the red warning light circuit by bridging fixed contacts (3), and the small contact pin closes the sprung contacts in the circuit of the camera operating solenoid. Referring to the sectional view of the radius arm given in fig. 5, it can be seen that a small spindle (5), which passes through the radius arm, carries catch claws (2) at each end, and has a heart shaped cam (3) rigidly fixed to its centre. The position of this cam, and hence the position of the catch claws, is governed by a trip plate (6) which rests in a slot in the radius arm and is at right angles to the small spindle. The trip plate is pivoted near its lower end and two helical springs (7) retain it in either of two positions, as dictated by stops which limit



- | | |
|--------------------|-------------------|
| 1 SPRUNG CONTACTS | 6 TRIP PLATE |
| 2 CATCH CLAWS | 7 HELICAL SPRINGS |
| 3 HEART SHAPED CAM | 8 SHOE |
| 4 PIN | 9 SPRING ARM |
| 5 SPINDLE | |

Fig. 5. Radius arm, sectional view

the movement of the radius arm. Referring again to fig. 3, it can be seen that the position of one of these stops is adjustable. The stop (28) is rivetted to the underside of a metal disc which is fitted over an extension

of the timing shaft and screwed to the under surface of the interval control knob. The metal disc, on the upper surface of which is engraved an arrow, is held friction-tight by a flat spring. Thus, the position of this stop can be varied radially by rotating the interval control knob. The second stop (23), which is fixed, is mounted on a small ebonite block attached to a pillar supporting the warning lamp contacts. When the interval control knob is turned, the distance between the trip pins, and therefore the time taken by the radius arm to travel from the fixed pin back to it, is altered. A particular time in seconds may be selected by setting the arrow on the disc fitted to the base of the interval control knob, to the appropriate mark on a scale engraved on a circular plate surrounding the knob. This scale is graduated in intervals of one second between limits of 2 and 51 seconds. Within the interval control knob which is shown cut-away in fig. 6 is a push button (2) which is spring mounted on the timing shaft. At its lower end the push button has a flanged bush (3) which, when the button is depressed against the action of the spring (1), bridges a pair of contacts (4) and closes the camera operating circuit. By this means, a single exposure can be made at any time, but the pilot has no warning that such a photograph is about to be taken.

Exposure counter

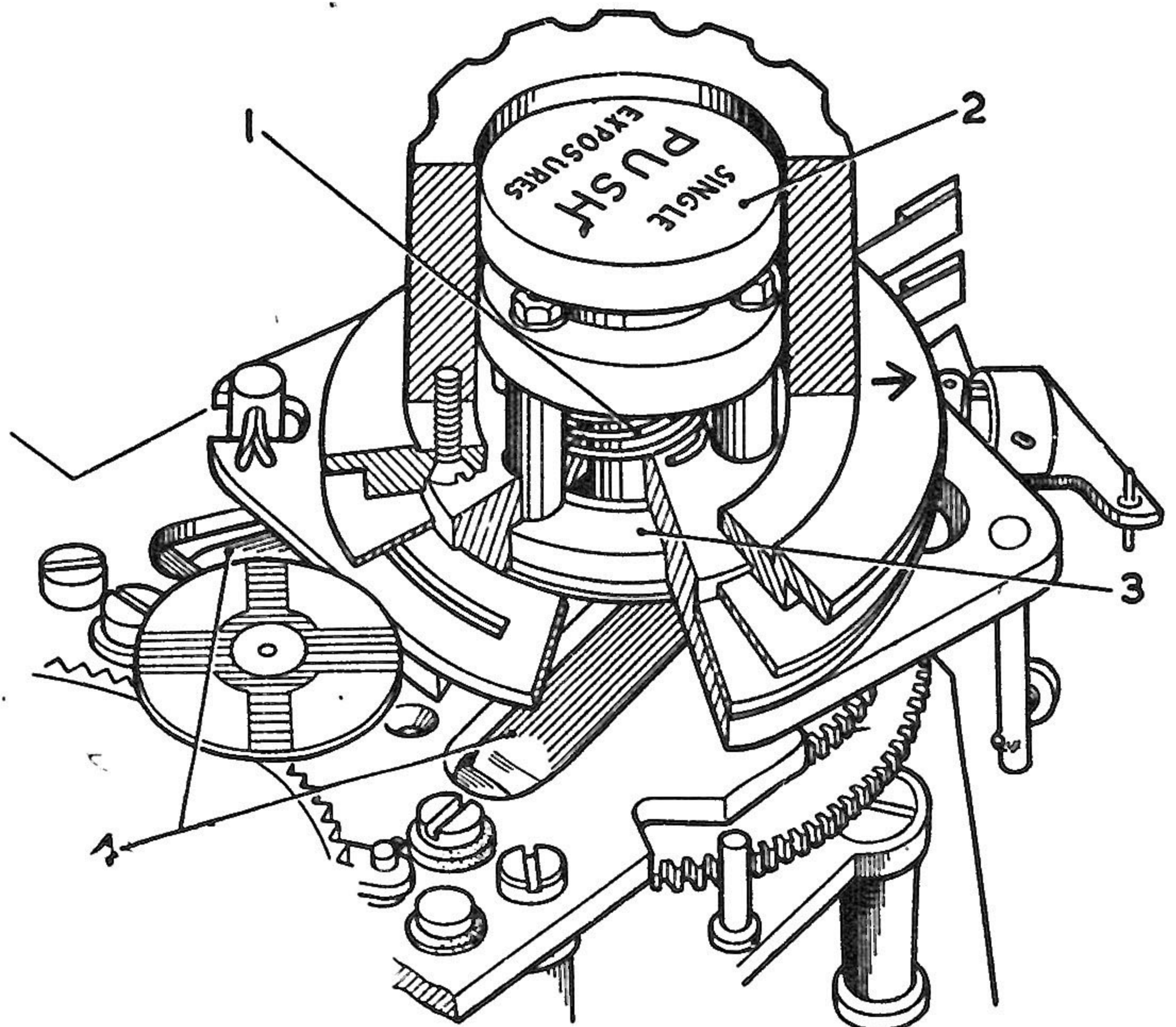
11. The following description of the exposure counter can be followed by reference to fig. 3. A spindle is supported in a fixed bearing in the top plate immediately above the motor. Mounted on this spindle and free to rotate thereon, is a brass boss, to a flange on which, by means of three countersunk screws, is secured a counter dial (11). The periphery of this dial is engraved with evenly spaced lines each representing an exposure; the lines being numbered in multiples of five, from 0 to 125. The figures and the divisions are visible through a window in the cover. A toothed counter wheel (12) is carried below the flange of the boss on a reduced diameter and is held in contact with the dial by a plate spring, which engages in a slot in the boss. This assembly is retained by a split pin which

passes through the top end of the shaft. A knob for re-setting the counter dial is secured to the boss by a countersunk screw and protrudes through a hole in the cover.

12. A pawl (19) which engages in the teeth of the counter wheel, is attached to the end of an operating arm (18) by a pin. The other end of the operating arm is secured to a torque rod (14) which is supported between a bearing bracket attached to the top plate and a bearing in the baseplate. Both the pawl and the operating arm are tensioned by springs. Fixed to the lower end of the torque rod is a rectangular armature (15) which, when attracted by the solenoid (16) partly rotates the torque rod and pulls the operating arm against the tension of the spring (13). When the solenoid is de-energised, the spring returns the arm to its original position and the pawl carries the counter wheel forward one tooth. The counter wheel is prevented from rotating in an anti-clockwise direction by a spring catch (10) which engages the teeth of the wheel.

Main on-off switch unit

13. The main on-off switch, which is illustrated in fig. 7, is so designed that when the control is at rest and the switch is in the OFF position, a shoe at the end of the radius



1 SPRING 2 PUSH BUTTON 3 FLANGED BUSH 4 CONTACTS

Fig. 6. Interval control knob, cut-away view

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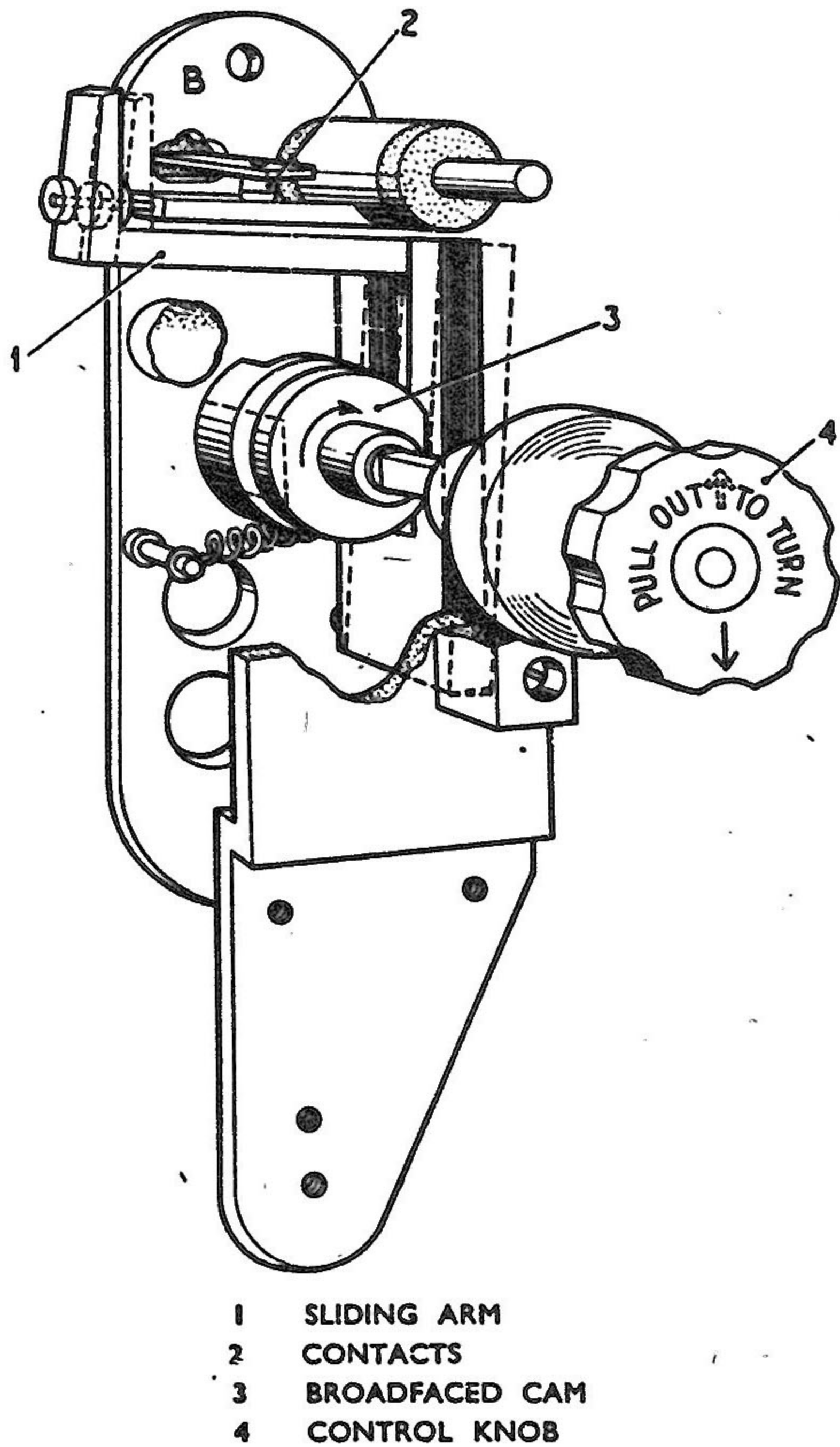


Fig. 7. Main on-off switch unit

arm presses on a sliding arm (1) and keeps apart the contacts (2) which are in the motor circuit. When the switch control (4) is turned to the ON position, the spring loaded sliding arm is allowed to return clear of the shoe at the end of the radius arm, the contacts close and the motor commences to drive the mechanism.

14. When the switch control knob is turned to the OFF position while the control is in operation, a broadfaced cam (3), which is fixed to the same shaft as the control knob, presses forward the sliding arm, but the contacts remain closed and the radius arm continues to move. However, when the shoe at the end of the radius arm meets the now extended sliding arm, it presses against the latter, the contacts are separated and the motor stops. By this arrangement, the radius arm always stops in the same position regardless of its position at the time of

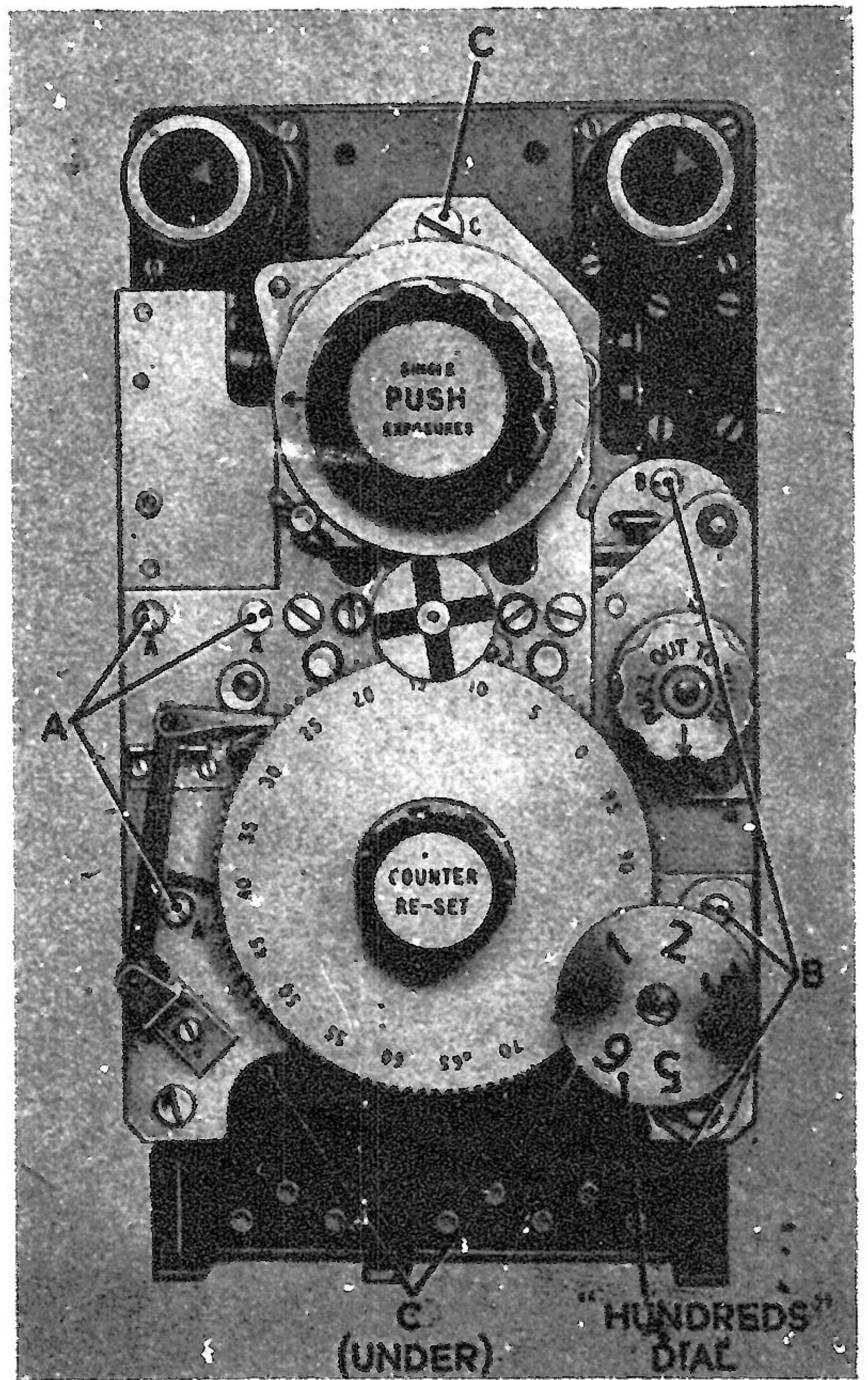


Fig. 8. Camera control, Type 35, No. 8A or 16A with cover removed showing "hundreds" dial and position of screws marked "A" "B" and "C"

switching off. The switch unit can be removed by unscrewing the screws marked B, fig. 8. The action of this switch is shown pictorially in fig. 12.

Camera operating contacts unit

15. The camera operating contacts unit which is shown in fig. 9, consists of two rocker arms each under spring tension and bearing contacts which are connected in the circuit of the camera operating solenoid. The unit is so arranged that as the spring metal strips at the end of the rocker arms are wiped by the pin at the end of the radius arm, the rocker arms are moved and the contacts are brought together by a sliding action. As a result of this sliding action the contacts are self cleaning. When the spring metal strips, and therefore the rocker arms, are

released from the pressure exerted by the pin at the end of the radius arm, the rocker action quickly parts the contacts and the circuit is broken. By unscrewing the three screws marked A (fig. 8), the unit can be removed easily.

Electrical connections

16. Electrical connections to the control are made by means of two sockets which connect respectively with 3 pins and 5 pins of the plug on the base. The circuit diagram of controls No. 7 and No. 8 together with the external camera circuits are shown in

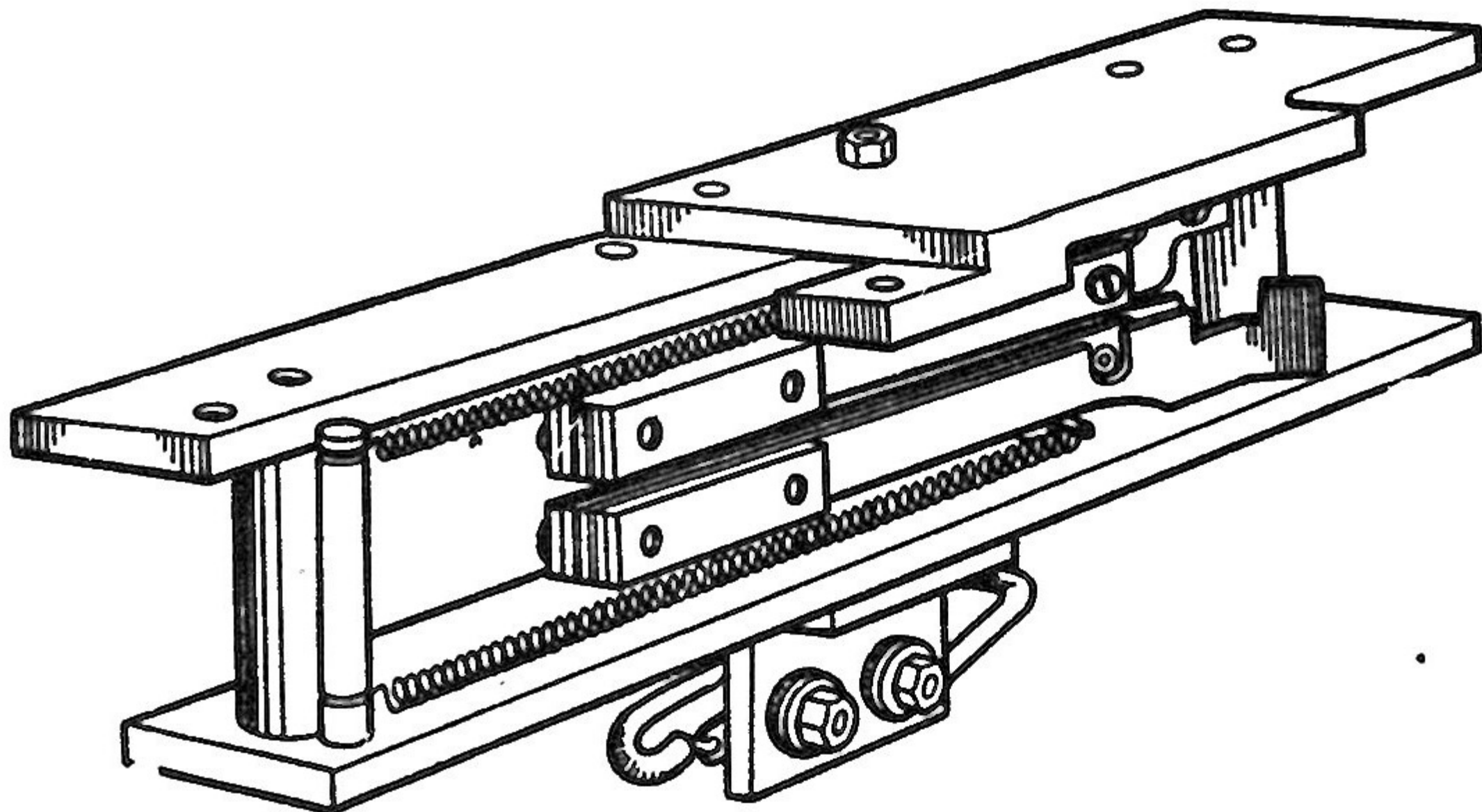


Fig. 9. Camera operating contacts unit

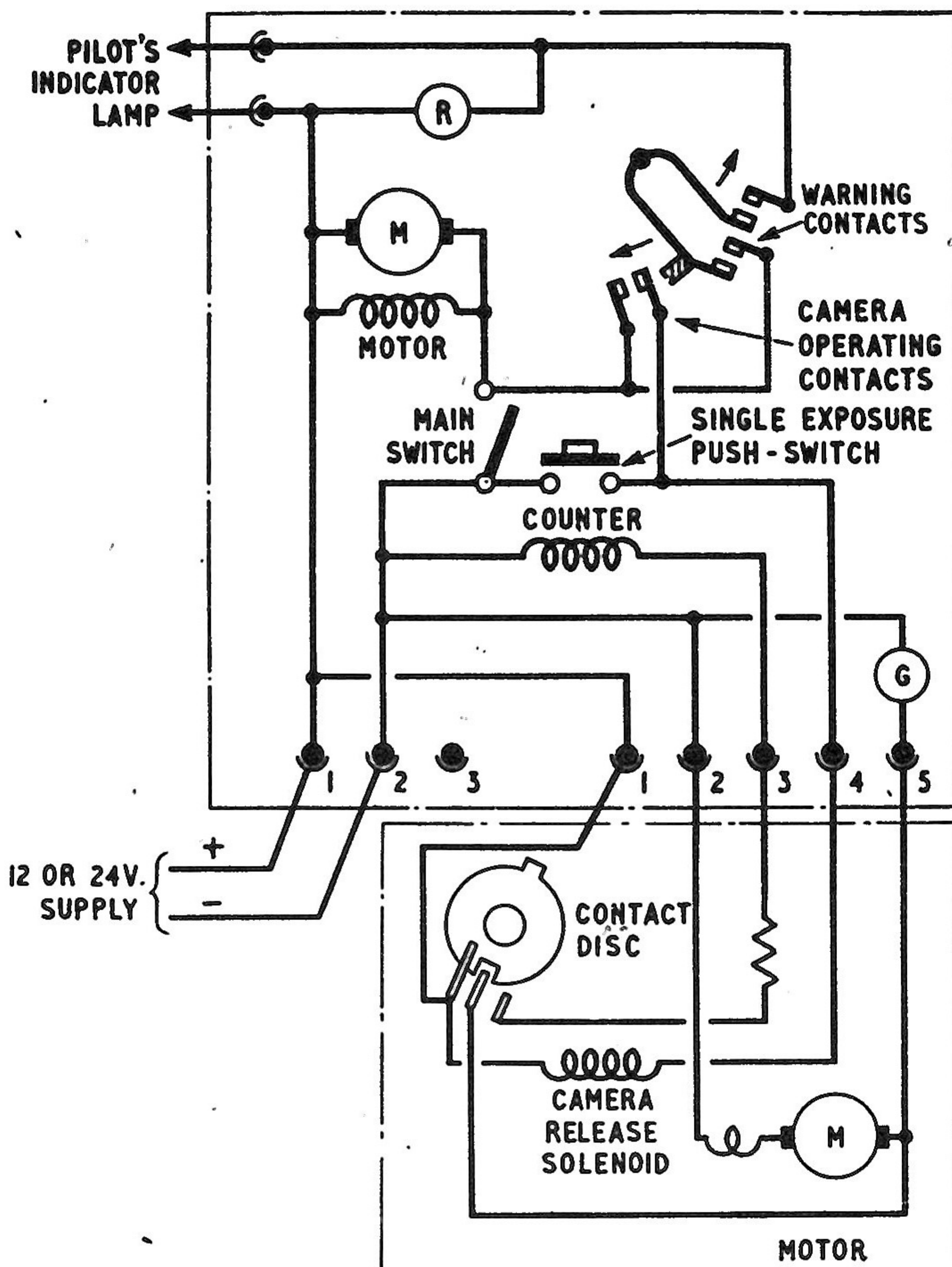


Fig. 10. Circuit diagram, camera controls, Type 35, No. 7, No. 8 and No. 8A

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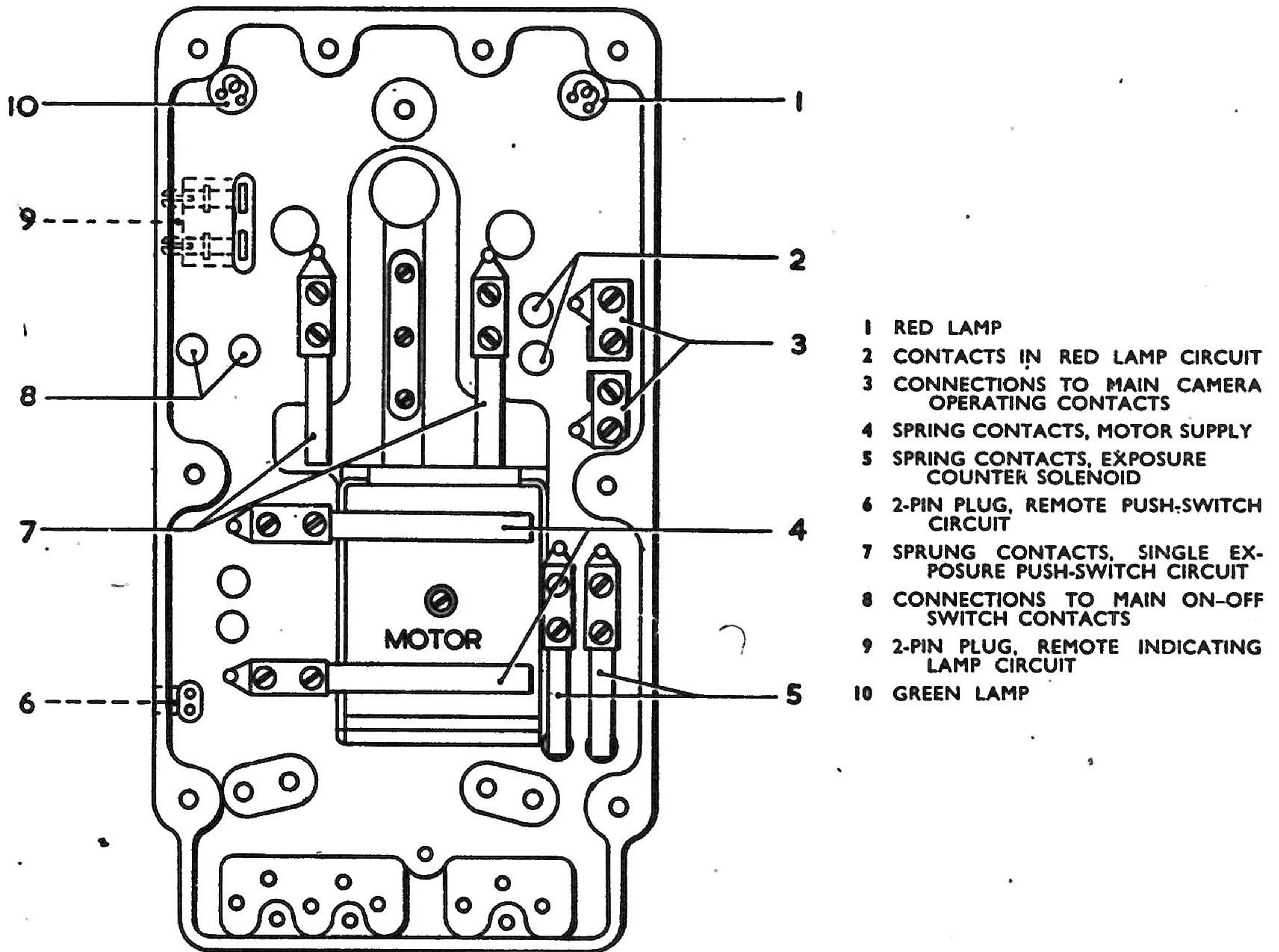


Fig. 11. Camera control, Type 35, backplate removed showing connecting points for wiring

fig. 10, the connecting points for the wiring, visible when the backplate is removed, being identified in fig. 11. To facilitate the removal of units from the base plate, the contacts associated with the motor, the single exposure push button and the exposure counter, consist of spring metal strips which make contact with the components through holes in the base plate. A plug is fitted to the base and its two pins are wired in parallel with the red warning light. This plug may be connected to a remote warning light by means of a socket and external lead, suitable holes being provided in the side of the cover to allow plug and socket connection.

OPERATION

17. In the following description of the operation of the control, the figures in parenthesis refer to the annotation in fig. 3. The action can be followed by reference to fig. 12. When the control is switched on,

the sliding arm in the on-off switch unit withdraws, due to spring tension, free of the shoe at the bottom end of the radius arm, the switch contacts close and the motor drives the upper and lower timing wheels (2 and 29) in opposite directions. The spring friction drive and escapement mechanism (21 and 22) maintains the speed of rotation constant at 20 r.p.m. As the timing wheels commence to rotate, the lower catch claw, which is engaged in a tooth of the lower wheel, is carried round in a clockwise direction taking the radius arm with it. When the trip plate in the radius arm is forced against the stop (28) the position of which can be changed by the interval control knob, the plate is forced over to its alternative position thereby rotating the small heart shaped cam (3, fig. 5) and the two catch claws. The lower catch claw is disengaged from the lower timing wheel while the upper claw engages the upper timing wheel and is carried, with the radius arm, in an anti-clockwise direction.

When the contacts (25) on the sprung arm at the side of the radius arm reach the contacts in the red warning lamp circuit (3), they complete the circuit and maintain it for 4 seconds. At the same time, the wiping pin (27), at the end of the radius arm, passes under the spring metal strips at the ends of the rocker arms but does not move the latter. Thus, the main contacts on the rocker arm, which are in the circuit of the camera operating solenoid, are not closed. Two seconds after the red warning light has been lit, the radius arm reaches the limit of its travel and the trip plate is moved into its other position by being forced against the fixed stop (23). Thus, the upper catch claw is disengaged from the timing wheel while the other claw is engaged in the lower timing wheel and the arm begins another cycle by moving anti-clockwise. Approximately $1\frac{1}{2}$ seconds after the new run has commenced (i.e., approximately $\frac{1}{2}$ second before the red warning lamp circuit is broken) the pin at the end of the radius arm presses on the spring metal strips at the ends of the rocker arm of the main contacts unit, the rocker arms move and the contacts, which are in the camera operating circuit,

are closed for between 0.4 and 0.75 seconds. When the camera drive motor is energized the green lamp lights since it is wired in parallel with the motor, and remains lit until the motor stops, i.e., until the shutter has been reset and the film wound over. Approximately half way through the cycle of operations of the camera, a tongue on the contact plate in the camera gearbox makes contact with the sprung contact arm connected in the exposure counter solenoid circuit and completes the circuit. The solenoid (16) which is in the control, Type 35, attracts the armature (15) and by means of the torque rod, operating arm and pawl assembly, the movement is transferred to the toothed counter wheel (12) which is moved forward one tooth. The control continues to operate the camera at regular intervals until switched off and, since the minimum time interval at which the control can be set is 2 seconds, and the red warning light is lit 4 seconds before each exposure, it follows that when the control is set for an interval less than 4 seconds, the red warning lamp remains lit continuously until the control is switched off.

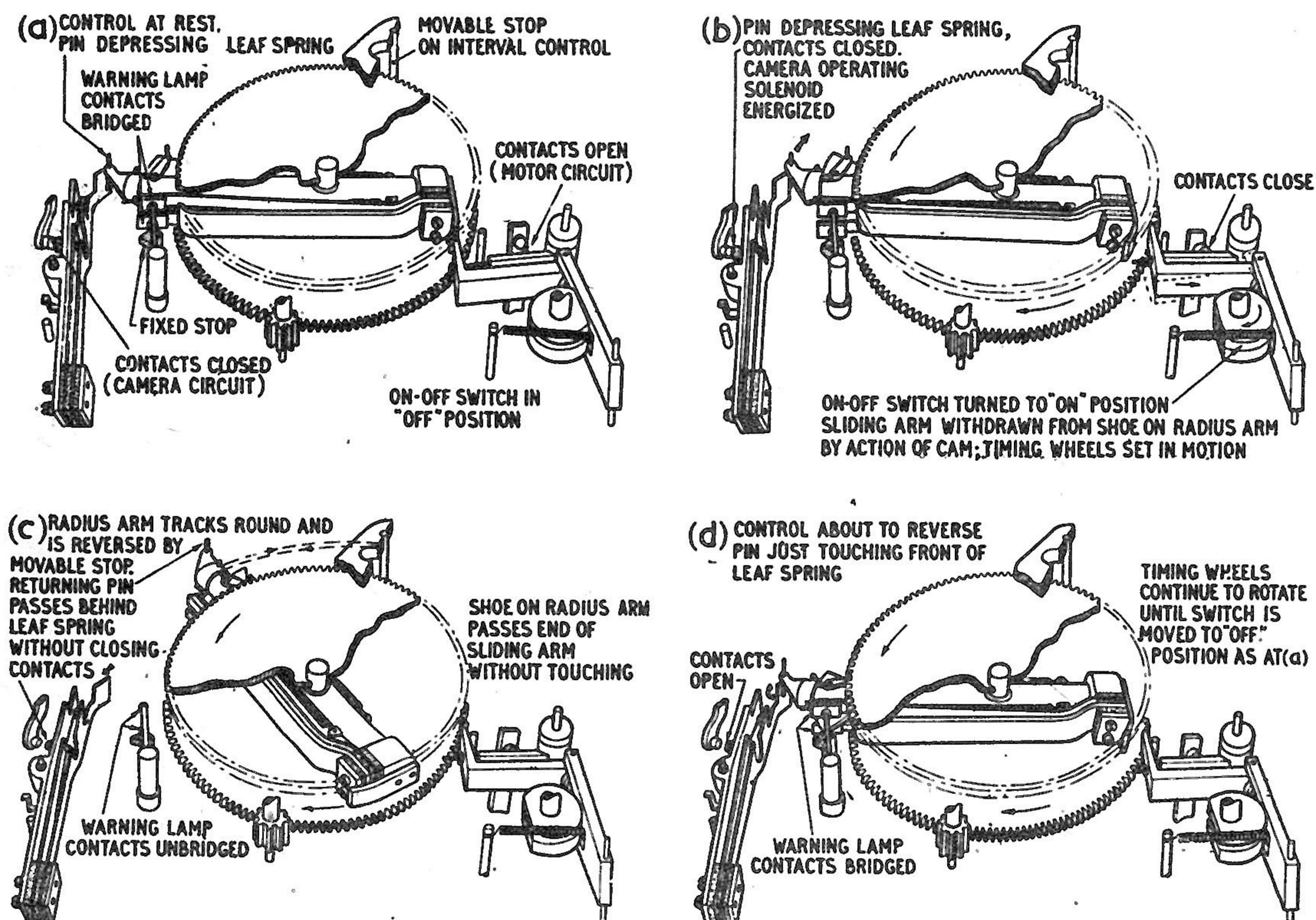


Fig. 12. Action of radius arm, on-off switch unit and camera operating contacts unit, camera control, Type 35, No. 7, No. 8 and No. 8A

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