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Airborne Photographic Equipment

A comprehensive line of integrated elements is offered for aerial surveying and mapping.

(*Abstract on page 974*)

INTRODUCTION

IN MOST PHOTOGRAMMETRIC PROJECTS, it is the flight crew that holds the rough end of the stick. As Murphy's First and Second Laws* are operative in the air more than on the ground, it is extremely fortunate for chair-borne photogrammetrists back at headquarters that mapping organizations always have a pilot who can fly "by the seat of his pants" and a navigator with a photographic memory for coming back on the next strip with just the right lateral overlap. In an attempt to take some of the skillful guesswork out of this fortuitous procedure, Wild has recently brought out a *Navigation Sight* called the Wild NF1.

During the development of this instrument, advantage was taken of the new opportunity to provide remote control of essential camera functions from the navigator's seated position at the new Sight. This in turn led to the development of a new motorized camera mount, the *Wild PAV2 Universal Mount*, which is designed to carry the versatile *RC8 Automatic Film Camera*, the *RC9 Super Wide Angle Camera* and also the *HC1 Horizon Camera*. Finally, the *RST2 Recording Statoscope* is available for use with the RC8 and RC9 camera types.

The whole group together forms an uncomplicated but flexible and complete equipment integrated for obtaining near-vertical photographs and the correlated auxiliary data for photogrammetric purposes.

† Presented by Mr. Kenneth Reynolds at the Annual Convention of the American Society of Photogrammetry in Washington, D. C., March 1965.

* Murphy's First: What can go wrong will go wrong.

Murphy's Second: What has gone wrong must get worse.

THE CAMERAS

The RC8 and RC9 Cameras form the core of this airborne equipment, of course. They are well and widely known, hence only short descriptions of the more important features are indicated here.

The Wild RC8 Automatic Film Camera (Figure 1) consists of the following standard parts:

1. Mount.
2. Drive unit.
3. Viewfinder telescope.
4. One of four interchangeable lens cones.
5. Magazines corresponding to the lens cone format, and lastly.
6. The control box.

The standard RC8 mount is not used with the combination described, it being replaced by the Universal Mount. Regarding the drive unit, it should perhaps be pointed out that this is separate from the optical unit itself. The interchangeable lens cones are available with the following lenses for 90° and 60° photography with different emulsions:

- The 6-inch Universal-Aviogon, $f/5.6$, $f=6$ inches, format 9×9 inches, with high-speed rotrary shutter and with filters suitable for photography on panchromatic, infrared, color and false color emulsions. The angular field is 90°.
- The 6-inch Universal-Aviogon R, with a glass focal plane reseau plate engraved with crosses at 10 mm. intervals; otherwise this lens cone has the same properties as the Universal-Aviogon.
- The smaller Aviogon $f/5.6$, $f=115$ mm., format 7×7 inches, angular field 90°, corrected for pan and color photography.
- The Aviotar $f/4$, $f=210$ mm., format 7×7 inches, angular field 60°, for pan and color.

The viewfinder telescope is not necessary if the RC8 is used with the complete equipment, since its functions are taken over by the Navigation Sight. A vacuum pump is now available for film flattening, but this is not needed if the Reseau lens is used.

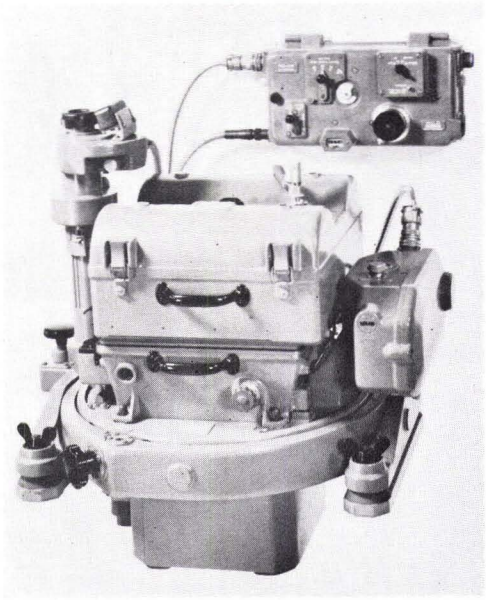

FIG. 1. The RC8 Automatic Aerial Film Camera.

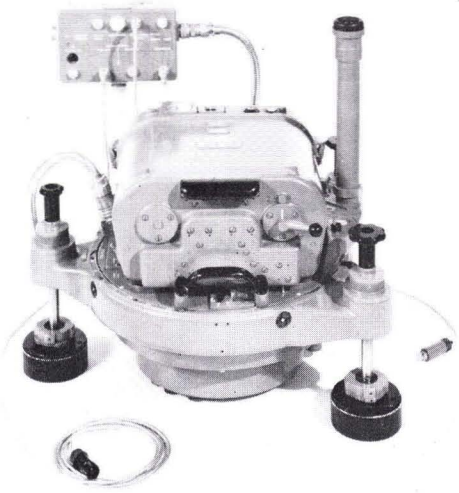

FIG. 2. The RC9 Super-Wide Angle Aerial Camera.

The Wild RC9 Super-Wide Angle Camera (Figure 2) is built on principles different from the RC8 since it uses daylight-loading cassettes instead of RC8-type magazines. The RC9 is equipped with either the Super-Aviogon $f/5.6$ lens which is corrected for panchromatic and color photography, or the Super-Infragon $f/5.6$, the optical units being non-interchangeable. Both lenses have a focal length of 88.5 mm. (i.e. $3\frac{1}{2}$ inches) for a 9×9 inches format and the field is therefore 120°. The RC9 also fits into the Universal Mount (but is shown in Figure 2 in its standard mount).

With the RC9 too, the viewfinder telescope is not necessary when the camera is used in conjunction with the instrumentation described in this paper.

The Wild PAV2 Universal Mount (Figure 3) has been developed as an integral part of the complete equipment, and can accept the RC8 or the RC9 Camera. The hand-operated leveling footscrews of the standard mount have been replaced by motorized re-circulating ball spindles. The Mount has push-button controls for direct operation of the tip and tilt movements (right), and of the drift movement (left), which is transferred to the camera through the drift ring. However, the direct operating mode is cut out automatically when tip, tilt and drift are remote-controlled from the Navigation Sight. The mount hinges on the two near footplates for filter changing.

The Universal Mount also serves as the platform for carrying the Horizon Camera. A console (Figure 4) can be bolted to the forward end of the mount for this purpose.

The Wild HC1 Horizon Camera (Figure 5) is well known from recent technical publications. From the four pictures of the horizon taken simultaneously with each exposure of the main camera, users claim to be able to

FIG. 3. The PAV2 Universal Camera Mount for the RC8 and RC9 aerial cameras.

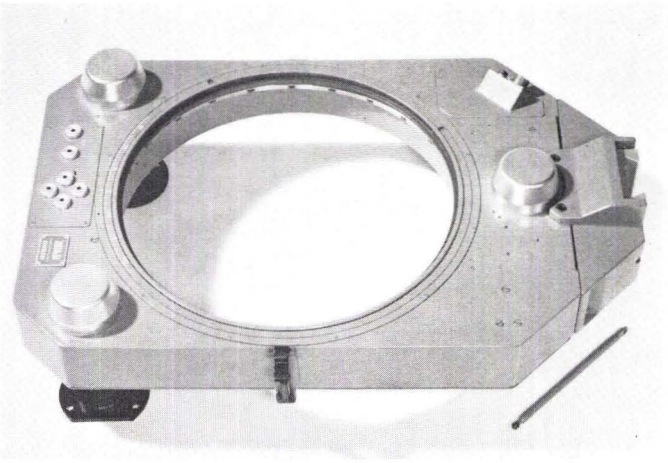

FIG. 4. The Universal Mount also serves as the platform for the Horizon Camera.

determine tip and tilt of the survey photographs to within a few minutes of arc.

The Horizon Camera is carried by a dovetail slide that fits the console. When installed, the principal vertical axis of the Horizon Camera is always parallel to the optical axis of the survey camera, while drift is transferred mechanically from the main camera to within very close tolerances. The vertical tube is turned in its sleeve bearing for this purpose; since the lens turret has a small diameter and is rotated about its own axis for drift setting, only a relatively small port is needed for the Horizon Camera.

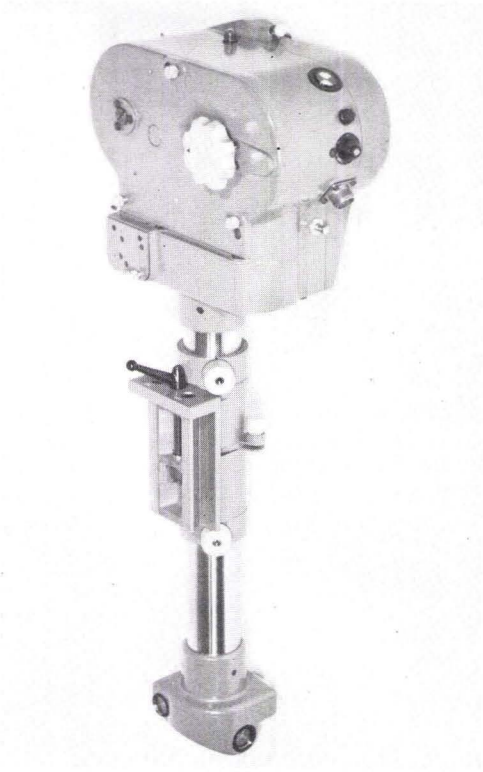

FIG. 5. The HCl Horizon Camera records in all four directions.

THE NAVIGATION SIGHT

The Wild NF1 Navigation Sight (Figure 6) is a vertical telescope with an objective lens that projects below the aircraft skin and that can be swung from a vertical position forward through 50°. Since its field of view is 97°, the navigator can scan the terrain from $48\frac{1}{2}°$ behind the nadir to $8\frac{1}{2}°$ above the horizontal. The image seen is laterally correct, so the observer need make no mental inversions.

The Sight is supported in a gimbal mount and provided with sturdy controls for leveling, that is, for verticalizing the principal optical axis: the image of a spherical level bubble is displayed in the field of view for this purpose. Once leveled, the navigator corrects for drift by turning the telescope tube until the images of terrain details move parallel to the longitudinal reticle line seen in the field of view.

For maximum convenience, the Navigation Sight is installed in front of the co-pilot's seat, thus allowing personal communication between pilot and navigator during photoflight. This is especially convenient both during the immediate approach to the site and when flying the strip, since the aircraft's nose obscures the view forward and below just when unobstructed vision is most necessary for precise adherence to the planned flight

FIG. 6. The NF1 Navigation Sight has an angular field of 97° and is remotely connected to the camera.

line. The Sight can of course also be installed in any other part of the cabin.

So far, only scanning functions have been mentioned; but although the NF1 can be used alone for just this purpose, scanning alone is not enough. By combining it with other known and tested elements, the Wild Sight has been developed to serve also the orienting functions of camera leveling and drift setting, and the photographic functions of exposure-interval measurement and exposure control.

Leveling and drift setting of the camera are controlled remotely from the Navigation Sight in the following way:

- Two potentiometers in the gimbal mount of the NF1 measure the omega and phi move-movements made when centering the bubble seen in the field of view; a third potentiometer measures corrections made to the drift setting, kappa.
- These movements are transferred to the survey camera through servo motors in the Universal Mount. The circuitry from Navigation Sight to Mount passes through a small Servo Control Unit called the PNG1.
- This servo control unit is also used for the initial correlation and subsequent possible periodic adjustment of the zero positions of omega, phi and kappa in the Sight and the Mount. Three identical plug-in printed circuits and easy correlation adjustment by means of a screwdriver are characteristics of the PNG1.

Before going on to the subject of remote control of the exposures, it will be helpful to explain the reticle of the NF1 Navigation Sight shown in Figure 7:

- In the center is the drift-setting guide line. After leveling the correcting for drift as already described, this line gives the track of the aircraft.
- The two short cross-lines marked "1": the time taken for the image of a terrain object to pass from the forward to the back line represents the interval between 60 per cent overlaps of super wide angle pictures. This interval (or a function of it in the case of other overlaps) must be set in the RC9 intervalometer, and it therefore follows that the operator of the Sight should have the control box of the camera within easy reach.
- "2" indicates the frame of a wide angle or 90° picture.
- "3" shows the frame of a normal angle or 60° picture.
- "4" shows a black ring engraved in the reticle for easy finding of the bubble image that is projected into the field of view for leveling the Sight.

The lines numbered 5 to 9 on the right

ABSTRACT: *The requirement for a simple optical sight for precise navigation during photographic flight for aerial survey purposes has resulted in the development by Wild Heerbrugg of their new NF1 Navigation Sight. Operated in conjunction with the control box of the Wild RC8 or RC9 camera, it provides remote control of essential camera functions through a servo control unit, the camera being carried in the new PAV2 Universal Mount. The mount also serves as a platform for the automatic HC1 Horizon Camera. This straightforward instrumentation is complemented by the RST2 Recording Statoscope. The Navigation Sight and the Universal Mount can also be used independently, the motorized mount then being operated directly through push-button controls.*

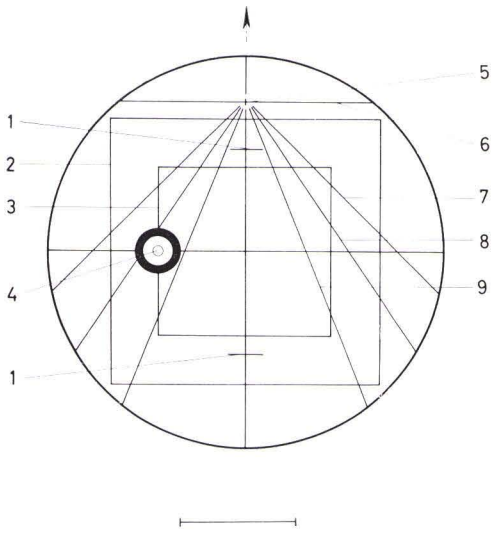

FIG. 7. Guide lines in the Navigation Sight.

apply when the Navigation Sight is leveled and the objective lens is in the forward-viewing position:

- "5" is the horizon heading.
- "6" represents the horizon.
- "7" shows the limits of cover of a straight-flown super wide angle strip.
- "8" indicates the limits of a wide-angle strip.
- "9" are those of a normal angle strip.

This figure is only a diagram; actually the Sight has a fairly pronounced barrel distortion. The optics of the Sight were computed primarily for clear and comfortable viewing at 0.6 magnification.

Super-imposed on the pattern of lines (and not shown in the figure) is also an off-center part of the reticle of spiral lines used for exposure-interval control of the RC8 Camera. The control box of the RC8 is mounted on its wedge nearby; a flexible shaft connects its overlap-regulating mechanism to the gears driving the reticle engraved with the spiral lines.

The RC8 control box carries the controls for setting the desired percentage of overlap for 60° and 90° photography, and for adjusting the speed of movement of the spiral lines to correspond to that of the terrain image seen in the field of view of the Navigation Sight. Also on the control box are the camera switch with positions for off, on, serial and single exposures; the exposure release button; a cycle indicator; and an exposure counter.

To prevent misunderstandings on the degree of remote control given by this system, it should also be said that for both the RC8 and RC9, remote monitoring of film feed or of vacuum operation for film flattening is not provided, nor is remote setting of the aperture. And with the RC8, the rotary shutter must be started and set on the camera itself.

A point of interest economically is that the RC8 Camera cycles up to and is held at the waiting position, thus making pin-point exposures possible, either as singles or as the first of a strip of pictures.

Figure 8 shows the group of airborne instruments as described so far, shown here with the RC8 Camera. Forward, on the right, are the NF1 Navigation Sight with the RC8 Control Box nearby; then the PNG1 Servo Control Unit; then, on the left, the photographic unit itself with the RC8 and the Horizon Camera carried in the PAV2 Universal Mount. For super wide angle photography, the RC8 Camera would be replaced by the RC9 and the operator of the Navigation Sight would have the RC9 Distributor Box and the intervalometer near at hand.

THE STATOSCOPE

The airborne instrumentation made by Wild and described so far is completed by their RST2 Recording Statoscope, shown in Figure 9.

The purpose of this instrument is to obtain information on the differences in height of the exposure stations when flying strips of photographs for aerial triangulation. Since the general principles are well known, mention will be made here of only the special characteristics of the Wild statoscope.

For maintaining the air in the aneroid chamber at a constant temperature, the RST2 uses not ice but a multi-layered electrically-heated jacket enclosing an aluminum bottle, with adequate insulation and sensitivity of the several thermostat heating controls. The maximum warming-up time is two hours.

The range of the RST2 is plus and minus 40 meters at 5,000 feet, i.e. if the pilot flies within a layer of a minimum of about 260 feet, the reference to the initial barometric surface will not be interrupted. There are three indicator dials:

1. One is on the panel exposed when the lid of the Statoscope is opened, as shown in Figure 10.
2. The second is the pilot's indicator built into the cockpit instrument panel. The lamp supplied with this instrument will light up when 25 of the available 40 height units are exceeded upwards or downwards. Further, on the panel of the RST2 there are two such warning lamps; one for showing that the

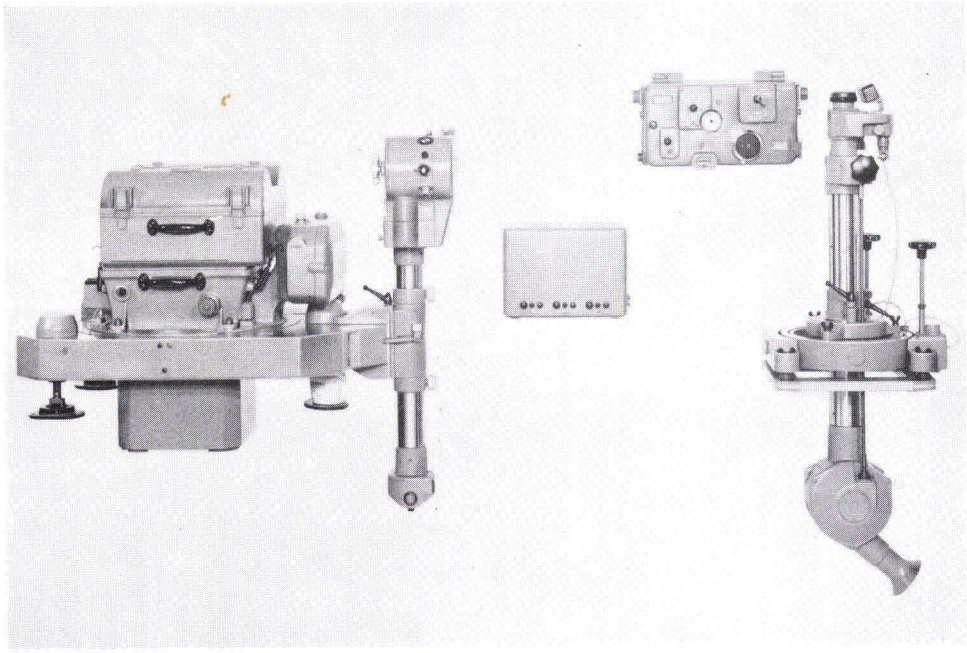

FIG. 8. A set of equipment includes the RC8 Camera, the Universal Mount, the Horizon Camera, control boxes, and the Navigation Sight.

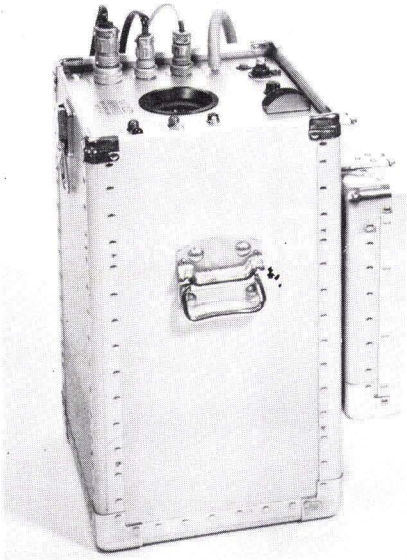

FIG. 9. The new RST2 Statoscope is operated without the use of ice.

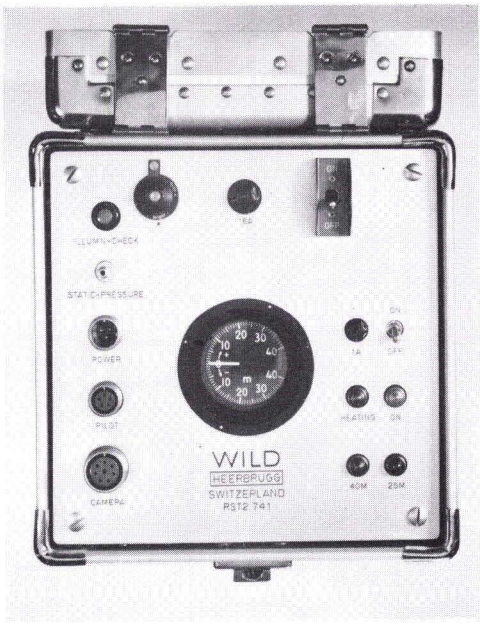

FIG. 10. The control box for the Statoscope operation.

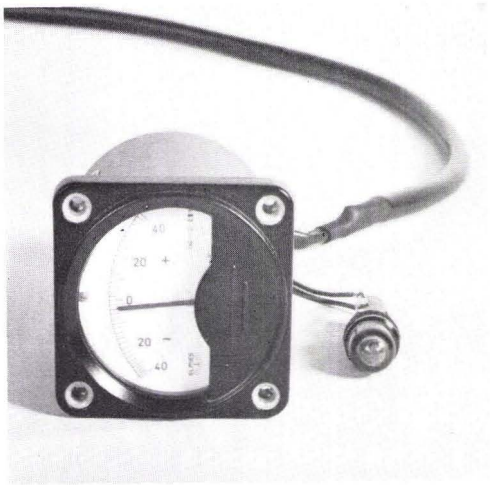

FIG. 11. Statoscope altitude indicator which is located in the aerial camera and photographed on each exposure.

± 25 units have been passed, and another for the total limits of ± 40 units. Since the RST2 is placed next to the Navigation Sight, the operator can warn the pilot when ± 25 units are exceeded, thus providing a safety check.

3. The third indicator (Figure 11) is the recording instrument built into the instrument panel in the RCB and RC9 Cameras, and is photographed with each exposure. If the total range of ± 40 height units is passed, the recording instrument is not illuminated for the next one or two recordings. The photogrammetrist will therefore know immediately that the subsequent illuminated recordings refer to a different barometric surface from the previous readings.

Figure 12 shows the complete equipment, this time with the RC9 Super Wide Angle Camera and with the Statoscope too. Here we have a different arrangement of the equipment to what was shown before: the operator of the Navigation Sight has the camera in front of him.

SUMMARY

The flexibility with which this aerial photographic equipment can be employed is noteworthy:

- The Universal Mount can be used with the RC8 and the RC9 Cameras.
- One can use any of four different lens cones with the RC8.
- There are two versions of the RC9: one with the Super-Aviogon lens, for pan and color photography, and the other with the Super-Infragon, for infrared photography.
- The Universal Mount can be controlled directly or remotely.
- The RST2 Statoscope can be used with any of the cameras.
- The Navigation Sight can be used alone purely for scanning purposes, or as a combination instrument for navigation and remote control of the essential camera functions.

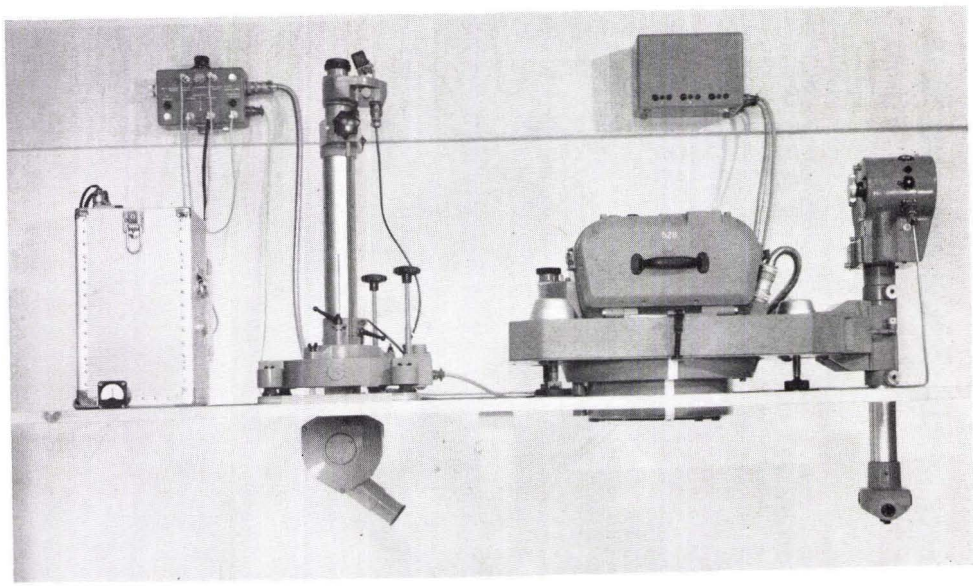

FIG. 12. Another set of aerial photographic equipment includes the Statoscope, Navigation Sight, RC9 camera, Universal Mount, and the Horizon Camera.