Gert E. Bormann*
Wild Heerbrugg Ltd.
Heerbrugg, Switzerland

The New Wild RC10 Film Camera

Fig. 1. The RC10 Universal Film Camera

This universal aerial camera uses pan, IR, color, and false-color films, has interchangeable wide-angle or super-wide angle cones, large film capacity, short cycle time, transistors, remote control, etc.

(*Abstract on next page*)

The remarkable progress of aerial photogrammerty in the past 20 years and the increase of potential of this survey method are based to a considerable extent on the development of a new generation of camera lenses. Greater resolving power, especially for low contrast, a more favorable light distribution, and small or even negligible distortion were the main advantages of these high-performance objectives over the former optical units. As a result, a higher measuring accuracy was obtained.

The economy of photogrammetric methods was further increased by lenses designed for extremely wide field angles, such as the 120° Super-Aviogon introduced in 1956. Recent technological progress in the manufacture of optical glass has opened new possibilities for the improvement of chromatic lens correction. Nowadays it is generally expected that an aerial camera's lens will produce high-quality photographs on panchromatic, infrared, color and false-color films without any alterations to the lens or camera being necessary, except for the change of filters.

Parallel to these remarkable achievements in the optical field, progress has been made in the design of camera constructions. Air survey flights are fairly expensive and the economic success of a photogrammetric project very often depends on the successful photographic missions, especially if the area to be mapped or measured is distant from the base of operation.

For an air survey camera the following requirements are therefore indispensable, in addition to the optical quality of the lens:

- Highest functional reliability even under extreme conditions (temperature, humidity, accelerations, etc.)
- Simple operation and supervision during flight.
- Safeguards against wrong manipulation by the operator.
- As many reliable automated functions as possible.
- Constant interior orientation.
- Capability of taking serial exposures and of instantaneous release of single shots.

Photogrammetric cameras are in fact true precision instruments and their procurement is a major investment. These cameras now

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have only the basic principle in common with ordinary amateur cameras. Photogrammetric projects, however, often require different cameras. Especially outside America, various formats and focal lengths were or are still in use. In view of this fact, the manufacturers have tried to make their designs as flexible as possible so that conversions can be made by the exchange of some of the components. A typical example of this is the Wild RC8 Camera with its interchangeable optical units, magazines and mounts.

Unfortunately, this desirable flexibility could no longer be maintained when the first super-wide-angle lenses were designed. New cameras were necessary, such as the Wild RC9. Other manufacturers encountered similar difficulties with their existing equipment. In recent years the use of aerial cameras has become ever more varied and further requirements resulted from this.

Additional auxiliary instruments such as horizon cameras, statoscope and APR, are used in connection with the survey camera. In many cases the aerial camera is not accessible in the aircraft during flight and must consequently be remotely controlled. The problem of stabilization, or at least approximate leveling, is of increasing interest. A film capacity greater than 200 feet is requested. For engineering projects sometimes very large photo scales are needed. If the base-height ratio is not to become too unfavorable for the required accuracy, low flight altitudes are necessary which, in turn, means short intervals between exposures and, consequently, a short cycling time for the camera. Furthermore, it can be stated with some relief that the 9 by 9-inch format becomes more and more the standard all over the world for conventional frame photography.

All these points have made it desirable to design a new aerial survey camera which meets the needs known today and will be flexible enough for future adaptations. The result of the research and development along these lines is the new Wild RC10 Universal Camera.

The basic RC10 equipment consists of the following interchangeable components:

1. Camera mount.
2. Lens cone.
3. Drive Unit.
4. Two half-cassettes.
5. Viewfinder Telescope with built-in overlap regulator.
6. Circuitry Unit.
7. Control Unit.
8. Set of connection cables.

The features of these main parts are briefly described below.

Abstract: *The RC10 aerial camera is a new development designed for taking high-quality photographs on panchromatic, infrared, color and false-color films. It can be equipped with interchangeable optical units of different field angles. Large film capacity and an extremely short cycling time of only 1.5 seconds are some of the features of this camera. All automatic functions are controlled by transistorized circuitry. Complete remote control is possible in connection with the new NF2 Navigation Sight.*

1. Camera Mount

The mount consists of a two-part base plate and a box-type housing with cardanic suspension which is supported by eight vibration isolators. The chosen design resulted in a very rigid and compact structure which allows the installation of the RC10 Camera even in relatively small aircraft. Thorough vibration tests have shown that the critical frequency encountered with full load under practical conditions lies at 8 cycles per second. A circular opening of 440 millimeters in diameter in the housing is provided for inser-

Gert E. Bormann

tion of the lens cone. For leveling the camera during flight, corrections for tip and tilt up to $\pm 5°$ can be introduced. The range of drift correction is $\pm 30°$. These elements of orientation can be set either manually or, in case of remote control from the new NF2 Navigation Sight, by means of three servo-motors with which all RC10 mounts are always equipped. The leveling speed is then 1.1 degrees per second and the setting accuracy ± 1.5 minutes of arc.

For the drift correction, the respective values are 6.6 degrees per second and ± 10 minutes of arc. The two sections of the base plate are hinged together. A self-locking spindle drive permits a 40-degree inclination of the entire camera to facilitate easy exchange of filters. All PAV10 mounts (this is the official type number of the RC10 mounts) are fitted for a rigid and rapid connection of the Wild HCl Horizon Camera.

2. Lens Cone

For the frame size of the RC10 photographs, the standard format of 9 by 9 inches was chosen, and provisions were made to accommodate optical units with lenses of different field angles. These lens cones can be exchanged during flight and contribute to the universality and economy of the camera. All lens cones are equipped with electric shutters of the rotating-disc type which permit any exposure time between 1/100 and 1/1,000 second. The change of diaphragm values is also actuated by an electric motor. The construction of the focal-plane frame provides for a rigid connection with the lens mount and ensures a constant interior orientation. Four corner fiducials are standard. On request the frame can be fitted with eight, *i.e.*, four additional, mid-side fiducial marks at the factory, prior to delivery. At present two types of lens cones are available for the RC10, which are equipped with the following lenses:

Universal-Aviogon $f/5.6$, 90°, $f=6$ in.
Super-Aviogon II $f/5.6$, 120°, $f=3.5$ in.

Other lenses are in development.

2.1 Lens Cone with the Universal-Aviogon Objective

This lens is well-known and it is therefore certainly not necessary to describe it here again in detail. Although the RC10 Universal-Aviogon differs from the same type lens of the RC8 camera with regard to barrel mount, new rotary shutter, diaphragm and filter holder, the optical characteristics were not changed. The lens is corrected for photography on panchromatic, color, infrared and false-color emulsions. Many lenses of this type are in daily use on photographic missions all over the world.

2.2. Lens Cone with the Super-Aviogon II Objective

The Super-Aviogon II lens is an entirely new design by L. Bertele. It was completed in 1968 and has only superficial similarity with its predecessor, invented in 1956. The new lens is in all optical aspects comparable with the Universal-Aviogon but has, at 120°, a larger field angle and even a slightly higher resolving power in terms of angular resolution. The Super-Aviogon II lens is fully color-corrected and can therefore be used in connection with the proper filters for panchromatic, infrared, color and false-color photography. More about this new lens will be reported in a separate publication in the next few months, but it should be mentioned briefly here that the maximum resolution measured on axis was 115 lines per mm and the minimum not less than 20 lines per mm at 60°. The average radial distortion referred

Fig. 2. Universal Aviogon and Super Aviogon II Lens Cones

FIG. 3. RC10 Half Cassettes

to calibrated focal length is less than 10 microns. The light fall-off follows closely a curve of cosine to the power of 2.9 of the half-field angle, and is corrected by antivignetting coating on the filters.

3. Drive Unit

The part named *Drive Unit* contains not only the elements for advancing and flattening the film but also carries other essential components of the RC10 camera and holds them together. It is a completely new construction with no similarity to parts with comparable functions in other Wild cameras. The drive unit consists of a circular base plate with segment-shaped side walls. Between these elements lies the hinged pressure platen and above this is the space for the cassettes. The lower part of the drive unit penetrates into the space between focal plane frame and cone housing when mounted on the lens cone.

In addition to the film transport motor, vacuum pump, regulator, indicator and pressure platen, the drive unit houses also the registering instruments (counter, note panel, altimeter, watch, statoscope indicator, greyfield rosette) and the film punch mechanism. The particular concept of this construction has the decisive advantage that the drive unit contains all components which are needed, no matter what type of RC10 lens cone is being used.

One of the remarkable features of the drive unit is the film transport mechanism. The take-up and feed spools are both driven via the cassette couplings. This design made it possible to increase the winding speed considerably without imposing undue stress on the film which, in turn, reduced the camera's cycling time to approximately 1.5 seconds.

4. Cassettes

Unlike the former Wild cameras, the take-up and feed spools are each accommodated in separate, but identical (and therefore interchangeable) half-cassettes. All commercially available $9\frac{1}{2}$-inch spools manufactured according to ASA specifications with flange diameters up to 6-5/8 inches can be used in these magazines. This means a capacity of 400 ft. of aerial film of normal thickness. The cassettes are easy to load in the darkroom. They are then hinged on the drive unit, first in a tilted position in order to feed the film from the feed cassette to the take-up cassette, and then swung into operating position. With the camera installed in the recommended way, the film is advanced in the direction of flight with the advantage that the film need not be

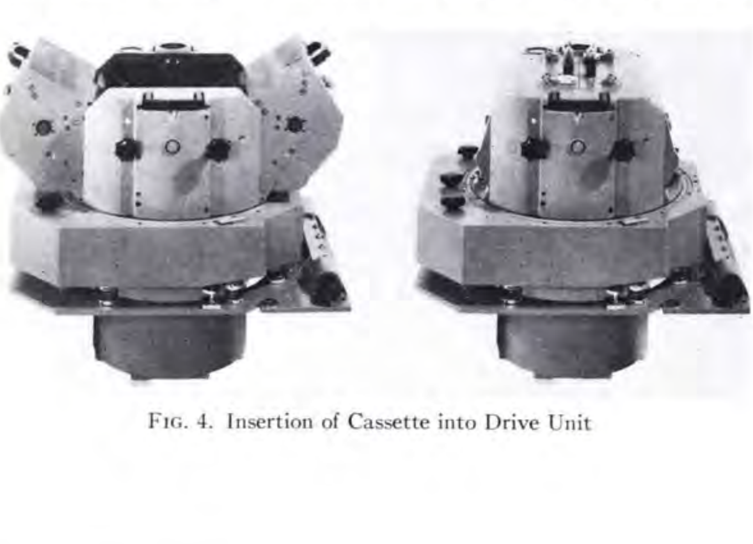

FIG. 4. Insertion of Cassette into Drive Unit

FIG. 5. Circuitry Unit (cover removed)

cut from the roll for observation under a suitable stereoscope.

5. Viewfinder Telescope with Overlap Regulator

The RC10 standard equipment includes a viewfinder telescope with built-in overlap regulator. It is inserted into a hole in one of the drive unit segments. The optical system produces a bright upright image of the ground. The large field angle of 110° permits observation of almost all the area covered by a super-wide-angle photograph. Corresponding to the purpose of the telescope for camera orientation and overlap control, two different reticles can be seen simultaneously. One retical indicates the format of the lens cone as projected on the ground, and the other contains the moving lines which needs to be synchronized in speed to the apparent movement of the observed terrain.

Different format reticles, corresponding to the field angles of the lens cone, can be selected. They can be switched into position by means of a knob. At the same time the field angle parameter is introduced in the overlap regulator which is basically an electro-optical pulse-generator and pulse-counter. The percentage of overlap can be selected in steps of 5 percent from 20 to 30 percent and from 50 to 90 percent. The setting is done on the control unit.

6. Circuitry Unit

The electrical equipment of the camera operates on 24–28 volts dc. All elements with control functions are transistorized and are accommodated in two separate housings, the Circuitry Unit and the Control Unit. Only

FIG. 6. RC10 Control Unit

such components are used which satisfy the rigorous military specifications. The electrical system is subdivided into different control circuits with regard to their specific functions. For the basic RC10 version, the Circuitry Unit contains six plug-in boards (with printed circuits) which can easily be exchanged and checked. In the housing there is space for four more boards. Three additional boards are needed for remote control of tip, tilt and drift in connection with the NF2 Navigation Sight. The Circuitry Unit is in a way the central electrical part of the camera. It also contains the fuses. All cable connections are also made here to and from the auxiliary equipment that might be used with the RC10. As power is transmitted from

FIG. 7. Wild NF2 Navigation Sight

the Circuitry Unit to the Camera, this unit should be placed not too distant from the camera, but it need not necessarily be accessible during flight.

7. Control Unit

All elements which are essential for the operation and supervision of the camera during flight are housed in the Control Unit. It must therefore be located within easy reach of the camera operator, whether his place be at the camera or at the Navigation Sight. On the panel of the Control Unit the following switches, knobs and instruments are mounted in a clear arrangement:

- Main switch with positions OFF, SERIES, SINGLE.
- Resettable exposure counter.
- Regulator knob for shutter speed and dial indicating exposure time.
- Switch for selecting diaphragm and corresponding control lamp.
- Switch for setting overlap.
- Regulator knob for moving lines in viewfinder telescope or navigation sight.
- Release knob for serial or single exposures.
- Release knob for blank film transport.
- Knob for film punch.
- Cycle indicator with control lamp and warning light denoting insufficient vacuum. It indicates in a count down of key numbers the interval between serial exposures as function of overlap, field angle, speed and flight altitude. The count down is started with each exposure. The cycle indicator is also available as a separate instrument for the pilot.

8. Additional Eequipment for the RC10 Camera

Various additional or auxiliary instruments can be connected to, or operated in conjunction with, the RC10 Camera. The existing Wild RST2 Registering Statoscope and the Wild HCl Horizon Camera are only mentioned because they have been previously described eleswhere.

A new development is, however, the NF2 Navigation Sight already mentioned. It can be installed in the aircraft at any suitable place even distant to the camera. With its total length of 50 inches, its use is also possible in larger aircraft. The optical quality of the NF2 is comparable with that of the RC10 Viewfinder Telescope. Rotation of the setting knob allows for switching from:

> Vertical view with a field angle 55° forward, aft and sideward of the vertical

to

> Tilted view 50° from the vertical with field angle 4° above the horizon down to 46° forward of the vertical.

Leveling of the NF2 is possible within a range of $\pm 5°$ in its mount, and the drift correction corresponds, at $\pm 30°$, to that of the RC10. When disengaged, the Navigation Sight can be rotated 360°, for a complete circular scan of the horizon. The NF2 head is equipped with the RC10-type overlap regulator and contains switch-over reticles with reference lines necessary for overlap control and navigation.

For remote control of the RC10, the NF2 is fitted with electrical elements for the transfer of tip, tilt and drift and only three additional circuitry boards must be plugged into the RC10 Circuitry Unit and the cable connections made.

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In the foregoing brief description, an attempt has been made to discuss the general design and the main constructional features of the new Wild RC10 survey camera. Many important details could not, however, be mentioned within the scope of this paper, but it is hoped that the description has demonstrated the universality and flexibility of this camera.