NEW FEATURES OF THE LMK AERIAL CAMERA SYSTEM

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GENERAL INTRODUCTION

Since the LMK serial camera system had first been presented at the 1982 Leipzig Spring Fair to the public, the instrument units of the system have worldwide been in use with great success. Important features, which had been realized for the first time in a commercial metric camera, were the linear forward motion compensation and differential exposure measurement as noval functional principles as well as the convenient operation from the central control unit, the clear arrangement of the system components and their easy manipulation (1), (2), (3), (4).

With such a comprehensive new design of a system it is inevitable that despite all carefulness in the conception wishes of both users and also designers will not be fulfilled, such wishes resulting from tests and especially from the application in practice. This requires a quick reaction from the side of the design staff.

In the following the new features of the LMK aerial camera system are presented, which will lead to a further increase of its utility value. Novel expansion features were in addition to the supplementation of the system by a lens cone with 210 mm focal length aspecially the extension of the compensating range of forward motion compensation and the possibility of simultaneous exposures by the coupling of several LMK systems. Another feature is the possibility of the individual and thus optimum exposure of the fiducial marks and side images as well as of the extra exposure of additional internal camera data and external alphanumeric

data on the margin of the photograph.

The settable f-numbers were extended by halving the stop increments.

In connection with these functional features a few electronic circuits were stabilized, so for example the control of the travelling grid speed. Finally the system has been completed by a new functional unit, the NCU 2000 Navigation Control Unit.

Instrument units with new functional features are marked by a "B" after the Serial No. to distinguish them from units of the earlier production. The new equipment system is termed "LMK 1000 Aerial Camera System".

PRESENTATION OF THE EXTENDED INSTRUMENT FUNCTIONS

With the design of the lens cone 21 the LMK 1000 Aerial Camera System follows the international trend towards a "semi-wide-angle type", which with a field angle of 72° lies between the wide-angle standard type (90°) and the narrow angle type (53°). These types have their special areas of application. Metric cameras of this kind are with advantage used, wherever a good height measuring accuracy is to be achieved in addition to the necessary narrow angle to avoid dead spaces. Examples of this are mappings of urban areas with narrow streets and high buildings or wood inventories in forestry. Furthermore, in special cases it is possible with the lens cone 21 to solve tasks, for which with lens cone 30 the given image scale, e.g. in high mountain photography, would lead to flying heights above ground, which exceed the service ceiling of the photographic aircraft or which cannot be kept for any other reasons.

Lens cone 21 is equipped with the newly designed Lamegoron PI 5.6/210 high performance lens, which with a standard distortion of $\pm$ 2 µm and a mean AWAR of 76 l/mm has the same high level of performance as the well-known and proven lens series of the other lens cones.

The utility value of the system is considerably increased by the extension of the forward motion compensation speed up to maximally 64 mm/s. Hence it is for the complete series of lens cones without restriction possible to compensate any image motion speed which may occur in connection with the speed range of the travelling grid realizable in the control unit. So, lens cone 30 being predestined for taking urban areas may now also be used for large scale photographs (up to about 1:1000) as they are, for example, commonly used for roof cadastres without the need of resorting to helicopters.

The possibility of taking simultaneous photographs with several LMK systems results in a considerable extension of the range of applications of the LMK. Thus, with lens cones of different focal lengths used in one flight photographs at different scales can simultaneously be obtained from one flying height, e.g. for triangulation purposes and mapping purposes.

In multicamera operation the LMK systems are connected by coupling the pertinent control units. The v_g/h_g ratio and the drift correction angle are ascertained on the master control unit and transmitted to the connected systems. Relative to the other photographic parameters such as exposure, overlap ratio etc. each of the systems operates autonomously according to the input values.

The optimization of the imagery of the fiducials marks and of the side images compared with the aerial photograph itself is brought about by correction switches, with which additions can be applied to the film sensitivity entered for exposure measurement. These additions are in the range from ± 1 to 7 DIN. They result in exposure time changes of the pertinent lamps or LEDs.

The additional exposure of alphanumeric auxiliary data is performed by means of a projector arranged in the cassette opposite the projector for the cassette No. It incorporates a

7-point LED line which during the film transport is activated in such a way that characters of a 7x5 point pattern are imaged. Internal camera data being imaged include the f number and the exposure time as well as the amount of image motion (which is 000 when forward motion compensation is used) and the consecutive frame number. External data, e.g. of a connected navigation system or also other photo flight data (date, flown terrain, information on weather and similar data) can be entered via an appropriate interface or an input unit and imaged.

Half stop increments were introduced to reduce the jumps in exposure time occurring in exposure control when changing to a different stop increment.

In the arrangement of the fiducial marks the "grid form" was abandoned and the mid-side marks were displaced by two millimetres outward, so that the free image space within the fiducial marks was increased.

In the Instruction Manual relevant notes have been given for the combination of instrument units of the LMK and the LMK 1000. Units of the LMK may to a certain degree be upgraded to the state of the LMK 1000.

NCU 2000 NAVIGATION CONTROL UNIT

The standard equipment of the LMK Aerial Survey Camera System comprises the control unit used for operating and controlling the camera. Visual navigation on a given flight route is carried out with the Aeroscope.
For operating the two instruments at the same time, a team of at least 3 persons is necessary (pilot/navigator/operator). Moreover, this instrument combination requires three floor holes altogether (camera/control unit/aeroscope).
Since this configuration involves certain problems especially for smaller photographic airplanes, the LMK 1000 System was equipped with a new instrument - the NCU 2000 Navigation Control Unit (Fig. 1) - combining the function of the navigation

instrument with the main control functions of the control unit. This way, the minimum staff as well as the necessary floor holes are reduced to two each.
Similar to the aeroscope, the NCU 2000 is constructed in the form of an observation telescope with vertical axis. The mount is the same as for the control unit so that the two instruments are easily interchangeable. The telescope can be disassembled into two halves, the bottom part being rigidly connected with the base part. This base part is inserted into the above-mentioned control unit mount and locked in position. Contrary to the aeroscope, the bottom part of the telescope can be inserted into the central mount opening from above. Thus, it is no longer necessary to mount the instrument already before the start (from the outside) so that there is no longer the danger of contaminating or damaging the protruding lens head during the start or landing of the airplane.
The upper part of the telescope is bolted with the bottom part. Using adapters, the overall length can be extended by maximally 200 mm. This provides rich possibilities for setting a convenient viewing height as well as for positioning the lens head below the airplane's fuselage so as to ensure free vision.
During the preparation of installation, it must be taken into account that the tilting motions to be made to ensure the verticality of the telescope require sufficient clear space even in case of larger thickness of the airplane fuselage. On the other hand, the required opening at floor level is smaller than that of the control unit. The line pattern for visual navigation (Fig. 2) is located in the image plane of the telescope eyepiece. According to the focal length of the attached LMK lens cone, one out of four reticles is selected by means of a turret. In addition to the course line in the centre, each reticle comprises the flight strip limitation lines both absolutely and for a 30 % lateral overlap as well as lines limiting the image along flight. The observation ray path in the lens head is folded through 36° relative to the vertical. The field angle is 90°; the limi-

tation of the visual field thus being at 81° frontwards and at 9° backwards. Like in the control unit of the LMK 1000 System, the nadir point is represented by a circular mark whose diameter corresponds to the terrain area covered by the sensor of the LMK exposure meter.
The course line is aligned to the flight direction above terrain by turning the telescope base. The set angle corresponds to the drift angle and is automatically transmitted to the connected aerial survey camera. With the drift position unvaried, there is an additional possibility of quickly turning the telescope, in its indexing positions, through 180° or ± 90°, resp. Thus, it is possible to change over from front view to rear view or to have a look, in "sideward navigation", at the adjacent route still to be flown. To this end, each line pattern has a continuous line (Fig. 2) for marking the adjacent route in the terrain at a lateral overlap of 30 % between the strips. Levelling the NCU 2000 is by means of the two setting knobs on the mount; the tilt correction amount is automatically transmitted to the connected LMK.
The actual novelty as compared to the aeroscope is that perspectively running travelling marks moving along the course line are additionally reflected into the eyepiece image plane. They have the same function as the travelling grid of the control unit, i.e. they serve for determining the v_g/h_g - ratio. The travelling marks have the form of luminous lines whose brightness can be regulated for adaptation to the terrain image or switched off, if necessary (e.g. during "sideward navigation"). Their moving direction is reversible so that the v_g/h_g - ratio can also be determined when looking backwards.
An optical image sequence indication is seen at the field edge. Similar to that on the control unit, it indicates the camera cycling rate by means of LED's.
The NCU 2000 is compatible both for the LMK 1000 and LMK System. It is connected via the control unit installed on a rigid mount (included in the equipment) within sight and reach of the operator.

The eyepiece head of the telescope only accommodates those operating elements as are absolutely necessary for taking an airphoto. Apart from the above-mentioned operating controls for illumination, and directional change of the travelling marks, these are buttons for releasing serial exposures as well as releasing single exposures and a control knob for travelling mark synchronization.
All other settings and controls are effected on the control unit.
The NCU 2000 represents a significant extension of the modular LMK 1000 or LMK System and is likely to substantially increase the applicabilities of these instruments.

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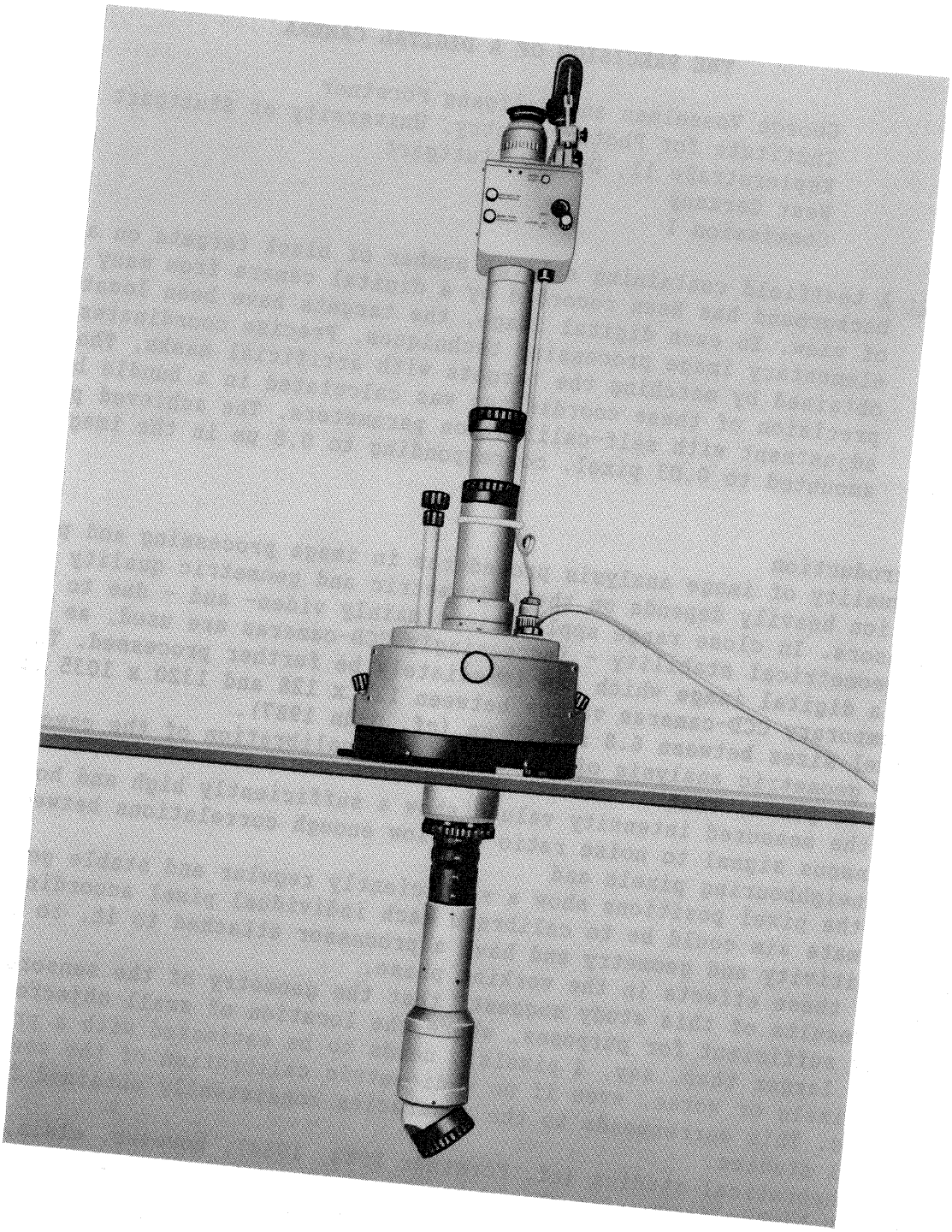

Fig. 1 NCU 2000 Navigation Control Unit