*Nistri Telescopic Photoprinter-Rectifier (Telerectoprinter)**

GINO PARENTI,
Ottico Meccanica Italiana, Rome, Italy
and
JACK FRIEDMAN,
O.M.I. Corporation of America, Alexandria, Va.

ABSTRACT: *The paper describes a new instrument designed and developed by Ottico Meccanica Italiana of Rome, Italy. This instrument, the Telerectoprinter, is a dual purpose diapositive printer. It serves as a transforming printer for transformation of an aerial exposure from the characteristics of the taking camera to the characteristics of the plotting camera. It also can rectify a tilted aerial photograph and produce a tilt-free diapositive, assuming the availability of the original tilt data.*

THIS year Ottico Meccanica Italiana introduces to the photogrammetric community a new diapositive printer. This instrument is not only new to OMI production but also is novel in its capabilities when it is compared to existing type diapositive printers. It does not particularly represent a new attempt to prepare diapositives better or perhaps more quickly than other instruments, but rather it is designed to accomplish a task which at present is not adequately performed by any existing instrument.

One of the ever prevalent problems in instrumental photogrammetry is the compatibility of the aerial (or ground) photography with available stereo plotting instruments. Sooner or later, no matter how well equipped an organization may be, a situation arises where certain photography is available which, either for reasons of focal-length, format or aerial lens distortion, is not well adapted for use with the stereo equipment on hand. This situation will continue to occur as long as photogrammetrists and instrument designers cannot reach a common agreement on a precise standard photogrammetric camera. It is true that we have progressed a considerable distance along these lines; nevertheless, there is still a marked discrepancy in lens distortion characteristics and focal-lengths of aerial cameras now in use. Of course this paper is not an argument for or against such standardization. The fact that it does not exist has led to the design and production of the Nistri Telescopic Photoprinter-Rectifier. This formidable and impressive title has been reduced to the more convenient and informal name of *Telerectoprinter*.

The Telerectoprinter was designed to fulfill two very important fundamental operations in stereo photogrammetry. These are: one, the preparation of a diapositive by transformation from the original aerial negative to any pre-determined and desired metric characteristics and, two, simultaneously the rectification of such diapositive to correct for moderate amounts of tip and tilt. In essence then, the purpose of this printer is to transform an aerial negative with certain known format, focal-length, and tilt data into a diapositive, of any other desired format, and with the tilt eliminated.

The first operation mentioned above, transformation, consists of modifying the original photograph negative. This has certain known interior orientation characteristics (principal-distance and lens distortion) of the original aerial camera. These characteristics are transformed in the diapositive to the characteristics of interior orientation of the stereo plotting projectors to be used. These transformed diapositives are such as would be obtained with film exposed in an aerial camera identical to that of the stereo plotter projector from the same point in space, and with the same exterior orientation as the original aerial camera.

This change of interior orientation or transformation permits the stereo plotting instrument to be independent of any aerial

* Presented at the Society's 26th Annual Meeting, Hotel Shoreham, Washington, D. C., March 23–26, 1960.

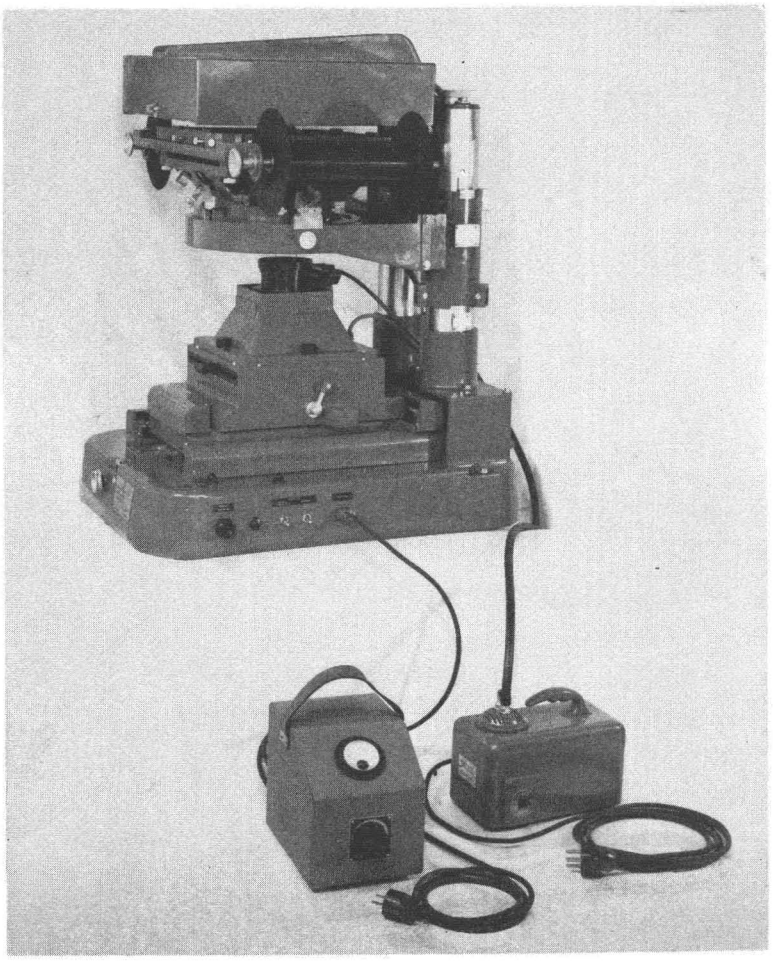

FIG. 1. Nistro "Telerectoprinter."

camera, and permits the use of material and equipment of various makes and models. Also, due to the manner in which the diapositive plate is prepared, the Telerectoprinter eliminates the necessity to employ rigorously flat diapositive plates for optical and optical-mechanical projection plotters.

The second operation which the Telerectoprinter can accomplish simultaneously with the first, consists of rectifying the original negative exposure by varying the tilt and tip. Should these values for the original exposure be known, they can be pre-set when the diapositive is being prepared and thus their effects eliminated. In this manner the diapositive can be the equivalent of a truly vertical photograph. In essence this would be equivalent to an aerial photograph which would be obtained with a camera identical to that of the stereo plotter projecter, at the same spatial point of exposure but as a truly vertical picture.

Knowledge of the exposure tip and tilt can be derived from various types of auxiliary data devices, such as spirit levels, horizon photographs, aerial triangulation or precomputation, dependent upon the position of ground-control points. It is also anticipated that these data can be made available by use of the Nistri gyroscopic system which is integrally built into the Nistri aerial cameras. In each of these cases transformed photographs approach truly vertical within the recording accuracy of the determination of the tip and tilt. The accuracy of the rectified diapositive is unlimited with respect to the rectification capability of the instrument itself. It is because of this rectification capability that the title of the photoprinter also includes the term "rectifier."

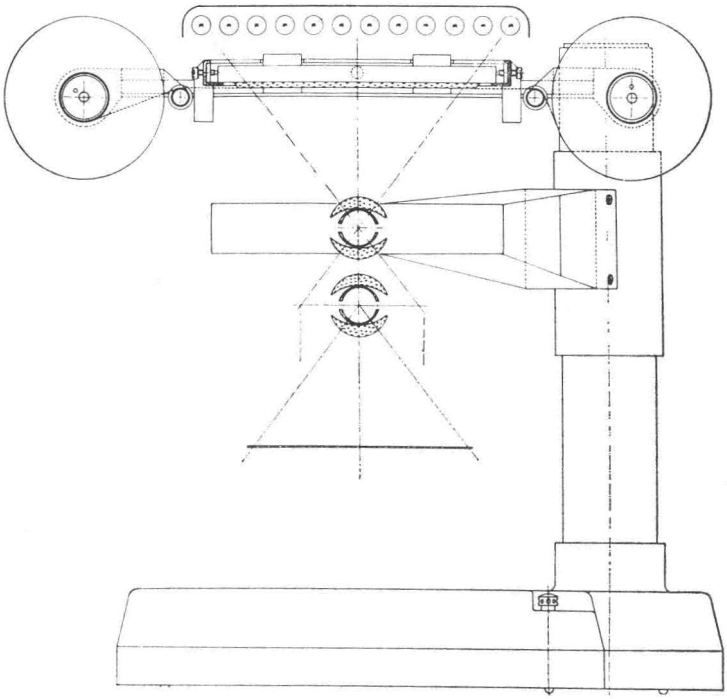

FIG. 2. Schematic drawing. Optical system of telerectoprinter.

The advantages of having diapositives with predetermined metric qualities and equivalently vertical exposure are quite obvious. They could be readily used in third-order stereo plotting devices with a high degree of convenience. Also, when used in more precise stereo plotters, they could greatly simplify the relative and absolute orientation problems.

The Telerectoprinter operation is based on the rigorous application of the Porro-Koppe principle. The instrument consists basically of two cameras mounted vertically one above the other. The upper camera is referred to as the primary camera. This is used as a projector for projection of the negative film which is to be transformed. The primary camera should possess all the metric characteristics of the camera by which the aerial negatives were exposed.

In certain cases, for types of cameras which have detachable cones, the identical cone can be utilized on the Telerectoprinter as the primary camera. The negative frame to be reproduced is projected by a cold light-source through the primary camera. The projected rays exit from the lens in a parallel condition or at infinite focus. These rays should be identical to the rays which entered the aerial camera at the time the negative was exposed.

It is, of course, unnecessary that the negative frame be cut from the film reel to which it belongs. The entire reel is mounted on the primary camera and the frame that is being projected is flattened by means of a vacuum system against the supporting glass on the side opposite to the projection. In this manner no intermediate element is placed between the projection lens and the film emulsion. A system of micrometer setting screws allows the photograph to be centered on the four fiducial marks which may be located either on the sides or in the corners of the primary camera, depending upon the desires of the purchaser.

The bundle of rays emerging from the primary camera is gathered by the secondary camera. This camera possesses the metric characteristics of the projector of the plotter with which the diapositives are to be used. In order to cover the entire angular field of the primary or projection camera of the printer (since the two respective lenses cannot penentrate each other and occupy the same position in space), the secondary camera automatically undergoes a translatory motion during exposure which covers the entire field of the primary projection lens. The entire scanning of the field is controlled automatically, and any possibility of operator

error during exposure is eliminated. At the end of the scanning process all movement stops and the projection light is extinguished.

The diapositive plate which is to be exposed is placed in the focal-plane of the secondary camera. This plane carries fiducial marks either on the sides or the corners which identify the new principal-point. The fact that the plate is printed under conditions exactly the same as those in which it will be used in the stereo plotter projector, eliminates any requirement for the diapositive to be flat. In fact, the plate can be seriously warped without any effect upon the ultimate formation of the stereo model. This, of course, is due to the fact that each point imaged on the diapositve plate in the secondary camera will be reprojected under exactly the same conditions, and the cone of rays exiting from the stereo plotter projector will be true, regardless of any warped plate.

The Telerectoprinter, when in its basic condition in which the focal-planes of the primary and secondary cameras are parallel, operates simply as a transformer of distortion and principal distance of the photograph. In this case the principal-point of the transformed photographs, identified by the marks of the secondary camera, coincide with those of the original photographs and hence of the primary camera.

However, as previously stated, a tilt and tip can be induced to the primary camera with respect to the secondary. In such case the Telerectoprinter operates also as rectifier, that is, it perspectively transforms the original photograph by changing its exterior orientation. In such case the principal-point of the diapositive no longer coincides with that of the original photograph but with its nadir-point, within the approximation of the determination of the elements of tip and tilt. The introduction of the predetermined tip and tilt is either accomplished by means of precise double-graduated bubble levels or, if the Nistri gyroscopic camera is used, a special accessory device, known as the pricking unit, identifies the nadir-point as determined by the gyroscopes and these data can be preset into the printer.

The rigorous application of the Porro-Koppe principle, that is the condition of parallel rays (infinite focus) existing between the primary and secondary cameras, makes certain the complete matching of distortion characteristics of the aerial camera and the stereo plotting projectors.

The Telerectoprinter can be used in full light, for the diapositives are loaded in special magazines in the dark room, but thereafter can be handled without any difficulty in a lighted room. The maximum format of photographs for the primary and secondary cameras is 23×23 cm. The secondary camera is normally supplied with a distortion free Omigon lens with a 152 mm. principal-distance and a maximum distortion of ± 0.006 mm. Actually both the primary and the secondary cameras can be prepared to accommodate almost any cartographic type aerial camera or stereoplotting system.

*The Student Status in the American Society of Photogrammetry**

J. R. MASTERS,
Senior in Civil Engineering
Univ. of Illinois, Urbana, Ill.

(*Abstract is on following page*)

PHOTOGRAMMETRY! A word that arouses curiosity and questioning in the minds of the uniformed student whenever this subject is mentioned, outside of the technical circles familiar with photogrammetry. The immediate reaction and question of these persons will invariably be, "What is Photogrammetry, another name for a photographer?" Laugh as you will, the student should not be ridiculed, for in all sincerity he has not been very well informed or briefed on the subject of photogrammetry.

* Presented at the Spring Technical Meeting of the Ohio Region of the American Society of Photogrammetry, held in Urbana, Ill., May 20, 1960.