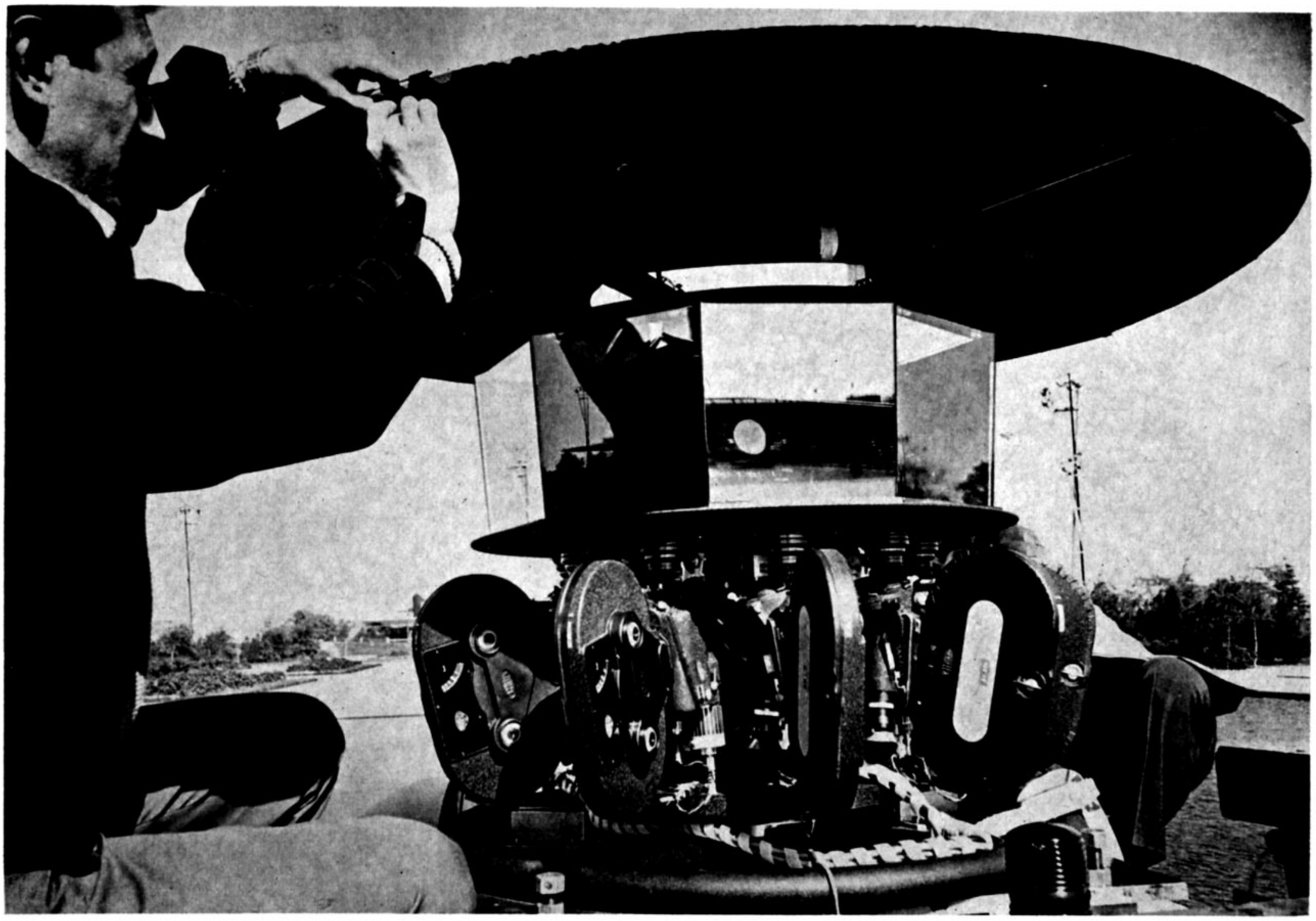

FIG. 1—NILES TECHNICIAN Carl Porcello prepares special Behrend-built panoramic camera complex for photography. Ten Arriflex 16M cameras precisely aligned and mounted vertically in a circle photograph segments of 360-degree scene as reflected in angular mirrors above them. Reflections seen in photo are from protective glass panels mounted before the mirrors.

PANORAMA MOVIES

New York World's Fair visitors will see spectacular movies filmed with this panorama camera complex, in which ten Arriflex 16mm cameras, mounted vertically, photograph a complete 360-degree scene reflected in mirrors.

By JOSEPH HENRY

ONE OF THE MOST unique motion pictures ever filmed, a 12-minute presentation telling the dramatic story of the New York-New Jersey Port and its 14,000,000 people, is in course of production for showing at the New York World's Fair next year. Producing the film for the Port of New York Authority is Fred A. Niles Communications Center, Inc., New York.

What makes this production unique is the multiple camera set-up being used to photograph it and the special projection techniques that will be employed to screen it as a 360-degree ultra-spectacular in a circular theatre in the Port Authority's Heliport and Exhibit Building at the Fair. The film will feature unusual and dramatic panoramic views of the New York City area with special emphasis on the transportation facilities operated by the Port Authority.

The "camera" used by the Niles production crew is actually ten cameras in one—a "rig" as they choose to call it, in which ten Arriflex 16M cameras are mounted in a circle to photograph scenes in a 360-degree circular format. Following specifications laid down by Niles technicians, Behrend's,

Inc., Chicago, distributors of professional motion picture equipment, designed and built the ten-camera unit pictured here especially for this project.

The "camera"—a term we shall henceforth use to describe the ten-camera rig—weighs 650 pounds, and at this writing is receiving rugged use, since Niles' New York camera crew is shooting from helicopters, rafts on the Hudson river, and from the top of the George Washington Bridge. It also will be suspended beneath a jet airliner to shoot a sequence of dramatic and spectacular aerial views of Manhattan.

Cameras Mounted Vertically

The camera assembly is 40 inches in diameter and 40 inches in height. The ten cameras are mounted vertically to shoot up into ten circularly aligned mirrors, as shown in the photo (Fig. 1) and in the diagrams (Figs. 3 and 4). Each camera is equipped with a Taylor, Taylor & Hobson 12.5mm lens having an angle of coverage of 42 degrees. This provides an extra 6 degrees of latitude in the angle of field which will be eliminated by appropriate masking in the projection equipment.

Both the optical and control components of the camera posed a number of problems in design and construction. To achieve the necessary parallax correction, for example, mirrors were employed to "fold" the light so that the nodal points of all ten lenses would coincide at one central point (Fig. 4). This insures even lines of sight at any point from 3 feet to infinity.

Without the mirrors, the image continuity between cameras of objects moving horizontally at close range would be broken. This is illustrated graphically in Fig. 2 which shows the "dead" areas "A" that otherwise would exist between the viewing range of the lenses of the ten cameras. In a 10-camera, no-mirror arrangement shown in this illustration, a person or a vehicle traversing the viewing range of, say three cameras, would be out of view during the intervals they moved through the "A" areas. This is because the angle of acceptance of each lens forms a triangle with the apex at the nodal point of the lens. Arranging the cameras so they shoot upward into the mirror complex, as previously described, eliminates this problem.

Sync-Interlock Method

A special gear interlock mechanism joins the drive shafts of each camera so that all ten operate in unison, with the shutters opening and closing precisely in unity, and with the pull-down claw movement also in sync.

Holding tolerances was yet another problem, according to Behrend's engineers. Maintaining mirror, mounting and other tolerances at the time of the

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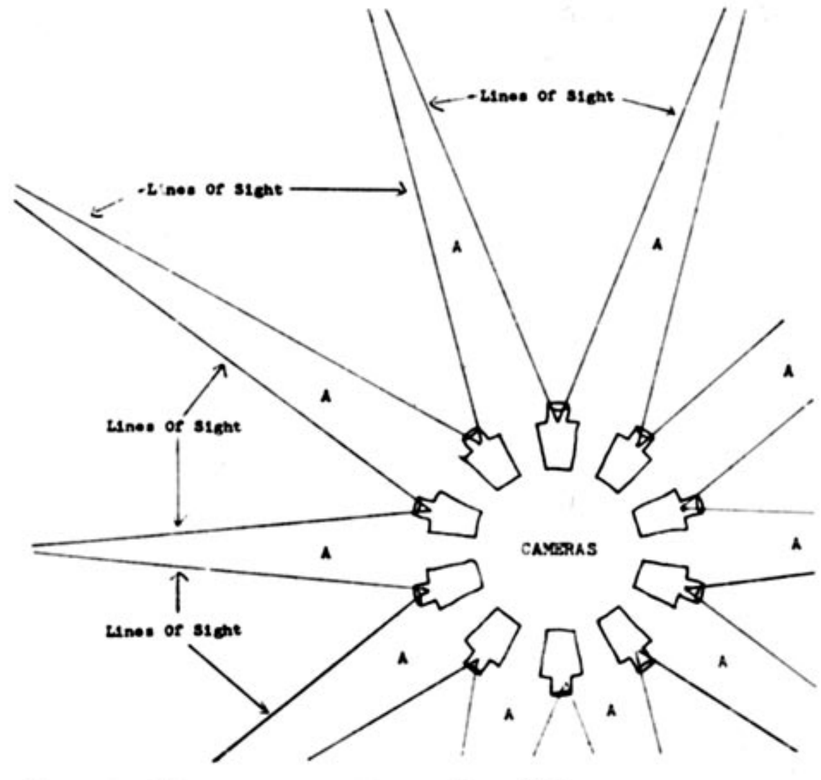

FIG. 2—Diagram illustrates one type of multiple camera arrangement for panoramic photography. It shows the lines of sight (field of view) of each camera where no mirrors are employed and cameras are conventionally mounted to shoot segments of the scene directly. Result is a series of "dead" areas (A) not covered by the lenses. Objects passing laterally before the cameras would not appear on screen in continuous action, as they would be out of camera range when traversing an "A" area. Now compare this with Fig. 3 below:

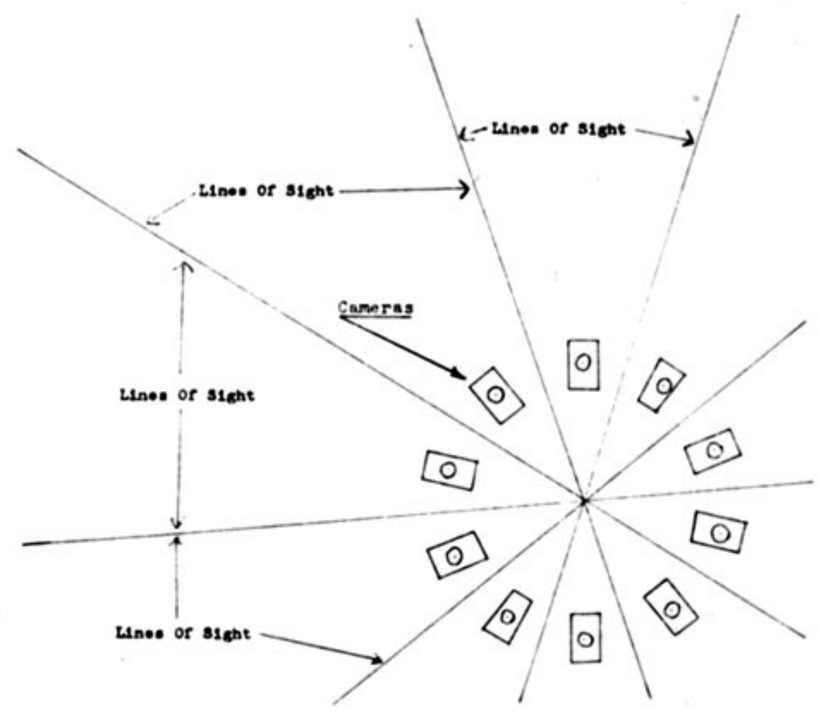

FIG. 3—Camera arragement in the Behrend-built panoramic camera complex. Each camera is mounted vertically and shoots upward into an angular mirror which virtually "folds" the light from a central nodal point to the position of the camera lens while still maintaining an effective central nodal point. Note that the lines of sight are contiguous and there are no dead areas as in A, Fig. 2. Thus an object passing laterally before the cameras would appear on the screen in continuous action.

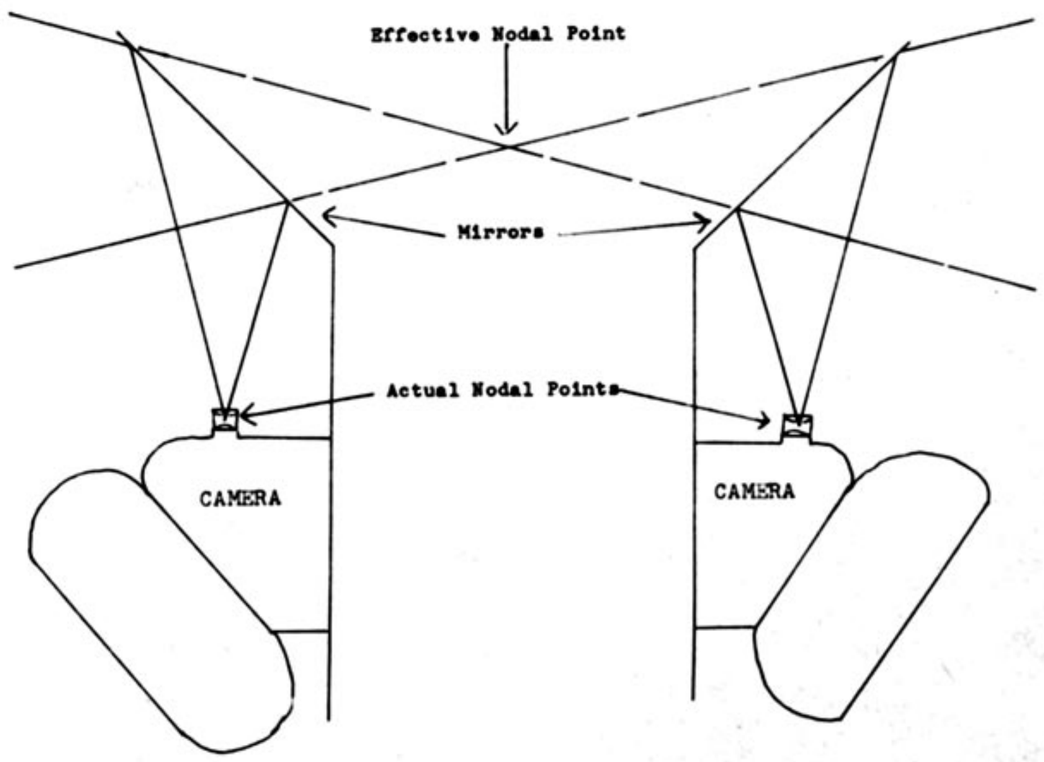

FIG. 4—Cross-section diagram of the camera assembly showing how mirrors are positioned at an angle above each camera lens with respect to the actual and effective nodal points. Cameras record scene segments reflected in the mirrors for a continuous 360-degree panoramic picture.

PANORAMA MOVIES

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camera's construction was problem enough, they said, and it was compounded by the built-in flexibility called for in the original specifications.

For example, each of the Arriflex 16M cameras had to be mounted within a tolerance of .00025 inch. No amount of deviation was permissible in any of the three axes, which insured that the horizons as recorded by each of the ten cameras would be in precise alignment to produce unbroken continuity. Additionally, it was important that such tolerance be maintained for each camera and be unaffected by the frequent removal of cameras for loading and unloading of film. To achieve this, each camera and its rig-mount were given corresponding numbers which insured that cameras would always be re-mounted in their original mounts.

The mounting mechanism employs a flexible, detachable, pin-indexed coupling, and any camera can be removed, unloaded and reloaded, then remounted on the rig in less than 45 minutes.

Alignment of the mirrors was just as critical as aligning the individual cameras, but it was achieved so that no further adjustment need be made when the 10-camera complex is being operated in the field. Optically-ground, water-clear windows are mounted in front of the mirrors to protect their first-surface coatings from dust, moisture, etc.

Main Structure

Steel was chosen over aluminum for the main structure of the 10-camera complex, because of steel's greater rigidity. Two 40-inch steel rings, top and bottom, make the rig easy to handle. Three-inch aluminum tubes can be at-

tached to the top ring to permit crews to carry the rig "sedan-chair" fashion.

Remote, simultaneous control of all ten cameras is achieved through a central control box that is connected to the rig by means of a 12-foot length of 36-conductor cable. The control box incorporates the following components:

1) Ammeter with selector switch that indicates the amount of current being drawn by each camera. One of the purposes of this feature is to provide advance indication of any possible motor burn-out or other malfunction, and to keep the energy balance equal.

2) Voltmeter that indicates condition of the 12-volt automobile battery which powers the device.

3) An electronic complex that automatically stops the 10-camera interlock when any one camera operates improperly.

Each of the Arriflex cameras is factory-equipped with a buckle-trip that stops the camera in event the film breaks, buckles or a lower loop is lost, etc. In such event, it would be indicated on the control box panel which camera was in trouble. Whenever all cameras are stopped through a malfunction, this safety control operates so quickly that no mechanical damage

can take place.

4) Pilot light that indicates when the 10-camera complex is running (shooting). This feature was installed primarily to aid the camera control operator when shooting in noisy areas or when the camera is suspended beneath a helicopter or other aircraft where sound of the cameras cannot be heard.

5) Fog button that turns on a cue light in each camera. This provides a start mark on the edge of the film as an aid to the film editor who must match up the heads of each of the ten film strips—each of which comprises a different segment of a given 360-degree circular scene.

6) Last but not least—a 50-ampere circuit-breaker, on-off switch.

During the actual shooting of a 360-degree scene, the f/ stops on all ten cameras must be identical to insure consistent perspective and depth of focus. The individual camera exposures are controlled and made uniform by means of neutral density filters.

The new Arriflex 16M camera was chosen for this multiple-camera rig because of its light weight, precise registration pin movement, the fact it can accommodate the lens desired, and its gear-driven film take-up and general rugged design. Each camera is equipped with a 400-foot magazine.

Following completion by Behrend's engineers, the camera was put through two weeks of rigid testing by the Niles organization. Immediately afterward Niles' camera crew was busy shooting the footage in 16mm color that will wind up as a 12-minute dramatic travelogue of the New York-New Jersey Port and its 14,000,000 people.

Meanwhile the Port Authority is building a circular theatre in its Heliport and Exhibit Building on the New York World's Fair grounds in which the ultra-spectacular film will be screened, and literally surround audiences. There will be no seats in this unique theatre. The circular screen will be about 7 feet above the floor, enabling visitors to wander about the theatre as projection of the picture is in progress. The projection room will be suspended from the ceiling, in the center of the theatre, thus eliminating obstructions on the floor. ■