Television Viewing of Rocket Engine Tests

By JAY P. MITCHELL

A remotely operated closed-circuit television system has been especially designed for viewing rocket engines under test conditions. The camera incorporates a zoom lens system, pan and tilt pedestal, and a weatherproof and soundproof camera housing. All camera functions, electrical, optical and mechanical, are completely controlled from a master control console. The problem of acoustic shielding against noise at levels around 200 db is described.

THE USE OF closed-circuit TV systems for remote observation has been adapted to many situations where, because of environmental conditions, a close study of an object or action would otherwise be impossible.

One of these situations is the viewing of rocket engines under test conditions. A major consideration in the design of the TV system is that of extremely high sound level conditions since sound levels as high as 200 db may be expected under test conditions. An additional consideration is that the camera must be able to cover a wide field of vision as well as provide close-up observation of an object. There should also be maximum coverage of the horizontal and vertical field of vision around the camera site. Since the camera is located outdoors, weatherproof camera housing is a necessity.

The controls for operating the TV system are located at a master control observation center several hundred feet from the rocket engine test site. Multiconductor cables connect the units of the system to the control center. The complete system is shown by block diagram in Fig. 1.

A vidicon-type camera chain of the Diamond Utiliscope Model 500 Series is used. This camera was chosen because of its small physical size and easy adaptation to remote operations.

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Sound Proofing

The camera is mounted on small rubber shock mounts inside a cylindrical housing of heavy-gauge steel. The shock-mounting is arranged to give shock protection in the longitudinal, lateral, and vertical directions. Another reason for internal shock-mounting is to prevent transmission of acoustic energy to the camera from the housing which would pick up noise radiated from the test cell. The interior of the steel housing is coated with a rubber compound to act as an absorber of external sound, and to prevent re-radiation inward to the camera.

To provide ventilation, holes were bored along the length and top of the housing necessitating a weather shield to prevent entrance of water into the housing. This shield is coated on the bottom with the rubberized compound and attached to the cylindrical housing by rubber shock-mounts. It also acts as

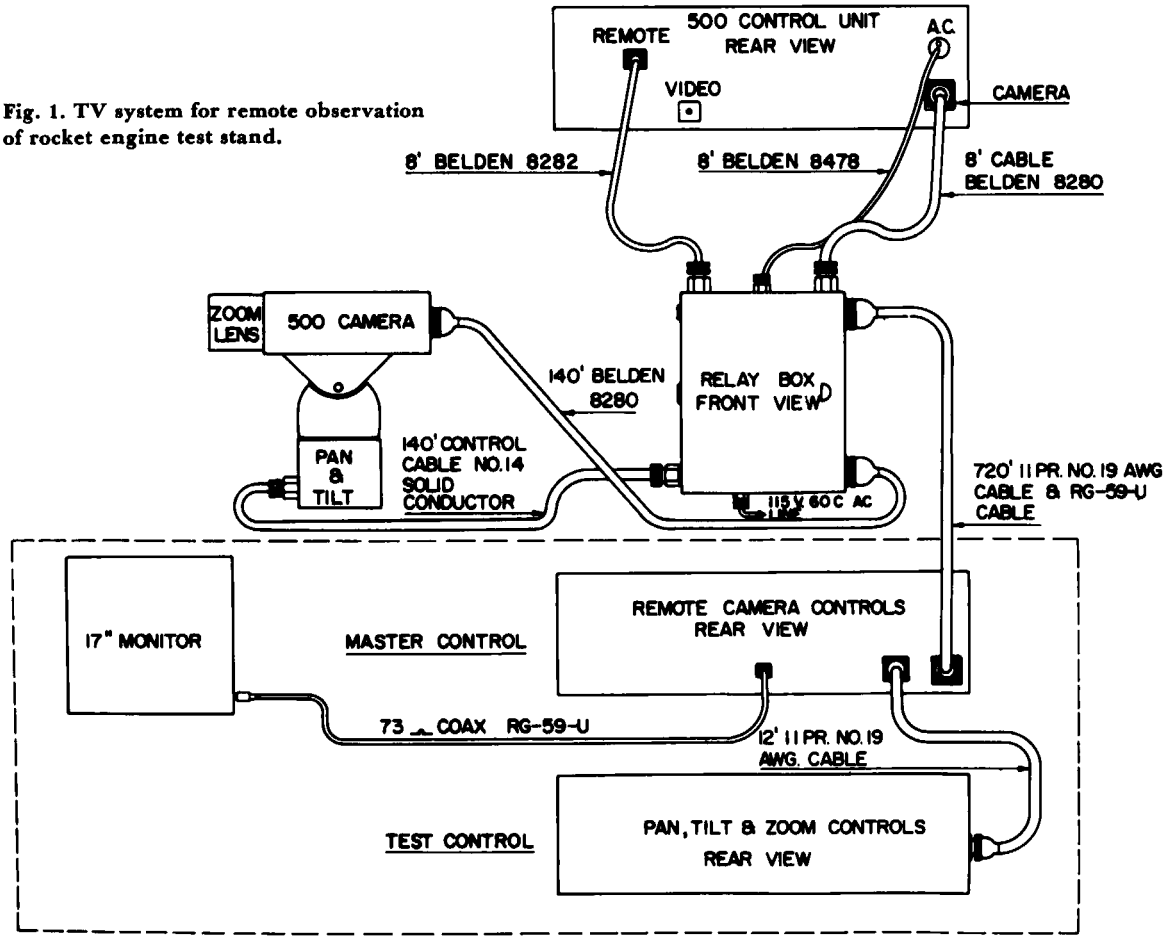

Fig. 1. TV system for remote observation of rocket engine test stand.

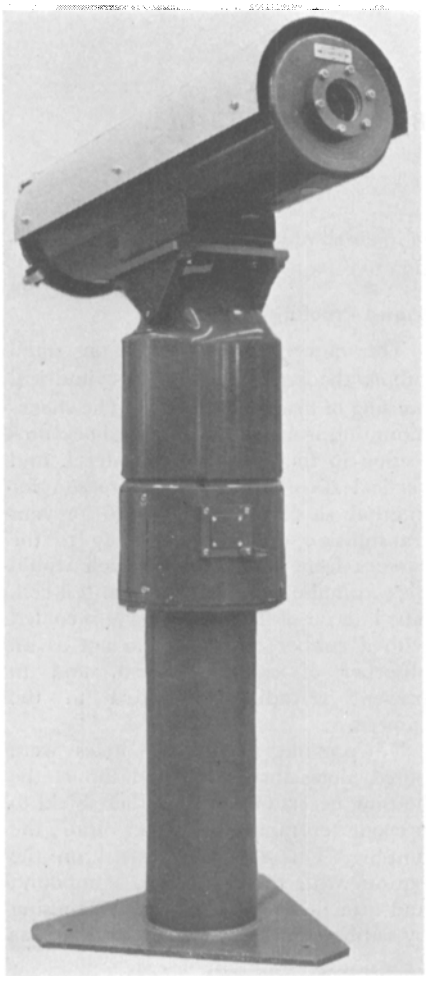

Fig. 2. Camera housing and pan and tilt pedestal.

a low-pass acoustic filter to reduce entry of noise through the vent holes.

The camera housing assembly is mounted on a motorized pan and tilt pedestal. A rubber pad is inserted between the housing and pedestal mounting plates to provide additional protection against vibration. The resilience of this pad is low to avoid interaction with the internal shock-mounts.

The front end of the camera housing is fitted with a thick glass window set in fiber bushings.

Optical System

The camera is equipped with a Perkin-Elmer zoom lens system. Small fractional horsepower d-c motors operate the zoom and zoom focus mechanism of the lens system. The focal length range of the lens is 30 to 150mm with a field of view of 30° at 30mm and 6° at 150mm. The maximum aperture is $f/2.7$ at 30 to 80mm focal length and $f/4.5$ at 150mm.* The lens iris is set at maximum aperture, since the TV equipment contains an automatic light level compensating circuit.

To fulfill the requirement for maximum coverage for the horizontal and vertical field of vision around the camera site, a motorized pan and tilt pedestal is used. This unit is capable of panning the camera through 320° and tilting it 45° above and below the horizontal plane of vision. This pedestal is constructed to support the weight of the camera and its housing (Fig. 2) (about 100 lb) and is weatherproof.

Operating Controls

To control operation of the pan and tilt motors, a relay control circuit is necessary. These relays are mounted in a box which also serves as a junction point for the multiconductor camera control cables. This unit is located in an area adjacent to the television control unit (Fig. 1). This area would normally be a protected location so that no special attention to shock mounting of the relays is required. All a-c power required to operate the TV system is fed into the relay control box and distributed from it.

An electrical braking circuit is included in the motor control circuit to prevent coasting of the tilt motor. A silicon rectifier rated at 5 amp supplies the direct current to obtain braking action when the tilt switch, located at the master control center, is released.

The control panel on which the tilt switch is located also contains the pan control switch, the power chassis and control switches for the zoom lens optical system. Two control switches are required to set the lens focusing so that the picture is constantly in focus as the lens is zoomed back and forth on the object by the zoom control switch. One switch operates the zoom focus motor and the other switch operates a fractional horsepower a-c motor in the camera. The a-c motor moves the camera vidicon tube with respect to the lens system. A selector switch gives the operator a choice of two speeds for the lens zoom control.

A second control panel is supplied with this system and this panel contains electrical operating functions for the camera, such as beam, target, electrical focus, blanking level, and the a-c power on-off switch.

* *Instruction Manual for the Auto-Zoom Lens Model 16TV*, Perkin-Elmer Corp.

Camera Chain

The vidicon camera chain consists of two units: a small camera, which weighs about 11 lb, and a control unit, which is constructed so that it can be rack mounted. The camera contains three video amplifier stages: two stages of blanking signal amplification, and the fractional horsepower focus motor. The amplifier stages utilize three subminiature tubes and one silicon transistor.

The control unit contains additional stages of video amplification, vertical frequency, and horizontal frequency scan circuits, automatic light level control circuit, vidicon protection circuit, transistor timer to generate the horizontal and vertical frequencies drive pulses for 525-line, 30 frames/sec interlaced scanning, and an electronically regulated power supply. The electrical controls for camera functions are normally located on the control unit, but in this installation, and others where remote control is desirable, controls are provided by a multiconductor cable. The camera and control unit are interconnected by a Belden Type 8280 multiconductor TV camera cable.

Summary

This television system was designed for a special application involving several complete systems of the type described here. As is generally the case in special applications of this nature, a complete solution of all problems arising in the field must be worked out during installation and initial operation of the equipment, under actual operating conditions. Undoubtedly, the use of closed-circuit industrial television for the study of rocket engine performance will be of increasing value in the furthering of scientific knowledge in this field.