Discussion

Charles Shelton (Radio Corp. of America): While engaged in a similar project at White Sands Proving Ground we have come up with similar conclusions. We, too, were concerned about the reduction of contrast when infrared filtering was used. I have seen it used in some applications with apparently satisfactory results, but we found at White Sands that in most practical applications the object did appear white, because it was above most of the atmosphere. Since you were interested in objects at lower altitudes, would you comment?

Mr. Roberts: I've heard some disrespectful people at White Sands refer to Point Mugu as the best instrumented fog bank in the world. The Navy's test range is on the Pacific coast, about 60 miles from Los Angeles. There is a smog problem. Most of the missiles tested do not exceed the altitude that research missiles at White Sands obtain. At such altitudes over water, the object contrast is usually darker than the sky. If it could be made lighter than the sky, it would greatly lessen the problem of getting range.

Harry Sombor (Pathe Pictures): Did the target imperfections — what we refer to as orth spots — give you erroneous information in these tracking operations?

Mr. Roberts: No. We must have had very good tubes because the orth spots didn't bother us. We defocused slightly to insure that they were invisible.

K. L. Warthman (Bell Telephone Laboratories): Do you have any figures on resolution — comparison between the film and TV systems in lines per millimeter?

Mr. Roberts: I can only say that the TV system is inferior to the film that was used. The two slides shown with the paper were super XX, but in the tests at Point Mugu color film was used. The film evaluators found it slightly easier to determine objects on the color film than on black-and-white.

Mr. Warthman: Have you tried using landing lights in the daytime?

Mr. Roberts: That has been discussed but it is usually impossible or undesirable to hang lights on an operational vehicle. The vehicle comes out for tests and the range people have to fire it without adding anything extra.

Mr. Wartham: Have you tried putting lights on airplanes that you track?

Mr. Roberts: No, because our primary concern is with missiles.

Hugh Stewart (Radio Corp. of America): Have you considered the effect of focal length on your tracking result? You used, I believe, a 600-cm. lens.

Mr. Roberts: In the equation, it was taken into account by the object size, alpha. We found that the optimum focal length was a cut-and-try procedure — it should be just long enough to insure that the object disappears because of loss of contrast rather than small size. This, on the other hand, raises the problem of target acquisition in the near range. It would be possible to use one TV camera with a short-focal-length lens and one with a long focal length. The tracking operator would then have what amounts to an instantaneous change of lenses at any time that the video operator switched from one camera to the other.

Charles O. Probst (Cinefonics, Inc.): Was there consideration of the infrared radiations of the power plant itself? Presumably the jet or rocket power plant would be emitting radiations not visible to the eye that could aid the tracking with devices such as those used in infrared-seeking missiles. Aircraft hot metal radiation peaks in spectral distribution at about 3.5 μ with ample energy emitted at wavelengths either side of this peak. See article in *Astronautics*, p. 33, May 1958.

Mr. Roberts: It was given serious consideration. The problem is to find a TV tube which is sensitive to infrared radiations of that wavelength. The infrared region which we use is the one sometimes referred to as the near-infrared region, just beyond the visible wavelengths. It is my impression that most radiations from jet engines are at considerably longer wavelengths.

Airborne Closed-Loop Television System

By ARTHUR F. FLACCO

An airborne television system which utilizes the image orthicon was developed for the USAF for use in a high-performance aircraft. The system requirements are such that the more sensitive wide-spaced image-orthicon pickup tube is used with a nonstandard line and field rate.

This television link is designed to meet Air Force specifications, for a specific Air Force requirement. This system is not a modified commercial chain despite the fact that some of the circuit requirements are quite similar to those of studio cameras. Most major circuit components are not recognizable when compared to their commercial counterparts. Tubes are JAN or military types. All components are ruggedized and adapted to military use. Materials and workmanship meet the requirements of Air Force equipment. The system is capable of operating with one or two cameras. The units required for operation as a single camera system are the camera, synchronizer, monitor and power supply. For dual camera operation, a second camera and an auxiliary unit are required.

Presented on October 7, 1957, at the Society's Convention at Philadelphia by Arthur F. Flacco, Airborne Radar and Missile Engineering, Defense Electronic Products, Radio Corp. of America, Camden 2, N.J. An earlier version of this paper appears in the *Proceedings of the National Electronics Conference, Vol. 13.*
(This paper was received on November 13, 1957.)

Description

The system operates with approximately 25 ft of cable between the cameras and the synchronizer and 170 ft of cable from the synchronizer to the monitor. To meet operational requirements, the yokes in the cameras and monitors were rotated 90° so as to obtain a raster scanning from left to right in the field or slow scan, and bottom to top during line or fast scan. "Horizontal" then became "vertical" and vice versa. In order to avoid misunderstandings, the terms "line rate" and "field rate" are used where applicable.

The power provided for the system is 400-c, 120-v, 3-phase a-c from the ship's supply. The complete dual camera system requires about 3 kw of power at maximum load. Over one-third of this power is required for heating the two cameras when the coldest conditions prevail. Normal power consumption when heating is not required is approximately 1800 w.

Temperature, altitude, vibration and shock characteristics of MIL-E-5272A (specifications applicable to airborne equipment) are required. Operation is required at temperature extremes from +160 F to −76 F, altitudes above 50,000 ft, impact shocks up to 10 G for 20 msec and under vibrations from 5 to 500 cycles.

In addition to these requirements, no components are permitted to operate at a temperature that might ignite fuel used by the plane and no corona or arcing is permissible. Vibration effects were not permissible in the picture presented on the monitor.

Unit Description

Camera

The tube used is the "Wide-Spaced" Image Orthicon, designated thus because it has a 150-mil spacing between the glass target and mesh as compared to a 3-mil spacing in the image orthicon commonly used for commercial studio work. By increasing mesh-to-target spacing, target capacity is reduced. This effects improved vibration characteristics, reduced time lag, and most important, better signal-to-noise ratios at very low light levels.

The wide-spaced tube is capable of producing useful signal information at 1×10^{-5} ft-c on the photocathode. At 1×10^{-3} ft-L of scene brightness the wide-spaced image orthicon can reproduce more information than can be discerned by the dark-adapted human eye.

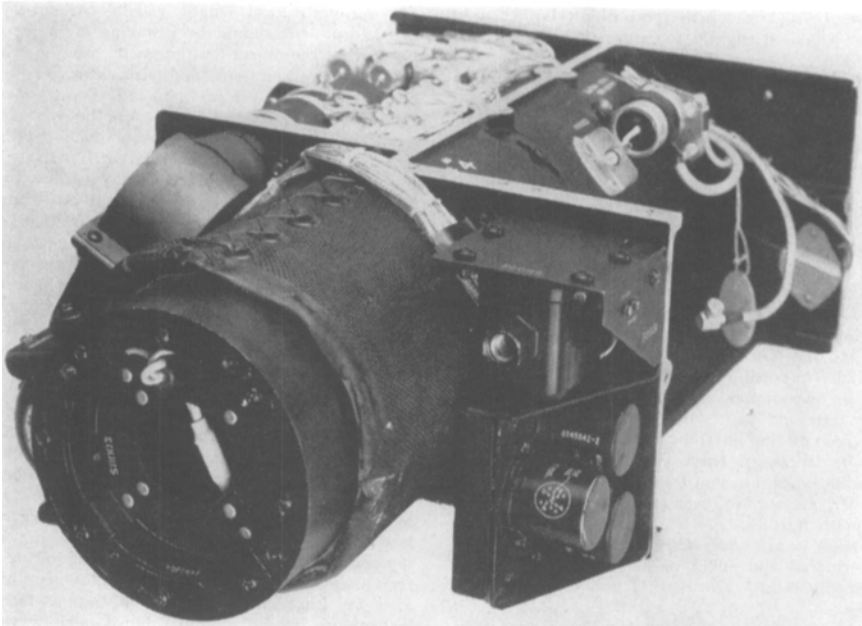

Fig. 1. Camera housing image orthicon. Camera contains preamplifier with voltage-regulated plate supply, dynode voltage dividers and heating and cooling system.

The camera housing the image orthicon (Fig. 1) contains a preamplifier, a voltage-regulated plate supply for the preamplifier, and the dynode voltage dividers. It also contains the heating and cooling system, which consists of a series of resistive heating elements in an internal forced-air system. This system maintains the image orthicon temperature within operating limits. In addition, the air stream is by-passed or recirculated in response to changes in the outside ambient temperature. At higher altitudes a barometric switch reduces the power in the convection heaters and heating is accomplished primarily by conduction through the camera housing. This system enables the camera to be brought to operating temperature within 20 minutes at any altitude from sea-level to over 50,000 ft.

Power Supply

The power supply unit (Fig. 2) provides all the d-c power needed to operate the system and includes some control circuits necessary to operate the camera.

Six volts d-c is provided for the filament of the image orthicon in one camera. Three regulated d-c supplies (+250, +150, −150 v d-c) are provided. A relay used in common with all three supplies causes them to go into operation after a time delay. This allows sufficient filament warm-up time to protect all tubes for approximately 54 sec before the plate supplies become available. The system also has a "standby" switch and an "emergency override" switch which by-passes the time delay and makes the plate supply voltages available immediately.

The power supply also contains a regulated focus current supply for one camera. A number of the controls necessary to adjust the camera are included in this unit. They are alignment controls, multifocus, image-orthicon gain, field size, and horizontal centering. A coaxial relay actuated from the control panel switches video from either camera to the monitor.

Monitor

The monitor (Fig. 3) contains a kinescope and associated circuitry which includes monitor line rate deflection, monitor and camera field-rate deflection, kinescope ultor-voltage, and a video amplifier.

Field-rate deflection is obtained by taking field-rate drive pulses from the synchronizer, and using them to trigger a field-rate deflection circuit. The circuit consists of a sawtooth generator, sawtooth amplifiers, and a power output tube which drives the field-rate yoke through the output transformer. Thermistors in series with the field-rate yoke compensate for temperature changes that would change the field-rate scanning.

Line-rate deflection is obtained through use of a reaction scan circuit from which an ultor voltage of 10 kv is obtained. A conventional damper diode prevents ringing in the line-rate sweep. The high voltage supply is regulated by means of a corona regulator tube.

The video signal obtained from the camera preamplifier is amplified in two stages, then d-c restored with a driven clamp. External mixed blanking obtained from the synchronizer is added to the video signal.

Synchronizer

The synchronizer (Fig. 4) generates the sync signals for the system. The field rate is 50 cycles with 2-to-1 interlace. The line rate is 625 lines/sec. The basic oscillator frequency is 31,250 cycles/sec, which when counted down in a 5:5:5:5 sequence yields the 50 cycles for the field rate. A divide-by-two stage provides 15,625 cycles for the line-rate drive and blanking signals. Other circuits in the synchronizer include most of the auxiliary circuits for one camera.

Auxiliary Unit

The units described comprise the equipment required for single camera operation. When using both cameras, an auxiliary unit is required. This unit contains the field-rate deflection circuits and most of the auxiliary circuits for the sec-

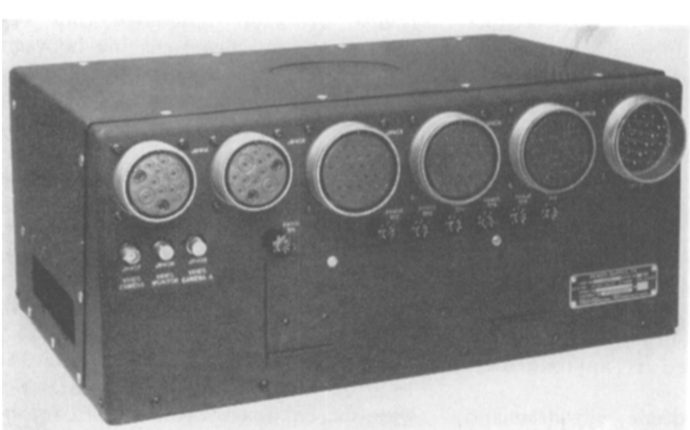

Fig. 2. Power supply unit for d-c power to operate the system.

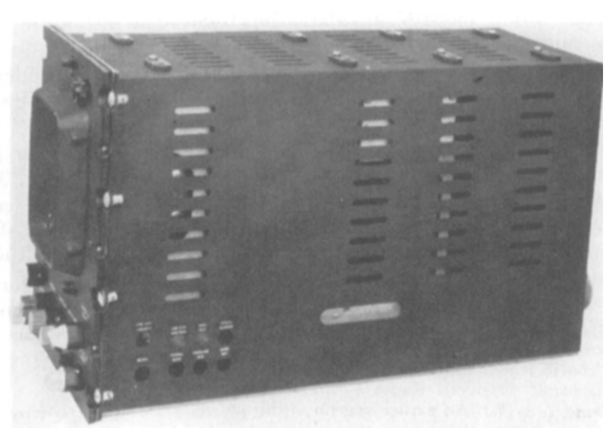

Fig. 3. Monitor containing kinescope and circuitry.

ond camera. Line-rate deflection is obtained, as noted above, from the synchronizer. During dual camera operation, the line-rate deflection yokes of both cameras are in parallel. When the second camera is removed it is necessary to substitute a dummy load consisting of an inductance simulating the second yoke.

System Performance

Because of schedule requirements it was not possible to thoroughly test engineering prototypes before this paper was written. It is expected that picture quality approximating that of studio equipment will be obtained at normal operating temperatures. At extremes in temperature some degradation is expected but it will probably be minimized through the use of the camera temperature-control system, feedback in deflection circuits, and the use of precision components in critical circuits.

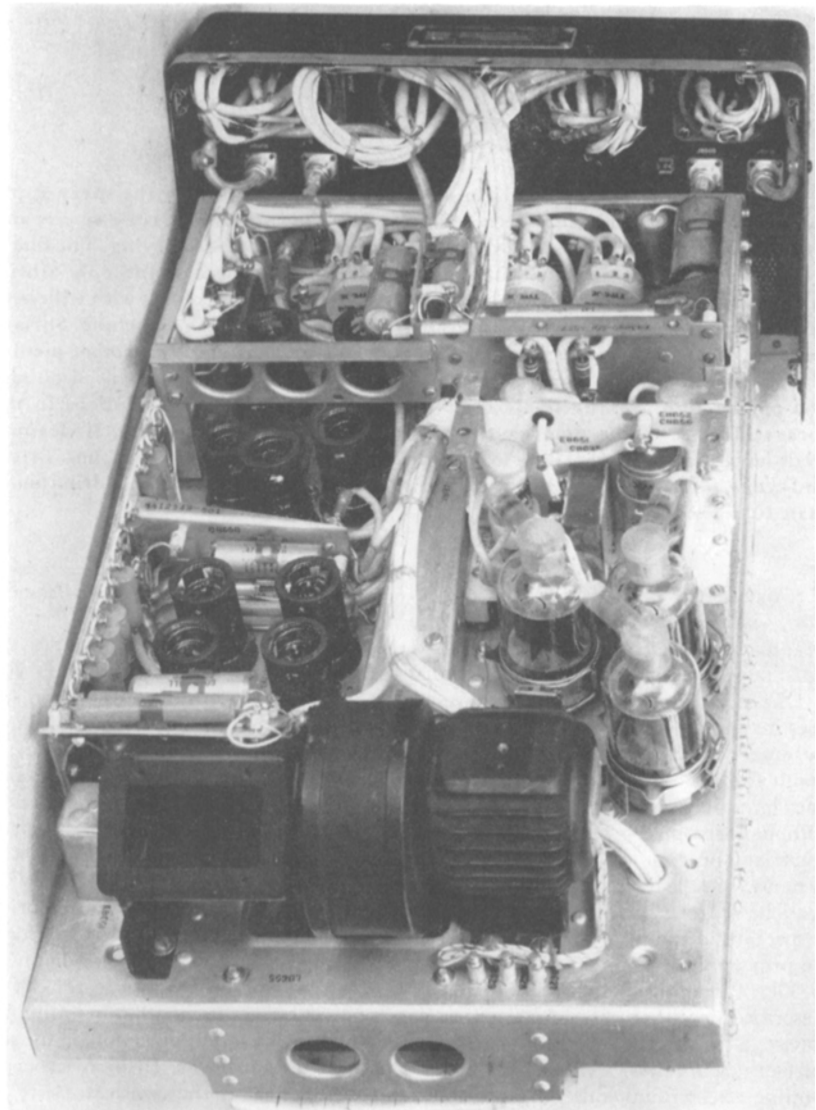

Fig. 4. Synchronizer generating sync signals for the system. Other circuits include auxiliary circuits for one camera.

Errata

A Directory for Members, April 1958, Part II:

On p. 9, change under **Papers,** *Europe*, GERMANY:
for: Hans J. Jost, Zerbster Str. 65, Berlin, Lichterlelche, Ost, Germany
read: Dr. Adolf Kochs, Bavaria-Filmkunst Ag, Schliessfach 9, Munich 9, Germany.

On p. 30, *for:* **Daily, C. R.,** Optical Eng., Paramount Pictures Corp.
read: ———, Hughes Aircraft Co., Research and Development Laboratories, Culver City, Calif.

On p. 36, *add:* **Haber, Jack,** Production Mgr. Mecca Film Labs. Mail: 1058 Cramer Ct., Baldwin, L.I., N.Y.

On p. 44, *for:* **Kreuzer, Barton,** Manager, Marketing, Astro-Electronic Products, Princeton, N.J. (F), *add* Radio Corp. of America.

On p. 48, *for:* **McGeary, Frank M.,** Pres., Motion Picture Laboratories, Inc. Mail: 1508 Pinewood St., Falls Church, Va. (M), *read:* ———, Mail: 1672 Union Ave., Memphis 4, Tenn. (M)

On p. 48, *for:* **Miller C. David,** Asst. Supvr., Eng. Research, Battelle Memorial Institute. Mail: 1511 Lincoln Rd., Columbus 12, Ohio. (M), *read:* ———, Cons. in Research and Development, 326 W. Fifth Ave., Columbus 1, Ohio. (M)

Progress Report, *Jour. SMPTE, 65:* 289–343, May 1958:

On p. 289, *The Committee: add* J. M. UNGER who was an active contributor to the report and was inadvertently omitted.

On p. 306, col. 1, para. 4; and Fig. 31: *Note* — The illustration presented as Fig. 31 is the Auto-Vac Model L, a vacuum forming machine of The Auto-Vac Company, 1984 State St. Extension, Bridgeport, Conn. This equipment, described as the largest vacuum forming machine ever made, has been used for making large sheets of fire-resistant plastic for studio set construction at the Columbia Broadcasting Studios.

On p. 322, col. 3, para. 3: *for:* The Industrial Vidicon Camera Channel Type BD835A . . ., *read:* The Industrial Vidicon Camera Channel Type BD-871. . . . (Figure 56 (p. 323) shows the BD835A which is earlier equipment not illustrative of the description on p. 322. The BD-871, as described on p. 322, is shown in the New Products column of this *Journal*, p. 510.)