DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

A Novel Application of High-Resolution Camcorders For the Marine Environment

by

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Open-File Report 92-537

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Introduction

This paper describes a new self-contained video camera and recording system designed to produce broadcast quality color video of underwater geological landscapes. Short time constraints and limited funding required that we redesign an existing deep-sea pressure case, previously housing our old video camera. The new design had to allow enough space to pack the video camera, recorder, and any additional electronic devices to program or distribute power. All electronic devices were to be mounted on a removable chassis mounted to the rear end cap of the pressure. The design criteria was for compactness and simplicity of operation while also affording the operator full access to each device for programming and servicing.

System Description

Old Version

The old video recording system (Chezar et al., 1985) was comprised of a two-part spherical glass housing which contained the video cassette recorder (VCR), tuner-timer (TT), and time-date generator (TDG). Power was derived from a separate battery pack and then distributed through the TT located in the glass sphere to all system electronics. The TT synchronously controlled the video lights and video camera power. An electronic relay served as a switching device to turn on the video lights. Camera power and video signal return was transmitted through the junction block and recorded on the VCR (Fig. 1A). The TDG superimposed time and date on the video signal prior to being recorded. The video camera (Fig. 2A) was housed in its own custom built pressure case (Fig. 3). All system component housings and connections were required to operate properly in ocean depths up to 6,200 m, equivalent to ambient pressures of 10,000 PSI.

An important limitation of this system was the steps required to program the VCR, TT, and TDG. To program the video to turn on once the camera system was near the ocean floor the operator had to set numerous switches prior to deploying over the side of the ship (Fig. 4). Once programmed, the glass sphere had to be methodically reassembled and bolted onto the camera frame, ensuring the numerous electrical and mechanical connections be properly mated. While this process was long and laborious it was quite successful throughout its years of use.

New Version

To replace and greatly simplify the operation we took advantage of the new video technology of high resolution camera recorders (camcorders). The camera we chose to be the heart of the system was a Sony Hi8mm TR-81 camcorder. With the camera and recorder combined as one unit we were able to totally eliminate the sphere which contained the VCR and other electronics (Fig. 1B). The quality improvement of Hi8mm over the old Betamax III recording speeds is greater than 150 lines of horizontal resolution, providing the broadcast level of recording we desired. The other advantage of Hi8mm recording is that the cassette size is one-fifth that of the Betamax cassette.

With the old system capable of recording up to four hours our only major stumbling block was how to record an equivalent four hours in Hi8mm format since the maximum recording time was only two hours per cassette. To overcome this limitation we chose to place two camcorders in series (Fig. 2B). By using the camera head of the most forward looking camcorder to video the underwater scenes and switching the recording from the front recorder to rear video tape recorder after two hours, the four hours of recording time was possible. In addition, these camcorders have built into their electronics a time-date superimposition capability eliminating the need for the TDG previously used. To replace the TT a miniature microprocessor positioned behind the camcorders was chosen to control the camera and lights The advantage of this configuration is that operator set-up time now is faster and less prone to electrical and mechanical mishap. With all components optimally packaged into one pressure case the new prototype meets the design parameters initially established.

Pressure Case Redesign

The old video camera pressure case was modified to house the new dual camcorder system. This conversion of the pressure case for the new video system necessitated drilling a new set of holes in the existing end caps to locate the square metal rods holding the system components. These new holes could not interfere with those already existing. To do this the entire pressure case and end caps were drawn into a Computer Aided Design (CAD) system. The new holes and case features were then superimposed on the drawing to ensure there was no interference.

The sectioned drawing (Fig. 4) shows the case and end caps, including both the old and new case features. By careful alignment of the camera within the case we were able to use the existing front window for the camera lens. Then only two additional holes on the interior surface were required to align the entire camera carriage with the window. The entire camera carriage, including the camcorders, microprocessor and switching electronics are mounted to the rear end cap. All of the holes were aligned either to make use of existing holes or to clear them without interference.

Once the machining was completed, the end caps were reanodized for protection and to provide a surface for painting. In the future, additional systems or replacements can be machined directly from the completed enlarged set of drawings.

Field Results

Recent field operations in the spring of 1992 recovered over 14 hours of Hi8mm video at seven camera stations. The video quality was some of the best we have ever recorded. We experienced two problems which limited our results. The first was that we learned it was essential that the camcorder be in manual focus preset rather than automatic infra-red focus. In automatic focus mode the camera tended to focus on bubbles lodged outside the front window or small particulate floating in the water column directly in front of the camera window. The second problem involved the tow cable inducing a high frequency vibration to the camcorder in the video housing creating a slight shaking and audibly noticeable hum. By more securely fastening the camcorder against the top mounting rod the vibration should be eliminated. More camera operations are planned in early 1993.

Figure Descriptions

Fig. 1 - These two flow diagrams compare the electronic paths necessary to operate the old and new video systems. By incorporating the video camera, recorders, and programming controls in the same pressure case (A) the glass sphere and junction block (B) can now be eliminated greatly simplifying the system layout.

Fig. 2 - With the end caps pulled out from the housing the mechanical configurations of the old and new video systems can be compared. The old design (A) has the camera attached to the front end cap while the new layout (B), places both camcorders, and switching electronics in-line and bolted to the rear end cap. This new design greatly simplifies servicing since now only the rear end cap needed to be pulled leaving the rest of the housing attached to the camera frame.

Fig. 3 - The video camera pressure case. Encircling the cylindrical housing is the lifting handle which also serves as an attachment point to the camera sled. The housing is made of high tensile strength aluminum and capable of a 6200 m operating depth.

Fig. 4 - Prior to deploying the old video system the operator must set the proper times on the programmer. To do this the sperical glass housing must be opened and connected to a monitor to verify VCR, TT, and TDG settings. Once set the sphere must be reassembled and attached to the camera platform.

Fig. 5 - Mechanical drawings of the video camera housing showing front, rear and internal views. Notice how the in-line placement of the camcorders allows enough room for mounting switching electronics and terminal strips towards the rear end cap.

Bibliography

Chezar H., Lee J., (1985) A new look at deep-sea video. Deep-Sea Research, Vol. 32, No.11, pp. 1429-1436.

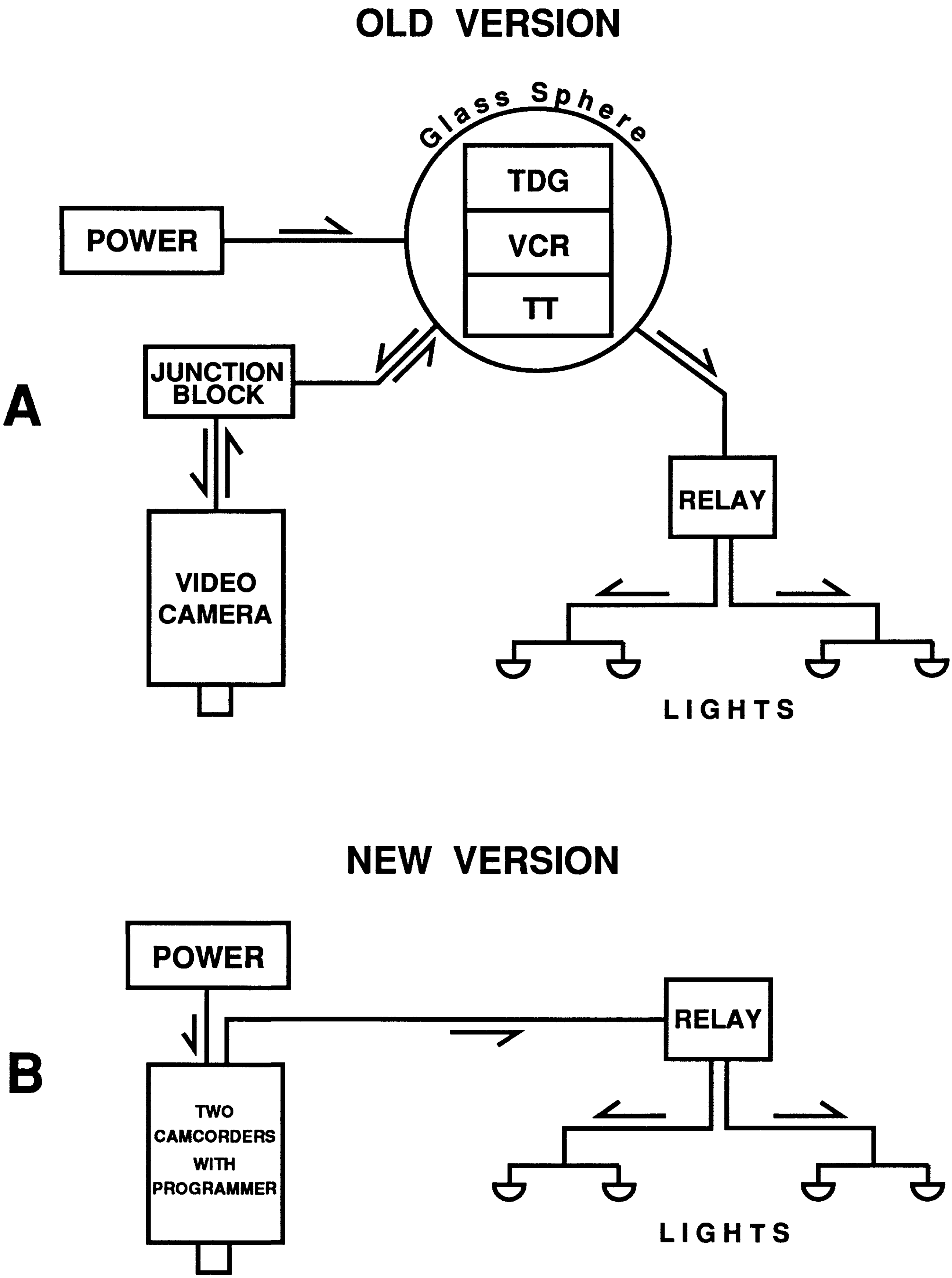
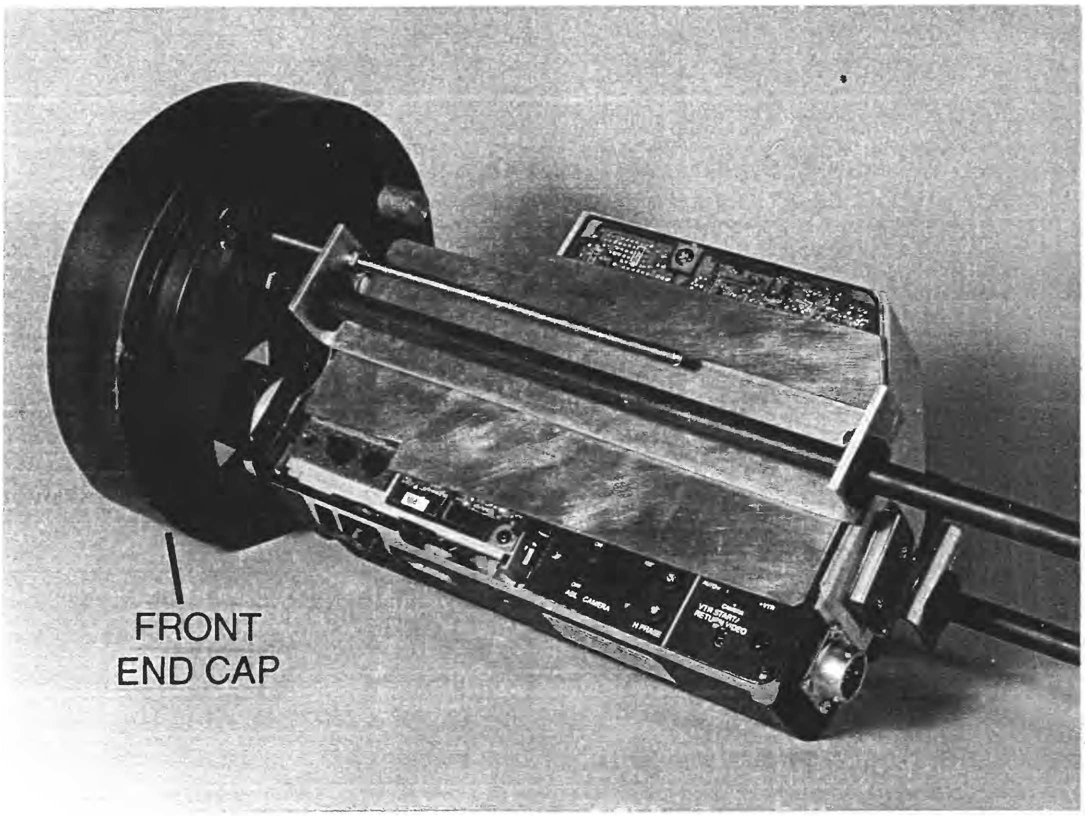

OLD VERSION
A
Glass Sphere
TDG
VCR
TT
POWER
JUNCTION BLOCK
VIDEO CAMERA
RELAY
LIGHTS
NEW VERSION
B
POWER
TWO CAMCORDERS WITH PROGRAMMER
RELAY
LIGHTS

Fig. 1

(A)



(B)

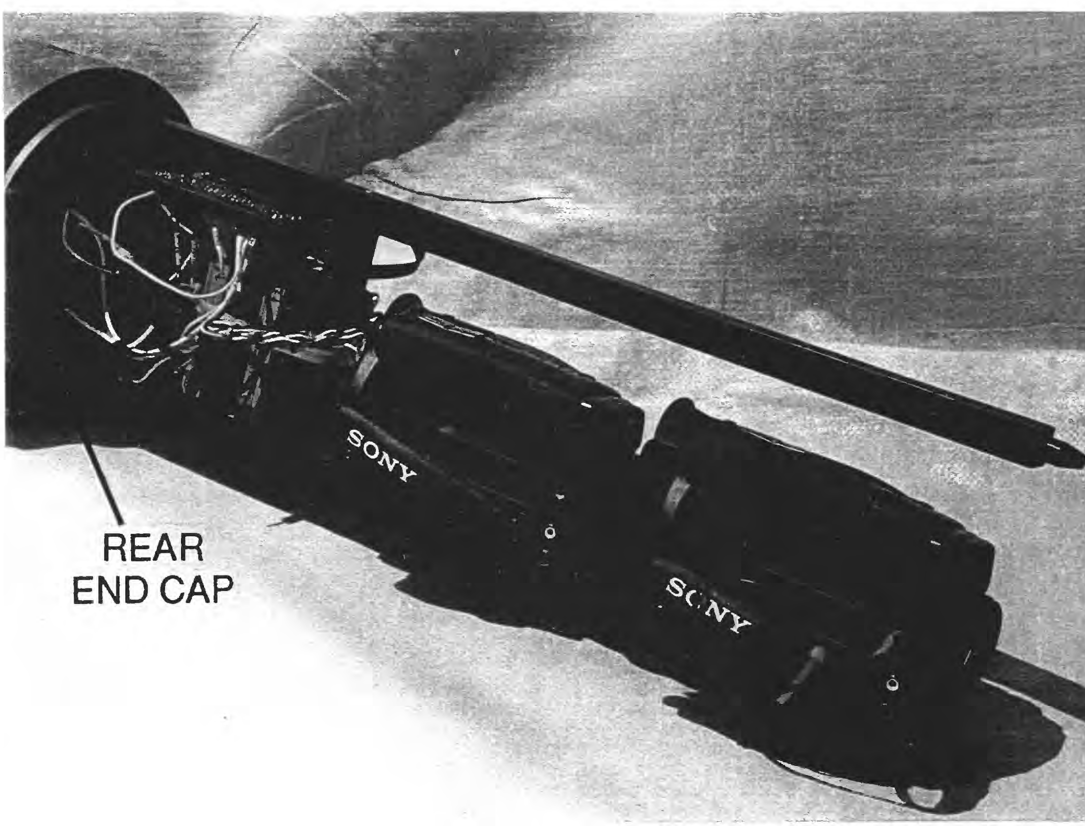


Fig. 2

Fig. 3

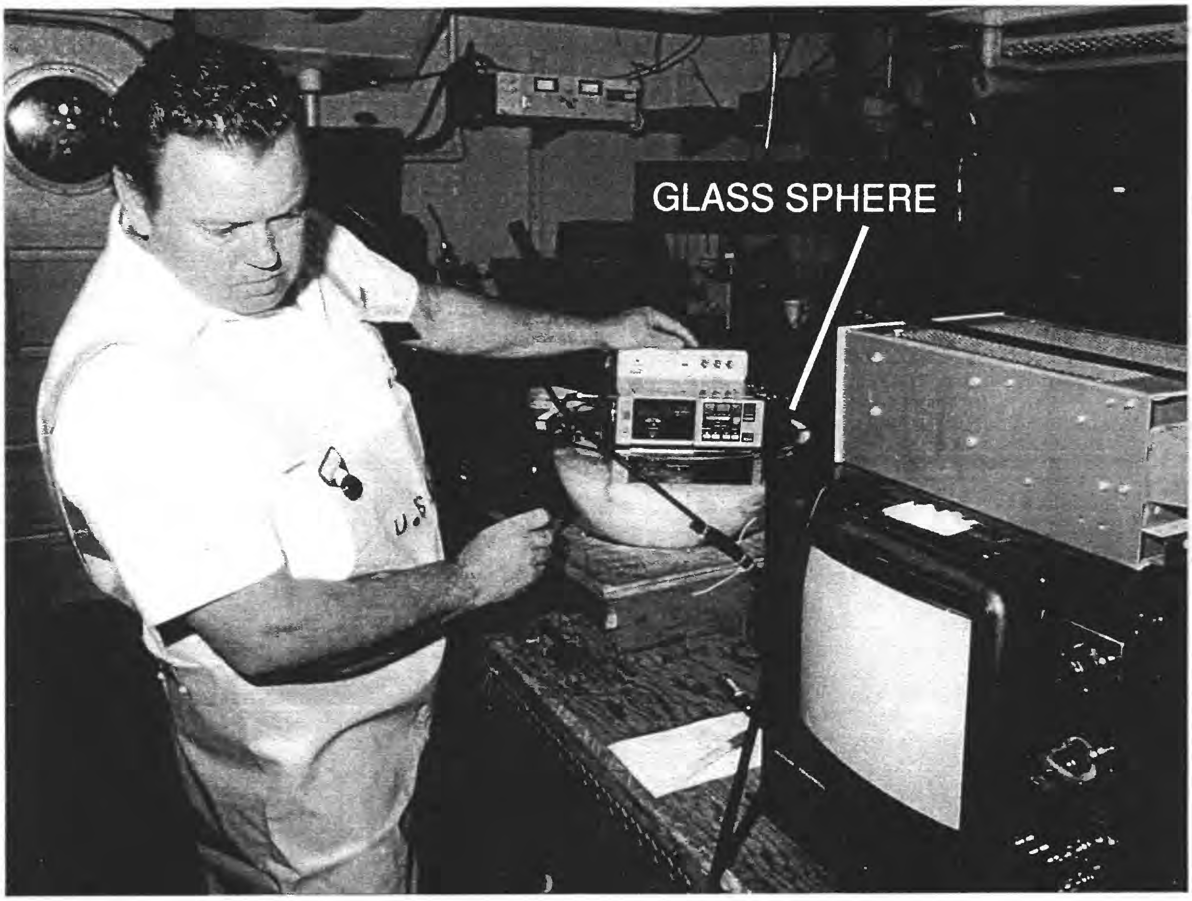


Fig. 4

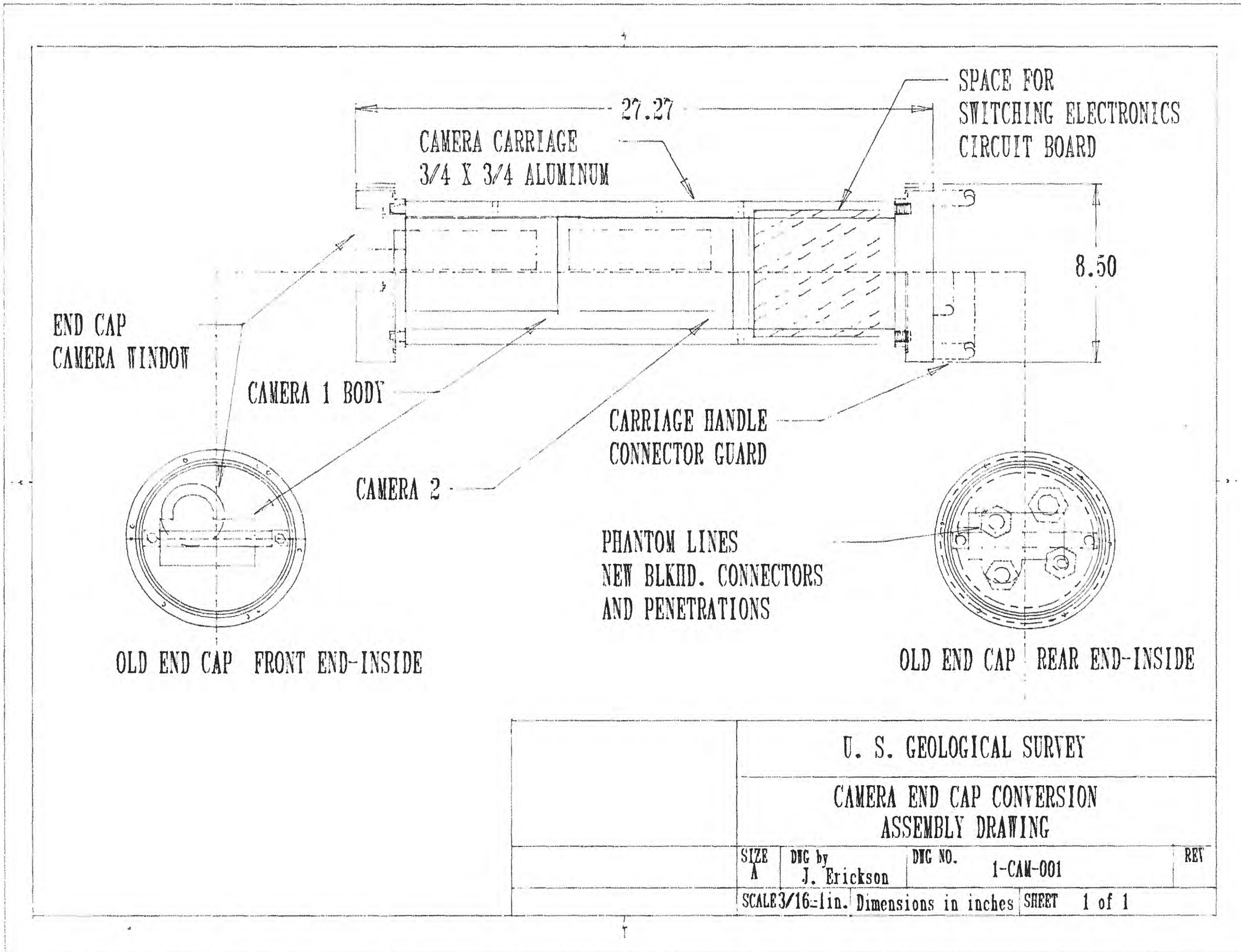

27.27
CAMERA CARRIAGE
3/4 X 3/4 ALUMINUM
SPACE FOR
SWITCHING ELECTRONICS
CIRCUIT BOARD
8.50
END CAP
CAMERA WINDOW
CAMERA 1 BODY
CARRIAGE HANDLE
CONNECTOR GUARD
CAMERA 2
PHANTOM LINES
NEW BLKHD. CONNECTORS
AND PENETRATIONS
OLD END CAP FRONT END-INSIDE
OLD END CAP REAR END-INSIDE
U. S. GEOLOGICAL SURVEY
CAMERA END CAP CONVERSION
ASSEMBLY DRAWING
SIZE A
DWG by J. Erickson
DWG NO. 1-CAM-001
REV
SCALE 3/16=1in. Dimensions in inches
SHEET 1 of 1

Fig. 5