THE USE OF PORTABLE UNDERWATER TELEVISION IN JAPAN

by Minoru NISHIMURA
Fisheries Agency, Ministry of Agriculture and Forestry, Tokyo
and Masamitsu HARA
The Nippon Columbia Company, Kawasaki City

1. — INTRODUCTION

In the past decade underwater television seems to have been widely used all over the world. However this has not been the case in Japan because the underwater optical conditions around Japan are not good, and also because the price of the equipment was so high that potential users could not easily afford it. The recently developed techniques in television and transistors have however stimulated the production of portable and low cost underwater television sets which can be easily applied in the field of oceanographic and fishery research [1].

This paper deals with the fundamental features of portable underwater television equipment, its operation in the sea, and some of the results obtained.

2. — UNDERWATER OPTICAL CONDITIONS AROUND JAPAN

One reason that underwater television has not been applied widely in our country is that underwater visibility is not good in the sea around Japan. Transparency does not there generally exceed 20 metres, with the exception of a few examples in special locations where the visibility is up to 30 metres, and it can therefore be said that the underwater optical conditions are not very suitable for the use of underwater television apparatus.

The relationship between the distribution of illuminance and the sea depth is shown in figure 1. The clearest water was observed in summer 1966 around Sado Island in the Japan Sea, but this is a special case. It seems, however, that the transparency around Japan is generally limited to less than 20 metres.

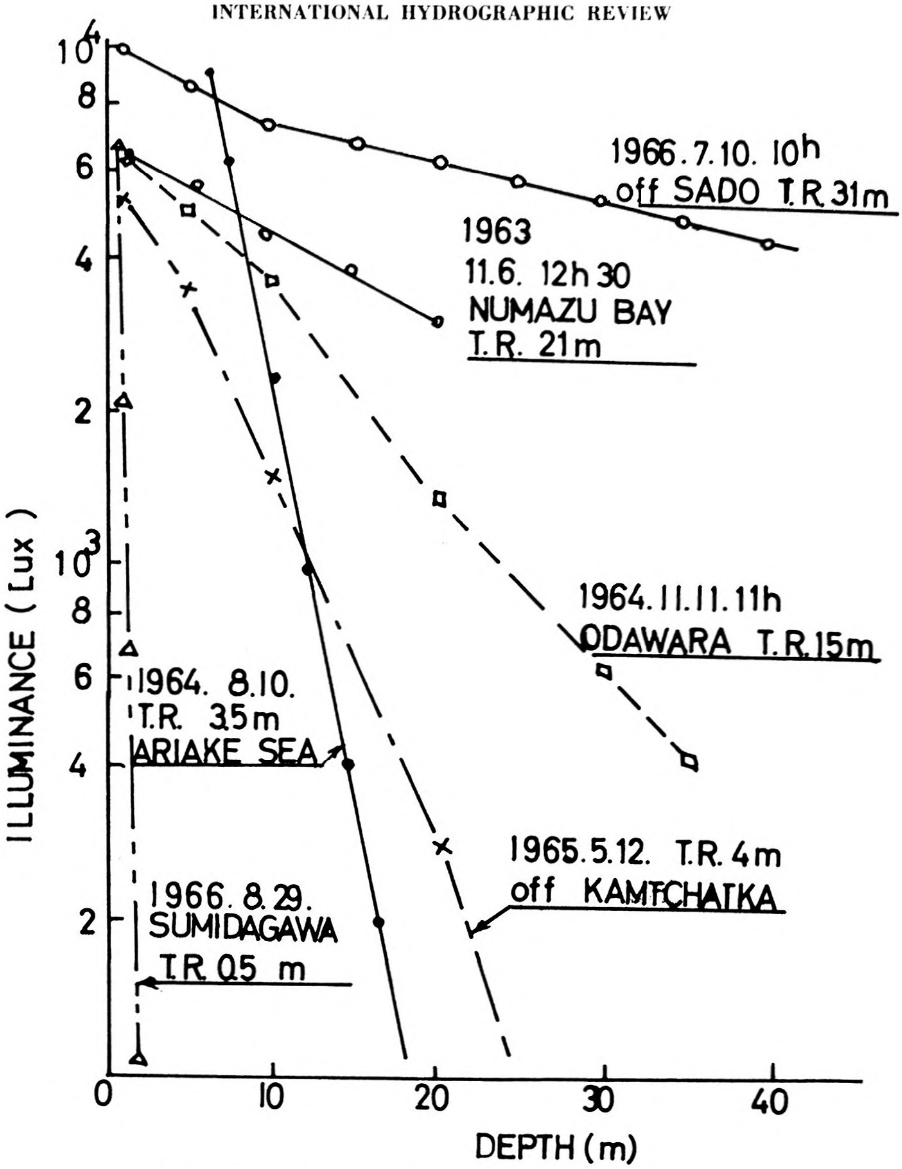

FIG. 1. — The relationship between the illuminance distribution and sea depth for the sea around Japan.

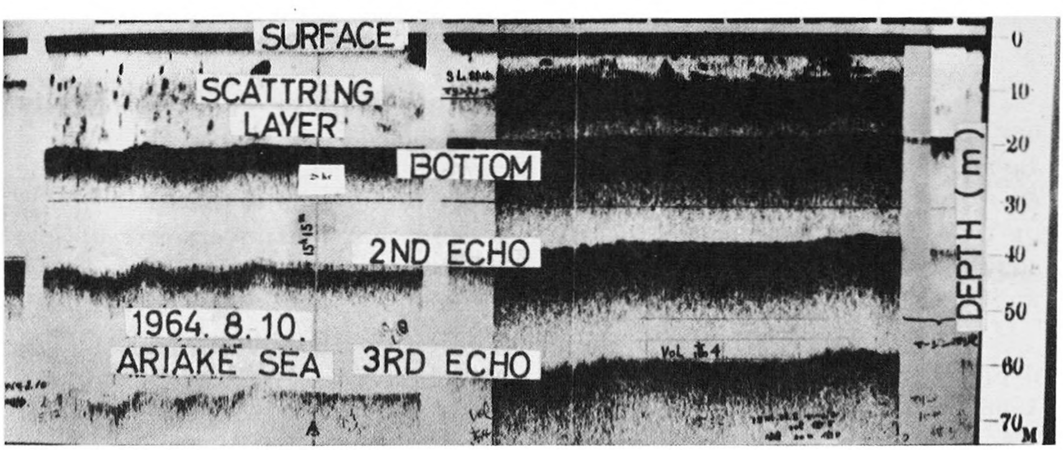

FIG. 2. — Scattering layer appearing on the echo-sounder chart.

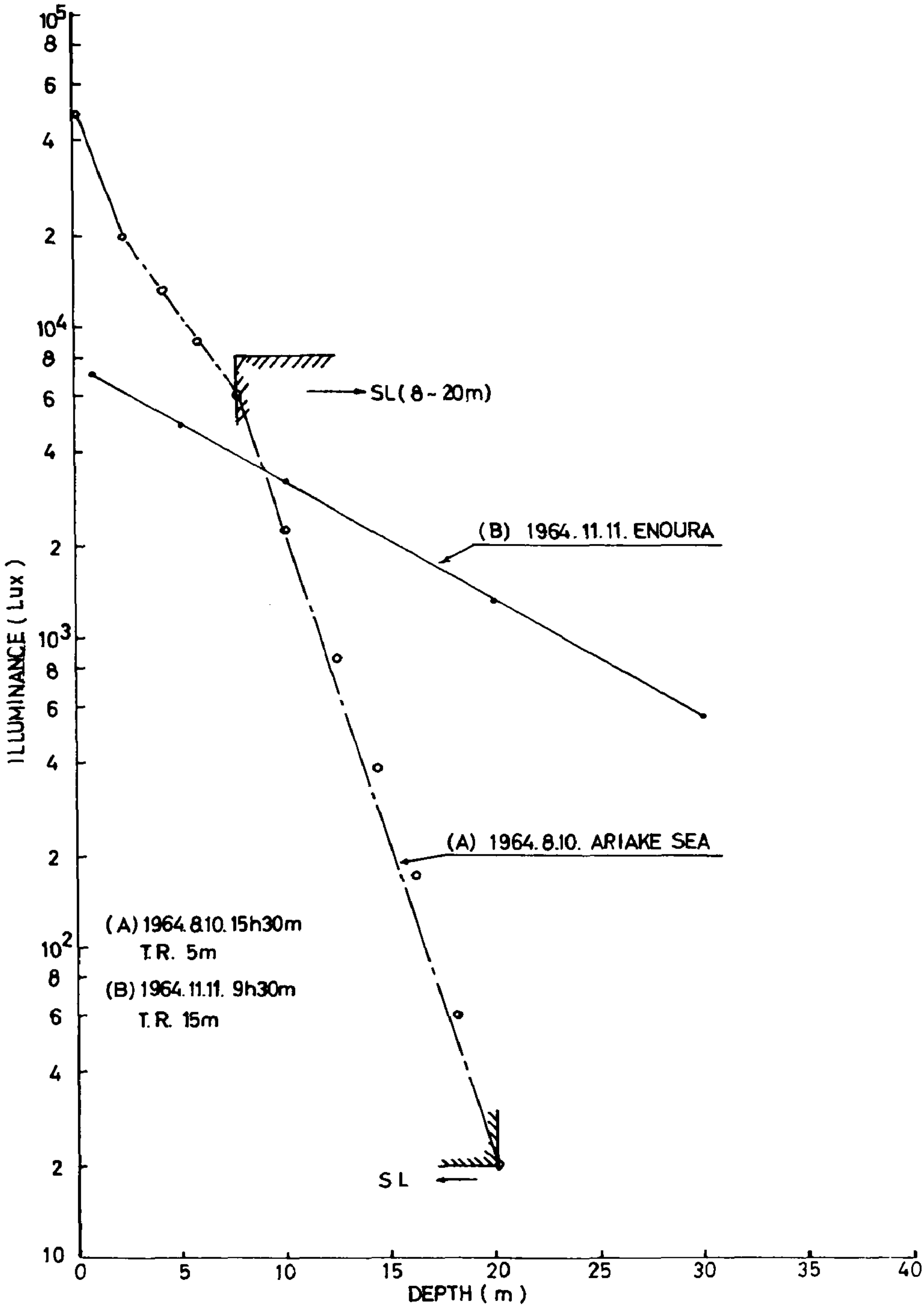

Fig. 3. — Change in underwater illuminance caused by scattering layer.

Underwater illumination must be used in many cases in order to get a clear image on the T.V. monitor because the sensitivity of the vidicon tube is not very high.

Illuminance of more than 100 lux on the object is desirable. In some of the underwater layers which have been considered the gathering of plankton, marine snow and other suspended material, owing to their optical absorption and scattering, constitutes a great obstacle to the use of underwater television. Figure 2, for example, shows the scattering layer as it appears on the echo sounder chart, and on which marine snow and soil can be observed. In such an area the vertical distribution of illuminance changed at the depth where the scattering layer appeared, and this is shown in figure 3.

From the results of many experiments at sea it can be said that the maximum distance that can be observed in the sea is about half the transparency value measured by Secchi disc.

The optical underwater conditions around our country therefore presented some difficulties to the designers of underwater television equipment.

3. — FEATURES OF UNDERWATER TELEVISION

The diagram of the assembly of a newly constructed underwater television set is shown in figure 4, A being the underwater television camera, B the T.V. monitor, and C the electric cable. The azimuth of the camera in the sea is indicated on the screen of the monitor by means of a magnetic compass, D, and an ultrasonic device (i.e. the transducer E) is used for measurement of the distance between the camera and an object, such as fish, in order to know the size of the object appearing on the screen of the monitor. An underwater still camera can be attached to the television camera to take a picture of the same scene as it appears on the television monitor.

The main features of this newly constructed underwater television equipment are as follows :

A. — Television system

(1) Pick up tube Vidicon 7262-A

(2) Lens : 12.5 mm, F 1.4

(3) Scanning : 630 lines, random interlace

(4) Picture frequency : 25 c/s

(5) Field frequency : 50 c/s

(6) Video amp : 5 Mc

(7) Resolution : 400 lines
(8) Picture angle : 42° (vertical)
(9) Power supply : 24 Volt D.C., or 100 Volt A.C.
(10) Spotlight : 150 Watt × 2
(11) Cable length : 200 m, max.

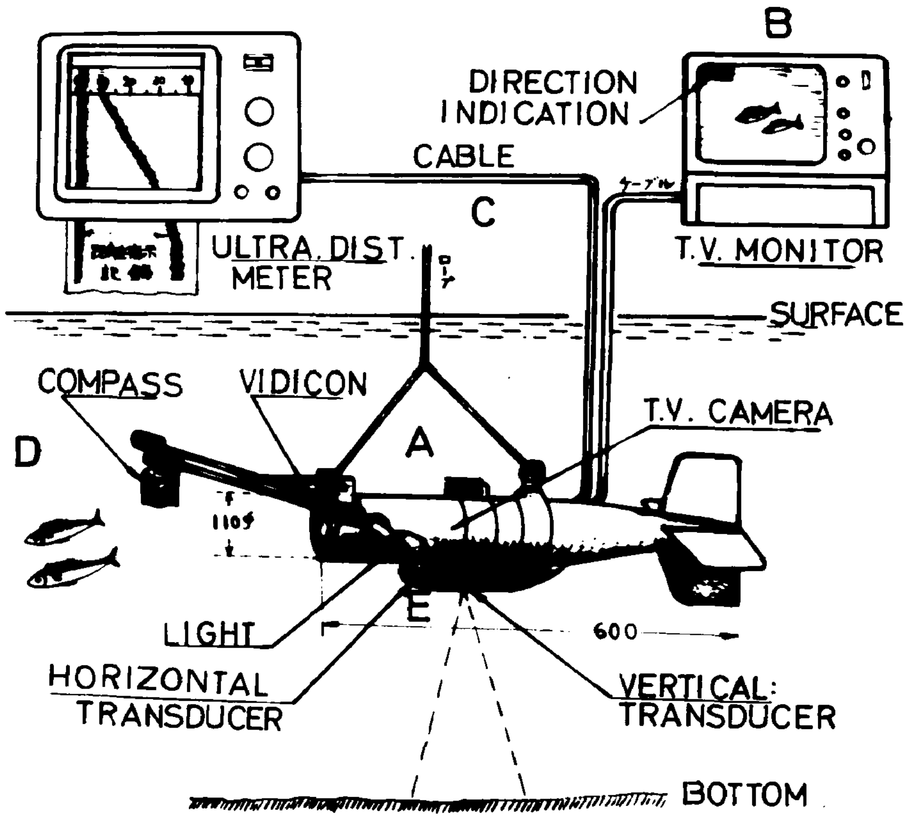

Fig. 4. — Diagram of the newly constructed underwater television equipment.

B. — **Acoustic system**

(1) Frequency : 200 kc/s
(2) Range : 0-40 m, 30-70 m
(3) Recording system : Wet or dry paper
(4) Transducers : Vertical, 40 mm in diameter
Horizontal, 30 mm in diameter
(Barium Titanate)
(5) Beam Angle : Vertical, 8°
Horizontal, 10°
(6) Minimum detection distance : 50 cm from camera

C. — **Underwater still camera**

(1) Camera : Ricoh Autoshot
(2) Lens : F. 2.0
(3) Operation : Shuttered remotely from boat
(4) Film width : 36 mm; black and white, or colour
(5) Film operation : 15 or more scenes can be shuttered automatically.

In this equipment the monitor screen will indicate clear underwater vision provided that there is sufficient underwater illumination. Figure 5 shows a comparison between the site pictured on a T.V. screen and an underwater still camera photograph. It is to be noted that the image pictured on the screen shows sufficient clarity around the submerged object. However, it would be desirable to combine the T.V. camera with a still camera for cases of instensified investigation.

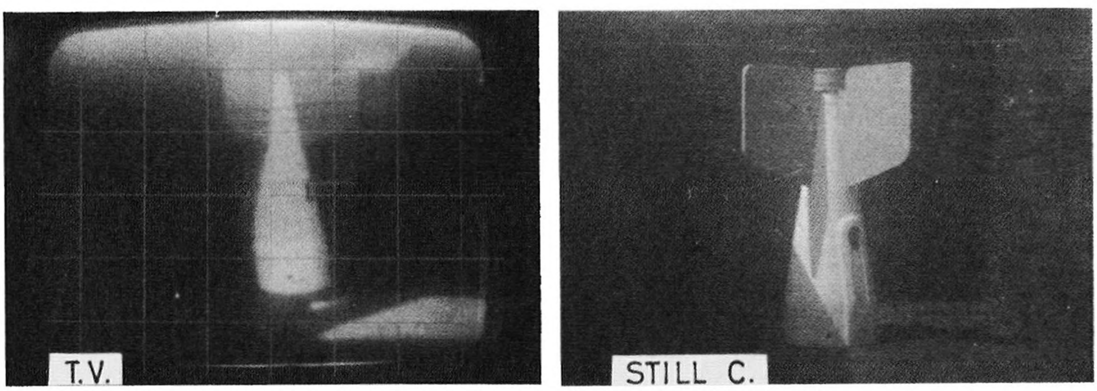

FIG. 5. — Comparison between a T.V. image pictured on a screen and a photograph taken by an underwater camera.

4. — OPERATION

For field operations the T.V. camera is usually installed on a frame. Figure 6 shows a photograph of a frame on which the T.V. camera, the underwater still camera and strobo flash are assembled.

There are several means of making sea observations : use of a frame or a sledge etc.

For continuous observations of underwater phenomena near the sea bed the camera unit is installed either vertically or horizontally on the frame which will be fixed to the sea bottom. The quality of the bottom, movements of fish and of current can be observed by such an arrangement.

When scanning for bottom quality or for counting fish, star-fish, shell-fish or crabs the frame is moved slowly at a speed of 1 to 2 knots by raising the frame to 50-100 centimetres above the seabed. From this experiment the authors obtained good results in their observations of the distribution of king crab, star-fish and the breathing holes of scallops.

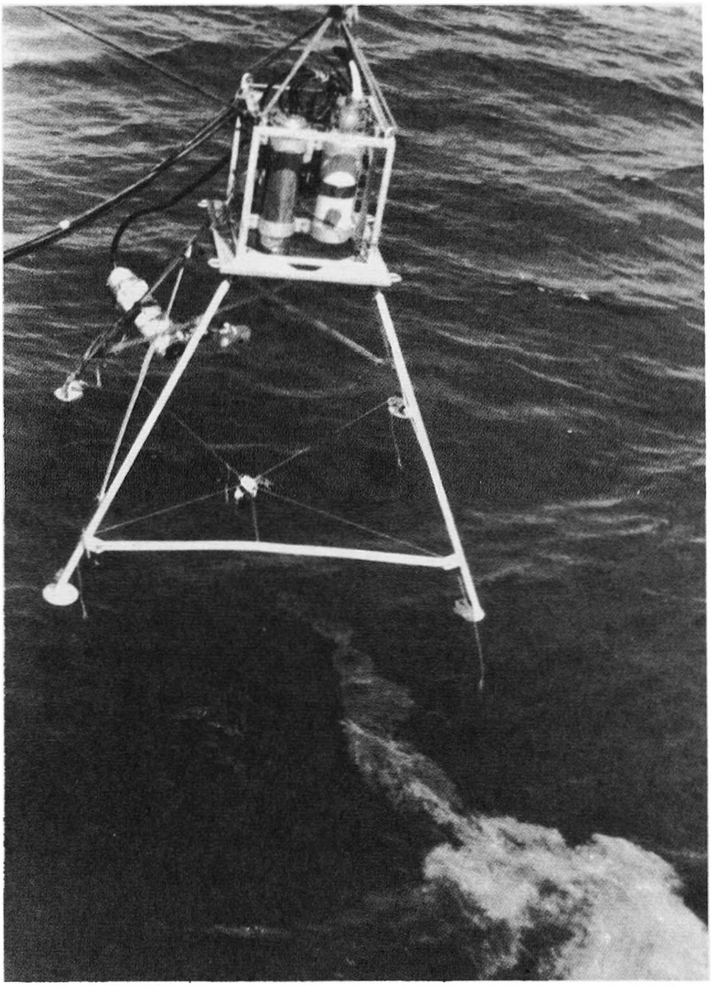

FIG. 6. — Installation of T.V. camera and still camera.

Two installation methods, namely the rotary and the sledge systems, are used for searching the sea over a wide area. In the rotary system a vertically installed camera is panned and tilted around the frame. The sledge system, which is towed by a boat, is used to make wide searches. There were no troubles caused by vibration of the sledge being towed over the sandy bottom at a speed of up to 2 knots on either the electronic circuit or the monitor screen image. Bottom ripple marks, distribution of star-fish, and some flatfish escaping at the approach of the sledge were observed on a sandy bottom at a depth of 30 metres. This system is also useful for observing the operations of laying submarine cables.

5. — APPLICATION OF UNDERWATER T.V. [1] [2]

The authors have used the newly constructed portable underwater television unit combined with the underwater still camera for undersea observation around Japan and in the Sea of Okhotsk. They have been able to observe many interesting submarine phenomena and to take pictures both for the T.V. monitor screen and using the underwater still camera.

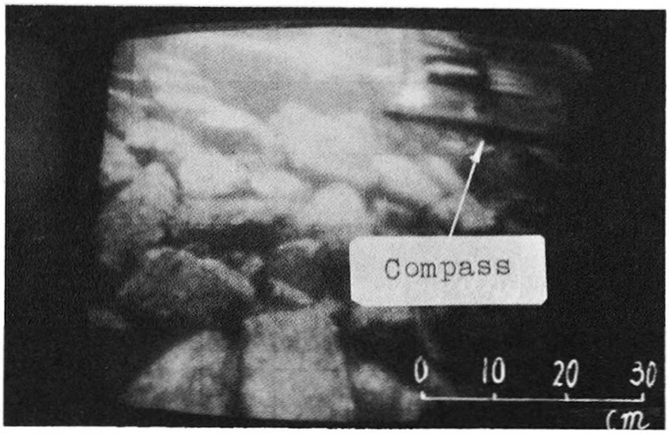

FIG. 7. — Photograph of T.V. screen showing rocky bed and location of underwater magnetic compass (6 November 1962, Numazu Bay, transparency 20 m).

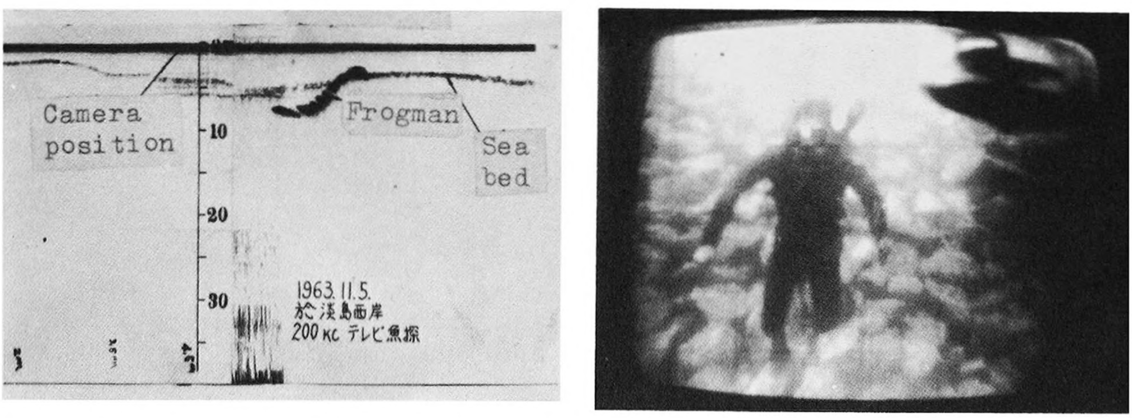

FIG. 8. — Photograph of T.V. screen showing frogman, and the echo-trace of his dive. (6 November 1962, Numazu Bay, transparency 20 m).

Figure 7 is of the image pictured on the T.V. screen and shows the rocky bed and the underwater magnetic compass for measuring the azimuth of the camera. Figure 8 shows a frogman swimming in front of

FIG. 9. — Photograph of T.V. screen showing a King Crab.
(10 May 1964, Okhotsk Sea, 57°28′ N - 156°27′ E, transparency less than 5 m).

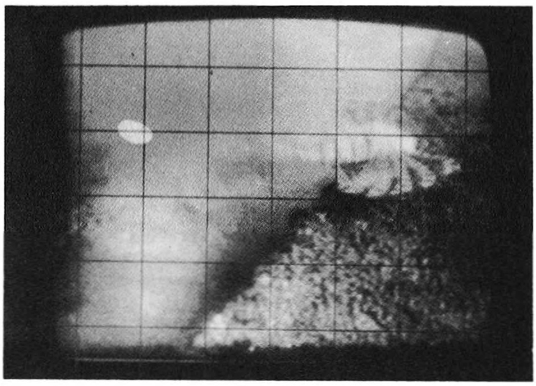

FIG. 10. — Photograph of T.V. screen showing fish near fish-dwelling.
(10 August 1964, off Nagasaki port, transparency 12 m).

FIG. 11. — Construction of net set at a depth of 80 m.
(6 July 1966, off Sado Island, transparency 31 m).

the camera and also his echo-trace as it appears on the ultrasonic distance measuring device. Figure 9 shows the image of a king crab as observed on the T.V. monitor in May 1965 off the Kamtchatka Peninsula in the Sea of Okhotsk where the transparency near the bottom was less than 5 metres. Figure 10 is a T.V. image of a fish in a fish-dwelling on the bottom at a depth of 20 metres. Figure 11 is the picture taken by a still camera of part of a net set at a depth of 80 metres, the construction of the net being clearly visible.

An underwater television set and still camera can be used to gain knowledge of the mechanism of underwater currents. Figure 12 shows an example of indicating the bottom current movement by shedding dyes in front of the camera.

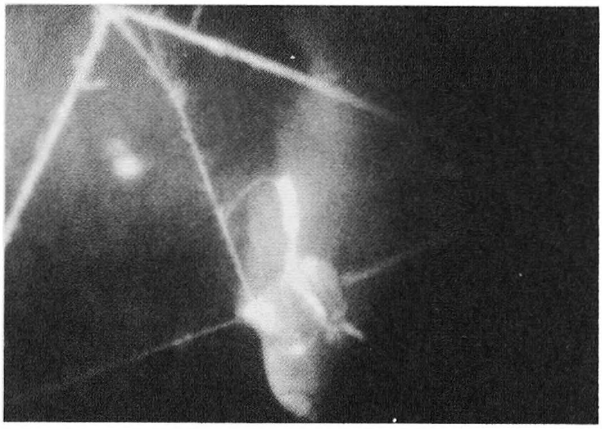

Fig. 12. — Observation of the mechanism of bottom current. (12 September 1966, off Takamatsu City, transparency 5.5 m).

6. — CONCLUSION

The experiments made in the sea around Japan indicate that the newly constructed underwater television set is useful for observing underwater phenomena even in such bad optical conditions as a transparency of only 4 metres. This television is easy to use because it can be operated on a 24 volt battery with a capacity of 50 amp/hours, and moreover it can be installed on even small boats of about 10 metres in length. The price of this television is not too high, so that marine constructors and fishery companies can comfortably afford it (the domestic price is less than 4 000 U.S. dollars for the basic unit).

It can be concluded that underwater television is useful for obtaining a rough estimation of the size or shape of an object. However, the combination of underwater still camera with the television is more effective for the investigation of the detail of objects. The authors also recommend the use of an underwater cine-camera and a Video Tape Recorder to make underwater oceanographic and fishery investigations fully effective.

REFERENCES

[1] HASHIMOTO, T., N. NISHIMURA, Y. MANIWA : Study on Underwater Television combined with an Echo-sounder. *Technical Report of Fishing Boat Laboratory*, **18** (9), 1964.

[2] NISHIMURA, N. : Study on the Applications of Underwater Television. *Technical Report of Fishing Boat Laboratory*, **20** (4), 1966.