

ATLANTIC OCEANOGRAPHIC GROUP

St. Andrews, N. B.

384

AN UNDERWATER CAMERA

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Introduction

To provide a useful tool for various aspects of marine research an underwater camera has been constructed which has proved satisfactory in comparatively shallow water. Some of its limitations have been examined, its mechanical features have been perfected, and it remains to be field tested as an instrument for a specific investigation.

General Description

A sketch of the unit is given in figure 1, showing the placement of the various parts. The arrangement is essentially similar to that used by Ewing and others at Woods Hole. The parts are assembled on a long pole which is so weighted as to retain its vertical aspect when lowered to the sea-bed. Uppermost is a water-tight case with a glass insert in its cover. On the inside of the cover are mounted camera and flash cells, and the case is mounted so that the camera is directed, through the glass, toward the bottom.

A few feet from the bottom of the pole a reflector is mounted for direction of the light from a photo-flash bulb into the field of view of the camera.

At the bottom of the pole is a switch which, on contact with the bottom, energizes a circuit which trips the camera lens

and fires the flash lamp.

Photo I shows the unit in position for lowering from the station launch.

Camera

The camera is a Kodak Vigilent Six-20 with Kodak Anastigmat f4.5 lens. This has proved to be quite an adequate instrument. Its size has necessitated having a rather large case, but the larger negative and eight exposure film roll give it certain advantages over the smaller 35 mm. cameras. Early examination of results can be made without cutting film strips or enlargement of negatives.

A solenoid tripper is attached to the shutter release. Four photo-flash cells in series form the supply which operates solenoid and flash bulb in parallel. The solenoid is adjusted to synchronize shutter opening with maximum brilliance of the light source.

Case

The case is constructed of a 10 inch length of 8 inch steel pipe, one end of which has been closed by welding in a steel plate. The other end is threaded to take the cover. A bracket is attached which mounts the case at such an angle that, when attached to the top of a 15 foot pole, the field of view of the camera just excludes the foot of the pole.

The cover consists of a 3/4 inch steel plate with a threaded lip. The thread has a fine pitch so that the milled edge of the case may be brought hard against a thick rubber gasket set in the cover. In the centre of the cover a 3/8 inch glass plate of 2 1/2 inch diameter is inset. The glass is set between rubber gaskets

and held down by a retaining ring.

The camera and flash cells are mounted to the cover and two twin conductor cab-tire cables lead through water-tight glands to the switch and to the reflector. The cover, with equipment mounted, is shown in Photo II.

Reflector

The reflector is one taken from an old automobile head-light. It has been given a high gloss white enamel finish.

A single contact bayonet type socket is mounted to take a #5 photo-flash bulb. The socket is kept packed with vaseline to cut down corrosion but no other protection is provided since the extremely low resistance of the flash bulb renders the short circuiting effect of salt water negligible.

The reflector is placed as close to the bottom as is consistent with good illumination of the field, so as to minimize loss of light and loss of resolution due to scattering.

Switch

A sketch of the switching apparatus is shown in figure 2. It consists of a micro switch sealed in a length of brass pipe. To the actuating arm of the micro switch is attached a small high permeability magnet. A sliding band on the outside of the pipe carries a similar magnet, so that the interaction of the two magnets holds the switch open. When the unit rests on the bottom, the band is pushed up, separating the fields and permitting the switch to close. This band is fastened to a lead weight which at once holds the unit vertical and prevents the switch from being closed by water resistance while lowering.

Poles

Two poles are provided. The shorter one gives a fixed camera to bottom distance of $5\frac{1}{2}$ feet; the other permits variation of this distance in steps from 3 feet, 8 inches to 13 feet, 8 inches.

Operation

The unit is first set up for the camera to bottom distance indicated by water conditions and detail desired. To allow for the index of refraction of water the camera focus is set to 0.75 times the distance.

With Kodak Super XX or Plus X film a shutter speed of $1/25$ or $1/50$ m. has been found satisfactory and permits a lens opening of f8 to f16 at the $5\frac{1}{2}$ foot distance with light 3 feet from the bottom. A little experience will make the choice of a suitable exposure an easy matter.

The shutter is cocked and the solenoid plug engaged, then the cover is screwed on tightly. A light application of water-proof grease to the gasket improves the seal. Next a flash bulb is inserted in the reflector and the unit is lowered to the bottom.

It is necessary to open the case after each exposure to advance the film and cock the shutter. This is not considered a disadvantage since even the models with automatic film advance must be brought to the surface to replace the bulb and to activate the shutter mechanism. There is little difficulty in obtaining a seal that will be tight in a few hundred feet of water and the time consumed in opening and closing the case is negligible.

Water Conditions

Suspended particles, of whatever nature, in the water cause scattering of light with a consequent loss of resolution. Under

extreme conditions so much scattered light enters the camera that the image is obscured and an apparent over-exposure is produced.

Water transparency should be evaluated with a Secchi disk before operation. This surface measurement may be entirely unrelated to the transparency at the depth of operation, but in general, it gives a fair indication. Camera to bottom distances of greater than half the Secchi disk reading should not be used, and it is not felt that worth-while results will be obtained in water where the disk reading is 10 feet or less except where the bottom is one of extremely high contrast.

As scattered light tends to be predominantly blue, some improvement may be obtained by the use of a light yellow filter (k-3) when operating under conditions of low transparency.

Field of View

A table is appended giving the approximate linear dimensions of the field of view and the depth of focus. These are tabulated for various lens openings and the different camera to bottom distances given by the poles provided.

As the camera looks to the field at a definite angle, the scale will not be constant over the field. This must be considered if it is desired to scale objects in the photographs.

Experimental

Photos IV to XII show some of the experimental pictures taken. Photo IV was taken in very clear, shallow, water at Chamcook lake for the purpose of checking the field of view and focus. The others were taken under less favourable conditions in Head Harbour. No printable negatives were obtained in Passamaquoddy

bay where Secchi disk readings of around 10 feet seem to be the rule. It is felt that the negative makes a record much superior to the print since many details which would be meaningful to a trained observer are lost entirely in printing, due to the low contrast which characterizes the bottom in this area.

Auxiliary Equipment

A list of equipment which should accompany the camera in the field is appended.

Appendix I

Field of view and depth of focus

<u>Camera to bottom</u>	<u>Focus</u>	<u>Approximate Field</u>	<u>Depth of focus</u>
		Short Pole	
5½'	4.1'	2' x 3'	f 5.6 5'1" - 6'1" f 8 4'11" - 6'3" f 11 4'9" - 6'10"
		Long Pole	
3'8"	2.8'	1½' x 2'	f 5.6 3'6" - 3'11" f 8 3'5" - 4' f 11 3'4" - 4'3"
5'8"	4.3'	2' x 3'	f 5.6 5'3" - 6'4" f 8 5'1" - 6'6" f 11 4'10" - 7'
7'8"	5.8'	2½' x 4'	f 5.6 6'11" - 9'1" f 8 6'8" - 9'3" f 11 6'3" - 10'6"
9'8"	7.3'	3½' x 5'	f 5.6 8'5" - 11'7" f 8 8' - 12'4" f 11 7'4" - 14'3"
11'8"	8.8'	4' x 6'	f 5.6 9'9" - 14'8" f 8 9'4" - 15'7"
13'8"	10.3'	5' x 7'	f 5.6 11'2" - 17'6"

Appendix II

Check List for Photographic Field Work

A. Photographic

1. Film supply Kodak Plus X or Super XX is recommended.
2. Flash bulbs G. E. #5
3. Film tank
4. Changing bag Suitable for loading film tank unless a dark room is available.
5. Developer Kodak DK60 A is recommended as a long lasting developer which gives quite a fine grain finish. If it is desired to make great enlargements of the negatives a fine grain developer such as Kodak Microdol should be used. Developer should be carried in a number of bottles each containing enough to fill the tank.
6. Fixer Any standard acid fixing bath.
7. Filters

B. Supplementary

1. Secchi disk Complete with line and weight.
2. Bar for tightening cover.
3. Waterproof grease for cover gasket.
4. Vaseline

C. Tools and Repair Equipment

- | | |
|--------------------------|-----------------------|
| 1. Pliers | 6. Light hook-up wire |
| 2. Screwdriver | 7. Rubber tape |
| 3. Solder iron (small) | 8. Friction tape |
| 4. Rosin core solder | 9. Rubber cement |
| 5. Photo flash cells (4) | |

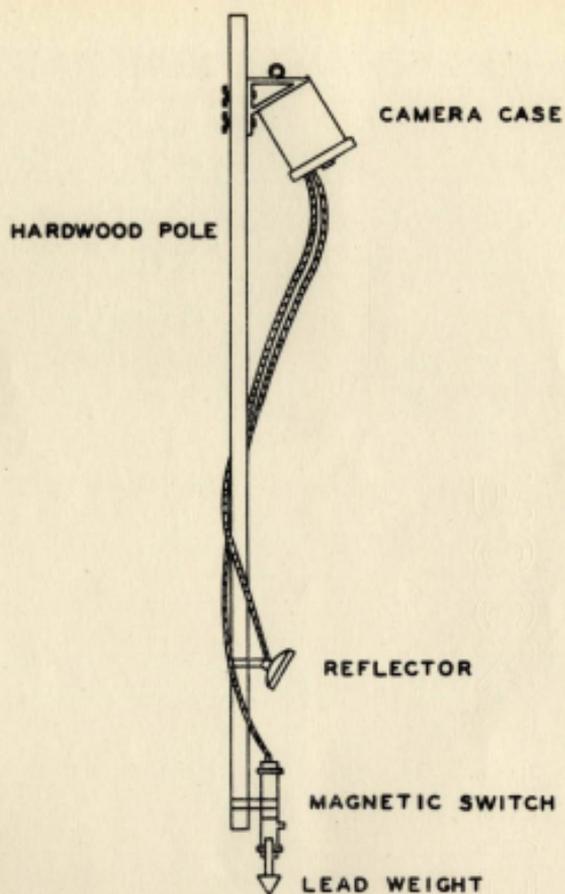


FIG. I

UNDERWATER CAMERA ASSEMBLY

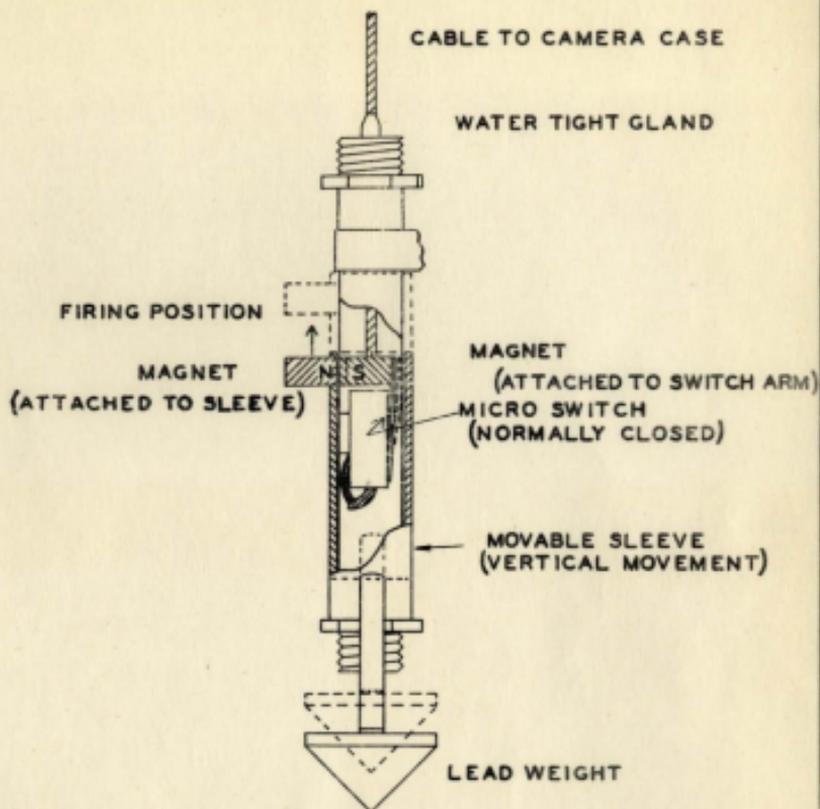


FIG II

MAGNETIC SWITCH FOR UNDERWATER CAMERA



Photo I.



Photo II.



Photo III.

- I. Camera Unit in Position
for lowering
- II. Cover with Camera
Equipment Mounted
- III. Switch Assembly



Photo IV.



Photo V.



Photo VI.

- IV. Chamcook Lake
4 Aug., 1949
1/50 f8
Depth 7'
- V. Head Harbour
25 July, 1949
1/25 f11
Depth 14'
Secchi Disk 20'
(White objects are
scallop shells)
- VI. Reef at mouth of
Head Harbour
2 August, 1949
1/50 f8 K-3 filter
Depth 20'
Secchi Disk 18'

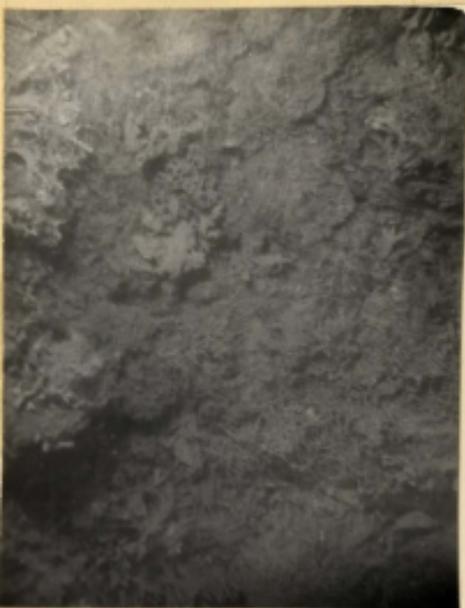


Photo VII.



Photo VIII.



Photo IX.

- VII. Head Harbour
25 July, 1949
1/25 f11
Depth 15'
Secchi Disk 20'
- VIII. Reef at mouth of
Head Harbour
2 Aug. 1949
1/25 f16
Depth 20'
Secchi Disk 18'
- IX. Head Harbour
25 July, 1949
1/100 f 4.5
Depth 15'
Secchi Disk 20'



Photo X.



Photo XI.



Photo XII.

- X. By Weir at mouth of
Head Harbour
2 Aug., 1949
1/50 f11
Depth 18'
Secchi Disk 18'
- XI. West side of Head Harbour
2 August, 1949
1/100 f 4.5 K-3 filter
Depth 31'
Secchi Disk 18'
- XII. Reef at mouth of
Head Harbour
2 Aug., 1949
1/50 f11
Depth 20'
Secchi Disk 18'

