A SIMPLE PIPE-DRAG SWEEPING DEVICE

by Ryokichi SUZUKI
Japanese Hydrographic Department

1. Introduction

It is very difficult to judge on echograms whether a doubtful echo is a real obstruction or merely electronic noise. The author has designed a pipe-drag sweeping device to examine doubtful echoes and made several trials with it. The first trial was carried out in August 1967 in Ube Passage off Ube, Yamaguchi Prefecture, and then others later in Chiba Harbour (November 1968), Yokohama (December 1968 and January 1970) and Negishi (February 1970).

2. Instruments

Figure 1 shows a sketch of the pipe-drag. Figure 2 shows the device being towed. Figures 3, 4, 5 and 6 show respectively the pipe and its cable connections, the buoy, the pipe depressor and the pulleys.

Table I gives particulars of the device with their dimensions.

3. Methods used at the trials

In order to lessen the likelihood of distortion the depth cables and connection cables were fixed 1.5 m from each end of the pipe (figure 3). The depressor was connected to the pipe at these points by cables. A towing cable connected the depressor to the launch. For lifting the pipe one pulley (the lower one in figure 6) was attached to the centre of the pipe, and another (the upper one in figure 6) was connected to the lower pulley by a lifting cable and then a small buoy was attached to this upper pulley to give it buoyancy.

During the trials the following were observed :

1. The horizontal and vertical deviation of the pipe due to alterations in the speed of the launch.

2. The depth at which the pipe was towed, and the efficiency of its depressor.
3. The change in tension when the device hit a protrusion.
4. The possibility of discriminating on the echograms between the cables and the sea floor.

The depth at which the pipe was towed was measured by an echo-sounder fitted to a buoy that was towed just above the pipe (figure 1). For measuring tension a spring dynamometer was used, and a current meter was employed to measure speed.

TABLE 1

Component	Description
Pipe	Ordinary iron piping. Length of pipe components 2.5 m ; weight 10 kg. Total length 10 m, total weight 40 kg. Diameter 50 mm, thickness 2 mm.
Coupling to the cable	Two rubber-cushioned plates, connected by bolts. Length 11 cm, width 16 cm.
Coupling between the pipes	Two rubber-cushioned iron plates connected by bolts. Length 25 cm, width 16 cm.
Depth cable	Nylon rope, diameter 6 mm.
Towing cable	Nylon rope, diameter 10 mm.
Connection cable	Nylon rope, diameter 10 mm, length 10 m.
Chain	Length 1.5 m, diameter 2 mm, used for fixing the pipe to the cable.
Buoy	Tubular aluminium buoy filled with polyurethane. Length 130 cm. diameter 30 cm, thickness 2 mm. Weight 10 kg. Buoyancy 50 kg.
Depressor	Length 60 cm, width 29 cm, height 10 cm, weight 16 kg. Made up of an iron plate weighted with lead.
Shackle, Swivel	Diameter 6 mm, length of swivel 12 cm.

4. **Results of the trials**

1. *Horizontal and vertical deviation*

Table 2 shows the data for the trials undertaken in November 1968.

It is seen that in this trial the horizontal deviation did not exceed 1 m and that the maximum vertical deviation was 0.1 m.

TABLE 2

Length of towing cable	Speed of launch(*)	Depth of pipe	Vertical deviation	Horizontal deviation
15 m	3.7 knots	3.7 m	0.1 m	Less than 1 m
15	2.4	6.5	0.05	"
25	3.7	5.3	0.1	"
30	4.0	7.2	0.05	"
30	1.9	9.6	0	"
30	2.0	9.8	0	"

Length of depth cable : 11 m.
(*) Ground speed

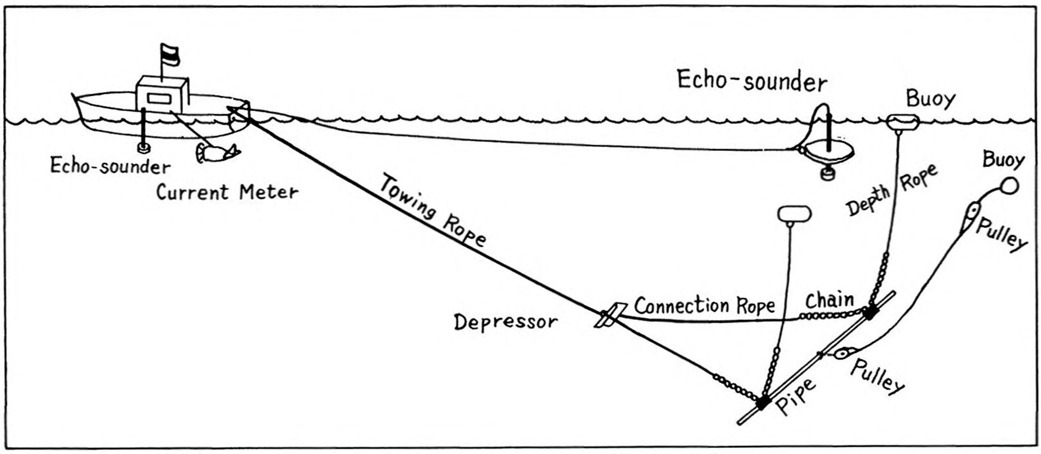

FIG. 1. — Sketch of the device.

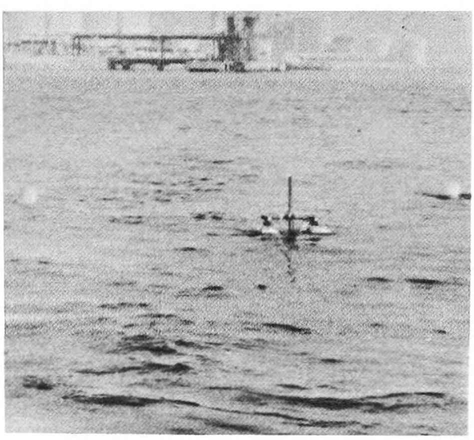

FIG. 2. — Buoys and echo-sounder being towed by the launch.

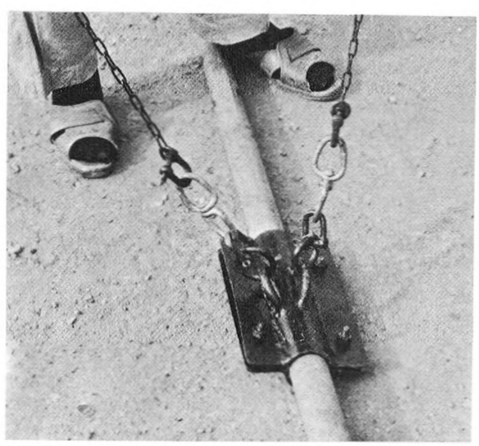

FIG. 3. — The device made up of lengths of iron piping.

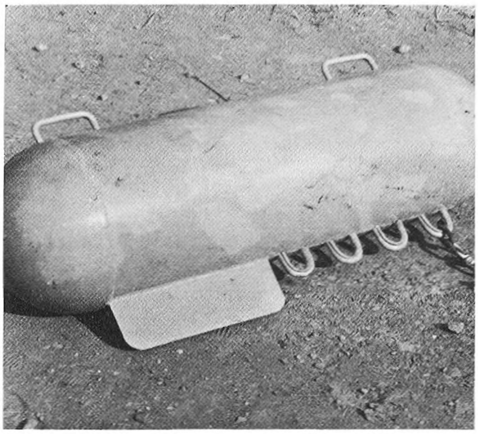

Fig. 4. — The buoy.

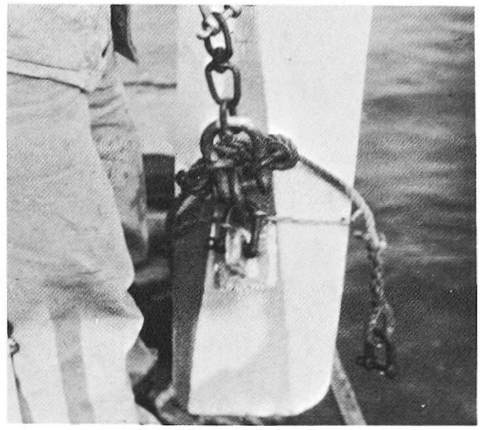

Fig. 5. — The pipe depressor.

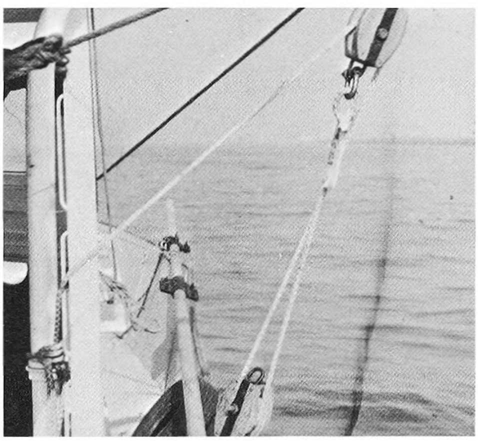

Fig. 6. — The pulleys.

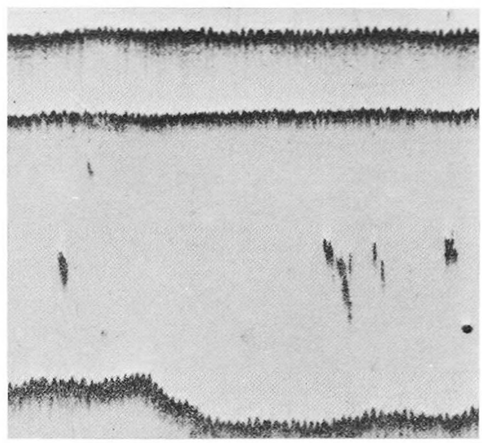

Fig. 7. — Echo sounder record :
Uppermost trace — pipe reflection from port sounder.
Intermediate trace — pipe reflection from starboard sounder.

Since the buoy contrivance shown in figure 1 had not yet been devised, the pipe depth was measured by another launch equipped with two echo-sounders, one to port and the other to starboard. The two upper traces in figure 7 are reflections from the iron bar, the port reflection being uppermost. The bottom trace is the seafloor reflection and was obtained with the port sounder. The starboard sounder's seafloor reflection does not appear on the echrogram. The two upper traces are for the same depth, the separation between the two traces being due to electric circuit delay. This fact demonstrated that the iron bar did not incline either to the right or to the left.

For this trial the depressor was not used, so two towing cables were employed. There was no recognizable difference in horizontal and vertical deviation between these two methods — the one using two towing cables and no depressor, and the other using one cable and a depressor.

2. *Depth of the pipe and efficiency of the depressor*

Figure 8 shows the relation between the speed of the launch and the depth of the pipe and its depressor. Figure 9 shows the relative positions of the pipe and the depressor. There are three possible ways in which to regulate the depth of the pipe; by changing the length of the towing cable, or else that of the depth cable, or by altering the speed of the launch. The easiest method was found to be changing the speed of the launch.

Assuming that a pipe depth of y (metres) can be represented by the formula :

$$y = aV + b$$

where V (knots) is the speed, we obtained $a = -2$ (metres/knots). We were therefore able to obtain a change in depth of 2 m by varying the speed by 1 knot.

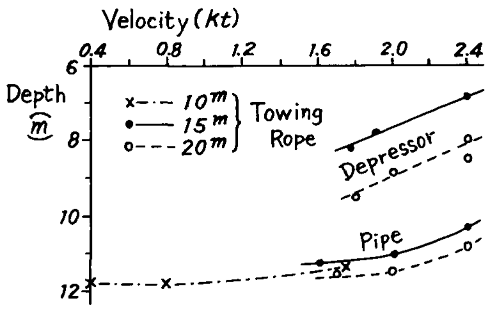

Fig. 8. — Depth of the pipe and its depressor versus speed of the lunch.

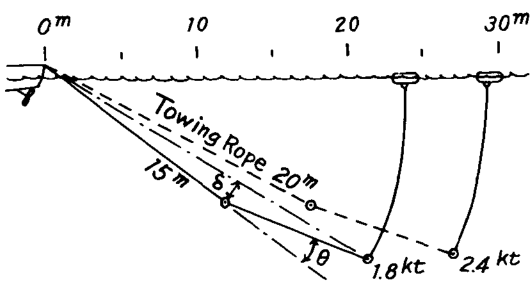

Fig. 9. — The pipe depressor and buoys viewed in elevation.

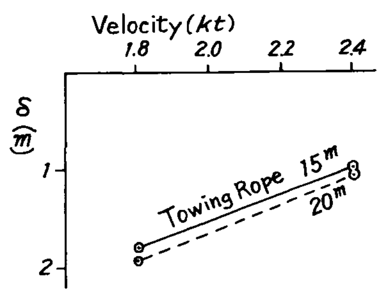

Fig. 10. — Depression versus speed of the launch.

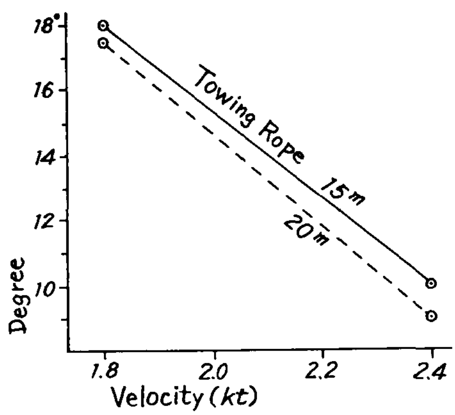

Fig. 11. — Angle of depression versus speed of the launch.

The efficiency of the depressor is represented by δ and θ in figure 9, and these quantities are also used in figures 10 and 11 where it is seen that the depressor was most effective at a speed of about 2 knots.

3. *Change in tension*

When the pipe travelling at a speed of 2-3 knots came into contact with a protrusion on the seafloor the tension rose to nearly 120 kg. At this speed the tension was ordinarily 50 kg. Figure 12 shows the result of the pipe hitting a protrusion. The pipe depth was here 0.6 m below the summit of the protrusion, and the towing speed approximately 1.4 knot. Before contact the tension was about 55 kg, during the contact about 65 kg.

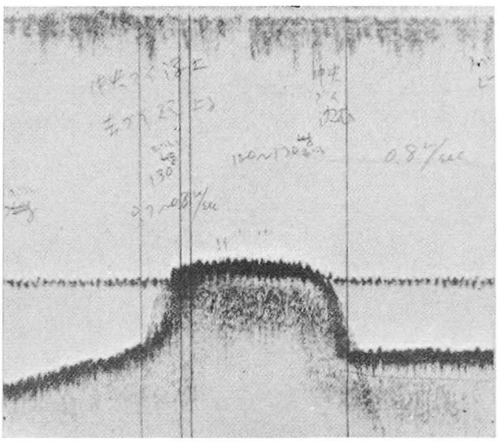

FIG. 12. — Contact of the pipe with a protrusion.

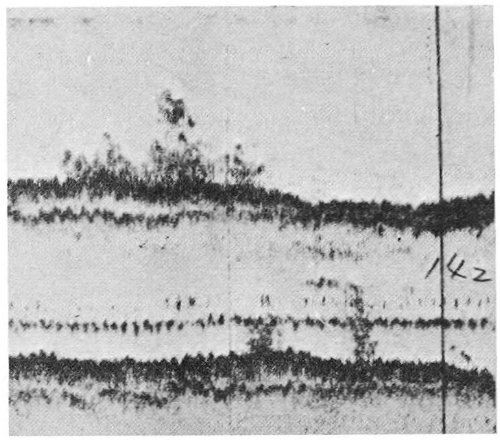

FIG. 13. — Record of the pipe passing clear over a doubtful sea floor.

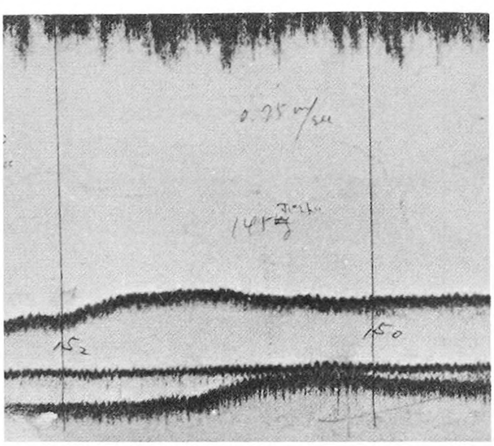

FIG. 14. — Record when the pipe was towed several centimetres above the sea floor.

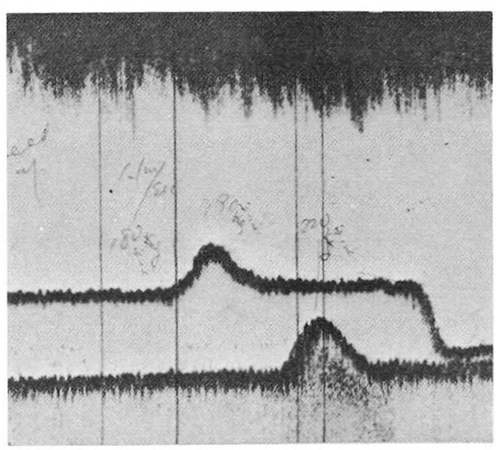

FIG. 15. — Record when the pipe was towed along the bottom like a trawl net.

4. *Observation of pipe depth*

The echo-sounder record was very effective for ascertaining any contact, and so echo-sounders were fitted to the launch and to the towed buoy. The two echo-sounders were thus separated by the length of the towing rope, and the sounder on the launch therefore recorded its echo before the one on the buoy's sounder was recorded (figures 13, 14 and 15). When the pipe passed clear where the launch's sounder showed a doubtful echo this indicated that there would be no risk of danger to shipping (figure 13). The pipe could be towed a few centimetres only above the sea floor (figure 14) as well as like a trawl net over a protrusion if this were not too abrupt (figure 15). In figures 13, 14 and 15 the upper echo trace is from the launch's sounder and the lower one that from the buoy device. The latter is received approximately 30 m after the upper one.

The launch's speed and the movements of the buoy were continuously observed in order to watch out for any contact with obstructions, but the small alterations in speed noted were not distinct enough to distinguish them from those caused by waves. However, when the pipe came into contact with a large obstruction the launch was brought to a halt and the buoys became horizontal (in the ordinary way when under tow the buoys were held partially immersed by the depth cable) and the small buoy attached to the pulley, ordinarily towed underwater came up to the water surface.

5. Points for consideration

Improvement of the instruments

1. Nylon rope was used for the depth cable, but fine chain might prove easier to handle.
2. Much time was needed to bolt the pipe components together. Rings for attaching the cables (figure 3) should therefore be welded directly onto the pipe. As the pipe proved too heavy it should be constructed of lighter material so as to make handling easier.

Remark

Maximum tension was 120 kg. A spring dynamometer for up to 200 kg should accordingly be used.

6. Acknowledgements

I should like to thank Mr. T. KOYAMA of Tokai Regional Fisheries Research Laboratory for his kind guidance and for the loan of instruments. I am also grateful to Mr. T. HASEGAWA in the Hydrographic Department's Metal Workshop for the construction of the depressor and pipe and its repair.

Reference

TAKAYAMA S., KOYAMA, T. (1963) : Studies on mid-water trawling, III. *Bulletin of Tokai Regional Fisheries Research Laboratory*, No. 37.