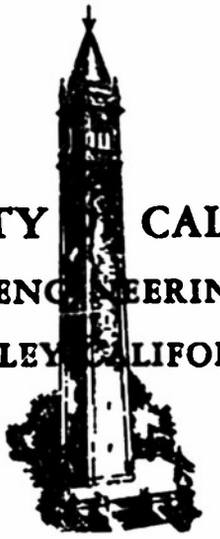

UNIVERSITY OF CALIFORNIA
INSTITUTE OF ENGINEERING RESEARCH
BERKELEY, CALIFORNIA

GUAM SHORE WAVE RECORDER INSTALLATION: II

By

M. A. Hall and R. L. Wiegel

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INTRODUCTION

In the summer of 1952 the University of California Waves Research group installed three shore wave recorders offshore from Orote Point, Ylig River, and Tarague Beach, Guam, M.I. (See Figures 1-4). It was later found that air in the neoprene bellows of the pressure heads was being lost by diffusion through the neoprene, and that some modifications were necessary to improve their operation. A contract amendment was written providing for the necessary modifications and for routine maintenance of the recorders during 1953.

On 31 December 1952 Typhoon Hester (Figures 12 and 13) passed 60 miles south of Guam and two of the recorders (Ylig and Tarague) became inoperative. Tests indicated that either the electric cables between the pressure heads and shore were broken or that water had leaked into the pressure heads. The maintenance task thus became complicated by the possibility of having to repair underwater breaks in the cable.

Although no data on the waves were available for the typhoon, some idea of the severity can be gained from a knowledge of the damage done along the reefs. At Ylig River, the sand beach and vegetation is protected by a coral reef about one thousand feet wide, at an elevation of zero feet MLLW; however, the waves and wind tide destroyed all of the underbrush to a distance of 200 feet inland to an elevation of about plus ten feet (Figure 10). Comparable though less severe damage was observed at Tarague Beach, where the beach is steeper and more protected. Several miles south of Ylig River a one-quarter mile section of newly constructed highway was also washed out during the storm.

Engineers from the University of California arrived in Guam in February 1953, one remaining through March and April. It was found that early spring was a particularly bad time for an operation of this sort, as the weather on Guam was unsatisfactory for working at sea. During this period easterly trade winds blew almost constantly over the area. These trade winds generated swell high enough to make working with divers and small vessels on the East side (windward) of the island nearly impossible. Evidently it is only during the summer months that the winds and swell decrease to a workable level for many days at a time. Even then sudden squalls sometimes cause trouble.

PRESSURE HEAD MODIFICATION

The changes in the Mk IX, Model 4 (Figure 7) pressure head, resulting in the Model 5 (Figure 8), were suggested by experiments which indicated that the Model 4 was losing air by diffusion of the air through the neoprene bellows exposed to the sea. One change was the specification of butyl rubber instead of neoprene for the bellows, the butyl rubber having a much lower diffusion constant

than the neoprene. Another modification was the substitution of 20 cu. in. of liquid in the lower bellows in place of air. Although under pressure some of the air in the transducer dome tends to dissolve in the liquid (in this case a silicone oil with a viscosity of 10 centistokes), the diffusion rate of air into the liquid, from the liquid through the butyl bellows, and out into the water, is much slower than for air directly through the bellows. The liquid in the bellows also made it possible to eliminate the diaphragm which was necessary to hold the oil in place in the transducer of the Model 4. The transducer oil was connected directly to the oil in the lower bellows by a redesigned mounting bracket. The only other modification was an enlargment of the filter restriction.

1952 INSTALLATION

A detailed description of the original installation has been presented in a previous report;[1], however, a brief summary is presented herein.

In Figures 5 and 6 are shown diagrams of the pressure head mountings, which were placed in 40 feet of water, approximately 500 feet seaward of the reef edge. Although minor modifications were made, the generalized sketches present a good picture of the installations at all three locations. The holes for the feet of the twenty feet high tripods were made with air chipping hammers at Orote, and by blasting with shaped charges (40 pound, MK III) at Tarague and Ylig. The Navy divers who did the underwater work reported the holes to be 3 feet deep and 2 feet in diameter at Orote and Ylig, and 2 feet deep and 4 feet in diameter at Tarague. The tripods were made secure by setting the feet in the holes and then filling the holes with burlap bags of wet concrete mixture. Reinforcing rods were to be driven through the bags for strength; however, this was not done at the Ylig site.

A small tripod was mounted on top of each of the large tripods, and the pressure head was mounted on the small tripod. Armored electric cable which connected the pressure head with the power supply and recorders on shore was fastened by clamps welded to one leg of the tripod. Seventy-five feet of cable, with the armor removed, was wound around two horns at the top of the large tripod, and the end of this light "pigtail" was fastened to the small tripod and connected to the pressure head. This arrangement was to allow the small tripod, with the pressure head mounted on it, to be unfastened by divers and lifted to a small boat on the surface for servicing.

No marker buoys were used for locating the positions of the tripods, for in good weather the units could be seen easily through the clear water.

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(1) "Guam Shore Wave Recorder Installation: I," by F.E. Snodgrass, University of California Institute of Engineering Research, Technical Report: Series 3 Issue 353, July 1953

SERVICING OPERATION

Orote Point Site:

Since the Orote shore wave recorder was operating, and because it was in the most sheltered location, it was selected as the first unit for modification. An initial attempt was made on 20 February 1953 using an LCM and Navy divers from the Ship Repair Facility; however, high winds hindered the maneuvering of the craft, and the tripod was not located. Arrangements were made with the U.S. Geological Survey to use their glass-bottomed boat to locate the instrument, and from which skin divers could work(2). On 28 February 1953, with fair weather and waves three feet high, the instrument was located and the pressure head brought to the surface (Figure 11). The modified instrument was installed on the small tripod, and the divers (using aqua-lung diving equipment) took it down again, but ran out of air before the small tripod could be mounted on the large tripod. After going back to the dock for more air, the divers again went down and completed the job.

It was necessary to replace a section of the cable running across the reef at this installation as the existing cable was old cable left from a previous installation. This was performed by Guamanian labor furnished by the Navy Public Works Center, Telephone Group, under the direction of the University Engineer, on 30 March 1953.

Ylig River Site:

This site is located 40 miles by sea from Apra Harbor. Because of the length of time necessary to get a vessel to the site, and because it is located on the weather side of the island, it was not possible to get a vessel to the site and perform the necessary work during the few mornings when the waves were low enough to allow working, unless a high speed craft could be made available. Because of operational and maintenance difficulties, use of either of the two high speed craft at Guam was not possible. It was necessary to make use of a Navy Fleet Tug (ATF), carrying a 40 foot launch. The large vessel was needed because Navy regulations precluded the sending of a slow small craft to an area where the seas might get high before the craft could get to a sheltered location. It was 24 March before all arrangements could be completed, and before conditions were such that diving could be performed efficiently. The wind was eight to ten knots and the waves were two to four feet high on the day the operation was undertaken. Considerable difficulty was experienced in lowering the launch, due to the waves. The launch was anchored at the intersection of ranges marked by flags erected on shore, this position being the location of the 1952 tripod installation. The divers (3) equipped with aqua-lung gear could not find the tripod, even though visibility under water was well over one hundred feet. The mooring cables used during the initial installation in 1952 were found, however. The divers searched until their air was exhausted, then leaving the diving equipment on the launch

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(2) The diving was done by M.A. Hall, University of California, G.H. Fisher, Naval Research Laboratory and S.O. Schlanger, U.S. Geological Survey.

(3) See Footnote (2)

swam on the surface for a wider search. As the tripod still was not located, the launch was moved to within two hundred feet of the reef edge, and a search was made for the electric cable, but it was not located. After more searching, the work was discontinued and the crew returned to Apra Harbor.

Considering that the Ylig site was less protected from Typhoon Hester than the Tarague site, and the great damage later found at the Tarague site, it appeared that the equipment at the Ylig installation was completely washed away.

Tarague Beach Site:

Tarague Beach was similar to Ylig in regard to exposure and distance from Apra Harbor; hence, the ATF was used. On 7 April 1953, the ATF went to Tarague Beach. Winds were from fifteen to twenty-five knots. Upon arrival the skipper of the ATF decided that the wind waves (about four feet high) were too large to risk lowering the launch from the ATF, so the vessel returned to port.

Arrangements were made with the Commanding General, Anderson Air Force Base, Guam, M.I. for the use of a B29 air-sea rescue boat. This boat was 34 feet long, equipped with a 4 cylinder inboard engine, and had removable wheels, which made it possible to tow it by truck to the site in a short time (Figure 9). All arrangements could be made within eight hours for use of the boat, compared with the two weeks notice necessary with the ATF. Thus, if waves were forecast to be low for a twelve hour period, the boat could be towed by truck to the site, launched, and driven through the Tarague Channel to the instrument with enough time for the divers to work.

On 25 April, the easterly trade winds shifted to the southeast, leaving Tarague Beach in the lee of the Island, so arrangements were made to use the Air Force boat. Considerable difficulty was encountered in towing the boat over the sand to the channel; however, no difficulty was experienced after that, even though there was a swift lateral current behind the reef. A boat was tied to a mooring which remained from the 1952 installation. After a swimmer had located the tripod, another line was tied to it by divers. A detailed inspection was then made of the remains of the installation by the divers.(4)

The installation was found to be nearly completely destroyed, and as such it was difficult to determine the cause of failure. The tripod had broken loose from its footing, and had been moved into a crevice about 50 feet to the west of its original position. The armored cable clamps which had been welded to the tripod had been pulled loose and were still attached to the cable. The section of the cable passing over the edge of the reef was in serviceable condition. The pigtail section of the cable was broken away from the small tripod, as was the pressure head. No trace of the pressure head was found. The holes into which the feet of the tripod had been placed and anchored with sacks filled with concrete and reinforced with iron rods, could not be found; however, judging from the position of the main cable and some of the debris left from the original installation, the holes were assumed to be those found

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(4) See Footnote (2)

on a coral ridge to the east of the tripod, which were filled with loose coral debris. The legs of the tripod were not bent, indicating that perhaps the concrete footings failed easily. A clump of the concrete was found, and the individual bags seemed solid enough, but the reinforcing rods did not extend into them a sufficient distance. These observations suggest that the failure may have been made easier by improper installation of the reinforcing rods.

CONCLUSIONS AND RECOMMENDATIONS

1. The damage to the wave recorders at Ylig River and Tarague Beach, in all probability caused by Typhoon Hester, was such that completely new installations are necessary. This work is beyond the scope of the existing maintenance contract.

2. The fact that the sections of the armored cable passing over the reef edge, at both Ylig and Tarague, were in serviceable condition, despite the severe damage done to the tripods, shows that the method of anchoring was good. It is recommended that any future installation of this type employ this proven method.

3. It is evident that a more reliable method must be used in anchoring the tripods. It is suggested that the base be anchored to large expansion bolts placed in holes at least two feet deep, drilled into the coral formations. It is further recommended that a smaller tripod be used.

4. The use of aqua-lung diving equipment by engineers is recommended; as it is absolutely necessary that a properly trained person inspect the finished job.

5. Where the waves are low for only short periods of time at locations relatively far from good protection, it is recommended that a DUKW be used. A DUKW can drive to the location in a short time, cross nearly any beach with ease, and proceed to the site in a minimum of time. In case of squalls, or a rapid increase in wave height, it can be driven out of the water and onto the beach in a few minutes. Further, it is easily anchored, can be worked in close proximity to a reef, and is large enough that aqual-lung equipped divers can operate from it, yet it has a low enough freeboard to allow the divers to board with ease.

ADDENDUM

During June and July 1953, G. H. Fisher, Naval Research Laboratory, did additional diving at the Orote Point and Ylig River sites. In order that the history of the Guam recorders be up to date, the following notes on the work done by Fisher are included in this report.

Orote Point Site:

As the wave records indicated that the potentiometer slider in the pressure head was sticking a little, and that the slow leak was not functioning properly, (i.e., the pressure pickup unit was following the tides), it was decided to replace the pressure head.

The first attempt, made on 27 June 1953, using the U.S. Geological Survey's glass-bottom boat, was unsuccessful, due to a very strong current which made it nearly impossible for the diver[5] to work under water. As it was believed the current was a tidal current, a trip was made on 9 July on the Admiral's Barge (a 68 ft. crash boat) at exactly low tide; there was no current. On 11 July a work party went out at exactly high tide on the Admiral's Barge to change the pressure head. There was no current; however, by the time the old head had been removed and a new head spliced onto the cable the current had started to run to such an extent that it was not possible to mount the head on the tripod, so it was lashed to the side of the tripod with rope. On 14 July Fisher went out again at exactly high tide, in a Peter-Peter boat, and completed the job.

It is interesting to note that the work was done during the times of the highest tides of the month, and that the current was running parallel to the breakwater, and toward the harbor entrance.

Ylig River Site:

On 24 June and again on 22 July, Fisher did some aqua-lung diving from a U.S. Marine Corps rubber boat at the Ylig River site, the rubber boat being taken through the reef at the Ylig channel. The diving was done in the morning before the winds became too strong. The swell was running about three to six feet the first time and two to four feet during the second trip.

A part of one leg of the tripod was found. It was pinned to the bottom by a coral boulder about eight feet in diameter. An examination indicated that the leg had been bent, first in one direction and then in the opposite direction, breaking it away from the tripod. The cable was still attached with the wire clamps to the piece of tripod and broken above this, apparently where the armor had been stripped to make the "pigtail". A short distance away a coral boulder nearly twelve feet in diameter was found pinning the cable to the bottom.

On his first trip, while at the bottom, Fisher cut the cable with a hacksaw, then at the surface stripped back about 20 feet of covering to check the cable for resistance and continuity. Before any conclusive checks could be made, the wind and sea picked up, causing suspension of the operation.

On 27 July the cable running from the piece of tripod leg onto the reef was examined visually to within forty feet of the reef edge, and apparently there were no breaks. In addition, sections about fifty feet long (three pieces were cut, totaling about 175 feet) were stripped back and checked for resistance and continuity. They were found to be soaked with sea water.

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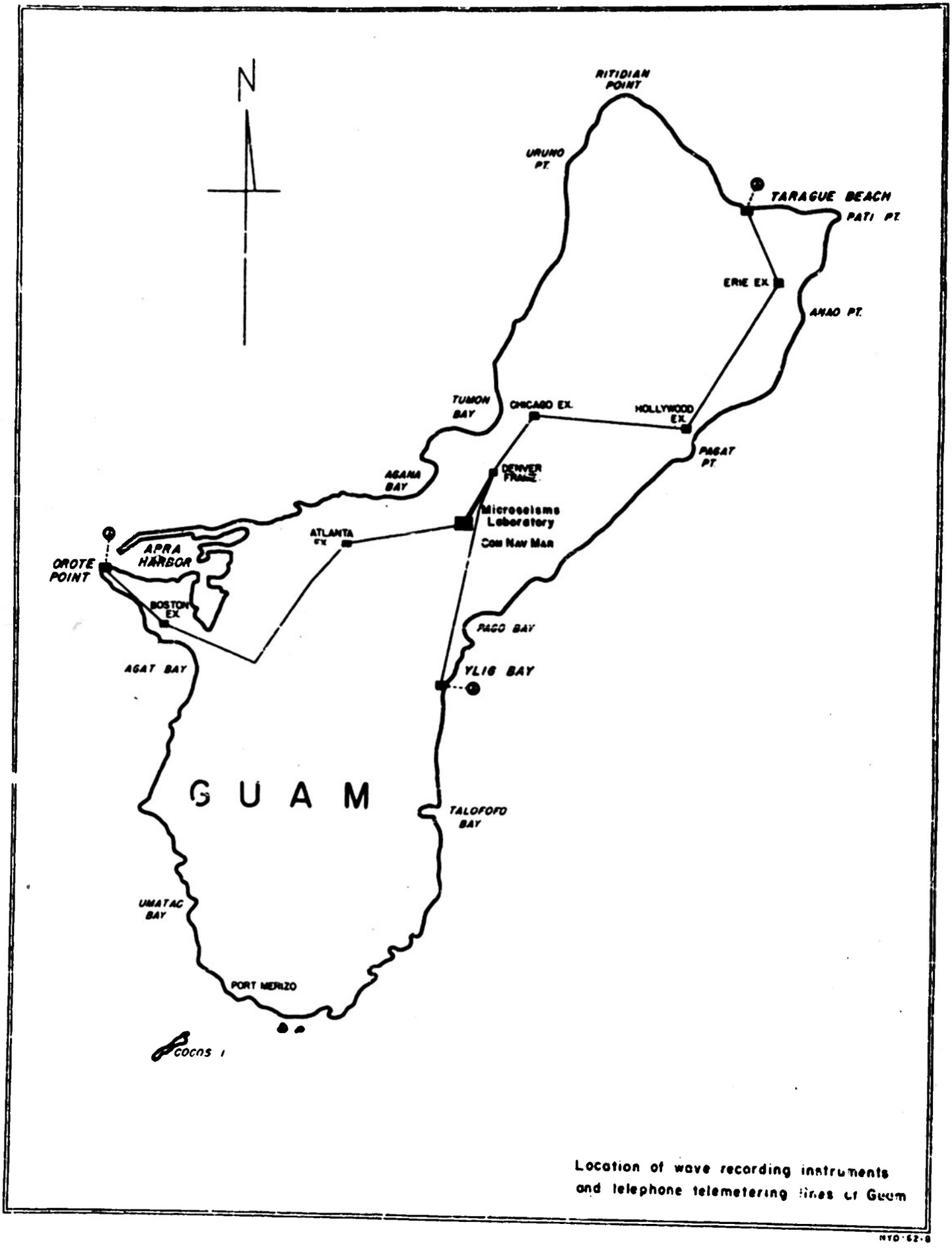
[5] G.H. Fisher.



Location of wave recording instruments and telephone telemetering lines of Guam

NYO-62-8

FIGURE 1

Fig. 2 - Aerial photograph of Orote Point showing (1) instrument location and (2) cable path

Fig. 3 - Aerial photograph of Tarague Beach showing (1) instrument location, (2) cable path and (3) Tarague Channel

Fig. 4 - Aerial photograph of Ylig Reef showing (1) instrument location and (2) cable path

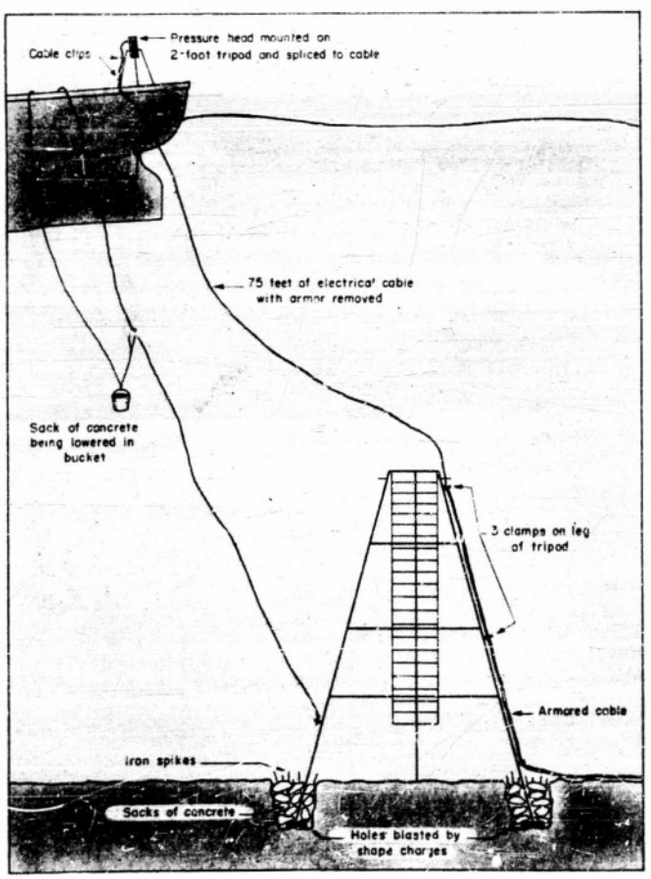


Fig. 5 - Diagram of instrument installation showing method of installing concrete and Mark IX wave pressure recorder

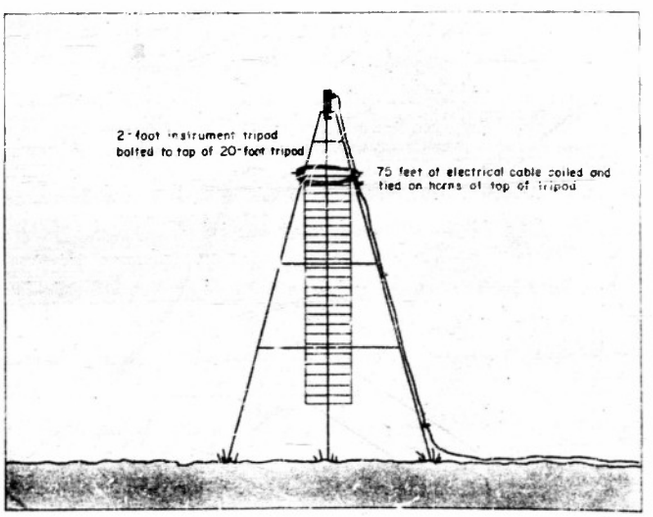
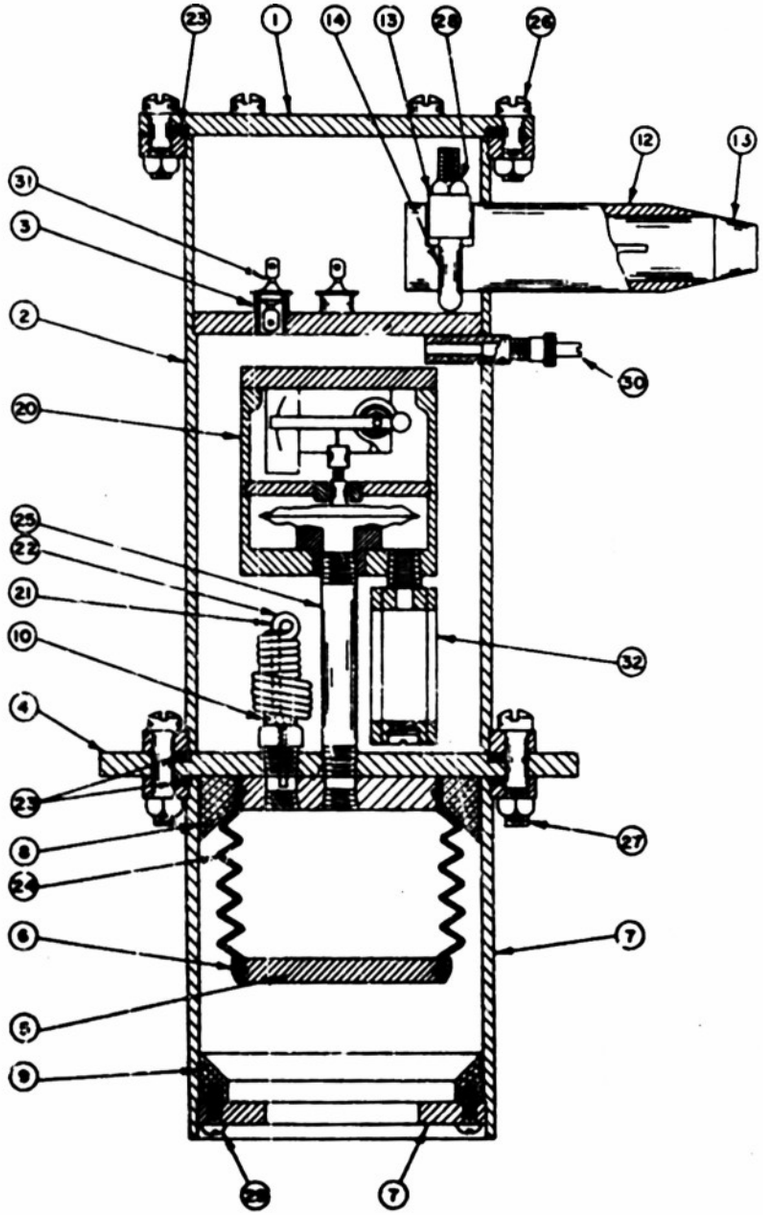


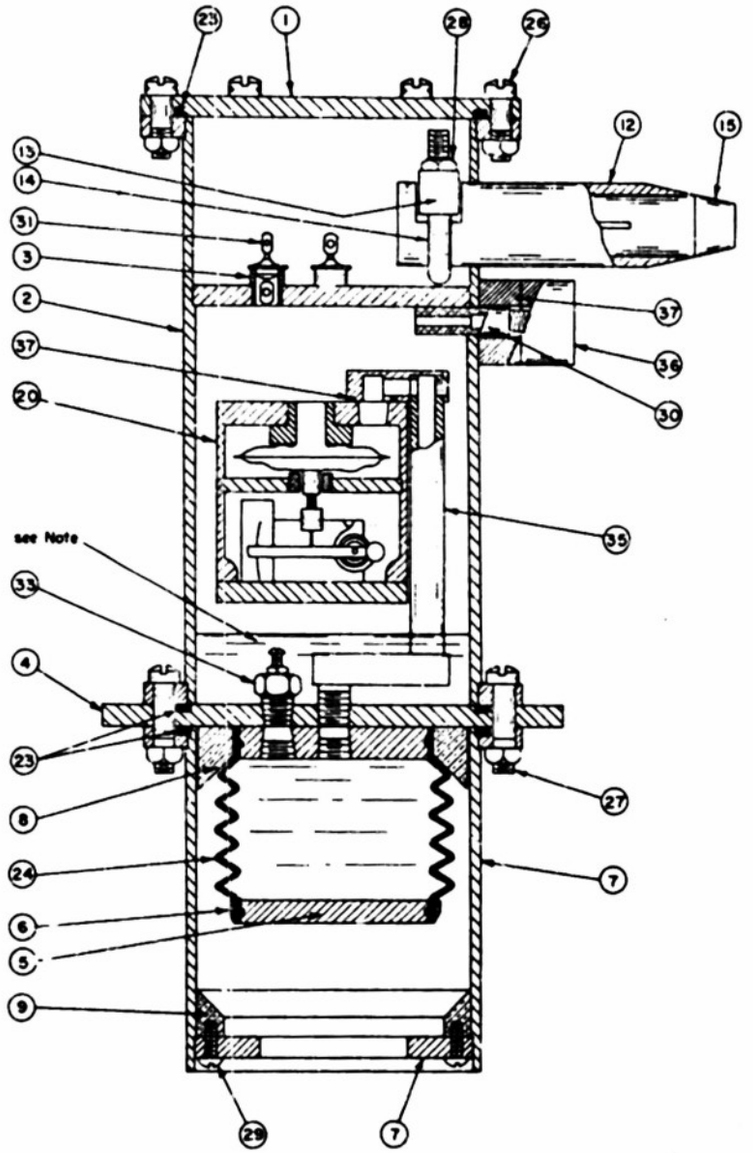
Fig. 6 - Diagram of instrument installation in final form



ITEM NO.	PARTS DESCRIPTION
1	Connection chamber cover
2	Transducer chamber
3	Fusite mounts
4	Mounting plate
5	Bellows end plate
6	Lower bellows clamp
7	Bellows chamber
8	Upper bellows clamp
9	Bellows support ring
10	Slow leak mount
12	Cable connector
13	Cable sleeve clamp
14	• • •
15	Cable sleeve
20	Bourns potentiometer #503
21	#110 capillary tubing 29" long
22	#24 (.020") wire inside #110 capillary tubing
23	"O" ring-linear #1966-16
24	Rubber bellows
25	1/8 brass pipe 2 1/2" long
26	1/4 - 28 x 3/8 fillister head S. cut
27	1/4 - 28 x 1 fillister head S. cut
28	1/4 - 28 nut
29	8 - 32 x 3/16 RHMS
30	Schrader valve (truck valve) & cap
31	Fusite connectors #112-FP
32	Diaphram mount

MARK IX, MODEL 4, PRESSURE HEAD

FIGURE 7



ITEM NO.	PARTS DESCRIPTION
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5	Bellows end plate
6	Lower bellows clamp
7	Bellows chamber
8	Upper bellows clamp
9	Bellows support ring
12	Cable connector
13	Cable sleeve clamp
14	• • •
15	Cable sleeve
20	Bourns potentiometer #503
23	"O" ring-Lincor #1866-16
24	Rubber bellows
26	5/16 - 28 x 5/8 fillister head & nut
27	1/4 - 28 x 1 fillister head & nut
28	5/16 - 28 nut
29	8 - 32 x 7/16 RHMS
30	Schrader valve
31	Fusite connectors #112-FP
33	Slow leak
35	Potentiometer mount
36	Valve stem cover
37	"O" ring #AN6227 B-9

Note: D-C 200 fluid silicone oil, fills Bourns potentiometer, potentiometer support, lower potentiometer chamber and bellows.

MARK IX, MODEL 5, PRESSURE HEAD

FIGURE 8

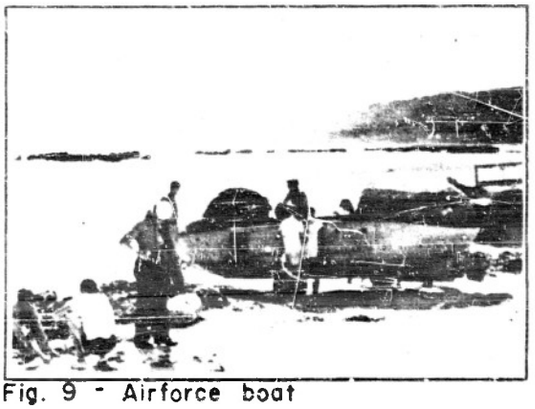


Fig. 9 - Airforce boat

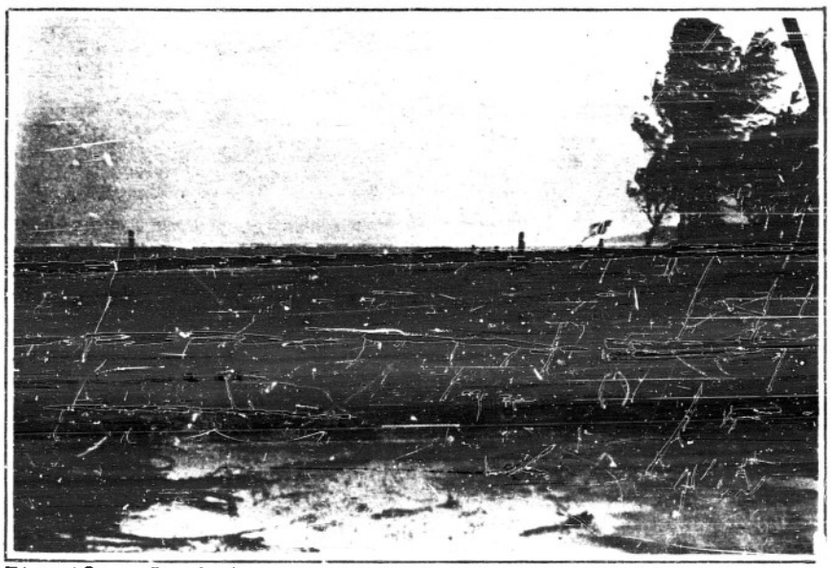


Fig. 10 - Reef damage

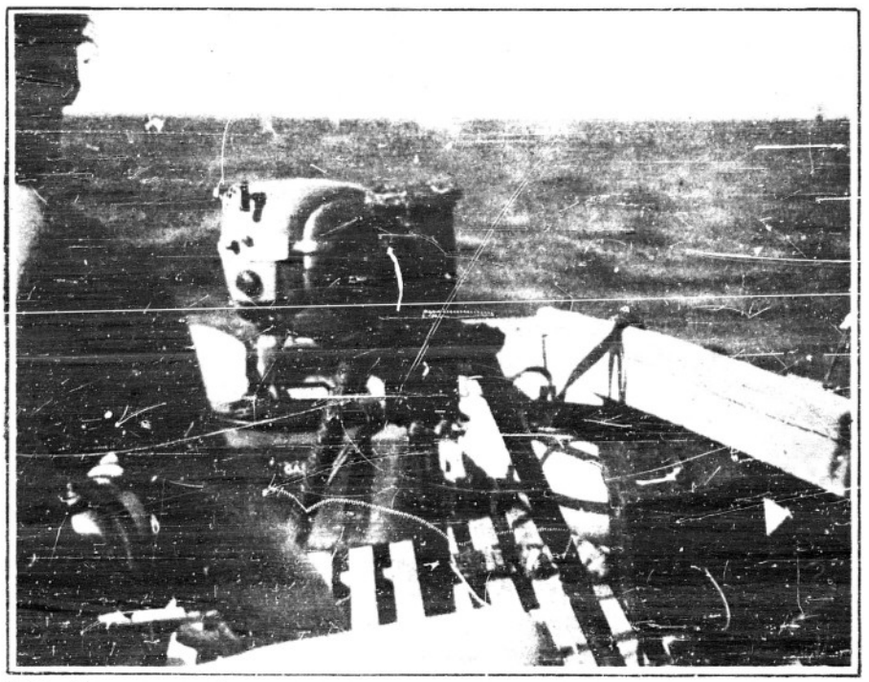
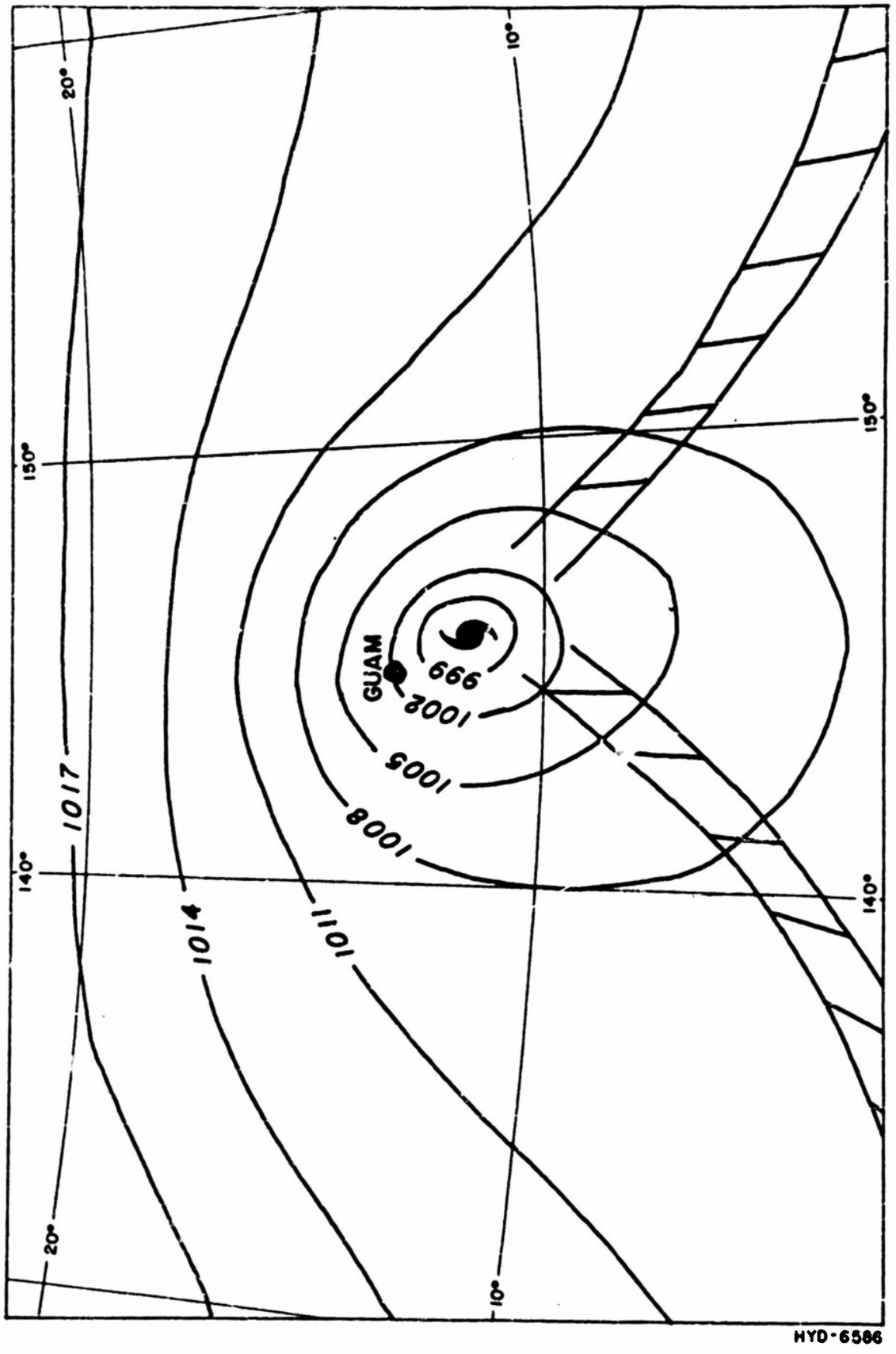
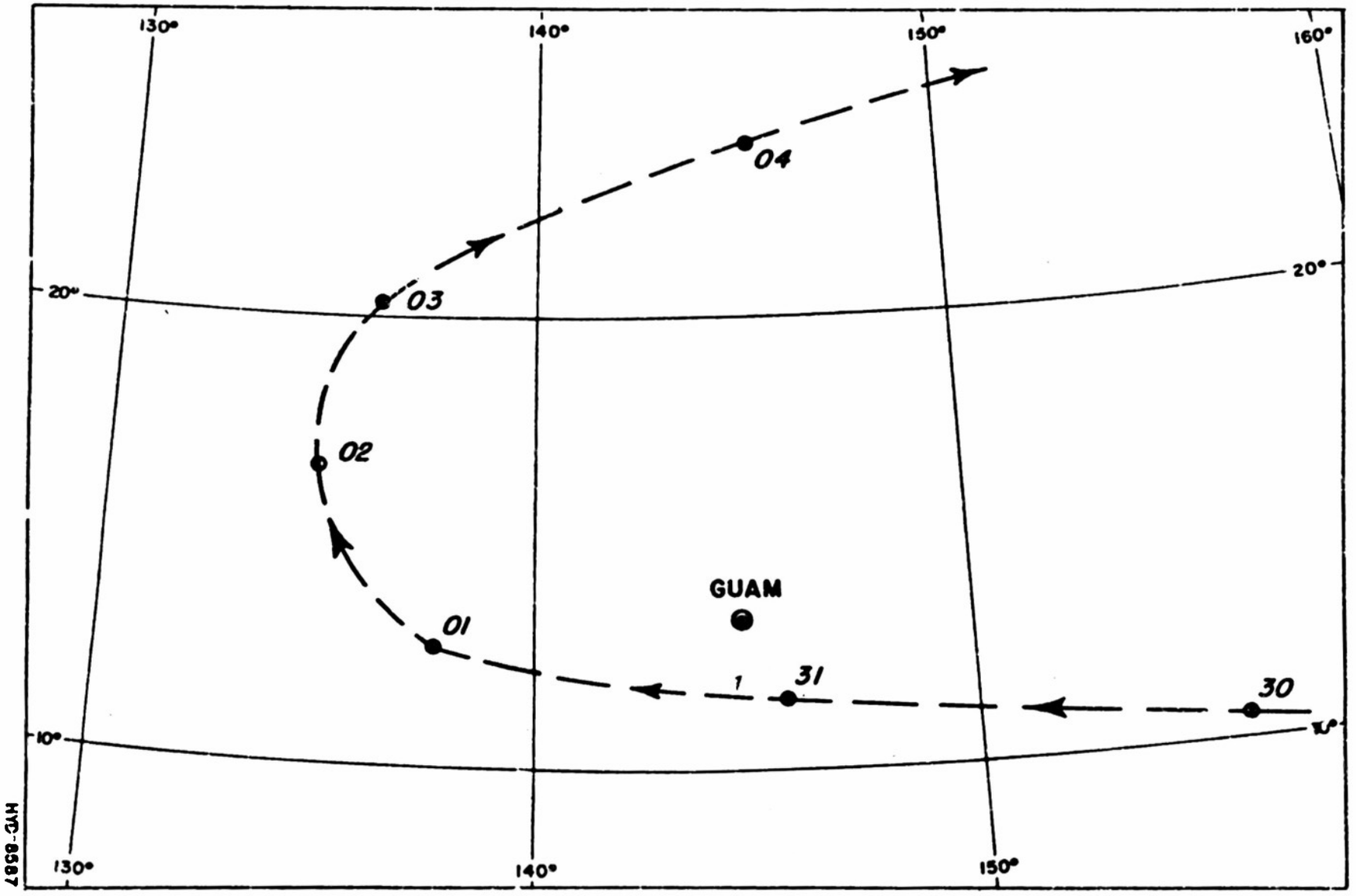


Fig. 11 - Mark IX model 4 pressure head being replaced by model 5 off Orote Point, February 28, 1953



Surface weather map, 0030Z, 31 December 1952

FIGURE 12



Track of typhoon "Hester", 30 December 1952 - 4 January 1953

FIGURE 13

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