I.O.S.

R.R.S. DISCOVERY CRUISE 62

25 MAY – 5 JUNE 1974

GLORIA MK II MODEL TOWING TRIALS.
BATFISH OPERATIONAL TRIALS.
DATA PROCESSING SYSTEM PROVING.

CRUISE REPORT No. 11

1974

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Institute of Oceanographic Sciences,
Wormley, Godalming, Surrey.

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Duration

Sailed Barry	1800	24th May
Arrived Barry	1600	3rd June

Scientific Staff

A. Bennett	Bedford Inst., Nova Scotia
R.M. Carson	I.O.S.
C.H. Clayson	I.O.S.
J. Dedman	I.O.S.
R.H. Edge	I.O.S.
W.E. Elford	I.O.S. (Principal Scientist)
A. Hall	I.O.S.
P.R. Hartland	I.O.S.
D. Lewis	I.O.S. (Barry)
P.J. Minnett	S.U.D.O.
G. Morrison	I.O.S.
B. Noyce (Mrs)	S.U.D.O.
R. Peters	I.O.S.
J. Revie	I.O.S.
T. Sankey	I.O.S.
M. Seatre	Tech. Inst. Trondheim, Norway
J. Sherwood	I.O.S.
M.L. Somers	I.O.S.
A. Voss	I.O.S.

Ship's Officers

G.H. Selby-Smith	Master
P.H. Warne	Chief Officer
A.G. Marsh	Second Officer
P.T. Oldfield	Third Officer
I.R. Hamilton	Radio Officer
R.D. Johnston	Chief Engineer
P. Maguire	Second Engineer
J.R. Richardson	Third Engineer
J.T. O'Keefe	Fourth Engineer
G.M. Batten	Extra Fourth Engineer
P.J. Ditchburn	Fifth Engineer
B.J. Winchester	Senior Electrical Officer

Objects of Cruise

The main purposes of the cruise were:-

(a) To check the hydrodynamic stability of the 'Gloria' Mk II model when towed by two alternative towing arrangements.
(b) To gain experience in the operational use of 'Batfish', and to verify navigational procedures for covering a set grid pattern relative to the water.
(c) To check the compensating capabilities of the forward compensated hydrographic winch.
(d) To prove various Data Processing programmes and techniques, processing of records from Batfish and Gloria Mk II model, and setting up navigational grids for Batfish.
(e) To pressure test a guided profiling current meter case, and to check the necessary ballasting for free fall down a wire.
(f) To check recording techniques when using a micro-current meter.

Narrative

R.R.S. 'Discovery' was due to sail from Barry at approx. 1000 hrs on 23rd May. Unfortunately, due to late delivery and testing of the new hydraulic capstan required for both 'Batfish' and 'Gloria' Mk II model trials, sailing was delayed until 1800 hrs on 24th.

During tests at the dockside on the hydraulic capstan, it was found impossible to make the pipe joints on the pipe runs from the hydraulic power pack to the capstan withstand the full operating pressures. This was overcome by obtaining locally at short notice, two lengths of high pressure flexible hose which were used during the cruise, thus bypassing the permanent installation.

After sailing, course was set for the operational area bounded by 45° and 47.5°N, and 8° and 10°W. The ship arrived at the area at 0500 hrs on 26th.

Start was made immediately on the pressure test of the G.P.C.M. case, to a depth of 600 metres. This was completed without tube collapse, although there were some signs of weld cracking around the end and strengthening rings.

The first launch of the 'Batfish' vehicle was made about mid-day on the 26th and it appeared to be working satisfactorily. At 1515, as preplanned, it was recovered for inspection and to check the recovery technique. Unfortunately, due to excessive swing on the aft crane, the body of the vehicle hit the stern of the ship during the recovery, cracking one of the rear wings. This damage was not considered to be of sufficient seriousness to prevent a further launching, so after inspection and topping up the hydraulic system, it was launched again at 1700 hrs. Runs were made at various cable scope lengths and ship's speed to determine optimum conditions for subsequent tests. At 2300

a navigational grid pattern was set up on the V.D.U. and an attempt made to follow this, the ship being navigated on Decca. After about eight hours of this, the vehicle failed to respond to command signals and it was recovered at 0830 hrs on 27th.

Subsequent inspection revealed that the rubber hydraulic accumulator had emptied and the bag had punctured by being extruded into the accumulator outlet hole. The system was drained, a new accumulator fitted, refilled with oil and launched again at 1430 hrs. Further tests were carried out at various ship's speeds and cable scopes until 1730 hrs, when the vehicle again failed to respond to commands and it was recovered. Once again, the rubber accumulator bag had punctured.

The decision was taken to postpone any further launches until a new larger PVC accumulator (ex Gloria) could be fitted. This break in the programme also allowed time for the wing, damaged during the earlier recovery to be repaired with Araldite.

During the late evening of 27th the ship was 'hove to' to carry out tests on the forward hydrographic winch. Conditions were such that very little roll or heave were imparted to the ship, the tests were not therefore very conclusive. During the latter part of these tests a mechanical fault arose in the magnetic brake on the main drive motor. This was found to be due to the locating pins in the magnetic brake armature plate coming loose and touching the motor case. Work on correcting this fault carried on during the following day.

On the morning of the 28th, the 'Gloria' Mk II model was launched on the first towing arrangement. Various test runs were carried out using different cable scope lengths and ship's speeds. Following these a series of computer logged runs were made, ending at 0215 on 29th.

At daylight, the 'Gloria' model was recovered and the cable changed for the second towing arrangement. Relaunching on this was carried out at 1330 and test runs at various cable scope lengths and ship's speeds carried out. Computer logged runs followed, terminating at 0100 hrs on the 30th.

Since the Gloria model could not be recovered until daylight, the opportunity was taken for a practice navigational grid for Batfish to be set up by the computer on the V.D.U. Unlike the previous runs, when the ship was navigated on Decca, the captain agreed to navigate the ship by command from the plotting room and to arrange for the first, second and third officers to take turns at the control point. This worked successfully and a good grid was completed.

The 'Gloria' model was recovered again at 0900 on the 30th, and the cable changed back to the first towing arrangement. It was launched again at 1330 and various computer logging runs started. These lasted until 2030 hrs. The model was recovered at 0930 hrs on 31st.

On the morning of 31st, Batfish was launched for the second series of runs. All seemed to be going well until late afternoon, when the vehicle ceased to respond to commands and it was recovered. Inspection showed that the propeller drive pin had sheared, and, although the new larger accumulator bag was not completely emptied, a certain amount of salt water had entered the hydraulic circuit. It was decided to replace the propeller drive pin and to manufacture a new filter cover with a piston type "O" ring to seal the hydraulic circuit. These modifications were carried out and the vehicle launched again at 0200 hrs on 1st June.

After initial response tests a start was made on a grid navigational pattern. After this was completed at 0200 hrs on 2nd, the vehicle failed to respond again and it was recovered. Inspection revealed that the propeller drive pin had once again sheared. The accumulator bag had partly emptied due to small leakages of hydraulic fluid - especially out of the pump drive shaft seal. It was agreed that little further information could be gained from continuing the trials, and it was decided to take the hydraulic unit back to I.O.S. for replacement of shaft seals and testing under bench conditions, before use on cruises 64 and 65.

At 0330 it was therefore decided to sail for Barry. During the whole period of the equipment trials, The Data Processing team had been working on the various computer programmes and techniques as shown in the section reports following.

The ship arrived at Barry and tied up at the refuelling berth at approx. 1600 hrs on 3rd.

W.E. Elford.

Project Reports

1. Data Processing

This cruise was mainly a preparation for cruises 63-66.

'Gloria' Towing Trials

9 channels of data were recorded at 1 second intervals for periods as required. The data was stored in a single file GLORI on disk 106. Samples of the collected data were displayed on the VDU using the program PLSEC. The digital gyro data has been cleaned up (to remove the bits of the input word used by the clock) using CDGYR. Zero spikes due to short sampling periods remain.

A program PCSSH has been written which accepts as input the output from the cross spectral analysis program WCSSH and plots coherence and phase as a function of frequency. Program WCSSH will need minor modifications to run in the laboratory since it at present only produces LUN 3 output.

'Batfish' 2100 - 1800 transfer

This is now working satisfactorily. During the cruise the 1800 sampling program was extended to cope with reloads and with 'no response' situations. The 1800 seems to cope quite well with the load. Approximately $1\frac{1}{2}$ minutes in every 5 is taken up with data reduction. The sampling itself is a negligible load. It is believed that the system is capable of coping with the plotting although it will tend to get behind at times e.g. during satellite calculations etc.

Protas Data Logger and Aanderaa Current Meter Relay Systems

Both these systems have been installed and appear satisfactory.

Rapco Replay System

This is now not required on board as the replay unit cannot be spared from the laboratory.

Live Track Plot

This was used to considerable effect during grid surveys towing 'Batfish'. The proposed grid track was laid out on the screen using the "fixed points joined together" facility and it was necessary only to steer the ship along the line. Since the objective was to survey a patch of water it was necessary to suppress all course updates and totally ignore the normal navigational aids. After 24 hours of manoeuvring, satellite fixes gave only $2\frac{1}{2}$ miles difference between our DR "water position" and a true geodetic position. At times this difference was larger, which suggests that there was some tidal movement of the water. Unfortunately only a few satellite fixes were obtained due to an interaction between the 'Batfish' sampling and the satellite navigator sampling. It is hoped that this is now fixed.

Miscellaneous Points

A number of points have been raised by users of the system over the last few months; this would seem a good opportunity to answer them.

(a) File Transparency Routines The problem whereby data whose start time fell between two files (e.g. fix times) could not be found, has been cured. A modification has also been made to prevent the system calling for disks it does not actually need (e.g. when the end of a data period coincides with end of a disk). There has not been an opportunity to try out this latter modification.

(b) Lack of space in FIXF The problem here is that data is retained on drive 1 until it belongs to at least the day before yesterday. When Loran-C was used on line the file filled up before any data was eligible for dumping. A modification has been made to the DUMP function of MANDP so that data up to a chosen time may be dumped. The default time remains the end of the day before yesterday. It is the operator's responsibility not to dump data that will be needed for an on-line course update.

This new option is also useful when drive 2 is to be occupied for long periods by a special system, such as 'Batfish'. Normally drive 2 is required at some time each day between 0001 and 1200 hrs. By dumping more data in advance the system can last up to 2 days without drive 2.

(c) Sampling System The problem with short sampling periods has been examined again. The trouble seems to be intermittent and has a habit of disappearing as soon as it is investigated. The problem would appear to lie with one or more of the following:

(a) Deficiencies in the synchronization program SCLOK
(b) Loss of interrupts due to erroneous masking
(c) Loss of time by the system clock, possibly linked with (b).

At present, when the system detects a short sampling period, it uses an alternative filter that uses only 60 samples. This should not seriously affect this data.

The problem with "Bad Gyro Readings" has been traced to the opposite effect of long sampling periods. A modification has been made to prevent the number of samples exceeding the maximum acceptable.

(d) Documentation During the cruise the header and comment cards of many source programs were brought into line with the requirements for the automatic documentation programs.

(e) Plotting Programs A new program for specification of a profile plot (PSPEV) from the ANT has been written. Profiles and track plots may now be specified on the ANT and optionally executed immediately with output on the VDU.

(f) System Programs New versions of the executive resident routines SUBIN, FEROR, MF10, and MDF10 were used on this cruise. These versions are based on those originating at Westminster Hospital and are much smaller than the original IBM programs. Some difficulties were experienced with MF10, and MDF10, but these will be corrected before the next cruise.

The paper tape version of the Assembler was used for the first time. An error occurs when an error in the source program is detected, but this is in hand.

2. Gloria Mk II model towing trials

The Gloria Mk II model was a torpedo shaped vehicle having a cylindrical central section with a hemispherical head and parabolic tail section. It was 0.4 m diameter, with an overall length of 6.1 m. Four radial fins were arranged on the tail, enclosed by a shroud ring the same diameter as the vehicle body. The model was towed from the nose by its armoured electric cable, and was arranged to be neutrally buoyant and balanced in the pitch mode. Roll stabilisation was arranged by having syntactic foam buoyancy fixed into the

upper half of the central cylindrical section and allowing free flooding of the remainder. This gave a natural roll period in the water of 1.8 secs.

A cast light alloy housing in the nose and forward body contained a gyro for measuring pitch yaw and roll, the yaw direction being controlled by a flux gate mounted in the tail, as far removed from the magnetic effects of the gyro as possible. The model was also fitted with an accelerometer to record heave motion, and a depth gauge.

Two different towing systems were used during the tests, these are shown diagrammatically in Figs. 1 and 2 respectively. In addition, in some of the tests, a 30 m length of polypropylene rope was attached to the tail of the vehicle to act as a drogue, and in other tests a canvas drogue 0.5 m diameter was attached to the end of the polypropylene rope.

Ship's heave motion imparted to the towing cable was measured by an accelerometer mounted on the after deck close to the cable sheave.

Cable tension was measured during steady towing runs by means of a strain gauged tension link fixed to the cable drum and a ship's bollard.

During all test runs, analogue recordings were made on an 8 channel recorder, initially calibrated in the laboratory, and selected runs were also data logged by the computer for eventual spectral analysis. Fig. 3 shows a typical section of an analogue recording, with calibrations.

No trouble was experienced with any of the internal equipment or with the recording facilities during the trials - or indeed with the launching and towing arrangements.

Although the final analysis of the records are not yet complete, some observations from the analogue records have been made as follows:-

(a) Vehicle Roll This never exceeded 3° peak to peak amplitude under any condition and was generally better than 2°. The roll period of 1.8 secs corresponded with the vehicle natural frequency as measured in the laboratory.

(b) Vehicle Pitch The vehicle pitch seems to depend on the towing speed and on the effects of the drogue attached to the tail. Taking results from the distributed load towing system (Fig. 1), with 313 m cable scope at a ship's speed of 8 kts, the vehicle pitch was 1° p-p with the model alone, $\frac{1}{2}^{\circ}$ p-p with the polypropylene rope attached and $\frac{1}{4}^{\circ}$ p-p with the polypropylene rope and canvas drogue.

(c) Vehicle Yaw There appeared to be no obvious correlation between yaw attenuation and ship's speed. Despite the scatter of results, there is a clear improvement of attenuation with increased cable scope. There was a deterioration

of yaw attenuation with an increase in the ship's yaw period. The two towing arrangements were not significantly different in yaw characteristics.

(d) Vehicle depth and depthkeeping The cable catenaries for the two systems were calculated before going to sea. With the P.E.S. system (Fig. 2), the vehicle running depth at 8 kts was within 4% of that predicted. With the distributed load arrangement (Fig. 1), it is clear that the fairing on the upper section of the cable scope was not as effective as had been hoped, consequently the model did not run quite as deep as anticipated.

Depth variation of the model is related to pitch stability. Running at 8 kts with 313 m cable scope (Fig. 1), the vehicle depth was 45.7 m with a variation of 2 m. The addition of the 30 m polypropylene rope and the canvas drogue brought the depth to 40.5 m with a variation of 1 m.

Using the P.E.S. arrangement (Fig. 2) the running depth was 56.4 m at 8 kts with a 244 m cable scope.

(e) Cable tension The cable tension when using the distributed load towing system (Fig. 1), with 313 m cable scope, varied from 1471N at 6 kts to 2746N at 10 kts when towing the bare model. With the polypropylene rope and canvas drogue attached the tension was 1863N at 5 kts, increasing to 3628N at 8 kts.

Using the P.E.S. arrangement (Fig. 2), with the polypropylene rope and canvas drogue attached to the model, the cable tension varied from 2255N at 6 kts to 4314N at 10 kts.

(f) Heave Motion There was some slight coupling of vehicle yaw with ship's heave motion. At its worst, the yaw from this effect reached 1° p-p.

Analysis of the computer logged records is still being carried out and a more detailed report will be issued later.

M. Somers.
R.M. Carson.

3. 'Batfish' trials

An account of the operational failures during the course of this work is given in the cruise narrative. The operational results which show the capabilities of the system are given below.

A series of runs were initially made to determine the cable tension in relation to ship's speed, cable scope and operational depth. The cable breaking load was stated to be 3000 kgf, the operational limit was therefore set at 1000 kgf, which should always be regarded as the upper limit. Cable tension peaks are markedly reduced when the cable scope is

large, due to the spring effect of the cable catenary. For this reason, the maximum cable scope should be used commensurate with the required operational depth. The equipment operator should be guided by the cable tension in determining what depth can be achieved in any given conditions.

The tabulated results shown below were taken with the ship's head to a wind of 18 kts, no significant swell, sea state 4-5.

Cable scope (m)	Ship speed (kts)	Depth (m)	Towing tension (kgf)
200	6	153	400
200	8	140	420
400	4	300	400
400	6	320	800
400	8	250	600
570	4	400	400
570	6	340	450
570	8	400	900

At 4 kts the vehicle depth control was poor, a speed of 6 to 8 kts was found to be better. Depth errors on steady tows were measured, using a 20 minute duration run with the full cable scope of 570 metres. The results are given below.

Nominal set depth (m)	Speed (kts)	Depth variation, p-p (m)
50	6	5.5 Could be improved by
50	8	5.5 using shorter scope
100	6	3.5
100	8	4
200	6	4
200	8	2.5
350	6	3
350	8	4.5

The depth variation sometimes showed a periodicity of 3 to 9 minutes; there seemed to be no obvious reason for this. In addition there appeared to be some drift in the servo loop. This could be corrected by the system operator for more accurate depth keeping if necessary.

Mechanically, the vehicle as delivered was not in good operational order. The hydraulic system was in a very poor state, having a leaking seal on the pump shaft, inadequate sealing on the filter cover plate, and insufficient capacity in the reservoir to make up for the leakage present. The coupling pin between the propeller and the hydraulic pump was not strong enough for the duty.

Some of these inadequacies were rectified on board, and which were sufficient to give the vehicle an operational life between recoveries of 24 hours. It is hoped that further modifications and replacement of the shaft seal will give the vehicle a life of 7 days or more. The cable handling and

deploying arrangements worked very well, but recovery of the vehicle was aided greatly by a recovery hook, made and fitted on board to the towing bridle.

Fig. 4 shows the ship's track over the set navigational grid. Initially, an attempt was made to steer the ship around the 90° bends, but this was later abandoned and semicircular loops made to pick up the next leg. The track shown is relative to the water mass, the ship being tracked by D.R. so that intersection points on the grid should be through the same water as before.

R.M. Carson.

Acknowledgement

The scientific staff are indebted to the Master, ship's officers and crew for their very valued co-operation in carrying out the cruise objectives.

W.E. Elford,
Principal Scientist.

G.L.O.R.I.A. MK. II MODEL TOWING STABILITY TRIALS SYSTEM 1

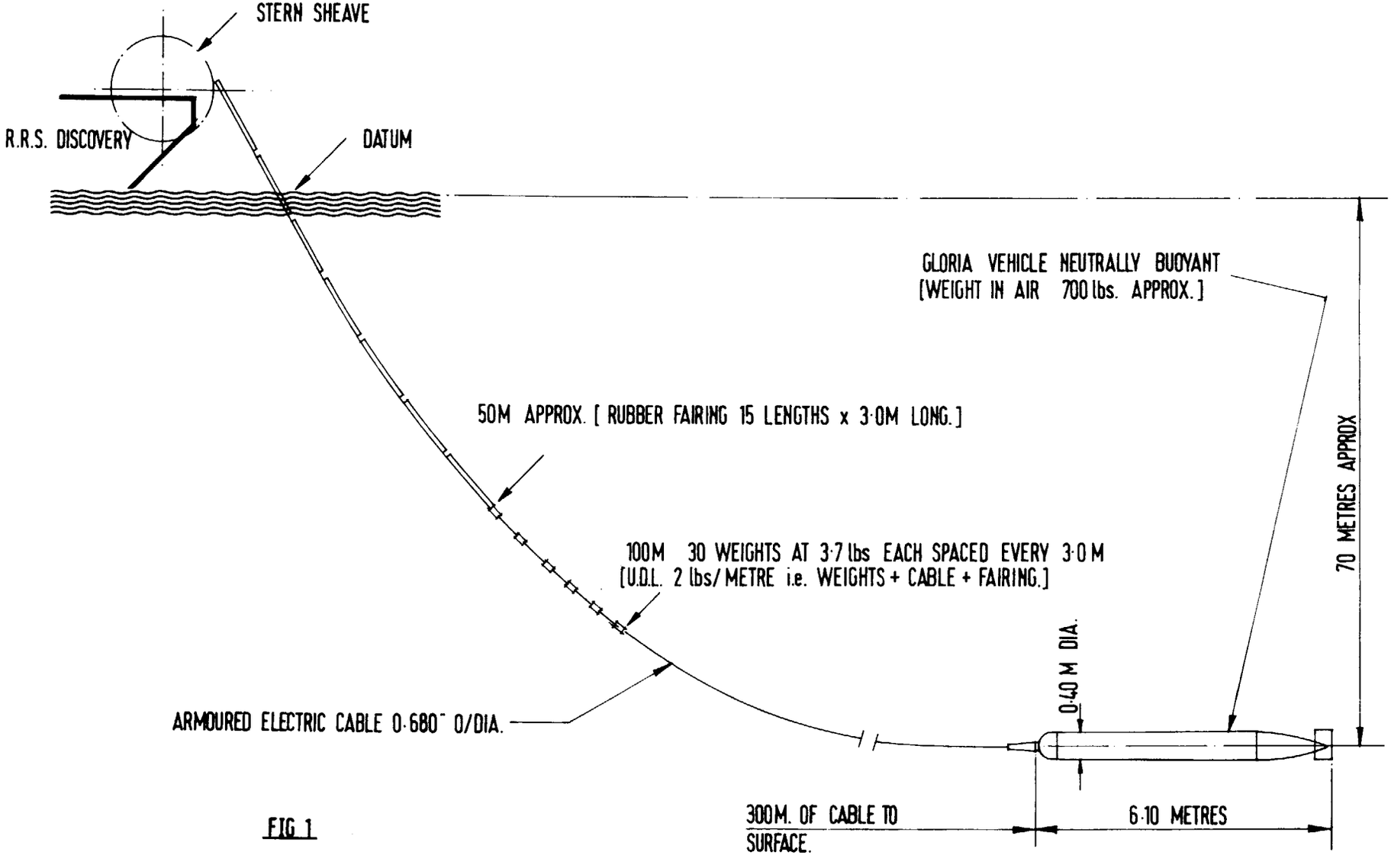

FIG 1

G.L.O.R.I.A. MK. II MODEL TOWING STABILITY TRIALS SYSTEM II.

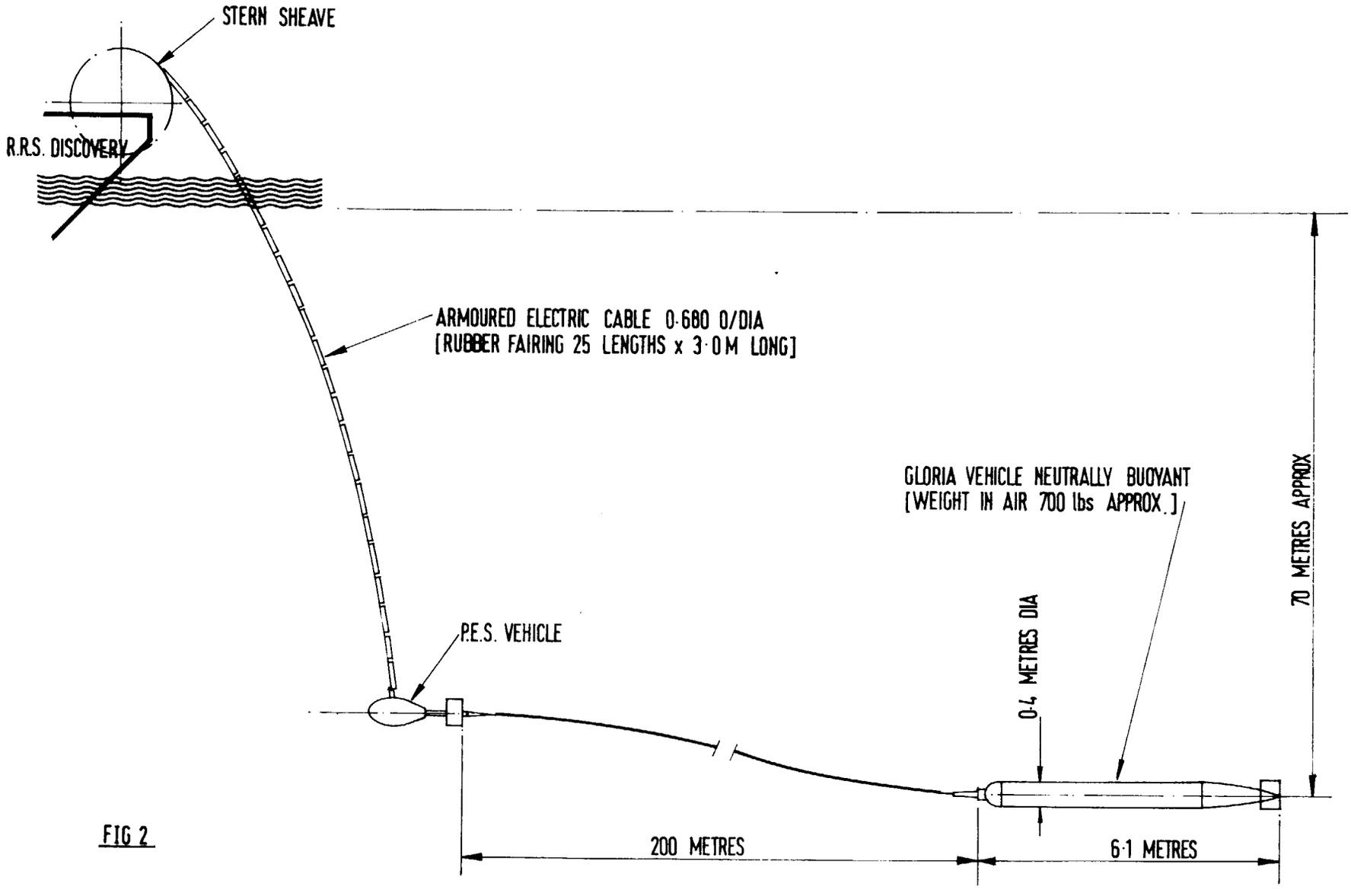

FIG 2

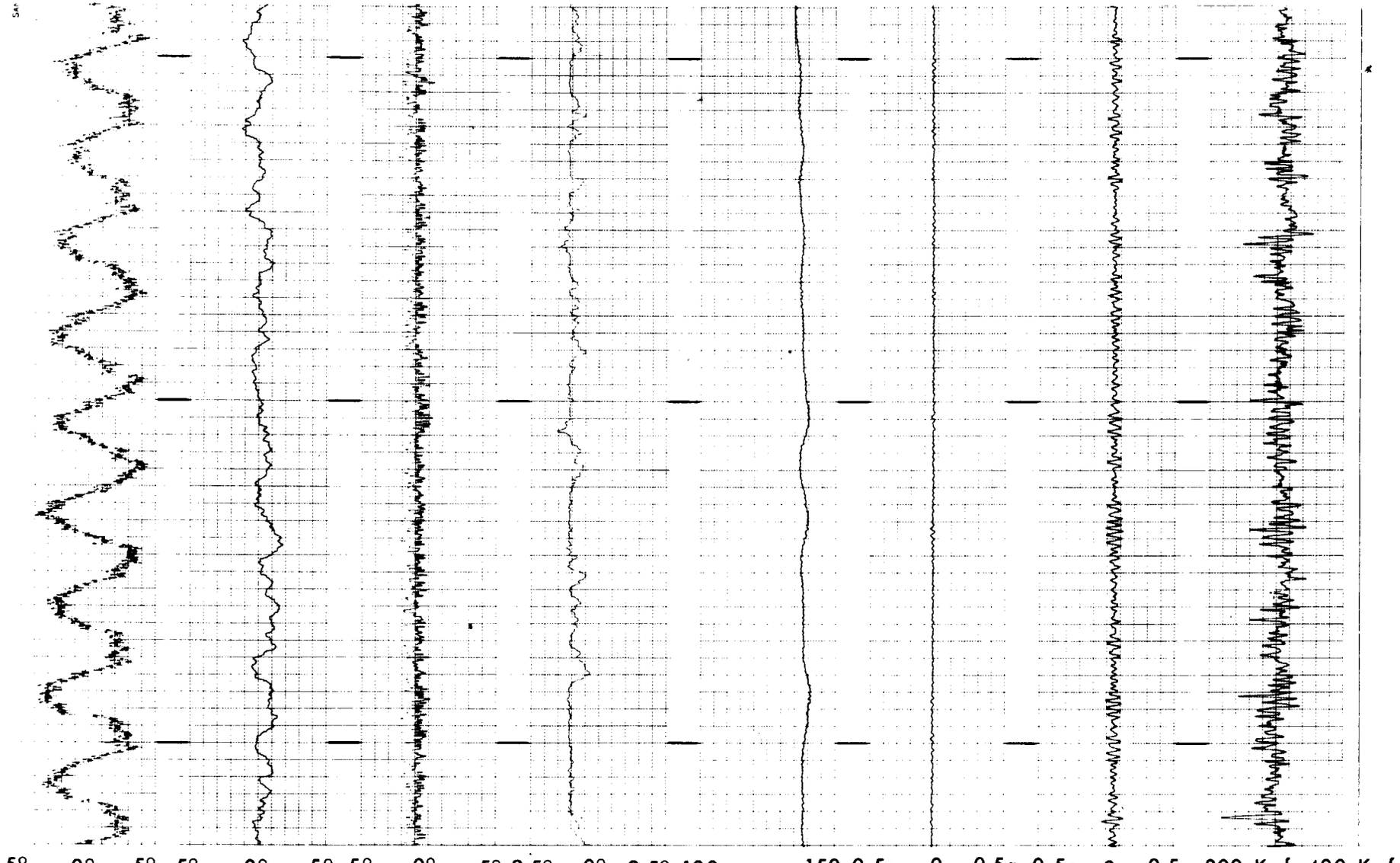
5° 0° 5°
5° 0° 5°
5° 0° 5°
2.5° 0° 2.5°
100 150
0.5g 0 0.5g
0.5g 0 0.5g
300 Kgf 400 Kgf
SHIPS HEAD
YAW
ROLL
PITCH
DEPTH
HEAVE ACCEL.
SHIP POOP ACCEL
TOWING TENSION

FIG. NO. 3.

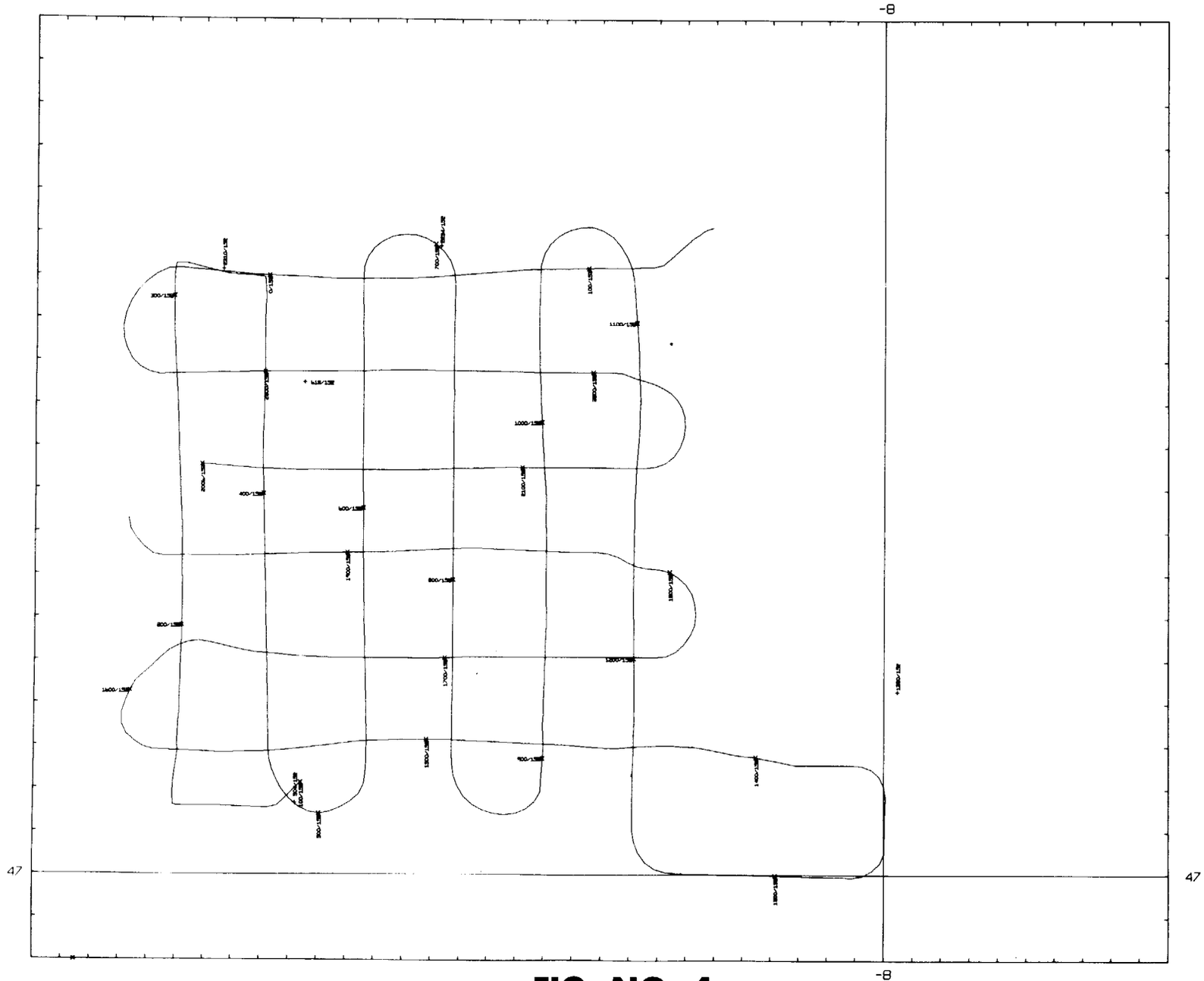

FIG. NO. 4.