ENVIRONMENTAL MEASURING SYSTEMS RECENTLY PROTOTYPED BY STAFF OF THE ENGINEERING SERVICES SECTION, NATIONAL WATER RESEARCH INSTITUTE FOR LIMNOLOGICAL AND OTHER WATER RESEARCH STUDIES

ES - 518

J.S. FORD, HEAD
ENGINEERING SERVICES SECTION

/IWD

January, 1980

ENGINEERING SERVICES AT THE CANADA CENTRE FOR INLAND WATERS

1979

INTRODUCTION

The Engineering Services Section of the Scientific Support Division serves all divisions and agencies at the Canada Centre for Inland Waters as well as detachments of Inland Waters Directorate in various regions of Canada. These services include the design, development, consultation, evaluation, specification, calibration and maintenance of a wide variety of systems used to sample or measure environmental variables and to process, record and display the variables.

The engineering problems involved often require innovative solutions because of the scientific, environmental and operational constraints which apply. To prevent duplication and to be cost-effective, much of the engineering effort is applied to evaluating, adapting and improving commercially available technology for the task at hand. When novel approaches are required, and the goals are transferable and finite, development is normally contracted. Should a suitable supplier not be available, or should the initial development require complicated interaction amongst study team members, development may be undertaken within the Section.

The Engineering Services Section has 9 professional and 20 technical and trades staff members. When necessary, additional personnel are employed under contract for specific activities or the occasional term employee may be hired.

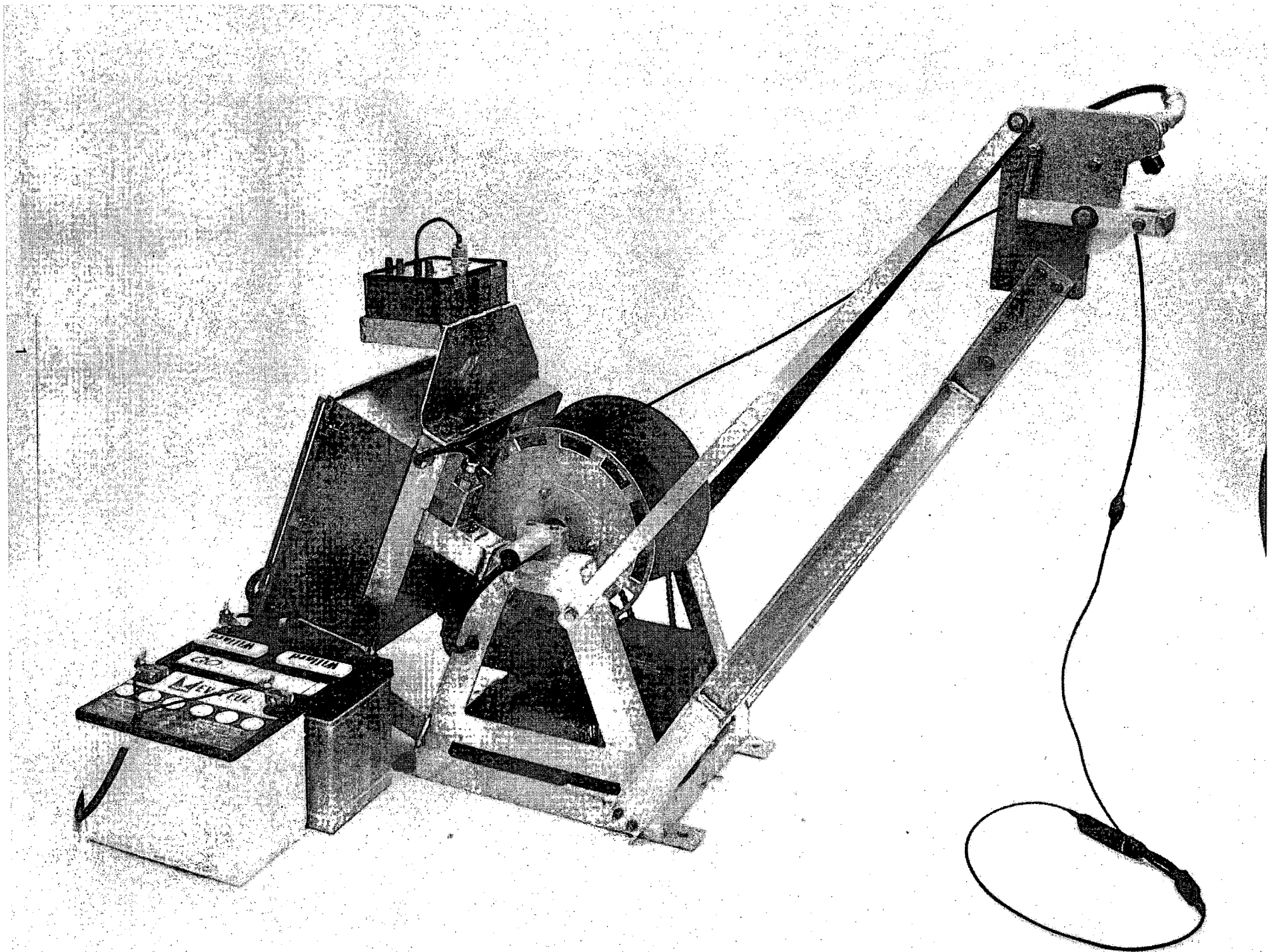
This is the fifth report in a series which reports the accomplishments finished in 1979. See also the unpublished reports of the same or similar title numbered ES-510, ES-512, ES-514 and ES-515.

Readers are requested to send their summaries of similar activities. We are eager to make use of your experience, knowledge and developments.

TABLE OF CONTENTS

TABLE OF CONTENTS

-cont'd.-



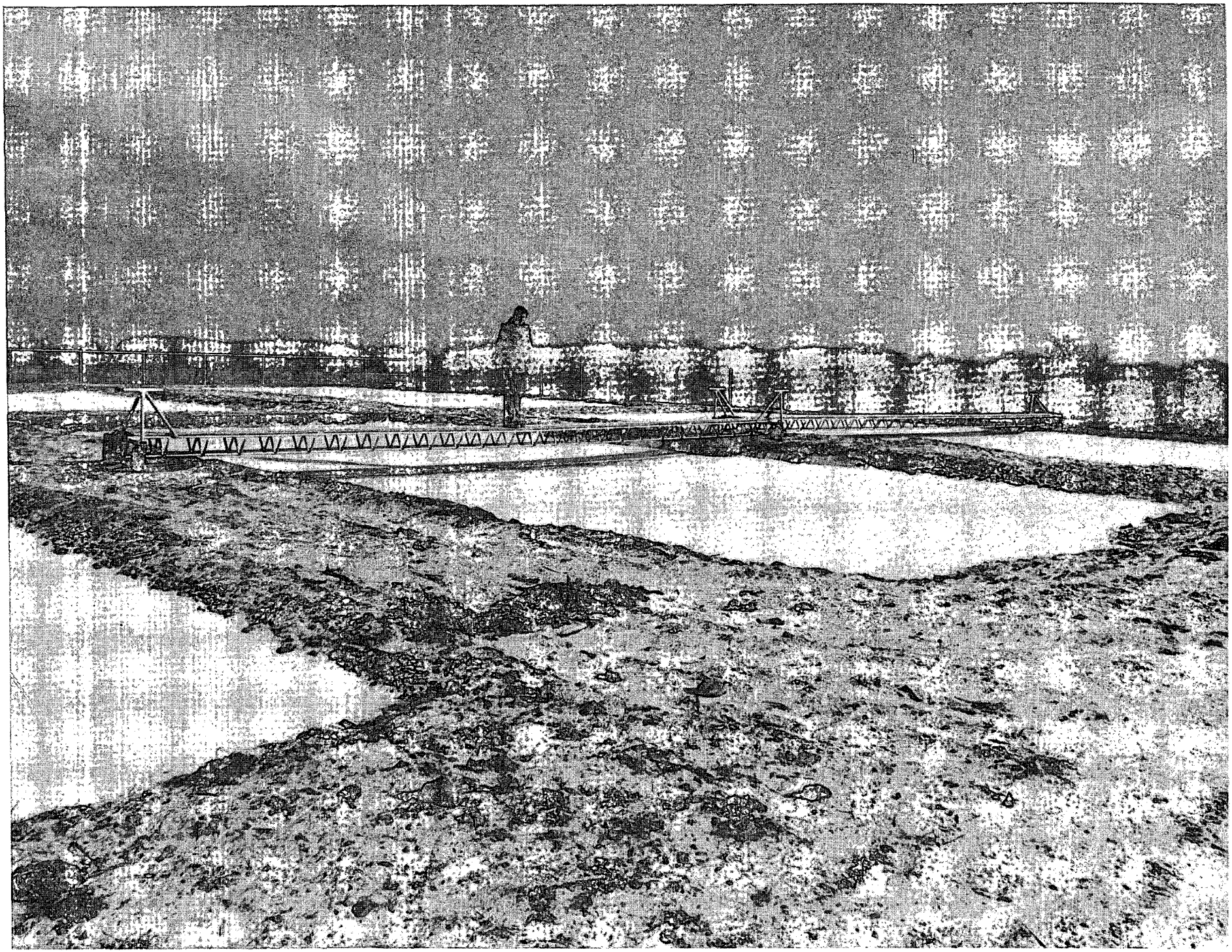
AUTOMATED ARCTIC WINCH MECHANISM

A new automated lightweight Arctic Winch has been designed in co-operation with O.A.S. With this winch, the operator is free to leave the site, particularly at night, and return to base. The winch is powered by automobile batteries.

The winch has its own 'A' frame with sheave and carries three safety limit switches for winch control signals.

SPECIFICATIONS

Length	130 cm
Width	50 cm
Height	110 cm
Mass	50 kg
Length of cable	350 metres of 3.5 mm Amergraph
Payload pull	1350 N
Endurance	50 hours on four, 12 V batteries
Speed	Variable - stepping motor



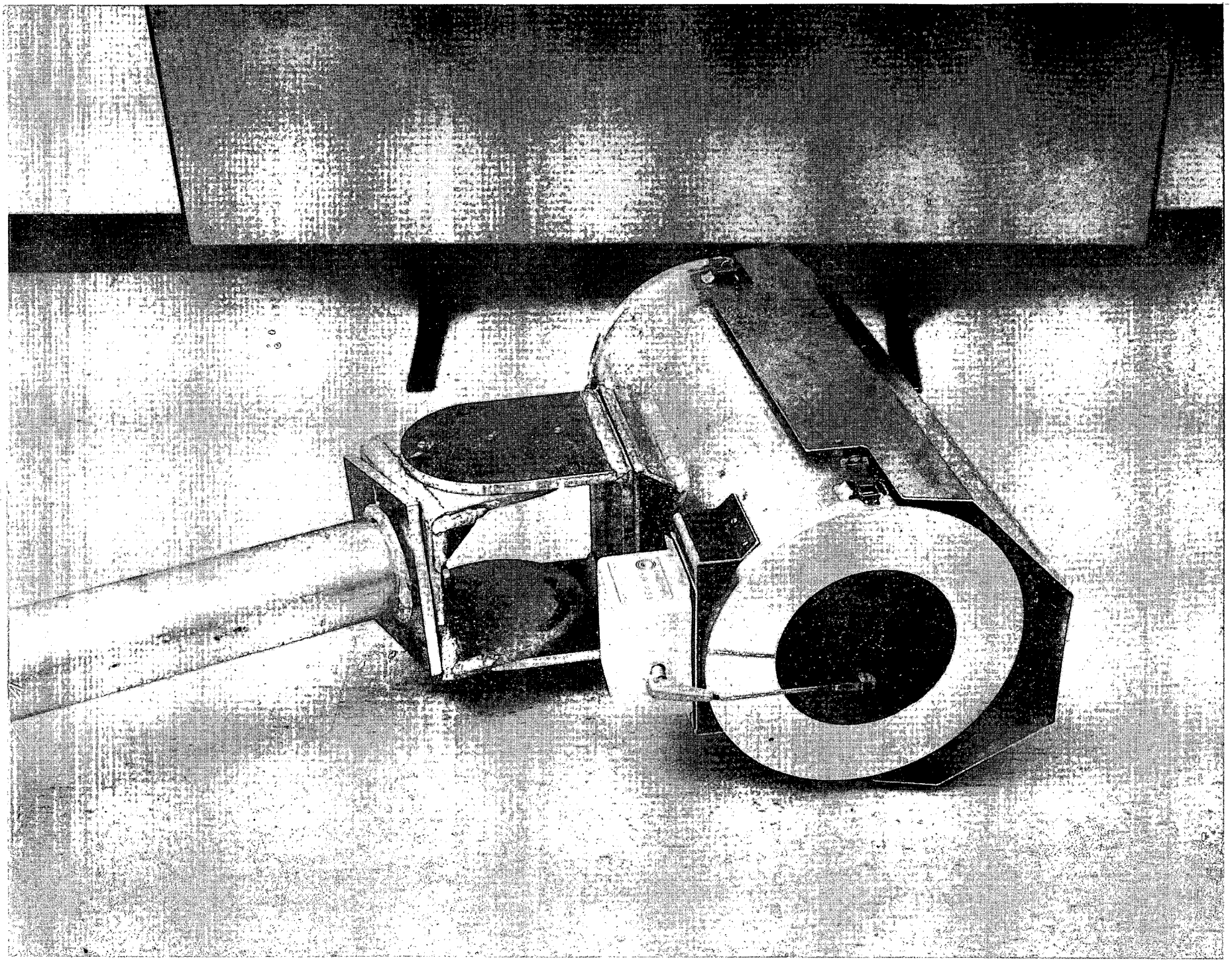
BRIDGE FOR WORKING OVER PONDS

A portable bridge was required to permit ease of sampling from overhead in a study using large artificial ponds.

A suitable supporting structure was provided by placing two sections of tower (commercially available TV antenna) side by side. Large diameter, pneumatic-tired casters are provided on both ends to move the bridge over relatively unprepared soft surfaces. The structure is sufficiently light and mobile to be readily pushed by two people over any one of the six ponds in the study area.

SPECIFICATIONS

Span	12 m (40 ft.)
Section Dimension	Trapezoid 69 cm top, 38 cm bottom, 33 cm deep (27" x 15" x 13")
Deck Width	61 cm (24")
Mass	136 kg (300 lb.)
Live Load (Working)	1.33 kN (300 lb.)
Deflection with load mid span (incl. pneumatic tires)	7.5 cm (3 in.)



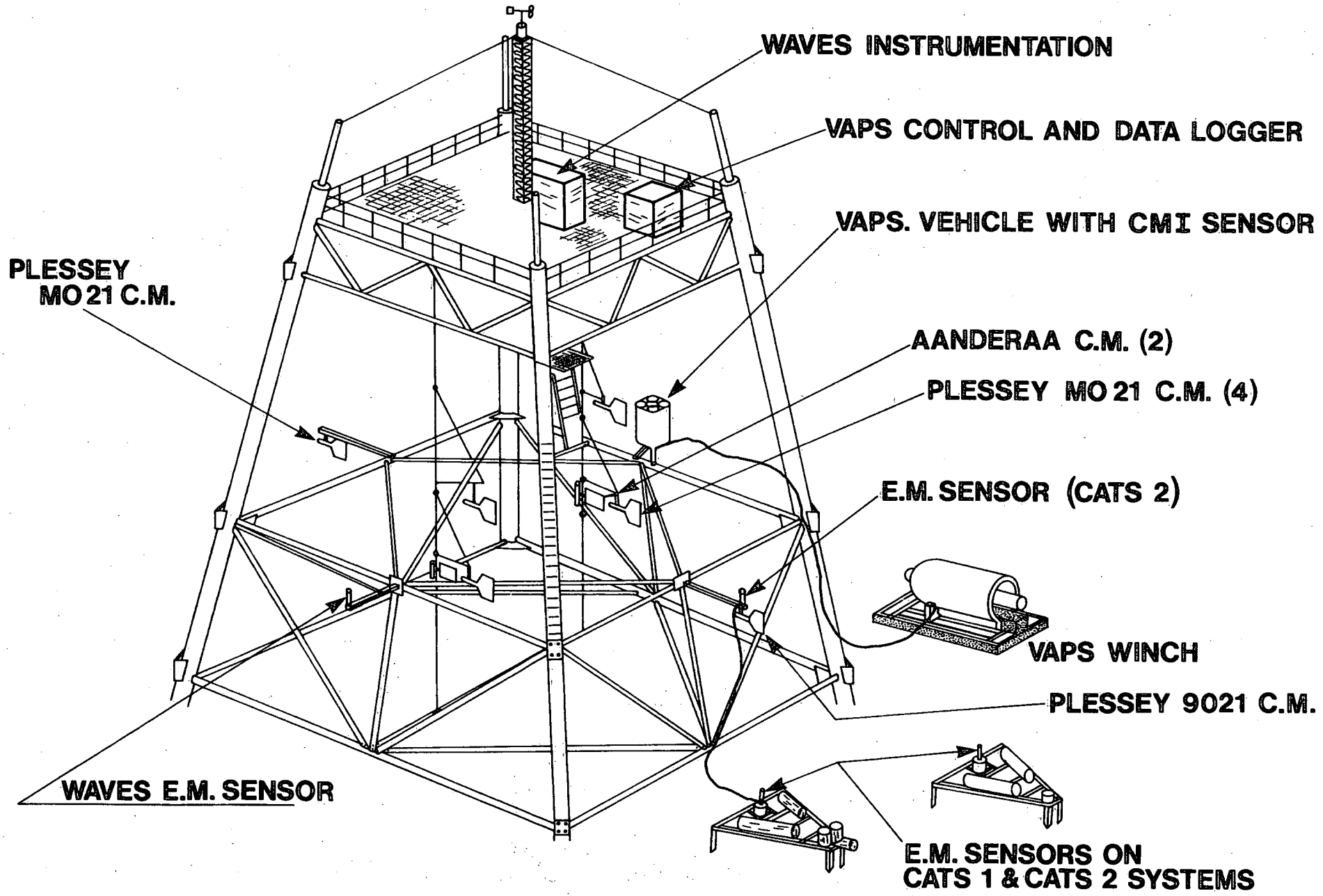
CAMERA FOR WAVE STUDY

To record pictoral information for wave studies, a photologger system was constructed. It consists of BOLEX 16 mm camera, auto exposure control, case heaters, blower timing circuitry and window wiper; all housed in a weatherproof case. The scene (off CCIW WAVES Tower) is photographed along with time, date, reference colours and contrast on a test target.

The system is connected to a control box via two cables. All the commands are generated by a shore based computer which services the several functions on the Tower.

SPECIFICATIONS

Image size	16 mm (10 x 8 mm)
System exposure capacity	4000 frames (30 m film)
Lens	10 mm Schneider-Kreuznach
Aperture range	f/1.6 to f/16
Field of view	93° diagonal
Depth of field	20 cm to infinity (preset to α)
Filming speed range	12 to 25 frames/s (preset to 24 f/s)
Shutter speed	1/33 to 1/65 (preset to 1/65)
Exposure control	Apex B, Photomatrix Corp. ASA 12-3200 Speed 1/12 - 1/12800
Reference information recorded on film	time, colour, contrast
Power consumption	Heaters: 225 W Wiper: 20 W Camera Electronics: 40 W Total Max. 285 W at 115 VAC
Operating temperature	-20 to +35°C 0 to +35°C (wrist)
Size	750 x 450 mm Dia. (approx.)
Mass	40 kg


WAVES INSTRUMENTATION
VAPS CONTROL AND DATA LOGGER
VAPS. VEHICLE WITH CMI SENSOR
PLESSEY MO 21 C.M.
AANDERAA C.M. (2)
PLESSEY MO 21 C.M. (4)
E.M. SENSOR (CATS 2)
VAPS WINCH
PLESSEY 9021 C.M.
WAVES E.M. SENSOR
E.M. SENSORS ON CATS 1 & CATS 2 SYSTEMS

CURRENT METER COMPARISON, PART II

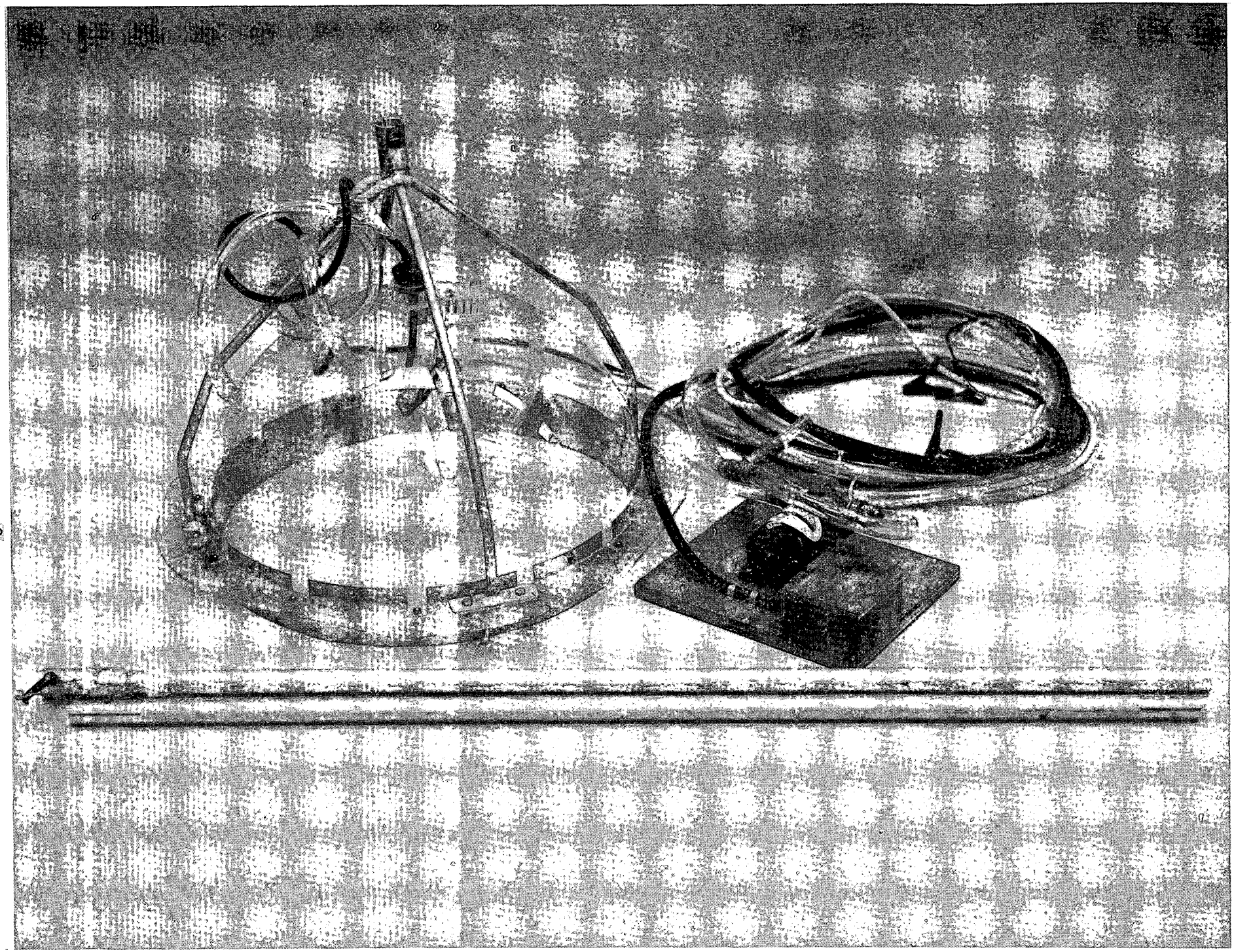
The current meter comparison study was formed mid fiscal 1976 to organize and execute a field experiment. The purpose was to compare at a single site a number of current measurement systems - some old, some new, and some under development - as a means of assessing confidence in their relative performance capabilities. In fiscal year 1977, the data from the experiment were processed and the comparison work was started. An intensive review of electromagnetic current sensor technology - including diagnosis of many previous applications of these sensors at NWRI was conducted. A polling of scientists was made to determine the development needs for future current measurement requirements.

The emphasis in this study has been placed on obtaining better estimates of data quality for water current measurements. Once the definition of the experiment requirements and the state of knowledge of the instrument response characteristics have been assembled, refined current measurement system models and instrument testing experiments can be developed effectively.

The unpublished report generated for this study is a collection of this and other related work. It is available only for limited distribution because of its size.

SPECIFICATIONS

Current Meters included in the intercomparison	
Plessey M021	5
Plessey 9021	1
Aanderaa RCM 10	2
Marsh McBirney M501 (WAVES)(CATS)	4
Christian Michelsen Institute Acoustics (VAPS)	1

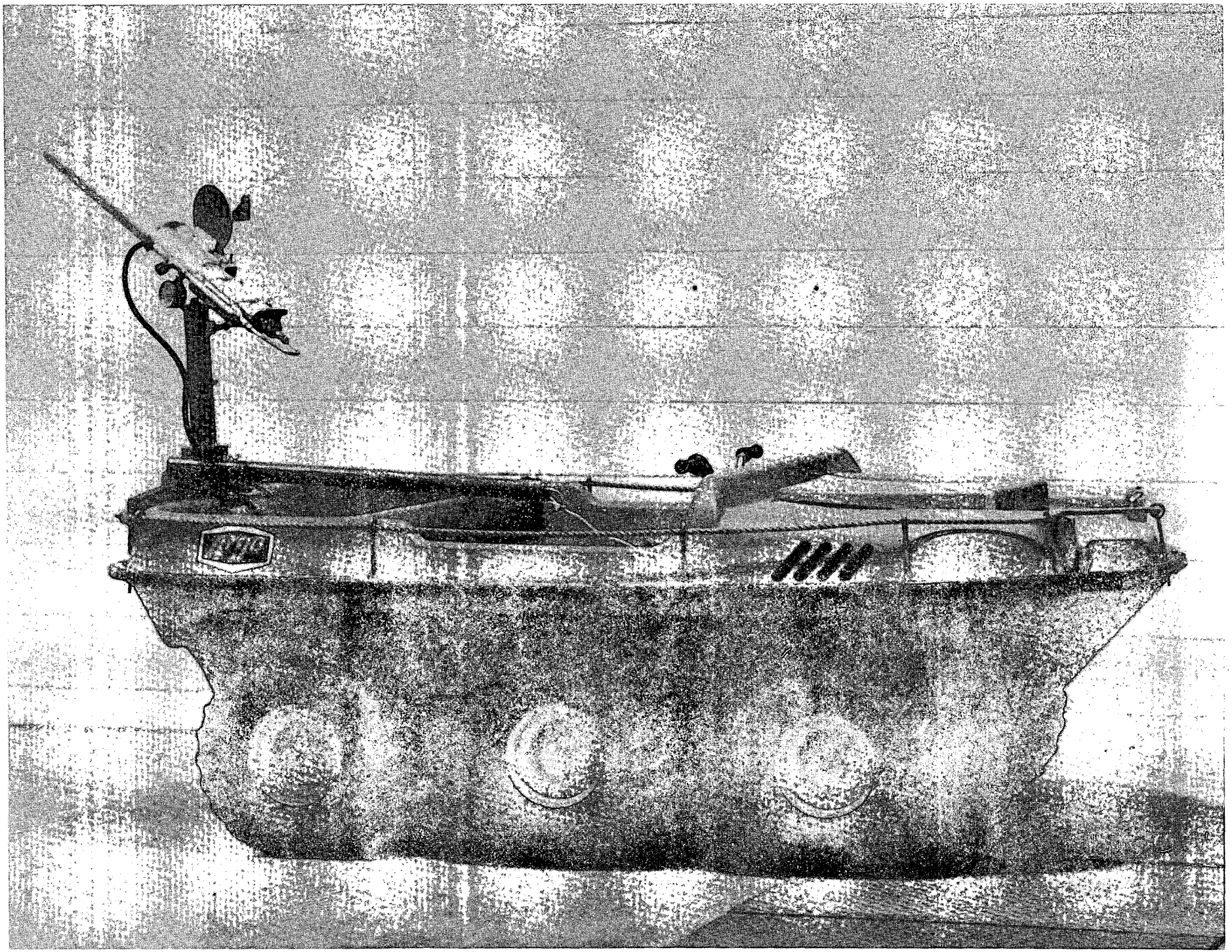


DOMES FOR MEASUREMENT OF GAS EXCHANGES IN LITTORAL ECOSYSTEMS

The use of transparent plastic domes has been successful for the measurement of oxygen exchange in lake sediments. Based on this experience, a simple trap was designed for the measurement of nitrogen fixation by underwater plants in the littoral zone. The trap consists of a thin wall acrylic hemisphere to which a skirt has been added for good isolation after the dome has been inserted into the lake bottom. Acetylene gas is fed to the dome through a tube from the lake surface. The gas bubbles up through the water inside the dome. A pump at the surface is used to keep the water inside the dome in constant motion. A gas lens is formed at the top of the dome which is then sampled for estimation of nitrogen fixation by the plants within the dome. To avoid the need for diving, the apparatus is installed and retrieved by means of a rod which can be assembled in sections.

SPECIFICATIONS

Pump	Jabsco Water Puppy Bilge Pump 12 V DC supply
Dome	54 cm diameter x 22 mm thick acrylic hemisphere (builders supply)



DROGUE SYSTEM FOR LITTORAL ZONE

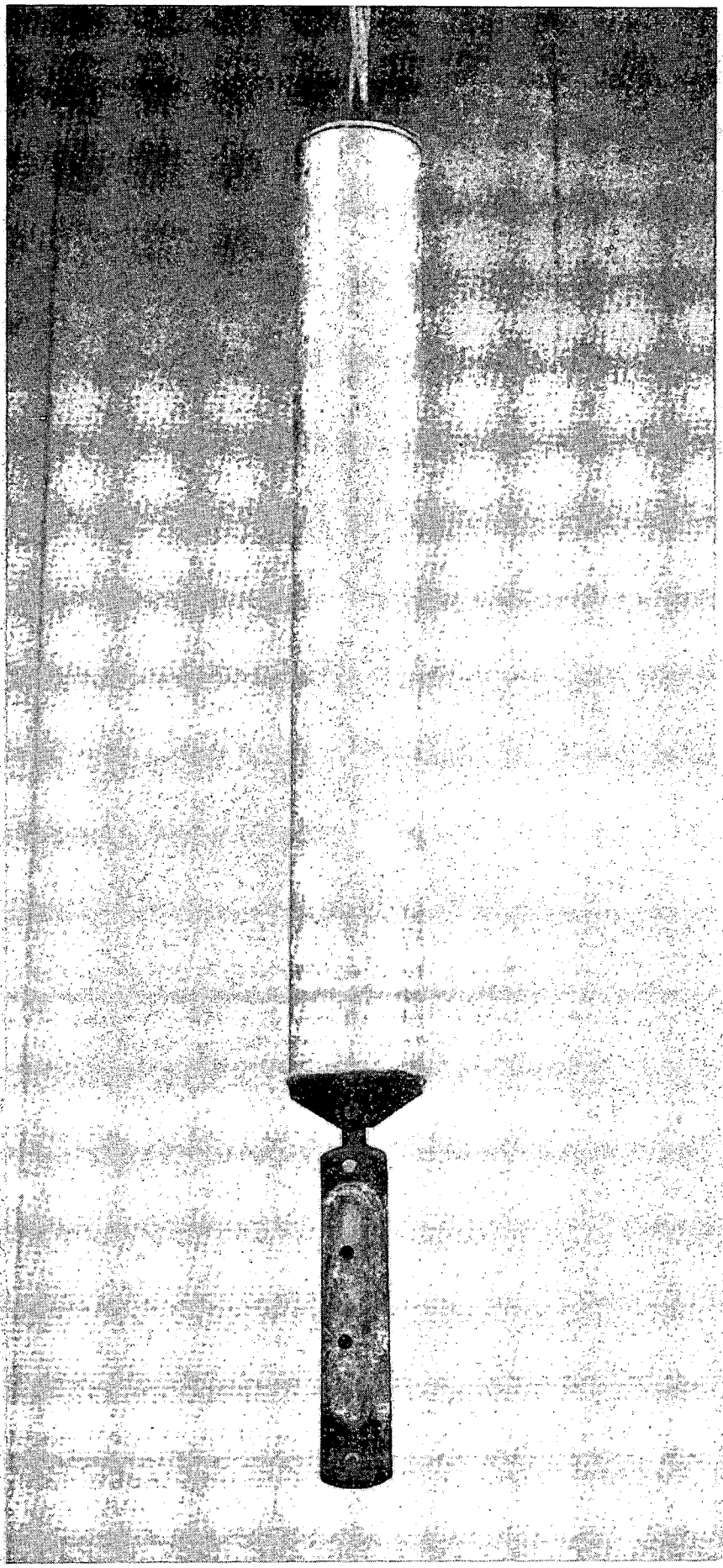
A system has been designed and built for tracking alongshore currents in the nearshore surf zone. The system comprises a number of small drogues and a launcher.

The drogues consist of orange tennis balls, modified either to float with one-third of their diameter exposed, or to sink for a period of time and then return to the surface by dropping a weight. The time delay for dropping the weight is obtained by the use of salt tablets which are glued between weight and ball.

The launcher is a muzzle-loading, compressed-air powered, single-shot cannon, mounted on an "Argo" all-terrain vehicle for mobility. The cannon can be trained in any azimuth. It is normally operated at a fixed elevation and range is varied by changing the air precharge pressure.

SPECIFICATIONS

Air supply for cannon	6.3 m^3 SCUBA tank
Air precharge pressure range	3.4 MPa to 10.3 MPa
Volume of precharge chamber	300 cm^3
Number of firings per tank	∿20
Maximum firing range	100 m (still air)
Maximum firing range	∿50 m (into a gale)

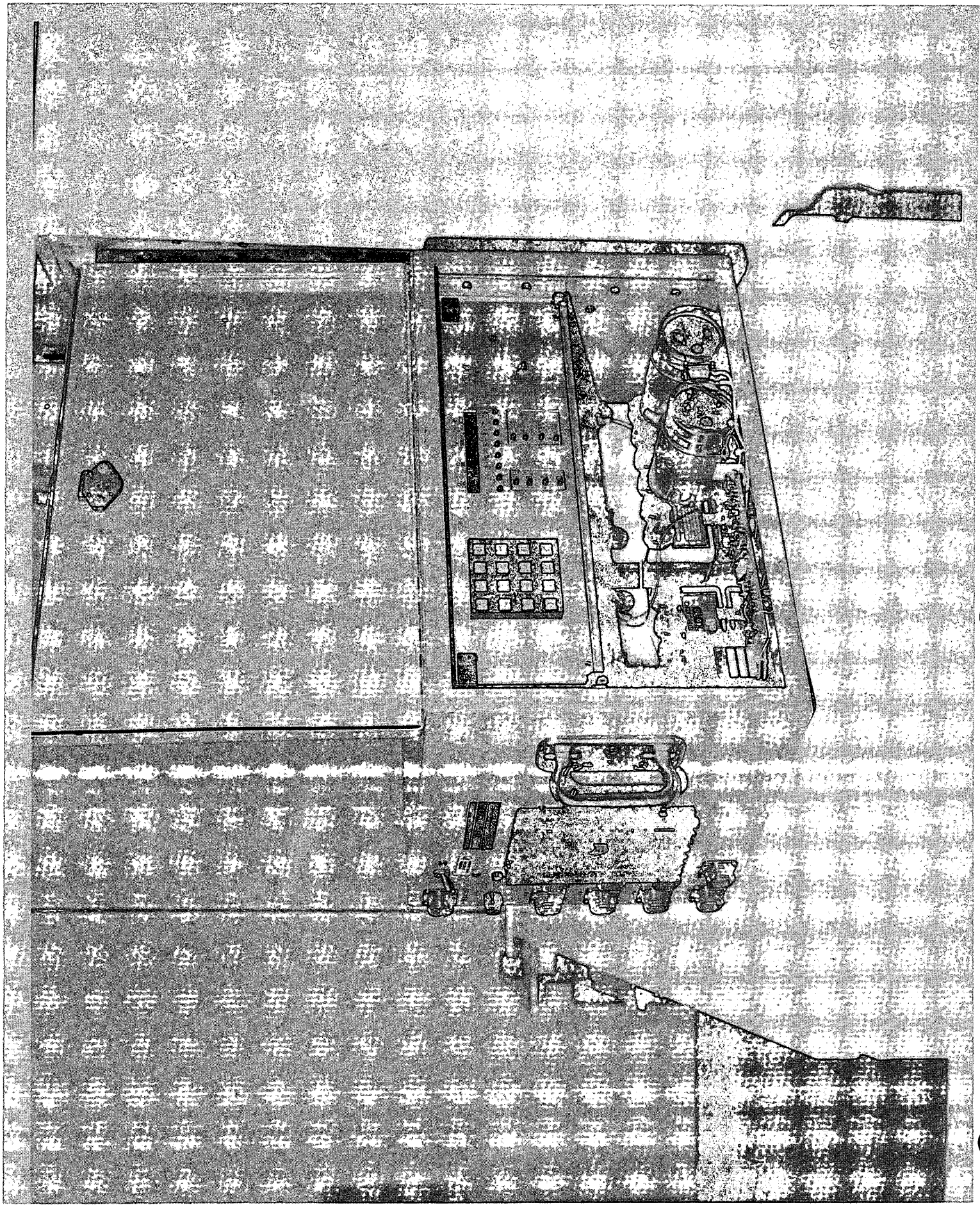


FLOAT AND ANCHOR

This simple device was produced for the Tides and Water Levels Group to permit the installation of a tide gauge through the ice. A taut mooring is assembled by attaching the anchor to the base of the gauge, a length of cable is strung above the gauge to the base of the float. Above the float is another line for retrieval purposes. A 23 cm diameter hole is cut through the ice and the mooring is lowered by hand until the upper line goes slack. This line is then frozen in. For later retrieval, a second hole is drilled adjacent to the first and the mooring is pulled up.

SPECIFICATIONS

Max. depth for float	25 m
Float dimensions	20 cm diameter x 1.5 m long
Buoyancy	350 N
Anchor mass	54 kg



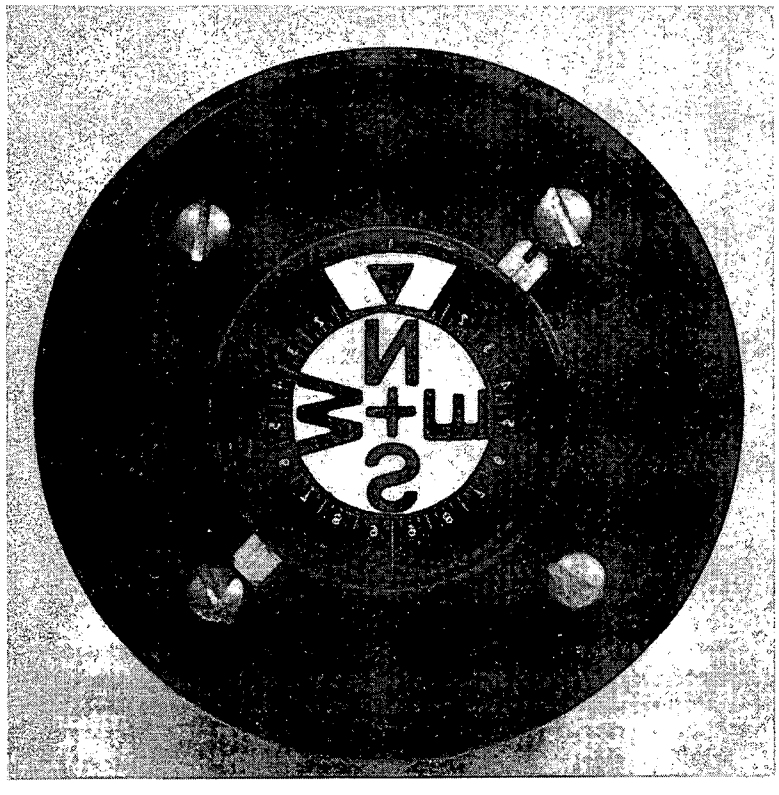
GENERAL PROGRAMMABLE TIMER AND CONTROLLER

In the past, N.W.R.I. has used mechanical and solid-state timer/controllers of various forms in a number of automatic, unattended equipment installations. Water sampling installations are but one example. Recent technological advances in microprocessors and in LSI (large scale integration) have made the design of sophisticated, programmable timer/controllers practical. These units offer considerably more capability at a cost competitive to the traditional mechanical units. To take advantage of current advances in the state-of-the-art and in addition, upgrade, N.W.R.I. timer/controller-based systems, Canadian industry was contracted to develop a general purpose, programmable timer/controller.

The timer is based on a Motorola 6802 CPU (central processing unit). Up to eight channels can be independently controlled (i.e., programmed). In addition, four different levels of programming are available for each channel. This feature permits highly complex timing cycles to be implemented. The timer operates on a seven day cycle with a resolution of one second. Battery backup preserves the timer program in the event of a power outage.

SPECIFICATIONS

Program cycle	7 day
Timer resolution	1 second
No. of channels	8 independently programmable
Level of program	4 per channel
Display	7 digit, time and day
Data entry keypad	Numerics 0-9 Program channel Enter data Erase timer Next timer Clear entry Lamp test
Power	115 VAC, 60 ±5% Hz 48 hour backup battery
Operational (design)	-20°C to +50°C 0 to 100% relative humidity



IMPROVEMENTS TO T.R.O.V.

Anomalies in the earth's magnetic field can be sufficiently severe, or the field can be too weak, causing magnetic compasses to be functionally inoperative. Since the underwater surveillance vehicle T.R.O.V. was planned to be used in locations having such effects, it was fitted with a gyrocompass unit. The unit was selected on the basis of low drift characteristics consistent with T.R.O.V.'s size, power and configuration constraints.

To keep the subsystem simple, no remote readout was ordered, instead a special mirror-lens viewing arrangement optimizes the visual display for the operator, who monitors the system readouts via closed-circuit T.V. Remote caging of the gyrocompass allows the unit to be preset to a given heading (usually North) prior to a surveillance run. Once uncaged, the gyrocompass will maintain this preset bearing, and the heading of T.R.O.V. can be monitored from a compass rose.

Other modifications and repairs were done to improve the performance of the T.R.O.V. system. These are:
welding of all possible joints in the electronics chambers to eliminate leaks and structural weaknesses;
paralleling of the air compensation cylinders for the ballast system to increase underwater endurance;
building new camera and flash unit mounts and reworking the remote triggering system for the 35 mm still camera system;
overhauling and reversing the umbilical cable to eliminate damaged portions;
fabrication of propellor guards to avoid cables or debris being trapped in the propellors;
reworking of the control servos to increase their reliability; and
a general overhaul of the complete machine with Technical Operations.

SPECIFICATIONS

Display	Visual 360° compass card with N,S,E,W pointers
Pitch & roll limits	±80° minimum
Drift	Within 10° cw or ccw during any 1 hour period
Run up to speed	3 minutes nominal
Time to cage	30 seconds nominal
Time to uncage	0.5 seconds nominal
Power	28 VDC ±2 V @ 310 mA nominal
Size	17 cm long x 6.4 cm dia.
Mass	1.4 kg
Service life	500 hours minimum

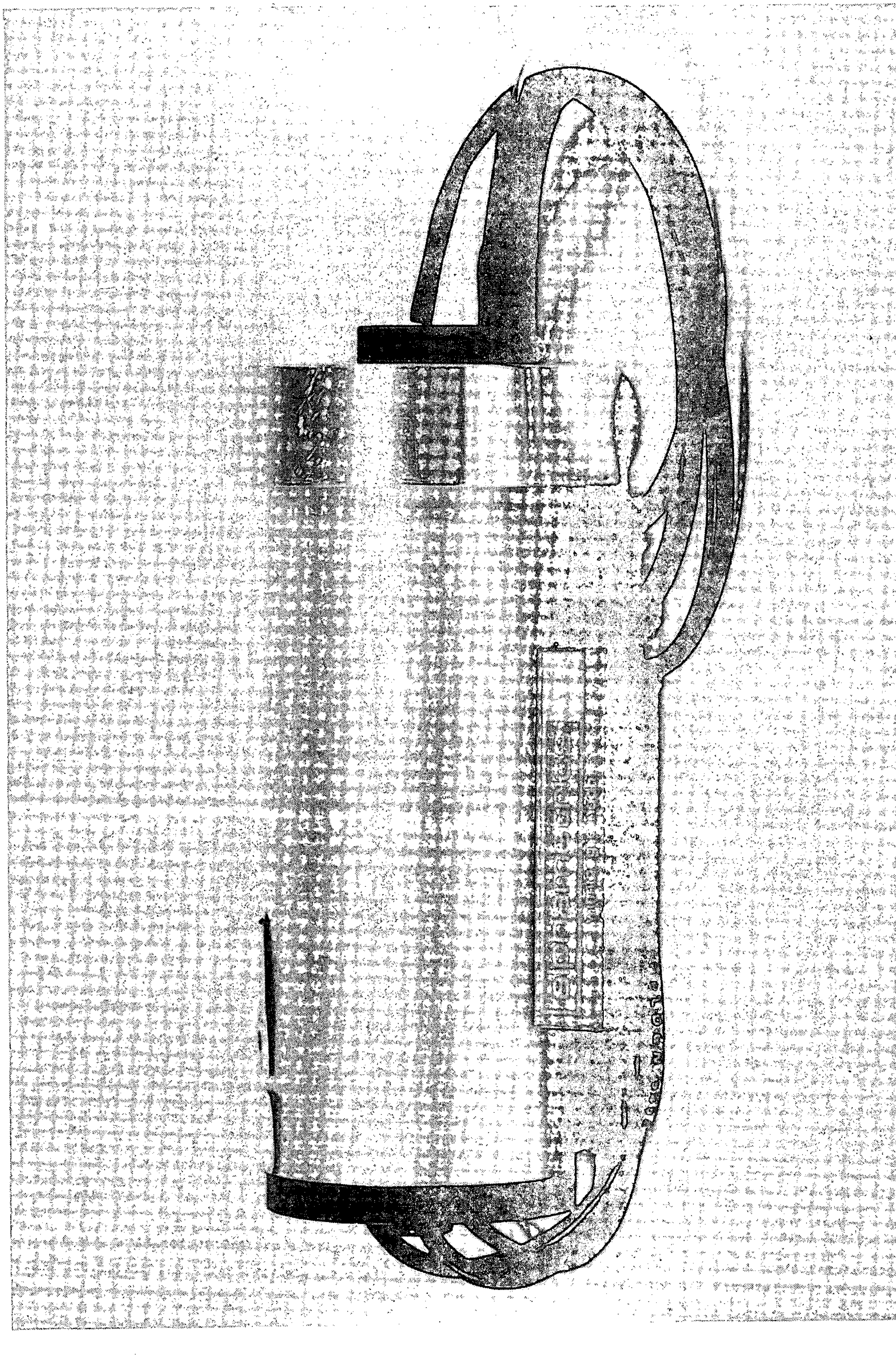
INCUBATOR FOR SHIPBOARD WORK

An incubator consisting of a flat tray with six separate compartments and six separate "picture frame" lids was manufactured in plastic materials. Within the six frames, neutral density filters of different values can be fastened.

In operation, samples of lake water with their own natural phytoplankton communities are collected from numerous stations, sealed in glass bottles and clipped into the six compartments of the incubator. Surface water from the lake is then pumped through the trays to maintain a uniform temperature. The effect of varying sunlight on primary production in lake water can be studied by means of the light filters.

SPECIFICATIONS

Tray size	1.2 m wide 2.5 m long 12 cm deep
Flow of water	16 L per minute minimum



LIGHT METER FOR INCUBATOR MONITORING

Biota are sensitive to radiation from all directions, and unless care is taken to measure radiation from all directions, errors may result. Because of this, there was concern about using cosine response probes for some incubators at NWRI. As a result, a small spherical probe was made to be inserted in the flasks used for biota cultures. A one centimetre diameter teflon ball was used together with one millimetre diameter fiber optic as the front end of the probe. The radiation from the fiber was measured by a light meter coupled to the fiber.

Using this meter it was shown that the radiation inside the bottle was essentially the same as that outside. Based on this a larger spherical probe, with a "photosynthesis-band quantum spectral response" meter was purchased and evaluated

---

SPECIFICATIONS

Small Probe (NWRI Probe & Alphametrics Meter)	
Dynamic range	2 to 10^5 lux for tungsten illumination
Probe size	1 cm diameter attached to 1 mm diameter x 50 cm long fiber
Angular error from nominal	down -25% at 90° if 0° down -40% at 180° if 0°
Immersion effect	Reads 0.9 of air value in filtered distilled water
Large Spherical Sensor (Licor Instruments)	
Dynamic range	0.001 to 10000 $\mu E.m^{-2}.s^{-1}$
Error	±10% typical
Linearity	±2%
Response time	1 s to 1000 s (with LI-188 meter)
Angular time	down about 12% at ±90° if long axis down about 66% at 180° if long axis
Depth	300 metres
Size	6 cm diameter (probe)
Display	3 LCD digits


DATA DISPLAY

LOGGER FOR ANCHOR STATION STUDY

An intensive, mid-lake, time-series study required a logger to record, and display temperature and depth data from two separate sensor systems. These were, a thermistor chain hung over the side of the ship, and the ship's electrobathythermograph (EBT).

The system was built up very quickly from readily available components. The controller was an HP 9845S desk-top computer. The EBT data were multiplexed through a Hewlett-Packard 6940A Multiprogrammer, then digitized with an HP 3455A integrating voltmeter. The thermistor chain data were conditioned by a set of amplifiers and bridges built at C.C.I.W. several years ago, then multiplexed and digitized by the H.P. multiprogrammer modules. The digitized data were then messaged by the computer and logged in computer compatible format on a Kennedy 1/2" Tape Drive. Aside from some special wiring for the inputs, the only custom hardware was an interface between the computer and Kennedy Tape Drive.

A back-up system consisted of a Sea-Data model 1250 data logger which was wired in parallel with the thermistor chain inputs to the multiprogrammer.

The system itself is a good example of the ease of putting together a relatively complicated system with the recent types of modular hardware and desk-top computers.

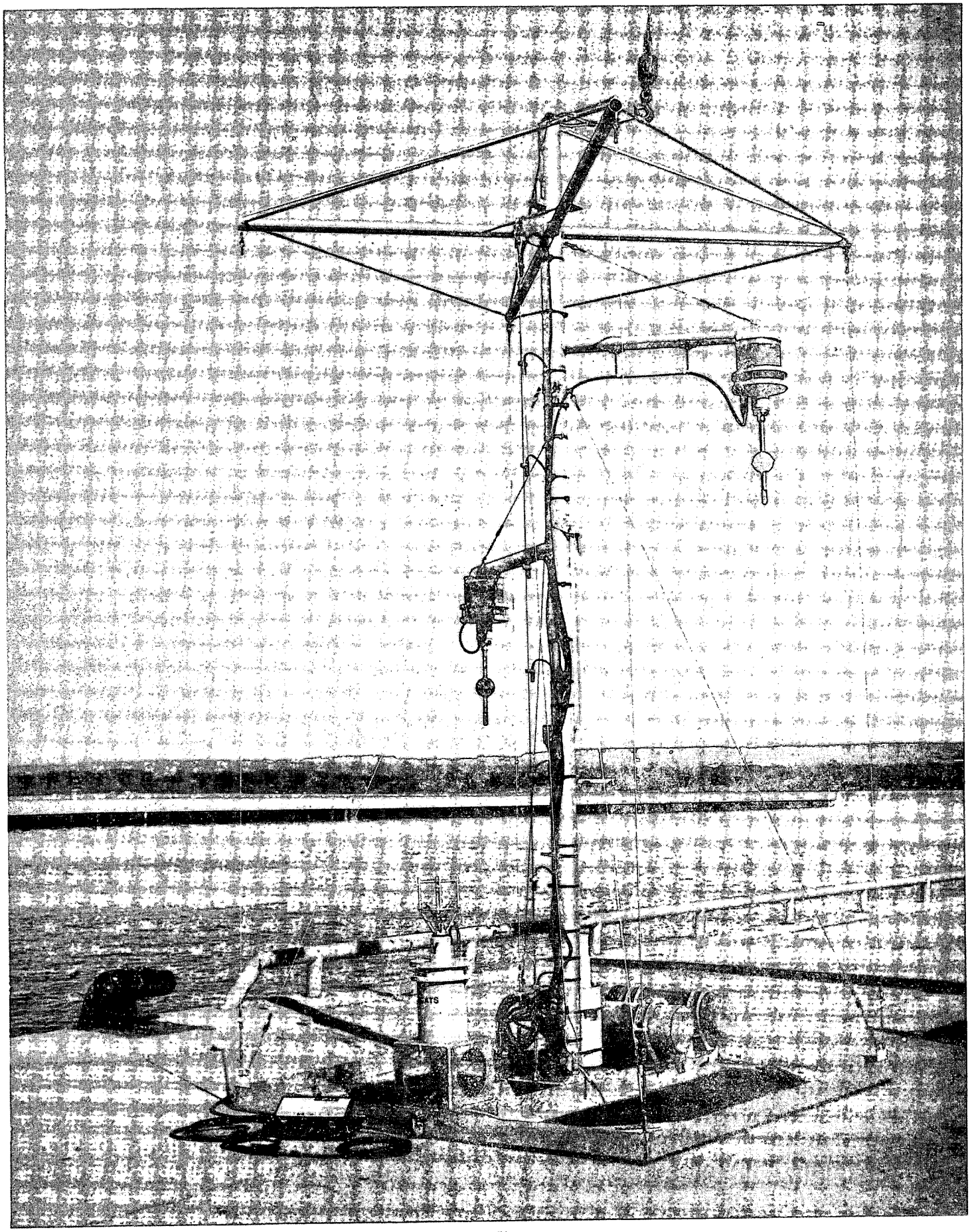
SPECIFICATIONS

Main System

Number of channels	11 thermistors 2 depths 1 temperature
Sample rate	1 scan per two seconds for thermistors and their depth gauge 5 scans per second for EBT digitizers
Resolution	1 in 4000 for thermistors 1 in 100 000 for EBT digitizer only
Capacity	50 000 scans

Backup System

Number of channels	11 thermistors 1 depth
Sample rate	1 scan per second
Resolution	1 in 4000
Capacity	61 000 scans



MOVEABLE CURRENT AND TEMPERATURE MEASURING SYSTEM

MCATS is a bottom mounted current and temperature measurement system. It consists of an array of three two-axis water current sensors and eight thermistors cabled to a digital data logger and system battery. The system is specially designed to measure the characteristics of processes near lake bottoms over periods of up to ten days. The sensors are sampled every 16 seconds by the data logger.

Following three successful missions in Lake Erie (1979) and an engineering endurance test, the system is undergoing modifications to increase the number of thermistors to replace the CMI Acoustic Current Sensor with a third electromagnetic sensor, and to triple the data capacity of the logger for longer missions.

SPECIFICATIONS

Temperature

(Fenwal 4k ISO-CURVE Thermistors)

Number of sensors	8
Range	3 to 25°C (4001 to 10000 ohm)
Resolution	10 m°C
Accuracy	±50 m°C
Time constant	16 seconds (achieved by coating fast thermistors with nail polish)

Water Velocity

(Marsh-McBirney Model 518 Electromagnetic Current Sensors)

Number of sensors	2
Range	0 to 150 $cm.s^{-1}$
Resolution	0.1 $cm.s^{-1}$
Accuracy	target of ±5% speed, ±5° direction at 4 $cm.s^{-1}$
Zero offset stability	±1 $cm.s^{-1}$
Time constant	16 second

(Christian Michelsens Institute Acoustic Current Sensor)

Number of sensors	1
Range	0 to 187 $cm.s^{-1}$
Resolution	0.1 $cm.s^{-1}$
Accuracy	±10% (speed of sound correction to be made on basis of temperature)
Zero offset stability	1 $cm.s^{-1}$
Time Constant	16 second

System Endurance

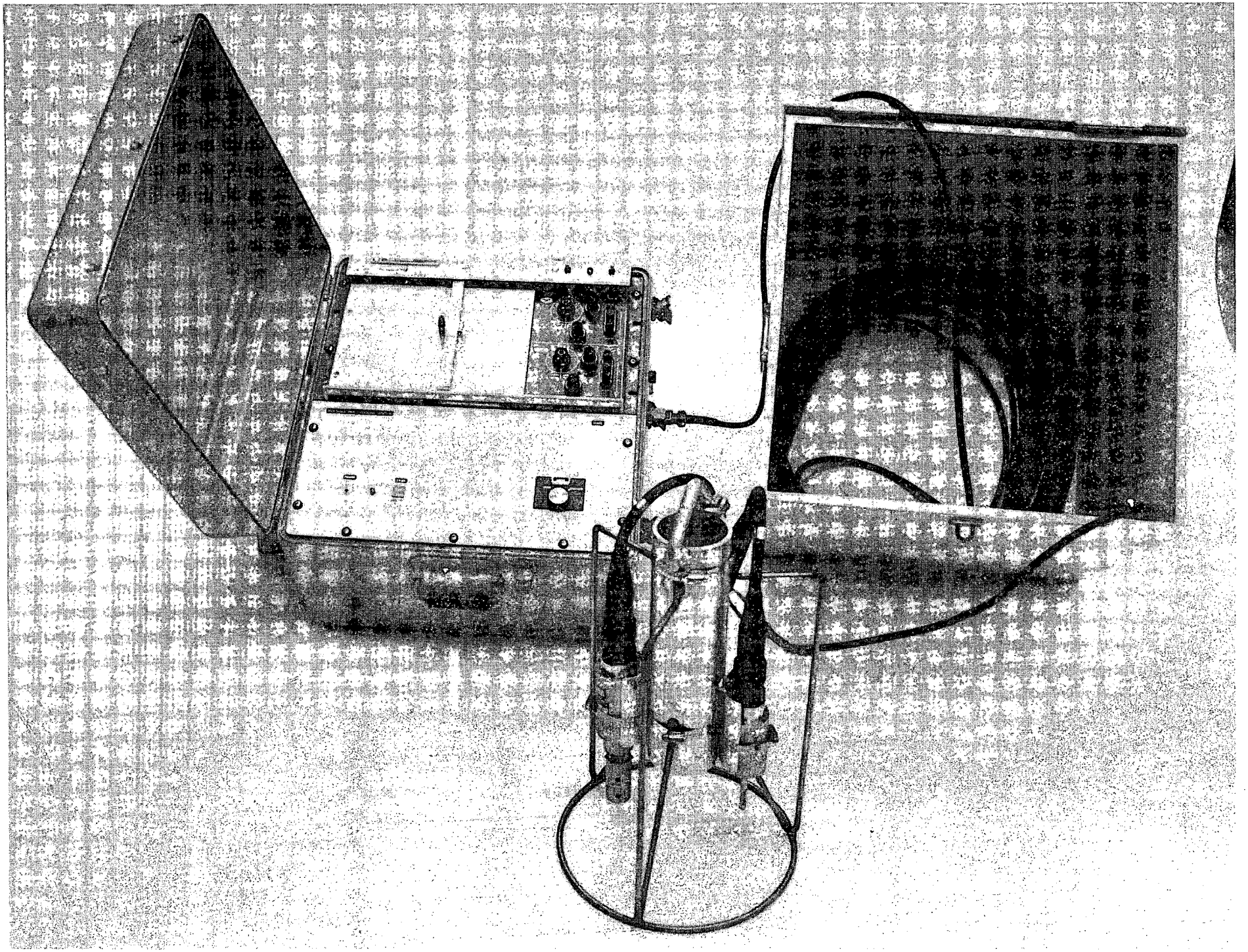
Sample interval	16 second
Endurance	10.9 days max.
Number of samples/channel	58900
Number of channels	16 (8 voltage, 8 resistance)

Time

Resolution	1 sample interval (16 s)
Range	0 to 1048575 (194 day)
Drift	less than 1 $s.day^{-1}$

Physical

Size	2.28 m square base, 4.72 m to top of mast
Mass	approximately 500 kg

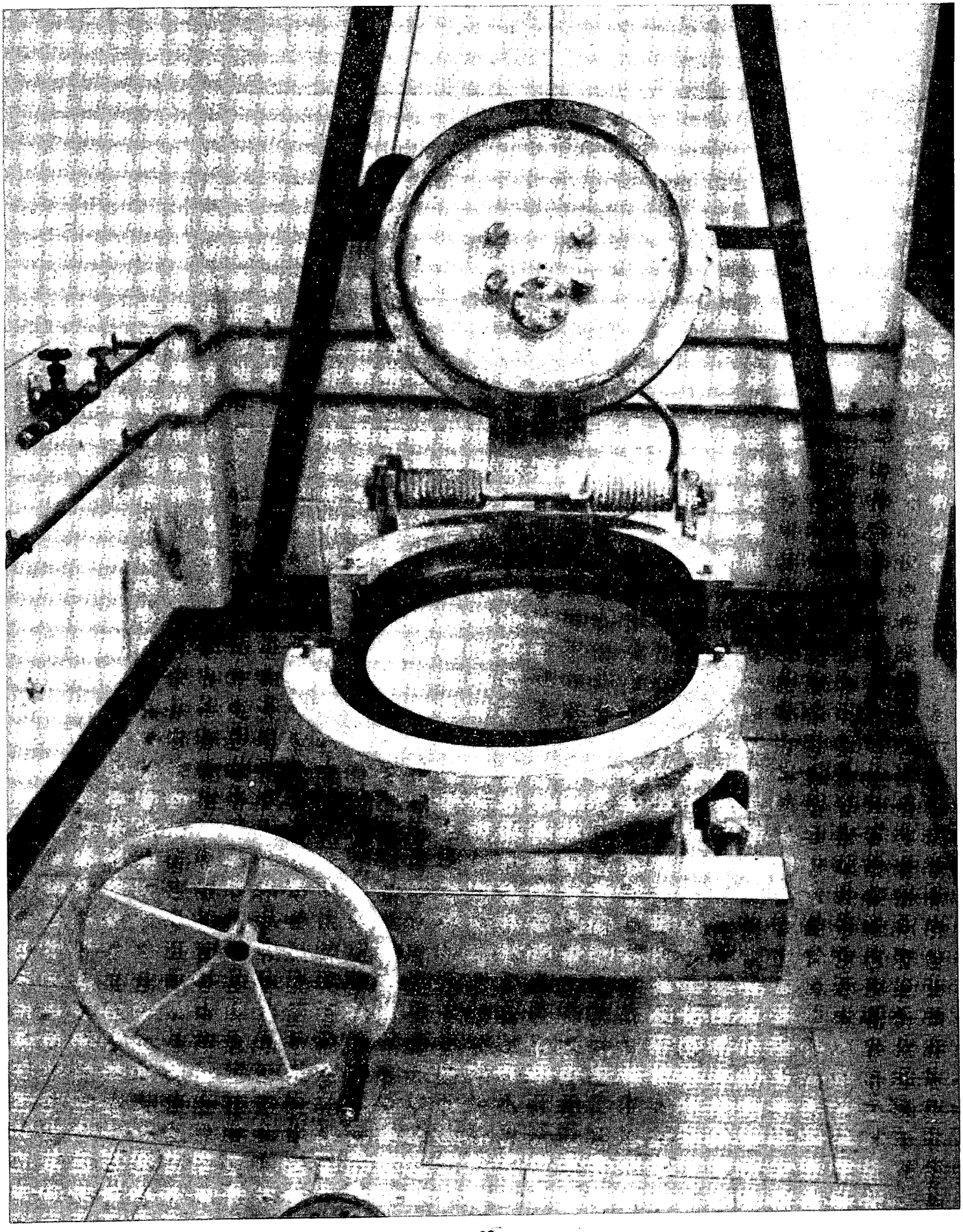


PORTABLE E.B.T.

To fulfil the increasing demand for portable temperature versus depth profiling systems, two new models were assembled. They are A/C powered with an X-Y recorder, calibration circuits and a sensor power supply, all in a weatherproof enclosure. A 30 or 100 m cable with a sensor assembly in a protective cage forms the sonde. A protective shipping case is provided with the units.

SPECIFICATIONS

	Temperature	Depth
Sensors	Rosemount 171 ED	Teledyne Taber 2000
Range	0 to 25°C	0 - 200 m
Input voltage	24 ±3V DC	24 ±3V DC
Output voltage	5 V F.S.	5 V F.S.
Accuracy	0.08°C (0.02°C on special calibration)	±0.3% F.S.
Time constant	0.06 s	
Output impedance	5 k Ω	5 k Ω
Output current	1 mA max.	1 mA max.
Recorder	HP 7035 X-Y Type	
Accuracy	±0.2% F.S. (any range)	
Input impedance	100 kΩ - 1 MΩ/ on range higher than 4 mV/cm	
Chart paper	Graphic Controls No. G10211	
Cable	30 or 100 m long Neoprene rubber jacketed, shielded	
System power	60 V.A. / 110 VAC	
System size	Control 50 x 50 x 38 cm / Cable Sensor Box 53 x 53 x 61 cm	
System mass	Control 20 kg Sensor Probe 5 kg	
System operating temperature	-10 to +40°C	



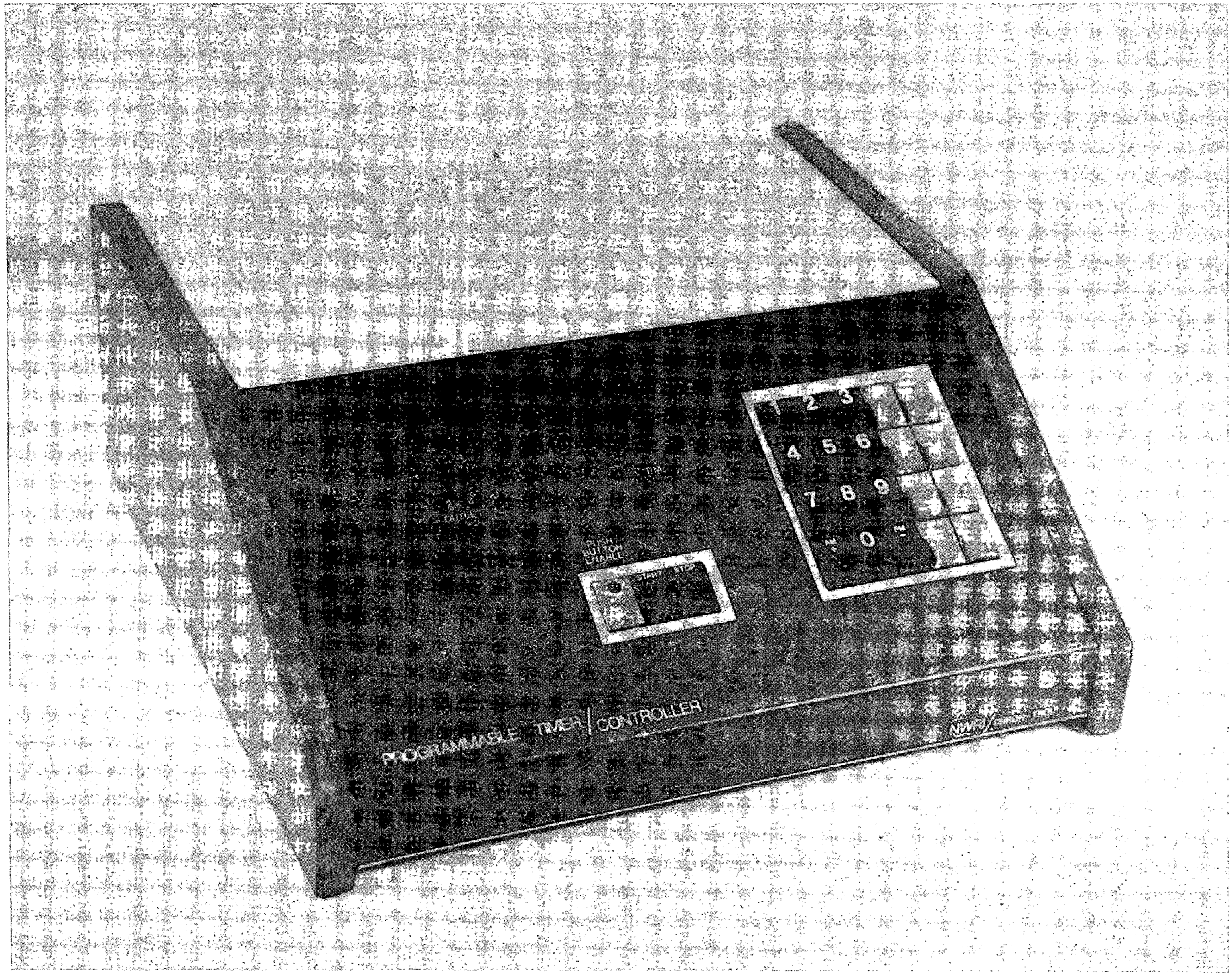
PRESSURE TEST FACILITY

A new pressure test facility has been designed, built and installed under contract to test submersible equipment at pressures up to the maximum found in the Great Lakes.

The facility is operated using tap water as the pressure medium and pressure is applied by the use of an air operated pump. All controls for filling, pressurizing, bleeding and emptying the tank are located on a control panel outside the room for safety reasons. The lid is O-ring sealed, and is clamped to the body by means of two semicircular shoes which are moved by linked threaded bolts and are driven by a single operating handle. The lid is raised by a hand operated winch and helper springs. The lid locking system is mechanically interlocked, so that it cannot be opened until all internal pressure has been released.

SPECIFICATIONS

Test equipment maximum diameter	55.9 cm (22.0")
Test equipment maximum length at full diameter	200 cm (79.0")
Maximum operating pressure	7.14 MPa (1035 psi)
Hydrostatic test pressure	10.0 MPa (1450 psi)
Lid opening or closing time	approx. 2 minutes
Electrical feedthroughs	5
Internal volume	0.61 m^3 (21.7 $ft.^3$)
Mass, filled with water	2563 kg (5650 lb.)


1 2 3
4 5 6
7 8 9
0
PUSH BUTTON ENABLE
START
STOP
PROGRAMMABLE TIMER / CONTROLLER
NWR

PROGRAMMABLE TIMER AND CONTROLLER

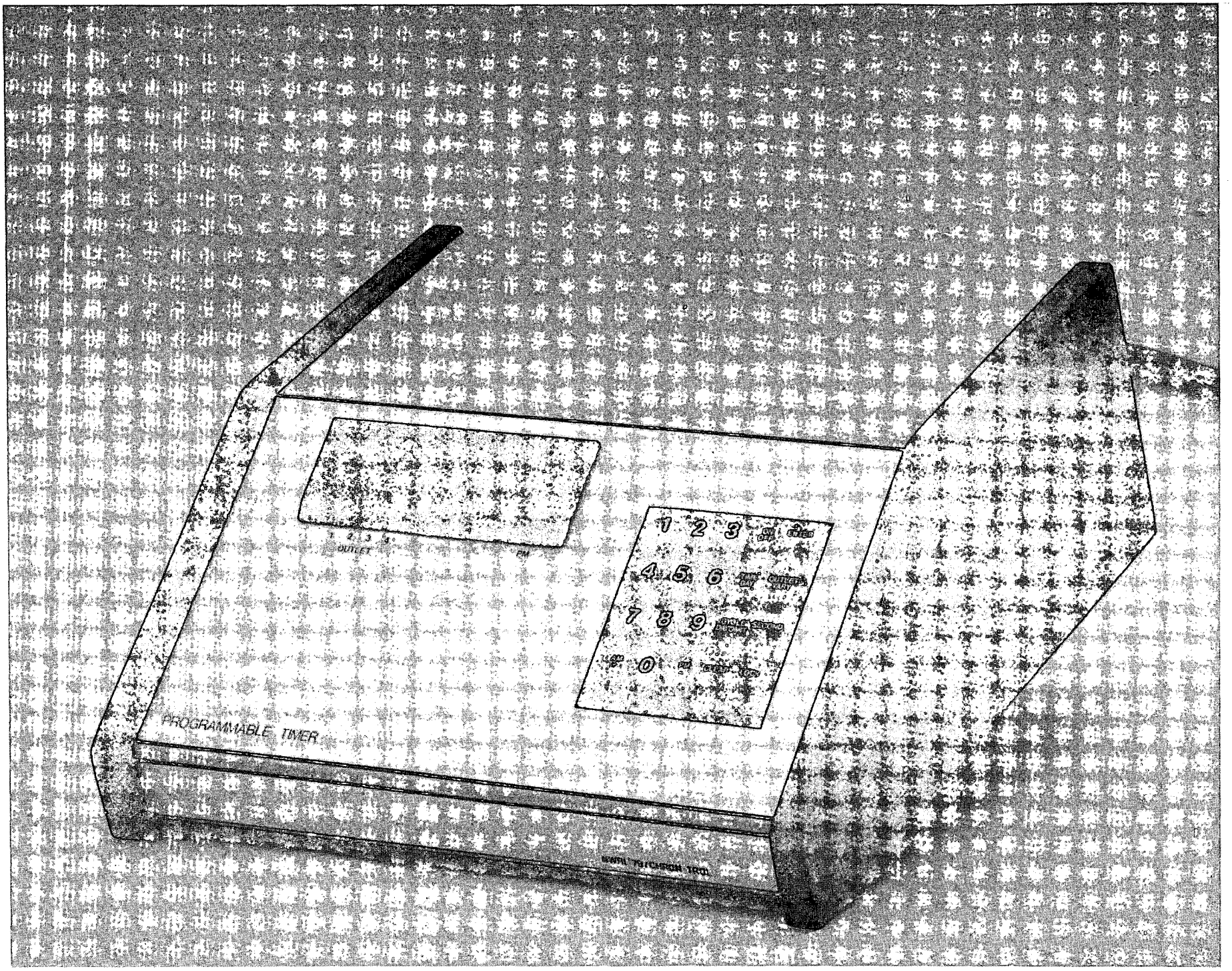
FOR CHEMICAL ANALYSER

The need to automate the repetitive tasks on a fraction collector made it necessary to use a programmable timer. The commercial unit that was bought was extensively modified to be converted into elapsed timer with start-stop functions. The timer is based on AMI SP 2000 4 bit microcomputer which was factory programmed as a timing device. External start and stop logic is made up from two integrated circuits and is connected to the Run and Reset pins of the microcomputer.

The external AC load is controlled via three parallel relay contacts. The fourth contact is brought out to a "synchronization" socket. This socket is then connected to fraction analyser motorized valve. The user can program up to 10 different on and off times, start or stop times and manually control outputs. The timer can also be used in real-time mode if that is useful.

SPECIFICATIONS

Number of controlled outputs	4
AC power switching	9 A max. per outlet 15 A max. total at 115 VAC
External contacts (synchronize)	3 A max. contact N.O. and N.C.
Minimum timing	1 s between on and off times
Maximum timing	1 week between on and off times
Program step	1 on, 1 off time, cycle, vary, day and omit function
Number of program steps	10
Display	4 digit LED for time of day or elapsed time and program information
Indicators	4 LEDs - Outlet on
Mode of operation	12 or 24 hour clock or elapsed time with manual start and stop
Temp. range of operation	-10 to +40°C
Power consumption	7 W @ 115 VAC
Size	250 x 250 x 115 mm
Mass	2.5 kg

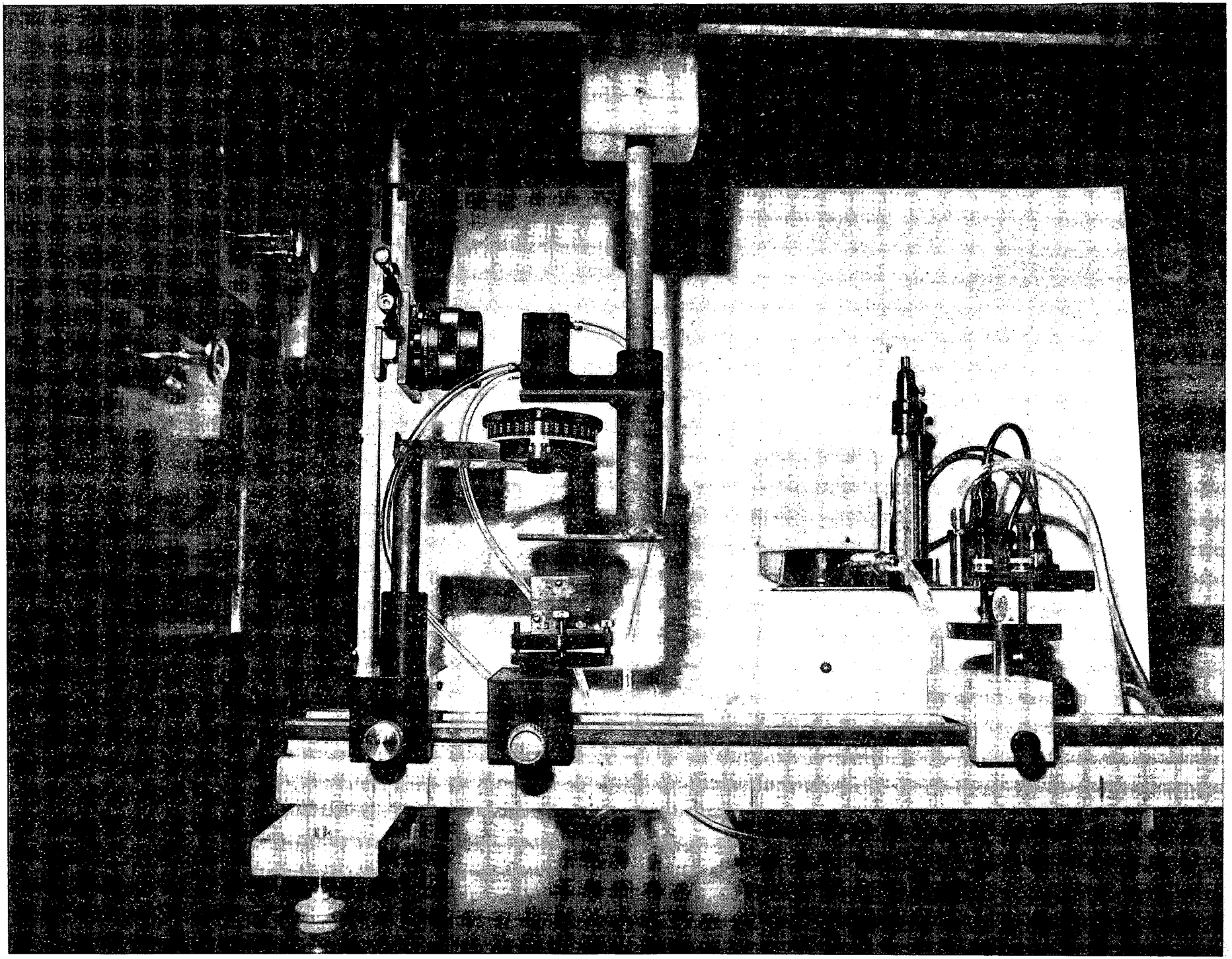

1 2 3
4 5 6
7 8 9
0
OUTLET
PM
PROGRAMMABLE TIMER

PROGRAMMABLE TIMER FOR WAVERIDER

To allow the unattended sampling of information from a waverider buoy, a timer was constructed that would automatically turn on the receiving and recording equipment. The basic commercial microprocessor unit was modified with a rechargeable battery, a charger, a 60 Hz crystal controlled oscillator, a new keyboard and new relays. The contacts on each relay are paralleled and brought out to AC sockets. The fourth contact is brought out to the "synchronization" socket. This socket can be used for external control such as ANDing or ORing, synchronization with another timer or the addition of a larger back up battery. The timer is based on the AMI SP 2000 microcomputer which is custom programmed.

SPECIFICATIONS

Number of controlled outlets	4
Power switching	9 A max. per outlet; 15 A max. total @ 115 VAC
External contacts (synchronize)	3 A max. per contact
Minimum duration of program	1 sec. between on and off times
Maximum duration of program	1 week between on and off times
Display	4 digit LED for time of day and program information
Indicators	LED - outlet on
Temp. range of operation	-10 to +40°C
Memory protection and program run on internal rechargeable battery	48 hours max.
Battery recharging time	Trickle charged, from discharged condition to full capacity - 48 hours
Power consumption	7 W @ 115 VAC
Size	250 x 250 x 115 mm
Mass	3.5 kg

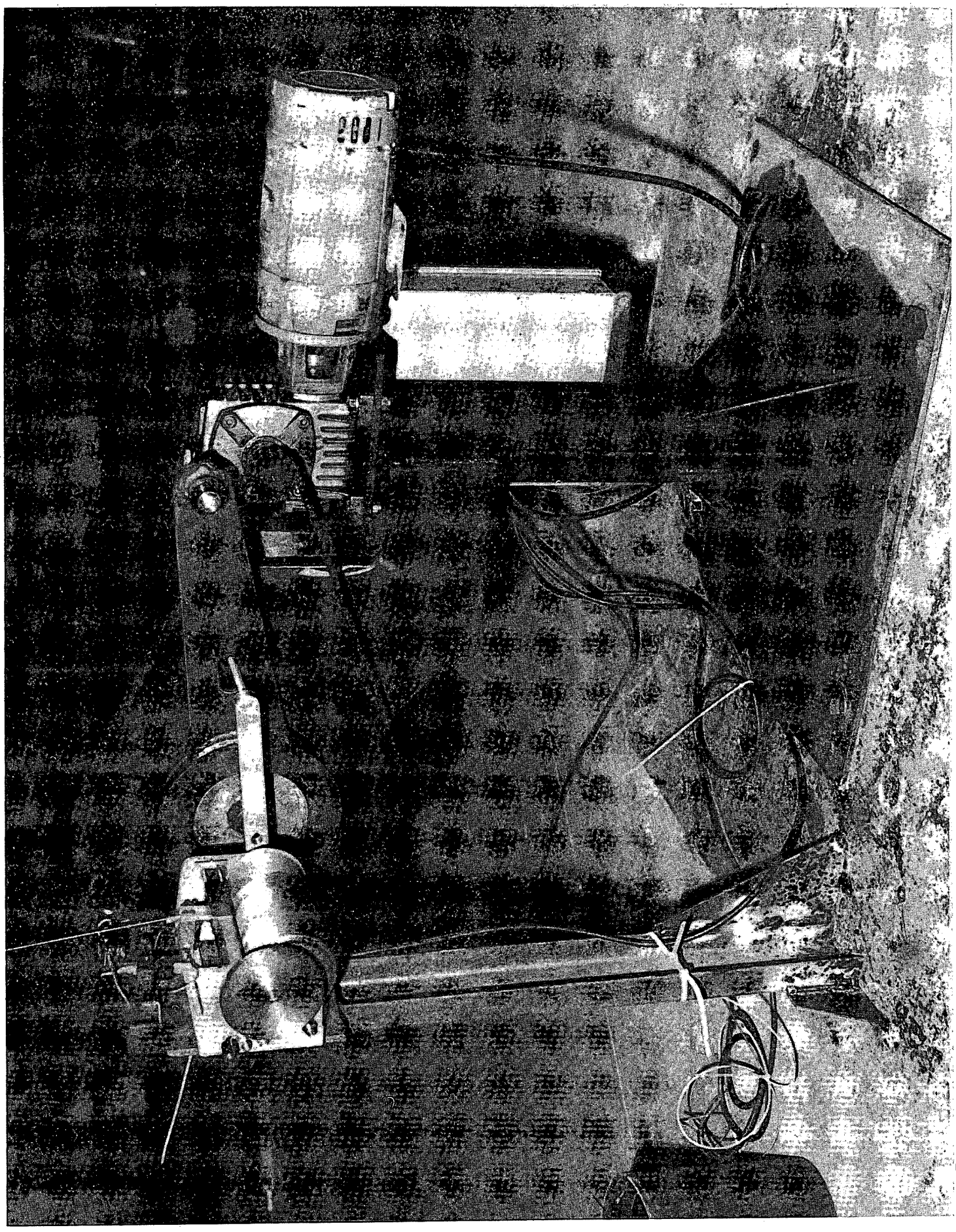


RAMAN SPECTROMETER ALIGNMENT

A Laser Raman Spectrometer manufactured by Jarell-Ash, previously used by the Glaciology component of the Inland Waters Directorate in Ottawa was transferred to N.W.R.I. As received, it was clear that the double monochromator was severely out of alignment. Using standard alignment techniques (as described in, for instance, "Spectrometry" by James and Sternberg), the monochromator was adjusted to give essentially the theoretical maximum resolution. This was checked by scanning across a spectral line of mercury hollow cathode lamp. The resolution is about 30 μm for 40 μm slits ($\sim$1 cm^{-1}) or 8 μm for 10 μm slits. The system as a whole was further checked by comparing the Raman spectrum of carbon tetrachloride to textbook results. The isotope shift was clearly evident. The alignment was done in co-operation with Dr. B. Oliver.

SPECIFICATIONS

Monochromator type	double, 1 m focal length, f/8.7. Czerny-Turner type, grating-monochromator
Spectral dynamic range	23,000 to 11,000 cm^{-1}
Bandwidth	<1 cm^{-1} for 40 μm slits (8 μm for 10 μm slits)
Detector type	Cooled RCA 31034 photomultiplier in a Products for Research housing
Detection electronics	Hamner photon counter (counting rates 100 Hz to 1 MHz)
Laser	Spectra-Physical Model 165 Argon ion
Size	2 m long x 1 m wide x 1.5 m high



RECIPROCATING TEST UNIT

An adaptable test unit has been set up for driving such things as hand winches or providing simple harmonic motions to test accelerometers and fatigue characteristics of equipment. The test unit comprises a silicon-controlled rectifier electric drive, a worm gear reduction box and a chain reduction to the output shaft. Everything is mounted on a rigid base.

The motor is capable of a 10:1 speed variation and is reversible by using limit switches. Cycles may be counted with a chart recorder or electric counter. Safety shutoff switches are provided. Output drives can be changed with a variety of crank throws and output speeds for each test as required.

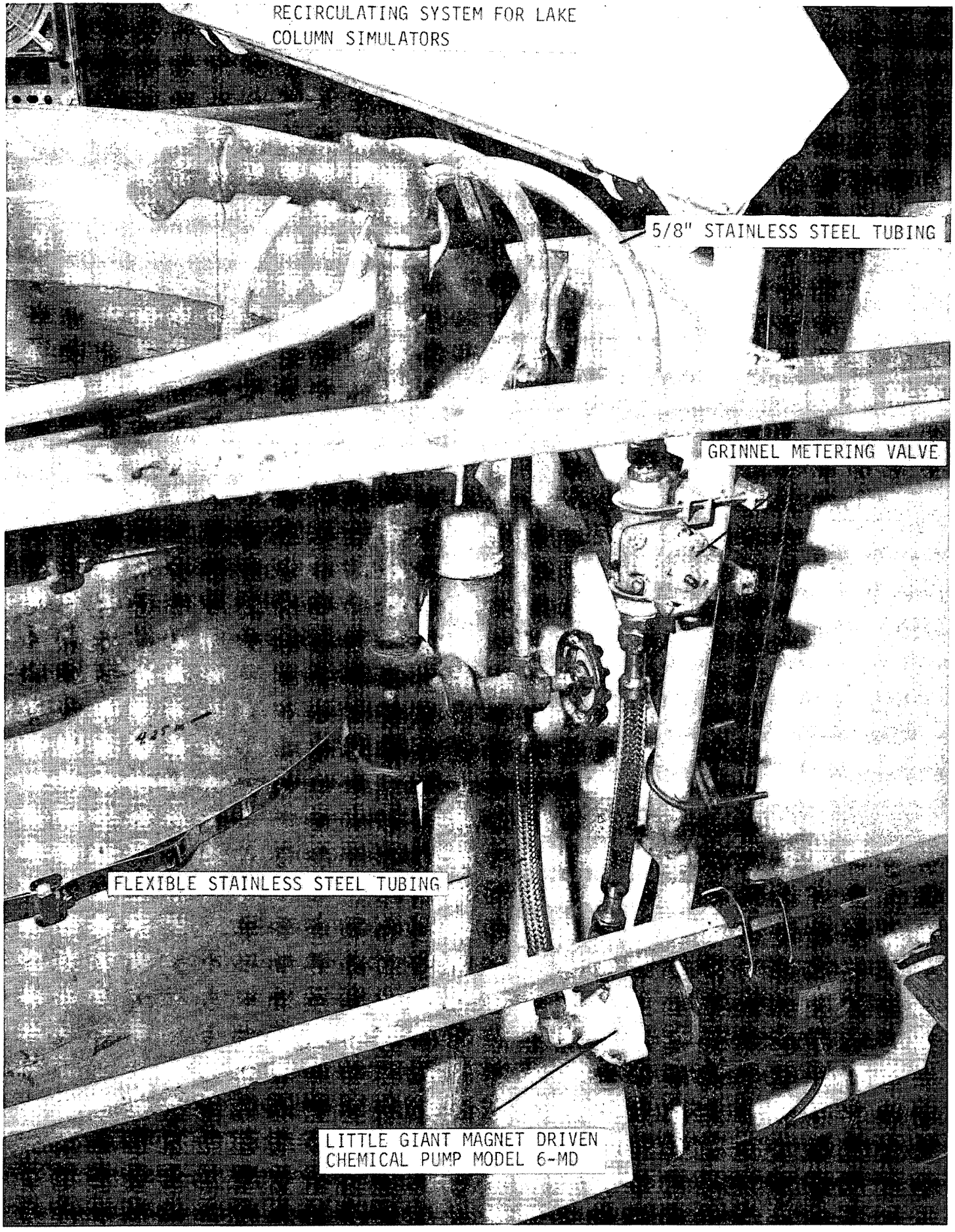
A typical example can be seen in the photograph. A commercially built hand winch is shown being tested for Water Survey of Canada as a special service.

Also the rotary test unit was used for the calibration of a wave-rider by subjecting it to a vertical simple harmonic motion of 1 m amplitude and 3-1/2 seconds period.

SPECIFICATIONS

Speed of output shaft	1 to 10 rpm
Max. amplitude of simple harmonic motion	1 m
Electric	220/208 V, 60 Hz, 1Ø, 0.7 kW

RECIRCULATING SYSTEM FOR LAKE COLUMN SIMULATORS



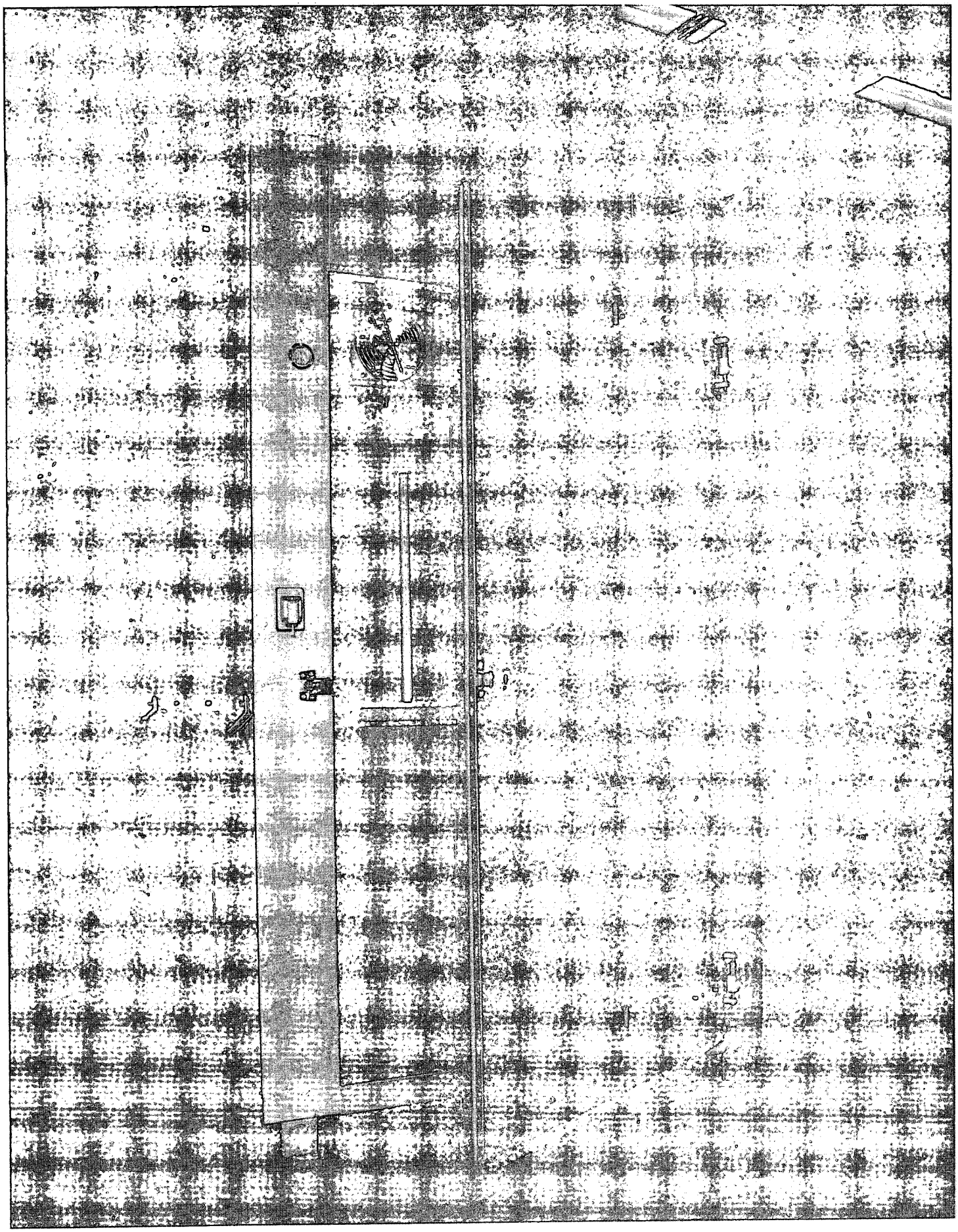
RECIRCULATING SYSTEM FOR LAKE COLUMN SIMULATORS

The Lake Column Simulators are large indoor water columns used to study biological processes. The columns have a glycol cooling system around their lower sections and this, together with an upper recirculating system added, gives a close simulation to natural lake conditions. The upper 2 m are well mixed with a temperature of 22°C, and below the thermocline the temperature is a fairly uniform 10°C. The simulators are in use to relate algae growth with different amounts of nutrients when P.C.B.'s are present in the water.

The recirculating system consists of the following: a pump, a diaphragm valve and several lengths of stainless steel tubing to give the desired mixing characteristics.

SPECIFICATIONS

Pump	Little Giant Model 6MD, 90 L/min
Valve	I.T.T. Grinnel, Model 2414-2-M (1/2")



REFRIGERATOR FOR SAMPLE STORAGE

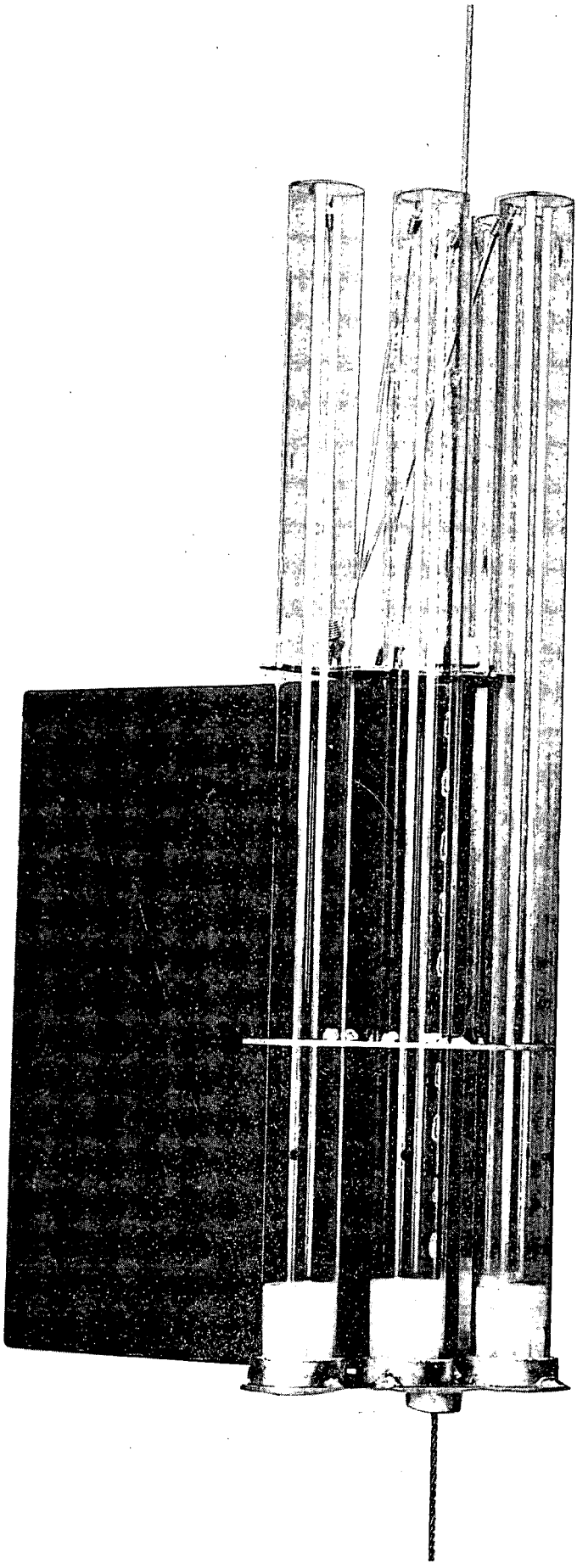
A specification and contract was raised for a larger, improved walk-in refrigerator for use on ships or on land. The unit will be used for preserving core samples and water samples at a temperature around +4°C.

The inside of the cabinet is metal clad with a corrosion resistant surface and is sealed at the floor, except for small floor drain. A lift-up heavy duty shelf has been added to give more storage capacity inside the freezer. Remote-reading Celsius thermometer for cabinet inside temperature. The exterior of the cabinet is metal clad, weatherproof and corrosion protected. The motor and cooling units are mounted on top of and outside of the cabinet. Both are made weatherproof. Lifting lugs are located at the upper four corners of cabinet-base and are suitable for lifting. Tie-down eyes are located at outside corners of cabinet at the 1 metre (3'3") level.

The transportable refrigerator has these features:

SPECIFICATIONS

Cabinet minimum inside dimensions	Height - 2.6 m (8'6") Width - 1.5 m (5') Breadth- 1.5 m (5')
Power	110 V AC, 15 A, 60 Hz with power-on monitor light
Maximum floor loading	2000 kPa (300#)
Mass of refrigerator	900 kg (2000#)



SEDIMENTATION TRAP IMPROVEMENTS

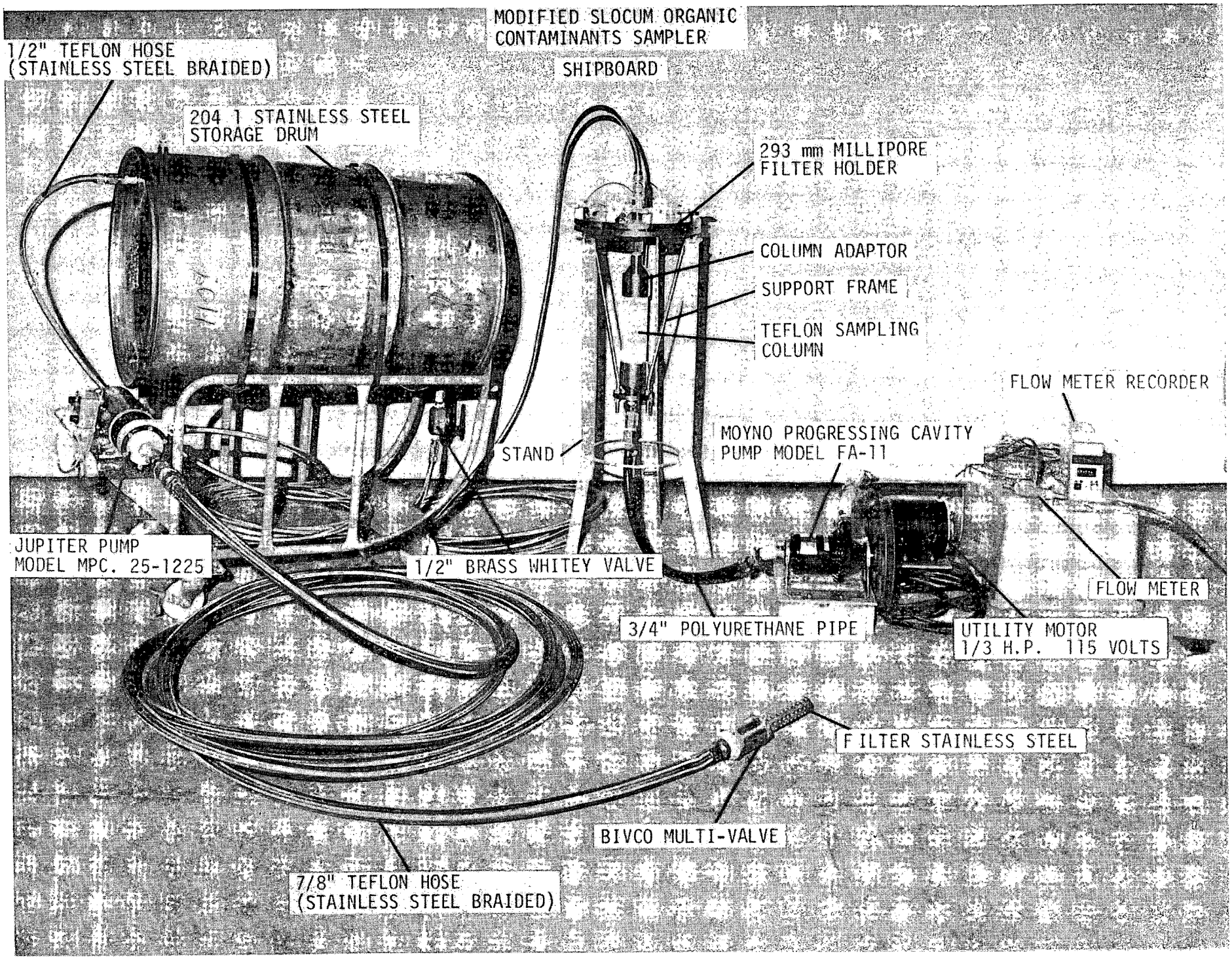
The development of a sedimentation trap, based on large aspect ratio (length/dia.) tubes, for use in lakes with intermittent or continuous currents was described earlier (1979 issue of this report.)

Modifications were made to these traps to improve handling of the trapped samples, simplify manufacture, and to ease set-up and handling of the traps in the field.

The removable bottom of the tubes was replaced with an easily replaced polyethylene cup which can be used for sample processing and storage. The method of holding tubes to the frame was changed from screw clamp to rubber shock cord with hooks. The pivot bearings for holding the frame to the vertical moored cable were also simplified.

SPECIFICATIONS

Number of tubes	5
Tube size	67 mm diameter by 915 mm long
Aspect ratio (length/dia.)	13:66 to 1
Range of current speed in which trap retains catch	up to 34 cm/s


MODIFIED SLOCUM ORGANIC CONTAMINANTS SAMPLER
SHIPBOARD
1/2" TEFLON HOSE (STAINLESS STEEL BRAIDED)
204 l STAINLESS STEEL STORAGE DRUM
293 mm MILLIPORE FILTER HOLDER
COLUMN ADAPTOR
SUPPORT FRAME
TEFLON SAMPLING COLUMN
FLOW METER RECORDER
STAND
MOYNO PROGRESSING CAVITY PUMP MODEL FA-11
JUPITER PUMP MODEL MPC. 25-1225
1/2" BRASS WHITEY VALVE
FLOW METER
3/4" POLYURETHANE PIPE
UTILITY MOTOR 1/3 H.P. 115 VOLTS
FILTER STAINLESS STEEL
BIVCO MULTI-VALVE
7/8" TEFLON HOSE (STAINLESS STEEL BRAIDED)

SLOCUM ORGANIC CONTAMINANTS SAMPLER (MODIFIED)

Organic contaminants in natural waters are at such low levels that processing of large volumes of water is required to extract sufficient sample for chemical characterization. A number of investigators, including Risebrough, have attempted to process large quantities of water without introducing contaminants from their own equipment. It is on the results of their work that the following sampling system was evolved.

The sampler consists of a standard stainless Millipore filter holder with 0.3 micron glass fibre filter paper to separate suspended particulates from the sample water. Attached to the holder is a Teflon column containing five specially cleaned polyurethane foam plugs which absorb the dissolved fractions of organic contaminants from the sample water.

The sampler can be used from a vessel in two ways. First, it can be lowered in the water column to the desired depth and sample water drawn through it at a low rate; or second, the sample water can be pumped directly into a stainless holding tank via a teflon line pump at a fast rate. The sample can later be drawn through the sampler at the slower rate while the vessel is underway.

SPECIFICATIONS

Stainless steel Millipore filter holder	Model YY 22 293 02, 293 mm diameter
Stainless steel holding tank	204 litres
Jupiter pump (teflon lined)	Model MPC 25-1225
Maximum flow of Jupiter	20 L/minute
Moyno Progressing Cavity Pump	Model FA-11, with utility motor, 0.25 kW (1/3 H.P.), 115 Volts
Maximum flow of Moyno	1.7 L/minute
Maximum sampling depth	10 metres
Teflon column	50 cm inside dia. x 30.5 cm long
Polyurethane foam plugs	6.6 cm dia. x 5.7 cm thick

MPX16SS
ON
OFF
PRB2013H
C. P. CLARE CAN
PRB2013H
C. P. CLARE CAN
PRB2013H
C. P. CLARE CAN
MC14049B
CP 7723
MC14049B
CP 7723
MC14049B
CP 7723
Beckman
899-1-R100K

SOLID STATE MULTIPLEXERS FOR W.A.V.E.S.

A previous W.A.V.E.System (see Unpublished Report ES 512) used mechanical reed relays as multiplexers in the data acquisition system. Difficulties in maintaining the operational specifications of these multiplexers, because of aging and progressive degradation through extended use, led to a design contract for the replacement of these multiplexers with a functionally interchangeable, completely solid state version. In this version, the mechanical reed relays are replaced by state-of-the-art dielectrically isolated integrated CMOS analog switches with signal buffering.

The solid state multiplexers have worked reliably in the W.A.V.E.S. '79 field program. The design was done by Hamilton Digital Design Co., Burlington, Ont.

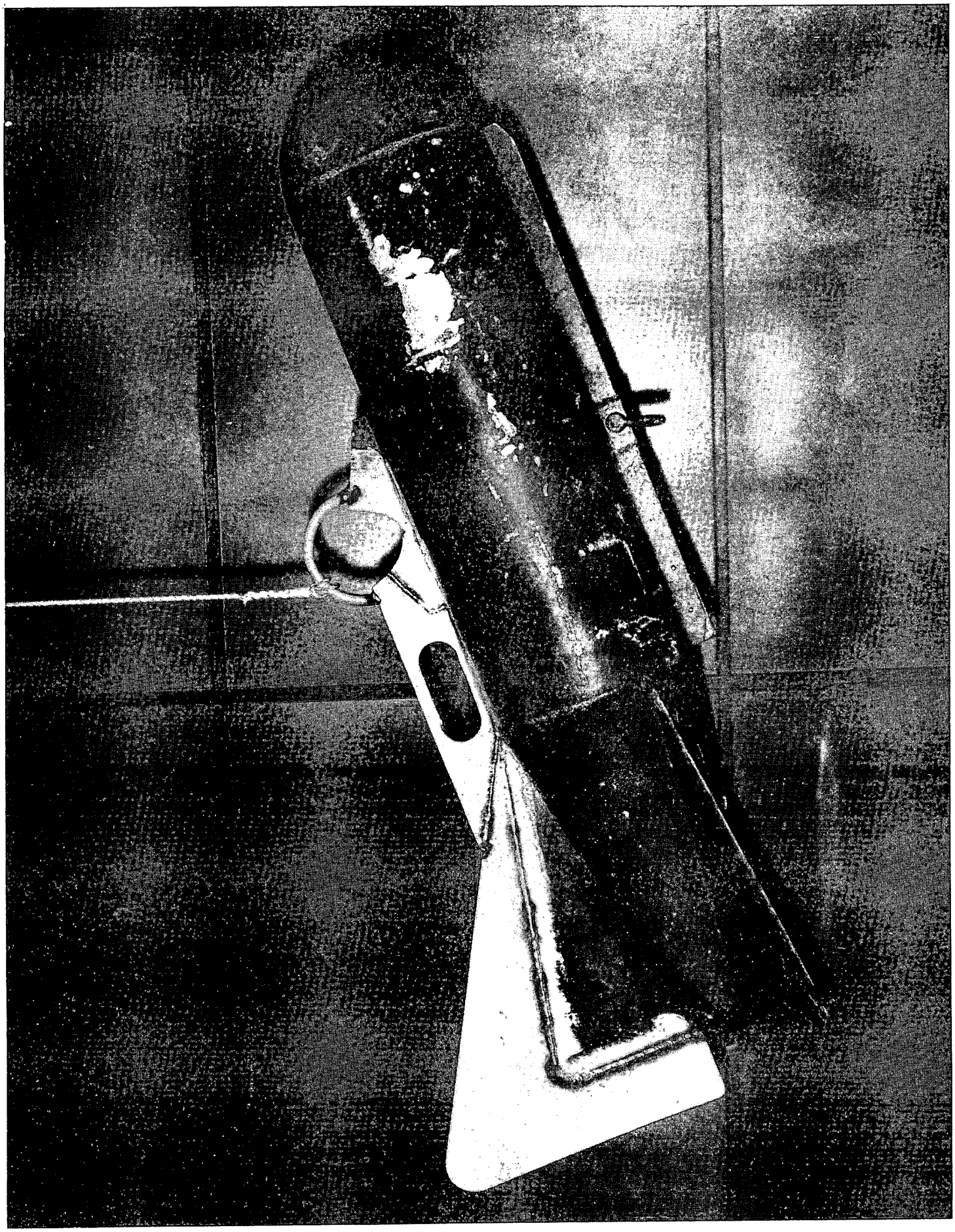
SPECIFICATIONS

Analog Channel Characteristics

Analog signal range	-15 to +15 V DC
Input resistance	10^{12} Ω typ (JFET buffered input)
Input capacitance	5 pF typ
Max. continuous input overvoltage	-35 to +35 V DC
Max. transient overvoltage	2 kV typ (static discharge)

Switching Characteristics

Access time (switches)	1.0 μsec max.
Break-before-make delay	80 nsec typ
Settling time (.025%)	3.5 μsec typ



SUB SURFACE FLOAT MODIFICATIONS

A number of errors can occur in the measurement of lake currents. One significant distortion can be caused by current meter mooring motion induced by the subsurface float. Analyses of data and visual study by divers have confirmed that the original (as bought) float was unstable. Problems with manufacturing quality, and deployment have also occurred.

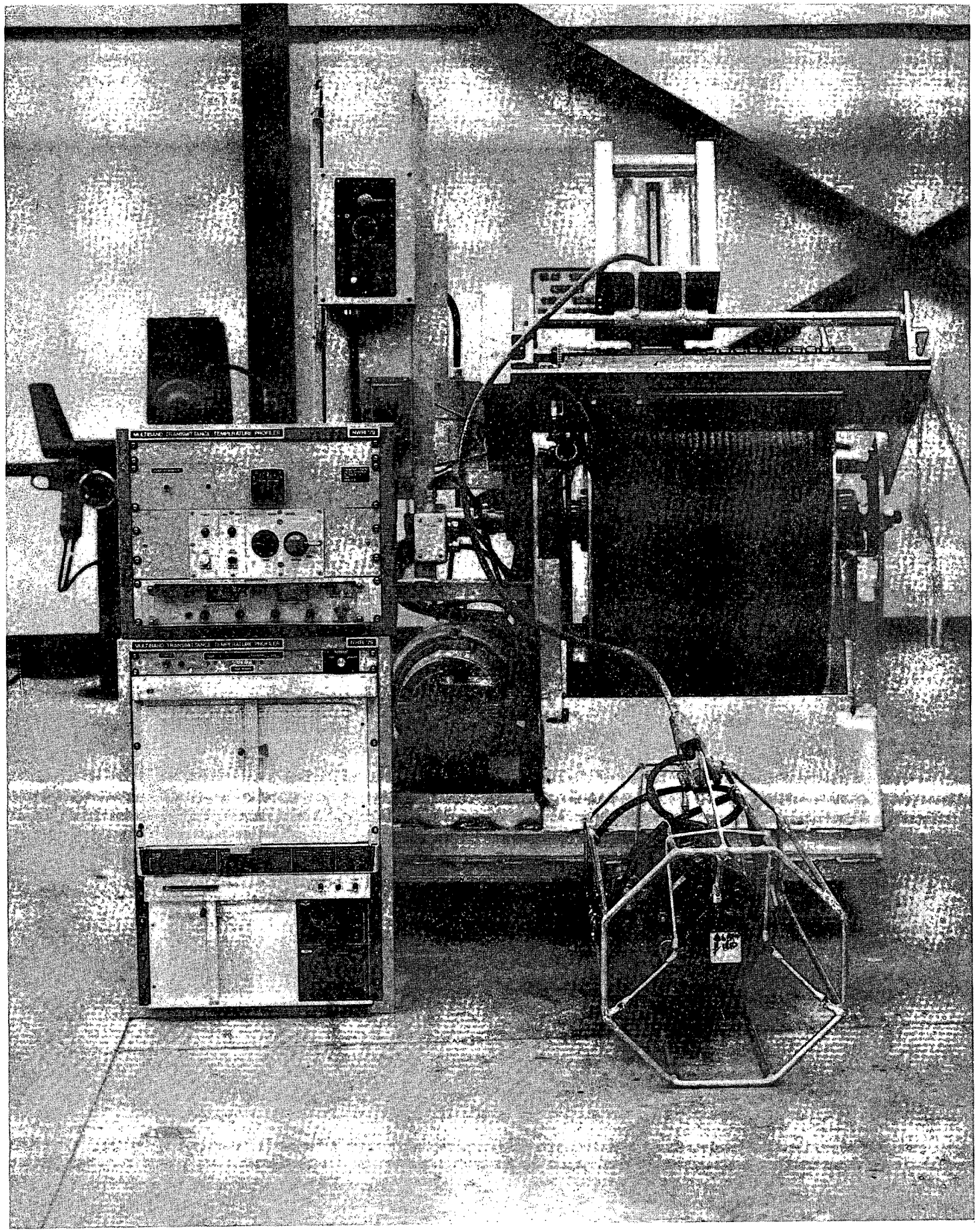
Modifications to improve stability consist of enlarging the rear, top tail, providing a new point of bottom attachment and adding a trimming 8 kg mass, resulting in a more stable nose down attitude of around 5°.

Improvements in reliability have been made by using stronger aluminum material, improving the welding specification, relocating the pressure test valve, and making a stronger bottom attachment.

For better deployment and retrieval, two upper hooking points are now available. The first is for grappling the float with a boat hook, and the second is for easy engagement of the ship's crane hook.

SPECIFICATIONS

Buoyancy of the modified float	2.05 kN
Mass of float	130 kg
Overall length	2.4 m

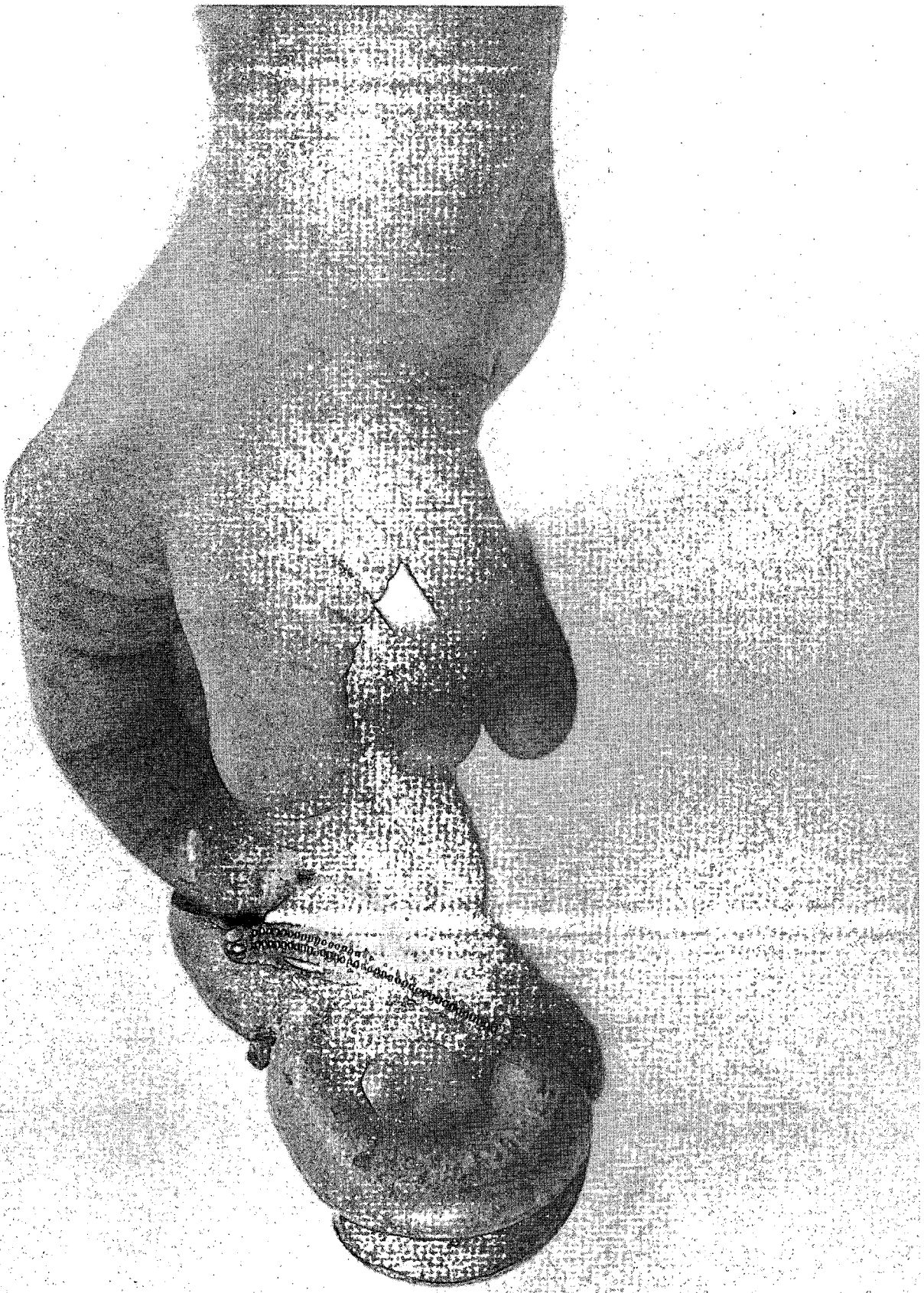


SURVEILLANCE MULTIBAND TRANSMITTANCE TEMPERATURE PROFILER

In 1979 NWRI authorized the development of a multiband transmittance and temperature profiler, to eventually replace the hand-over-hand Martek transmittance profilers now used on surveillance cruises. The new system incorporates a sensor with the regular BG18 and Wratten 45 filter as previously used, and also four other filters should they be required for remote sensing experiments. Improved electronics were installed to increase the sensitivity and the linearity of the sensor. Temperature and depth sensors were installed in the sonde as well. The sonde was balanced and shock mounted in a cage for smooth and reliable profiling. The system time constants were verified in a tow tank. Two sondes were constructed to compare the influence of the field of view in the data. The signals are recorded on rack mounted X-Y recorders.

SPECIFICATIONS

Transmittance Sensor	
Power transmittance	99 - 1% (20 db dynamic range)
Equivalent attenuation coefficient range	0.04 - 18.4 m^{-1} (1/4 m path length)
Filter centre wavelengths	430, "Wratten 45", 534, 575, 633 nm ±5 nm except for Wratten 45
Spectral handwidth (full width at half max.)	30 nm (nom.), 60 nm (nom.) for Wratten 45
Receiver field of view	1) Regular sensor: 2.6° to 2.3° full field in water depending on source size limiter 2) Narrow field sensor: 0.9° full field in water
Accuracy + Linearity	±3° F.S. [does not include inherent errors due to field of view]
Precision	±1% F.S.
Drift	±2% F.S. after 1/2 hr. warmup at room temperature
Temp. drift	<±0.3%/°C for Wratten 45 filter <±0.15%/°C for F.S. for interference filters
Temp. range	0 - 30°C
Sample dimensions	5 mm ø x 260 mm
Flow speed of response	<400 ms to 63% final value <2 s to 98% final value
Vibration effect	<1% F.S. at gravities
Output	0 - 3 V F.S. (100% transmittance in water)
Input power at sensor head	29 V nom. 350 mA
Sensor mass	20 kg
Temperature Sensor	
Temperature dynamic range	0 - 25°C
Accuracy + Linearity	±50 m°C
Flow speed of response	70 ms time constant (single pole transfer function)
Output	0 - 5 V F.S. into 1 kΩ or greater
Input power	28 + 8 VDC 40 mA - 4 VDC
Depth Sensor	
Depth	0 - 100 m F.S.
Output	0 - 5 V F.S.
Accuracy + Linearity	±0.3% F.S.
Power	28 VDC + 8 VDC 35 mA - 4 VDC
Deck Unit	
Displays, recorders and controls	X-Y recorder (28 x 21 cm), X-axis transmittance Y axis depth X-Y recorder (49 x 28 cm), X-axis temperature, Y axis depth Transmittance filter position indicator - taut band meter "Calibrate", "Zero", and "Operate" front panel switch. Power and Sensor output test points on front panel.



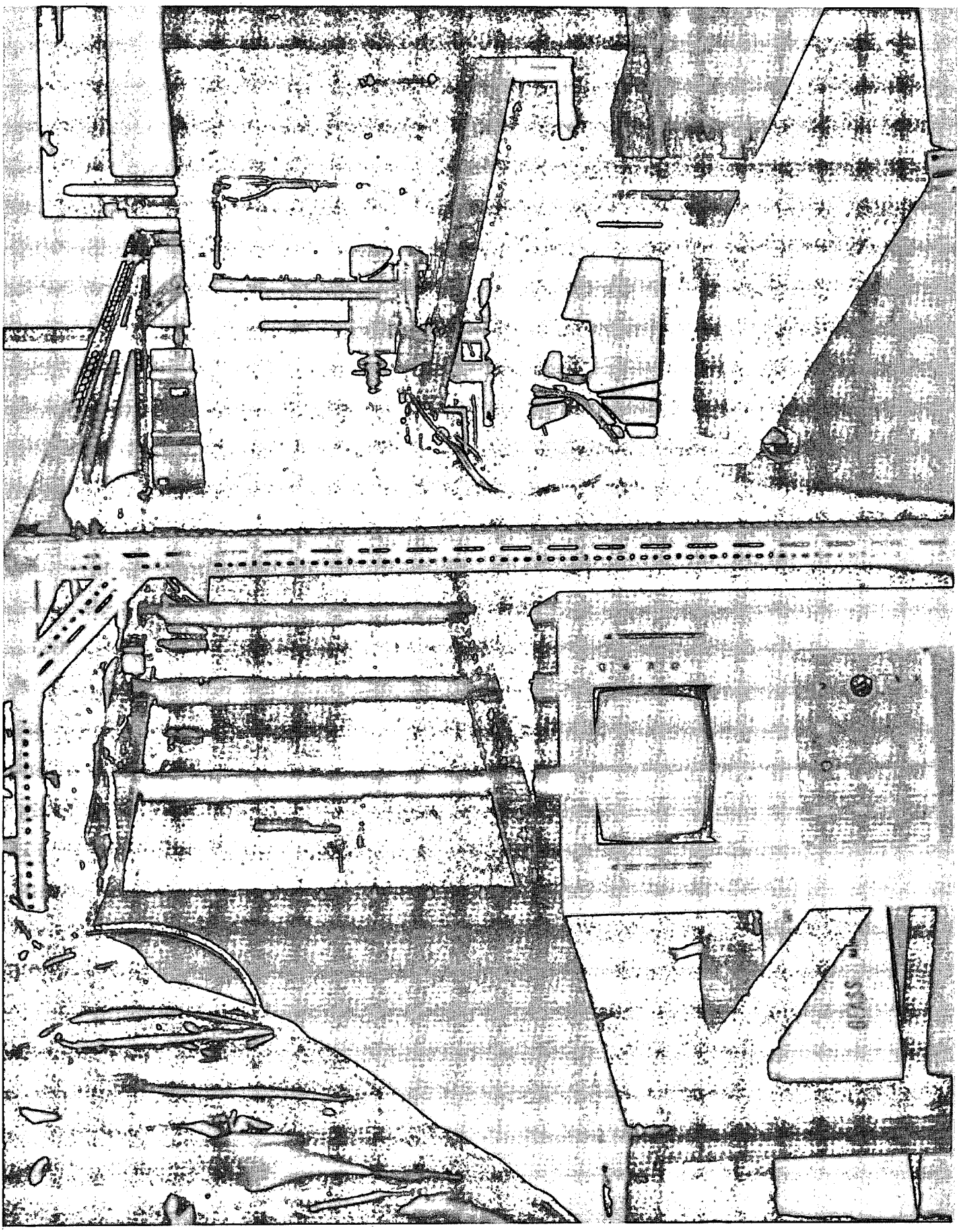
SWINGLINK WITH SAFETY SPRING

The standard swinglink coupling is especially useful in the installation of moorings because of the speed and ease of use. Unfortunately, the standard swinglink relies upon constant tension to keep it closed and with short mooring lines this does not always occur.

The swinglink has therefore been modified by the addition of a single stainless steel spring joining the two halves across the fulcrum. Since the spring is under slight tension in the closed position, the swinglink will remain closed even if a mooring goes slack. However, the spring is sufficiently light that it does not impede the operator in opening the link.

SPECIFICATIONS

Size	5/8" standard



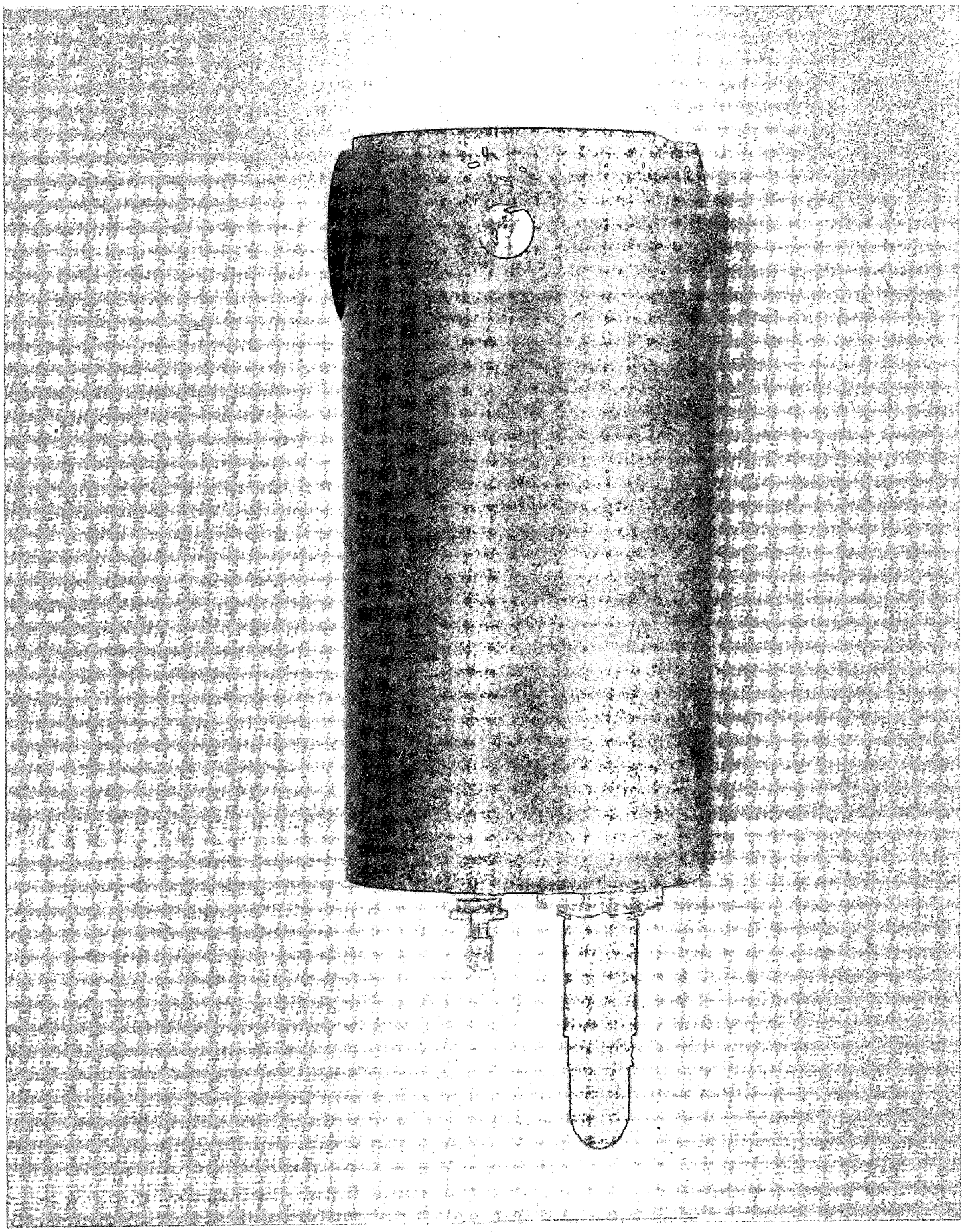
TELEVISION MONITORS ON FISH STRESS CHANNEL

The original Fish Stress Channel was designed and developed to evaluate the responses of toxicant-located fish exposed to simulated, natural stream stresses. See Unpublished Report ES-514.

As a further refinement to the system, T.V. cameras have been mounted on tracks on both sides of the channel in order to remotely monitor and record the activities of the fish. The cameras are electric motor, and chain driven to traverse the full length of the channel's viewing windows. The elevation of the cameras is manually adjustable. The new equipment is mounted inside light-tight containers which can easily swing out of position when not being used. The channel has been raised 1 m for better servicing.

SPECIFICATIONS

Closed circuit T.V. Camera	'COHU' Black and White
Video monitor format	Electrohome EVM-111-OR-MNT EIA RS170 output - 525 line, 2:1 interlacing monitor
Camera traversing distance	2.4 m maximum
Camera vertical adjustment	30 cm

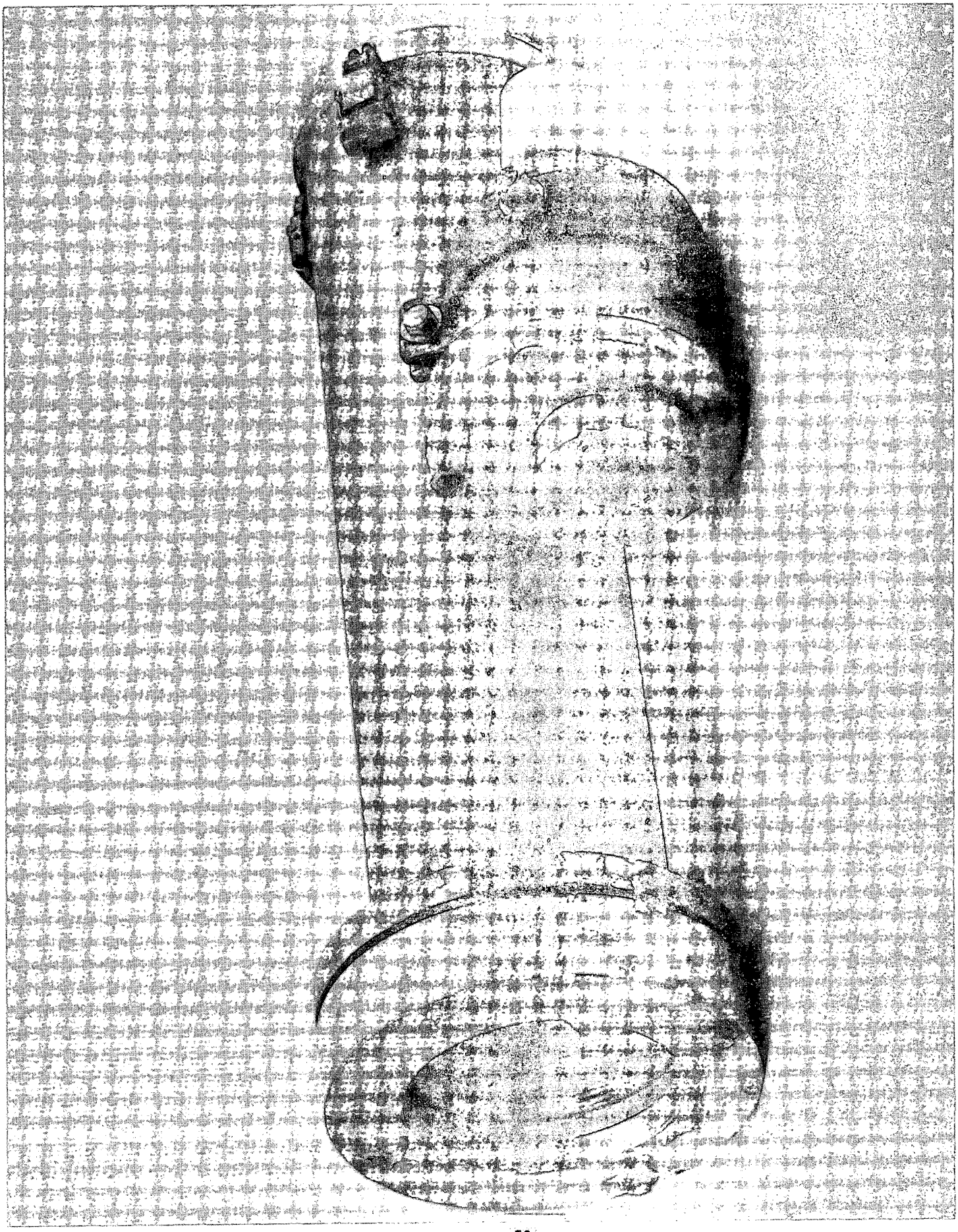


TURBIDITY SENSORS

Prototypes of a new in situ turbidity sensor were manufactured in Canada for N.W.R.I. by H.F. Instruments Ltd., Toronto. These sensors incorporate state-of-the-art photodetectors and electronics, making them faster and more stable than previous units. The optics are as simple as possible. Turbidimeters in general must be used with care when dealing with uncontrolled suspensions and emulsions.

SPECIFICATIONS

Dynamic range	1 - 1000 FTU [formazin trubidity units]
Speed of response	<100 ms
Output	"0" to 5V F.S. log output; approx. 1.2V / decade
Input	15 to 28 V DC, 550 mA
Depth rating	400 m (4 M Pa) nominal

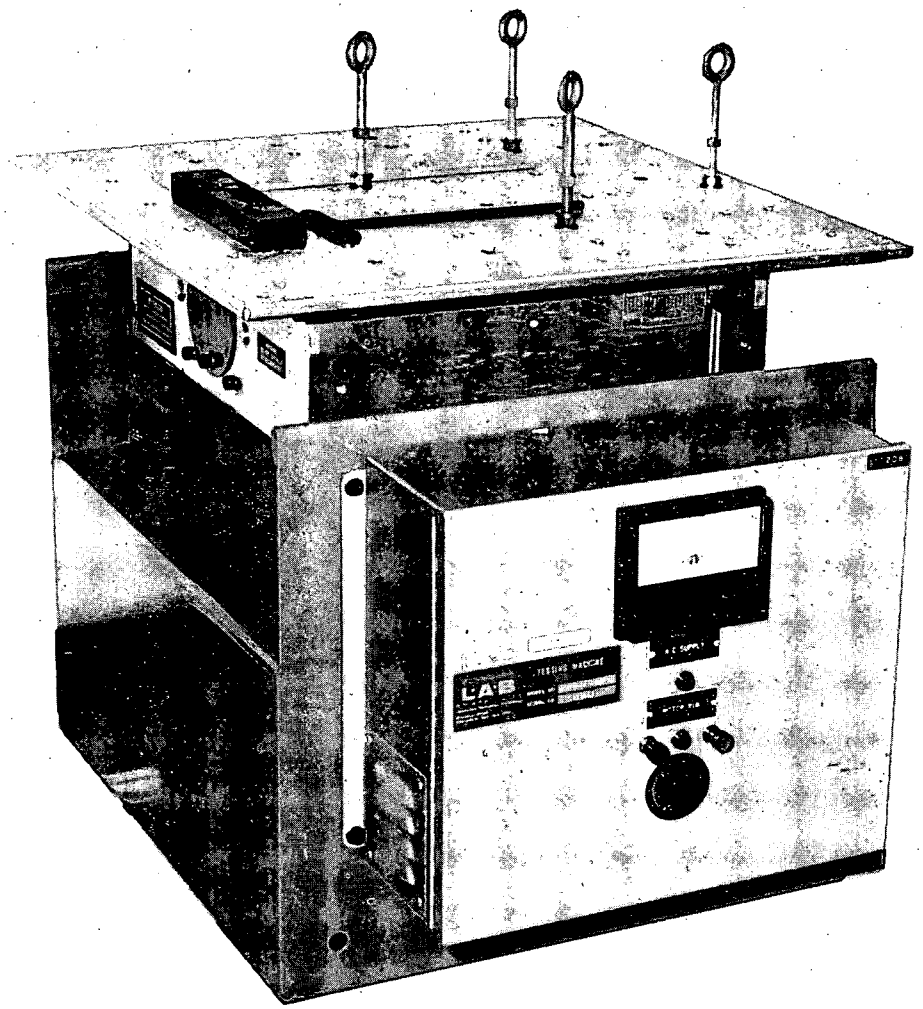


UNDERWATER FLASH WITH AUTO-ADJUSTMENT

To compensate for varying lighting conditions for underwater photography, a commercial auto-flash unit with a remote sensor was re-packaged. The remote sensor, which is placed near the camera, measures the returned light. This then controls the duration of the flash in an attempt to produce a constant exposure on the film. Laboratory and field tests proved the practicality of the unit.

SPECIFICATIONS

Luminous intensity-time product (exposure value)	3700 cd.s maximum
Source field at 1/2 power	±20° nominal without baffles 7° and 9° vertical Assymetric referred 8° and 11° horizontal to mechanical axis
Remote sensing field of view	±9° (full width at half power)
Colour temperature	5600 K
Dynamic range with remote sensor	5 f/stops (32:1)
Ambient light	Compensated between approx. 0 lux to 1000 lux incident on the object
Recycling time	0.3 to 30 seconds, depending on repetitive no. of flashes and exposure setting
Trigger	10 µs, 0.5 A pulse, 25 V nom.
Power	24 to 28 VDC 1.25 A input
Depth rating	400 m
Size - Flash Unit	15 cm Ø x 60 cm long
Remote Sensing Unit	15 cm Ø x 15 cm long
Mass - Flash unit	5 kg approx.
Remote Sensing Unit	2 kg approx.



VIBRATION TEST MACHINE

This vibration machine is a commercially bought unit, and is part of our environmental test facilities. Its main features are: a horizontal table, a variable-speed motor-drive, adjustable eccentric weights, an air suspension system and capabilities of 3.2 gravities for a 90 kg load.

There are three main purposes for vibration testing limnological equipment: mechanical endurance testing, measuring an instrument's responses to vibration, and troubleshooting intermittent instruments such as ones with loose contacts.

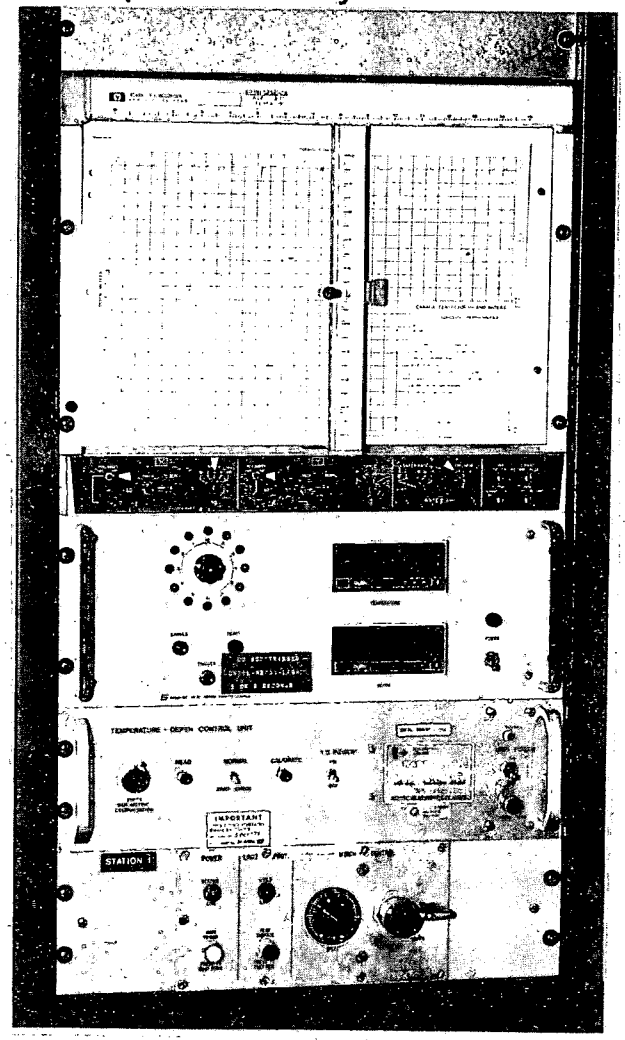
This unit was selected to be large enough to hold most of our underwater instrumentation packages. The frequency and acceleration range reflect military standards for testing equipment for shipboard use.

The manufacturer is L.A.B. (Mech. Techn. Inc.) Skaneateles, N.Y.

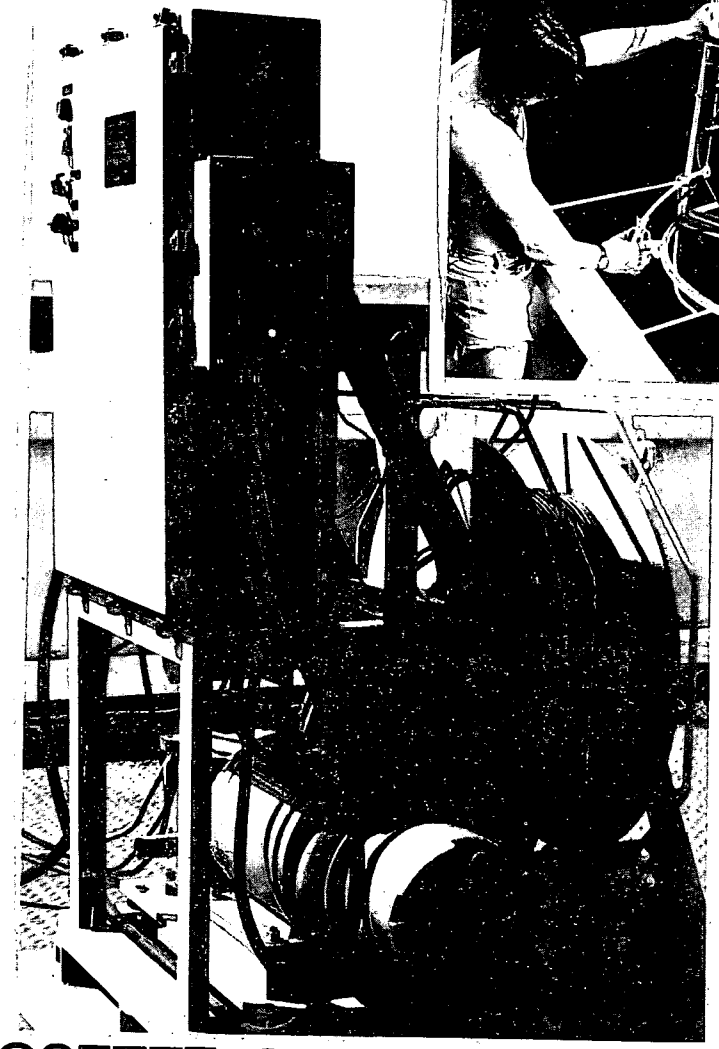
SPECIFICATIONS

Model	BRVFD-24-200
Table size	61 x 61 cm
Load @ excursion and gravities	45 kg @ 1.88 mm and 10 90 kg @ 1.3 mm and 3.2
Amplitude adjustment	Mechanically alterable counterweights
Frequency adjustment	8 - 60 Hz, SCR control, meter readout

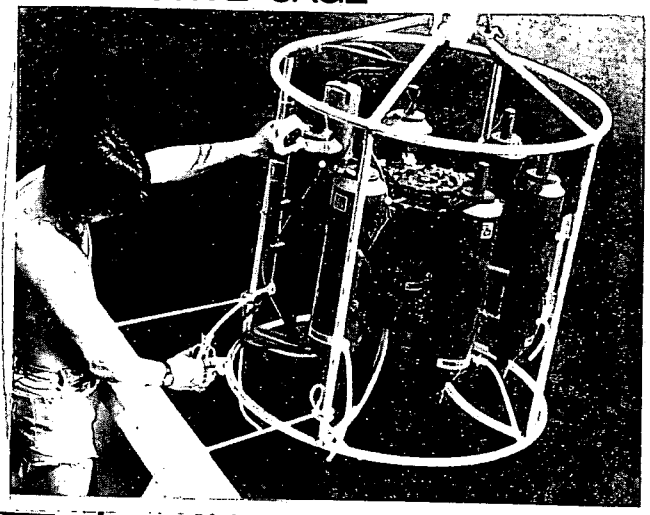
CONTROL RACK
(in ship's laboratory)



WINCH



SAMPLING BOTTLES,
PROTECTIVE CAGE



ROSETTE SAMPLER

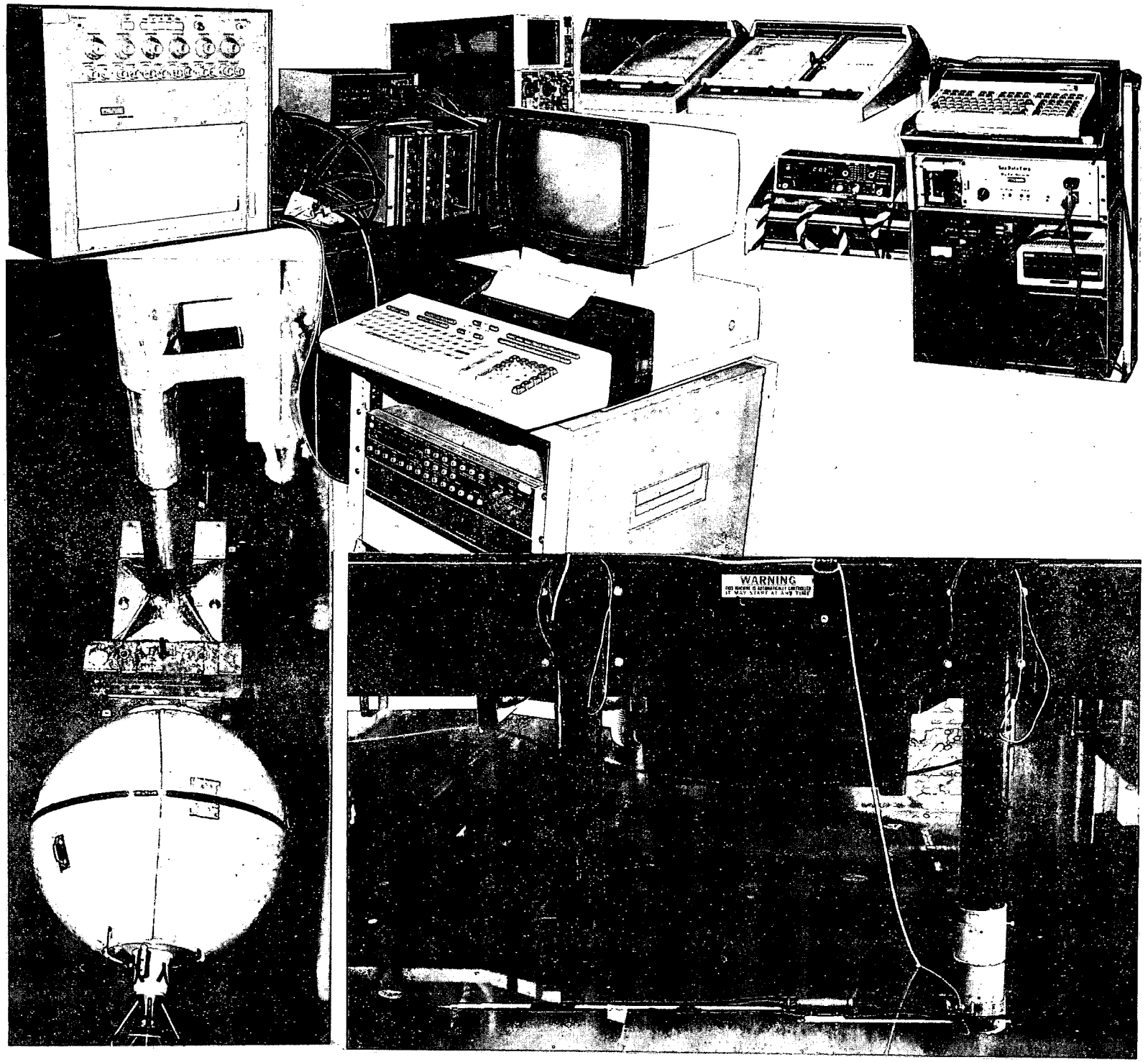
WATER SAMPLER USING ROSETTE SYSTEM

Some advantages of having a Rosette Sampler System rather than traditional methods (clamp-on bottles, messenger) is that the sampling can be done at the desired locations, because the temperature-depth profile is seen concurrently; the procedure is faster; the bottles are further away from ships' disturbance and several samples can be taken on one deployment.

This system consists of, a probe with water sampling bottles plus temperature and pressure (depth) sensors; a winch; surface controls for winching, sampling, and signal calibration; digital signal readouts and an X-Y recorder. The system uses commercial products from General Oceanics and Guildline, as well as NWRI-built interfaces and special devices.

SPECIFICATIONS

Water Sampling	
Manufacturer	General Oceanics, Miami, Fla.
Model No.	10105-12-215
Bottles	11, 2.5 litre Niskin (Model 1010)
Optional	5, 5-litre Niskin, GO-FLO style available, open at 5 m depth
Temperature-Depth Probe	
Manufacturer	Guildline Mfg., Smiths Falls, Ont. (with NWRI modifications)
Temperature	0 to 30°C, ±50 m°C
Depth	0 to 400 m ±1% of FS (±.25% of 50 m @ 50 m). (See also Unpublished Report ES 510 Jan. 1976 p. 18)
Winch	
Manufacturer	National Water Research Institute, Burlington. (See EBT report above)
Descent rate	0.5 m/s typical
Ascent rate	2 m/s max. in water
Sampling package - mass	100 kg typical (incl. water samples)
Motor size	5 HP
Control	Regenerative drive to provide dynamic braking. (See also Unpublished Report ES 510 Jan. 1976 p. 18)
Deck Controls & Readouts	
Winch	UP, DOWN, Variable speed, jog & emergency stop
Rosette	Push button sample control, stepping indicator, digital T&D readouts
T.D. Probe	X-Y recorder, Probe calibration controls, Barometric pressure compensation
Upper limit	Depth signal stops winch at 3 m
Retrieval	Override the upper limit with jogging control


WARNING

WATER VELOCITY SENSOR CALIBRATION TECHNIQUES

Calibration of novel current meters or sensors employed in sophisticated environmental measurement systems, requires special mechanical, electronic and software facilities to complement the normal tow tank facility. A few mechanical fixtures have been designed and built to attach sensors and systems to the tow carriage. They provide safe, convenient mountings which permit manual rotation through 360° about the vertical axis, and some offer the equivalent 360° about the horizontal axis in 15° keyed steps. A motorized rotator, with electrical slip rings, gives a continuous changing flow direction for two axis sensors.

Electronic data acquisition, logging and display systems have been assembled from laboratory instruments, special interfaces (such as the IEEE Std. 488.1975) and programmable scientific calculators. They collect data from the sensors under tests, and other inputs such as the tow carriage displacement reference signal. The data are reduced, printed and plotted in real time, to provide the operator with an intelligent display of the experimental results, thereby reducing errors or omissions during intensive calibrations.

SPECIFICATIONS

System or Sensor	Test Equipment Used
3-D Flowsphere	6 channel chart recorder, digital voltmeter, scanner HP 9825A or HP 9845A calculator, HP 9862A plotter, special tow jig, special force balance jig (lab)
E VAPS Vehicle	NWRI/Sea Data-Data Interface, digital counter, optical isolator, HP 9825A calculator, two HP 9862A plotters, E VAPS tow fixture, temperature test jig (lab)
Two Axis E/M Sensor	2 channel chart recorder, rotating jig with slip rings
Two Axis CMI Sensor	2 channel chart recorder, rotating jig with slip rings, PRT temperature sensor, digital voltmeter, temperature test jig (lab)

WINCH FOR MODERATE SAMPLING AND PROFILING LOADS

With the increasing use of lake profiling equipment such as thermometers, transmissometers and Rosette samplers, the supply of winches to serve these instruments was severely strained. Therefore, new, improved winches were designed inhouse with greater power, better brake, and generally more rugged.

SPECIFICATIONS

EBT MK II Winch

Overall max. dimensions:	Height	172 cm (65.75 in.)
	Width	114 cm (45.0 in.)
	Length	122 cm (48.0 in.)
Power		3.75 kW (5 HP) DC electric motor, 240 V DC Model No. 6703, regenerative drive SCR control. AC operated disc brake
Gear box		20:1 single worm reduction
Brake		AC operated disc
Max. load		215 kg (475 lbs.) including cable mass
Speed		1.5 m/s (5 ft. s)
Drum diameter		33 cm (13 in.)
Drum cable capacity		500 m (1650 ft.) of 7.55 mm 0.30 M OD 7 Cond. Amergraph
Winding		Scramble
Slip ring		Guildline, 8600-10W, 10 conductor
Mass		500 kg

Medium Duty Winch

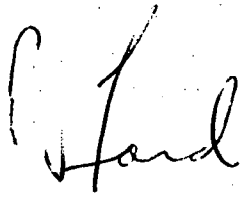
Height	180 cm (71 in.)
Width	146 cm (57.5 in.)
Length	150 cm (59.0 in.)
Power	3.7 kW (5 HP) DC electric motor, 240 V DC, Model no. 8803 SCR control
Gear Box	30-1 single worm reduction
Brake	AC operated disc
Max. loading	215 kg (475 lbs) including cable mass
Speed	1.5 m/s (5 ft./s) up and down
Drum cable capacity	500 m (1650 ft.) of 1.6 cm (5/8") OD cable
Drum diameter	71 cm (280 in.)
Winding	level
Limit switches	Fully adjustable
Slip rings	14 conductor (1000 V, 5 amp per ring)
Special sampling	Plumbing for hose-in-cable termination
Mass	700 kg

ACKNOWLEDGEMENTS

There are many facets of the Engineering Section which I have not yet acknowledged in this series. They include the people who mainly carry on the continuing services such as administrating, calibrating, drafting, expediting, filing, illustrating, machining, maintaining, movie projecting, photographing, printing, requisitioning, searching, secretarial assisting, storeskeeping, testing, typing and welding. Without people such as J. Bidinost, J. Bodnaruk, M. Brechin, R. Chumley, J. Diaz, M. Donnelly, W. Finn, A. Fletcher, I. Green, K. Kalter, P.McColl, K. Mollon, E. Smith, S. Smith, J. Thomson, A. Tyler, J. Valdmanis, J. VanNynatten, D. Whyte; none of these achievements would have been possible. The Section is an engineering business in itself, offering a wide variety of highly specialized services throughout C.C.I.W. and Canada. These people make it an excellent Section.

This acknowledges A. Fletcher's contribution as he retires in 1980. His calm, confident and fully effective way of carrying out his maintenance tasks gives him a special place in the Section.

A.S. Atkinson's leadership is also acknowledged as he retires in 1980 as Assistant to the Director, N.W.R.I. His dedication to serving the scientific community through the Engineering Services Section is recognized.



J.S. Ford, Head
Engineering Services Section.