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REPORT OF TRIAL ON MOTOR SUBMERSIBLE CANOES

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FROM: THE OFFICER-IN-CHARGE, CLEARANCE DIVING TRIALS TEAM, WEST LEIGH HOUSE, NEAR HAVANT, HANTS.

DATE: 24th November, 1954.

TO: THE CAPTAIN, H.M. UNDERWATER COUNTERMEASURES AND WEAPONS ESTABLISHMENT, LEIGH PARK HOUSE, NEAR HAVANT, HANTS.

SUBJECT

REPORT OF TRIAL ON MOTOR SUBMERSIBLE CANOES

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REPORT OF TRIAL ON MOTOR SUBMERSIBLE CANOES

SUMMARY

This report discusses a trial of motor submersible canoes and makes an attempt to evaluate them as a method of improving divers' mobility. The conclusions show the inadequacy of the present craft for mine hunting and beach clearance but emphasise the increase in searching efficiency under good conditions that even the present type gives the clearance diver.

2. Recommendations are made which propose modifications of existing types to enable more useful trials to be carried out and suggest the construction of a new craft specifically designed for mine hunting.

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SECTION 1. OBJECT OF THE TRIALS

3. Since the problems of searching for mines by Clearance Diving Teams and for beach obstacles by Clearance Diving Teams (Amphibious) have many common features, this first attempt at improving divers' mobility was carried out jointly by the Clearance Diving Trials Team and the Clearance Diving Team (Amphibious). The major requirements in both cases are therefore laid down in Section 2, self evident though many of them are.

SECTION 2. REQUIREMENTS

4. These requirements are that:-

(a) the area swept is clear of mines or obstructions;

(b) the method used shall be safe to the clearing force;

(c) the area is swept quickly and with minimum effort;

(d) in the case of beach clearance, the enemy will not be given any warning of activity near the beach before H-hour.

5. Any submersible craft which may satisfy the above should have the following general characteristics:-

(a) cheap to manufacture;

(b) simple to operate with very little practice;

(c) highly manoeuvrable in depth and azimuth;

(d) have sufficient space for a crew of two, diver's aids and simple navigational instruments;

(e) have an endurance of up to 2 hours at 5 knots;

(f) a maximum diving depth of 200 feet;

(g) easily manoeuvrable in 3 feet of water without surfacing;

(h) fitted so that it can be towed and lifted easily;

(j) silent in operation;

(k) as small a magnetic field as possible.

SECTION 3. EQUIPMENT

6. Equipment in use

(a) Three Motor Submersible Canoes Mk. III supplied by the Amphibious School, Royal Marines.

(b) Universal Breathing Apparatus Patt. 5562.

/(c).....

(c) Underwater Swim Suits Mk. I.

(d) M.F.V.1098 as accommodation and base ship, loaned by H.M.S. VERNON.

7. A full description of a Motor Submersible Canoe Mk. III is contained in Appendix A to this report.

SECTION 4. TRIALS PERSONNEL

8. The units taking part in the trial were:-

(a) Amphibious School Clearance Diving Team (Lieut. Neill).

(b) U.C.W.E. Clearance Diving Trials Team (Lieut. Terrell).

SECTION 5. TRIALS NARRATIVE

9. M.F.V.1098 sailed from Portsmouth for Fowey at 1730 on 24th August, manned by the Amphibious School Clearance Diving Team under the command of Lieut. Neill. After a choppy passage, during which the ship took 2½ feet of water into the for'd hold which could not be pumped out, she arrived in Fowey at 1930 on 25th August and berthed alongside H.M.S. ORWELL at the Swinging Buoy. Facilities were made available by H.M.S. ORWELL and the water was pumped out after two hours pumping.

10. Thursday, 26th August At 0800 the U.C.W.E. C.D. Trials Team joined M.F.V.1098. She then slipped and proceeded to St. Austell Bay and anchored at 0900 in 30 feet of water. A jack-stay, 200 yards long, was laid and marked and two canoes prepared for running. This first day was devoted to rediscovering the art of trimming and handling learned some weeks before in Horsea Lake and it was due to the difficulty inherent in handling these craft that the driving was finally left entirely to Lieut. Neill and P.O. Christmas in order to obtain results rather than waste time teaching others to drive. It was found to be quite feasible to carry one observer on the bow who could give the whole of his attention to looking out while the pilot concentrated on trimming and steering.

11. Friday, 27th August Slipped from H.M.S. ORWELL at 0830 and arrived in the area at 0915. It was intended that the canoes should be used in a search together, one keeping station by sight on the other, but owing to the low visibility prevailing (10 feet) and an erratic trim caused by a leaking battery tank of one canoe, it proved to be impossible to keep the canoes together. C.P.O. Fawcett then attempted to drive, without much success, and as a consequence it was decided that an effort should be made to simplify the third canoe available, in an attempt to improve its underwater shape, and increase the pilot's control over the craft, particularly at high speed and when near the sea bed. The present craft require to be trimmed very exactly, which calls for constant practice and a high degree of skill before they can be driven fast at a constant depth. High speeds raise the bow and the craft tend to surface. If the bow touches the bottom, the stern will settle down so that the only ways of "taking off" again are either by propping up the bow with a large stone, partially blowing the main ballast tanks, or getting the observer to lift

/the.....

the bow off the bottom.

The conversion was begun in the evening. The main ballast tanks were removed as there is sufficient buoyancy in the for'd trim tank to float the craft. The trim tank became a ballast tank and had its pump replaced by a Kingston valve. One air bottle, the pilot's seat, the compass, compass shield and after canopy, were removed. Foreplanes, constructed from a broom handle, the after canopy, and some garden canes, were added, passing through the trim tank compartment, and linked directly to the after planes (see Plate No. 1, Fig. 2).

12. Saturday, 28th August 0830 Slipped and proceeded up river to collect two experimental aquaplanes that had arrived by rail and to make some administrative telephone calls. While lying at the buoy it was found that the auxiliary air compressor clutch of the M.F.V. had finally worn out and would have to be repaired before the main engine could be started again. With aid from the R.A.F. Air Sea Rescue Unit (Fowey) this repair was completed by 1400 and the M.F.V. was able to anchor again in St. Austell Bay at 1500. However, the engine was kept running while the ship was at anchor as the clutch was not entirely reliable and the main engine air start bottles leaked.

The converted canoe was tried out and after being ballasted with 19 lb. of lead aft, was found to handle easily and was simple to operate for the short time before its battery tank filled up through the side of the tank itself and the craft dived out of control to the bottom. It was soon recovered but only ran once more later in the trial before being abandoned as irreparable with the facilities and in the time available to the teams present. The only criticism of this conversion was that, as far as could be ascertained, the for'd control surfaces were not sufficiently effective to eliminate the bow up angle adopted when the motor was put to full ahead. Later, another after canopy was attached to the bows to counteract the effect of the flat deck for'd but its effect was not discovered.

After the canoe had been recovered, it was found that the water was rising in the engine room of the M.F.V. and was already 3 feet deep. The main engine was stopped and the water stopped rising, from which it was deduced that a connection to the circulating water system must have broken.

C.-in-C., Plymouth, was asked for assistance and while waiting, the jack-stay, sinkers and markers were recovered. At 2400 a T.R.B. of the R.A.F. Air Sea Rescue Unit (Fowey) arrived to tow the M.F.V. into Fowey, where she was secured at 0200.

13. Sunday, 29th August The M.F.V. was moved to the swinging buoy at 1030 by one of the harbour-master's launches and at 1530 was taken in tow to Plymouth by H.M.S. CARISBROOKE CASTLE, arriving there at 1930.

14. Monday, 30th August Arrangements were made for the necessary repairs to be effected to enable her to return to Portsmouth and also to borrow a boat with which to continue the trials in Cawsand Bay. The latter was forthcoming from the Royal Marine 4th Raiding Flotilla who loaned an L.C.A. complete with driver for the week. The M.F.V's defect list was taken in hand with despatch by the dockyard and gear was prepared for recommencing the trials the next day.

15. Tuesday, 31st August At 0930 the teams left No. 4 Basin in the L.C.A., towing two canoes, one of which was the conversion, and arrived in Cawsand Bay at 1015 where the L.C.A. was anchored in 25 feet of water. The bottom

/here.....

here proved to be better than that in St. Austell Bay as it is nearly free from large weeds and is flat, sandy and firm. There was good visibility up to a maximum of 20 feet, negligible current and a dense population of spider crabs. The first run in the converted canoe was a failure as she sank, out of control, with a flooded battery tank shortly after being trimmed down. Runs were carried out with the other canoe to determine the difference to trimming and efficiency in searching that the addition of a second member to the crew made to the craft.

The following points, most of which had been made before, were confirmed:-

(a) it was found possible to steer and trim far more efficiently when that was the only job for the driver to concentrate upon while the second crew member kept a constant watch for'd;

(b) movement of the lookout diver made a considerable difference to the trim;

(c) cold affected both pilot and observer after ¾ hour in the water although the temperature was 64° F. and they were both dressed with undersuits, sweaters and underclothes;

(d) the observer was able to keep his constant and undivided attention on looking out;

(e) if the craft bottomed by mistake, the observer could lift the bows up and enable the craft to take off again.

16. Wednesday, 1st September After some delay caused by business with the dockyard, the teams arrived in Cawsand Bay at 1045. A jack-stay 125 yards long was laid and marked. Two canoes were used in the first run to try and search with a crew of two in each and to maintain station along the jack-stay by visibility alone. It was found to be almost impossible to remain in company for more than a minute at a time due to a number of hindrances such as insufficient visibility distance (10-15 ft.), the limited field of view imposed by the U.B.A. mask, varying and different trims, and lack of communication between craft. Each pilot could, however, follow the jack-stay with ease when once he found it, or steer a straight compass course from one marker to the other. It was found to be difficult to manoeuvre laterally with an observer on the bows and in order to turn round, it was often quicker to surface, turn, and dive rather than remain dived while turning. The second run was carried out with both canoes towing two swimmers each, one on either quarter, and searching up the jack-stay independently. As the batteries were low on both craft, and the point of tow was not ideal, it was difficult to proceed at anything approaching full speed. However, the search was carried out at 1 knot with both swimmers towing comfortably and able to keep a constant lookout slightly ahead and 35-40 degrees on either side of their line of advance. Swimmers on their own required the jack-stay to guide them and the best could only make ½ knot over the distance.

On return to harbour, eight batteries were taken to H.M.S. ORWELL for charging as the dockyard voltage available was too low for the purpose.

17. Thursday, 2nd September At 0730 it was found that the batteries being charged by H.M.S. ORWELL had not responded to charging and would require topping-up and a long charge all day. One canoe was taken for

/a run.....

a run in Cawsand Bay after searching in vain for a rifle dropped by a Royal Marine cliff climbing unit. The battery of this canoe was low and only one run, towing 2 swimmers, was possible and this confirmed previous findings. The canoe with the swimmers found one of two objects laid at a distance from the jack-stay while swimmers alone failed to do so and were slower.

18. Friday, 3rd September The batteries on charge in H.M.S. ORWELL were still unsatisfactory and were left for a further eight hours slow charging. The ratings of the U.C.W.E. Clearance Diving Trials Team had to leave in order to get transport to the station with gear required for trials at Shoeburyness. As none of the canoes now had operational batteries and as the L.C.A. had to be returned early for refuelling before the dockyard closed for the week-end, it was decided to carry out a few runs to see if the canoes could be towed underwater successfully. The first run was made with just the pilot in the canoe and speed was increased from $2\frac{1}{2}$ to 3 knots. At three knots, any look-out at all was impossible while sitting up. The breathing bag was pressed against the diver's chest so that breathing was difficult, and his mask was vibrated violently. At $2\frac{1}{2}$ knots and lying out on the foredeck, a good look-out could be maintained. The craft kept a constant depth with full dive on the after planes. This depth depends directly upon the length of tow and the length of the supporting pendant from the bow to the towing line and it can only be decreased by manipulation of the planes, not increased. The tow yawed over about 10° and this could not be controlled by the rudder nor was it possible to leave the wake of the towing craft and tow from the quarter.

The second run was made with a pilot and observer at slow speed (2 knots) and it was found that the presence of the observer on the foredeck made a distinct difference to the towing characteristics of the craft. It tows better with an unobstructed deck. On both runs the cold felt by the crews was most noticeable, even though the longest time down did not exceed half-an-hour.

On return to harbour, the charged batteries were collected from H.M.S. ORWELL and installed in the canoes.

19. Saturday, 4th September Arrived at Cawsand Bay at 1000 with two canoes fitted with freshly charged batteries. The weather was bright and there was practically no wind but the previous day's wind and swell had reduced the underwater visibility to no more than six or eight feet.

The first runs of the day were made, towing one canoe behind the L.C.A. and passing close to a marker for photographic purposes. However, because of the murk, the canoe with its crew of two only came into sight once in four runs. At a towing speed of two knots the crew were quite comfortable and could concentrate on searching, but the fixed depth of operation frequently denied them sight of the sea bed. Another run was carried out to ascertain whether it was possible for two canoes to maintain station and co-operate when connected together by a light line. Although better results were obtained than when the pilots were trying to keep station by sight alone, yet it was obvious that in order to produce any useful results, a great deal more practice and experience would be necessary as well as some method of communication between them. Even when steering a pre-determined course, the canoes were observed in all positions relative to each other and finally one broke away and had to be chased by the dinghy to bring it back.

One canoe was then taken inshore and manoeuvred in four feet of water with success so long as the pilot could see the bottom. Finally a search

/for.....

for the concrete sinker and yellow buoy, sunk for searching purposes, was made by a diver on an experimental fibre-glass aquaplane towed by the L.C.A. at two knots. This was the fastest towing speed possible for the prevailing visibility and even then many objects could be seen but not recognised in the short "seeing time" available. A path about 15 feet wide could be swept efficiently, depth could be altered easily but there was little flexibility in azimuth. The best depth for searching when the visibility was about ten feet was found to be three or four feet from the bottom. During this search, a 250 Kg. bomb of German origin was found and buoyed and the L.C.A. returned to harbour to report the discovery to C.-in-C., Plymouth. (The bomb was later disposed of by the Bomb and Mine Disposal Officer on C.-in-C., Plymouth's Staff.)

GENERAL NOTES

20. Throughout the trials, divers complained of cold after 30 minutes in the water whether as drivers or observers of an M.S.C. Divers were wearing Undersuits Mk. II and Diving Sweaters underneath Underwater Swimsuits Mk. I.

21. Delays and difficulties were encountered in carrying out the trials due to the age and bad mechanical condition of the craft. Defects in Blowing Valves, bottle connections and battery seals were prevalent.

22. The motors and propellers of the craft were extremely noisy when running at full speed. An M.S.C. could be heard while running at a distance of 20 ft. by other divers. The steel hull of the craft caused large deviations of the steering compass, being as much as 30 degrees on some courses.

23. Conditions under which trials were carried out

Date	Place	Depth of Water	Visibility	Water Temp.	Sea and Swell
26th Aug.	St. Austell Bay	25-35 ft.	10-15 ft.	65°	Nil
27th Aug.	St. Austell Bay	25-35 ft.	10 ft.	66°	1 foot
28th Aug.	St. Austell Bay	25-35 ft.	10-15 ft.	65°	Nil
31st Aug.	Cawsand Bay	15-25 ft.	10-15 ft.	65°	Nil
1st Sept.	Cawsand Bay	15-25 ft.	10-15 ft.	66°	1 foot
2nd Sept.	Cawsand Bay	15-25 ft.	10 ft.	65°	1 foot
3rd Sept.	Cawsand Bay	15-25 ft.	10 ft.	64°	Nil
4th Sept.	Cawsand Bay	15-25 ft.	5-8 ft.	64°	Nil

SECTION 6. CONCLUSIONS

24. As a result of trials carried out, the following conclusions are reached:-

(a) That the M.S.C. is not an ideal craft for Beach Clearance and

/Mine Hunting.....

Mine Hunting for the undermentioned reasons:-

(i) It has only fitted positions for 1 diver as crew.

(ii) The bow heavy trim required for running and lack of bow hydroplanes make the craft difficult to handle while near the bottom and when stopped.

(iii) The M.S.C's acoustic and magnetic properties are bad.

(iv) The M.S.C. is too complicated and requires a high degree of skill and practice on the part of the diver.

(b) That the craft can be modified, made simpler, and more easily manoeuvrable by an unskilled pilot if

(i) the main ballast tanks are removed and the trim tank converted into a ballast tank,

(ii) for'd hydroplanes are added,

(iii) the underwater shape is improved by the addition of a canopy forward,

(iv) fixed accommodation is provided for another crew member forward of the pilot.

(c) The M.S.C., even in its present form, provides a possible means of carrying out pre H-hour beach clearance in clear water. Visual searching speeds attainable are greater and searches more efficient than those attainable by swimmers.

(d) The canoe could be fitted to tow behind any surface craft at speeds to be determined by experiment but which might be as high as ten knots if the visibility was very good and the crew completely protected by a canopy.

(e) The craft at present provided are so old and mechanically unsound that the trial suffered through continual defects in the tanks, bottle connections, and battery compartment seals.

(f) The batteries are fitted and sealed in such a way that they cannot be easily or quickly changed, so that when they are run down, the craft is out of action for some hours until the seal on the replaced battery cover has set.

(g) That skids and propeller protection are necessary.

(h) That considerable practice is necessary before the present type of craft becomes an efficient instrument even in the hands of experienced clearance diving officers and C.D.Is.

(j) It is considered that divers' aids could be carried and could be operated at the maximum speed of the craft and they could be larger with better and more accurate displays than when they have to be carried by a diver on foot.

/(k).....

(k) Underwater craft cannot operate in close co-operation unless fitted with good telephonic communication.

(l) Divers require to be totally enclosed in a craft if speeds are to exceed $2\frac{1}{2}$ knots.

(m) Divers suffer from cold while inactive in an underwater craft. Extra protective clothing is required.

SECTION 7. RECOMMENDATIONS

25. The following recommendations are made:

(a) that a number of motor submersible canoes be refitted and modified as suggested in Section 6, paragraph 24 (b), and that they should then be used for further more exhaustive trials to enable ideas to be clarified or confirmed;

(b) that an interim submersible craft should be built to enable progress in the investigation of clearance divers' mobility to be maintained. A provisional specification for such a craft in the light of present knowledge is:

(i) a two-man enclosed but free flooding craft;

(ii) minimum equipment for manoeuvring i.e. forward and after hydroplanes directly linked; large diameter propeller; one centrally placed small ballast tank blown by a single bottle and one bottle valve; motor control as at present;

(iii) electrically driven motor giving speeds up to 5 knots; and alternative bicycle pedal propulsion;

(iv) battery capacity for 5 knots for 2 hours;

(v) diving depth of 200 feet;

(vi) a good underwater shape that does not display any peculiarities when manoeuvring at all speeds and one that will go astern as easily as ahead;

(vii) space for divers' aids; (and demolition stores for C.D.T.(A)s.);

(viii) good all round vision for the pilot and observer;

(ix) some communication between pilot and observer;

(x) towing and lifting positions to be fitted;

(xi) fitted with simple navigational instruments e.g. a compass, depth gauge, and possibly a simple and reliable automatic plot;

(xii) silent;

/(xiii).....

(xiii) non magnetic;

(xiv) able to skid along the bottom.

(c) that the role of small, diver-operated submersible craft fitted with mine detectors for mine hunting and beach obstacle clearance be investigated.

Report written by:

Lieut. M. Terrell, R.N.
Lieut. Neill, R.N.

Approved [signature]
Lt. Cdr., R.N.

Date: 24th November, 1954.

SECRET AND DISCREET

APPENDIX A

THE MOTOR SUBMERSIBLE CANOE MK. III

Description

Length 12 ft. 8 ins.
Beam 2 ft. 3 ins.
Weight 600 lbs.

Designed and constructed in 1941-1942.

Propulsion

24 volt electric motor.
4 x 6 volt batteries.

General Description

The Motor Submersible Canoe Mk. III has a surface canoe-shaped hull made of steel with a slightly convex deck. The single seat cockpit is situated aft. The whole of the hull is free flooding when submerged, containing the following items from for'd to aft:-

(a) Trim tank fitted with a vent, a non-return Kingston valve, a pumping line through which water may be pumped into the tank, and a compressed air line connection.

(b) A battery compartment, being a pressure-tight compartment, containing 4 six volt batteries in two groups that may be connected in series or parallel by positioning the motor switch. The compartment is sealed by a large plate secured by brass bolts.

(c) The main ballast tanks and compressed air bottles are fitted each side of the driver's legs in the cockpit. The ballast tanks are fitted with a main vent and Kingston valves and Compressed Air Line connections.

(d) The driver's controls, consisting of a joy-stick type hydroplane and rudder control, motor switch, airline control valves to the pressure gauge, main ballast and trim tanks, trim tank vent and pump, and main ballast tanks vent and Kingston valves, are all situated in the cockpit in front of the driver.

(e) A compass, depth gauge and air pressure gauge are fitted on the canopy in front of the driver.

(f) Immediately behind the driver is situated a buoyancy tank, with the hydroplanes on either side of it. The motor is fitted in a pressure-tight compartment underneath the buoyancy tank, driving a small propeller. An aluminium alloy canopy is fitted over the buoyancy tank as a head rest for the driver.

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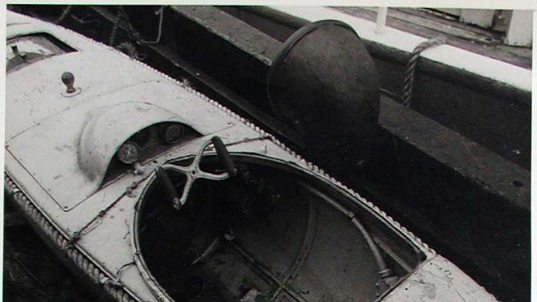

FIG 1. COCKPIT AND CONTROLS OF MOTOR SUBMERSIBLE CANOE

FIG. 2 MOTOR SUBMERSIBLE CANOE SHOWING JURY RIGGED FORE HYDROPLANES AND MODIFIED BOWS

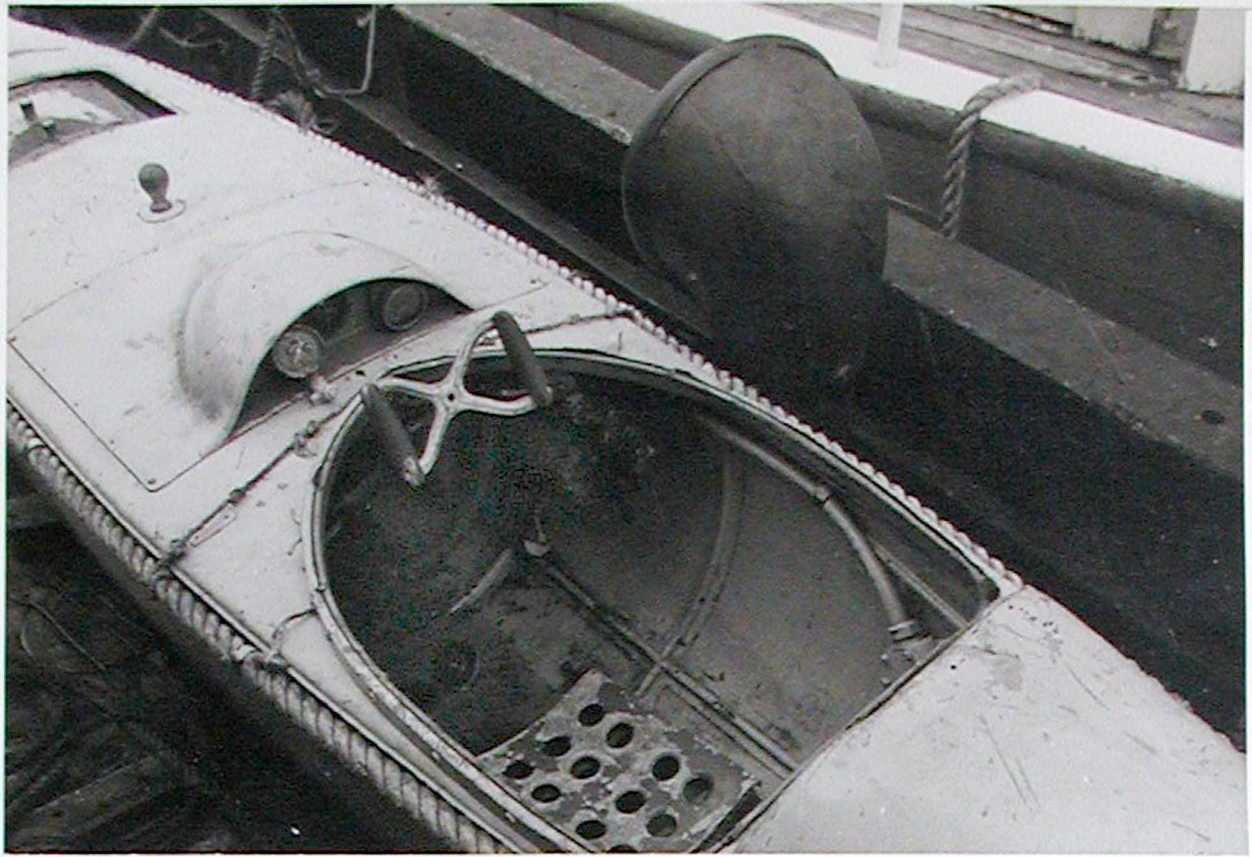

FIG 1. COCKPIT AND CONTROLS OF MOTOR SUBMERSIBLE CANOE

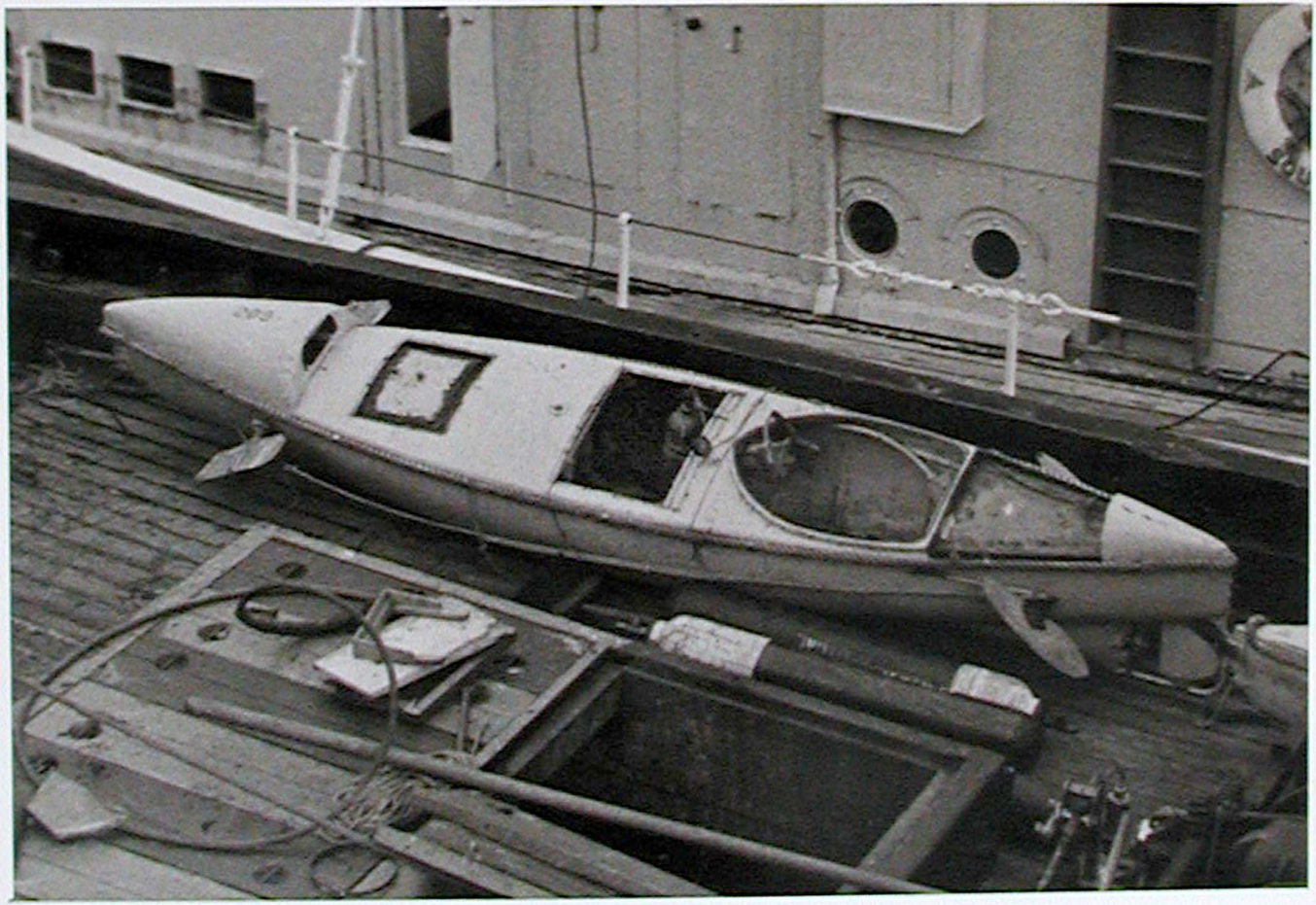

FIG. 2. MOTOR SUBMERSIBLE CANOE SHOWING JURY RIGGED FORE HYDROPLANES AND MODIFIED BOWS