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MARINE CORPS
LANDING FORCE DEVELOPMENT CENTER
MARINE CORPS SCHOOLS
QUANTICO, VIRGINIA

(NAVMC—QUANTICO)

One Man Rotorcycle;
Final Report

PROJECT NO. 52-58-03

CONDUCTED BY

MARINE CORPS EQUIPMENT BOARD

TENTATIVE ONLY UNTIL APPROVED BY
COMMANDANT OF THE MARINE CORPS

DATE JUL 25 1961

11590-A Navy-MCS Quantico, Va.

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52-58-03

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MARINE CORPS EQUIPMENT BOARD
Marine Corps Landing Force Development Center
Marine Corps Schools
Quantico, Virginia

46/4A/RMH:lpd

CLASSIFICATION: Unclassified

PROJECT NO.: 52-58-03

SUBJECT: One-Man Rotorcycle; Final Report of

RD 11922 (162)

ABSTRACT

1. A test and evaluation was conducted on the Gyrodyne YRON-1 rotorcycle to determine its tactical suitability for Marine Corps use as a vertical lift vehicle portable by one man, simple to maintain, and requiring operator training of a degree comparable to that given motor vehicle operators.

2. The YRON-1 did not satisfy the stated requirement for a vehicle of this type. Maintenance and operator training requirements are considered excessive for the intended operational purpose of the vehicle, therefore it is considered unsuitable for Marine Corps use.

3. Although there appears to be no place for a vehicle of this type in the Marine Corps aviation inventory, it is recommended that the Marine Corps continue its efforts to develop a vertical lift vehicle to meet the stated tentative ground requirement.

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REFERENCE:
(a) CMC ltr AAP-3-sla of 9 Oct 1958, Subj: One-Man Rotorcycle
(b) NATC, Patuxent River Report No. PTP AC-4042 of 20 Oct 1959
(c) CMC ltr AAP-5-sla of 27 Oct 1960
(d) BuWeps spdltr RA-421/121:RHB to CMC of 28 Sep 1960
(e) Dir, MCLFDC ltr 46/4A/lpd over 52-58-03 of 18 Mar 1960
(f) Article 0465, Navy Regulations

1. INTRODUCTION

a. Purpose - In accordance with reference (a) the Gyrodyne YRON-1 rotorcycle was tested and evaluated to determine the suitability of the one-man rotorcycle for use by the Marine Corps in the following areas:

(1) Determine whether or not the rotorcycle fulfills to a satisfactory degree the requirement for a vertical lift vehicle portable by one man, simple to maintain and requiring operator training of a degree comparable to that now given motor vehicle drivers. Operator training is defined as training given a non-aviator in order to qualify as a rotorcycle driver.

(2) Determine whether or not the rotorcycle incorporates the desired development features and meets the minimum acceptable performance required to tactically execute the vehicle's intended mission.

(3) Determine the over-all tactical suitability, doctrine for employment and operational concepts.

(4) Determine whether or not the rotorcycle can specifically fulfill its intended operational missions more efficiently and economically than can a small multi-place vertical lift vehicle operating under the same concept of tactical employment and environmental conditions.

(5) Determine what operational and maintenance problems are most likely to be encountered under varying conditions of weather and terrain.

(6) Based on the determination outlined in paragraph 1.a(1) through 1.a.(5), if appropriate, prepare recommendations relative to an orderly and time phased procurement program and subsequent fleet introduction of the rotorcycle.

b. Background - In 1952 the Commandant of the Marine Corps stated a tentative requirement for a one-man helicopter for use by infantry in Marine Corps operations. The Chief of Naval Operations promulgated an operational requirement and the Bureau of Aeronautics held a design competition. The Gyrodyne Company of America, Inc. and the Hiller Aircraft Corporation were awarded contracts to provide a satisfactory one-man helicopter (subsequently termed a rotorcycle) suitable for use by the Marine Corps. Three Gyrodyne YRON-1 rotorcycles were delivered to the Marine Corps Schools on 25 November 1959 after undergoing tests (reference (b)) at the Naval Air Test Center, Patuxent River, Maryland. The Hiller YROE-1, which incorporates a single main rotor system with a conventional tail rotor system was also tested by the Naval Air Test Center, Patuxent River. However these machines were not evaluated at Marine Corps Schools, Quantico due to the cancellation of Project 52-58-03 by reference (c). In addition reference (c) requested a summary report of progress, which also would serve as a final report. Reference (d) authorized the transfer of the Gyrodyne YRON-1 rotorcycles to the Bureau of Weapons Representative, St James, Long Island for custody. This report, which constitutes a final report, is based on operations utilizing the Gyrodyne YRON-1.

c. Description of test item - The Gyrodyne YRON-1 rotorcycle (see figures 1, 2 and 3 of Annex D) is a one-man vehicle incorporating two, two-bladed coaxial counter-rotating rotors of 17 feet diameter. Power is supplied by a Porsche automotive engine, model YO-952, modified with a Model YO-956 engine crankshaft. (See Figure 4 of Annex D). The rotorcycle is equipped with a pull-type hand starter. The engine has a normal rating of 55 Brake Horsepower (BHP) at 640 RPM and a take-off rating of 62 BHP (2 minute duration) at 640 RPM. The fuselage is of tubular construction with an inverted V empennage. Conventional helicopter cyclic and collective control sticks are provided. Directional control is provided by rotor tip brakes consisting of small hinged end plates mounted on the tip of each blade. Movement of the rudder pedal extends one pair of tip brakes on one set of rotor blades increasing the drag on that rotor which develops a turning torque on the fuselage in the opposite direction. The landing gear is a tricycle type with a non-swiveling nose gear. The landing gear has no brakes. General statistics of the YRON-1 as flown during the evaluation are as follows:

(a) Weight (empty)	430 pounds
(b) Rotor Diameter	17 feet
(c) Length (fuselage)	11 feet
(d) Width (fuselage)	5'8"
(e) Height (fuselage)	8'
(f) Fuel (Quantity and Type)	5 gallons, 91/96 aviation gas
(g) Oil (Quantity and Type, engine)	3 3/4 qt/MIL-L-2104A; 10-30 wt
(h) Oil (Quantity and Type, transmissions)	1 3/4 qt/MIL-L-25336 (SING-L-743)

2. DISCUSSION

a. Although the physical characteristics of the YRON-1 rotorcycle did not satisfy the stated Marine Corps tentative requirement for a vehicle of this type, it was found that when the rotorcycle was flown by an experienced helicopter pilot certain tactical missions could be performed. These missions could also have been performed by a larger helicopter and the utilization of a larger helicopter would have resulted in a more flexible and greater mission capability. However the rotorcycle had certain maintenance, cost and logistic advantages. It is considered that the YRON-1 did not satisfy the requirement as to operator training in that the machine was relatively complex and somewhat difficult to fly.

b. Based on the test results of the YRON-1 it was found that the performance of the machine was more than adequate. With the exception of its engine it proved to be fairly reliable. However many of its components were restricted to low life by the Bureau of Weapons. Tactically, it is considerably more restricted and less flexible in mission assignment and usage than a larger helicopter and hence can be considered less desirable. Although phases II and III of reference (e) were never initiated, the training of non-helicopter or non-designated operators would have been most difficult and undoubtedly would have required more time that that given to motor vehicle operators. (See Annex C).

3. CONCLUSIONS

a. On the basis of operations conducted during the test and evaluation, it is concluded that:

(1) The YRON-1 in the hands of an experienced operator can perform limited reconnaissance, observation, courier and resupply missions during daylight hours under favorable weather conditions. The tactical use of the rotorcycle is limited due to its short range and endurance, small payload, and questionable operating capability under other than good weather conditions.

(2) The YRON-1 during its closely controlled and limited evaluation period performed with acceptable reliability with the exception of its engine.

(3) The YRON-1 was economical to operate.

(4) The YRON-1 was similar to other helicopters in flight characteristics, once a qualified helicopter pilot had become accustomed to the light control responses and certain idiosyncrasies peculiar to the machine. Due to the absence of a cockpit structure, the outer periphery of the rotor tip plane could be used as a substitute reference to control the altitude of the rotorcycle while

operating at altitude. For further comments see Annex C.

(5) Any attempt to qualify non-helicopter pilots as YRON-1 rotorcycle operators without benefit of previous instruction in a dual control helicopter would be extremely hazardous to both the trainee and the rotorcycle.

(6) The rotorcycle can best perform missions when assigned to specific echelons of command, down to battalion level, as opposed to being in a central location on call.

(7) The YRON-1 could be improved from an operational viewpoint with the addition of the changes discussed in Annex B.

(8) The YRON-1 did not meet the tentative requirement for a vertical lift vehicle portable by one man, simple to maintain, and requiring operator training of a degree comparable to that given motor vehicle operators, as stated in reference (a).

(9) There is no requirement for the YRON-1 in the Marine Corps aviation inventory. The YRON-1 is too complex for a non-aviator to operate. As a consequence, it would have to be assigned to a light helicopter squadron where the mission it might perform can be performed more efficiently by the Assault Support Helicopter (ASH).

(10) Since it is contemplated that rotorcycles would be operated solely by ground units, it would appear desirable to procure future rotorcycles outside the regular Naval and Marine aircraft inventory.

(11) It is extremely doubtful if the Gyrodyne YRON-1 could be modified sufficiently for it to meet the tentative requirement stated in reference (a).

4. RECOMMENDATIONS

a. The Marine Corps continue its efforts to develop a vertical lift vehicle to meet the tentative requirement as stated in reference (a).

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b. When and if a suitable rotorcycle is found, that the Marine Corps request that the Secretary of Navy amend reference (f), if necessary, to permit the Marine Corps to procure rotorcycles without reference to the Bureau of Naval Weapons.

Submitted by:

R. M. BAKER
Colonel, U. S. Marine Corps
President, Marine Corps Equipment Board

C. A. LASTER
Colonel, U. S. Marine Corps
Director, Marine Corps Landing Force Development Center

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DETAILS OF TESTS

1. Test No. 1 - Maintenance Features

a. The purpose of this test was to determine the maintenance features associated with the YRON-1.

b. Maintenance man-hours/flight hours. During a prescribed period three rotorcycles were flown a total of 23.5 hours with 27.7 maintenance hours being required to keep the machines in commission for an average of 1.2 maintenance man-hours/flight hours. It should be noted that this ratio might change over a longer operating period and under a variety of operating conditions. No factory overhaul or maintenance figures have been included in the data. A factory inspection and overhaul of certain components was required and was performed after the first 25 hours of operation for each rotorcycle.

c. Maintenance problems encountered under varying conditions of weather and terrain. Operations under field conditions while participating in PHIBLEX 33-60 disclosed no problems which could be considered peculiar to the YRON-1. With the exception of one minor incident three rotorcycles were maintained in commission and ready for operation during the four days of the problem in which they accumulated 26 hours of aircraft time. However during the overall evaluation period one crankshaft failure was reported on a test engine which necessitated the three YRON's being returned to the factory for installation of heavier crankshafts. In addition, one camshaft failure traceable to the installation of an old type fly wheel on a new type shaft during factory overhaul, was experienced at Quantico.

d. Life span components. Undetermined. The total operating life of the YRON test vehicles was established by Bureau of Weapons at 50 hours each.

e. Operating cost. Operating cost of fuels and lubricants averaged $1.36 per flight hour.

2. Test No. 2 - Performance

a. Details of performance are contained in reference (b); however general performance data are outlined below.

b. Autorotation Capability. Autorotation procedure in the YRON-1 is conventional. Rate of descent is relatively high being approximately 1600 ft/min. Recovery is commenced at 15-20 feet altitude. Control response is excellent in recovery. A left yawing motion is encountered at the time of recovery, but is easily correctable with the application of right rudder.

c. Fuel consumption. 32 lbs/hr (5.2 gal/hr) at 55 BHP.

d. Maximum Speed (Vmax). 60 knots.

e. Best Climbing Speed. 38 knots.

f. Vertical rate of climb. 408 ft/min at 688 pounds gross weight and 55 BHP.

g. Range. 62.5 nautical miles at 53 knots calibrated airspeed (CAS).

h. Endurance. 1.26 hours at 39 knots CAS.

i. Service ceiling. Restricted to 3,000 feet pressure altitude until altitude compensating carburetors have been installed.

3. Test No. 3 - Tactical Suitability

a. The purpose of this test was to determine to what degree the rotorcycle could fulfill a requirement as a tactical vehicle. Participation in a major fleet exercise (PHIBLEX 33-60) occurred during the period 2 May to 13 May 1960. The rotorcycles were used in reconnaissance, observation, courier and limited resupply missions. Some highlights during this exercise are discussed below.

(1) Three YRON-1's were assigned to operate with the aggressor force on the first day of the operation. Specifically, the assigned mission was to conduct reconnaissance and observation functions throughout the landing area. Each rotorcycle was assigned a zone of responsibility of approximately 100 square miles. Two methods of gaining intelligence were used. One method consisted of landing on high, unoccupied ground and scanning the area with binoculars. This method is satisfactory when operating in mountainous terrain but its value would be questionable in flat or wooded country. The rotorcycle is an excellent vehicle to transport an operator-observer to an observation post. Due to its small size and relatively low noise level it can approach quite close to troops before they are aware of its presence. The second method consisted of flying observation

missions. These missions were flown at an altitude of from 500 to 800 feet. It was definitely ascertained that it is feasible for a trained rotorcycle operator to fly the vehicle and observe activity on the ground. Maps were attached to pilots' knee pads and activity on the ground could be pin-pointed and noted on the map. On D+1, an HRS crashed a short distance from the battalion CP. The battalion commander was unable to obtain information over his radios relative to the crash. A rotorcycle, which was located at the CP, was dispatched immediately to obtain all possible information. This rotorcycle returned within twenty minutes with all of the essential initial details, including the number of dead and injured personnel, their names and organizations.

(2) Another type mission for which the rotorcycle appears to be adaptable is that of providing courier and messenger service. Three rotorcycles were maintained on an alert status at an assigned command post. Any one or all three rotorcycles could be airborne within five minutes following receipt of a mission. Assigning the rotorcycle to a specific echelon of command, down to battalion size, and maintaining it on an alert status is believed to be the best means of gaining maximum utilization. One specific example of having the rotorcycle readily available to perform missions occurred on D+2 when the Brigade Commander moved his CP ashore. Although complete communications had not been installed at this time, the Brigade Commander was able to obtain an up-to-date picture of the situation ashore within a forty-five minute period by dispatching the three rotorcycles to the various CPs and having them pick-up overlays and situation reports. The rotorcycle is particularly suited for carrying messages which cannot be transmitted by radio.

(3) The rotorcycle performed limited resupply missions. In all instances this support consisted of delivering batteries for the PRC-10 radios to isolated outposts. In one instance a battery was delivered to an OP atop San Onofre Peak (Elevation 1725'). This mission was completed in less than 10 minutes. Delivery by motor vehicle would have required much more time. In another instance two batteries were delivered to a radio relay post situated about seven miles from the CP. Delivery was completed 12 minutes following receipt of the mission. Both of the above missions could have been accomplished by HRS, HUS, or HOK helicopters; however more delay and expense might have accrued.

(4) Three rotorcycles landed aboard the helicopter platform of the U. S. S. Estes (AGC012) almost simultaneously. Sufficent room

remained aboard the platform to accommodate two more rotorcycles.

(5) The YRON-1 operated at elevations up to 3,000 ft. with routine regularity at less than maximum permissible power.

b. Transportability by Fixed and Rotary Wing Aircraft. YRON-1 rotorcycles have been transported in R4Q, R4D-8 and HR2S aircraft. The YRON-1 should be prepared prior to transport by removing the rotor blades and tail truss, draining the fuel tank, and, if it is to be carried in the HR2S or the R4D, the oil tank (crankcase) should be drained. Time required to prepare the YRON-1 for transport is 1.5 man-hours per rotorcycle. Complete reassembly requires 1.5 man-hours per rotorcycle. In addition, when the YRON is to be transported in the R4D, the rotor mast must be completely disassembled. This action is considered to be a factory function and therefore transport by this means is not recommended except in unusual cases.

(1) R4Q Aircraft

When the rotorcycles have been prepared as described above, five of them can be carried simultaneously. The top of the rotor mast (8') clears the overhead of the cabin by two to three inches.

(2) HR2S Helicopter

In addition to the preparations described above, the rotorcycles must be attached to a specially designed dolly (see figure 5, Annex D). This dolly permits the rotorcycle to be rotated back 90° (see figures 6 and 7, Annex D). The YRON must be carried in this manner when being transported in the HR2S due to insufficient overhead clearance when it is in the upright condition. The mast can be rotated to prevent its striking an obstruction when the rotorcycle is being loaded through the forward cargo door. Five rotorcycles can be accommodated inside an HR2S when prepared in this manner.

4. Test No. 4 - Training

a. Only helicopter pilots have flown the YRON-1 to date. Flight experience of those pilots who have flown it ranges from 650 to 1650 helicopter flight hours. All pilots were able to hover the YRON after only a few minutes of ground operation. An experienced helicopter pilot usually will recognize the light lateral control forces immediately.

In all cases but one, no difficulty was encountered. One pilot entered a "Pilot Induced Oscillation" due to the sensitivity of the lateral control but he was able to make a safe landing. He overcame this tendency to over-control on his next attempt to hover. It is generally agreed that a controlled flight syllabus of four hours duration will qualify the average helicopter pilot to the point where he can execute a tactical mission. No attempts were made to check-out non-helicopter pilots or non-aviators in the YRON-1 since authority for entering Phase II and III, discussed in reference (e) was not received.

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DEFICIENCIES AND RECOMMENDED MODIFICATIONS

1. The cyclic stick on the three YRON-1 rotorcycles delivered to Quantico was considered to be excessively long. Accordingly, the stick was shortened approximately 6 inches and a standard aircraft stick grip added (see figure 8, Annex D). The shortened stick provided better control, permitted the pilot to rest his arm on his leg during flight, and with the addition of a radio, would have permitted the pilot to use the control button on the stick grip to transmit.

2. Back pads and seat cushions were added after the YRON-1s were delivered to Quantico (see figure 9, Annex D). The addition of these two items provided a more comfortable seat for the operator. In cold weather the metal seat allowed the cold to penetrate even heavy winter flight clothing. The added weight of four pounds is not considered excessive for the comfort gained by the operator.

3. A PRC-6 radio was installed on each rotorcycle (see figure 10, Annex D). Satisfactory communications were not attained with this installation. The addition of a small, battery powered radio is considered essential for non-aviator operator check-out flights and if maximum effectiveness is to be gained from a rotorcycle. Two such radios were ordered for this purpose but were not received prior to termination of the tests.

4. The addition of an electric starter in lieu of the present hand starter is considered desirable. An electric starter would permit more positive and rapid starting.

5. The rotor brake on the YRON-1 was not entirely satisfactory. It is possible to leave the engine running without the vehicle being manned but the rotor must be stopped before the pilot can leave the rotorcycle. When conducting courier missions some time was lost waiting for the rotor to stop turning.

6. The landing gear configuration (wheels instead of skids) is considered a desirable feature in that it permits the YRON-1 to be maneuvered

easily on the ground by one man. However, the addition of brakes on the main wheels would prove to be an asset. Unless care was used in selecting a flat landing surface, the rotorcycle tended to roll after power was reduced. In two instances near mishaps occurred when operating in hilly terrain and landings were made on a sloping surface.

9 June 1960

SUBJECT: Flight Report on YRON #4011 Conducted 3 June 1960

TO: Director, Development Center

1. Preliminary checkout consisted of going over the pilot's handbook, the written examination, and a visual inspection of the aircraft with Captain Valentine. He then started it, gave it a quick check and turned it over to me.

2. I had complete confidence in my ability to fly the machine which lasted until I attempted to hover. It was then apparent (although forewarned) that the controls were more sensitive and the aircraft far more responsive than anything I had previously flown. The initial reaction was to pull up on the collective pitch control for more maneuvering room which in this case would have probably provided more altitude from which to crash. Instead the aircraft was set down before I lost lateral control to the extent that there was danger of toppling sideways. The problem, of course, was one of getting familiar with the control characteristics, and particularly, to the control sensitivity, so that I could avoid the pilot induced oscillations resulting from overcontrolling.

3. After some 10 to 15 minutes and many lifts to altitudes of six inches of so, I finally recovered enough confidence to take off for normal flight. Once a feel for the reaction of the aircraft was attained I was quickly convinced that I could control it as well as I could any other helicopter - and even developed some enthusiasm for its responsiveness. Normal maneuvers involving hovering, slow flight forward, sideways and backwards were performed. A maximum altitude of 500 feet was attained.

4. From the standpoint of stability I consider it inherently as stable as most other helicopters. However, due to its size and weight it is very susceptible to gusts and difficult to control in rough air. At higher altitudes it is difficult to control its attitude as the pilot has no cockpit structure for a reference to use against the ground, sky or horizon. It appears to have plenty of power and is very responsive to changes in power. It is also very responsive to the controls. While this leads to overcontrolling, until the pilot acquires a feel for the controls, this is considered necessary to properly control such a light aircraft. Reduction of control sensitivity and responsiveness would of necessity also reduce the pilot's ability to control the aircraft in rough air and this is already

marginal due to its small size and light weight.

5. I am of the opinion that basically this aircraft is similar to any other helicopter from the standpoint of control and stability and that the same basic procedures should apply in learning to fly it. In at least one respect it can be expected to be more deadly. Because it is so maneuverable I felt as if I were in a hot rod, and it can be expected that there will be a tendency for pilots (particularly young ones) to push it beyond reasonable limits. It is considered imperative that a dual control trainer closely simulating the characteristics of the YRON be developed prior to embarking on any major program involving the training of pilots for this type aircraft.

6. I would like to emphasize that to me this is just another of the growing family of helicopters. Basically it has the same control and stability characteristics of the others. Additionally, it is more sensitive and responsive and is more susceptive to the effects of the elements. The pilot, too, is more vulnerable to the elements and to injury as he has no protection whatsoever which an enclosure, to some extent, would provide. Initially, at least, training procedures for the YRON should be similar to those now used in the helicopter program. Deviation from this well established program should be approached with caution.

7. Conclusions:

a. The YRON is inherently similar in control and stability characteristics to most other helicopters.

b. Response to control and power changes while a critical problem in checkout of pilots are to be expected in a helicopter of this size and weight.

c. Flying at altitudes in excess of 500 feet should be avoided until reasonable experience in the aircraft has been attained.

d. A dual control trainer specifically tailored for pilot training for this type of helicopter should be developed.

e. Basic training procedures for helicopters should be followed in training pilots for the YRON.

6. Operation of a helicopter of this type will require close supervision to prevent accidents resulting from radical maneuvers.

/s/ MARION E. CARL
Colonel, USMC

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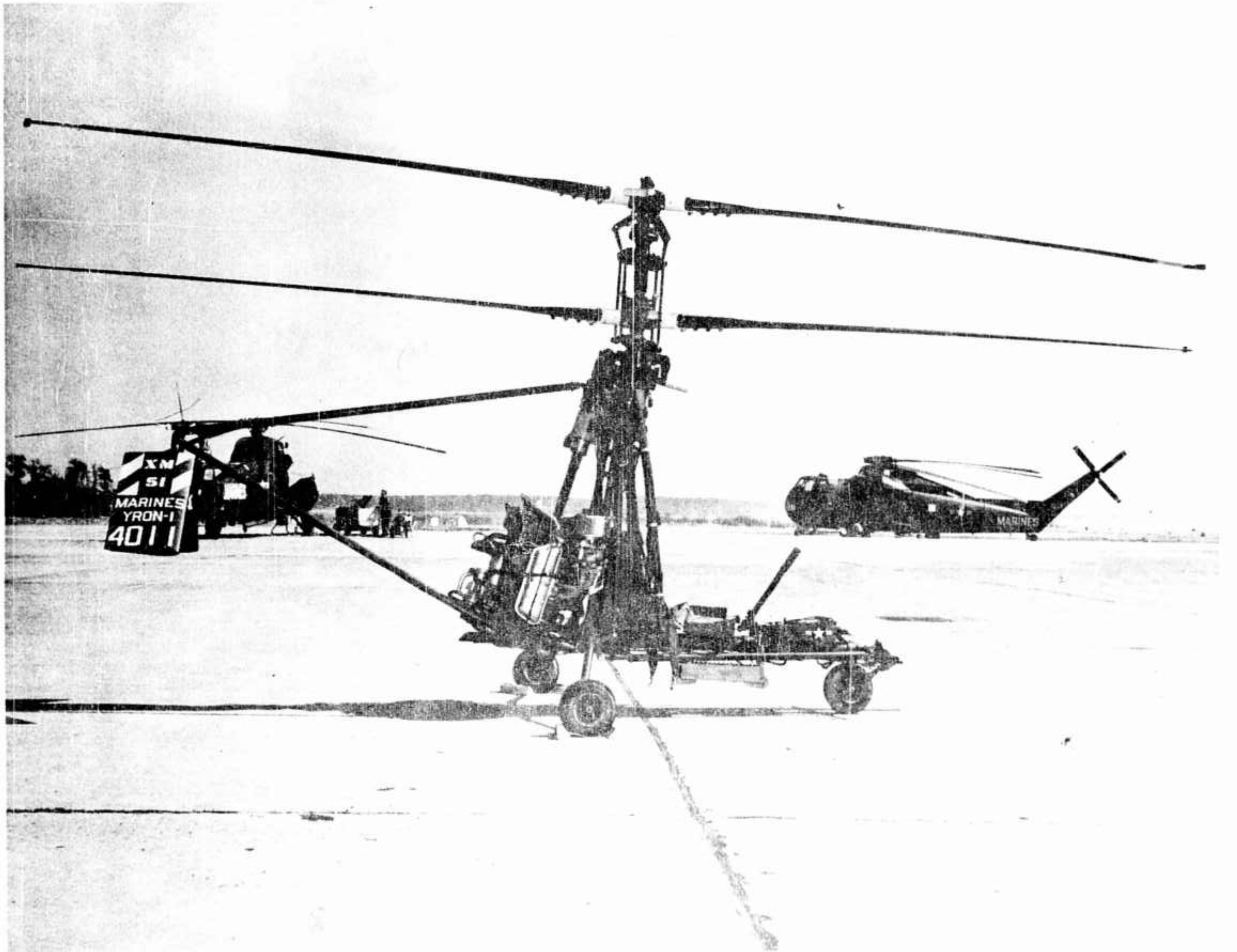

YRON-1 Rotorcycle

ANNEX D

MARINE CORPS EQUIPMENT BOARD
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YRON-1 Rotorcycle in Flight

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YRON-1 Instrument Panel

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MARINE CORPS EQUIPMENT BOARD QUANTICO, VA.
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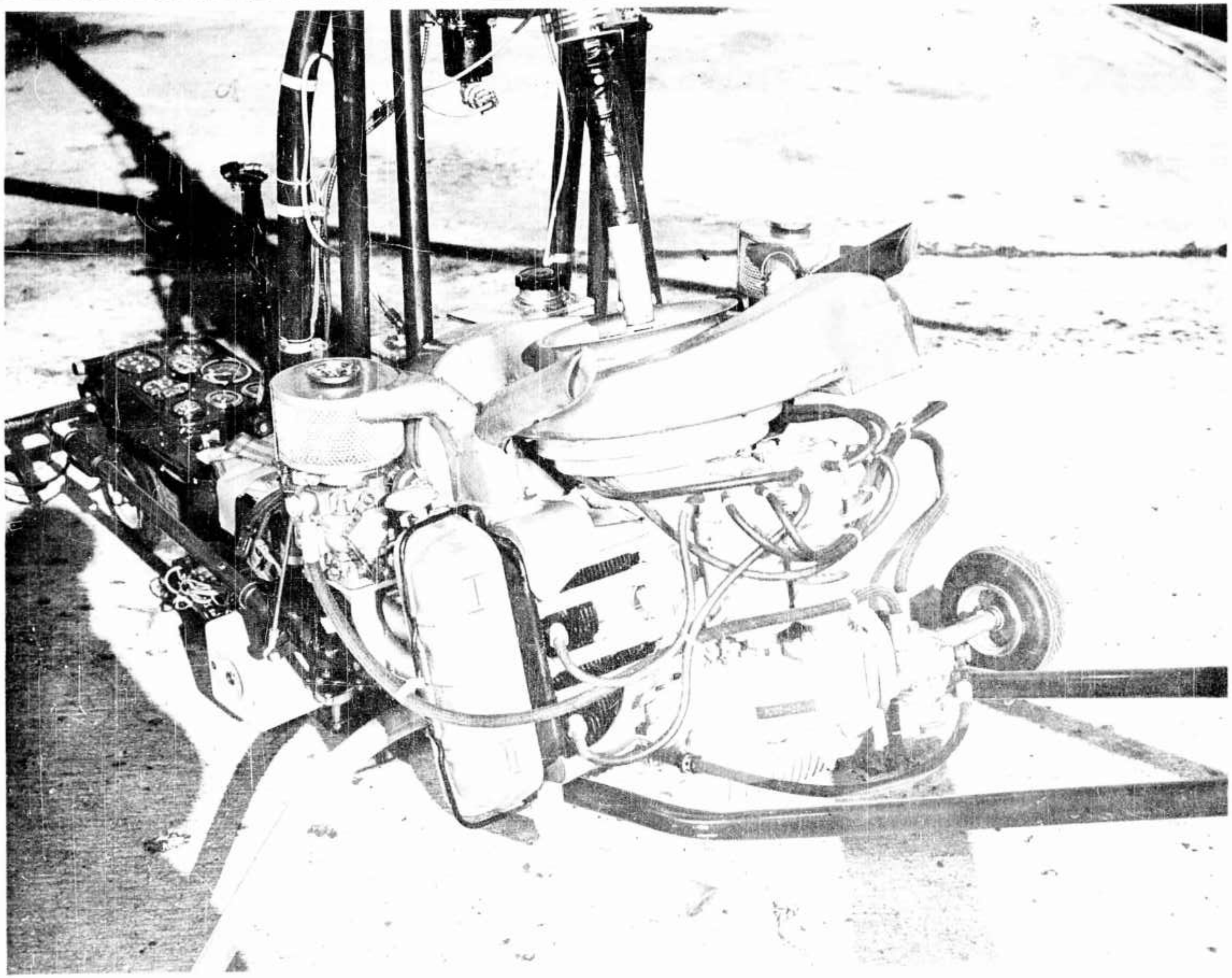

12 Feb 1959

Porsche Engine, Model YO-95-2

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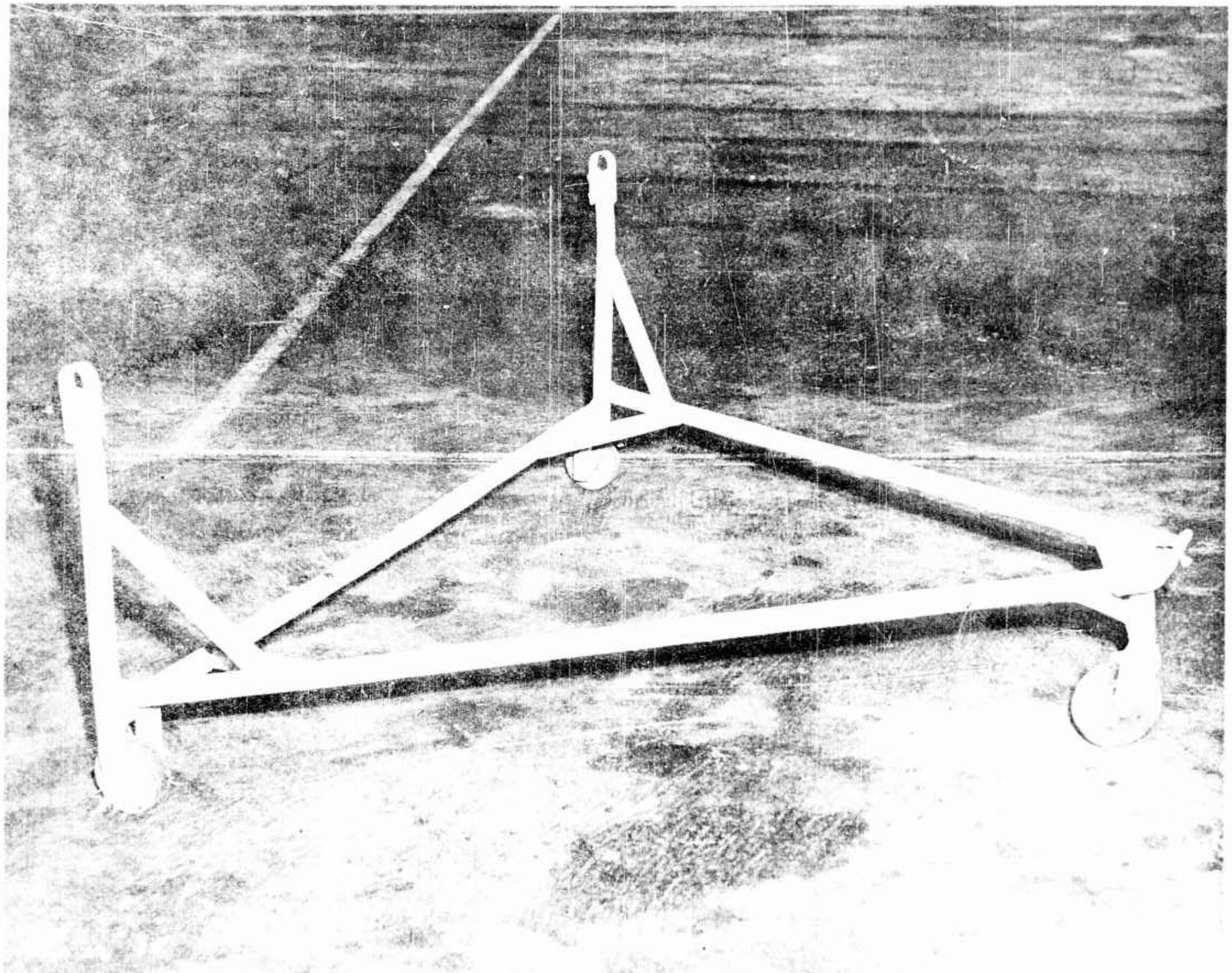

4 Apr 1960

Locally manufactured dolly for transporting YRON-1 Rotorcycles in the HR2S Helicopter

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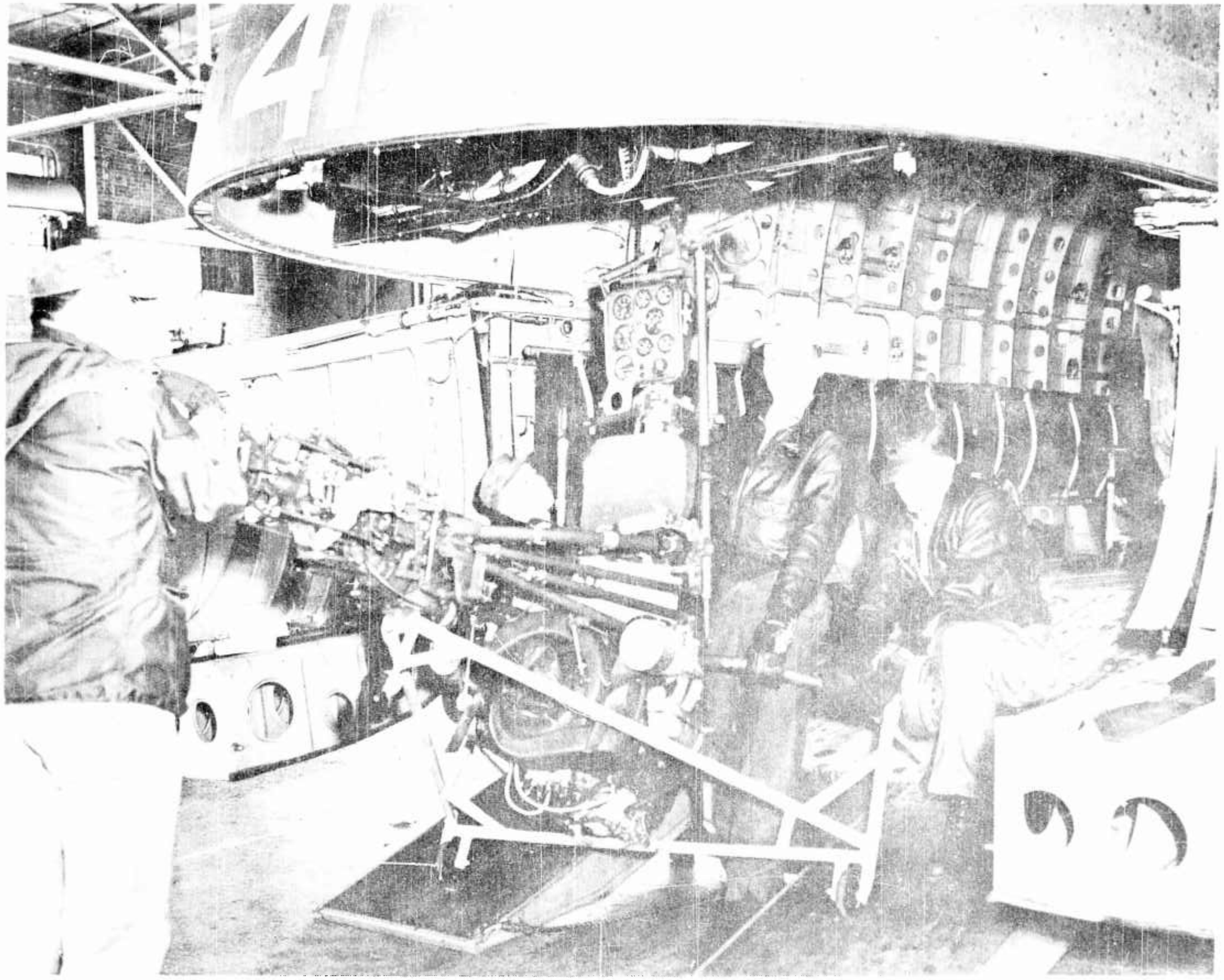

8 Mar 1960

YRON-1 being placed in HR2S Helicopter

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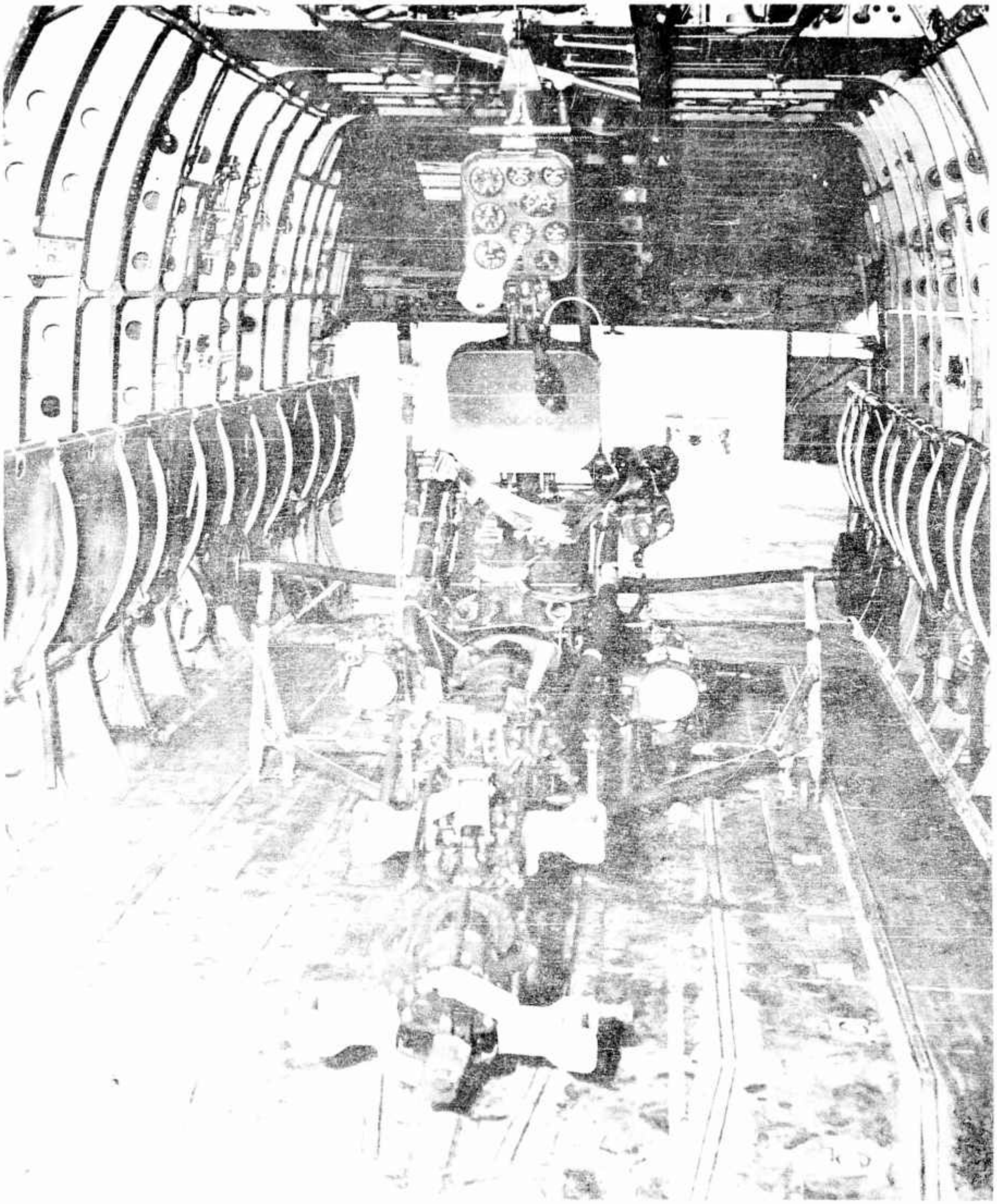

8 Mar 1960

YRON-1 ready for transport in HR2S helicopter

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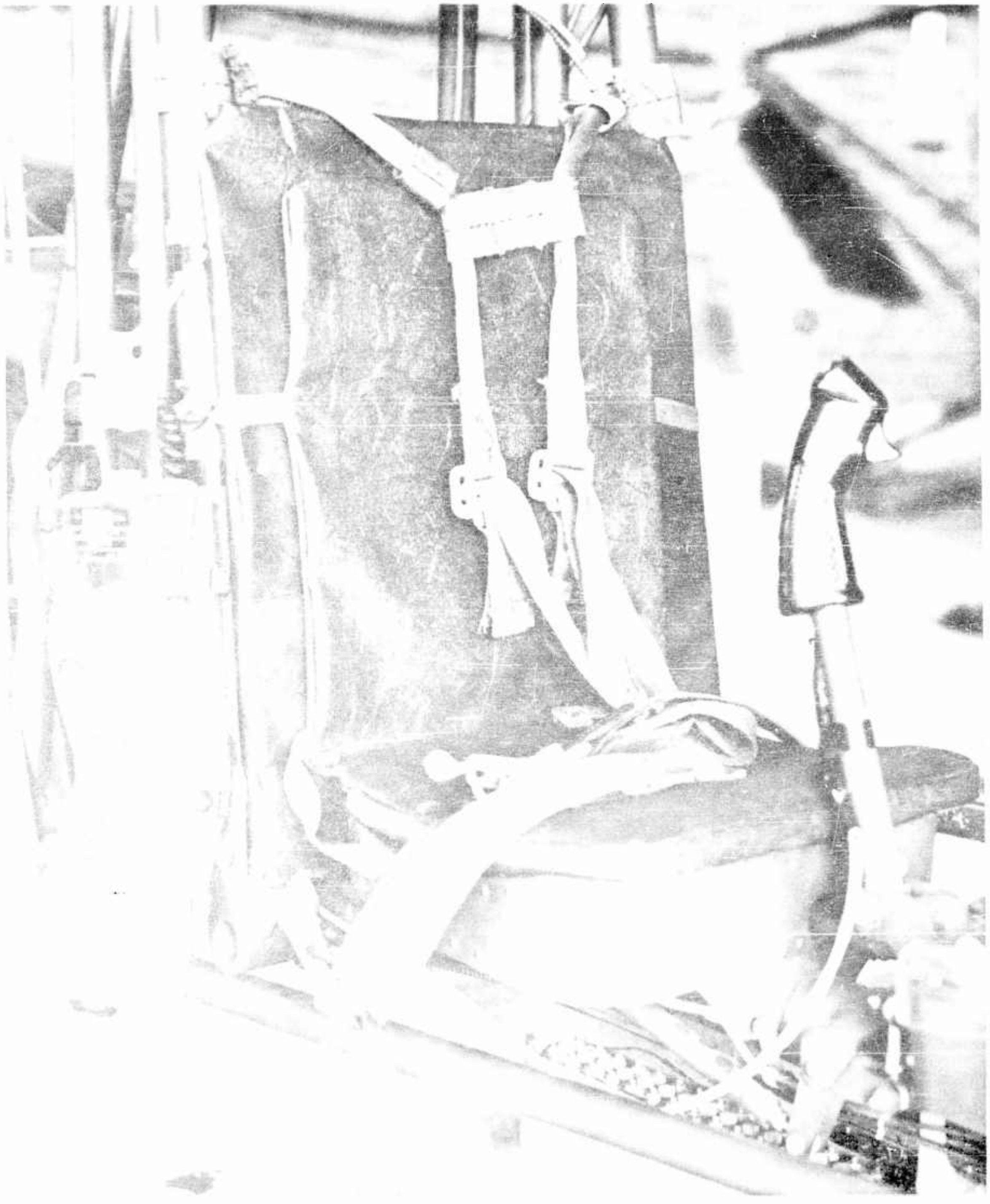

25 Mar 1960

View of cyclic control stick modified with standard aircraft stick grip

ANNEX D

MARINE CORPS EQUIPMENT BOARD
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25 Mar 1960
Seat cushions and back pads fabricated by HMX-1

ANNEX D

MARINE CORPS EQUIPMENT BOARD
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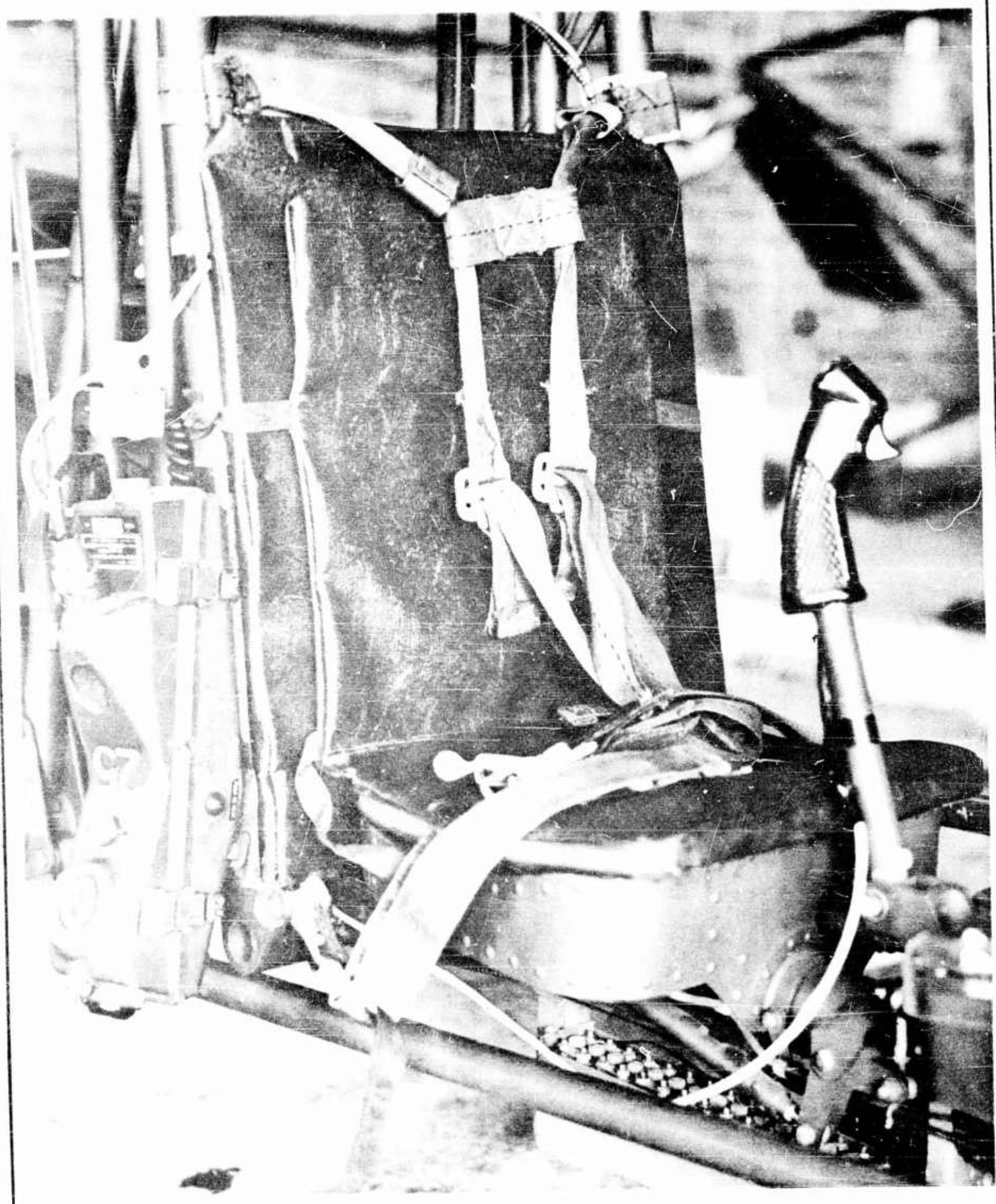

PRC-6 mounted on YRON-1 Rotorcycle

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