FILE COPY

OTTAWA January 25, 1945.

# REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1783.

Investigation of Corrosion Resistance of Lightened Mortar Base Plates and Bipod.

(Copy No. 5.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A January 25, 1945.

# REPORT

of the

## ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1783.

### Investigation of Corrosion Resistance of Lightened Mortar Base Plates and Bipod.

---

**Origin of Request and Object of Investigation:**

On November 27, 1944, a letter (File No. H.Q.S. 8928-11-67, Vol. 3 (DVA); H.Q.S. 46-32-17 (DVA)) was received from Colonel J. L. McAvity, Director of Vehicles and Small Arms, of the Department of National Defence (Army), Ottawa, Ontario, requesting that a corrosion test be performed on two lightened mortar base plates and one lightened mortar bipod to determine the following:

1. The resistance of the metal parts to corrosion conditions, especially conditions in which salt water is the corroding agent.

2. The amount of acceleration produced in the corrosion of the magnesium parts when they are in contact with iron.

3. The amount of protection from this accelerated type of corrosion which can be obtained by chrome-pickling the magnesium surfaces which lie in the neighbourhood of the iron.

The bipod consisted of magnesium, aluminium and iron parts in contact with one another. One base plate was of magnesium and the other of aluminium. The magnesium plate was coated with ordinary khaki-coloured service paint and the aluminium one with a blue-grey paint.

TESTS PERFORMED:

A. Salt Spray Test -

One leg of the bipod was detached and given a chrome-pickle treatment. The rest of it was left untreated. A magnesium collar separated from a brass collar by a non-metallic gasket was also chrome-pickled. A large, threaded piece of iron was then screwed into a hole in the magnesium collar. The circular iron part at the centre of the magnesium base plate was removed and the magnesium surface thus exposed was chrome-pickled. The iron part was then replaced.

All of these parts were placed in the salt spray cabinet and exposed to the action of a spray of 5 per cent salt (sodium chloride) solution for 200 hours at a temperature of 95° F. (35° C.).

Results of Salt Spray Test:

After 5 hours. Considerable rust was observed on the iron parts which were located some distance from the magnesium surfaces; for instance, the greater part of the large threaded piece of iron which was screwed into the magnesium collar.

After 60 hours. The chrome-pickled magnesium surfaces showed some signs of corrosion but much less than the surfaces which had not been treated.

After 200 hours. All magnesium surfaces were corroded badly. Those which were in contact with a small area of iron were in little or no worse condition than the other surfaces, as shown in Figure 9. Those which were in contact with a large area of iron were corroded to a greater extent than other surfaces, as shown in Figure 7. (As mentioned above, a large threaded piece of iron had been screwed into the hole in the magnesium collar before the test began). This phenomenon

(Tests Performed, cont'd) -

could be predicted on the basis of electrochemical principles. Aluminium surfaces on both bipod and base plate were only slightly affected. Those adjacent to iron surfaces were slightly attacked.

The parts were photographed as they came from the salt spray cabinet (Figures 1, 2, 3 and 4). They then were cleaned and photographed again (Figures 5, 6, 7, 8 and 9). The extent of the pitting could be noted much more readily on the cleaned surfaces than on the uncleaned ones.

-

B. Analysis of Castings -

Samples for chemical analysis were taken from the magnesium part of the bipod, the magnesium base plate, and the aluminium base plate.

Results:

The results of the analyses were as follows:

| | Magnesium Base Plate | Magnesium Bipod | Aluminium Base Plate |
|---|---|---|---|
| | | - Per Cent - | |
| Iron - | 0.009 | 0.022 | 0.64 |
| Aluminium - | 6.39 | 6.17 | Remainder. |
| Zinc - | 3.20 | 3.15 | N.D. |
| Manganese - | 0.21 | 0.15 | 0.02 |
| Silicon - | 0.12 | 0.02 | 0.87 |
| Copper - | 0.02 | 0.004 | 4.48 |
| Lead - | 0.03 | N.D. | - |
| Magnesium - | Remainder. | Remainder. | Faint trace. |
| Titanium - | - | - | 0.16 |

N.D. - None detected.

It will be noted that the iron content of the magnesium castings is comparatively high. It is a known fact that even a minute amount of iron will decrease the corrosion resistance of magnesium considerably.

-

(Tests Performed, cont'd) -

C. Microscopic Examination of Corroded Surfaces -

Small samples of magnesium were taken from the pitted surfaces of both bipod and base plate. These were polished, and etched, and examined under the microscope.

Results:

The structure of the metal at and near the pitted surface of the bipod (Figure 12) was the same as that in the interior of the specimen. In the case of the sample from the base plate the metal near the surface was found to be much more porous (Figure 10) than the metal in the interior (Figure 11). It is believed that this porosity is not due to corrosion but to some peculiarity of the casting process.

---

CONCLUSIONS:

The following points were brought out during the test:

1. The khaki-coloured service paint gives little protection to magnesium.
2. Chrome-pickling the magnesium surface delays the corrosion for a short time but does not prevent it.
3. Whether or not the corrosion of magnesium is accelerated by being in contact with iron depends upon the relative areas of the magnesium and iron surfaces exposed to the corroding agent. If the exposed area of magnesium is great compared with that of the iron, then little or no acceleration of the corrosion rate will take place. If, on the

other hand, the exposed area of the iron is great compared with that of the magnesium, a considerable acceleration of rate can be expected.

4. According to our belief, salt water corrosion takes place only on the surface of the metal. Porosity does not appear to be produced below the surface.

It is felt that the magnesium would have been considerably more resistant to the action of the salt spray if the iron content had been below 0.003 per cent. Such material is available at the present time.

A suitable protective coating would prolong the useful life of the magnesium considerably.

It should be pointed out that these mortar parts would be carefully cleaned and oiled at least once per day while in actual service. This would increase the life of the material greatly. Information has been received to the effect that a film of oil is particularly useful in eliminating the accelerated corrosion of magnesium due to contact with iron, even under severe tropical conditions.

FUTURE ACTIVITIES: → Inv. # 1801

A survey is being made to determine the most satisfactory protective coatings for magnesium. Companies which claim to have developed satisfactory coatings are being contacted in an effort to obtain specimens for test.

The following information already has been obtained.

1. Chrome-pickle, though one of the most widely used coatings, is definitely not the best.
2. Metal coatings applied by electroplating,

(Future Activities, cont'd) -

spraying, etc., are dangerous to use because the corrosion of the magnesium is accelerated wherever pores occur in the coating.

3. Useful coatings can be applied by treatment in a chemical solution under pressure in an autoclave. Such coatings possess unusually good resistance to abrasion.

4. Useful coatings can be applied by anodic treatment in chemical solutions.

5. Rubber coatings have been applied to magnesium by electrolytic means. It has been stated that a sample of magnesium coated with rubber and immersed in concentrated hydrochloric acid was unaffected after one year.

The following information is being sought regarding these rubber coatings:

(a) Are they being applied on a large commercial scale or is the process merely a laboratory curiosity at the present time?

(b) What are the operating conditions of the process?

(c) What degree of adherence can be obtained between the rubber coating and the magnesium?

6. For best results, inorganic coatings applied by ordinary chemical methods, pressure methods or anodic methods should be covered by at least two coats of paint. The prime coat should contain zinc chromate pigment as a passivating agent. Such zinc chromate should be carefully made to conform to special specifications. For instance, the total salt content

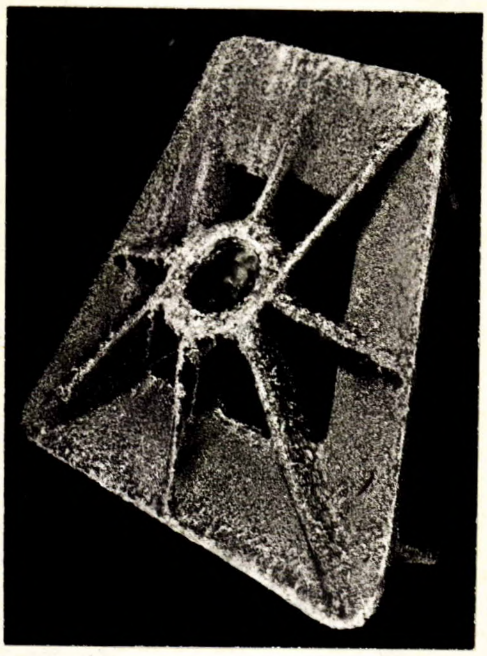
(Future Activities, cont'd) -

(sulphates plus chlorides, etc.) of the zinc chromate should be considerably lower for use on magnesium surfaces than for ordinary uses.

ooooooooooo
ooooo
o

RRR:GHB.

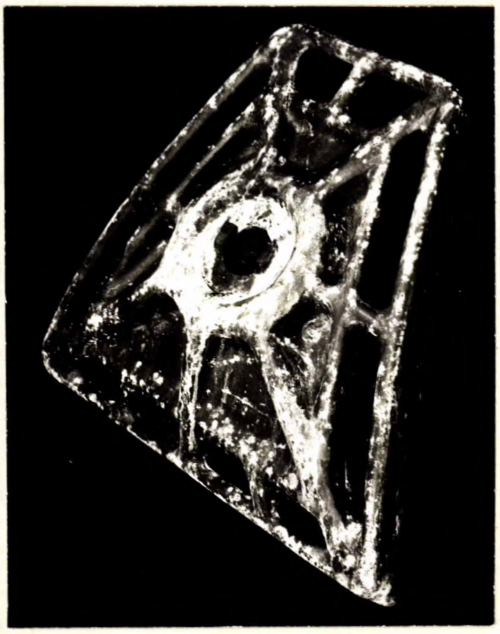
Figure 1.



MAGNESIUM BASE PLATE AFTER 200 HOURS IN THE 5 PER CENT SALT (SODIUM CHLORIDE) SPRAY AT 95° F. (35° C.). UNCLEANED.

-

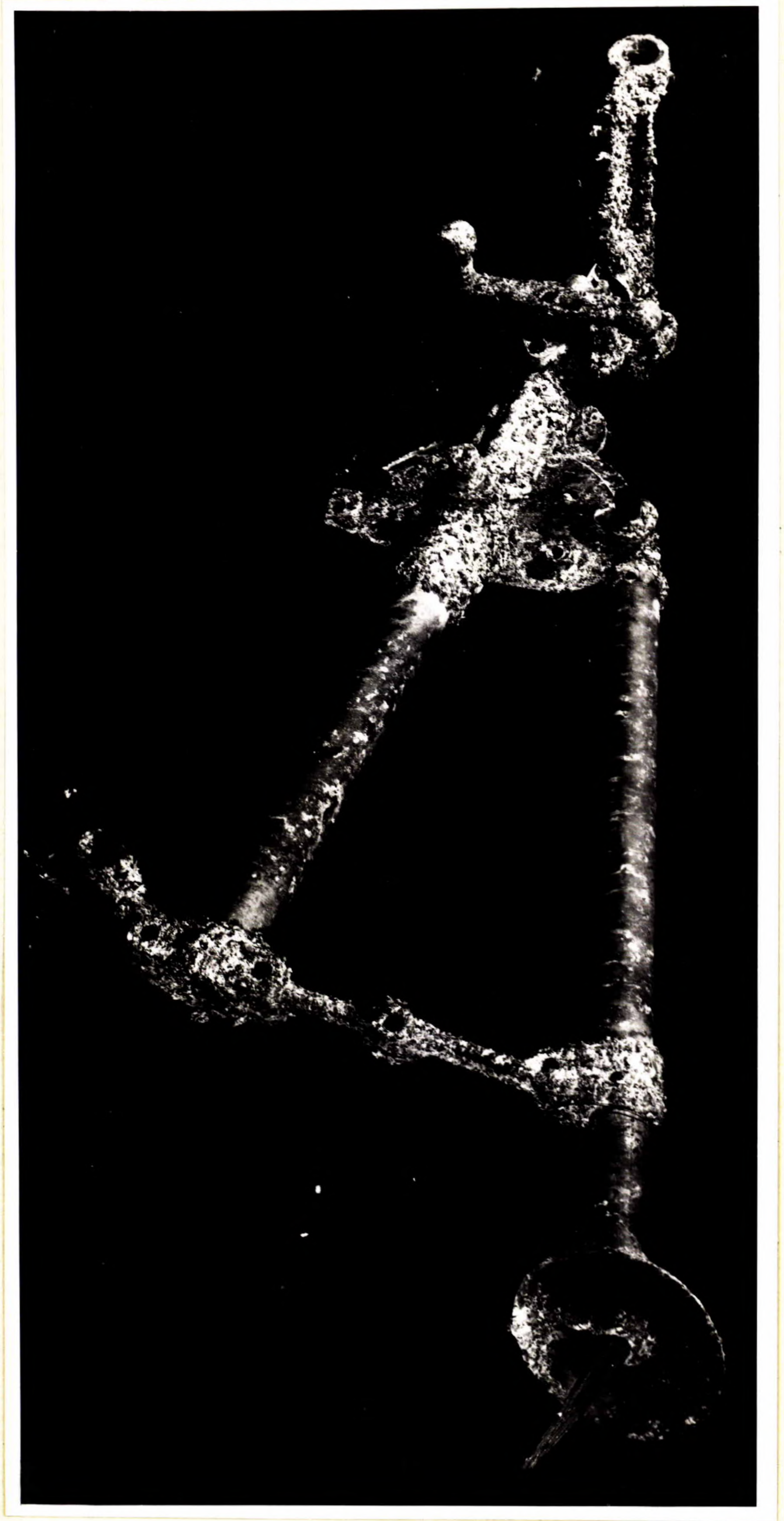
Figure 2.



ALUMINIUM BASE PLATE AFTER 200 HOURS IN THE 5 PER CENT SALT (SODIUM CHLORIDE) SPRAY AT 95° F. (35° C.). UNCLEANED.

-

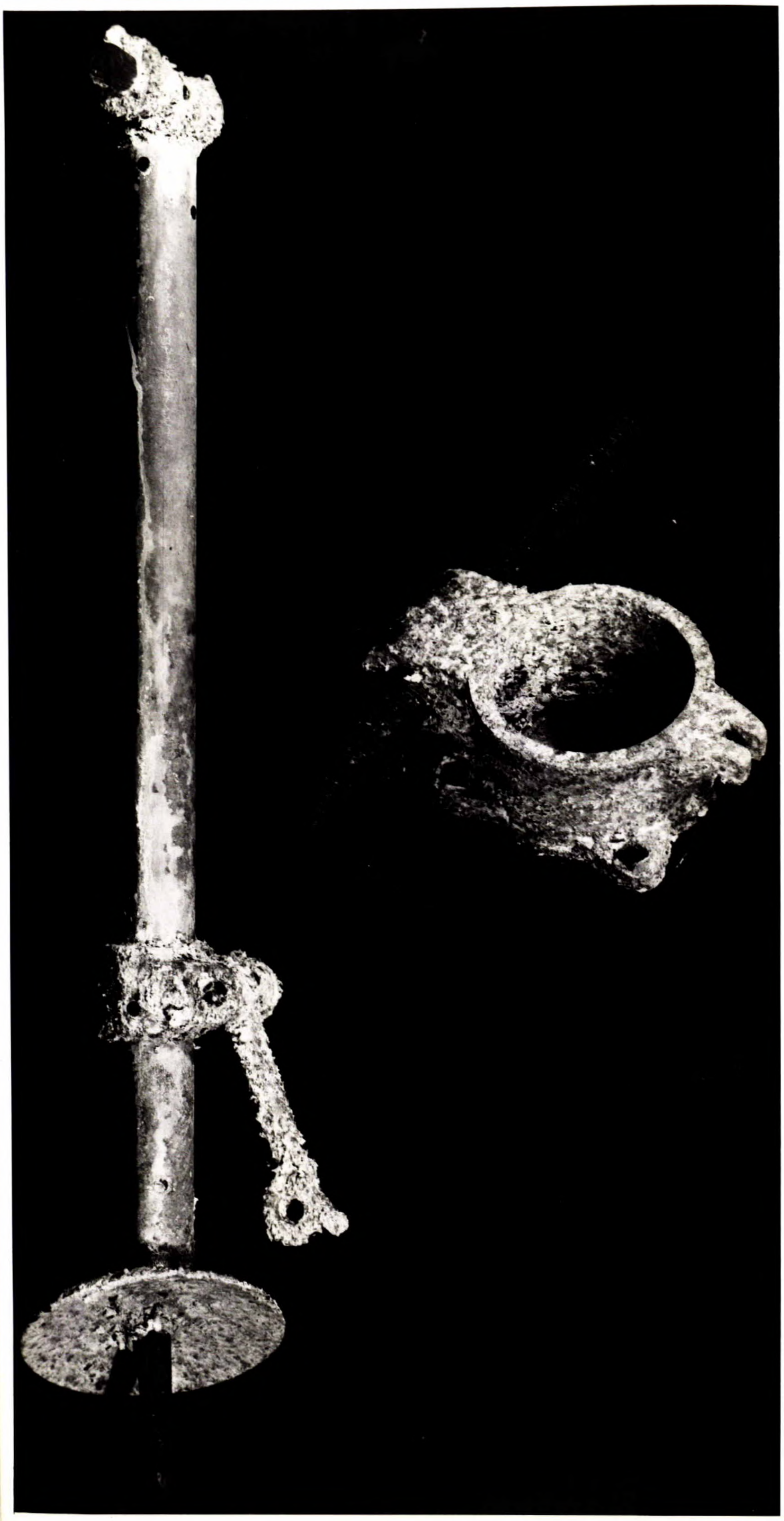
Figure 3.



UNTREATED SECTION OF LIGHTENED BIPOD, CONSISTING OF MAGNESIUM, ALUMINIUM AND IRON PARTS. AFTER 200 HOURS IN THE 5 PER CENT SALT (SODIUM CHLORIDE) SPRAY AT 95° F. (35° C.). UNCLEANED.

The small dark circular parts are of iron, the long cylindrical parts which are comparatively free from corrosion are of aluminium and the badly corroded parts are of magnesium.

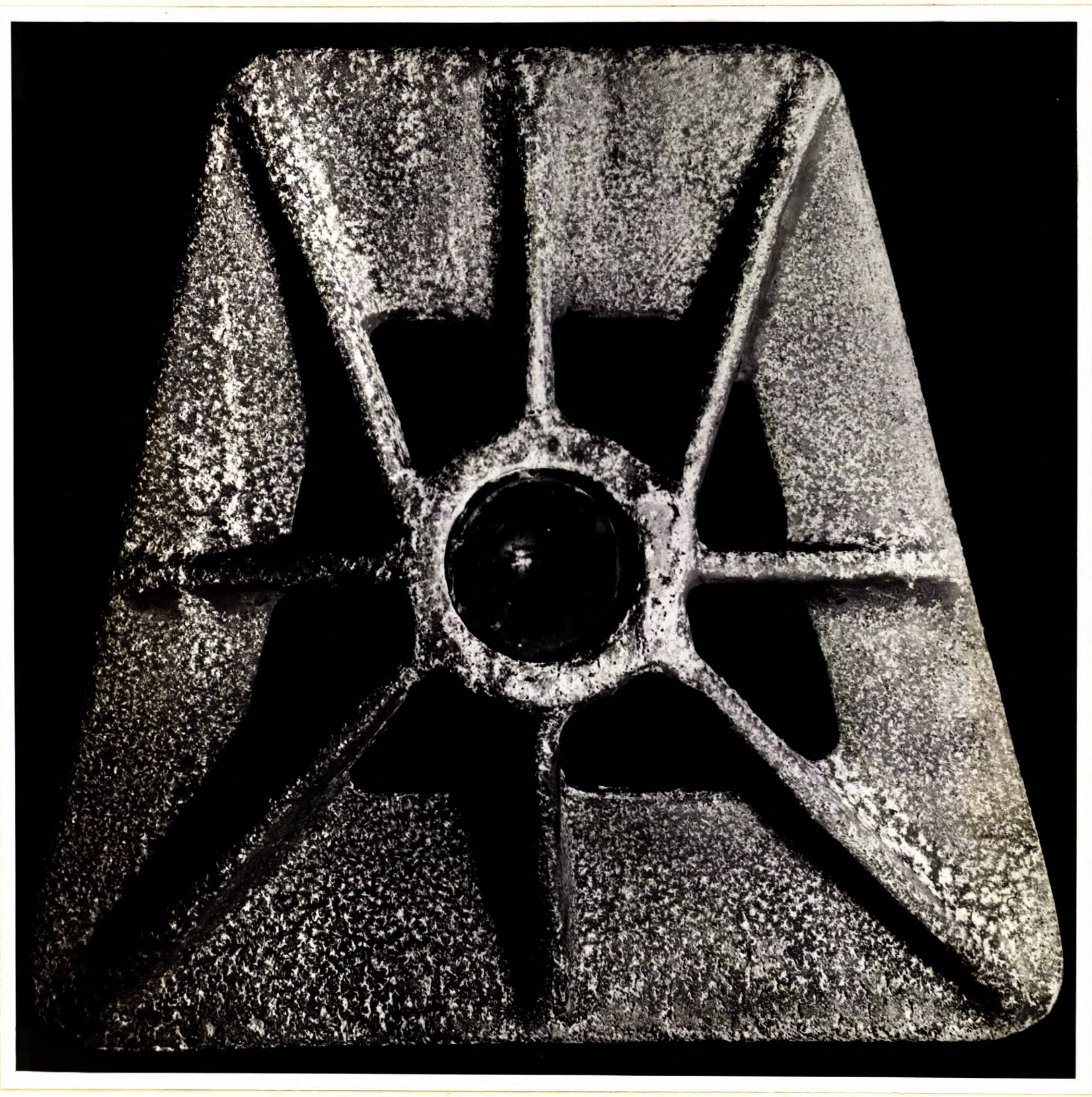
Figure 4.



PARTS OF LIGHTENED BIPOD WHICH WERE CHROME-PICKLED AND THEN SUBJECTED TO 5 PER CENT SALT (SODIUM CHLORIDE) SPRAY FOR 200 HOURS AT 95° F. (35° C.). UNCLEANED.

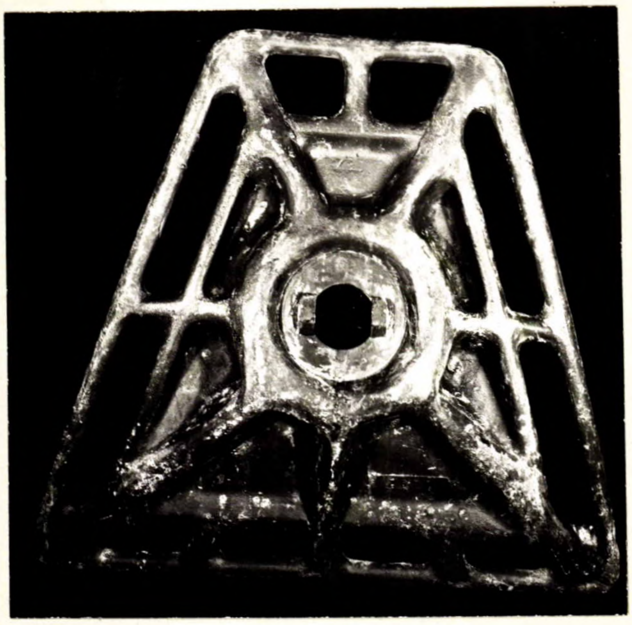
The small dark parts and the large threaded part are of iron, the long cylindrical part is of aluminium, and the badly corroded parts are of magnesium.

Figure 5.



MAGNESIUM BASE PLATE AFTER SALT
SPRAY TREATMENT. CLEANED.

Figure 6.



ALUMINIUM BASE PLATE AFTER SALT SPRAY TREATMENT. CLEANED.

-

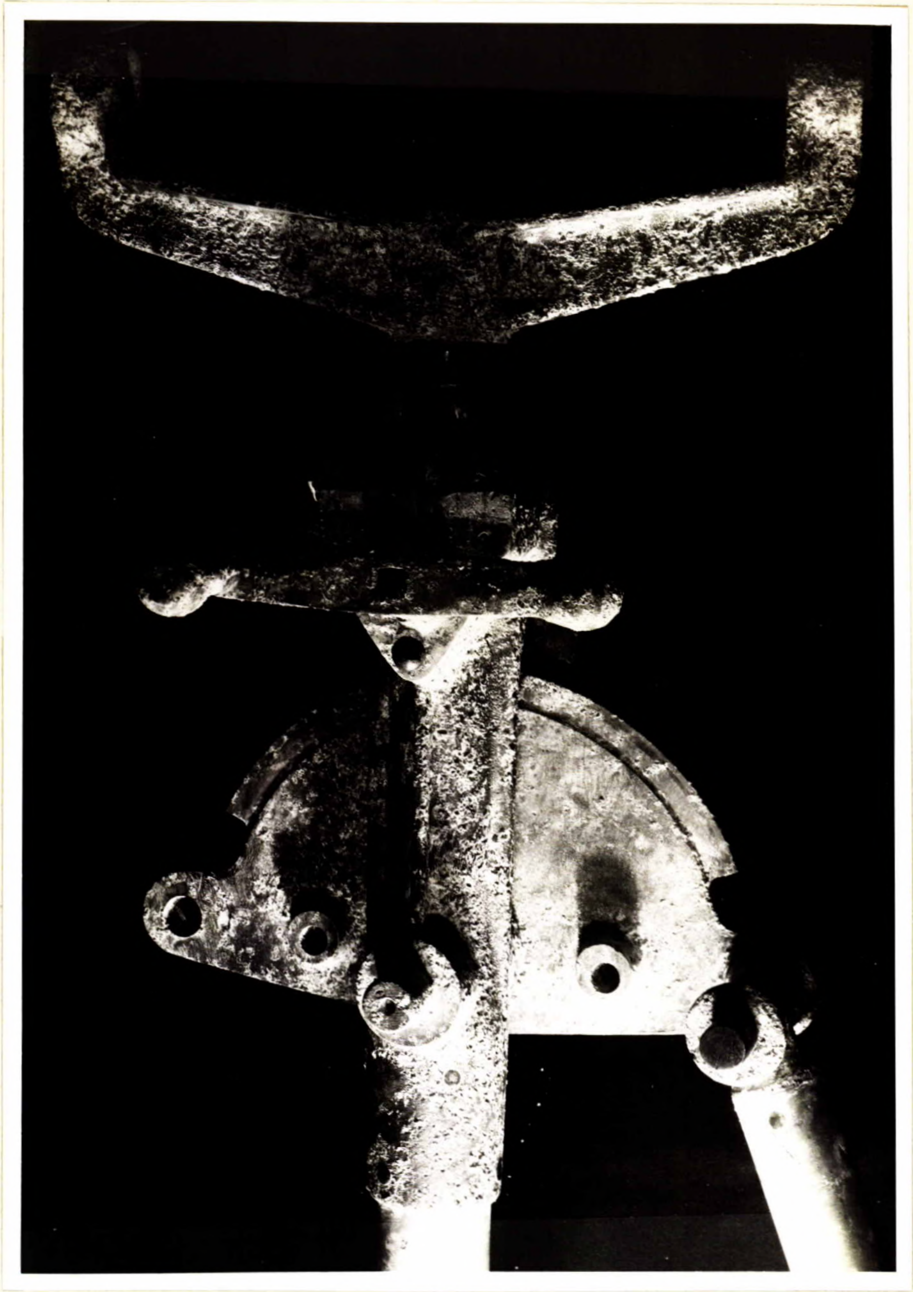
Figure 7.

MAGNESIUM SLEEVE (BOTTOM) BOLTED TO BRASS SLEEVE (TOP) FROM WHICH IT IS SEPARATED BY A NON-METALLIC GASKET. AFTER SALT SPRAY TREATMENT AND CLEANING.

Note the unusually deep pits around the hole in the magnesium sleeve. During the salt spray treatment a large threaded iron part was screwed into this hole.

-

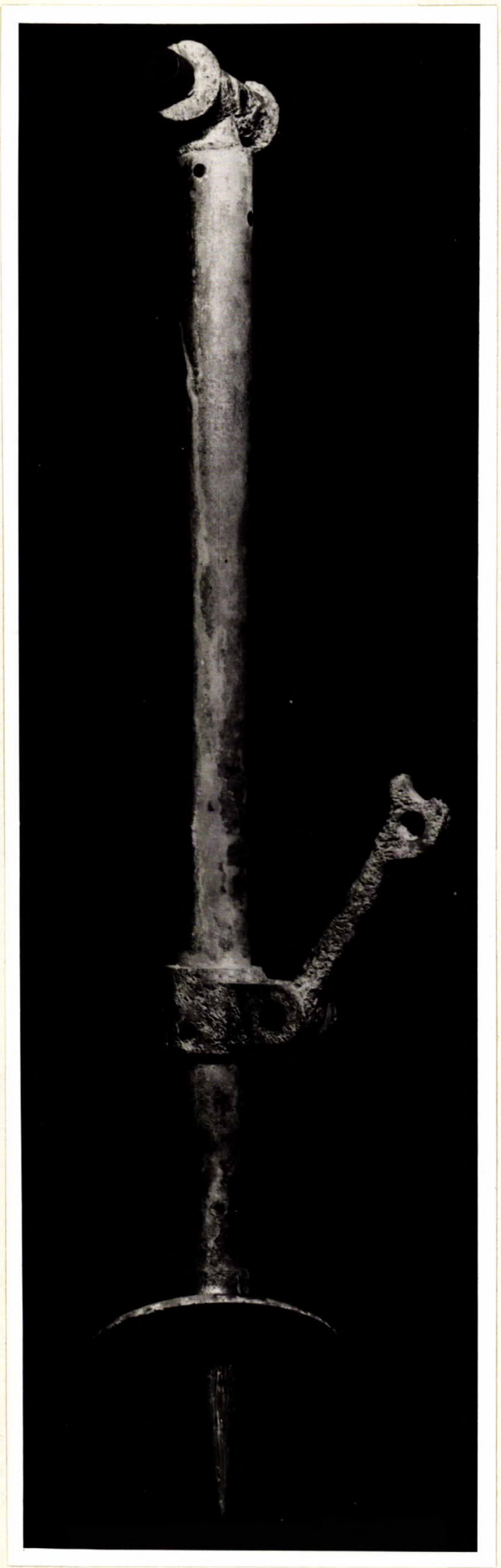
Figure 8.



PART OF THE UNTREATED SECTION OF THE BIPOD SHOWN IN FIGURE 5, AFTER CLEANING.

-

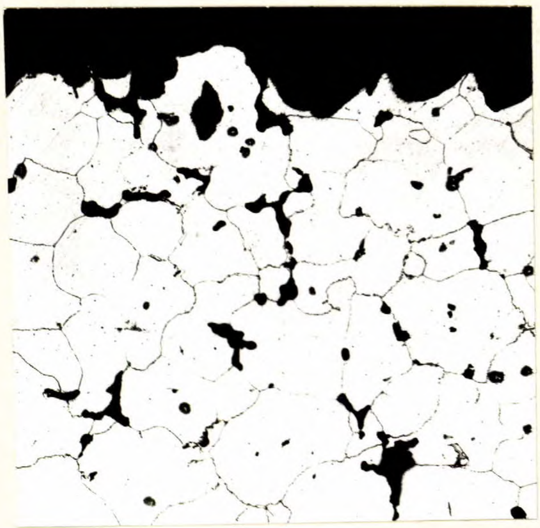
Figure 9.



CHROME-PICKLED SECTION OF THE BIPOD
SHOWN IN FIGURE 4, AFTER CLEANING.

-

Figure 10.

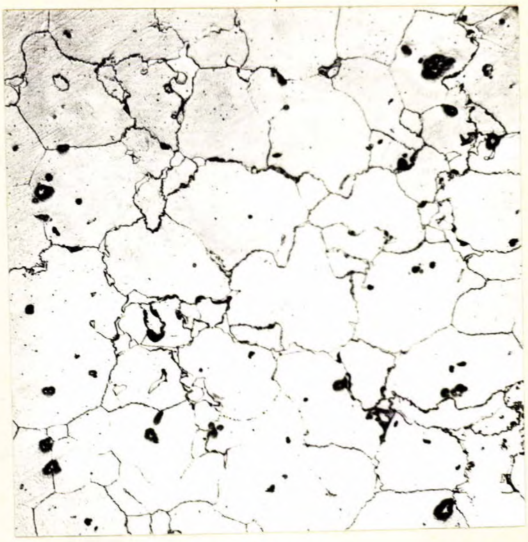


X100.

THE CORRODED SURFACE OF THE MAGNESIUM BASE PLATE AND THE METAL IMMEDIATELY UNDERNEATH.

Note the large cavities underneath the surface.

Figure 11.



X100.

INTERIOR OF THE MAGNESIUM BASE PLATE.

Note the absence of large cavities similar to those which appear in Figure 10.

Figure 12.

X100.

CORRODED SURFACE OF ONE OF THE MAGNESIUM CASTINGS IN THE BIPOD, AND THE METAL IMMEDIATELY UNDERNEATH.

Note the absence of cavities similar to those which appear in Figure 10.

RRR:GHB.