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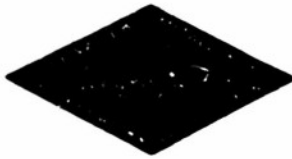
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AMERICAN ELECTRO METAL CORPORATION

YONKERS, NEW YORK



PROGRESS REPORT NO. 5

Contract No. N-ONR-295 (01)

October 2, 1952
to
March 1, 1953

March 11, 1953

Office of Naval Research
Department of the Navy
Washington 25, D. C.

Attention: Mr. Fred C. Weisner, Power Branch

Re: Task Order Nour295 (01)

Gentlemen:

Enclosed please find four copies of our Progress Report No. 5 under the above referenced contract, covering the period from October 2, 1952 to March 1, 1953.

We believe that good progress has been made and that blades will be submitted in the near future for actual tests by NACA.

Comments and criticism of this report would be appreciated.

Yours very truly,

AMERICAN ELECTRO METAL CORPORATION



George Stern
Vice President - Technical Director

GS:ht
Encl-4

cc: Dr. Saul Berman, Office of Naval Research,
Department of the Navy
Washington 25, D. C.

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PROGRESS REPORT NO. 5

Contract No. N-ONR-295(r1)

HOLLOW PERMEABLE TURBINE BUCKETS
SUITABLE FOR TRANSPIRATION COOLING

Progress Made From October 2, 1952 to March 1, 1953

Work Done By:

J. P. Scanlan - Project Leader

Louis Alter - Assistant

Approved By:

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George Stern

GEORGE STERN
Vice President - Technical Director

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HOLLOW PERMEABLE TURBINE BUCKETS SUITABLE FOR TRANSPIRATION COOLING

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This report summarizes the work and findings on hollow permeable stainless steel turbine buckets suitable for transpiration cooling, carried out under Contract N-ONR-295(01) with the Office of Naval Research, from October 2, 1952 to March 1, 1953.

SUMMARY

The major effort during this period has been devoted to the fabrication of molded and sintered turbine buckets. The molding die was received from the Brooklyn Navy Yard, and sintering fixtures were developed to prevent warpage and breakage of the new bucket shape. Experiments to add a supporting member to the blade as recommended by NACA are under way. This is to give additional strength to the blade, and to proportion the air flow to different sections of the airfoil. The coining die is expected from the Brooklyn Navy Yard early in March.

MOLDING DIE

During the latter part of November, the molding die was received from the Brooklyn Navy Yard. Considerable time was spent in gaining experience in the handling of this die and in ironing out the mechanical difficulties. Due to the geometry of the bucket, it was necessary to modify the molding procedure somewhat in order to obtain a satisfactory bucket. The construction and components of the die are shown in detail in photographs nos. 1, 2, 3 and 4.

MOLDING PROCEDURE

A predetermined amount of powder with the incorporated phenolic binder is put into the bottom of the die. The knife is then inserted into the cavity, being held securely in place by the locator. The remaining powder is then poured into the die cavity, the locator removed and the upper punch inserted. Up to this point, the procedure is the same as that developed for fabricating the facsimile bucket.

Because of the geometry of the actual turbine bucket, it became necessary to jog the entire die assembly to eliminate bridging of the powder and to improve the surface finish of the bucket. This is the same procedure as used in the ceramic industry to completely fill molds which have long narrow cavities. This operation is accomplished by assembling it in a spring suspended jig and then jogging the die assembly downwards against a block of steel. The upper punch is removed after this operation, and the die assembly is put into a furnace at 450° F. for 30 minutes to cure the plastic.

After the curing of the thermo-setting plastic, the knife is extracted from the die. The die is removed from the nest by putting a block of steel in the bottom hole of the nest and then exerting pressure on the rim. After the die is removed from the nest, the molded and cured bucket can be removed. Machining operations can now be performed on the base of the bucket without any difficulty.

SINTERING

The sintering procedure is identical with that which was developed for the facsimile bucket. The bucket is heated to 2280° F. for 80 minutes in hydrogen in a gettered boat. It is allowed to cool to room temperature in the water cooled chamber of the furnace.

Early sintering experiments with this new type bucket resulted in cracking of the airfoil section. It was found necessary to develop sintering fixtures to eliminate this condition. A cradle was machined from a high temperature refractory brick to conform to the convex section of the bucket and its adjoining root section. This fixture lent support to the bucket during the sintering operation and thus eliminated cracks and warping.

In photographs nos. 5 and 6 are shown molded and sintered turbine buckets made from type 316 stainless steel powder. In photograph no. 6 the bucket has been sectioned and outlined to show the hollow construction.

NACA STRUT SUPPORTED BUCKET

In the early part of January 1953, a meeting was held at the NACA Laboratories in Cleveland to acquaint us with the findings on transpiration cooled buckets and engines. As a result of this meeting it was thought by NACA that the bucket should be augmented by adding internal struts. This was to perform two functions, first to add structural strength to the bucket and second, to preferentially distribute the air to various sections of the airfoil. NACA has been working on a strutted skeleton bucket which is covered with a skin of rolled wire cloth.

Some preliminary experiments have been carried out at AEMC, using rolled wire cloth as the skeleton structure. Although these experiments were not completely successful, it was found that by careful fabrication and annealing of the skeleton structure it was possible to incorporate it into the molded bucket. During sintering, cracks occurred in the airfoil section of the bucket. This was attributed both to the weave of the wire cloth and the method of fabrication. However, the results were encouraging enough to warrant further work. A perforated sheet 0.011" thick, having 331 holes to the square inch, each hole 0.033" in diameter, has been obtained and will be fabricated to fit over the knife. This structure will then be molded into the bucket.

Along with the idea of incorporating a skeleton structure in the molded bucket, work will be done to partially infiltrate the root section of the bucket with copper to gain added strength in the area where the airfoil and root sections meet.

The coining die is nearing completion at the Brooklyn Navy Yard and delivery is expected early in March.

FUTURE WORK

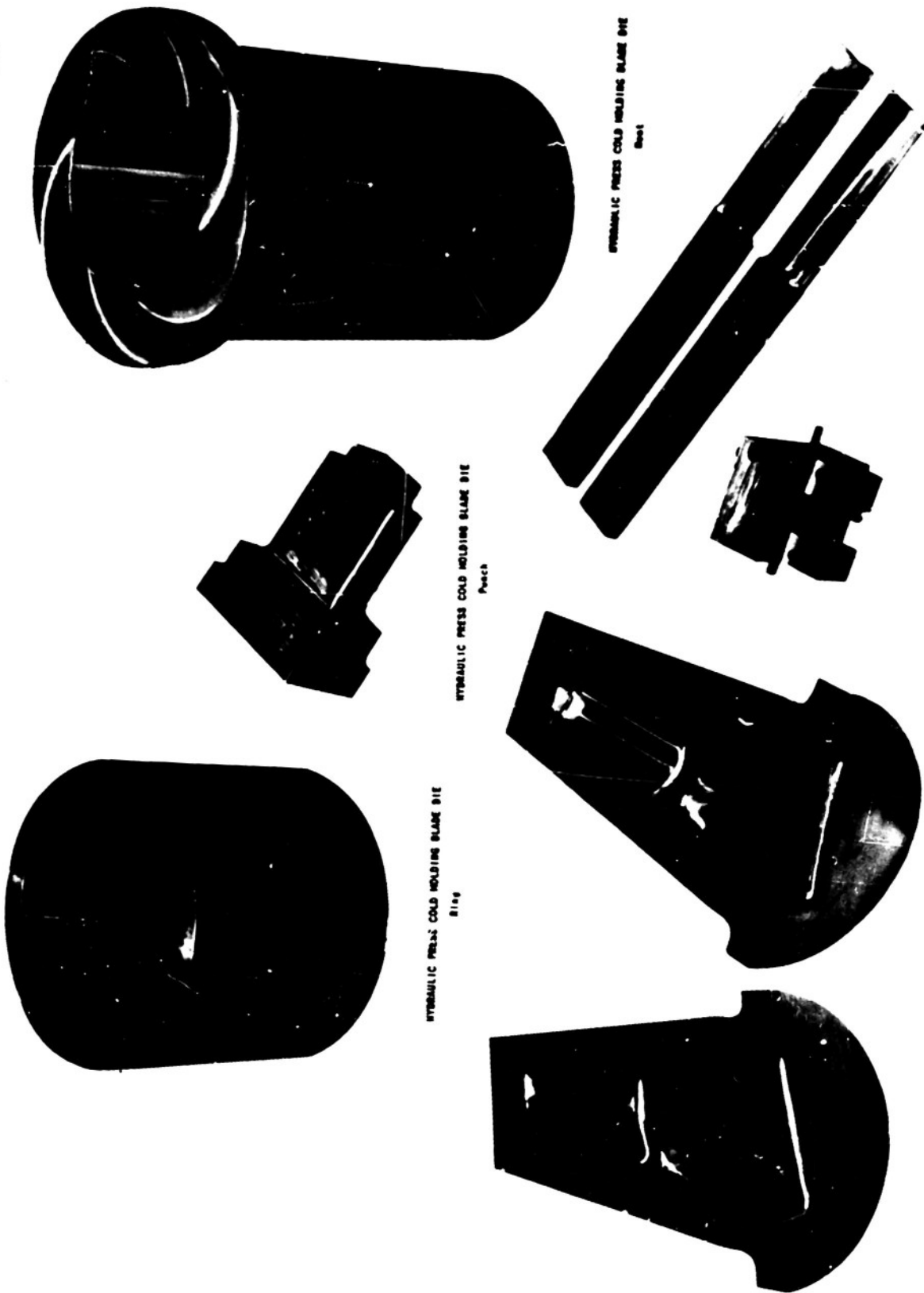
Future work will be concerned with the following:

1. Making a sufficient number of molded and sintered buckets for coining experiments and for testing by NACA.
2. Continuation of the work on incorporating a supporting skeleton structure in the bucket.
3. Development of techniques to infiltrate the root section of bucket for added strength in that area.
4. Study of physical properties--vacuum sintering and gettered sintering.
5. Vacuum sintering of turbine buckets.

ACKNOWLEDGMENT

We sincerely wish to express our appreciation to the personnel of the New York Naval Shipyard, Brooklyn, New York, for their assistance and cooperation in the fabrication of the molding and coining dies for the turbine bucket.

We also wish to credit the staff of the New York Naval Shipyard for the excellent photography in the report.

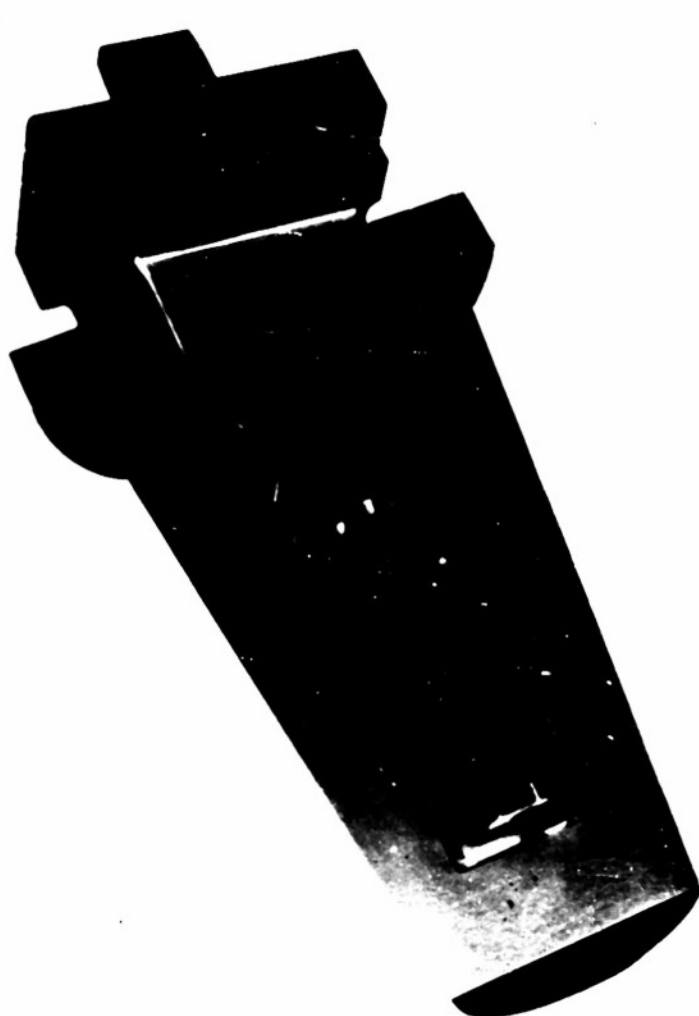


PHOTOGRAPH NO. 1

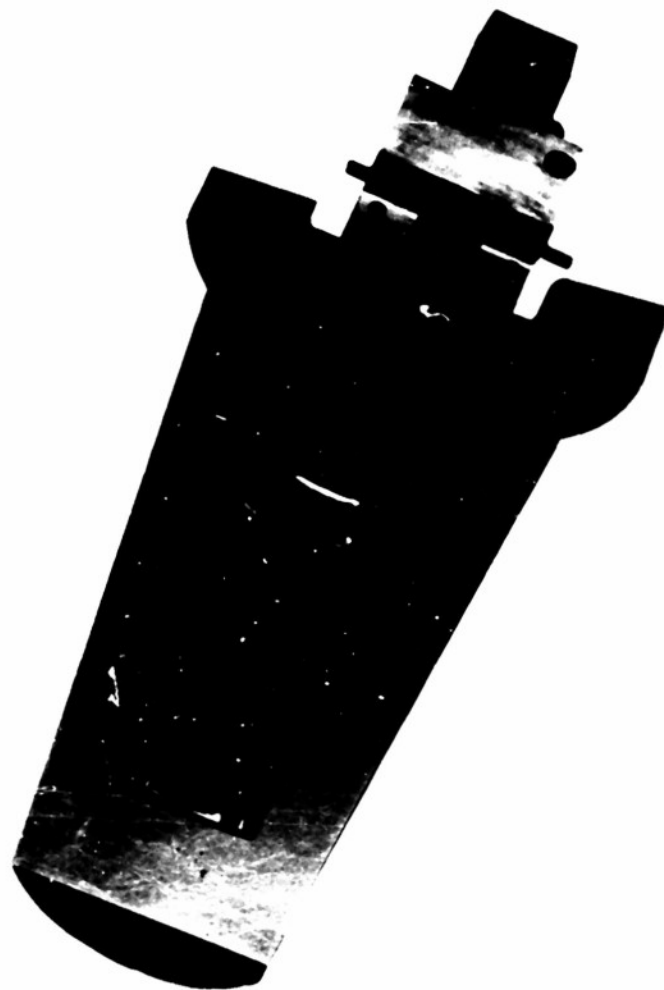
HYDRAULIC PRESS COLD HOLDING BLADE DIE
 Die
 NEW YORK NAVAL SHIPYARD, NAVAL BASE, BROOKLYN 1, N. Y.
 NY3-1601(L)-10-52
 FARM IN WORK AMERICAN ELECTRO METAL CORPORATION
 SHOP 06. YONKERS, N. Y.
 MOLDING DIE FOR TRANSPIRATION COOLED TURBINE BUCKET.
 ONR CONTRACT #NONR-295-01. ONR PROJECT NO. 29785.

HYDRAULIC PRESS COLD HOLDING BLADE DIE
 Core Bar Locator
 NEW YORK NAVAL SHIPYARD, NAVAL BASE, BROOKLYN 1, N. Y.
 NY3-1601(L)-10-52
 FARM IN WORK AMERICAN ELECTRO METAL CORPORATION
 SHOP 06. YONKERS, N. Y.
 MOLDING DIE FOR TRANSPIRATION COOLED TURBINE BUCKET.
 ONR CONTRACT #NONR-295-01. ONR PROJECT NO. 29785.

HYDRAULIC PRESS COLD HOLDING BLADE DIE
 Core Blade clamping both sides
 NEW YORK NAVAL SHIPYARD, NAVAL BASE, BROOKLYN 1, N. Y.
 NY3-1601(L)-10-52
 FARM IN WORK AMERICAN ELECTRO METAL CORPORATION
 SHOP 06. YONKERS, N. Y.
 MOLDING DIE FOR TRANSPIRATION COOLED TURBINE BUCKET.
 ONR CONTRACT #NONR-295-01. ONR PROJECT NO. 29785.



HYDRAULIC PRESS COLD MOLDING BLADE DIE
(assembled with Punch & Core Rod)



HYDRAULIC PRESS COLD MOLDING BLADE DIE
(assembled with Core Rod & Locator)

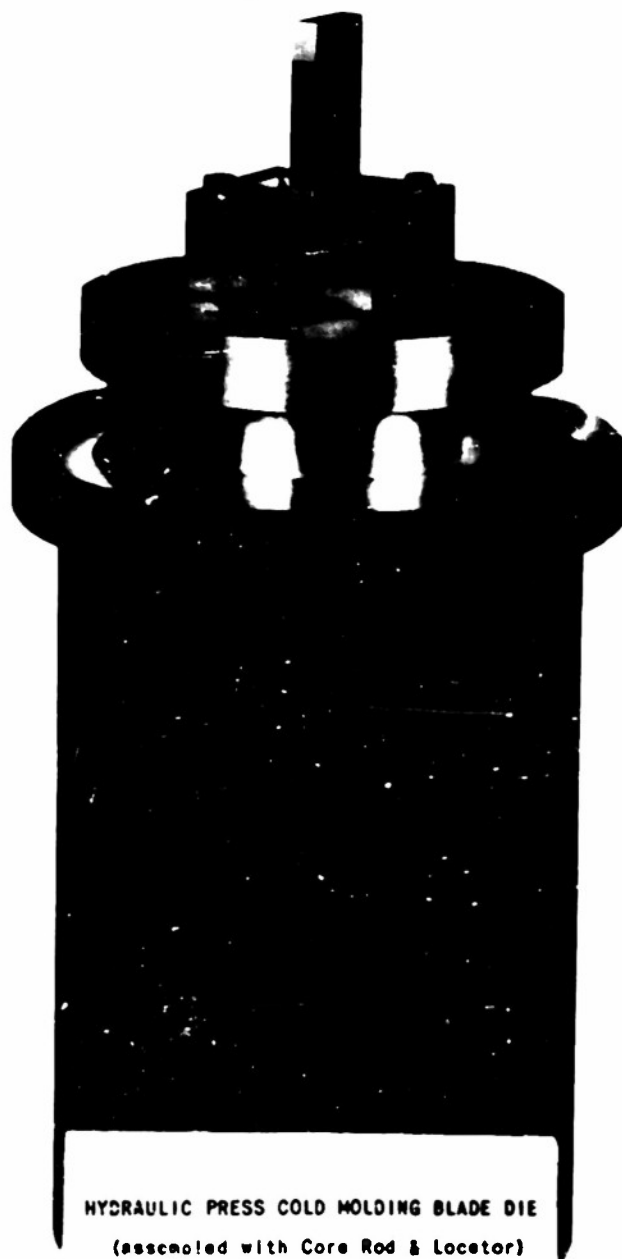
NEW YORK NAVAL SHIPYARD, NAVAL BASE, BROOKLYN 1, N. Y.
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HYDRAULIC PRESS COLD MOLDING BLADE DIE
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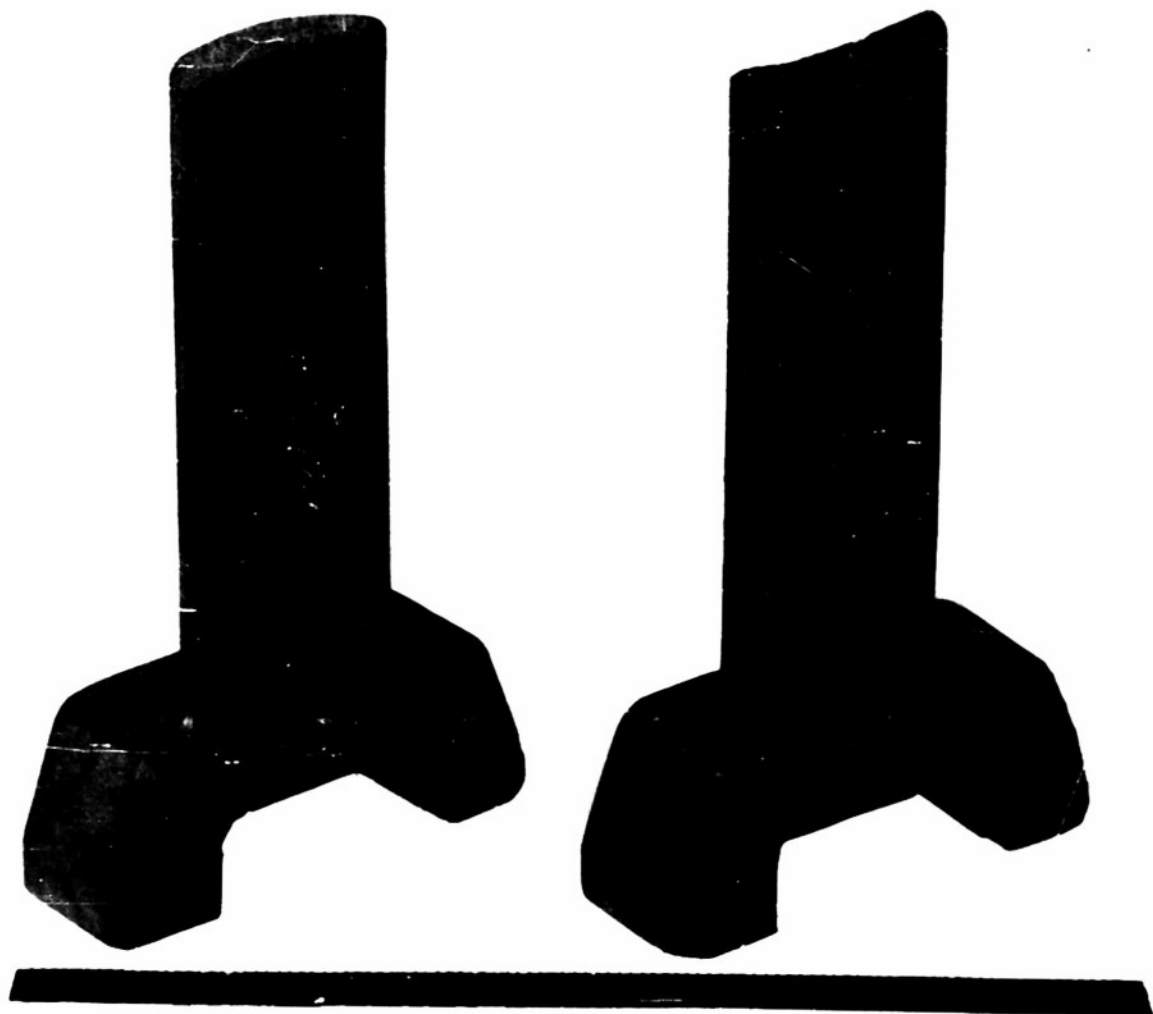
PHOTOGRAPH NO. 3



NEW YORK NAVAL SHIPYARD, NAVAL BASE, BROOKLYN 1, N. Y.
NY3-1603(L)-10-52 20 OCTOBER 1952
FARM IN WORK AMERICAN ELECTRO METAL CORPORATION
SHOP 06. YONKERS, N. Y.
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ONR CONTRACT #NONR-295-01. ONR PROJECT NO. 29785.

PHOTOGRAPH NO. 4

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PHOTOGRAPH NO. 5
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PHOTOGRAPH NO. 6

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