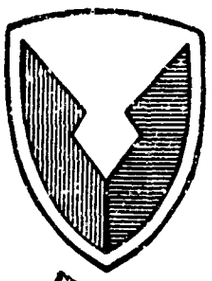

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CCL REPORT NO. 238

FINAL REPORT

SINTERED IRON BRAKE CYLINDER PISTONS
FINAL RESULTS OF LABORATORY AND FIELD TESTS

BY

CHARLES B. JORDAN

NOVEMBER 1967

U. S. ARMY COATING & CHEMICAL LABORATORY
Aberdeen Proving Ground
Maryland

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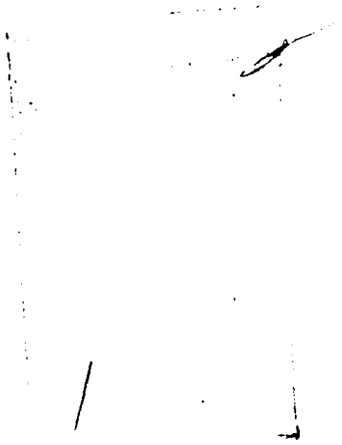

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SINTERED IRON BRAKE CYLINDER PISTONS
FINAL RESULTS OF LABORATORY AND FIELD TESTS

BY

CHARLES B. JORDAN

NOVEMBER 1967

AMCMS CODE NO. 5025.11.802

DEPARTMENT OF THE ARMY PROJECT NO.
1C024401A108

U.S. ARMY COATING AND CHEMICAL LABORATORY
ABERDEEN PROVING GROUND
MARYLAND

ABSTRACT

A four year study of sintered iron brake wheel cylinder pistons versus aluminum pistons was conducted. Laboratory, static, and operational field tests were run.

Corrosion was eliminated and gumming was greatly reduced in all cylinders containing sintered iron pistons. In operation, wear was diminished and the volume of sediment which formed in the brake system was greatly reduced.

TABLE OF CONTENTS

I. INTRODUCTION

Aberdeen Proving Ground, Maryland, was authorized by AMC Directive AMCMS Code 5025.11.802 dated 1 August 1966 to conduct research on hydraulic brake fluids.

One facet to be considered during the development of brake fluids is their compatibility with brake system components. The brake system of automotive vehicles contains several dissimilar metals which promote galvanic chemical action. Subsequently, the brake fluids oxidize and cause corrosion and gum formation inside the brake cylinders. The removal of one of the more reactive metals from the system decreases the galvanic action. So the replacement of aluminum pistons by sintered iron pistons should theoretically reduce brake fluid oxidation, corrosive action, and gum formation.

A previous report, CCL Report No. 216, dated November 1966 gave the results of a preliminary investigation of sintered iron pistons. Other tests which were in progress at that time have been completed. This report contains the results of these tests.

II. DETAILS OF TEST

A. Sintered Iron Pistons

The sintered iron pistons for all tests were supplied by the Delco Moraine Division of GMC. These pistons are made from iron powder and small quantities of Babbit. They are compressed and sintered to a Brinell hardness of about 85-95, approximately the hardness of standard aluminum pistons. They have a porosity of about 20%. They are then impregnated with an inhibited synthetic preservative lubricant of the polyoxyglycol type. This material exudes and supplies lubrication as well as increased corrosion protection. It is compatible with conventional brake fluids. Pistons ranging in size from 3/4-inch to 1-3/8 inch were tested in this program.

B. Tests Conducted

(1) Packaging Tests. Brake cylinders containing sintered iron pistons were packaged with different brake fluids and stored in an unheated warehouse. Duplicate cylinders were packaged with aluminum pistons. Periodic examinations were made by removing the right hand piston from each cylinder and replacing it after examination. If a cylinder showed excessive corrosion or gumming, it was removed from test. After four years storage, the cylinders were disassembled and photographed. Fluids used in this test included those meeting Federal Specification VV-B-680, Military Specification MIL-H-13910, and Military Specification MIL-P-46046.

(2) Simulated Standby Storage Tests. This series of tests involved the use of systems simulating vehicle brake systems, in the open and subjected to weather and temperature conditions prevalent in this locality. Corrosion and gumming of brake parts correlates with that found in vehicles on standby storage or in a prepositioned status. Each system consists of one master cylinder and two wheel cylinders. Duplicate tests were run on cylinders containing sintered iron pistons and aluminum pistons. Fluids used in this series of tests included an operational fluid meeting Federal Specification VV-B-680 and a limited operational preservative fluid meeting Military Specification MIL-P-46046. Periodic inspections were made by opening the boot of one wheel cylinder in each test. After a 12 month period, one wheel cylinder in each system was removed, completely disassembled, examined, and photographed.

(3) Stroking Tests. Stroking tests were conducted on equipment specified in Method 361 of Federal Test Method Standard No. 791. The tests were run at 158°F. and 500 psi for 300,000 strokes. Six different operational brake fluids were stroked. Comparative tests were conducted with sintered iron wheel cylinder pistons and aluminum pistons.

(4) Operational Field Tests. Test brake cylinders were installed on facility vehicles at Yuma Proving Ground, Arizona. Included in the test were 1/4-ton, 3/4-ton, and 2-1/2 ton vehicles. Comparative tests were conducted on sintered iron wheel cylinder pistons and aluminum pistons. All other brake components were flushed and filled with all-weather brake fluid meeting MIL-H-13910A. Each vehicle was examined monthly for fluid leaks or brake malfunction. Brake applications and mileage figures were recorded.

After one year's service, one cylinder from each vehicle was removed, examined, photographed, and reinstalled on the vehicle. The test was terminated after two year's service. All cylinders were removed and forwarded to C&CL for evaluation.

III. RESULTS OF TESTS

A. Packaging Tests

Inspections in this series through three years were reported in CCL Report No. 216. Results of the four year inspection are included in Table I. All cylinders containing operational fluids and aluminum pistons were removed after two years due to their inoperable condition. After four years, moderate gum deposits and slight stains were found in the cylinders containing aluminum pistons and MIL-P-46046 fluids. All cylinders containing sintered iron pistons were still operable and contained very little gum and no corrosion, after four years, with both operational and preservative fluids.

B. Simulated Standby Storage Tests

The results of the 12 month inspection are included in Table II and are shown in Photographs 1 and 2. It was found that the use of sintered iron reduced or eliminated stain, corrosion, and gum formation regardless of the fluid used. In the case where an operational fluid was stored with cylinders containing aluminum pistons, the pistons could not be manually removed; the cylinders were inoperable.

C. Stroking Tests

The results of stroking tests were reported in CCL Report No. 216. All fluids tested with sintered iron pistons passed specification requirements. Metal parts showed less wear and residual fluid showed less sedimentation than that formed in tests with aluminum pistons.

D. Operational Field Tests

Results of the one year inspection of the cylinders in operational tests at Yuma Proving Ground were reported in CCL Report No. 216. The results of the two year inspection are included in Table III. All cylinders containing sintered iron pistons were in excellent condition. Very little gumming and no corrosion occurred. There were no operational malfunctions during the test. The cylinders containing aluminum pistons performed satisfactorily. However, there was evidence of corrosion and slight to moderate deposits in most of these cylinders. Those containing sintered iron were rated definitely superior. For visual comparison of results, see photographs 3 and 4.

IV. CONCLUSIONS

Sintered iron brake cylinder pistons impregnated with a properly inhibited base lubricant reduces or eliminates corrosion, staining, and gumming of brake cylinders in warehouse storage, standby storage, and operational situations. Metal wear is diminished and sediment in the brake system is greatly reduced. All systems containing sintered iron pistons were superior to those containing aluminum pistons.

The use of sintered iron pistons in military vehicle brake systems will greatly improve packaging and storing of brake parts and will allow prepositioning of vehicles for much longer periods of time with operational brake fluids in the system. This advance, coupled with improved rubber cups (specifically ethylene-propylene cups now in the final stages of development) would virtually eliminate the serious problem of corrosion and gumming in storage which has plagued both the military and civilian population for many years. Brake system maintenance would be less frequent and brake malfunction reduced.

Sintered iron pistons are available and cost no more than anodized aluminum pistons. They have been supplied and tested in all sizes from

3/4-inch to 1-3/8 inch, and no difficulty is foreseen in larger sizes. They have been used in all GMC vehicles for 3 years and GMC has reported that their performance has been superior.

V. RECOMMENDATIONS

It is recommended that aluminum pistons in the brake wheel cylinders of all military vehicles be replaced with sintered iron pistons in the earliest possible time-frame.

VI. REFERENCES

1. Authority: AMC Directive, AMCMS Code 5025.11.802 dated 1 August 1966.

2. Federal Specification VV-B-680, Brake Fluid Automotive, dated 15 December 1964.

3. Military Specification MIL-H-13910A, Hydraulic Fluid, Non-Petroleum Base, Automotive Brake, All-Weather, dated 15 May 1963.

4. Military Specification MIL-P-46046, Preservative Fluid, Automotive Brake System and Components, dated 26 August 1964.

5. CCL Report No. 216, Sintered Iron Brake Cylinder Pistons, dated November 1966.

6. Federal Test Method Standard No. 791, dated 1 July 1965.

APPENDIX A

TABLE I

Warehouse Packaging and Storage of Brake Wheel Cylinders
Sintered Iron VS Aluminum Pistons

Four Year Inspection

	Fluid	Sintered Iron Pistons	Aluminum Pistons
1.	VV-B-680	Slight Stain, no corrosion, moderate greasy deposits	Frozen - Discontinued after 2 years
2.	MIL-H-13910A (Reference Formulation)	Very slight stain, no corrosion, slight greasy deposits	Frozen - Discontinued after 2 years
3.	MIL-H-13910A (Commercial)	Slight stain, no corrosion, slight greasy deposits	Frozen - Discontinued after 2 years
4.	MIL-P-46046 (Compositon 3)	No stain or corrosion very slight deposits	Moderate stain, Moderate gum deposits, slight rust on cylinder wall

TABLE II

Simulated Standby Storage for Brake Wheel Cylinders
Sintered Iron VS Aluminum Pistons

12 Month Inspection

Fluid Tested	Sintered Iron Pistons	Aluminum Pistons
Operational Fluid VV-B-680	Slight stains, no gum or corrosion (operable)	Heavy deposits - both pistons frozen Cylinder wall - severe stain and etching (inoperable)
Preservative Fluid MIL-P-46046 (Composition 1)	No stains, gum, or corrosion (operable)	Slight stain, slight deposits, very slight rusting (operable)

TABLE III

Final (Two Year) Brake Cylinder Inspection Data
Operational Field Test - Yuma Proving Ground
Sintered Iron VS Aluminum Pistons

Vehicle	USA Reg No.	No. Brake Appl	No. Test Miles	Remarks
Cast Iron Cylinders with Sintered Iron Pistons				
M151	2F5821	38,117	13,225	Right Front Cylinder One piston had slight dry deposits, no corrosion Brake cups were in good condition Cylinder walls were free of corrosion with moderate moist deposits away from piston area in center of cylinder Left Front Cylinder Pistons had very slight dry deposits Brake cups were in good condition Cylinder walls were free of corrosion and deposits Slight sand in center of cylinder away from piston area Right Rear Cylinder Pistons were free of corrosion and deposits Brake cups were in good condition Cylinder walls had normal wear and no corrosion or deposits Left Rear Cylinder Same as right rear cylinder

TABLE III (Continued)

Vehicle	USA Reg No.	No. Brake Appl	No. Test Miles	Remarks
Cast Iron Cylinders with Sintered Iron Pistons				
M37	3C1257	55,225	15,668	Right Front Cylinder Pistons had very slight dry deposits; no corrosion Brake cups were in good condition Cylinder walls had normal wear areas with no deposits or corrosion Left Front Cylinder Pistons had slight dry deposits; no corrosion Brake cups were in good condition Cylinder walls had slight deposits; normal wear; no corrosion Right Rear Cylinder Pistons had slight dry deposits Brake cups were in good condition Cylinder walls had slight dry deposits; cylinder boots were full of dry sandy deposits; no sand inside cylinder Left Rear Cylinder Pistons had slight dry deposits; heavy deposits between pistons and cylinder boots Brake cups were in good condition Cylinder walls had slight dry deposits; no corrosion

TABLE III (Continued)

Vehicle	USA Reg No.	No. Brake Appl	No. Test Miles	Remarks
Cast Iron Cylinders with Sintered Iron Pistons				
M35	4C9839	11,431	4,727	Right Front Cylinder Pistons were free of deposits, pitting or corrosion Brake cups were in good condition Cylinder walls had slight deposits in center of cylinder between pistons; no corrosion Left Front Cylinder Right Intermediate Cylinder Left Intermediate Cylinder Right Rear Cylinder Left Rear Cylinder Same as right front cylinder
Cast Iron Cylinders with Aluminum Pistons				
M37	3C1255	88,839	16,236	Right Front Cylinder Pistons had very slight corrosion and deposits Brake cups were in good condition Cylinder walls had slight deposits and slightly rusted areas Left Front Cylinder Pistons had very slight deposits; no corrosion Brake cups were in good condition Cylinder walls were free of corrosion; slight deposits in area away from piston

TABLE III (Continued)

Vehicle	USA Reg No.	No. Brake Appl	No. Test Miles	Remarks
M37 (Cont)				Right Rear Cylinder Pistons had very slight deposits Brake cups were in good condition Cylinder walls had slight rust and slight dry deposits Left Rear Cylinder Pistons had slight stain and slight moist deposits Brake cups were in good condition Cylinder walls had slight rust and slight deposits
Cast Iron Cylinders with Aluminum Pistons				
M49	8015824	14,780	5,702	Right Front Cylinder Pistons had moderate dry deposits; slight pitting underneath deposits Brake cups were in good condition Cylinder walls had slight deposits; no corrosion Left Front Cylinder Pistons had moderate deposits; slight pitting on smooth surface of pistons Brake cups were in good condition Cylinder walls had slight deposits; no corrosion Right Intermediate Cylinder Pistons had slight dry deposits; no corrosion Brake cups were in good condition Cylinder walls had very slight deposits; no corrosion

TABLE III (Continued)

Vehicle	USA Reg No.	No. Brake Appl	No. Test Miles	Remarks
M49 (Cont)				Left Intermediate Cylinder Pistons had slight deposits; very slight pitting Brake cups were in good condition Cylinder walls had slight deposits; very slight pitting Right Rear Cylinder Pistons had slight deposits; slight pitting on smooth surface Brake cups were in good condition Cylinder walls had very slight deposits; no corrosion Left Rear Cylinder Pistons had moderate dry deposits; very slight pitting on smooth surface Brake cups were in good condition Cylinder walls had very slight deposits; no corrosion

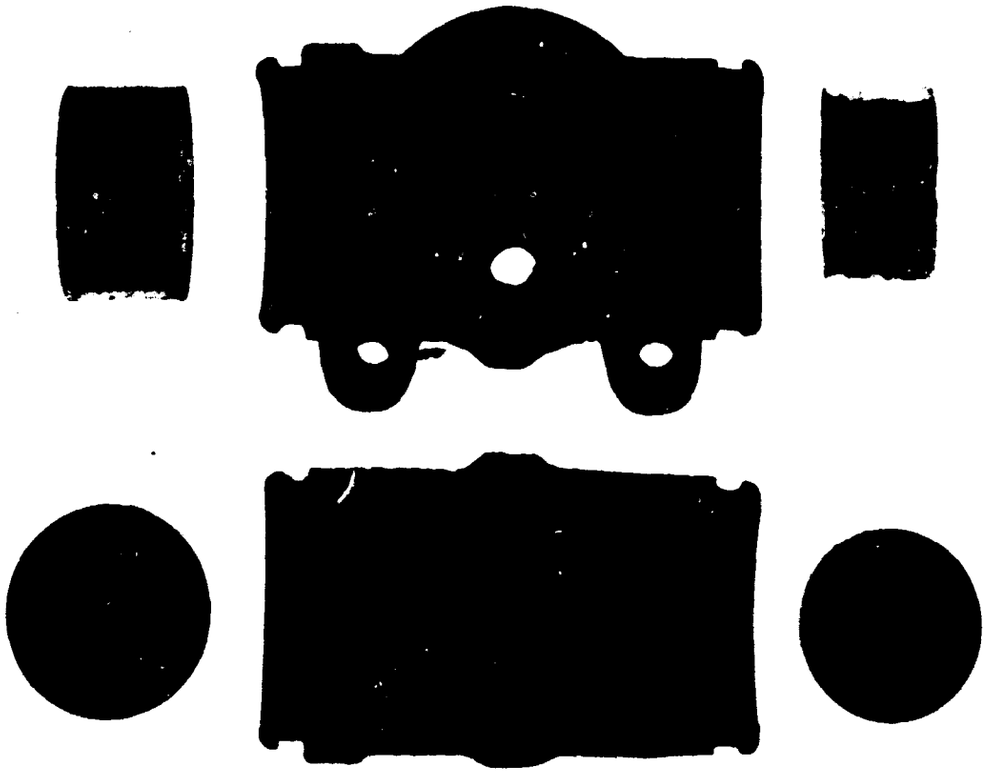
APPENDIX B

PHOTOGRAPH 1

1 YEAR SIMULATED STANDBY STORAGE

OPERATIONAL BRAKE FLUID

ALUMINUM PISTONS

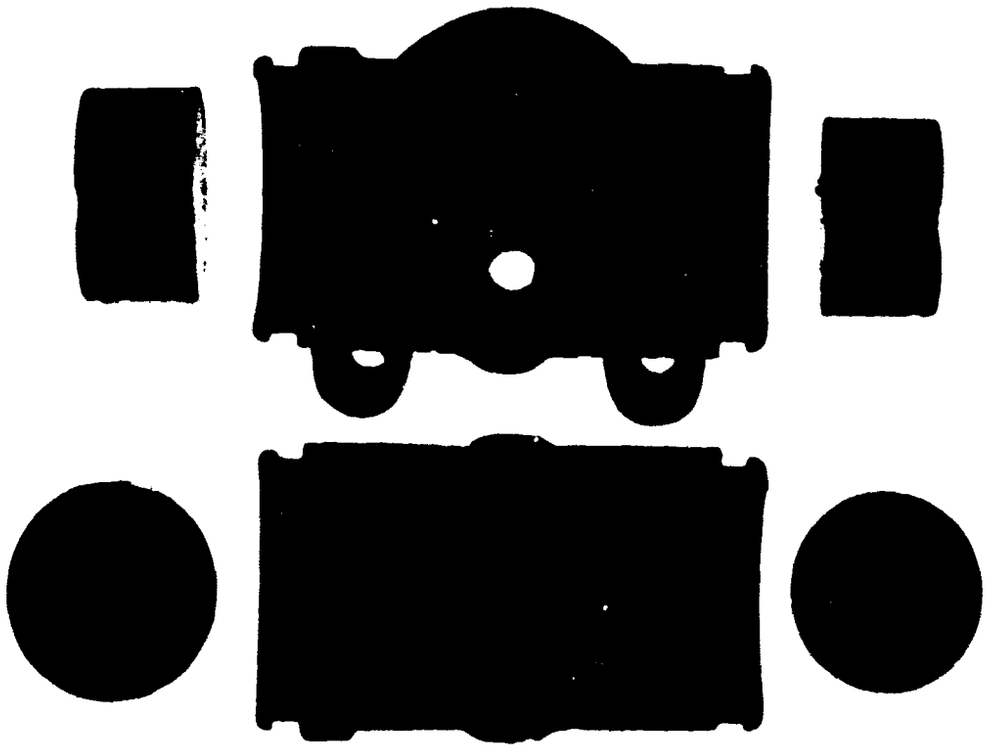


PHOTOGRAPH 2

1 YEAR SIMULATED STANDBY STORAGE

OPERATIONAL BRAKE FLUID

SINTERED IRON PISTONS

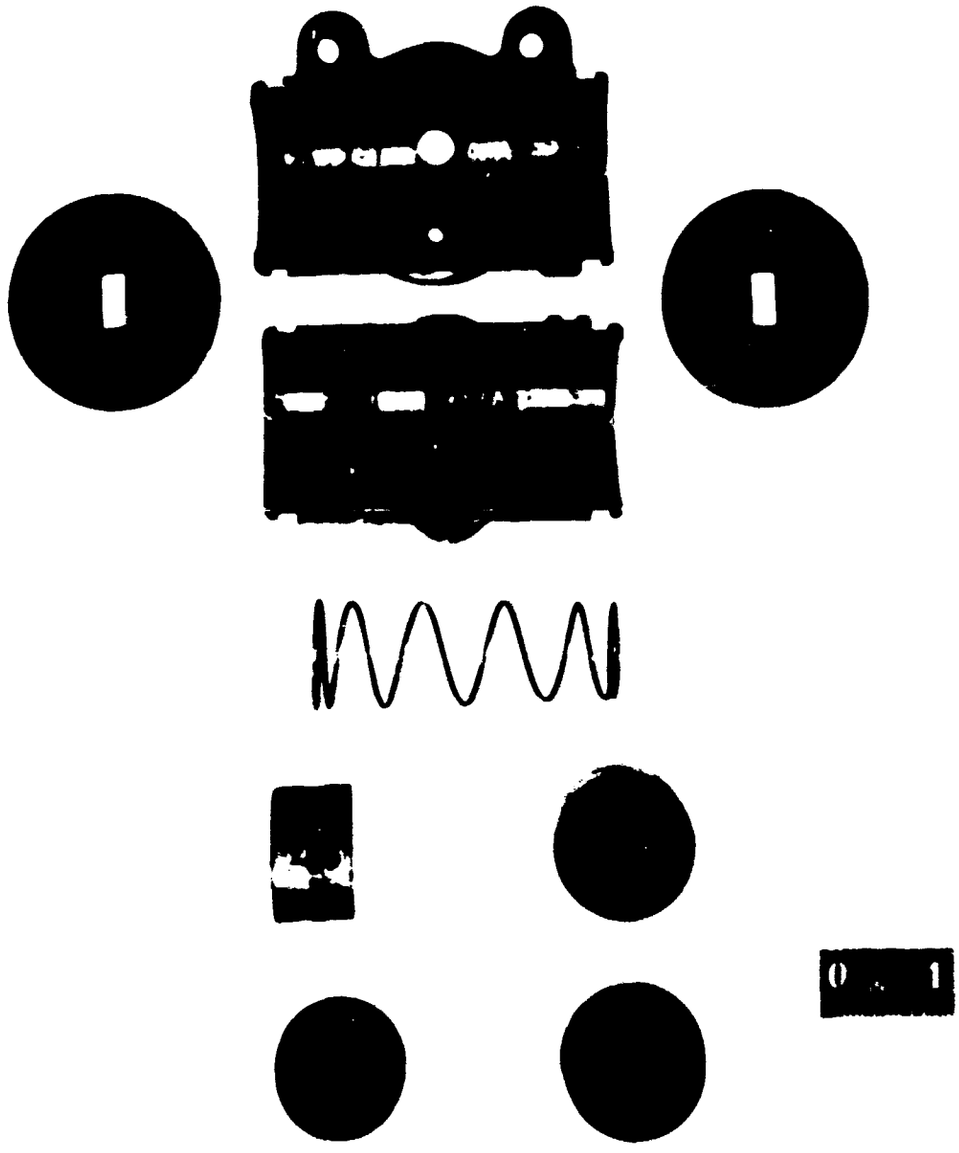


PHOTOGRAPH 3

U.S. ARMY COATING & CHEMICAL LABORATORY

2 YEAR OPERATIONAL BRAKE CYLINDER FIELD TEST
CONDUCTED AT YUMA PROVING GROUND

ALL WEATHER BRAKE FLUID
ALUMINUM PISTONS



PHOTOGRAPH 4

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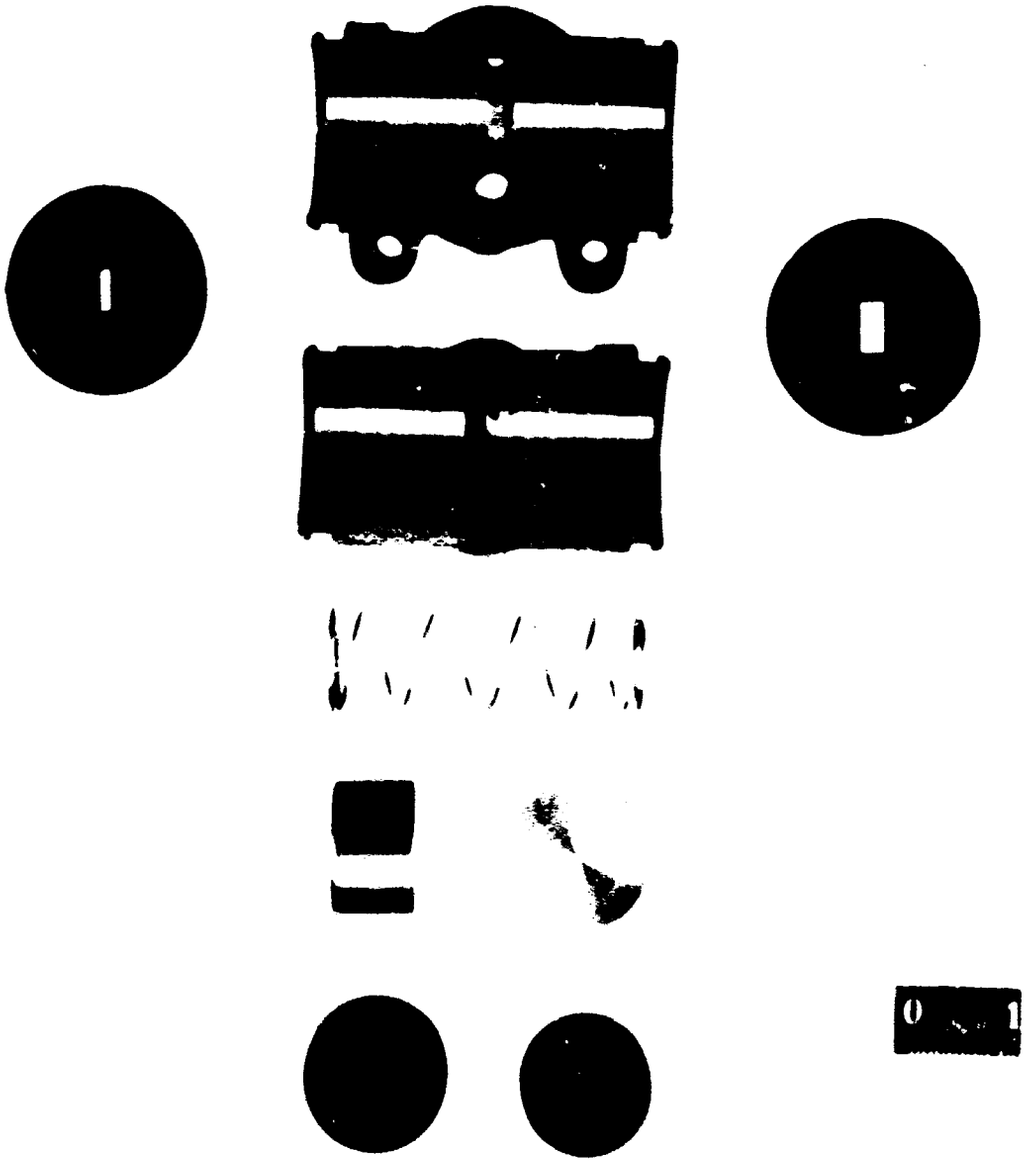

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