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SUBMITTED TO:  ARMED SERVICES TECHNICAL INFORMATION AGENCY
ARLINGTON HALL STATION
ARLINGTON 12, VIRGINIA


CONTRACT:  DA-28-017-ORD-3079

SUBMITTED BY
M. Garrity
Project Engineer

APPROVED
R. F. Hurst
Vice President

MOLDED INSULATION COMPANY
335 E. PRICE STREET PHILADELPHIA 44, PA. code 215 Victor 4-2626

PRODUCTS
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1. INTRODUCTION

The purpose of this report is to outline the processes used in the production of the M18A1 APERS Mine and to illuminate any difficulties encountered and suggest changes that will facilitate production.

This item will be procured in quantities of fifty thousand or greater so this report will deal only with large quantity production.

The design changes that occurred during this production study will not be discussed.
The mine assembly is unique in anti-personnel mine systems in as much as it can be aimed when set in place and fired by remote control. This assembly is built to withstand a drop test of six feet to a steel plate without impairing its service.

Durability for the mine is important for it is given rough treatment from the time it is issued to the foot soldier until its destruction. The fiberfill material is compounded of fiber glass and polystyrene which coupled together make a strong but not brittle material yet flexible enough to withstand high impact. The high percentage of glass imparts good dimensional stability and the styrene bonds easily to itself or other plastics. This is the reason that this material was used for the various items.
CASE NO. 8800915

The predominant feature is the Case no. 8800915. This is injection molded of Fiberfil per MIL-M-21347. Due to the molded threads in the detonator well cavities two loose pins are required for each mold cavity. Orientation of the thread termination in relation to the case proper must be considered when designing the mold and an additional set of pins will increase the mold production. Two minutes cycle time is sufficient to produce a perfectly molded part regardless of a single cavity or multicavity mold. The gate location should be in the vicinity of the detonator wells to give a good fill with a minimum cylinder pressure. This will also maintain flash that can be removed by tumbling.

Fiberfil material is hydrostatic and should be stored in a dry area and warmed prior to loading in the injection cylinder. The Fiberfil Corporation of Warsaw, Indiana will cooperate in the design of the mold and processing of the raw material.
4. COVER NO. 8800916

The Cover no. 8800916 is the mating part for the case and of less complex configuration which results in less costly mold design and higher production figures. This part can be produced in a completely automatic press using the same material precautions as with the case and simply tumbled to remove molding flash.
5. DETONATOR WELL ADAPTER

The Detonator Well Adapter no. 8800913 is made of the same material as the case and cover and it too can be molded automatically.
6. DETONATOR WELL PLUG

The Detonator Well Plug no. 8800923 is ideally suited for automatic molding and its material linear polyethylene requires no special handling.
7. ANGLE BRACKET

The Angle Bracket no. 8800907 is an example of simplicity in design for the lowest cost without sacrifice of function. Low carbon steel as specified is in abundance and the cheapest wrought material available. The progressive die necessary to produce this part can be made in any tool room and run in a press at one hundred strokes per minute. The tool necessary to do one good part will turn out several million.
8. LEG NO. 8800908

The Leg no. 8800908 is designed to support the mine on any terrain with some penetration of the leg into whatever surface it may be placed. Again low carbon steel is used with the best results but the die is a little different in design. Shaping the punch is the most difficult part but once shaped it can be fitted to the die steel. A good toolmaker can make this tool in fifty hours. This part can also be run at approximately one hundred strokes per minute.
9. WASHER - SPRING

The Washer - Spring no. 8837131 is a standard part produced by Shakeproof Incorporated and should be checked for hardness and temper retention.
10. WASHER - FLAT

Washer - Flat no. MS15795-308 can be manufactured with simple tools or can be purchased at any flat washer organization for very nominal prices.
11. STEEL BALL

Steel Ball no. 8800922 is similar to parts of like nature produced by all of the ball manufacturers. The material is low carbon steel in the range of 1009 to 1014 carbon and hardened to \( R_C 43-47 \) to a depth of .020 to .030.

The first stage of manufacturing is heading where the steel wire is thread thru a die clamped and peened to form a shape roughly the same as a ball but with an equator raised about fifteen thousandths above the shaped diameter with a base section approximately ten to fifteen thousandths thick.

Production rate for the size ball required is in the neighborhood of three hundred per minute. After this operation the balls are then poured in a hopper of a grinding machine. This is a single purpose machine whose sole function is to rough grind the equator off the headed ball. Thousands of these balls are run thru this machine at one time recirculating about every two or three minutes to pass the multisegmented grinding wheel that is the heart of this machine. It takes several machine hours to process a single batch of balls.

Succeeding this grinding operation the balls are then heat treated to full hardness in a rotating carbonizing furnace. After this a temper drawing operation is conducted to reduce the full hardness down to the \( R_C 45 \).
The depth of the case dictates the length of time in hours to achieve the proper ball characteristics. A light acid dip is sufficient to remove the fire scale.
13. LEG ASSEMBLY

The Leg Assembly no. 8837129 can be processed on a standard riveting machine with standard tooling. This operation can be automated fully with hopper feeds for all parts in the proper sequence but the tooling cost would require production figures of at least one million pieces.

Riveting the leg assemblies to the case is performed in the same manner as assembly of the legs on the same equipment.
12. BALL POTTING MATERIAL

Several combinations of Devcon "A" and resins were tried to provide the best all around compound. The iron filings as found in the Devcon "A" are essential to provide a mat to support the resin prior to setting-up and when detonation occurs it, offers a density similar to the balls which tends to retard the blast as it escapes thru the small openings that exist between balls. The resin mines provide ease of handling and a tough body after curing.
14. ASSEMBLY NOTES

The balls can be dispensed within the count tolerance from an Exact Weight Scale into the front tray. After experimenting on many different fixtures and devices, the most economical method was to provide an operator with a small vacuum type probe which could lift a single ball and transport it to another section. The probe was also used to move many balls at one time and in a short training period, an operator could orient the tray full of balls in less than one minute.

The potting material can be dispensed from any of the many available grease gun type dispensers available. Enough potting compound can be mixed for one day's production and stored in a cold box until used. When dispensing, the operator should trace a line about one inch from each case side for the entire length of the tray and do the same at each end except that the line should be about one half inch from the case end. Coordination of the movement of the gun and the volume of compound dispensed will deposit the right amount on the balls. The "right amount" being enough to cover thoroughly the balls without puddling in low spots of the case contour. A polyethylene paddle makes a very handy spreader to usher compound into starved areas. Water acts as a good lubricant on tools in contact with the compound and industrial alcohol is a good solvent.
The principle resin used is epoxy, and particular care should be exercised in cleaning the hands and tools as well as providing adequate ventilation.
4. Lettering to be centered as shown.

5. Characters to be engraved, 1/4 high, 1/32 raised, 1/16 wide lettering.

6. These dimensions will not be put into effect until notification from Pic. Arsenal.

Ordinance Part No. 8800916
NOTES -

1) MATERIAL - GLASS FILLED STYRENE PER MIL-P-3796; NATURAL COLOR

2) A 2° DRAFT ANGLE MAY BE USED WHERE NECESSARY TO FACILITATE MOLDING.

3) COVER CONTOUR MUST MATCH A MINIMUM TEMPLATE AND CASE SURFACE OF .06 MAXIMUM AT ANY POINT.

MATERIAL: SEE NOTE 1
FINISH: NONE
DESIGNED FOR: 
FILE: 
ALL DIMENSIONS ARE IN INCHES.
LIMITS: FRACTIONS ± 1/64" DEGREES ± .005"
ANGLES ± 1/8" UNLESS OTHERWISE NOTED.
SUPERSED: SUPERSED BY:
CHECK WITH ENGINEERING DEPT. ON LATEST ISSUE BEFORE USING THIS PRINT.

COVER

SCALE: FULL SIZE
DATE: 7-28-1960
DRAWN: S. FRY
CHECKED: 
APPROVED: 

MOLDED INSULATION CO.
335 E. PRICE ST., PHILADELPHIA 44, PA. U.S.A.

DATE OF PRINT: 7007-11

0916
NOTES:

1. SPEC. MIL-G-2550 AND MIL-ST-3130 APPLY
2. MATEL: ALUMINUM ALLOY, SHEET, NOOF, SPEC. QQ-A-561
3. FINISH: ALL OVER 125√

MATERIAL: See Notes
FINISH: See Notes
DESIGNED FOR: File:

ALL DIMENSIONS ARE IN INCHES.
LIMITS: FRACTIONS ± 1/64" DECIMALS ± .005"
ANGLES ± 1/4" UNLESS OTHERWISE NOTED.

SUPERSEDES: SUPERSEDED BY:

CHECK WITH ENGINEERING DEPT. ON LATEST
ISSUE BEFORE USING THIS PRINT.

ORD. PART NO. 3837133

CUP: WELL

MATERIAL: See Notes
FINISH: See Notes
DESIGNED FOR: File:

ALL DIMENSIONS ARE IN INCHES.
LIMITS: FRACTIONS ± 1/64" DECIMALS ± .005"
ANGLES ± 1/4" UNLESS OTHERWISE NOTED.

SUPERSEDES: SUPERSEDED BY:

CHECK WITH ENGINEERING DEPT. ON LATEST
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**NOTES:**

1. SPEC. MIL-G-2550 APPLIES.
2. MATERIAL - STEEL COLD ROLLED 1/2 HARD, FS 1020, PER SPEC. QQ-S-00640.
3. FINISH - CADMIUM PLATE (ELECTRODEPOSITED) PER SPEC. QQ-Z-325 CLASS 3, TYPE 2.
4. REMOVE ALL BURRS & SHARP EDGES.

**ORDNANCE PART NO.** M515795-308 M.I.C. Pt. No. 7007-28

- **WASHER BEARING.**
- **ORDINANCE CORPS**
- **DEPT OF THE ARMY**
- **DOVER, NEW JERSEY**

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- **TOLERANCES ON:**
  - DECIMALS: FRACTIONS
  - ADDITIVE

- **MATERIAL:** SEE NOTE 2.
- **MEAT TREATMENT:** NONE
- **FINAL PROTECTIVE FINISH:** SEE NOTE 3.

- **ORIGINAL DATE OF DRAWING:** 2/29/60
- **ORIG CORPS:**
- **DRAFTSMAN:** FRY
- **CHECKER:**
- **TRACER:** CHECKER
- **ENGINEER:** ENGINEER

- **APPROVED BY ORDER OF THE CHIEF OF ORDNANCE:** MAY 3 1960

- **SCALE:** 2=1
- **UNIT:**

- **DRAW SIZE:**
- **PICATINNY ARSENAL**
- **ORDNANCE CORPS**
- **DEPT OF THE ARMY**
- **DOVER, NEW JERSEY**

**SPECIFICATIONS:**

- **CALCULATION:**
- **UNIT:**

**REMARKS:**

- **ENGINEER:**
- **CHECKER:**
- **DRAFTSMAN:**

- **SUBMITTED:**
- **APPROVED:**
- **DRAWN:**

**REFERENCES:**

- **ENGINEER:**
- **CHECKER:**
- **DRAFTSMAN:**

**DRAWN **

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**APPROVED **
NOTES:
1. SPEC MIL-G-2550 APPLIES.
2. MATERIAL - STEEL, COLD ROLLED
   1/2 HARD FS #1020
   PER SPEC. QQ-S-006-10
3. FINISH - NO. 4.1 4.2 4.3 4.4 4.5 OR 4.8
   FOLLOWED BY SYSTEM NO. 20.3
   (GREEN NO. 24087) OR
   MIL-STD-171 ALL OVER.
4. REMOVE ALL BURRS & SHARP EDGES.

ORDNANCE PART NO. 8800907 REV. B  M.I.C. 7007-26

PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY
NOTES:
1. SPEC. MIL-G-2550 APPLIES.
2. MATERIAL - STEEL COLD ROLLED 1/2 HARD
   FS #1020 PER SPEC. QQ-S-00640.
3. FINISH - NO.4.1, 4.2, 4.3, 4.4, 4.5 OR 4.6 FOLLOWED
   BY SYSTEM NO. 26.2 (GREEN NO. 34087)
   OF MIL-STD-171 ALL OVER.
4. REMOVE ALL BURRS & SHARP EDGES.
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**SUPPLEMENTED BY**

HS 6585-332

M. SCREED 9/9/64
NOTE:
1. SPEC MIL-G-2520, MIL-STD-8, MIL-S-9, MIL-STD-10, PA-PD.
2. GLASS FILLED STYRENE PER MIL-P-37946 NATURAL COLOR.
3. UNTOLERANCED DIMENSIONS NEED NOT BE GAGED.
4. FINISH ALL OVER V/2.

PHYSICAL PROPERTIES

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MATERIAL:
SEE NOTE 2

HEAT TREATMENT

ORDNANCE PART NO. 8800913

ORIGINAL DATE OF DRAWING

DRAFTSMAN

TRACER

ENGINEER

SUBMITTED

APPROVED BY ONE

CHIEF OF ORDNANCE
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-12 NC-1A (MODIFIED)
MAJ. DIA. .5601-.0158
PITCH DIA. .3060-.0109
MINOR DIA. .4379 MAX.

AND 30-1-7 APPLY

SUPERCEDED BY
ADAPTER
MAY
2/27/60
6880913
UGAR

PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY

B 8800913
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INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

2 - WASHER, FLAT
MS 15795-308
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NOTES:

1. SPEC MIL-G-2550 APPLIES.
2. NO VOID LARGER THAN ONE BALL PERMISSIBLE. BALLS TO BE FLUSH WITH BOTTOM OF CASE.
3. BOND BALLS TO CASE AS SHOWN USING DEVCON A. SEE NOTE 6.
   APPROVED SOURCE:- CHEMICAL DEVELOPMENT CORP., DANVERS, MASS., OR APPROVED SUBSTANTIAL EQUAL. NOTE 4.
4. ALL SOURCES MUST COMPLY WITH THE PHYSICAL AND FUNCTIONAL REQUIREMENTS OF THE MANUFACTURER'S ITEM INDICATED.
5. REMOVE ALL EXCESS RESIN TO MAINTAIN INNER CONTOUR.
6. ADVISORY:- THIN DEVCON A TO ALLOW FOR A Mixture OF 75/7 STEEL.
7. THE LEG AND BRACKET ASSEMBLIES SHALL NOT ROTATE ABOUT PIVOT JOINT WHEN A MIN. TORQUE OF 25 FT. LBS. IS APPLIED AND SHALL ROTATE WHEN A MAX. TORQUE OF 175 FT. LBS. IS APPLIED.
NOTES:
2. MATERIAL: LOW CARBON STEEL
3. HEATED & HARDENED TO ROCKWELL C: 43 TO 48
4. BALL MUST BE SPHERICAL WITHIN THE SPECIFIED TOLERANCES
NOTES:
1. SPEC MIL-G-2550, MIL STD-8 PA-PD, APPLY
2. MATERIAL HIGH DENSITY OLIVE DRAB
   POLY STYRENE
3. ALL CORNER RADI 0.010 MAX
4. UNTOLERANCED DIMENSION NEED NOT BE GAGED
SECTION A-A

SUPERSEDED BY
EO PA 7116 5/12/81

MIL-7007-20

PLUG, DETONATOR, WELL
BEVEL SPRING WASHER-8837137(2)

LEG BRACKET-8837136

RIVET-MS 16535-304

WASHER BEVEL SPRING-8837137

CASE ASSEMBLY-8800918

BEARING WASHER-8837138

RIVET-MS 16535-307

NOTE:
1. SPEC MIL-G-22550 APPLIES.
2. THIS ASSEMBLY EXISTS AT TWO LOCATIONS ON EACH CASE.

ORDNANCE PART NO. 8837129 REV. C W.I.C. Pt. No. 7007-29