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THE PRODUCTION OF URANIUM POWDER COMPACTS

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Report written by O. Cammann

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Massachusetts Institute of Technology

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THE PRODUCTION OF URANIUM POWDER COMPACTS

Work done by J. Aulff, T. A. Edwardsen, O. Carman
Report written by O. Carman

ABSTRACT

The method of preparation of uranium pieces, 1 inch by 1 inch by 0.5 inch, of high purity and with a density of about 16 g/cm³ is described. They were made by pressing in hardened steel dies at 60 to 70 tons per square inch. The pressed pieces were pyrophoric and had to be stored and shipped at "dry-ice" temperatures to prevent ignition.

1. Introduction

The procedures on the pressing of uranium powder herein described were developed in response to an emergency in August 1942. Considerable numbers of compacts were required one-inch square and one-half to one inch in thickness and with a density not less than 15 g/cm³. Production was only intended to continue until the Metal Hydrides, Incorporated of Beverly, Massachusetts could arrange to do their own automatic pressing. Lubricants, such as stearic acid, paraffin or graphite could not be tolerated. The urgency of production did not permit the making and using of carbide-lined dies, automatic ejection of the material from the die, and sintering; the method of fabrication was based wholly on the equipment available and previous experience.

2. Production

2.1 Raw Material.--The uranium powder was furnished by Metal Hydrides, Incorporated, packed in "dry-ice". The properties of the powder, such as apparent density, particle size distribution, pressing ratio, and moisture content varied from shipment to shipment. To make compacts of proper size, the necessary die-fill had to be determined

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for each lot; once ~~determined~~ a constant weight of powder was used. The powder had to be pressed from both sides in order to procure a self-sustaining compact.

2.2 Dies.--The die used consisted of a soft steel box or frame, lined with rectangular hardened steel inserts which formed the sides of the cavity for the one-inch-square compacts. The inserts were held in place by set-screws in two adjacent sides of the frame. The top and bottom of the cavity were formed by two punches which were free to move within the cavity with a clearance of about 0.001 inch.

Failure of the die inserts was frequent and was caused by (a) scoring of the surface adjacent to the end of the punch and next to the compact by the abrasion of the powder, and (b) cracking, probably brought about by the deflection of the insert acting as a beam. The principal cause in the latter case was probably uneven support, resulting from the spacing of the clamping screws or from small amounts of powder remaining on the inserts. Care in removing dirt from the insert surfaces reduced this type of failure.

Breakage of the punch at the upper corners which were in contact with the press platen was another type of die failure. This was considerably reduced by locating a soft-steel pad directly between the punch and press platen, always in the same position relative to the punch so that the punch fitted exactly into the impression made in the soft steel.

Dies were lubricated by oiling the parts with a solution of stearic acid in carbon tetrachloride and then wiping off the excess material. The impurities which might be introduced by a substantial quantity of lubricant could not be tolerated.

*The production of uranium oxide compacts - J. G. ...
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3. The Pressing Operation

The operations of pressing were accomplished in the following sequence: The proper quantity of uranium powder to make a compact one-half inch thick after pressing was weighed out. The correct weight (usually about 130 grams) was determined by trial for each lot of powder processed. The die parts were assembled and clamped into place; the powder was poured into the die cavity and the punch was inserted above the powder. The loaded die was lifted from the loading table and located in the press; the ram of the press was lowered against the punch of the die until the gage indicated the specified pressure, and the die was then removed from the press to the unloading table. Finally, the die was opened, the compact was removed and placed on "dry-ice", and the die parts were cleaned in preparation for the next cycle.

Each compact was inspected for thickness, visible cracks and fractures. After passing inspection, compacts were wrapped in Kleenex and packed in metal containers between layers of "dry-ice."

To reduce both the dust and fire hazard a high velocity suction system was installed in the pressing room and kept in operation whenever work was in progress.

4. Production Record

Compacts were pressed in quantity from approximately August 13 to September 15, 1942. The maximum production for any one day (24 hours) amounted to 1457 compacts or an average of about one minute per compact. The maximum production for any one shift (8 hours) was 598 compacts or about 48 seconds per compact. If a supply of powder had been available at all times the capacity would have been about 400 pounds per day or something over a ton a week.

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5. Properties of the Compact

The compacts as pressed were pyrophoric and had to be maintained at low temperatures (-18°C to "dry-ice" temperature) to prevent ignition. They were weak and had to be handled with great care. The average density was 16 g/cm^3 .

After sintering, which was done elsewhere, many of the briquettes were returned to the laboratory for melting and casting. They were not immune to oxidation at room temperature. A number of the briquettes were analyzed by the vacuum fusion method with the following results.

Table 1. Analysis of Sintered Uranium Compacts

Date	Per cent Oxygen	Per cent Nitrogen
Sept. 10, 1942	0.65	0.28
Sept. 11, 1942	0.73	0.18
Sept. 11, 1942	0.25	0.10

6. Conclusions and Recommendations

The lack of time and available facilities did not permit necessary or desirable changes to be put into effect. The following conclusions and recommendations appeared self-evident to those working on the problem:

- (a) Automatic presses permitting an application of pressure from both sides are imperative if the production rate is to be increased.
- (b) The use of lubricants such as stearic acid or paraffin which can be removed during sintering would permit less breakage of compacts.
- (c) Dies lined with tungsten-carbide, although of higher initial cost, would permit higher eventual savings.

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(d) Compacts if possible should be reduced in size to permit the use of rapid-acting mechanical presses.

(e) A vacuum or inert-gas sintering furnace should be set up close to the pressing operation to reduce the fire and breakage hazard of unsintered uranium compacts during shipment.

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