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DEVELOPMENT AND OPERATION OF AN AUTOMATIC PRESS
FOR CERAMIC POWDERS

by

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ABSTRACT

The construction of a small automatic pelleting press is described. Details of the piping and timing mechanism are discussed. The sequence of operation is given and some details of the granulation procedure used for preparing powders for the press are discussed.

INTRODUCTION

A large number of small ceramic pellets were required for the ceramic loading of the Borax-IV reactor. Several automatic presses were available but were not suitable for enclosure in the glove boxes situated in the ceramic laboratory. Total enclosure of the press was considered necessary because of the toxic nature of the materials, and because of the strict accountability of the material.

As commercial presses were deemed unsuitable, it was decided to build a small automatic press which would fit inside one of the glove boxes in the ceramic laboratory. The design of the press was not new; however, its simplicity, compactness, and its mode of operation created a good deal of interest, and for this reason a detailed description of the press and its operation has been made available.

CONSTRUCTION

The press was essentially a small horizontal press constructed of eight air cylinders arranged in two opposing rows, and mounted on a steel base plate. Between the opposed rows of cylinders was mounted a mild steel die block which held the female dies shown in Figure 1. These dies were constructed of soft steel with a hardened tool steel insert (Figure 2). The insert was held in the die case by three set screws. The clearance between the punch and the die was $0.002 \begin{smallmatrix} +0.001 \\ -0.000 \end{smallmatrix}$ inch. In manufacture, the

hardened steel insert was put in the die case and the opening was ground into the insert. This design simplified the manufacture of the pellet die, and allowed some flexibility for changing the size of the pellets. The die block, cylinders, and air manifolds, as shown in Figure 1, were installed in the glove box as shown in Figure 3.

The piping diagram is also shown in Figure 1. Compressed air was supplied by a two-stage air compressor capable of supplying a pressure of 160 psi. The pressure was regulated by a combination regulator, filter, and lubricator.* The pressing cylinders shown at "E" in Figure 1 were actuated by a Model 6248B*, 4 way - 3 position master air valve in conjunction with two Model P23857* solenoid operated 3 way - 2 position pilot valves shown at "M" in Figure 1. The backing or holding cylinders shown at "F" in Figure 1 were actuated by a Model 6245* 4 way - 2 position master air valve in conjunction with two Model P5771* direct attached 2-way electrically operated valves shown at "C" in Figure 1. Two Model 6401* ("H" Figure 1) adjustable air speed control valves were also inserted in the exhaust side of the master air valve to control the speed of the holding, or backing, air cylinders.

The solenoids and electric valves were actuated by a timing mechanism shown at "D" in Figure 1. This mechanism consisted of a small Bodine fractional horsepower motor which was connected to a shaft on which was mounted two discs. Three adjustable cams were fastened to the rims of the discs with set screws. These cams actuated four microswitches which, in turn, energized the solenoids and electric valves for the sequence of operation. This timing mechanism was connected through an electrical distribution box ("A" in Figure 1) which contained fuses, pilot lights, and connections for a foot switch. The press cycle was controlled by positioning the cams on the rotating discs while the rate at which the press operated was set by the rpm of the drive motor. The drive motor was connected to the shaft on which the timing discs were mounted by means of a slotted sleeve coupling. This device allowed the easy removal of the drive motor so that the speed of the press could be changed by substituting a drive motor of higher or lower rpm. A photograph of the valve assembly and timing mechanism is shown in Figure 4.

OPERATION

The press, which included the die base, air cylinders, and the manifolds, was installed in the glove box (Figures 1 and 3). The control panel (Figure 4) was attached to the outside wall of the glove box. A four-compartment hopper was attached to the die block.

*Supplied by Logansport Machine Company, Logansport, Indiana.

In operation, alternating pressing cylinder pistons were withdrawn (Figure 1) and the back-up cylinder pistons moved forward to close the exit side of the die. Granulated freely flowing material dropped into the die cavity and the pressing punch closed, forcing the material from the die cavity into the die where it was compressed under full pressure by both cylinders.

The back-up punch was then withdrawn and the pressing punch moved through the die to eject the pressed pellet. In this manner alternating cylinders went through the same cycle, and four pellets were pressed for each revolution of the timing motor.

In operation pellets 0.250" in diameter were pressed. Using 2-1/2" air cylinders, the ratio of the square of the diameter of the cylinder to the square of the diameter of the punch was 100 to 1. With air pressures of 130 to 150 psi, pressures of 13,000 to 15,000 psi could be developed in the press. The pressures developed, of course, would be dependent on (1) the air pressure, (2) the sizes of the air cylinders used in the press, and (3) the sizes of the punches used in forming the pellets.

The success of this volume-loading die design was contingent upon the degree of granulation of the material to be pressed. Material to be pressed was mixed with 2-1/2 w/o polyvinyl alcohol and this mixture was then dampened with approximately 12 w/o water containing 0.5 w/o aerosol. The damp material was forced through a 16-mesh screen and then dried at 80°C for four hours. This procedure produced a freely flowing material which resulted in pellets which were 1/2 inch $\pm$ 1/8 inch in length when fabricated in the pellet press.

Powdered material, or material which had not been granulated, could be processed in the press; however, as this type of material was not freely flowing, it had a tendency to bridge over in the hopper, which prevented filling of the die cavities. To allow the pressing of ungranulated material, a small vibrator was mounted on the base plate adjacent to the die block. The amplitude of the vibrator was controlled by means of a rheostat; by adjusting the amplitude of vibration, ungranulated material could be pressed with a fair degree of success. Pellets formed from ungranulated material were found to vary in length from 1/4 inch to 5/8 inch.

In operation a 19.8-rpm motor was used first. At this speed the press produced approximately 80 pellets per minute. This rate was found to be too fast for efficient handling of the pressed material, and this motor was replaced later by a 5.7-rpm motor. At this rate (approximately 23 pellets per minute) approximately three kilograms of thoria were pressed per hour. Die wear was negligible in pressing 600 kilograms of thoria.

A small rubber belt conveyor was installed beneath the punches on the exit side of the dies. This conveyor facilitated the removal of the pressed pellets. The conveyor is shown in place beneath the punches in Figure 3, while a view of the exhaust side of the conveyor is shown in Figure 5.

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BACKING PUNCH
(HARDENED AND GROUND)

PRESSING PUNCH
(HARDENED AND GROUND)

TOOL STEEL
DIE INSERT
(HARDENED AND GROUND)

DIE CASE (MILD STEEL)

Figure 2. Punch and Die Drawing

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Figure 3. Press Installed in Glove Box

Figure 4. Press Control System

Macro 20950

Figure 5. Conveyor Discharge from Press

Macro 20951