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(54) Title: MOULDING OF APERTURED ARTICLES

(57) Abstract

An article (10) having side holes (11), e.g. a spacer (10) for a central heating radiator, is made of compacted loose particulate material in a die comprising a plate (1) having a vertical cavity (2), a top punch (7) and a bottom punch (4). An inner core rod (3) forms a central passageway (12) in the spacer (10) and side core rods (6) form the side holes (11). The density of the compacted material defining the side holes (11) is higher than in the remainder of the article (Figure 2).

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# MOULDING OF APERTURED ARTICLES

The invention relates to the moulding of apertured articles. In particular, the invention relates to the manufacture of an article by pressing or compacting particulate material in a mould shaped to provide the article with a hole extending at right angles to the direction of pressing.

It is established industrial practice that when making an article of metal powder or the like by pressing, holes cannot be moulded in a direction at right angles to the axis of pressing see, e.g. Iron Powder Handbook, 1957 Volume 1, Section D, Chapter 20, page 45 and Handbook of Powder Metallurgy, second edition, 1982, page 144. As a result it is considered to be necessary to form such a hole as a second operation by machining. We have now discovered a method of making a side hole at the same time as moulding the article.

According to the invention in one aspect there is provided a method of moulding an article of particulate material, the article having at least one hole in a side wall thereof, the method comprising:

- placing a side core rod to form the hole in one mould part so as to extend from one side of the mould part towards the other side thereof

- placing particulate material in the one mould part

- contacting the first mould part with a second mould part and compacting the material by applying pressure along an axis substantially at right angles to the axis of the core rod, thereby to mould the article with the hole, and

- removing the formed article from the mould.

Preferably the method includes the step of placing an inner core rod in the mould parts so that the rod extends in the direction of pressure applied to the mould parts thereby to form a passageway in the article, the hole being formed by the side core rod extending from the side wall of the article towards the passageway. Preferably the side core rod is dimensioned so that the hole communicates with the passageway. Preferably the method includes placing at least two hole forming core rods at diametrically opposite sides of the mould part.

In a known die, loose particulate material, e.g. metal powder, is placed in the open press. The punch is then moved in a rectilinear direction to compress the particulate material by a factor of about 2:1 to a predetermined density, typically about 6.5g/cm$^3$. When in accordance with this invention a side core rod is present in the mould, the compression ratio is higher, especially in the regions of the core rod, so that the density in those regions can be as high as about 7.4g/cm$^3$. The extent to which the density may be adjusted in the region of the formed hole will depend on a number of factors, e.g. the cross-sectional dimensions and shape of the side core rod. While we do not wish the scope of the monopoly to be limited in any way by the following theory, our investigations suggest that in this invention the particles tend to move laterally as well as in the direction of pressing, leading to a concentration of compacted material and hence higher density in the areas which define and bound the formed hole. More specifically, our investigations show that, contrary to conventional theory, powder particles are displaced from above and below the side core rods during the initial stages of compaction in sufficient volume to achieve a satisfactory mid-range density between the holes with higher density above and below the holes. The method of the invention can thus be used to make articles having variable density in different areas in a single pressing. This can give increased strength and hardness in those areas. There is a need for an easy way to make such articles where parts of the article are to be subjected to

high force. One example is a spacer for a central heating hot water radiator or other heat exchanger which is subjected to a bursting force when connected, e.g. riveted, to one or more panels. The radiator may be of any known construction. The method of the invention may be applied to the manufacture of any article by pressing where a hole is to be formed in the side wall.

In a preferred aspect the invention provides a method of moulding a tubular article of compacted particulate material having at least one hole in a side wall thereof, the method comprising:

- placing an inner core rod in a female rigid mould part;
- placing at least one side core rod in the mould to extend generally at right angles to the inner core;
- placing loose particulate material in the mould;
- urging a male rigid mould part into the female mould part to compact the loose particulate material,
- retracting the rods, and
- removing from the mould the formed tubular article having at least one hole in the side wall thereof.

The particulate material may be any suitable material, typically metal powder or a sintered metal powder or the like.

After shaping the formed article may be subjected to a further treatment, e.g. a heat treatment.

In yet another aspect, the invention provides a die for use in making a tubular article of compacted particulate material, the article having a passageway and a side hole; the die comprising a female rigid mould part defining a die cavity, a first punch at one end of the cavity, an inner core rod extending into the cavity from the first punch; at least one retractable side core rod extending into the cavity at right angles to the inner core rod, and a second punch at the other end of the cavity, whereby in use, after the first punch has been advanced to cause the inner core rod to extend in the cavity and the side core has been moved to extend towards the inner core rod, loose particulate material is introduced into the cavity and the punches are moved towards each other to compact the particulate material in the cavity to form the article.

In yet another aspect the invention extends to an article formed of compacted particulate material and having an axial passageway and having at least one side hole extending towards the passageway, the article having been formed in one pressing.

The invention offers an economical method for the production of articles, eliminating the need for drilling of side holes after compaction; reduces the amount of raw material required; and offers a control of the density of the article to give higher strength in the areas of most stress in use relative to lower strength areas which suffer less stress in use.

We are aware that DE-A-2145006 discloses a technique of isostatic pressing using a flexible female mould part and a side core. That technique is not relevant to the present invention because the pressing is in a transverse direction, not longitudinal, and the rods are floating. In GB-A-1097355 a preform is subjected to a press step in a mould including side rods but the rods are located in preformed holes.

In order that the invention may be well understood it will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure l is a sectional view of a die for making a central heating radiator spacer during the filling stage;

Figure 2 is the same view as Figure l during the ejection stage;

Figure 3 is a perspective view of a formed article, and

Figure 4 is a side elevation thereof.

The die comprises a metal plate l having a vertical cavity 2. An inner core rod 3 is present in the cavity surrounded at its lower end by a bottom punch 4. When the cavity is empty the inner core rod 3 is level with the top face of the die. Passageways 5 are present in the sides of the plate l and open at the sides of the cavity 2; the passageways are in horizontal axial alignment. The passageways contain side core rods 6 which can be advanced by power means, not shown, to contact the inner core rod 3. Four such rods 6 are present. A top punch 7 is present above the cavity 2.

In use, the cavity 2 is filled with a loose compactable material such as iron powder optionally with suitable additives. Before filling the cavity, the top of the inner core rod 3 is level with the top face of the plate 1. The side rods 6 are preferably already in contact with the inner side rod 3. The top punch 7 is lowered and the bottom punch 4 raised relative to the top punch to compact the material to form the spacer. The pressing is thus in the axis of the vertical cavity 2. The compression ratio is about 2:1. After the application of the pressure for a predetermined time the top punch 7 is raised free of the plate 1, and the side core rods 6

are retracted and the bottom punch 4 is further raised to bring the formed spacer to the top surface of the plate 1. The spacer 10 formed (shown in Figures 3 and 4) is removed and the cycle is repeated. The spacer 10 consists of a ring of compacted iron powder having a central passageway 12 and two pairs of diametrically opposed holes 11. The passageway 12 has been formed by the inner core rod 3 and the side holes 11 by the side core rods 6. Examination of the walls of the holes 11 showed that they are of increased material density and hardness above and below the holes and that the wall of the holes is less sharp than one would expect to see if the hole were drilled. The formed spacer may be treated further, e.g. subjected to a heat treatment.

Because of the way in which the compaction takes place it is possible to compact the particulate material so that the article formed has areas or zones of different density. The material is of increased density about the hole formed by the side rods. This means that the spacer is stronger in what would otherwise be a region of weakness and substantially cheaper to manufacture because the article is moulded in a single operation.

Most hot water central heating radiators of pressed steel construction have the inlet and outlet connectors going into the rear panel at the corners. Some just have bottom connectors, some have both top and bottom, i.e. at each corner on the rear panel. Most manufacturers projection weld the connectors onto the rear panel. Since the radiator is hollow at this point, a spacer is placed between the front and the rear panels to support the rear panel during the welding operation. The spacers are generally in the shape of a ring, so that in use water can pass through the connection into the centre of the ring, and out through holes or slots provided in the spacer. During production the spacer has to be fed and accurately located either over a hole already pierced in the back panel or to a definite location under a diamond shaped punch. The spacer is then secured to the panel by a punch which plunges material into the spacer centre hole, or by the diamond shaped punch piercing and plunging to hold the spacer in position. It is also known to pierce a hole in the panel into which is fitted a

spacer with a collar, which is then lightly peened to hold. Because a spacer of this invention has increased strength about the hole, it is better able to resist forces undergone by the spacer when it is fixed to the panels which may form a part of a radiator which may be a single, double or triple panel structure.

The invention is not limited to the embodiment illustrated. For example, additives may be added to the powder to be compacted, e.g. those known to improve the flow of loose particulate material. The number and disposition of the side core rods may be varied. Steps may be taken to prevent damage to the side core rods, during compaction, e.g. to equalise pressure above and below by allowing the die to float downwards during the compaction.

CLAIMS

1. A method of moulding an article (10) of particulate material, the article having at least one hole (11) in a side wall thereof, the method comprising:

- placing a side core rod (6) to form the hole (11) in one rigid mould part (2) so as to extend from one side of the mould part towards the other

- placing loose particulate material in the one mould part (2)

- contacting the first mould part (2) with a second mould part (417) and compacting the material by applying pressure along an axis substantially at right angles to the axis of the core rod (6), thereby to mould the article (10) with the hole (11), and

- removing the formed article (10) from the mould (1).

2. A method according to Claim 1, including the step of placing an inner core rod (3) in the mould parts so that the rod (3) extends in the direction of applied pressure to the mould parts (2,7) thereby to form a passageway (12) in the article, the hole (11) extending from the side wall of the article (10) towards the passageway (12).

3. A method according to Claim 2, wherein the side core rod (6) is dimensioned so that the hole (11) formed communicates with the passageway (12).

4. A method according to any preceding Claim, including placing at least two hole forming core rods (6) placed at diametrically opposite sides of the rigid mould part

(2).

5. A method of moulding a tubular article (10) of compacted particulate material, the article having at least one hole (11) in a side wall thereof, the method comprising:

- placing an inner core rod (3) in a female mould part (2);

- placing at least one side core rod (6) in the mould (2) to extend generally at right angles to the inner core (3);

- placing loose particulate material in the mould part (2);

- urging a male mould part (4) into the female mould part (2) to compact the material;

- retracting the rods (3, 6), and

- removing from the mould the formed article (10) having a passageway (12) and at least one hole (11) in the side wall thereof.

6. A method according to any preceding Claim, wherein the moulded article is a spacer for a hot water central heating radiator, heat exchanger or the like.

7. A die for use in making a tubular article (10) of compacted particulate material, the article (10) having a side hole (11); the die comprising a rigid mould part (1) defining a die cavity (2), a first punch (4) at one end of the cavity, an inner core rod (3) extending into the cavity from the first punch (4); at least one side core rod (6) extending into the cavity at right angles to the inner core rod (3), and a second punch

(7) at the other end of the cavity.

8. An article (10) formed of compacted particulate material and having an axial passageway (12) and having at least one side hole (11) extending towards the passageway (12), the article having been formed in one pressing.

9. An article according to Claim 8, wherein the material defining the side holes (11) has been compacted to a higher density than the remainder of the article.

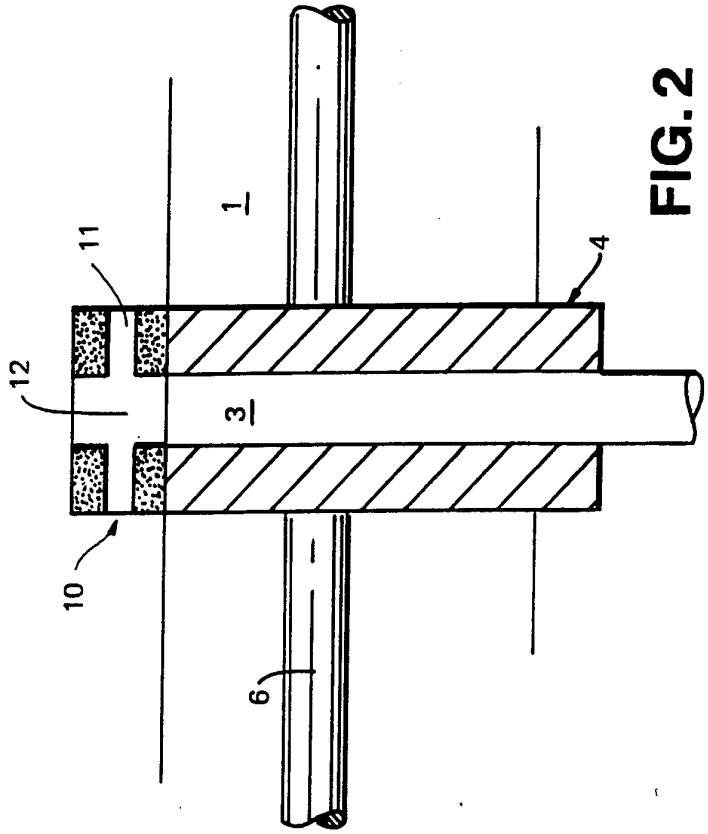


FIG. 2

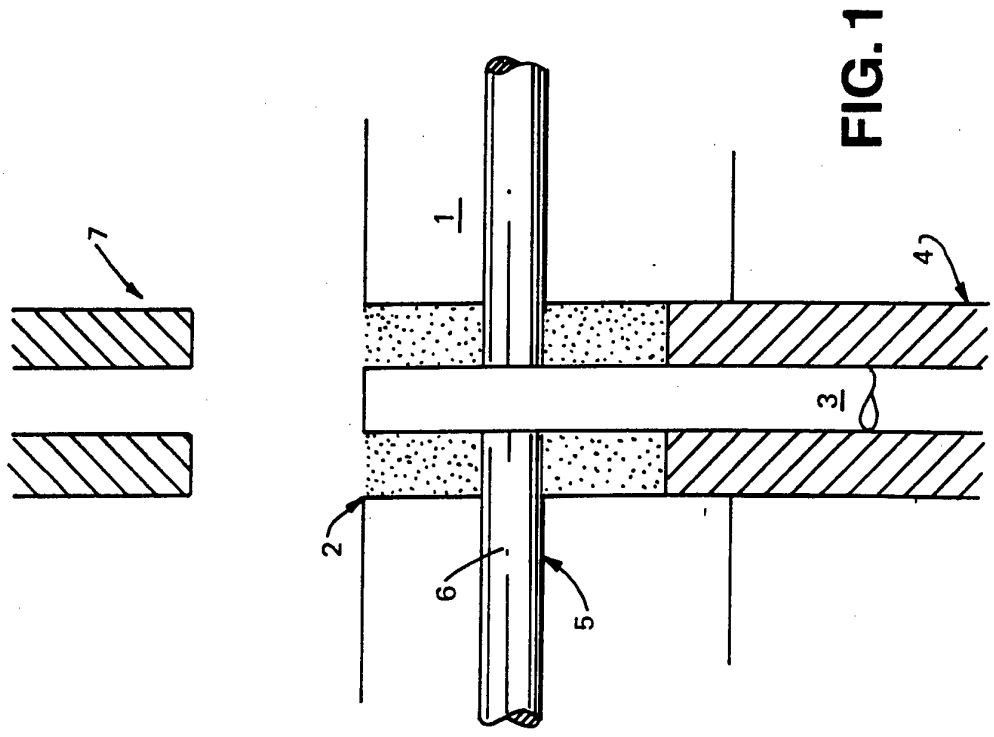


FIG. 1

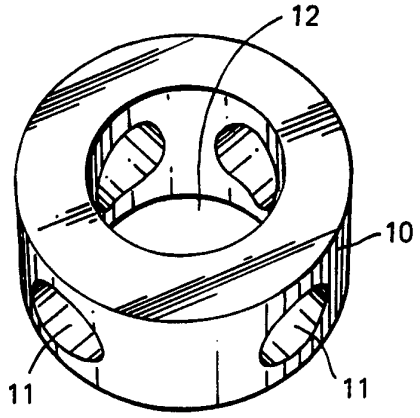


FIG. 3

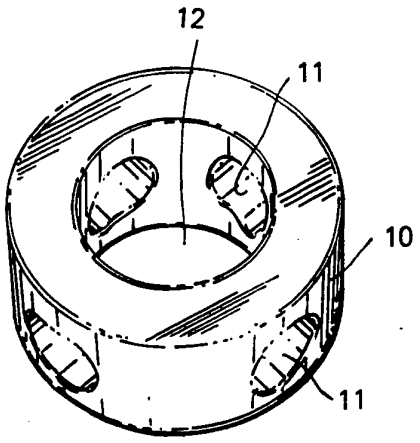


FIG. 4

# INTERNATIONAL SEARCH REPORT

Inter. nal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 B22F5/00 B22F3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 B22F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | DE,A,28 52 429 (OLLING) 13 June 1979<br>see page 5, line 11 - line 16; figures | 1,7 |
| A | DE,A,21 45 006 (SINTERMETALLWERK) 22 March 1973<br>cited in the application<br>see page 4; figure 5 | 1,5,7,8 |
| A | GB,A,1 097 355 (FEDERAL-MOGUL) 3 January 1968<br>cited in the application | |
| A | PATENT ABSTRACTS OF JAPAN<br>vol. 009, no. 261 (M-422)18 October 1985<br>& JP,A,60 108 199 (TOYOTA JIDOSHA KK) 13 June 1985<br>see abstract | |

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[X] Further documents are listed in the continuation of box C.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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| A | FR,A,2 607 740 (AUTOMOBILES PEUGEOT ET CITROEN) 8 December 1986 | |

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

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| DE-A-2145006 | 22-03-73 | GB-A- 1391089 | 16-04-75 |
| | | US-A- 3897531 | 29-07-75 |
| GB-A-1097355 | | NONE | |
| FR-A-2607740 | 10-06-88 | NONE | |