

July 24, 1951

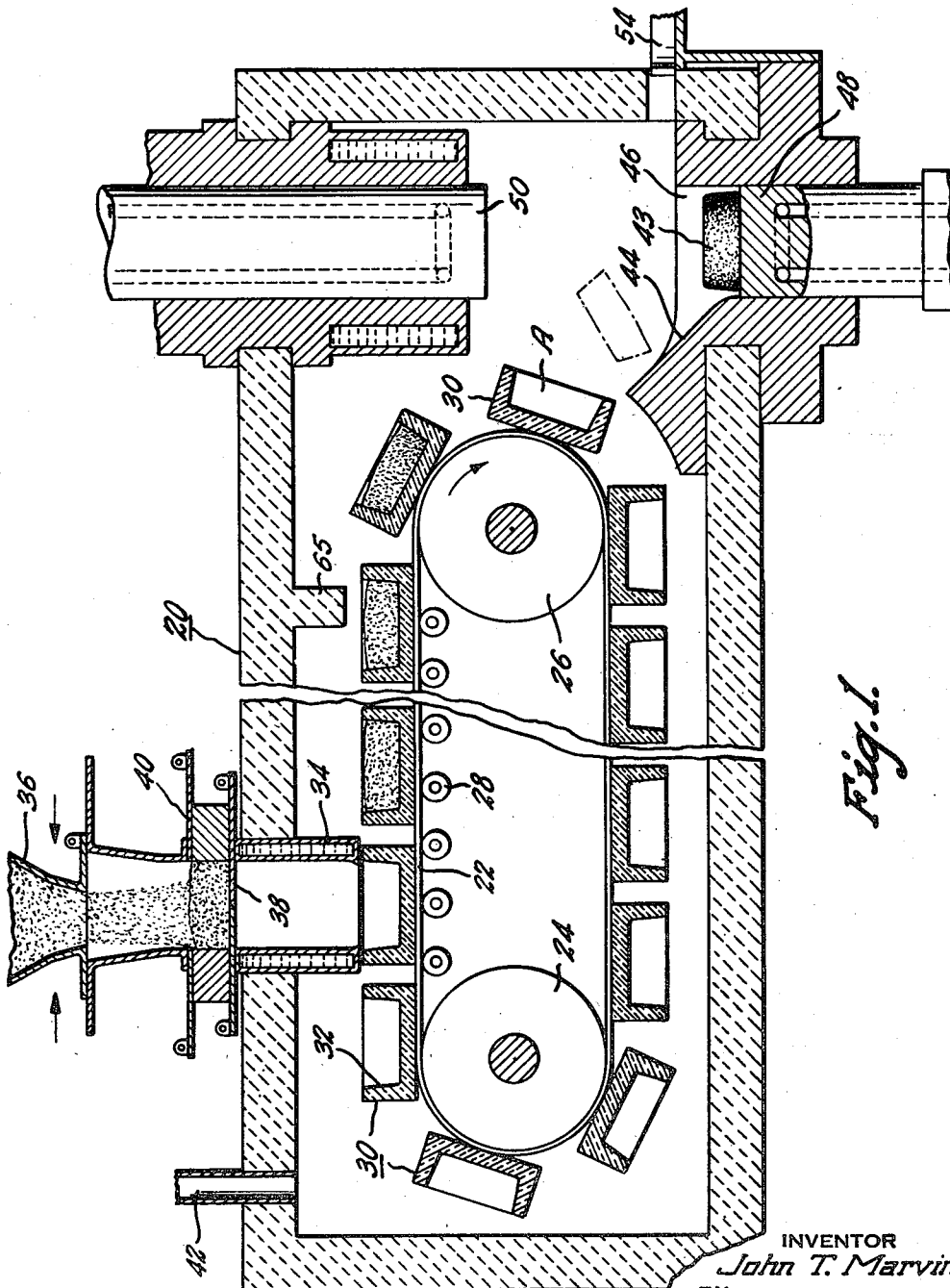
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2,561,583

METHOD OF MAKING ARTICLES FROM METAL POWDER

Original Filed May 15, 1941

2 Sheets-Sheet 1



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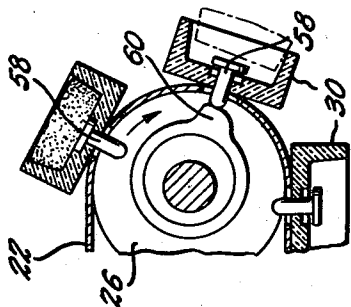


Fig. 4.



Fig. 5.

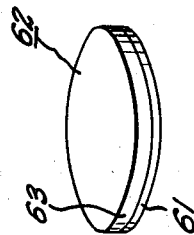


Fig. 6.

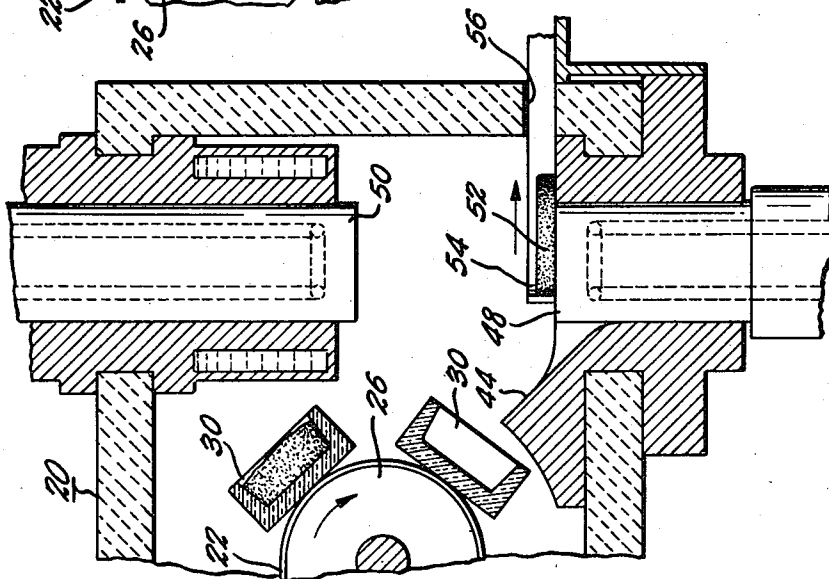


Fig. 3.

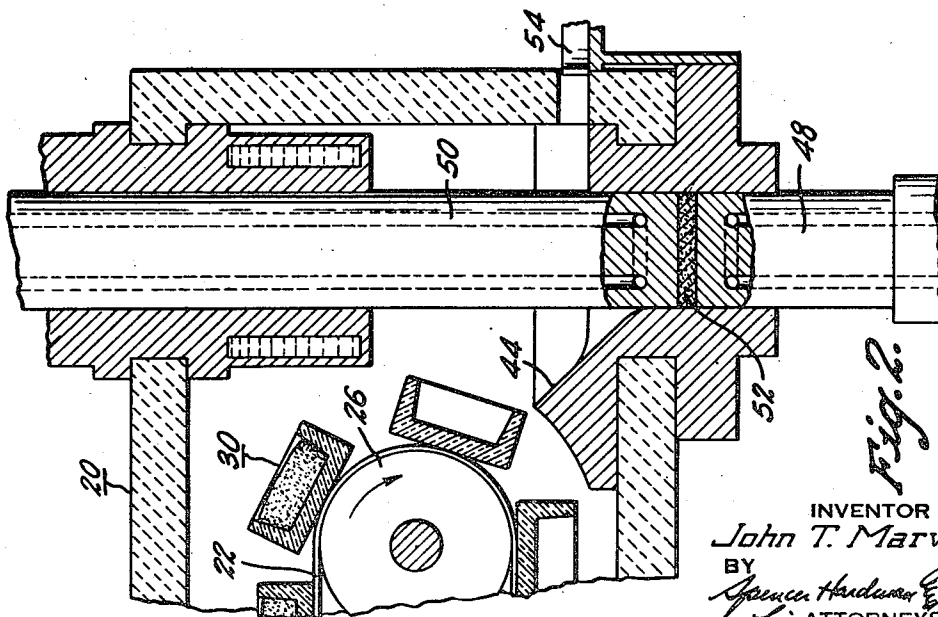


Fig. 2.

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METHOD OF MAKING ARTICLES FROM METAL POWDER

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Original application May 15, 1941, Serial No. 393,610. Divided and this application January 28, 1948, Serial No. 4,843

1 Claim. (Cl. 29—160.5)

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This application is a continuation of Serial No. 393,610, filed May 15, 1941, now abandoned.

This invention relates to a method of making articles from powdered metals and is particularly directed to a method which includes a hot pressing step for consolidating the metal particles into a strong homogeneous article of the exact size and shape desired.

An object of the invention is to provide a method of making articles from metal powder wherein a charge of metal powders in a loose non-compacted condition is heated to a sintering temperature and is then hot pressed to the exact size and shape desired.

A further object of the invention is to accomplish the above object by heating a charge of metal powder to a suitable sintering temperature and then hot pressing measured increments thereof into articles of the desired size and shape.

Another object of the invention is to provide a production method for hot pressing articles of powdered metal wherein the briquetting step heretofore used in the manufacture of such articles is eliminated.

A still further object is to provide a method for making ferrous articles from ferrous metal powders wherein the powder is heated in a loose non-compacted charge and is then delivered to the hot pressing die in measured increments whereupon articles of the desired shape and size are made.

A still further object is to provide a method wherein loose metal powder is molded into blanks of the approximate size and shape desired, which blanks after sintering are hot pressed to the exact size and shape desired.

A further object is to provide a method which is continuous in operation and wherein articles may be manufactured in production quantities without intermediate handling.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

Fig. 1 is a diagrammatic view in section of a sintering furnace which includes a hot pressing die wherein articles may be made continuously from metal powders.

Fig. 2 is a fragmentary view of one end of the furnace showing the die in operation and after a blank has been compressed to the exact size and shape desired.

Fig. 3 is a fragmentary view of the apparatus

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shown in Fig. 1 wherein the article which has been hot pressed is being removed from the die.

Fig. 4 is a fragmentary view of the conveyor belt showing an alternative construction of the mold wherein an ejecting pin is provided.

Fig. 5 is a view in perspective of a disc made in the apparatus shown in Fig. 1.

Fig. 6 is a perspective of a disc which can be made in the apparatus shown in Fig. 1, wherein a steel supporting plate is bonded to the more porous metallic layer which has been formed from metal powders.

The use of metal powders in industry is becoming increasingly important. Articles formed from metal powders may be closely controlled and formed in a multitude of shapes which are difficult and often impossible to cast by conventional casting methods whereby the formation of the article by powder metallurgy permits elimination of the machining steps and difficult casting operations. Articles made from powdered metals in the porous state do not as a rule have as great strength as articles formed by casting and in order to increase this strength hot pressing has been utilized wherein the density of the article is increased and if sufficient pressure is applied approximates the density and strength of articles formed by conventional methods. By utilizing powder metallurgy together with hot pressing it is also possible to use scrap material as a starting product, that is to say, finely comminuted turnings may be sintered together into a self-sustaining mass and may then be hot pressed to the desired size and shape without intermediate operations thereon. It is apparent, of course, that metal powders as they are known to the art may likewise be utilized or may be supplemented by scrap material, if desired.

The present invention is particularly directed to a method wherein powdered metals may be continuously heated to a sintering condition and formed under pressure while hot to articles of the desired size and shape.

In the past, hot pressing has been utilized in connection with briquetted articles, that is to say, metal powder has been briquetted in conventional briquetting presses into self-sustaining objects of a suitable size and shape, which objects are sintered under suitable conditions and are then hot pressed. It is apparent that this hot pressing step reduces the dimensions of the article and therefore the briquetting die must be of a predetermined size greater than the desired size of the finished article. In the present invention, no briquetting is required since the

metal powder is heated into a self-sustaining mass in a loose non-compacted condition whereupon the mass is placed in a hot pressing die and pressed to the desired size and shape. It is often desirable to heat the loose metal powder in blank form in the approximate size and shape ultimately desired and this may be accomplished by utilization of molds made from non-adhering material such as graphite, ceramics, or surface oxidized heat resisting alloys which molds are of the approximate size and shape of the article finally desired and wherein the powder may be sintered as separate increments of the total mass within the furnace after which the blanks are ejected into a hot pressing die wherein the final sizing is accomplished. It is also within the scope of this invention to utilize a charge of metal powder which is progressively heated to a desired temperature and is then ejected in measured increments into a hot pressing die whereupon the die separately compresses each ejected increment into an article of the desired size and shape. Apparatus for accomplishing this result is disclosed in Koehring application Serial No. 415,446, filed October 17, 1941, now matured into Patent No. 2,362,701.

The drawings show one type of apparatus which may be used in the manufacture of discs to be made from powdered metals. In this instance, referring particularly to Fig. 1, 20 designates a furnace which is suitably heated either by electricity or gas and which contains an endless conveyor belt 22 therein which is supported and driven by two rolls 24 and 26. The belt likewise is supported on a plurality of smaller rollers 28 on the upper side thereof. On the belt 22 which is preferably formed from a heat-resisting metal are disposed a plurality of molds 30, which molds are shaped in the approximate size and shape of the article ultimately desired. It is to be noted that the cavity within the molds is suitably tapered to provide draft therein so that the sintered charge may be readily ejected therefrom. The belt 22 with the molds 30 thereon operates in steps whereby a mold is positioned directly under a water cooled chute 34 to be charged with metal powder. The metal powder is preferably fed from a vibrating hopper 36 in a substantially uniform layer upon the surface of a shutter-like gate 38. When sufficient powder is upon the gate 38 a second gate of similar type 40 closes thereover and cuts off any excess metal powder, thereby leaving only a measured quantity between the gates 38 and 40. The gate 38 is then opened, preferably in a manner similar to a shutter on a camera whereupon the metal powder in the space between the gates 38 and 40 drops into the mold 30 directly beneath the chute 34. The gate 38 then shuts and the gate 40 opens through the use of suitable camming mechanism and the belt 22 moves sufficiently to bring the next mold 30 directly under the chute 34 whereupon the operation is repeated. The action of the gate 38 and the movement of belt 22 are synchronized so that the charging of the molds is accomplished without spillage of the metal powder. The molds 30 with a charge of metal powder therein in non-compacted condition next pass through the furnace which is maintained under suitable conditions by the introduction of a suitable controlled atmosphere through pipe 42. As the belt 22 goes around roll 26 to the position of mold 30, shown at A, the sintered or coalesced blank 43 of metal powder is dumped down a chute 44 into a die 46 on top

of a plunger 48. The plunger cooperates with an upper plunger 50, said plunger being synchronized with the belt 22 whereby action occurring in Fig. 2 is accomplished, wherein both plungers 48 and 50 move downwardly with plunger 50 moving through a greater distance than plunger 48 to press the blank into an article 52 of the desired shape. The next step of the process is shown in Fig. 3 wherein the plunger 50 recedes and the plunger 48 moves the article 52 upwardly whereupon it is ejected by means of ejector 54 through the opening 56 out of the furnace. The article 52 may be withdrawn through opening 56 into a controlled atmosphere chamber for cooling, or it may be taken directly out into the air if oxidation is not detrimental to its intended use, or if it is desired it may be dumped into a quenching tank containing any suitable quench which is well known in the art. It will be noted, that the present die equipment is preferably water cooled to prevent overheating thereof and likewise it will also be noted that the molds 30 at no time leave the furnace so that the heat contained therein is not lost. This is important from a continuous operation standpoint since the mass of the molds is often greater than the mass of metal powder being sintered therein and thereby includes a large amount of heat utilized within the furnace. By the present apparatus this heat is not lost and once the apparatus is brought up to the desired temperature, the only heat required to maintain the temperature is that required for usual radiation loss together with the heat required for sintering the metal powder.

In some instances the metal powder after sintering thereof may adhere slightly to the walls of the mold. This does not usually occur since metal powder in loose non-compacted condition usually shrinks to some extent. However, when using oxidized metal molds, or the like, adherence is sometimes noted which is sufficient to prevent easy dumping of the blanks from the molds. In order to overcome this difficulty, when necessary, ejecting pins 58 may be provided in the bottoms of the molds, as shown in Fig. 4. These pins are contacted by a cam 60 which rotates independently of the roll 26 and which cam 60 causes pin 58 to move inwardly when the mold 30 is in the right position for ejection. This action is shown clearly in Fig. 4. The finished metal article which may be formed in the apparatus depicted herein is a plate 52, as shown in Fig. 5.

If desired, steel discs 61 may be positioned in the bottom of the molds 30 whereupon composite articles such as discs 62 shown in Fig. 6, having a steel plate 61 with a more porous layer 63 bonded thereto may be fabricated.

It is manifest that the particular shape of mold is not a limiting factor in the present invention and that molds of various shapes may be utilized, the prime purpose thereof being to provide a receptacle for sintering or coalescing the metal powder wherein the metal powder approximates the size and shape of the finished article and of most importance includes a predetermined quantity of metal powder so that during the hot pressing operation substantially no excess metal powder is apparent.

Other types of apparatus for carrying out this method may be utilized, the diagrammatic showing herein being directed to one form only for illustrative purposes; likewise the molds may be filled manually if desired. The use of various

metal powders may also be utilized, for example, articles may be formed which have the usual bronze formula, 90% copper and 10% tin and which also may include zinc and graphite, if desired. In this instance with the charging mechanism utilized, it is preferable to use powders having a constituent rich surface, that is to say, have the constituent metals held mechanically or metallurgically in relative positions so that segregation does not occur although this expedient is not necessary when using some other types of equipment. Likewise, other metal powders or mixtures may be used, for example, copper-nickel, iron-copper, iron, steel powders or any other type of metal powder from which articles of commercial use may be formed. Sintering temperatures and times are well known in the art, for example, when sintering copper-tin mixtures, it is preferable to utilize a temperature of from 1200° to 1800°. Likewise, when sintering copper-nickel, it is desirable that the sintering temperature be above 1981° F., the melting point of copper but below the melting point of nickel preferably in the range of 2,000° to 2,100° F. When sintering iron powders, a temperature of from 1800° to 2400° F. is preferred. Similarly, steel powders and other iron alloys may be sintered within this range. However, the particular times and temperatures are not limiting since it is apparent that any time and temperature which will provide the desired result is adequate.

It is important, however, that the blanks of metal powder should be relatively hot when placed in the hot pressing die. In the case of iron or other ferrous metal blanks this temperature should be above 1200° F., and it is obvious that as the temperature increases, the hot pressing step is simplified, since the higher the temperature of the metal blank, the more easily it may be compressed. These temperatures therefore are best arrived at by trial for the particular piece in question. The temperature may be regulated at the die by the use of a baffle within the furnace wherein the molds with the charge of powder therein can be cooled to a predetermined

temperature before ejection of the charge, or the charge may be ejected within the furnace at its maximum temperature as the particular case may require.

The term powder in the appended claims includes metal powders of all types such as electrolytic, reduced oxide, atomized, broken up chips and/or turnings or mixtures thereof.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claim which follows.

What is claimed is as follows:

- 15 The steps in the method of making ferrous articles from ferrous metal powders, consisting of; filling a mold of the approximate shape of the article ultimately desired with ferrous metal powder in the non-compacted condition; heating the mold with metal powder therein under suitable controlled atmospheric conditions to a temperature of from 1800° to 2400° F., and for a time period sufficient to cause coalescence; removing the ferrous article from the mold; and then hot pressing the article under suitable conditions to the exact size and shape desired.

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