Aug. 23, 1949. F. DE MARINIS 2,480,076

METHOD OF MANUFACTURING FRICTION PLATES

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Fig. 1

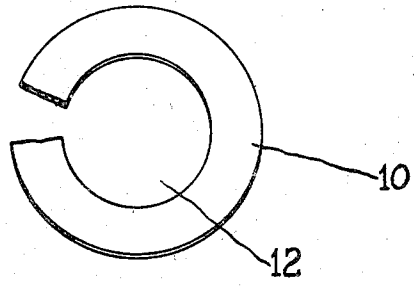
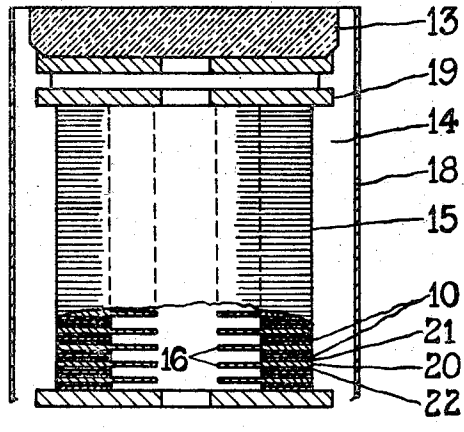


Fig. 2



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METHOD OF MANUFACTURING FRICTION PLATES

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2 Claims. (Cl. 29—189)

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This invention relates to metallurgical apparatus and more particularly to furnace separator members used in the formation of bearings, friction elements, disks, and the like, from powdered material.

One of the objects of the invention is the provision of a new and improved furnace separator that under pressure and high temperatures will have a comparatively low thermal coefficient of expansion, a high creep strength, and that will have a smooth surface that will not bond to powdered metal during sintering operations.

Another object of the invention is the provision of a new and improved furnace separator that is corrosion resistant to a large extent under sintering conditions of powdered metal.

A further object of the invention is the provision of a new and improved furnace separator member that leaves the sintered article with a smooth and even surface on the side or sides of the article after the sintering and compressing operation has been completed.

A still further object of the invention is the provision of a new and improved furnace separator member that will not be deleteriously affected by gases escaping from the powdered metal during the sintering and pressing operation; that will be capable of withstanding high temperatures without serious changes or deterioration; one in which its physical properties will not change under either the reducing or the oxidizing atmospheres of the furnace; and one that will not bond with lead or other ingredients of the mix sweated out when the furnace is allowed inadvertently to attain higher than normal brazing temperatures.

Another object of the invention is the provision of a new and improved furnace separator that is normally stable in structure, undergoes a minimum physical or chemical change under pressures and high temperatures and that is relatively inexpensive to construct.

Other and further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawings in which

Fig. 1 is a perspective view of one of the separator members, with parts broken away;

Fig. 2 is a sectional view of a portion of a heat treating furnace showing the invention in position therein.

In the manufacture of articles from powdered material the major portion of which is powdered metal a considerable amount of heat and pressure is applied. The temperature must be such

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as to sinter the entire mass of powdered metal and the pressure such as to produce a solid article by causing the sintered metallic particles to coalesce, fuse or weld. In the production of friction disks the temperatures may be around from 1450° to 1900° F. or even more or sometimes less depending on the quality of the powdered material. It is usually around 1450° F. The pressures may be from 100 to 250 pounds per square inch or even higher. Here again the type of material must be considered.

In commercial production, the powdered material including powdered metal is first subjected to a briquetting operation, i. e., it is first evenly distributed in a mold and then considerable pressure, say around 11 tons per square inch, is applied to form briquettes or cookies as they are referred to in the art. These cookies are then placed on a metal backing member or in certain instances, the backing member is a core sandwiched between two cookies thus forming a disc assembly unit. This core or backing member is of such material, or its surfaces have been so treated, that the cooky, or cookies, under the proper amount of heat and pressure will become sintered and bonded to the core or backing member forming therewith a unitary structure such as a clutch disk or the like.

On a production basis, it is impractical to treat each article separately so the articles are built up in stacks, as they are called, that is, in vertical columns, which may be easily and readily done where the articles are flat as discs or clutch plates. They are stacked in heat treating presses or furnaces where the outside air is prevented from entering during the operation and heat and pressure simultaneously applied. During the sintering operation the air within the chamber is caused to change from an oxidizing to a reducing atmosphere by the use of charcoal and gas or like material in the furnace as disclosed in United States patent to Wellman, 2,258,431, Oct. 7, 1941.

In order to prevent the bonding of the entire mass of the stacks together during the heat treating operation, separator plates are inserted between the different disk assemblies. These separator plates must be of such material, or the surfaces thereof of such material, or be graphited, or otherwise treated so as to prevent the adjacent cookies from becoming bonded together.

It is common practice to employ separators of steel or like material by first painting the surfaces with a water suspension of graphite for preventing the briquettes from bonding to the sur-

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faces thereof. But this requires time and labor and it must be done each time. The surface of the separator after it is thus painted is not smooth and even, thus causing the surface of the work to be more or less uneven and pitted. Furthermore, a separator plate of common steel is seriously objectionable because of the expansion, creep, and warping thereof thus requiring frequent replacements.

All metallic articles have a thermal coefficient of expansion and in certain metals this is much lower than in others. Under continued application of high temperatures and pressures, these articles become permanently distorted or expanded and are said to "creep" or "grow." This growth increases with the pressure and also increases with the temperature applied in making the articles.

The resistance of the material to this permanent deformation or growth is known or referred to in the art as "creep strength." In the manufacture of certain types of articles of powdered material the amount of creep strength of the metallic separators employed is not so material, as where the articles are plane surfaces continuous throughout their extent or the tolerances are large, while in others such as disks having hubs or axial openings or the tolerances are small, the creep strength of the separators becomes very important for the separators must be of such dimensions as to separate all portions of the cookies of one assembly from those of the adjacent assemblies as otherwise the adjacent assemblies may become bonded together at their non-separated points. A peculiarity of a metal plate separator in the form of an annulus when subjected to high temperatures and pressures is that it tends to become permanently distorted or enlarged radially outwardly during continued use so that its inner as well as its outer diameter is increased. It will thus be seen that unless the annulus has great creep strength, it can be used only a few times as a furnace separator before its inner diameter becomes so enlarged as not to properly protect or separate the surfaces of the cookie adjacent the axial opening thereof against bonding to an adjacent cooky during the sintering operation.

During the numerous experiments that were conducted in an effort to discover a furnace separator that would be satisfactory under the various conditions incident to the manufacture of friction plates, disks, and the like, having friction surfaces made from powdered material, it was discovered that the expansion of the separator causes a corresponding expansion and consequent growth of the cores or backing members to which the cookies are bonded. In other words, the expansion of the separator drags the core along with it. If the expansion of the separators is great the expansion of the cores or backing members will likewise be great and vice versa. This is true irrespective of the type of material of the separator or core. It is also immaterial whether or not the separators have been graphited. This peculiar characteristic of the expansion of the separator member causing a correspondent expansion of the cores is not well understood, but a large number of experiments with different materials have demonstrated that it is true.

A peculiar characteristic of growth of cores of friction disk assemblies is that, contrary to expectation, the growth of the cores when sandwiched between separators of unlike material is somewhat below the average of that of the two

materials when taken separately. For instance, in one case the growth of the core sandwiched between two separators of one material was .0324" O. D. and between separators of another material was .0076" O. D. while sandwiched between one of each of these materials was .0125" O. D., much below the average of the two. It is evidently desirable that the furnace separators be of a material that has a high creep strength, as otherwise the growth of the steel cores may be objectional and require too frequent replacement of separators or trimming of cores, or both.

Another serious objection to the expansion of the separator members is that when their diameters increase through continued use it is difficult unless they are trimmed to aline the briquette and cores in the furnace preparatory to the brazing operation.

Certain alloys have a low coefficient of expansion. "Invar" for instance, which has a composition roughly of 33 to 36% nickel and the remainder steel, has practically zero coefficient of expansion but only at comaratively low temperatures say below 700° F. but sintering temperatures are much higher than this.

In order that a furnace separator shall be satisfactory for commercial use, it must have, at least, the following characteristics to a maximum extent:

1. It must have a high creep strength;
2. It must have a low thermal coefficient of expansion:
3. It must not bond to the work:
4. It must have a smooth surface under operating conditions and leave a smooth, unpitted surface on the work when the latter is removed from the furnace.
5. The surfaces of the separator must not be seriously affected by the furnace atmosphere or by the gases escaping from the sintering material and must have a minimum tendency to bond with lead or other metal sweated out when the furnace is allowed inadvertently to attain higher than normal brazing temperatures.
6. It must not warp on continuous heating and cooling.
7. It must not affect the frictional properties of the sintered friction material.
8. If a plated separator is used the plating must be adherent to the base metal under continued operating conditions.

Numerous materials have certain of these requirements but are unsuited because of their lack of other requirements. For instance, certain chromium steel alloys will not stick to the work but have objectionably high coefficient of expansion. On the other hand, there are certain nickel-steel alloys that have high creep strength but these will adhere to the work and also have objectionably high coefficients of expansion. It appears that in steel alloys having chromium therein, the chromium probably forms a chromium oxide on the surface of the plate or separator after being heated and this oxide does not adhere to the briquettes in the sintering operation. A large number of experiments indicate that a material that has a high creep strength at the temperatures and pressures employed does not undergo a phase change during the brazing operation.

The experiments also indicated that no commercial steels in the ferritic group have sufficiently high creep strength to be practical. There are a number of alloys in the austenitic group that have this peculiar property of high creep

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strength but have a high thermal coefficient of expansion, which is objectionable.

It was found that a nickel-chromium-steel alloy of approximately the following analysis was admirably adapted for this type of use:

(1)

Cr	25–35%
Ni	3–5%
Mo	1–1.5%
C	as desired. Usually around .15%
Fe	remainder

It will be noted that in this formula iron is the major ingredient. The creep strength of this material is such that it may be used over and over again a great many times before its growth is such that it must be replaced.

Material having approximately the following analysis may be used but its high cost limits its use.

(2)

	Percent
Cr	11–15
Ni	70–80
Mn (maximum)	1
Fe	6–10
Si	0.5
C	0.15

Not all nickel-chromium-steel alloys have a low coefficient of expansion, a high creep strength and a surface to which the briquettes will not bond under sintering conditions. For example, separators of the material of Number 1 analysis have many advantages over the conventional stainless steel (18% Cr, 8% Ni, Rem Fe) some of which are as follows:

1. It is easier and faster to set up the work with Number 1 separators.

2. Separators of Number 1 may be heated to higher temperatures than 18–8 stainless steel without injuriously affecting them.

3. Separators of Number 1 material are stronger and harder than those made of Number 2 and therefore do not bend so easily.

4. The use of separators of Number 1 material causes much less expansion or growth in the final product.

A large number of the experiments were made in the manufacture of friction disks having cores of 12.7'' O. D. (outside diameter). The separators were annular with an O. D. (outside diameter) of 12.875'' and an I. D. (inside diameter) of 10.5'' and were around .025'' to .070'' in thickness. While the powdered material including powdered metal may be changed or the proportions given may be varied within wide limits, the powdered material used had approximately the following analysis:

(3)

	Percent
Cu	60–75
Sn	4–10
Fe	5–10
SiO_2	2–7
Graphite	3–10

Referring now to the drawings, the reference character 10 designates a separator plate which in the form selected to illustrate one embodiment of the invention comprises a disk-like member having an axial opening 12 therethrough. The thickness of the disk may vary considerably, but in the form shown is as indicated above approximately .025'' and about 12.875'' O. D. and around 10.5'' I. D., the inner and outer diameters of these separators may vary within very wide limits. The material of the disk is substantially that outlined in analysis (1) above.

The furnace 13 within which the friction disks are heat treated is substantially the same as that shown in Fig. 8 of patent to Wellman, referred to above and need not here be described in detail any further than to state that the heating chamber is shown at 14 and the stack 15 of friction disks 16 and separators 10 are placed within the protecting air seal structure 18 within the furnace beneath the pressure block 19. As shown in Fig. 2 the stack 15 comprises a series of friction disks assembly units 16 alternating with the separator plates 10. The friction disks each comprises a steel core 20, Fig. 2, the surfaces of which have been treated by copper plating or the like to cause the cookies to bond thereon and briquettes or cookies of powdered material 21, and 22 are sintered and bonded on one or both sides of the core to form a disk assembly unit. The separators 10 alternate with these assembly units. When the stack is in position, the furnace is heated to the proper temperature which is usually around 1450° F., sometimes higher, depending on the mix of powdered material and simultaneously a pressure of from 100 to 250 pounds per square inch is applied for causing the sintering of the briquette and its bonding to the surfaces of the steel cores.

The separators being of material that has a low coefficient of expansion, a high creep strength and a surface to which the briquettes will not adhere cooperate to prevent enlargement or growth of the friction discs during the sintering operation. This is considered an important feature of the invention while the thickness and diameters of the separators are given, this is by way of example only as these dimensions may vary, as desired.

While the type of separators herein disclosed is useful in the bonding of powdered metal onto disks and annular plates for use on brakes and clutches, it is understood that it is intended to be used in the sintering and bonding of powdered metal briquettes or cookies to cores and backing members for forming or manufacturing plates for use in various relations.

It is thought from the foregoing, taken in connection with the accompanying drawing, that the use of my device will be apparent to those skilled in the art and that changes in size, shape, proportions and composition of the material may be made without departing from the scope and spirit of the appended claims.

I claim as my invention—

1. A method of sintering and bonding briquettes of powdered material to metallic cores with a minimum amount of growth of said cores under high pressure and high temperature conditions which comprises conditioning at least one selected surface of each core, positioning a briquette of powdered material on each of said prepared surfaces to form a plate assembly, positioning the plate assembly between two separator plates of an alloy comprising chromium approximately 25 to 35%, nickel approximately 3 to 5%, carbon .15%, and the remainder principally ferrous material, applying pressure around 100 to 250 pounds per square inch at a temperature around 1450° F. to each plate assembly and simultaneously inhibiting creep of said cores while under said pressure and temperature.

2. A method of manufacturing friction plates from metallic cores and briquettes of powdered

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material which comprises copperizing at least one surface of each of said metallic cores, positioning briquettes of powdered material, comprising powdered copper and tin as the principal ingredients and silica, carbon, and ferrous material, in contact with said copperized surfaces to form assemblies, arranging said assemblies in stacks alternating with separator members comprising thin separator plates of an alloy comprising chromium about 25 to 35%, nickel about 3 to 5%, carbon about .15% and the remainder ferrous material, subjecting said stack to a pressure of from 100 to 250 pounds per square inch at a temperature around 1450° F. and simultaneously inhibiting the creep of said cores and causing the bonding of said briquettes to said cores.

FRANK DE MARINIS.

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