July 5, 1938. C. BOCKIUS ET AL 2,122,405

METALLIC INLAID FRICTION SURFACE

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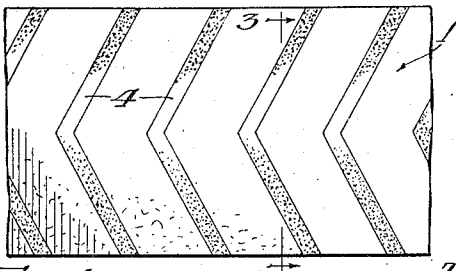


Fig. 1.

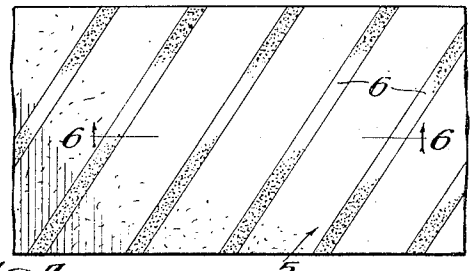


Fig. 4.

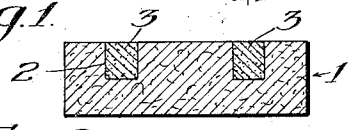


Fig. 2.

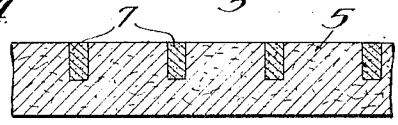


Fig. 5.

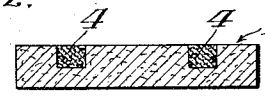


Fig. 3.

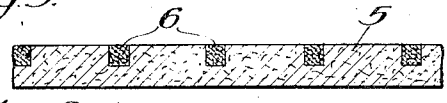


Fig. 6.

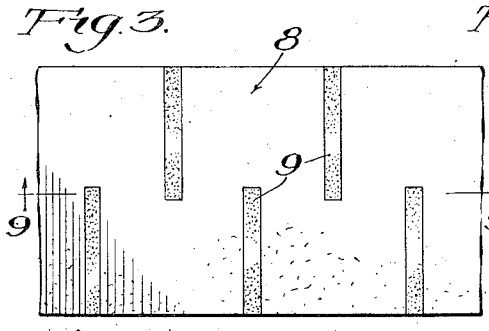


Fig. 7.

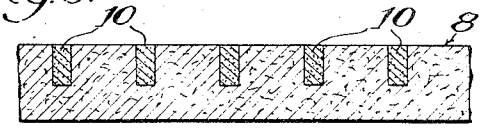


Fig. 8.

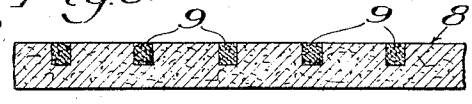


Fig. 9.

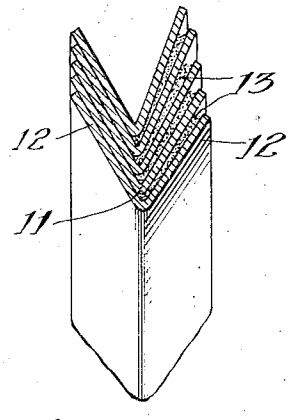


Fig. 10.

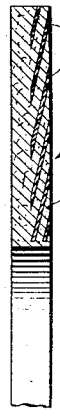


Fig. 12.

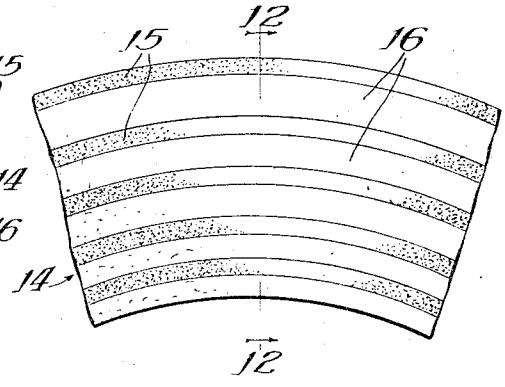


Fig. 11.

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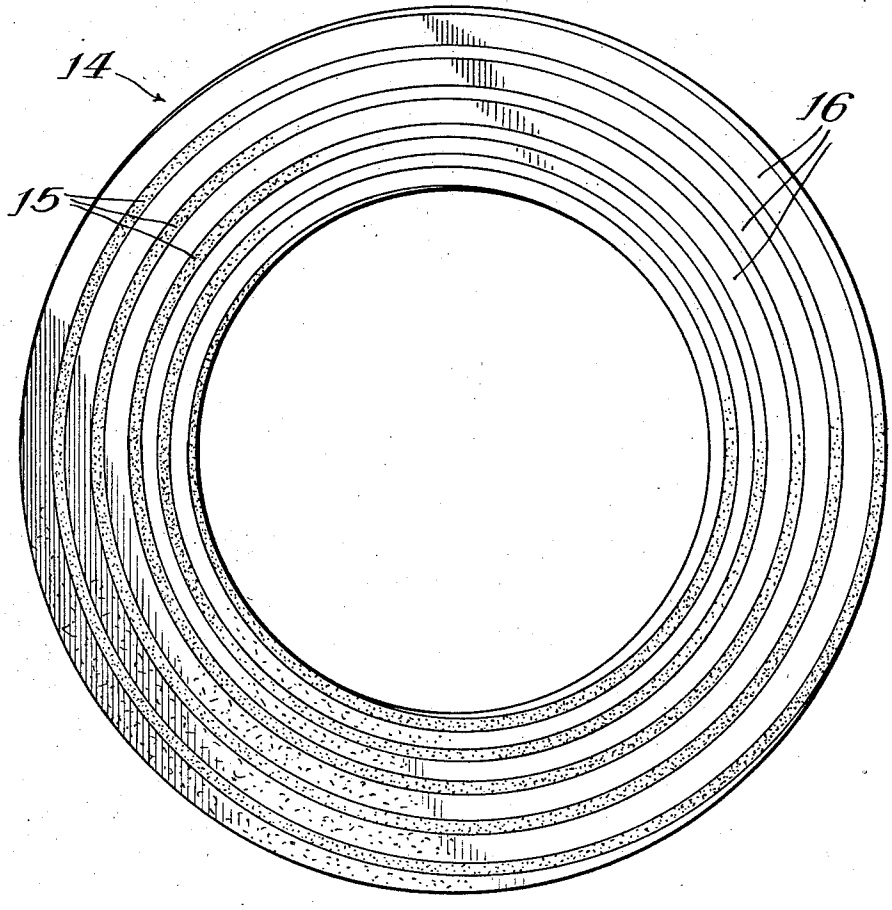
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METALLIC INLAID FRICTION SURFACE

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Fig. 13.



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UNITED STATES PATENT OFFICE

2,122,405

METALLIC INLAID FRICTION SURFACE

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Application January 23, 1937, Serial No. 121,930

10 Claims. (Cl. 188—251)

This invention relates to improvements in friction materials and refers specifically to a friction material and a process of making the same wherein metal inlays derived from powdered metal are incorporated in the body of the friction element.

It is well recognized that the presence of certain types of metals or alloys at the engaging surface of a friction material during engagement imparts a desired frictional quality. At relatively low engaging temperatures low melting point metals function in a desirable manner. However, at relatively high engaging temperatures, the low melting point metals liquefy and are lost.

To obtain the advantages of metals at relatively high engaging temperatures, it has heretofore been proposed to incorporate relatively high melting point metals in the friction material, either alone, in the form of alloys or with metals of lower melting point. However, due to the manner of incorporating such metals, the metals have functioned individually and with little or no cooperative effect. That is, at low engaging temperatures, if low melting point and high melting point metals are used, the low melting point metal will plasticize and eventually liquefy. During this period the high melting point metal will not be appreciably changed nor will it impart any useful function, in fact, it may cause scoring. If and when the engaging temperature reaches the melting point or the point where appreciable plasticity of the higher melting point metal occurs, the lower melting point metal will have long since liquefied and the available supply thereof will have been lost. However, in most cases the engaging temperature never rises to the point where appreciable benefit may be obtained from the higher melting point metal.

This indifferent and unsatisfactory condition, we have found, is primarily due to the improper association of the metals in the friction material. For instance, one well known practice consists in homogeneously mixing metal powders of different type metals with the friction material. Although some beneficial results have been obtained, at lower engaging temperatures, little or no benefit has been obtained from the higher melting point metals either at high or low engaging temperatures. Again, metal wires of different physical characteristics have been used with substantially the same effect. Metal inserts have also been proposed comprising blocks or buttons of metal, the metal inserts of different characteristics being spaced from each other by the base material of the friction element. Here, again, indifferent success has been obtained.

We have found that if relatively soft metals of comparatively low melting point are properly associated with ductile metals of relatively high melting point, the first mentioned metal, in some manner, influences the properties of the higher melting point metal so that a metallic film is secured by which desirable frictional engagement is obtained at an extremely wide range of engagement temperatures. In addition, the higher melting point metal will not tend to produce scoring at low engagement temperature, nor will the supply of low melting point metal be materially depleted or lost at high engagement temperatures.

Briefly described, our invention contemplates the incorporation of the powder of two or more metals of different physical properties into a friction material, the metal powders forming, when the friction material is finished, inlays each composed of said metals. The metals comprise at least one soft metal of relatively low melting point and at least one ductile metal of relatively high melting point. The softer metal thus brought into intimate relationship with the ductile metal of higher melting point appears to act upon (either chemically or physically) the higher melting point metal and so modify the characteristics of the latter as to form a film which is unattainable with either of the metals alone or with both metals not associated in the manner described.

Broadly our invention contemplates a friction material carrying such metals in intimate association irrespective of the manner of application of the metals to the base material or the state of the metal during application. Another aspect of the invention resides in the application of the metals to the friction base material in powdered form resulting in inlays in the finished friction material.

Other objects and advantages of our invention will be apparent from the accompanying drawings and following detailed description.

In the drawings, Fig. 1 is a fragmentary face view of a friction material provided with powdered metal inlays.

Fig. 2 is a sectional view of the friction element shown in Fig. 1 before compression or cure.

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1, illustrating the same section as shown in Fig. 2 after compression and cure.

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Fig. 4 is a view similar to Fig. 1 of a slightly modified form of our invention.

Fig. 5 is a sectional view through the element shown in Fig. 4 before compression.

Fig. 6 is a sectional view taken on line 6—6 of Fig. 4.

Fig. 7 is a fragmentary face view of a friction material illustrating another modification of our invention.

Fig. 8 is a sectional view thereof before compression or cure.

Fig. 9 is a sectional view taken on line 9—9 of Fig. 7.

Fig. 10 is a cross-sectional view of a portion of a spirally wound clutch facing carrying powdered metal between the convolutions of the spiral adjacent the working face of the facing.

Fig. 11 is a fragmentary face view of the facing after compression and cure.

Fig. 12 is a sectional view taken on line 12—12 of Fig. 11.

Fig. 13 is a face view of a spirally wound facing having a spiral metal inlay.

Referring in detail to the drawings, 1 indicates a fragmentary portion of a friction element such, for example, as used for clutch facings or brake linings. The element 1 is illustrated as an unwoven friction material such as a molded, sheeted or extruded material comprising essentially asbestos and a binder, preferably a heat hardenable binder. However, as will be apparent hereinafter, our invention is equally applicable to woven friction elements as well as to those of the unwoven type.

During or after the formation of the element 1, and before compression and cure, recesses 2 are provided in one face of the element, preferably opening to the working face of the element. The recesses may be of any desired shape and any desired number thereof may be provided in a predetermined area of the face of the element. The recesses are provided to a depth sufficiently below the surface of the element to provide adequate anchorage for the metal inlays hereinafter described.

Prior to compression and cure of the element, as illustrated in Fig. 2, powdered metal 3 is positioned in each of the recesses 2. After compression and cure, as illustrated in Figs. 1 and 3, the element 1 is reduced in thickness and the powdered metal 3 appears as metal inlays 4, the surfaces of which are adjacent to, or flush with the surface of the element. Of course, during or after the compression step the element is heat treated to cure the binder and under some circumstances the element is baked at a temperature as high as 550° F. However, it is not necessary to heat treat or sinter the metal inlays in any way other than the heat required to cure and bake the element. It is possible to heat treat or bake the element up to 800° F., the approximate breakdown point of asbestos. In cases where the mechanical interlock between the inlays 4 and friction element base offers poor support and crumbling of the inlay might occur, the higher temperature treatment has advantages. However, in general practice, it is usually unnecessary to employ heat other than required to cure and bake the element.

The composition of the metal powder inlay may vary considerably but preferably comprises at least a soft metal of relatively low melting point and a relatively ductile metal of comparatively high melting point. Metals which have been found exceptionally suitable are copper, lead, tin, zinc, aluminum and soft iron. It is to be understood that these metals may be used in any desired mixture or alloys of some of said metals may be used with other metals or alloys of other of said metals. When the metals comprising the inlays 4 contact the opposing member (the brake drum or clutch pressure plate, in the case of a brake lining or clutch facing), the metals smear and form a relatively light or thin film, possibly mixed with some of the binder compound which is abraded from the body of the element, over substantially the entire surface of said opposing member. The metallic film so formed may or may not alloy, depending upon the metals and the working temperature of the surface.

As has been hereinbefore described, it is preferable that metals or alloys be chosen on the basis of their relative ductility and melting point, and that a mixture is preferably employed comprising a soft metal of relatively low melting point and a relatively ductile metal of comparatively high melting point. For example, we have found that solder (an alloy of lead and tin) and copper form a desirable film on the working faces. It appears that the solder, the soft metal of low melting point, acts to assist the copper to form a composite film having desired properties which film would not be formed by the solder or copper acting alone or being present in the friction base in a less intimate relationship.

When solder and copper are employed the inlay may comprise about forty to seventy percent copper, ten to fifty percent lead and naught to thirty percent tin. Undoubtedly some alloying of the copper and tin occurs in operation, that is, at the working face, but whether this is so or not, the desirable results are obtained. The properties of the above mixture or combination may be changed by changing the proportion of the metals or by adding additional metals. Of course, this example is not to be construed as a limitation since various other mixtures, combinations or alloys may be employed.

The presence of the soft metal of relatively low melting point, of course, imparts desirable frictional qualities particularly at low temperatures. The presence of the ductile metal of higher melting point gives the film a degree of stability against heat and acts as a seal of the surface of the friction element hindering volatilization of the binder and reducing so-called "bleeding" of the binder. In addition, the presence of the film on the face of the friction material including the exposed faces of the inlays, prevents excessive liquefication of the softer metal of low melting point at higher working temperatures. Obviously, this prevents loss of the softer metals after repeated cycles of high working temperature. The inlay, together with the film, has an unusually high resistance to wear probably attributable to the fact that plastic or semi-plastic metal is abraded from the element and is redeposited in a new location on the working surfaces.

The coefficient of friction may be varied by changing the type or types of metals in the inlays, for example, the addition or increase of lead or tin to an inlay containing copper lowers the coefficient of friction and improves the smoothness of operation, while increasing the copper or adding aluminum increases the coefficient of friction.

Referring particularly to Figs. 4, 5 and 6, 5 indicates a friction element having inlays 6 disposed in the friction material in a slightly modified manner. In this case the inlays are

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disposed diagonally in spaced relationship across the width of the element. Similar to the form shown in Figs. 1, 2 and 3, the inlays are deposited in powdered form, as indicated at 7 in Fig. 5, before the element 5 is compressed, cured and baked.

In Figs. 7, 8 and 9, another form is shown wherein 8 indicates the friction element having inlays 9 which extend in staggered relationship from opposite edges of the element. Similar to the forms hereinbefore described, the metal powders are deposited in preformed recesses, as indicated at 10 in Fig. 8; the element being subsequently pressed, cured and, if desired, baked.

Referring particularly to Figs. 10, 11, 12 and 13, our invention is illustrated as applied to a commercial form of clutch facing known to the art as a "Chevron" facing. In this type of facing a woven strip is folded longitudinally and wound in spiral fashion in an internested manner, as shown at 11 in Fig. 10. In the construction of this type of facing the strip is initially wound relatively loosely whereby the arms 12 of the V-sections are spaced from each other in a divergent manner. The spaces between the adjacent V-sectioned convolutions inherently afford spaces in which powdered metal 13 may be deposited. Preferably the metal is deposited only adjacent one face of the element, but if relatively high heat conductance is sought, the metal may be deposited adjacent both faces.

The powdered metal may comprise any mixture or combination of metals hereinbefore mentioned and may be deposited or inserted in the facing manually or by means of a hopper (not shown). After the insertion of the metal powders, the facing is compressed at about 5,000 pounds per square inch or higher, cured and baked if necessary, producing an element such as that shown at 14 in Figs. 11, 12 and 13. It will be seen that in the facing 14 a spiral body of metal 15 appears at the surface of the facing interspersed by spiral friction material 16.

If desired, the metal powder may be inserted in the recesses in the elements 1, 5 or 8 and between the arms 12 in facing 14 by extrusion. In this case a mixture of 5% bentonite clay, 5% resin and 90% powdered metal may be made into a paste by adding about twice its weight of water and such paste may be extruded into the recesses or interstices. After extruding the facing is dried, pressed, cured and baked in the usual manner. In such mixtures, the proportions of the selected metal content should be as high as possible consistent with the ability of the mix to flow through the orifice of the extruding head and retain the metal particles in suspension, so that the property of the compressed metallic inlay to smear and form the metallic film heretofore referred to is not appreciably diminished.

Another manner in which the desired association of the powdered metals may be brought about comprises mixing the selected powdered metals and compressing the same into briquets. To accomplish this, the mixed powdered metals are placed in a mold and pressed at 5,000 to 25,000 pounds per square inch or more. In this case the briquets so formed are fitted into slots or recesses pre-formed in the uncured or semi-cured friction material which may comprise woven, molded, sheeted or extruded friction material comprising essentially asbestos and a heat hardenable binder. After insertion of the briquets, the element is finish cured at full temperature and pressure. The element is then compressed around the inserted briquet, locking it securely in place.

For most work it is not necessary to sinter the briquet, but where the support or backing of the block is not good, we have found it desirable to slightly sinter the briquet in an inert atmosphere before insertion only to the extent necessary to improve the structural strength of the briquet.

The briquets may be formed of any of the mixtures, combinations or alloys hereinbefore described and for example the following mixtures are cited; 75% copper, 20% lead, 5% tin, also 62.5 aluminum and 37.5 lead have shown good results. Of course, many other mixtures may be used as well as different proportions of the mixtures mentioned and, hence, we do not wish to be limited to these specific examples.

With inserted briquets of this type a metal film is formed as in the other embodiments of our invention previously described and heat dissipation is greatly increased with consequent lower surface temperatures. This latter attribute is inherent also in our hereinbefore described embodiments.

By powdered metal is meant comminuted metal made by electro-deposition, oxide reduction or other means. By relatively soft metal of low melting point is meant those metals which are normally rendered plastic at low or moderate operating temperatures, such as lead, tin, antimony, zinc and alloys such as solder, Babbitt-type metal or the like. By ductile metals of relatively high melting point is meant those metals which are rendered plastic only at high operating temperatures or which normally are not rendered materially plastic at temperatures met with in practice, such as, aluminum, copper, soft or low carbon iron and the like.

We claim as our invention:

1. A friction element comprising a body of friction material including essentially a fibrous material and a heat hardenable binder carrying inlays derived from powdered metals adjacent a surface of the body.

2. A friction element comprising a body of friction material including essentially asbestos and a heat hardenable binder carrying compressed inlays derived from powdered metals adjacent a surface of the body.

3. A friction element comprising a body of friction material including essentially asbestos and a heat hardenable binder provided with a plurality of recesses filled with powdered metals, the friction material and the metal powders being compressed and heat-treated to cure and bake the friction material.

4. A friction element comprising a body constructed of spirally wound tape having metal inlays exposed to a surface of the body interposed between adjacent tape convolutions.

5. A friction element comprising a body constructed of spirally wound tape having a spiral area of metal appearing at a face of the element interposed between adjacent convolutions of the tape.

6. A friction element comprising a base including a fibrous material and a binder characterized in that said base carries a metal inlay comprising a relatively soft metal of low melting point and a ductile metal having a relatively high melting point, said metals being present in the base in relatively close proximity.

7. A friction element comprising a base includ-

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ing a fibrous material and a binder characterized in that said base carries a metal inlay comprising a relatively soft metal of low melting point and a ductile metal having a relatively high melting point, said metals being present in the base in discrete particles mechanically held together.

8. A friction element comprising a base including a fibrous material and a heat hardenable binder, characterized in that said base carries a metal inlay comprising a plurality of metals at least one of which is a relatively soft metal of low melting point and another of which is a ductile metal of relatively high melting point, said metals being present in the base in intimate relationship.

9. A friction element comprising a base including a fibrous material and a heat hardenable binder, characterized in that said base carries a metal inlay derived from a plurality of powdered metals at least one of which is a relatively soft metal of low melting point and another of which is a ductile metal of relatively high melting point, said metals being present in the base in intimate relationship.

10. A friction element comprising a base including a fibrous material and a heat hardenable binder, characterized in that said base carries a metal inlay derived from a plurality of powdered metals at least one of which is a relatively soft metal of low melting point and another of which is a ductile metal of relatively high melting point, said metals being present in the base in intimate relationship being compressed and subjected to heat during the curing and baking of the element.

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