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E. CHAPMAN

2,970,775

METHOD OF BACKING CRUSHER PARTS

Filed May 2, 1958

2 Sheets-Sheet 1

Fig. 1

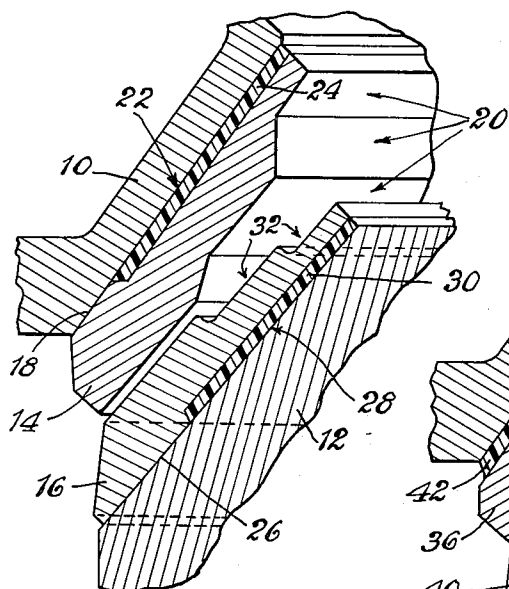


Fig. 2

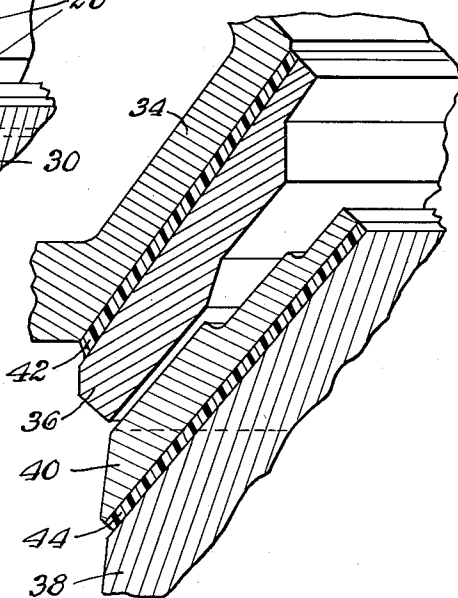


Fig. 3

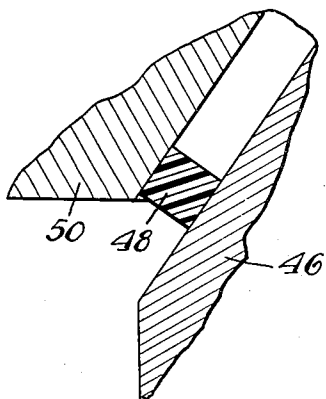
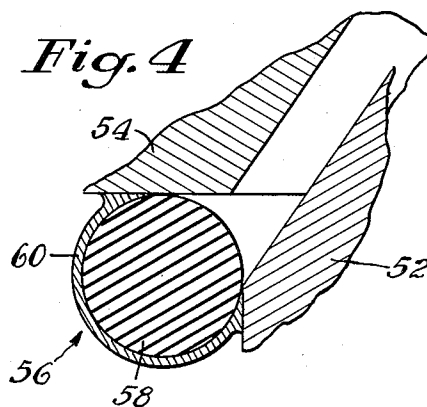


Fig. 4



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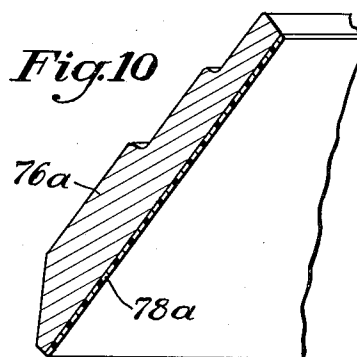
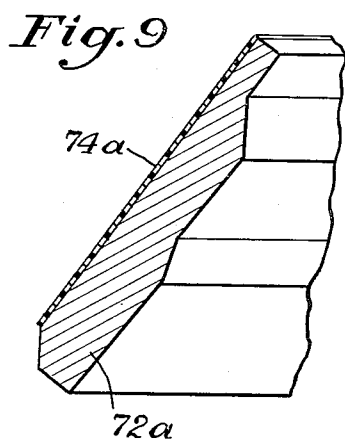
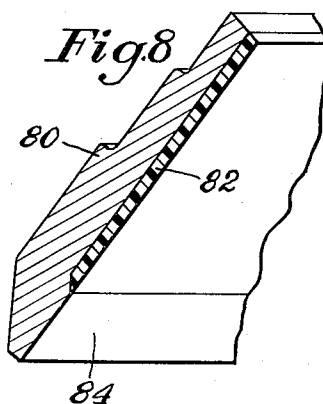
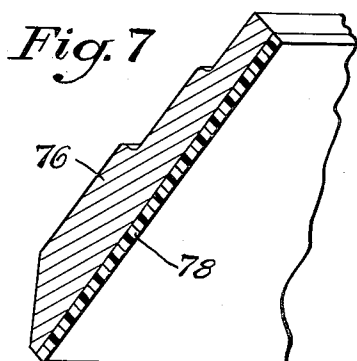
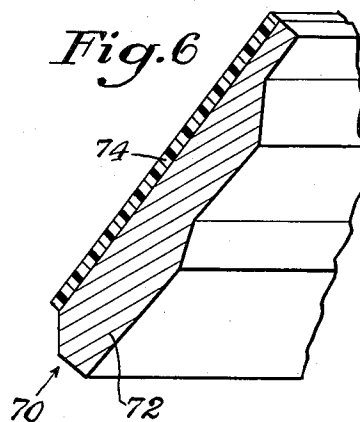
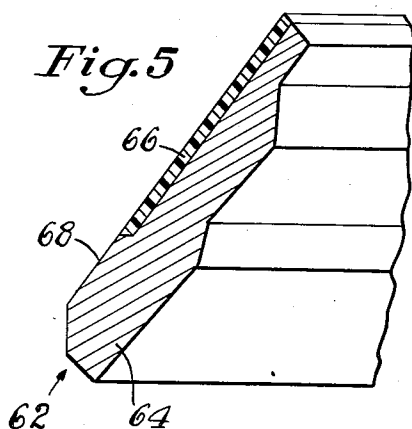
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2 Sheets-Sheet 2



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METHOD OF BACKING CRUSHER PARTS

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5 Claims. (Cl. 241—30)

This invention is in the field of wearing parts or elements such as are used, for example, in grinding mills, jaw and gyratory crushers, and other equipment in which metal wear-taking parts are used, and in fact are used up, in crushing and grinding ore, rock and other hard materials. The problem solved is the provision of proper and efficient backing means for such wear-taking parts, whether applied at the point of use, or formed on and shipped and applied with such parts.

A primary purpose is to provide a complete overall backing which gives full and uniform support throughout the area of such parts, for the full life or use of the part.

Another important purpose is to provide a backing which differs from the part itself in its resilience, elasticity and responses to strain, and thereby has advantageous cushioning characteristics.

Stated more specifically, a composite wearing part or element is provided which includes a metal body portion of manganese steel or other suitable metal, with which is provided a non-metallic backing layer which is in use situated between the rear or non-working face of the body, and the abutting supporting part of the mill or crusher, the backing layer being effective to constitute an adequate backing or cushion, and to prevent any supporting metal to metal contact between the body portion and the machine with which the wearing part is used.

One purpose is to minimize distortion of the supporting structure by thus isolating it from participation in the crushing or grinding impact or strain.

Another purpose is to provide an improved backing for manganese steel crusher parts which will substantially reduce or eliminate the peening or flow of such steel under crushing or impact receiving conditions.

Whereas the backing layer may, if desired, be applied at the point of use, one object of the invention is to provide a preformed wearing element which includes a metal body and a non-metallic backing, which may be shipped and applied as a unit, and is adapted for quick and easy application at the point of use.

Another object is a method of supporting and backing a wearing part in a material reduction machine.

Another purpose is to provide a plastic backing, or parts with preformed plastic backings, in which, as a matter of illustration, an epoxy plastic may be used.

Other objects will appear from time to time in the course of the specification and claims.

The present application is a continuation-in-part of my previously filed applications Serial No. 665,350, filed June 12, 1957, and Serial No. 675,987, filed August 2, 1957, both now abandoned.

The invention should be considered in its relation to the problem of mounting metal wear-taking parts on crushers, grinders and the like. It may advantageously be discussed in its application to the head surrounding mantles and to the bowl liners of gyratory crushers. As

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a matter of illustration, it is herein shown as applied to the liners and mantles of gyratory cone crushers.

In such crushers it is current practice to pour a backing of zinc or the like, the metal being applied at the point of use, when the liner or mantle is being mounted on the machine. This procedure has numerous disadvantages, including the fact that pouring the hot metal is difficult and dangerous, involves considerable extra time and expense, and causes frequent casualties to personnel. The zinc, unfortunately, even when poured with the greatest care, does not form or provide an adequate backing layer. By inspection of typical jobs one learns that the zinc, when poured into the narrow space occupied by the backing, solidifies too rapidly, even when preheated for pouring. It sets in discontinuous lobes or fingers which prevalently do not merge even when they meet, and do not completely fill the space between the liner or mantle and the part of the machine which is supposed to support it. The trouble is increased by the fact that the zinc shrinks substantially on solidifying, and is inherently unable to fill, after it solidifies, the space into which it has been poured while in a molten condition. In use, under the inevitable pounding, to which it is subjected during the use of the crusher, it breaks up, even pulverizes, and becomes useless, even nonexistent, as a backing.

The present invention provides a backing which avoids and corrects the faults of current practice. It provides backing layers which maintain full efficiency for the life of the backed part. The plastic employed has full dimensional stability, and, when poured in the field, as when the wearing parts are being applied to the machine, it completely fills the cavity into which it is poured. Being thermo-setting, it does not cool or set prematurely, and in practice completely covers the entire area of the rear face of the wearing part. This, taken in connection with the fact that it has dimensional stability and scarcely shrinks on hardening, ensures a full backing efficiency for the life of the part. For these reasons it is possible to use a backing layer thinner than the zinc layers now being poured. The use of a plastic, such as a thermo-setting epoxy resin, has the further advantage of permitting the use of various fillers or volumes of particles, which may be used to obtain a variety of desirable results. Strengthening fibers may be used, or fillers, to reduce costs or to increase heat transmission, or to reduce fluidity. Practical applications of the invention will now be described in detail, the wearing parts of a gyratory crusher being used as a matter of illustration.

The invention is illustrated more or less diagrammatically in the accompanying drawings in which:

Figure 1 is a vertical fragmentary section of a part of a gyratory crusher and its wearing elements;

Figure 2 is a modified form of Figure 1;

Figure 3 is a further modification, on an enlarged scale;

Figure 4 is a further variation;

Figure 5 is a vertical section of a complete bowl liner;

Figure 6 is a variation of Figure 5;

Figure 7 is a vertical section through a composite mantle;

Figure 8 is a variation of Figure 7; and

Figures 9 and 10 are sections similar to Figures 7 and 8, illustrating the use of a thinner backing layer.

In Figure 1 is illustrated, at 10, the bowl of the general type of gyratory cone crusher shown in U.S. Patent No. 2,684,208. The details of the crusher do not of themselves form part of the present invention. Within the bowl a gyratory crushing head is indicated generally at 12. The details of the bowl and head are not a part of the present invention. Suffice it to say that between them they define what may be considered as the crushing space or cavity.

A bowl liner is indicated generally at 14 and a mantle on the gyratory head generally at 16. Considering the bowl liner first, it is conventional to provide a generally conical surface as at 18 on the outer surface of the liner which matches or mates with the corresponding portion on the bowl. In the usual fashion, the liner is mounted by moving it up from below until it seats against the bowl, and is held there rigidly by any suitable connecting mechanism which has not been shown. The somewhat frusto-conic surface 18 snugly fits against a portion of the bowl and provides a more or less effective bottom closure for the cavity to be filled. The crushing face of the liner may have a series of steps, as shown at 20. The upper portion of the outer surface of the liner is relieved or spaced from the bowl so that a somewhat frusto-conic cavity is defined between them, such as at 22, and a backing material designated generally 24 is disposed in this cavity, the cavity being closed at the bottom by the above-mentioned closure.

The mantle 16 is generally similar. The lower inner surface is provided with a somewhat frusto-conic or conical portion 26 which closely matches or mates with the head to provide a more or less effective lower closure. The upper portion of the inner surface is somewhat spaced or relieved to define a suitable cavity 28. This cavity is also filled with a backing material, designated generally at 30, to be explained in detail hereinafter. The working surface of the mantle may be divided into a number of steps, designated generally 32.

In current practice the liners and mantles shown in Figures 1 and 2 are initially applied without backing, and the zinc backing layer is poured in the molten state. While the herein-described plastic backing may be applied to the wearing parts in the field, one primary object of the invention is to provide composite wearing elements which can be shipped, and applied to machines, with their backing already in place.

One of the important aspects of the present invention is the particular type of backing material used. Previously, zinc had been the usual material but, as earlier mentioned, it has been found objectionable because it must be heated until molten and overheated or superheated to prolong solidification against the cold walls of the cavity. In practice it is heated to 1100° F., though its melting point is only 787° F. Handling this superheated molten zinc is very dangerous and the resulting backing is not satisfactory. If any moisture is in the cavity, a great deal of sputtering will result and zinc in a hot, semi-molten condition will spray out the top of the cavity and possibly injure personnel.

An example of the use of an improved material in accordance with my invention is an epoxy resin, a thermosetting or thermohardening material, but other resins or plastics may be employed. An epoxy resin is particularly advantageous for the above described backing function because it has very little shrinkage during cooling. Proper fillers can be used to prevent any perceptible shrinkage. Additionally, it has a compression strength of the order of 8000 to 12,000 p.s.i. Such a plastic or resin may be purchased at the present time from one of a number of conventional chemical houses. This particular material has the advantage over zinc that all heat developed during mixing of the resin and activator or curing agent is internal and no external source of heat is necessary. It should be noted that the maximum temperature reached by the plastic as the result of the mixing of the two above-mentioned components is of the order of 160° F. This should be contrasted to the 787° F. melting point of zinc and to the overheat to 1100° F., which is normal in pouring zinc in backing crusher parts in the field.

The epoxy comes commercially in two parts; first, a resin which is a thick, creamlike substance and, second, an accelerator or curing agent which may be a clear, somewhat more viscous substance. The specific weight of the end material is one-fourth that of zinc. The resin

and activator are thoroughly mixed, and are then poured. If the backing is to be applied in the field, the mixture is poured into the space between the wearing part and the head or bowl to which it is applied. However, it is often advantageous to apply the backing layer to the liner or mantle even before it is shipped, and before it is applied to the crusher. In preforming the backing, it is practical to employ a form or mandrel to provide a space into which to pour the plastic, with the space being completed by positioning the wearing part in proper relation to the mandrel, and by sealing the bottom opening between wearing part and form. It is also practical to mold the backing layer separately, for subsequent application and bonding to the liner or mantle or other wearing part with which it is used.

Since the cross-linking reaction between epichlorhydrin and a polyhydric phenol does not produce any by-products, the epoxy is used without high pressure equipment. However, for reducing the pouring time, and for ensuring a positive fill of the cavity, it is practical to elevate the mixture, to get the advantage of an hydraulic head, which speeds the pour and ensures a uniform fill.

Figure 2 shows the preferred form of wearing parts for cone crushers, in which the backing layer extends from top to bottom of liner or mantle. In this figure the bowl is indicated generally at 34, the liner at 36, the head at 38 and the mantle at 40. In this case the plastic backing material extends to the bottom edge of the respective wearing elements, such as at 42 for the bowl liner and 44 for the mantle. The conical metal to metal matching or fit surfaces of Figure 1, such as at 18 for the liner and 26 for the mantle, are eliminated. The plastic conforms to the somewhat frusto-conic wearing element and extends from the top to the bottom. Thus, any hammer and anvil effect during crushing as applied to that portion of the wearing element or manganese steel next to the fit surface for both the mantle and liner will be eliminated by the resilient backing which prevents any supporting metal-to-metal contact between the wearing part and the head or bowl to which it is applied.

The epoxy resins being fast flowing when mixed, centering and sealing means generally must be provided, whether the pouring is done at the factory or at the point of use. Such means are shown in Figures 1 and 2. To provide the proper spacing between the wearing element, which may be the bowl liner as at 46 in Figure 3 and the bowl 50, a plurality of slugs or segments may be used, shown at 48, which are advantageously of identical or compatible material so that they will join the plastic as a homogeneous support with no stress raisers present in the form of foreign inserts. These slugs or elements are spaced around the cavity between the wearing element and crusher at suitable locations to provide the proper spacing. This practice may be followed in the field, and it, or some comparable spacing procedure may be used in making the preformed units.

In Figure 4, the liner and bowl are indicated generally at 52 and 54. When the plastic is poured, it may be in a highly fluid, viscous, or liquid condition and may require a suitable seal, for example, such as is designated generally at 56 in Figure 4, to prevent the plastic from flowing out through the bottom of the cavity between the wearing element and the crusher. Such a seal may include a member or O-ring 58, of sponge rubber or any other suitable material, which may be stretched into position so that in use it is under tension. To prevent the highly fluid material from flowing or leaking past the O-ring, one may coat the outside of the O-ring with a suitable coating, for example dam babbitt, but any other suitable sealing or coating material may be used. The important point is that during the pouring period if the plastic is poured in a highly fluid state, it will leak through the smallest cracks. If it is thought desirable to reduce the pouring period and thus to make the liquid plastic easier to handle and to seal, its pouring qualities

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can be reduced. To make the plastic relatively stiff, it is advantageous to mix fibers, for example glass fibers, in the mass of the plastic. A mixture of glass fibers or glass flock performs the double function of much stiffening of the mixture and at the same time of increasing the strength of the backing layer when the plastic is set.

Figures 5, 6, 7 and 8 show various forms of what may be considered a wearing element package which may be supplied by the manufacturer and shipped preformed, for quick application at the job. In Figure 5, a bowl liner is indicated generally at 62 and includes a main body element 64 of manganese steel or the like and a backing material 66 of an epoxy resin. In this form the surface 68 engages the bowl on the crusher. In Figure 6, the liner designated generally at 70 includes a main body element 72 of manganese steel or its equivalent and a layer of backing material 74 which extends the full length of the liner. The preferred liner is the form of Figure 6.

Figures 7 and 8 show mantles. In Figure 7 the main body portion of the mantle is designated 76 with the backing material designated 78, and shown as extending the full length of the mantle from the top or throat to the bottom edge, while in Figure 8 the main body portion 80 and backing material 82 are not fully coextensive. The form of Figure 7 is preferred.

Figures 9 and 10 illustrate liners and mantles in which the backing layers are substantially thinner than in the earlier figures. It is practical, and even advantageous, to employ a plastic backing layer as thin as from one-eighth to a quarter of an inch. Satisfactory results are also obtained with layers ranging from slightly less than one-eighth of an inch to thicknesses of the order of from one-half to three-quarters of an inch. While the plastic can be used in even greater thicknesses, such thicknesses may involve a waste of material with no consequent advantage.

It will be realized that many changes and variations may be made without departing from the spirit of the invention; the description and drawings are to be taken as in a broad sense illustrative and diagrammatic rather than as limiting to the precise showing herein.

The use, operation and function of the invention are as follows:

The invention is described in connection with replaceable wearing elements for a gyratory crusher, though it may be used with other mills. In finding an adequate backing material for such parts, it is found that a plastic backing has many advantages over the currently used zinc.

One advantageous use of the invention includes the shipping of the wearing part and backing portion as a unitary package, to the place of use, and the employment, there, of a smaller mass of resin or of resin and activator applied at the point of use. The user may, for example, employ a smaller body of the epoxy and activator, mixing them at the point of use and applying them as an additional surfacing, either to the backing portion of the wearing part or to the surface of the support which will receive such backing portion. One advantage of this procedure is to make certain that any small gaps or cavities caused by any difference in contour of the backing and of the support will be filled by the relatively thin layer of the plastic applied on the job.

In preparing a preformed replaceable wearing element in the shop for use in the field, it is convenient to provide a form which has the same general shape as the part of the crusher that supports the wearing element. This form may be applied to the manganese steel wearing element, be it a liner or a mantle, cleaned and free of grease, in the proper position to define a cavity to receive the plastic material. First, one may grease, wax or otherwise lubricate or apply a non-adhesive or non-cohesive material or substance to the surface of the form. Thereafter, the plastic may be poured into the cavity and allowed to solidify. The grease or wax or

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other suitable material if and when used on the form, will prevent the plastic from adhering to the form. When the plastic has solidified, it will tightly adhere to the liner or mantle; the form may be removed and the wearing element will be a complete package with the plastic integral backing secured thereto.

It may under some circumstances be advantageous to form the backing layer separately and thereafter bond it either to the metal body of the wearing part, or even to the part of the machine, such as head or bowl, to which the wearing part is to be applied.

During crushing, the energy used in crushing or grinding the material will be dissipated in the form of heat through the wearing elements. Heat is generated in any resilient material under repeated flexing due to hysteresis. For efficient crushing, it is desirable to conduct this heat away as fast as possible. Hence it may at times be of importance to use a heat conducting filler in the plastic, for example, powdered aluminum or a suitable powdered metal to be thoroughly mixed with the epoxy resin and activator. Other fillers, such as sand, silica, etc., may be used to reduce the cost of the layer. Fibrous particles or layers may be employed for strength. Fiber glass is a practical addition. Fibers, for example glass fibers, also slow the pouring characteristics, and simplify the sealing problem.

An important advantage is that no external source of heat is necessary to liquefy the backing material. In the use of epoxy, when the resin and activator are intimately mixed, they develop their own internal heat and should be poured generally just before reaching the highest temperature of 160° F. or less. Sealing of the lower end of the cavity is important because the hot liquid plastic is highly fluid and will seek out the smallest crack or opening.

In the example given, namely, an epoxy, the material is sufficiently inexpensive, is easy to handle, has no significant shrinkage during solidification, and is sufficiently malleable to be usable in all applications. It will cushion the crushing blows but at the same time is rigid enough to provide efficient crushing. While epoxies are satisfactory for the purpose, other plastics may be used.

The setting temperature of the epoxy may be widely varied. For instance, for convenience, one may use a room temperature setting epoxy. This plastic will withstand without deterioration a temperature in the region of, say, 200° F. If one needs a plastic that will withstand a continuous temperature of, say, 350° F., one uses a mixture which may be cured at, say, 150° F. In this manner the top deterioration temperature of the epoxy can be extended.

To consider more specifically the particular plastic to be used, while a range of other plastics may be used, epoxy resins have various characteristics which make them practical for the desired purpose. The modulus of elasticity of the epoxies is of the order of from 400,000 to 600,000, in contrast to the modulus of elasticity of various steels, of from, say, 28,000,000 to 32,000,000. This relationship of the characteristics of body and backing has in practice turned out to be highly practical. A highly efficient backing and cushioning effect is thereby obtained, even though the backing layer is in thickness a mere fraction of the three inches or more thickness of the wearing part. Stated generally, advantageous results have been obtained where the modulus of elasticity of the backing plastic layer is in the general range of from one to three percent of that of the steel body portion. One and one-half to two and one-half appears to be the preferred range, but substantial departures therefrom appear to be practical.

The compressive strength is satisfactory. An epoxy resin, for example, may have a compressive strength of the order of 8,000 to 12,000. A thermosetting plastic, such as an epoxy resin, provides a backing which is dimensionally stable and which conforms precisely and

completely to the abutting metallic surfaces. It can be bonded firmly to the wear-taking body or to the backing part of the machine, or to both, or, if desired, to neither. It has little or no solidification shrinkage. It is thixotropic. While holding its general form it will seal gaps, it will fill interstices, and will accommodate itself to shifts and changes.

When the epoxy and its curing agent are mixed they generate the necessary curing heat to polymerize the resin. The liquid is easily poured and is not hot enough to provide any handling problem. Its period of solidification is not critically short, so that the operators have ample time to pour after mixing. It will be clear that a backing having both the handling and the functional characteristics and advantages of a thermosetting resin has a tremendous advantage over the zinc which has heretofore been used.

In order to make sure, especially in field pouring, that the epoxy and the curing agent are properly mixed and at a proper temperature, it is practical to use resin of one color and a curing agent of another. For example, the resin may be colored blue and the curing agent yellow. When they are properly mixed, the resultant color is green. If streaks show then there has been a failure to mix adequately. The operator thus has an immediate visual telltale. It is also advantageous to provide a temperature telltale or alarm set to signal when a predetermined temperature is reached. For example, the mixing container may have associated with it any suitable heat responsive element which, in turn, is connected to actuate a visual or audible signal, or both, when the mixture has reached a predetermined temperature. Thus the operator has a double check, and is warned and informed as to the proper mixing and as to the state of the mixture. In outside cold weather pouring the mixing assembly may, of course, be protected from ambient temperature. The location of the heat responsive element may be widely varied.

In handling a plastic, particularly the epoxy plastics, it is advantageous to use containers and mixing devices of Teflon, or having the parts which engage the plastic formed of or covered with Teflon. The epoxy resins will not adhere to Teflon. If it is necessary to employ containers of metal or of other materials, it is possible to remove the plastic before it sets by the use, for example, of methyl alcohol.

It should be kept in mind that epoxy resins, for example, may be varied to satisfy different conditions and to obtain different results. Epoxy resins are chemically stable at temperatures up to 200° C., which gives them an indefinite shelf life. Epoxies are extremely resistant to most caustics, to most solvents, and to all but the strongest oxidizing acids. A variety of curing agents may be employed, including, for example:

Diethylene triamine
Diethylamino propylamine
Amine-resin and amine-glycidyl adducts
Amine-ethylene oxide adducts
Various amine blends
Cyclic aliphatic amines, and
Organic acids and various acid anhydrides

It is possible to employ free-flowing liquids mixed with the epoxy to reduce the viscosity of the resin, to get better penetration in casting, to increase the pot life or to make the peak temperature during curing somewhat higher than in unfluidized resin. Typical dilutants are:

Butyl glycidyl Ether
Styrene oxide Xylene
Phenyl glycidyl

Various fillers may be used to lower cost, to lower the co-efficient of thermal expansion, to reduce shrinkage, to increase thermal conductivity, to alter surface hardness, to reduce maximum temperatures during curing, to im-

prove adhesive properties, and to change the handling characteristics of the resin system. Such fillers may be either organic or inorganic, either metallic or non-metallic. Some fillers have been mentioned above. It is worthwhile to mention bentonite and other clays, synthetic resins, asbestos, uncompressed silica, talc, and, as earlier mentioned, powdered aluminum. Metallic and oxidized fillers increase hardness. Some fillers reduce impact resistance, but fibrous fillers, including short fiber asbestos, tend to improve impact resistance and to reduce the rate of flow and the penetration of leaks. Metallic fillers and coarse sand improve thermal conductivity. As additional modifiers, other resins may be mixed in with the epoxy to modify the properties of the cured system. Phenolic resins may be used to increase heat distortion temperatures. Other resins may be used to impart flexibility or to give high impact strength or greater thermo-shock resistance. In general, the best results are obtained with resins which actually react, at least to some degree, with the epoxies, rather than acting as inert fillers. Some resins which may be thus employed are: the phenolic monomers; the analym formaldehyde resins, the ureas and melamines, the furfurals, the polyesters, the vinyls, the fluorocarbons, and the silicone resins, and anyone could be selected for the particular properties desired. Whereas the epoxy resins have been emphasized, it will be understood that the above mentioned resins may, in some circumstances, be employed as a substitute for the epoxies, preferably with suitable hardening additives or fillers. For example, molybdenum disulphide may be employed as a filler for thermosetting plastics, including but not limited to the epoxy resins. It is itself flexible and is accepted by the resins.

I claim:

1. A method of supporting a wearing element in a material reduction machine, including the steps of positioning such a wearing element in a material reduction machine in closely spaced relation to a supporting part of the machine, and in position so that one surface of the wearing element defines at least a part of the material reduction zone in the machine, while the other surface of the element is opposite the supporting part, at least partially supporting the wearing element in such position in the material reduction machine by providing thermosetting plastic spacing means between the said other surface of the wearing element and the supporting part of the material reduction machine, with the wearing element otherwise substantially completely out of contact with the supporting part of the material reduction machine to thereby define a relatively thin wall cavity between the wearing element and the supporting part of the machine, sealing the lower opening of the thus defined thin wall cavity to provide a closed bottom open topped thin wall chamber between the wearing element and the supporting part of the machine, introducing a thermosetting plastic compatible with the thermosetting plastic spacing means, in liquid form, into the thus defined chamber to substantially completely fill the chamber, and allowing the thus introduced liquid plastic to solidify.

2. The method of claim 1 further characterized by and including the step of applying a greasing composition to the supporting part of the material reduction machine prior to introducing the liquid thermosetting plastic into the thus defined chamber to prevent the plastic, when it solidifies, from adhering to the supporting part of the machine.

3. The method of claim 1 further characterized by providing a plurality of peripherally separated spacing plastic elements as the spacing means between the said other surface of the wearing element and the supporting part of the material reduction machine.

4. The method of claim 1 further characterized by providing the spacing means and introducing it into the material reduction machine and against the supporting part thereof separate from the wearing element.

5. A method of mounting and backing frusto-conic annular wearing elements in material reduction machines, such as gyratory crushers and the like, such wearing elements having one side intended to function as a supporting surface to be positioned opposite a supporting part in the machine with the other side intended to function as a material reduction surface and to define at least a part of the material reduction zone in the machine, which includes the steps of preliminarily applying a relatively thin backing layer of a thermosetting plastic material to the generally conic supporting surface of said wearing element in such fashion that the backing layer conforms closely to and adheres to such generally conic supporting surface of the wearing element substantially continuously circumferentially about the body portion and throughout substantially the entire area of said conic surface, positioning such wearing element in the machine with the preliminary backing layer opposite but slightly spaced, substantially uniformly, from the supporting part of the machine to define a thin walled circumferential cavity, and thereafter providing a finishing layer of plastic by introducing a thermosetting plastic compatible with the

thermosetting plastic of the preliminary backing layer, in liquid form, into the thus defined thin walled cavity to establish an over-all contact between the supporting surface of the wearing element and the supporting part of the machine, and allowing the thus introduced finishing layer to solidify.

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