July 28, 1925.

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C. STEENSTRUP

COMPOSITE METAL

Filed March 30, 1923

Fig. 1.

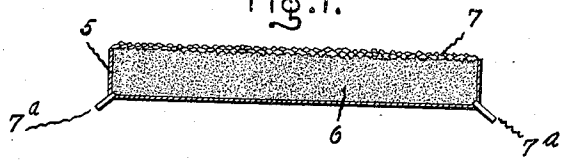


Fig. 2.

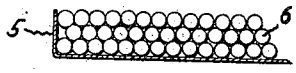
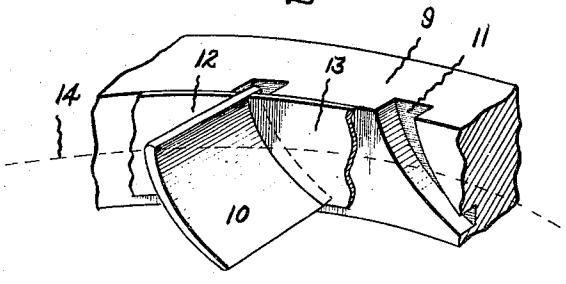


Fig. 3.



Fig. 4.



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UNITED STATES PATENT OFFICE.

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COMPOSITE METAL.

Application filed March 30, 1923. Serial No. 628,926.

To all whom it may concern:

Be it known that I, CHRISTIAN STEENSTRUP, a citizen of the United States, residing in Schenectady, county of Schenectady, and State of New York, have invented certain new and useful Improvements in Composite Metals, of which the following is a specification.

I have invented or discovered a composite metal of relatively high tensile strength which is capable of wide application in the mechanical and electrical arts and have also invented or discovered a method of making the same.

In carrying out my invention, two metals are employed, one which may be termed the base material and the other the void-filling and fusing material, the latter having a lower melting point than the former. In practicing the invention according to the best method known to me, mild steel, preferably having a low carbon content, is employed for the base material, and in the form of relatively small pieces or particles which are in their nature self-packing. By this is meant that the particles or pieces are of such shape or character that when poured into a container they will flow to every part thereof and completely fill the same. In this respect they act in the same manner as ordinary lead shot when poured into a container. In some cases it may be desirable to jar the container by some external means to facilitate the settling of the pieces. To obtain this self-packing feature one simple way, for example, is to make the pieces as nearly as possible in the form of small spheres, balls or shot having relatively smooth surfaces but it is not necessary that they be true spheres or balls although they are the best for the purpose. The nearer the pieces are to true spheres the smaller will be the aggregate of the voids in the mass which is the thing to be desired, and the more dense and homogeneous will be the final product. For the sake of convenience, I shall hereafter refer to these small, smooth particles as shot but without limitation, however, to true spheres or to truly round particles or pieces.

The size of the shot may be varied within quite wide limits, so long as the voids between them when assembled into a mass are of a capillary nature. In some cases it may be found advantageous to use various sizes of shot in the same finished article or piece. When this is done the smaller shot are preferably of such size that they substantially fill the voids between the larger ones. Under these conditions the shot should be thoroughly mixed before being poured into the container.

While the shot may be very small they are nevertheless of appreciable size, and as bearing on this point I have discovered that in the course of the development of my invention powdered metal is not satisfactory whether it be placed loosely in a container or subjected to a substantial pressure. In the former case the finished material shrinks and cracks and in the latter case the void-filling and fusing material does not properly penetrate the mass. This is due to the fact that as the void-filling material begins to penetrate the powdered mass it picks up a sufficient amount thereof to raise its melting point and consequently solidifies before complete penetration can take place. I have also found that iron filings and other small, irregular metal particles do not make a satisfactory material on account of the shrinkage, the result being much the same as that obtained with loose powder. Further, the final product is in no case dense and homogeneous.

These self-packing particles or pieces may be definitely formed or made in any desired way, one of which is as follows:—A closed tank of suitable size is provided which is partly filled with water. A small stream of molten metal is poured into the tank from a suitable source through a suitable nozzle. In the side of the tank adjacent to the descending stream of molten metal and above the water level is a second nozzle through which steam or some reducing or neutral gas at fairly high velocity is discharged in such manner as to impinge on the molten metal and break it up, the result being that a sort of fog is formed within the tank composed of gas and small metal particles. The particles in their travel through space are formed into shot and on account of their greater weight drop into the water while the gas is permitted to escape through a restricted outlet, either to the atmosphere in the

case of steam or in the case of a neutral or reducing gas to a pump which returns it to the source of supply. The gas and water serve to wholly or largely prevent oxidation of the shot.

Material secured in this manner will contain some hollow or imperfect shot, some slag or other impurities. The undesirable material is removed by a separator of any desired character, after which the shot are subjected to heat to dry them. It is also desirable in the case of steel to pass the shot through a hydrogen furnace to reduce any oxide thereon and also through an apparatus for grading them so that those used in any particular job may be of predetermined size. Shot made in this manner are very small and will run freely into any chamber or recess much the same as ordinary lead shot will.

Care should be exercised to see that the void-filling and fusing metal is free of impurities, especially when copper is used which I prefer where the base material is of mild steel. The ordinary commercial grade of copper contains some impurities which should be eliminated before use if the best results are to be obtained. These impurities manifest themselves chiefly in the form of gas which is liable to be trapped in the voids and cause imperfections in the finished product, and under some conditions may actually cause a displacement of the shot. I have found that boronized copper is suitable for the purpose, also copper which has been treated long enough in a hydrogen furnace to drive off most if not all of the impurities. The copper when in the proper state is preferably cut up into small pieces for convenience in handling and distributing. The amount of copper used should be sufficient to fill the voids and in any given case can readily be ascertained by simple experiment. The steel shot and the copper are unmixed in the container because when mixed the gases which are formed cause pockets in the finished product or else cause displacement of the shot or both. By placing the copper on top of the shot the gases are liberated outside and hence are not carried into the base material.

The chambered receptacle or container for the base material may be made in a variety of ways depending on the nature of the finished product. It may be made wholly of thin sheet metal, such as steel, or of heat resisting material such as asbestos or of a compound containing asbestos. The character of the container will depend upon whether it is to form a part of the finished product or not.

After the container is completed it is filled with the base material to the desired level and on top thereof is distributed the necessary amount of void-filling and fusing material, said materials and container being at room temperature. The container and its contents are then placed in a closed furnace in which a supply of hydrogen or other selected gas is constantly maintained. The furnace is then heated to a temperature sufficiently high to cause the void-filling and fusing metal to melt but not the base material. When this temperature is reached, (and it can readily be observed by ordinary sight tubes in the furnace) the fusing metal flows by capillary action into the voids and fills them. Any excess may be drained off by providing small drains in the bottom of the container. By preference the temperature of the furnace and its contents after the operation is completed, is reduced rather rapidly at the start during which time the fusion of the steel shot and copper is completed, after which the cooling takes place more gradually. During the fusing operation a certain amount of alloyage of the two metals takes place, which increases the strength of the finished product.

One very great advantage flowing from my invention is the low cost of production. This will be apparent from the fact that the steel used in making the shot may be scrap material or it may be in the form of steel pigs or billets received directly from the steel makers and before any work is done thereon. The apparatus used in making the shot is very simple and the cost thereof is not much greater than that of the raw material. To reduce the amount of shot required, especially in making large pieces, pieces of steel or scrap material may be employed which are placed in the container before the shot is poured in.

The fact that copper is used to fuse the steel shot very naturally raises the presumption that the finished product would have about the same strength as copper. I have found, however, by suitable tests that the finished product has practically the same tensile strength as that of mild steel, and that it may be employed in a great many cases as a substitute therefor, and for some purposes is vastly superior thereto. For example, in uniting two or more separate pieces of metal, and in making structures having articles embedded therein.

The resulting product having as it does the general characteristics of mild steel may be subsequently treated in much the same way, that is to say, it may be rolled hot or cold, swaged, forged, machined or ground by the usual and ordinary means.

In the following description I have set forth as illustrations but not as limitations, some of the many uses to which my invention is applicable.

In the accompanying drawing, Fig. 1 shows a means for making up a flat slab, plate or bar of my improved material; Fig.

2 shows some of the steel shot on a greatly exaggerated scale used as the base material; Fig. 3 shows a flat plate made of my improved material having an article embedded therein, and Fig. 4 shows a means for uniting two pieces of metal with my improved material.

To form a slab, plate, bar or other shape a container 5 of any suitable size or shape is provided. It may be formed wholly of metal, of heat-resisting material, or a combination of both. The shot 6 are poured into the chamber of the container and caused to settle. Fig. 2 may be taken as illustrative, on an exaggerated scale, of the way the shot appear in cross section. Small pieces of copper 7 in suitable quantity are then placed on top of the shot, after which the container and its contents are placed in a closed hydrogen furnace and subjected to a temperature high enough to melt the copper and cause it to fuse the shot to each other and to the walls of the container, but not high enough to melt the shot. During the fusing operation a supply of hydrogen is constantly maintained. It is also desirable that the cooling take place in a hydrogen atmosphere. The container is preferably one which is not fluid-tight so that any excess of copper may drain therefrom. For example, in the container shown in Fig. 1, at the lower corners where the vertical sides join the bottom, open drains 7ª may be provided for the purpose of permitting the excess copper to drain therefrom.

Fig. 3 illustrates a plate structure designed to have embedded therein an element or article of definite shape such as a bar or rod 8 of any desired cross-section. It may be wholly or partly embedded depending upon the use to which the final structure is to be put. As shown, both ends of the article project through and beyond the walls of the container. In such a case the article is inserted in the container and suitably supported after which the remainder of the chamber is filled with steel shot. The element may be supported wholly by the walls of the container or the container may be partly filled with shot, and the element placed on top thereof, after which the container is filled to the desired level. The subsequent treatment in the hydrogen furnace is the same as previously described. In the fusing operation the shot are fused to each other, to the walls of the container, and also to the wall or walls of the embedded article thereby making a very solid construction. Such a construction is well adapted to form anchoring devices for bars, rods and the like since it permits of the use of standard stock shapes. The composite material may also be considered as a holder for the article 8.

In Fig. 4 I have shown how two or more pieces of metal may be united by my improved composite material. The union between any two pieces may take place at one side, at the end, or at both sides and end. This feature of my invention finds particular application in the arts where it is desired to unite one part to another, which part by reason of its use has to be of particular shape and which must not be distorted in any way. In the figure 9 indicates a relatively heavy member such as a cast steel ring, and 10 a rather thin steel part which has been previously given some exact shape as shown and which must be united to the member without any distortion, and which must occupy a definite position with respect to said member. In such a case a channel or slot 11 is provided in the member for the reception of one end of the part 10. If a large number of such pieces are to be united to the member a corresponding number of slots are provided. These slots are substantially larger than the inserted ends of the pieces 10 so as to form a chamber thereof. As a general proposition the lower wall of the slot will determine the lower position of the pieces and some portions of the walls or other means may be employed to hold the part in its proper vertical position. In the present illustration the chamber for the end of each part 10 is completed by the pieces 12 and 13 which are preferably of heat-resisting material such as asbestos. They may be held in place by friction or other suitable means.

If desired, the opposite ends of the parts 10 may be secured in like manner to another member, the peripheral edge of which is indicated by the dotted line 14. In such a construction the two members are cast separately and hence any shrinkages or distortions take place before they are united with the parts 10. It is of course evident that the parts or elements 10 may be supported at one or both ends. It is also evident that either or both members may be made wholly of my improved composite metal.

After the parts are arranged as described steel shot are poured into each chamber completely filling the same. The necessary amount of copper is then distributed over the shot after which the structure is treated in a hydrogen furnace as previously described.

I believe it is broadly new with me in the manufacture of composite metal to utilize self-packing or freely-flowing particles or pieces of metal of any kind as the base material in combination with an added metal of lower melting point and of such character that when melted it will flow by capillary action into and fill the voids between said particles or pieces and also fuse the same into a dense, homogeneous mass. As one specific illustration of my invention I have described steel shot for the base ma-

terial and copper as the void-filling and fusing metal since the composite metal thus formed is capable of very wide application in the arts. As another illustration of my invention when applied more especially to the electrical art, the self-packing particles or pieces may be made of copper and the void-filling and fusing material of silver or spelter. The advantage of composite material of this character resides in the fact that its electrical conductivity is high which renders it available for many purposes and especially for uniting two or more parts through which current flows, as for example, in the case of a squirrel cage rotor where it is desired to unite the conductors carried by the rotor with the short-circuiting end rings.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. A composite material comprising a base of self-packing metal particles, and a void-filling metal of a lower melting point than the metal particles which unites said particles into an integral mass.

2. A composite material comprising a base of self-packing metal particles having voids of a capillary nature between them and a void-filling metal having a lower melting point than the metal particles which fills said voids and unites said particles into a dense, integral mass.

3. A composite metal comprising a base metal in the form of small shot, and a second metal having a lower melting point than the first which fills the voids between the shot and unites them into an integral mass.

4. A composite material comprising a base of steel shot and a second metal having a lower melting point than the base which fills the voids in said base and unites the shot composing the same into an integral mass.

5. A composite metal comprising a base metal in the form of small mild steel shot, and copper filling the voids between the shot and uniting said shot into an integral mass.

6. The method of forming a metallic body which comprises assembling self-packing metal particles into a body of the desired shape, adding another metal of lower melting point in sufficient amount to fill the voids between said particles, and subjecting the same to a temperature sufficiently high to cause fusion of said particles and the added metal.

7. The method of forming a metal body which comprises assembling self-packing particles into a body of the desired shape, adding another metal of lower melting point and in sufficient amount to fill the voids between said particles, inserting the body thus formed in a closed furnace in which a supply of selected gas is maintained, and subjecting it to a temperature which is above the melting point of the added metal and below that of the metal particles, to cause fusion of the metals.

8. The method of forming a metallic body which comprises assembling small shot into a body of the desired shape and size, the voids between the shot being of a capillary nature, adding another metal in sufficient amount to fill the voids between the shot, and subjecting the same when in the presence of a selected gas to a temperature sufficiently high to cause fusion of the shot and the added metal.

9. The combination of a base comprising self-packing metal particles, a metal filling the voids in the base metal which metal has a lower melting point than the base metal, and a metallic article which is wholly or partly embedded in said base, said void-filling metal uniting the particles and the article into an integral structure.

10. The combination of a base comprising self-packing metal particles, copper filling the voids in the base material and which has a lower melting point than the base material, and a metallic article which is wholly or partly embedded in said base, said copper uniting the base and article into an integral structure.

11. The combination of a base material in the form of steel shot, a metal filling the voids in the base and which has a lower melting point than the base, and a metallic article which is wholly or partly embedded in said base, said base and article being united into an integral structure by the void-filling metal.

12. Two or more separate pieces of metal arranged in juxtaposition in combination with a composite metal comprising self-packing metal particles which are located between the pieces, and a metal filling the voids between the particles, said void-filling metal uniting the base material and said pieces into an integral structure.

13. Two or more separate pieces of metal arranged in juxtaposition but separated by a small space, in combination with a composite metal comprising small shot which fill the space between the pieces, and a metal filling the voids between the shot, said metal uniting said pieces and shot into an integral structure.

14. Two or more separate pieces of metal arranged in juxtaposition but separated by a small space, in combination with a means uniting them, said means comprising small steel shot which fill the space between the pieces, and copper filling the voids between the shot and uniting said pieces and shot into an integral structure.

15. The method of uniting two metal pieces which comprises assembling them in the desired relation one to the other with a chamber between, filling the chamber with

self-packing metal particles, adding sufficient metal to fill the voids between the particles, and subjecting said added metal to a temperature sufficiently high to cause it to fill the voids and fuse the pieces and particles together.

16. The method of uniting two metal pieces which comprises assembling them in the desired relation one to the other with a chamber between, filling the chamber with shot, adding sufficient metal to fill the voids between the shot, and subjecting the added metal to a temperature sufficiently high to cause it to fill the voids and fuse the pieces and particles together.

17. The method of uniting metal pieces which comprises assembling the pieces in juxtaposition with a limited space between them, filling said space with small self-packing metal particles, adding another metal in sufficient amount to fill the voids between the particles, placing the structure thus assembled in a closed furnace in which a supply of selected gas is constantly maintained, and subjecting the same to a temperature sufficiently high to melt the added metal and cause it to fuse said elements and the particles into a unitary structure.

18. The method of forming a metallic body which comprises assembling self-packing metal particles in a container which has an open drain, said particles having voids of a capillary nature, adding another metal of lower melting point and in sufficient amount to fill the voids, the excess escaping through the drain and subjecting the added metal to its melting temperature to cause it to fuse the particles together.

19. A composite material comprising, as a preponderant constituent, self-packing metal pieces, and a second metal filling the voids between said pieces and so intimately uniting the pieces that the strength of the material is greater than that of the void-filling metal.

20. A composite material comprising self-packing metal pieces forming the base thereof and a second metal set from fusion filling the voids between said pieces and uniting them into an integral mass, said material having a strength greater than that of the void-filling metal.

21. A composite material comprising metal shot in packed formation, united by a second metal set from fusion in the voids between the shot, said material having a tensile strength greater than that of the second metal.

22. A composite material comprising steel shot in packed formation, intimately united by copper set from fusion in the voids between the shot, said material having a strength substantially equal to that of mild steel.

23. A composite material comprising a base of self-packing metal particles having voids of a capillary nature, and a metal filling the voids which has a lower melting point than the particles and which so intimately unites the particles that the strength of the material is greater than that of the void-filling metal.

24. A composite material comprising, as a preponderant constituent, packed metal particles having voids of a capillary nature, and a metal filling the voids which has a lower melting point than the particles and which is alloyed with the particles to a certain extent, said material having a strength which is approximately the same as that of the preponderant constituent.

25. Two or more separate metal members arranged in juxtaposition with a space between them, in combination with means for uniting them, said means comprising packed metal pieces filling the space between the members and a metal having a lower melting point than the pieces which so intimately unites them with the members that the strength of the joint thus formed is greater than that of the metal having the lower melting point.

In witness whereof, I have hereunto set my hand this 29th day of March, 1923.

CHRISTIAN STEENSTRUP.