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J. H. L. DE BATS
CENTRIFUGALLY CAST PRODUCT
Filed Jan. 18, 1932

1,939,768

Fig. 1.

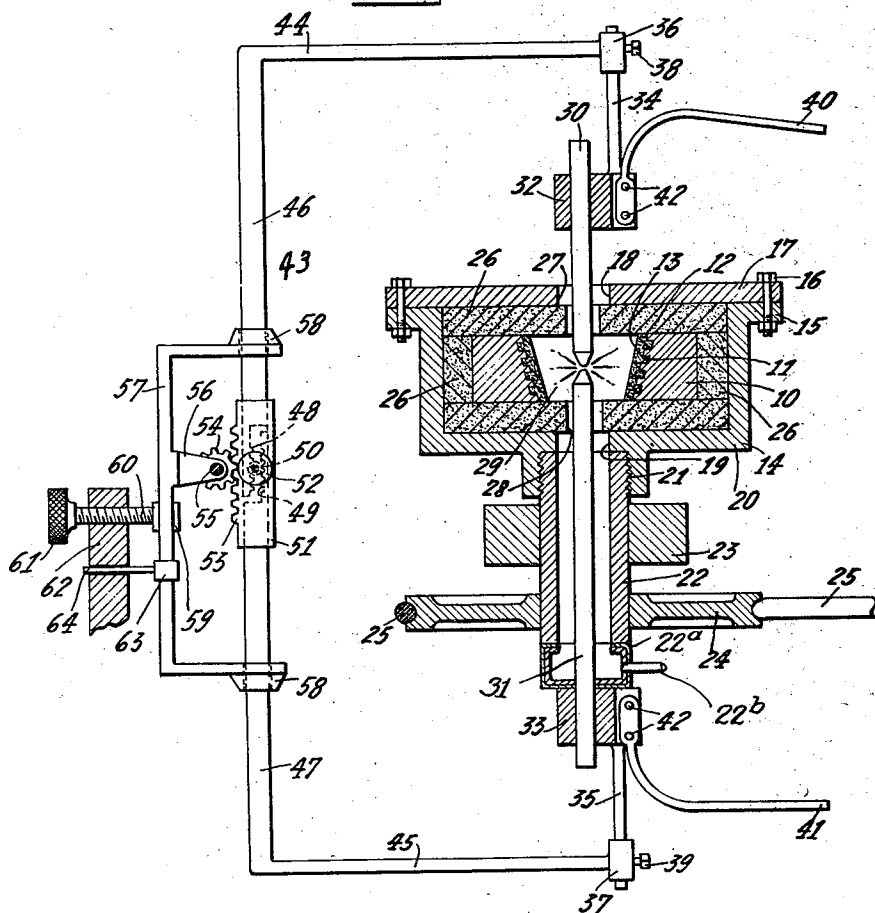


Fig. 3.

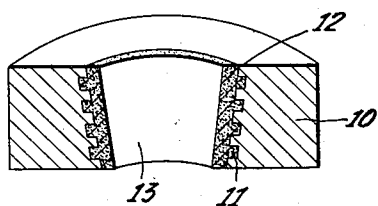
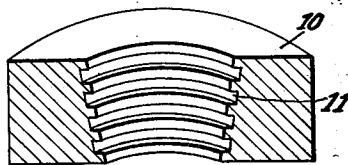


Fig. 2.



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CENTRIFUGALLY CAST PRODUCT

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7 Claims. (Cl. 207—17)

This invention relates to new and useful improvements in wear-resisting facing materials, such as tungsten carbide alloyed or bonded with cobalt, iron, nickel or like alloying or bonding metal or material, or wear-resisting alloys or compositions generally, sintered or not, as applied to extrusion and forming dies as well as to articles generally that require some portion thereof to be wear resistant or forming alloys in place. The invention also pertains to the improved articles so prepared and to the apparatus for applying the wear-resistant materials.

More specifically, the present invention relates to wear-resisting surfacings as formed upon or applied to dies and other articles such as valve seats while the die-holding apparatus is rotated. The materials used may be applied as an alloy mix and the alloying step completed by the subjection of same to a suitable temperature such as secured from an electric arc or by suitable resisting members, or yet again by high temperature gas flames such as oxyhydrogen, oxyacetylene and other like sources of high heat or temperature. The temperature and amount of heat imparted to the materials used may, as indicated, be sufficient to cause a true alloying of the materials such as tungsten carbide alloyed with a metal of the group comprising iron, nickel and cobalt, or the temperature may be held below the alloying point and sufficient to cause a sintering or bonding of the materials due to the softening of the lowest melting component of the mix under the low heat and relatively high pressure used. Where desired the invention comprehends the carrying out of this treatment in the presence of an inert gaseous atmosphere to prevent undesirable oxidations, particularly where the reactions are carried out in the presence of and by the aid of the electric arc.

Hitherto it has been proposed to form or manufacture extrusion or forming dies or other articles requiring a high wear-resistant surface in a variety of ways, among which may be mentioned the melting of materials composed of chromium, tungsten, cobalt, vanadium, molybdenum, nickel, or other such metals, in a crucible, casting to shape and hardening by heat treatment; also casting such materials onto a block, the finished die surface being machined or ground to the appropriate size in both instances. Yet another prior method consists in casting such molten carbides centrifugally onto the surface of a die.

It is an object of this invention to provide an improved wear-resisting tool or die having a wear-resisting facing of compacted tungsten carbide alloyed or bonded with cobalt, iron, nickel or like alloying or bonding metal or material, or like wear-resisting material, fused, sintered or bonded in place.

Another object of this invention is to provide an improved wear-resisting tool or die having a wear-resisting facing of tungsten carbide or like wear-resisting materials mixed with suitable amounts of an alloyable metal of the group comprising cobalt, nickel and iron, the alloy being formed in place upon the tool or die.

Another object of this invention is the provision of an improved wear-resisting tool or die having a wear-resisting facing of tungsten carbide or other like wear-resisting material mixed with a suitable bonding metal such as cobalt, iron, nickel or equivalent materials heated to a temperature sufficient to cause sintering of the materials without causing complete reaction therebetween.

A further object of this invention is the provision of an improved wear-resisting tool or die having a wear-resisting facing of tungsten carbide or other like wear-resisting material mixed with a suitable bonding metal such as cobalt, iron, nickel or equivalent materials and heating while subjected to sufficient centrifugal pressure to compact the materials under treatment and secure a desired bonding of the components of the mass.

These, and other desirable objects and advantages will be described in the accompanying specification and illustrated in the drawing in which a preferred apparatus for carrying out the improved process of the present invention has been shown. As other specified devices may be used it is not intended to be limited to the apparatus here shown, except as such limitations are clearly imposed by the appended claims.

In the drawing like numerals refer to similar parts throughout the several views, of which

Fig. 1 is a vertical section through a centrifugal casting apparatus showing a die in place and an electric arc in position;

Fig. 2 is a vertical section of a die block; and

Fig. 3 is a view similar to Fig. 2 showing the compacted wear-resisting material in place, and showing the finished surface of the wear-resisting materials.

Referring more specifically to the drawing, the centrally apertured die block 10 is provided on its inner surface with a plurality of channels

or serrations 11 which are adapted to receive a molded wear-resisting facing material 12. This material may comprise a completely reacted alloy formed from tungsten carbide, in suitable amounts, and a metal of the group comprising iron, nickel or cobalt, or the material may be made up of the unreacted components of said alloy which is subsequently heated to an alloying temperature, or otherwise treated, as will be described more in detail hereinafter. The compositions used may comprise from 40% to 75% of the hard materials such as tungsten carbide or its equivalents and the balance cobalt, iron, nickel or equivalent material, as set forth more fully hereinafter. Such a composition range assures a desirable toughness of the facing material, together with the requisite wear-resistance. The forming or extrusion die block is preferably machined to an inside diameter which will receive the amount or thickness of a facing 12 which may be of tungsten carbide alloyed or bonded with cobalt, iron, nickel or like alloying or bonding metal or material, or other wear-resisting materials, as may be desired. In the preparation of the finished die or valve seat or other article with a wear-resisting facing, as comprehended within the present invention, the material 12 is made up of any suitable compound, including therein, preferably in high percentages, tungsten carbide alloyed with or bonded by cobalt, iron, nickel or like alloying or bonding metal or material, tantalum carbide, similarly alloyed or bonded, including metals and/or alloys, or other materials having high wear-resisting qualities, and is molded, in a suitable state of fineness, and compressed into and upon the die block 10 in such manner as to present a substantially smooth wearing surface 13.

The invention also comprehends, as above intimated, the use of completely reacted alloys of tungsten carbide with a metal of the group comprising iron, nickel and cobalt, which alloys may be prepared in a suitable state of fineness and applied to the tool or die surfaces in any desired manner and shape and thereafter remelted and compacted. It will also be appreciated that the high melting compositions, such as alloys of tantalum, molybdenum, etc., may be applied in the manner and form designated.

The die block 10 with its adherent facing material 12 is inserted in a rotary mold comprising a dished casing 14 having a flange 15 adapted to receive bolts 16 for attaching a cover 17 thereto. The cover is provided with a central aperture 18 in alignment with a similar aperture 19 in the bottom 20 of the casing. This bottom portion is provided with an integral, internally threaded boss 21 adapted to receive threaded shaft 22 mounted for rotation in bearing 23. A driving pulley 24 is secured to the shaft 22 and is provided with suitable driving means such as a belt 25 connected to a suitable source of power, not shown. The die block 10 is spaced from the walls of the mold 14 by any desirable insulating material, such as blocks 26, of magnesium, which are cut to the requisite size to provide a support for the die block and to maintain it insulated from the mold casing, and also to have its longitudinal axis coincide with that of the aligned apertures 18, 19 above described, as well as the aligned apertures 27, 28 formed in the magnesia blocks disposed at the top and bottom of the die block.

The facing material 12 is heated to a desired

degree by means of an arc 29 fed by a current of suitable amperage and having a temperature of the order of 3000 to 3600° C., as formed between electrodes 30 and 31 passing through the apertures in the cover and the bottom of the mold, the bottom of electrode 31 also passing through the hollow shaft of the centrifugal mold assembly. The electric arc may be maintained close to the surface to be heated to insure maximum reaction temperatures, or it may be moved away from such surface to a desired distance to decrease the defective temperature at such surface. The details of the apparatus for obtaining these desired conditions will be described in detail hereinafter.

The operation is preferably carried out in the presence of hydrogen or other inert gases to prevent excess oxidization. The hydrogen may be introduced through the hollow shaft 22 through a stuffing box or feed line 22a, provided with an inlet tube 22b, although, if hollow electrodes are used it may be introduced through the electrodes. The electrodes preferably are held in aligned relation by means of clamps 32, 33 which are provided with arms 34, 35 adapted for sliding engagement in the clamps 36, 37, where they may be maintained in locked or fixed position by means of the screws 38, 39 respectively. Suitable electrical conductors 40, 41 are secured to the conductive clamps 32, 33 by means of rivets or bolts 42, and these conductors may be connected to any suitable source of power such as a generator, not shown.

To permit the adjustment of the arc in any direction with respect to the inner die face 12, the following apparatus may be made use of. A yoke 43 having side arms 44 and 45 is provided with connecting arms 46, 47 which form a substantially continuous member slit at its middle, the said members respectively provided with racks 48 and 49 adapted to engage a pinion gear 50, the whole being mounted in a movable sheath member 51 and adapted for sliding movement therein, the amount and direction of such movement being controlled through the racks and pinion gear, which latter is in turn controlled by the hand-wheel or control member 52. The sheath 51 is provided with a rack 53 adapted to enmesh with and be moved by the gear 51 movable with shaft 55. The gear 54 and shaft 55 are mounted on a lug 56 connected to and integral with a yoke 57 which is provided at the extremities of its arms with suitable bearings 58 with which the sections 46 and 47 of yoke 43 are adapted to move. The bearings 58, together with the sleeve 51, form supports for the arms 46 and 47 and prevent their non-linear movement. The yoke 57 is adapted to be moved laterally in or out and for this purpose a member 59 is secured thereto and connected to a screw 60 which is provided with a control 61, the said screw being suitably mounted in a standard 62. Upon operation of the control 61 the yoke 57 is moved toward or from the standard 62 which is of suitable size and strength to support the yoke 43, and associated apparatus. This inward and outward movement of the combined yoke assembly will cause the electrode holders with the associated electrodes to move away from or toward the die surface, thus decreasing or increasing the effective heat applied to such surface by the arc 29.

To maintain the yoke 57 and the associated yoke 43 in a desired plane while permitting the movement above described the standard 62 is

suitably apertured to receive a guide 64 integral with a sleeve 63 secured to the yoke 57. The member 64 may, of course, be dispensed with, or it may be so arranged as to be adjustable with respect to the standard 62 so as to permit the angular rotation of the yoke 57 about the screw 60 as an axis.

The side arms 44, 45 may be moved toward or away from each other by manipulating the control member 50, when this movement, as noted above, imparts like movement to the electrode holders 36, 37 which are respectively secured to the ends of the said arms 44 and 45 and which are so arranged as to maintain the carbons in aligned relation. The distance between the electrodes may be varied by unscrewing the screws 38 and/or 39, and after adjusting the arc, securing them to permit of a fixed separation of the carbons with the definite determined arc distance therebetween. The screws 38 and 39 may be replaced by suitable gears adapted to enmesh with suitable racks formed on members 34 and 35 to permit a desired adjustment of the length of the arc. The distance between the carbons may also be regulated by any other well known mechanisms not here shown.

It will be appreciated that the arc 29 formed between the ends of the carbons may be raised or lowered within the mold by suitably rotating the gear 54 to effect upward or downward movement of the member 51, and in this manner the effective heat of the arc may be applied at any given height or position within the mold. This feature, in conjunction with the lateral movement of the arc made available by proper adjustment of the control 61, permits the use of this device for large die and valve members as well as for small ones.

In the bonding, sintering, or alloying of a facing mix upon the die surfaces the requisite quantities of heat may be applied to such surfaces for the purposes desired by suitably adjusting the arc with respect to such surface and the condition of the surface material which is to be finally secured. This combination of apparatus features, as intimated above, permits the manufacture of large dies having wearing surfaces of any desired composition, which surfaces will be characterized by their substantially complete uniformity throughout their extent due to the uniformity of treatment received by the materials from same.

In the operation of the improved apparatus herein shown, the mold 14 with the die 10 and the compressed facing material 12, mounted therein, are set in rotation at a desired speed, which may be varied substantially between 300-7200 R. P. M., as required for the particular article and the composition being alloyed, sintered, cemented or bonded thereto. An arc is then sprung between the electrodes, and the die-facing material is brought to a temperature to give it the desired consistency. By suitably spacing the arc from the surface under treatment the materials may be heated to an alloying temperature, to a sintering temperature or to a still lower temperature at which the lower melting components of the mix are softened and compacted under the centrifugal pressures obtained.

It will be appreciated that by raising the facing material 12 to its softening or fusing point while rotating the mold at a relatively high speed, depending upon the thickness of the die facing, the softened fused material will be re-

acted and the alloy formed will be forced into contact with the channels or grooves 11 of the die block, and upon attainment of a sufficient degree of heat throughout the mass of the facing material, the reacted material will fuse to the said die block, and be compacted thereon. Due to the high centrifugal pressures obtainable by suitable varying the speed of rotation of the die supports, the bonded or sintered materials will also be compacted in place without attaining a reacting temperature.

Where the materials have been initially alloyed and then reduced to a suitable state of fineness and applied to the die surface, or where the alloy components have been mixed in a ground condition and applied as a mix to the die surfaces and thereafter heated in place to an alloying temperature, the rotation causes the low melting alloy components to be extruded toward the supporting surfaces of the die blank and at the temperatures involved, to react therewith to a greater or less degree, thus providing an improved integral bond between the die blank and the novel die surfacing. The extent of this interaction of the facing and the die blank materials will depend upon the constitution of the low melting components of the wear-resisting alloy, which in turn will depend upon the relative percentages of the high melting carbides or like materials used with the alloying metals of the group comprising cobalt, iron and nickel. This low melting component of the alloy composition under the combined influences of heat and centrifugal pressure not only provides a desirable means for providing an intermediate cushioning metal which forms a bond between the surfaces of the die blank and the wear-resisting surface, but also permits the segregation or concentration of the high wear-resisting component of the alloy at the wear-resisting surface of the die when the alloy mass has finally attained a uniform temperature during the formation of the die facing.

To avoid causing the fused mass to collect at the end of the block having the largest aperture diameter, the arc may be initially positioned at such diameter, to cause the facing or wearing material to be fused and centrifugally compacted and bonded to the block. By thereafter lowering or moving the arc toward the aperture of lesser diameter, this progressive movement being so adjusted and carried out as to permit the progressive fusing of the intermediate portions of the facing material, while at the same time permitting a slight cooling of the already compacted mass, whether fused or merely softened the latter is enabled to act as a dam for the successively fused or softened masses of compacted facing material.

This progressive softening or fusing of the facing material is particularly desirable where the mold is to be run or operated at relatively high speeds, while, with lower speeds the arc may be so positioned and operated as to accomplish a substantially uniform softening, semi-fusing or fusing of the entire mass 12 of the facing material, whereby to bond, cement, sinter or alloy the material, as may be desired.

The progressive fusing of the facing material may result in the formation of a series of inter-bonded rings of compacted wear-resisting substances which act as mutual supports and which, due to their laminated structure, would prevent the propagation of any surface cracks or fissures

from one edge of the aperture directly through to the other edge.

This method includes, among other advantageous characteristics, that of permitting an equal distribution of wear-resisting material throughout the inside circumference of the die, and allowing the deposit of compacted material upon the inside face of the die to be made up to any desired thickness, while at the same time producing uniformity of the deposited alloyed, bonded, sintered or cemented tungsten carbide composition or other wear-resisting materials, and producing a wear-resisting facing which, at the utmost, will require but slight grinding and polishing or lapping to acquire the exact size of aperture desired.

The improved dies and other articles having compacted, cemented, sintered or fused wear-resisting facings resulting from this treatment not only have a longer life, but are more easily and economically formed, due to the fact that separate forming, heating, casting and pouring operations, with subsequent rough-forming and final finishing steps, are minimized, as, under the present process, there is an initial forming to substantially the correct dimensions, requiring but a single finishing operation to attain the desired dimensions of the wearing portion of the die or other article.

It will now be appreciated that there has been disclosed a novel method of preparing dies for drawing or extruding metal in tube, wire or rod form, as well as wear-resisting facings generally for other articles, which dies and other articles are characterized by certain novel features of construction adapting them for the more perfect carrying out of their useful functions and being, at the same time, endowed with a longer operative life and also being susceptible of formation at relatively low costs. In addition, there has been disclosed a novel apparatus for securing the desirable results of this invention.

While the invention herein is disclosed in one or more forms, it is to be understood that various changes and modifications may be made, but such changes or modifications come within the spirit and scope of the invention as defined in the claims hereof.

What is claimed is:

1. An improved extrusion and forming die comprising a body portion of relatively soft metal and having a central aperture provided with a plurality of annular ridges therearound, and a wear-resistant facing formed on said annular surface and fused and compacted in place. 80

2. An improved extrusion and forming die comprising a body portion of relatively soft metal and having a central aperture provided with a plurality of annular ridges therearound, and a wear-resistant facing formed on said annular surface and sintered and compacted in place. 85

3. An improved forming and extrusion die comprising a body portion of metal having an apertured central portion presenting a die surface, a wear-resisting facing adhered to said die surface, said facing comprising a preformed mass of tungsten carbide alloyed by cobalt, iron, nickel, and like metals and alloying material simultaneously heated and compacted in place by centrifugal force. 90 95

4. An improved extrusion and forming die comprising a body portion of relatively soft metal and having a central aperture provided with serrations on the face of the aperture, and a wear-resistant facing formed on the serrated surface and fused and compacted in place. 100

5. An improved extrusion and forming die comprising a body portion of relatively soft metal and having a ridged central aperture and a wear-resistant facing formed on the ridged surface of said aperture and fused and compacted in place. 105 110

6. An improved extrusion and forming die comprising a body portion of relatively soft metal and having a serrated central aperture, and a wear-resistant facing formed on said aperture surface and sintered and compacted in place. 115

7. An improved extrusion and forming die comprising a body portion of relatively soft metal and having a ridged central aperture and a wear-resistant facing formed on the ridged surface of said aperture and sintered and compacted in place. 120

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