

March 24, 1942.

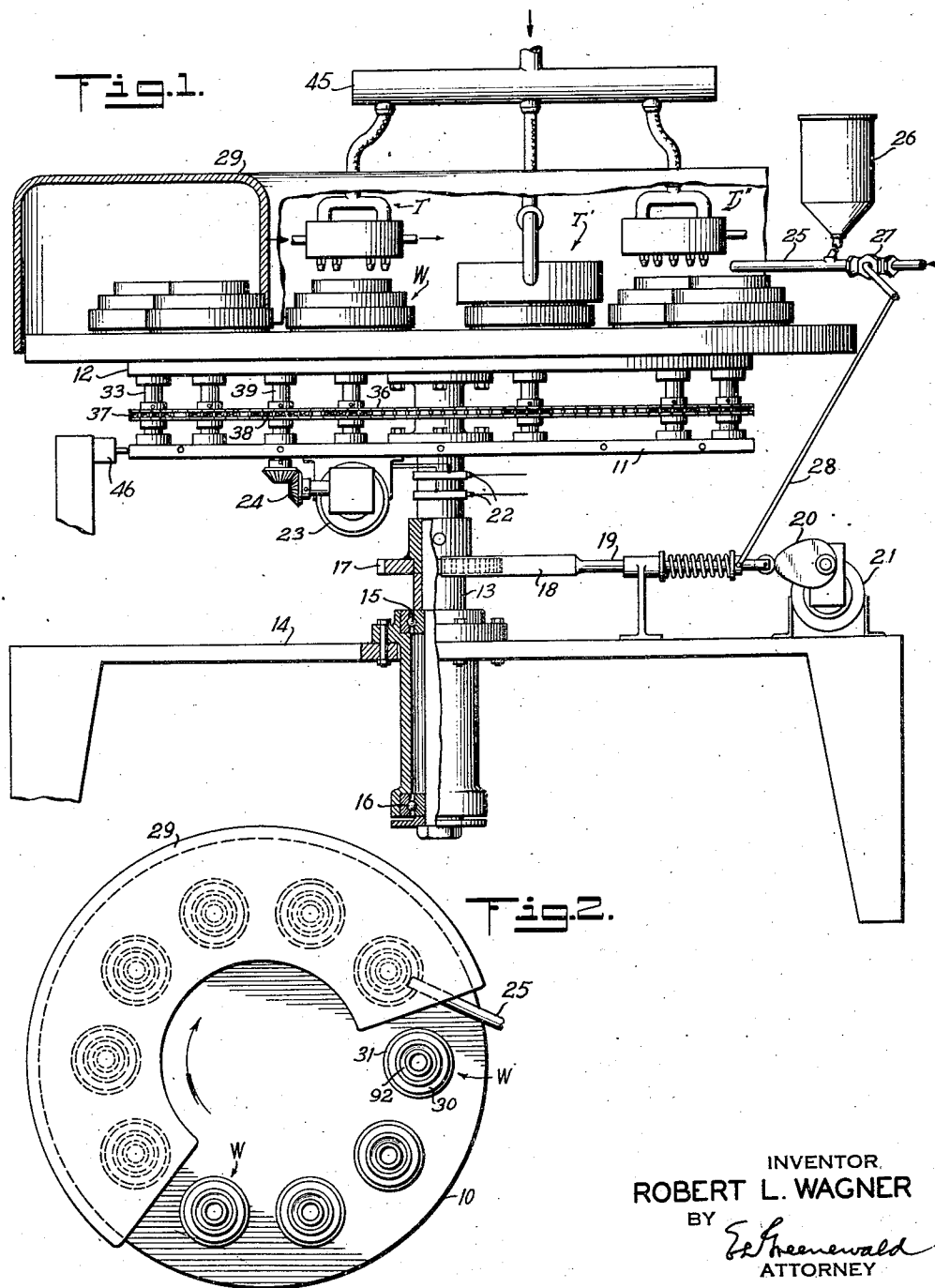
R. L. WAGNER

2,277,571

METHOD AND APPARATUS FOR APPLYING PROTECTIVE METAL

Filed June 28, 1940

3 Sheets-Sheet 1



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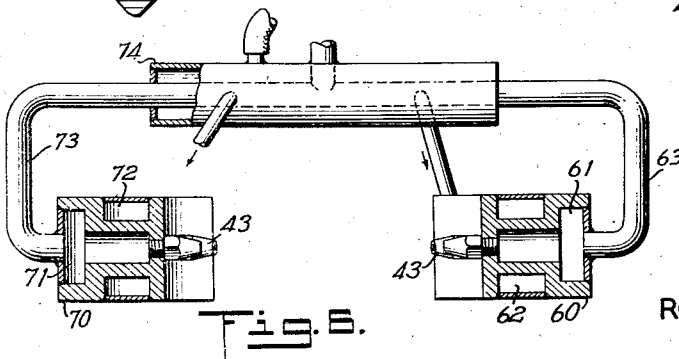
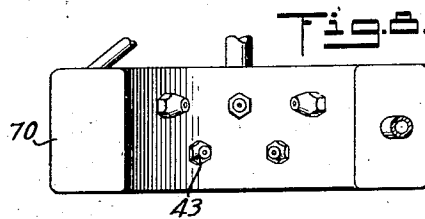
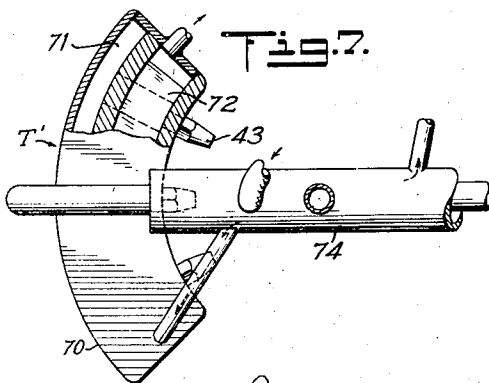
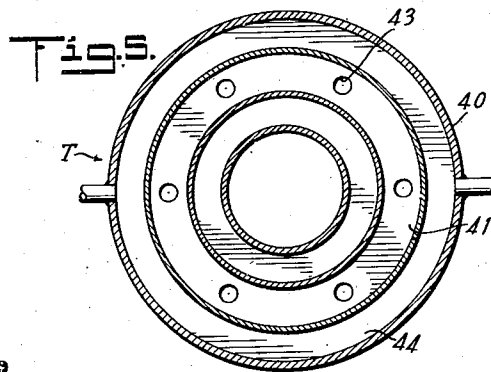
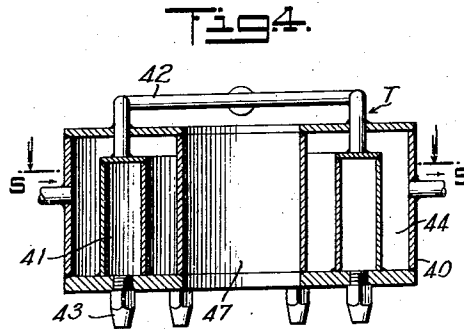
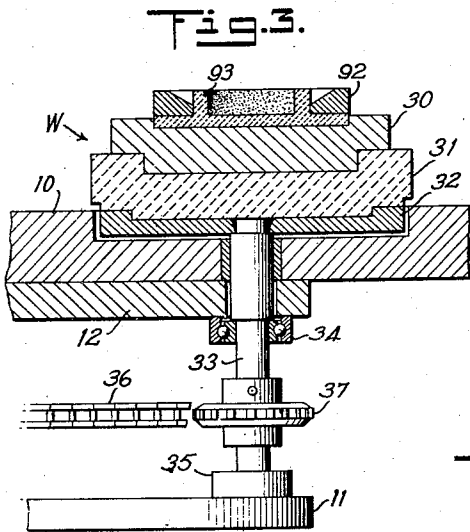
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3 Sheets-Sheet 2



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Fig. 9.

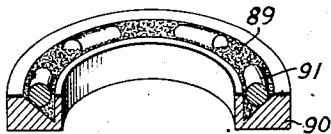


Fig. 10.

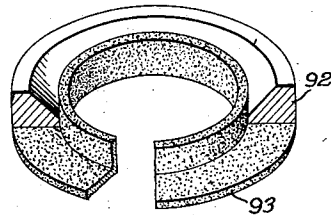


Fig. 11.

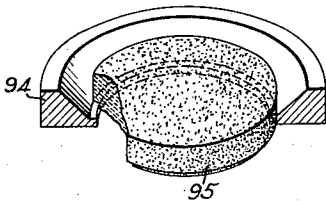


Fig. 12.

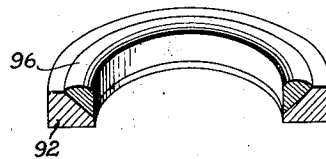


Fig. 14.

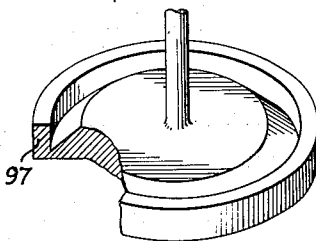


Fig. 13.

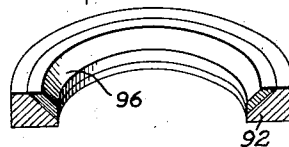


Fig. 15.

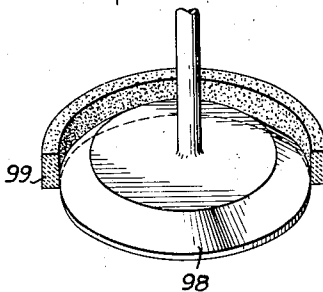
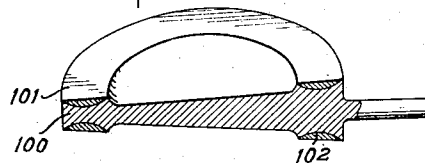


Fig. 16.



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METHOD AND APPARATUS FOR APPLYING
PROTECTIVE METALRobert L. Wagner, Niagara Falls, N. Y., assignor
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Application June 28, 1940, Serial No. 342,913

9 Claims. (Cl. 22-58)

This invention relates to the formation of layers of protective metal united to articles subject to wear or oxidation or both. The invention is particularly useful for forming annular layers of protective metal, for instance an alloy of cobalt, chromium, and tungsten that has great resistance to abrasion and to oxidation at high temperatures, on such articles as valves and valve seats. For the sake of conciseness and clarity, this use of the invention will be described in detail; but that other and analogous uses of the invention are possible will be apparent.

The seating surfaces of valves and valve seats are frequently provided with surface layers of protective metal by a hand operation using fusion-deposition welding methods, a welding rod, and a torch flame or other source of high temperature heat. This manual method is slow, producing in a typical case only 14 surfaced valve parts per hour per welder. The layers so produced have the surface irregularities and imperfections inherent in manual work of this kind, and a substantial percentage of the welded valve parts must be rejected or rewelded. Metal can not be deposited manually as a smooth layer of uniform thickness and, consequently, a substantial excess of metal must be applied and thereafter removed during the finishing operations.

Thus, the manual method involves a waste of time, labor, and materials, and there is a demand for automatic or semi-automatic methods and machines that decrease or eliminate this waste. It is an object of this invention to provide such a method and machine. A further object is to provide a method of preparing valve blanks, valve-seat blanks, and similar articles to receive layers of protective metal. The manner in which these and other objects of the invention are attained will become apparent as the description of the invention proceeds.

Typical embodiments of the several features of the invention are illustrated in the accompanying drawings, in which

Fig. 1 is a front view, partly in section, of a machine for applying annular layers of protective metal to the seating surfaces of valve parts;

Fig. 2 is a top view of the machine shown in Fig. 1;

Fig. 3 is a detail section of an individual work table W shown in Figs. 1 and 2, with a valve seat 92 thereon ready for the application of a layer of protective metal;

Fig. 4 is a section of a torch T with vertical tips, shown in Fig. 1;

Fig. 5 is a section of the torch T on the line 5-5 of Fig. 4;

Fig. 6 is a partial section of another type of torch T', with horizontal tips, shown in Fig. 1;

Fig. 7 is a top view, partially in section, of the torch T';

Fig. 8 is a side view of a portion of an alternative form of the torch T' having tips in two rows;

Fig. 9 is a section, in perspective, of a valve seat blank 90 of one type prepared for the application of a layer of protective metal 91;

Fig. 10 is a partial section, in perspective, of another type of valve seat blank 92, fitted to a refractory insert 93;

Fig. 11 is a partial section, in perspective, of another type of valve seat blank 94 fitted to a refractory insert 95;

Fig. 12 is a section, in perspective, of a partially completed valve seat 92 provided with a welded-on layer 96 of protective metal;

Fig. 13 is a section, in perspective, of a completed valve seat 92 having a seating surface formed in the layer 96 of protective metal;

Fig. 14 is a partial section, in perspective, of a poppet-valve head 97 prepared for the application of a layer of protective metal;

Fig. 15 is a partial section, in perspective, of an alternative form of poppet-valve head 98 fitted with a refractory sleeve or ring 99; and

Fig. 16 is a section, in perspective, of a valve gate 100 having two seating surfaces protected with layers 101 and 102 of protective metal.

Although the apparatus illustrated in Figs. 1 to 8 may be operated in many different ways and may be used to treat many different articles, it will possibly find its greatest use in the application of annular layers of protective metal to the seating surfaces of valve parts, and in such use the following procedure is preferred.

According to the preferred procedure, the valve part and protective metal are suitably prepared and then gradually heated throughout to a temperature just below the melting temperature of the protective metal, and the protective metal is then brought to its melting point. The surface of the valve part is not melted to any substantial depth. Under such conditions, complete union of the protective metal with the valve part occurs with a minimum danger of damage to the valve part. Excessive melting of valve part metal and commingling or alloying of the latter with the molten protective metal are avoided. Commingling of the valve part metal and protective metal dilutes the latter and is therefore undesirable.

In practice, when providing steel valve parts

of a size customarily used in automobile engines, with a cobalt-chromium-tungsten alloy similar to "Stellite," for instance, the valve part and the surfacing alloy may readily be brought to a temperature of about 1000° C. in twenty seconds, and the protective alloy then melted in ten seconds, thereby attaining a production rate of 360 hard surfaced valve parts per hour. Different articles and different metals will require correspondingly different temperatures and times; but the melting and uniting time should preferably be an aliquot part of the preheating time. The metal valve part should have a melting point not much lower, and preferably higher, than that of the protective surfacing metal or alloy.

Typical methods of preparing valve-part blanks for treatment are illustrated in Figs. 9, 10, 11, 14, and 15. For example, a groove may be formed in that portion of the blank on which the protective metal is to be applied, as shown in Figs. 9 and 14, and pieces 91 of protective metal, with or without a suitable powdered flux 89, may be placed over or in the groove as shown in Fig. 9. Alternatively, a bevel or chamfer may be formed in the blank, and a suitable refractory insert, ring, or plug, may be fitted to the blank to form a groove to hold the protective metal, as shown in Figs. 10, 11 and 15. Instead of separate pieces of protective metal, a substantially complete ring of such metal may be used; or the protective metal may be fed to the blank at a uniform rate in the form of a rod of such metal.

A prepared blank and associated parts, such as shown in Fig. 3, may be mounted on a work table W as indicated in Figs. 1 and 2, and subjected to high temperature flames in a plurality of successive steps which includes preheating the blank and the protective metal, melting the protective metal, and welding the latter to the blank. The welded blank is then removed from the work table, and at this stage has an appearance similar, for example, to the article shown in Fig. 12. A grinding or other machining operation may then be performed to prepare the finished valve part, which may have the shape illustrated in Fig. 13.

An apparatus for automatically or semi-automatically applying preheating and melting flames to the prepared blanks is illustrated in Figs. 1 to 8. The apparatus illustrated comprises a plurality of individual work tables W, mounted for rotation on a spindle supported on a rotatable platform 10. The latter is provided with suitable mechanism for positioning each table successively under preheating torches T and T' and a melting torch T'', in preselected relation to each torch.

The individual work tables W, shown in detail in Fig. 3, are identical and comprise a work positioning member 30, of copper or other suitable material, resting upon a refractory member 31 that in turn rests upon a metal plate 32 secured to a shaft 33. The shaft 33 is supported by the platform 10 through a bearing 34 and by a base 11 through a bearing 35. The shaft 33 and the members supported thereon may be rotated at a uniform selected rate by a drive chain 36 and a sprocket 37. The drive chain 36 is driven by a sprocket 38 that is rotated by a shaft 39 driven by a motor 23 through bevel gears 24. Electric current for the motor 23 may be supplied through a brush and slip ring device 22.

Ten work tables W are shown in Figs. 1 and 2. This has been found to be a suitable number; but more or fewer tables may be used if desired.

The tables are disposed at equal distances apart in a circle on a platform 10 provided with a spindle housing and reinforcing member 12. The platform 10 is fastened to a rotatable main shaft 13 that is supported on a frame 14 by suitable bearings 15 and 16. The shaft 13 and the platform 10 are intermittently rotated at a selected rate by a ratchet 17 and pawl 18 driven by a reciprocating arm 19 connected through a cam 20 to a motor 21. In the modification shown in Fig. 1 the throw of the cam 20 is sufficient to rotate the table 10 one-tenth of a revolution for each revolution of the cam 20. At the end of each stroke of the cam 20, the motion of the platform 10 ceases, and the platform may be held in position by a resilient stop 46 engaging shallow depressions in the edge of the base 11 until cam 20 is again actuated.

Supported above contiguous work tables W in the direction of movement of table 10 and in fixed relation to the frame 14, in the modification shown in Figs. 1 and 2, are respectively a top preheating torch T, a side preheating torch T', and a melting torch T''. The torches are supplied with a combustible mixture of fuel and oxygen from a manifold 45. While the apparatus shown in Figs. 1 and 2 is designed to rotate in a clockwise direction, a reverse arrangement may of course be used if the parts are appropriately transposed. In the arrangement illustrated, a valve part blank or other article is placed, during each dwell and either by hand or by a suitable mechanical device, on each work table W ahead of the top preheating torch T. The platform 10 carries each work table to and past the torches T, T', and T'', and the treated article may then be removed from its work table by hand or mechanically during a dwell of the intermittently rotating platform 10.

As the platform 10, carrying the work tables with the articles to be treated, moves intermittently at equal fixed intervals of time, and by equal portions of a revolution, each work table is brought successively under the respective torches T, T', and T'' and remains under each torch for a predetermined constant time interval. Each of the work tables is continually revolved at the same uniform rate by the motor 23, whereby uniformity of heating of each article is promoted. If desired, as each work table reaches the melting torch T'', a flux may be placed on the article being treated. This may be effected, for example, by an injector 25 connected with a flux reservoir 26 and actuated from a source of gas under pressure. A short blast of gas may be supplied to the injector 25 by the operation of a quick-acting valve 27, actuated by a lever 28 connected to the reciprocating arm 19. It may also be desired to confine the heat of the torches T, T' and T'' by a hood 29 that does not rotate with the platform 10. Such hood preferably contains one or more apertures or transparent sections (not shown) to permit visual inspection of the torches T, T' and T''.

A suitable top preheating torch T is shown in detail in Figs. 4 and 5 and comprises an annular hollow body 40 surrounding a central chimney 47, the said body 40 containing an internal annular chamber 41 that serves as a manifold for a fuel-oxygen mixture. A mixture of fuel, for instance acetylene, and oxygen or air is brought to the manifold chamber 41 by a conduit 42, and the manifold chamber 41 supplies the mixture to a row of torch tips 43. A cooling water chamber 44 at least partially surrounds the manifold chamber 41. If desired, for instance for con-

venience in the treatment of the under sides of poppet-valve heads, the torch body 40 may be formed in two or more separate parts in a manner similar to that used in the construction of the side preheating torch T', to provide clearance for the stem of the poppet-valve.

A side preheating torch T' that has been used successfully is shown in detail in Figs. 6 and 7 and comprises a pair of similar hollow arcuate bodies 60 and 70, each provided with a manifold chamber 61 and 71 and a cooling water passage 62 and 72. A fuel-oxygen mixture is brought to the manifold chambers 61 and 71 by conduits 63 and 73, and the manifold chambers deliver the mixture to torch tips 43. Portions of the conduits 63 and 73 exposed to high temperature heat are protected by a cooling water jacket 74, and cooling water leaving such jacket 74 is conducted to the cooling water passages 62 and 72 of the torch bodies 60 and 70. If desired, as in the treatment of relatively thick articles, the torch tips 43 may be arranged in two or more rows as shown in Fig. 8, the tops of each row preferably being staggered with respect to those of the next adjacent row. The side preheating torch T' is supported at such a height above the platform 10 that the torch tips 43 are opposite the sides of the valve seat blank 92. If poppet-valve heads are to be heated, the jacket 74 should be far enough above the bodies 60 and 70 to clear the spindle of the valve head.

The melting torch T'' may be substantially the same as the top preheating torch T, although more torch tips 43 should ordinarily be used in the melting torch than in the preheating torch.

In each of the torches T, T', and T'', the central opening acts as a chimney for the products of combustion.

Instead of being mounted in fixed position, as illustrated, one or more of the torches may be given a uniform selected rotary or transverse oscillatory motion on an axis coaxial with that of the annular valve seating surface, and in such a case it may be desired not to rotate the work tables.

Fewer or more preheating torches than the two illustrated may be used as circumstances may dictate, and although it is usually preferred to apply a top preheating torch before the side preheating torch, some articles may require the reversal of this order or the use of either top preheating alone or of side preheating alone. Furthermore, both top flames and side flames may be applied simultaneously. At a sacrifice of convenience, preheating means other than torch flames—a muffle furnace for instance—may be used.

The melting torch T'' may be followed by any suitable means for delaying or retarding the solidification of the molten protective metal, and such means will in some instances improve the soundness of the deposited metal.

The platform 10 need not be circular, of course, and it may be replaced by an equivalent means for transporting the work tables, for instance by an endless chain or belt moving intermittently, step by step at a selected rate, in either a horizontal plane or in a vertical plane.

The work tables may all be rotated simultaneously, as illustrated, or they may be provided with individual separate driving mechanisms to permit independent control of the time and rate of rotation of each work table. It is easier to place work on, and to remove articles from, the work tables if provision is made to stop the ro-

tation of each table at one or more stations remotely from the heating stations. If desired, the flux dispensing mechanism may be omitted, or an equivalent device may be used.

Uniformity of heating of the valve parts is promoted by the uniform slow rotation of the work tables W, suitably at a speed of 30 to 50 R. P. M.; by supporting the valve part being surfaced upon a member 30 of a metal such as copper having a good heat conductivity and by applying the preheating and welding heat in identical manner to each of a succession of work pieces by means of a plurality of torch tips 43. At the speeds of rotation just indicated, and the total preheating time of twenty seconds and melting time of ten seconds mentioned above, each part of the metal to be heated passes under each flame a number of times. The rate of heating may be regulated by the rate of supply of combustible gas mixture to the torches, and by the number and sizes of the torch tips 43. The number and distribution of the torch tips 43 may be varied by replacing some of the tips 43 by plugs.

An excess-acetylene oxyacetylene flame is preferred as the heating medium at each of the heating and melting stages.

If the preferred procedure described above is used, it is possible to apply two layers of protective metal, one on each side of a valve part, as illustrated in Fig. 16, by applying one layer, turning the part over, and applying the second layer. Inasmuch as only the topmost layer is raised to a melting temperature, the application of the second layer does not remelt the first.

In addition to the advantages described above, of rapidity of operation, efficiency in the utilization of materials and labor, uniformity of the quality of the products, and adaptability to a wide variety of surfacing procedures, the method and apparatus of the invention insure the production of sound, homogeneous surface layers of protective metal free from laps and thoroughly bonded to the metal of the article. Materials other than "Stellite," for example bronze, "Monel metal," and high chromium steel, may of course be applied as protective metals. Not only valve parts, but also other articles such as circular shears, wearing rings, punches, core drills, and various dies including extruding dies, may be treated as described herein.

This application is in part a continuation of my application Serial No. 211,367, filed June 2, 1938.

I claim:

1. Method of forming a seating surface of protective metal on preformed receiving surface of a valve part which comprises placing the valve part on a rotatable work table; advancing said work table successively to at least one preheating station and at least one melting station, and maintaining the work table at each of said stations for the same length of time; introducing protective metal onto said receiving surface in the valve part; preheating the valve part by applying high temperature flame thereto at said preheating station or stations; at said melting station or stations applying high temperature flame to said protective metal on said receiving surface, for a time sufficient to melt only the protective metal and to bond the molten metal to said receiving surface; and at each of said preheating stations rotating the article and the work table a plurality of revolutions to preheat the receiving surface throughout, and at each of said melting stations rotating the article and the

work table a plurality of revolutions during the application of said high temperature flame.

2. Method of forming an annular seating surface of protective metal on a valve part which comprises removing metal from a portion of the valve part to receive the protective metal; placing on such portion an amount of said protective metal approximately equal to the amount of metal so removed; positioning the valve part, with such protective metal uppermost, on a work table; advancing said work table successively to two preheating stations and a melting station; applying substantially vertical high temperature preheating flames to the said valve part at one preheating station; applying substantially horizontal high temperature preheating flames to the sides of the valve part at the other preheating station; applying substantially vertical high temperature melting flames to the protective metal at the melting station; at each station, rotating the article relative to the flames for a plurality of revolutions; applying the melting flames for a time only sufficient to melt the protective metal and to bond the same to the valve part; and maintaining the work table at each of said stations for the same length of time.

3. In a method of forming an annular deposit of protective metal on a preformed receiving surface of a metal valve part or the like, wherein said receiving surface is brought to an elevated preheat temperature below its melting point by applying thereto high temperature flame and said protective metal is melted, deposited on, and bonded to, said preheated receiving surface by applying high temperature melting flame to said protective metal, the improvement which consists in rotating said valve part or the like relative to each of said flames for a plurality of revolutions, whereby all of the receiving surface is preheated before any protective metal is melted and whereby the deposited protective metal is subjected a plurality of times to each melting flame.

4. In apparatus for applying layers of surfacing metal to metal articles, a plurality of work tables supported at equal distances; means on each table to hold an article and surfacing metal in position for treatment; means providing a zone of preheat; means providing a zone of melting heat; means for positioning each successive work table first in the zone of preheat and then in the zone of melting heat, such last-mentioned means including means for maintaining each table in the zone of melting heat for a time that is an aliquot part of the time such table is in the zone of preheat.

5. Apparatus for applying layers of surfacing metal to metal articles which comprises a platform; a plurality of work tables supported in a circle by the platform, the distance between adjacent tables being the same aliquot part of the circumference of such circle; means to rotate said platform by aliquot portions of one revolution, said portions bearing the same relation to an entire revolution as the said distance between adjacent tables bears to the said circumference; a holder on each table adapted to hold an article and surfacing metal in position for treatment; a torch for producing a high temperature flame to provide a zone of preheat on a portion of said circle; and a torch for producing a high temperature flame to provide a melting zone adjacent to and following the zone of preheat.

6. In apparatus as defined in claim 5, means to rotate each work table about its axis independently of the rotation of said platform.

7. In apparatus as defined in claim 5, a torch constructed and arranged to provide a substantially vertical preheat flame and a separate torch constructed and arranged to provide a substantially horizontal preheat flame.

8. In apparatus as defined in claim 5, means for intermittently applying welding flux to the surfacing metal within the welding zone.

9. Apparatus for applying annular layers of protective metal to the seating portions of circular valve parts which comprises a rotatable circular platform provided with means for rotating such platform intermittently; a plurality of rotatable work tables supported in a circle by the platform, the distance between adjacent tables being the same aliquot part of the circumference of said circle, each table being adapted to hold a valve part and a supply of protective metal in horizontal position for treatment and each work table being provided with means to rotate such work table about its axis; a stop cooperating with said platform to limit the rotation of said platform to aliquot portions of one revolution, said portions bearing the same relation to an entire revolution as the said distance between adjacent tables bears to said circumference; a substantially vertical annular preheat torch providing a flame directed downward towards a portion of said circle; a torch providing a substantially horizontal flame directed inward and adapted to apply preheat to the sides of a valve part on a work table; and a torch providing a substantially vertical annular melting flame directed downward towards another portion of said circle.

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