

Nov. 10, 1942.

W. A. WISSLER ET AL

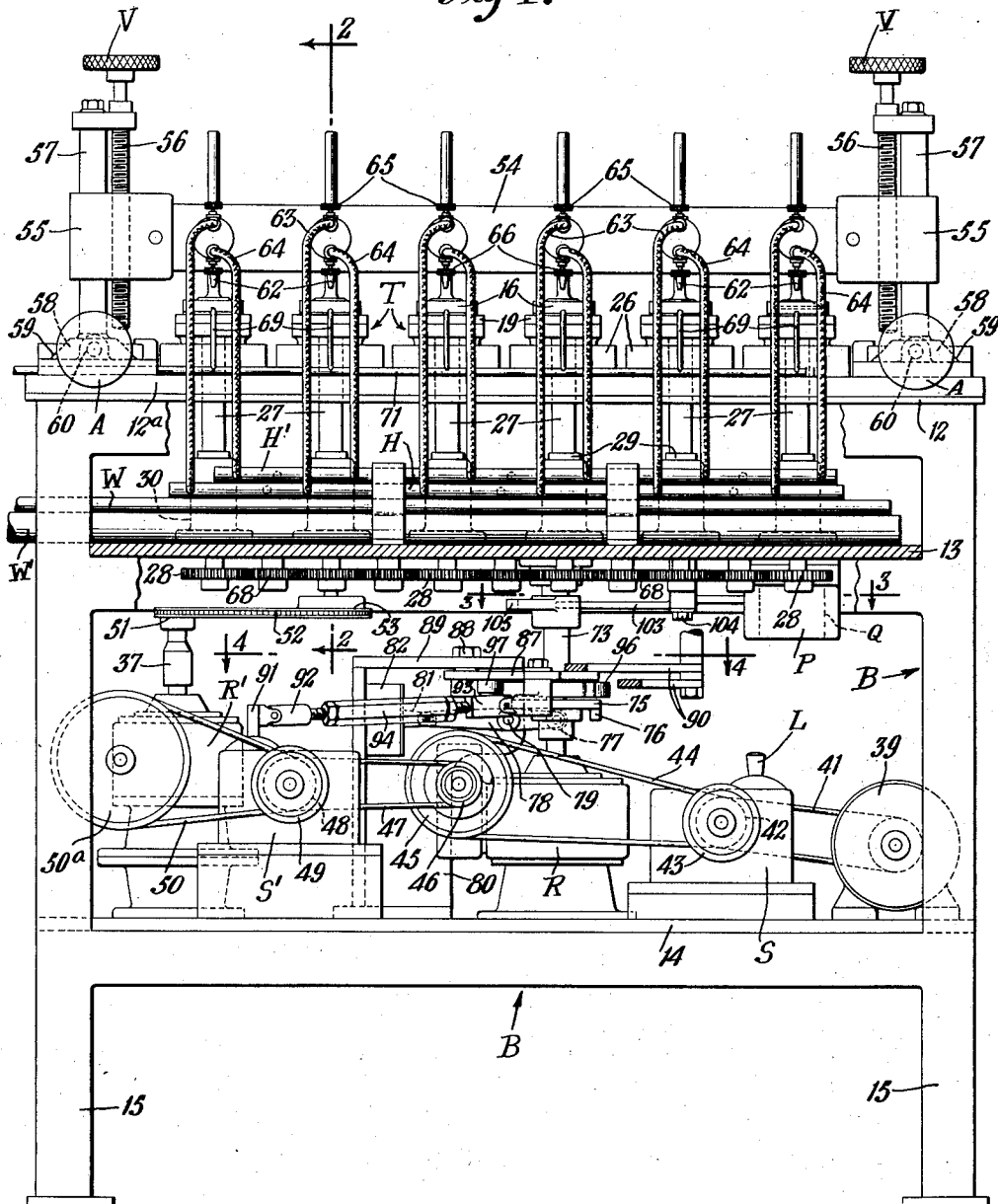
2,301,909

PROCESS OF AND APPARATUS FOR CONDITIONING METAL DEPOSITS

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3 Sheets-Sheet 1

Fig. 1.



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3 Sheets-Sheet 2

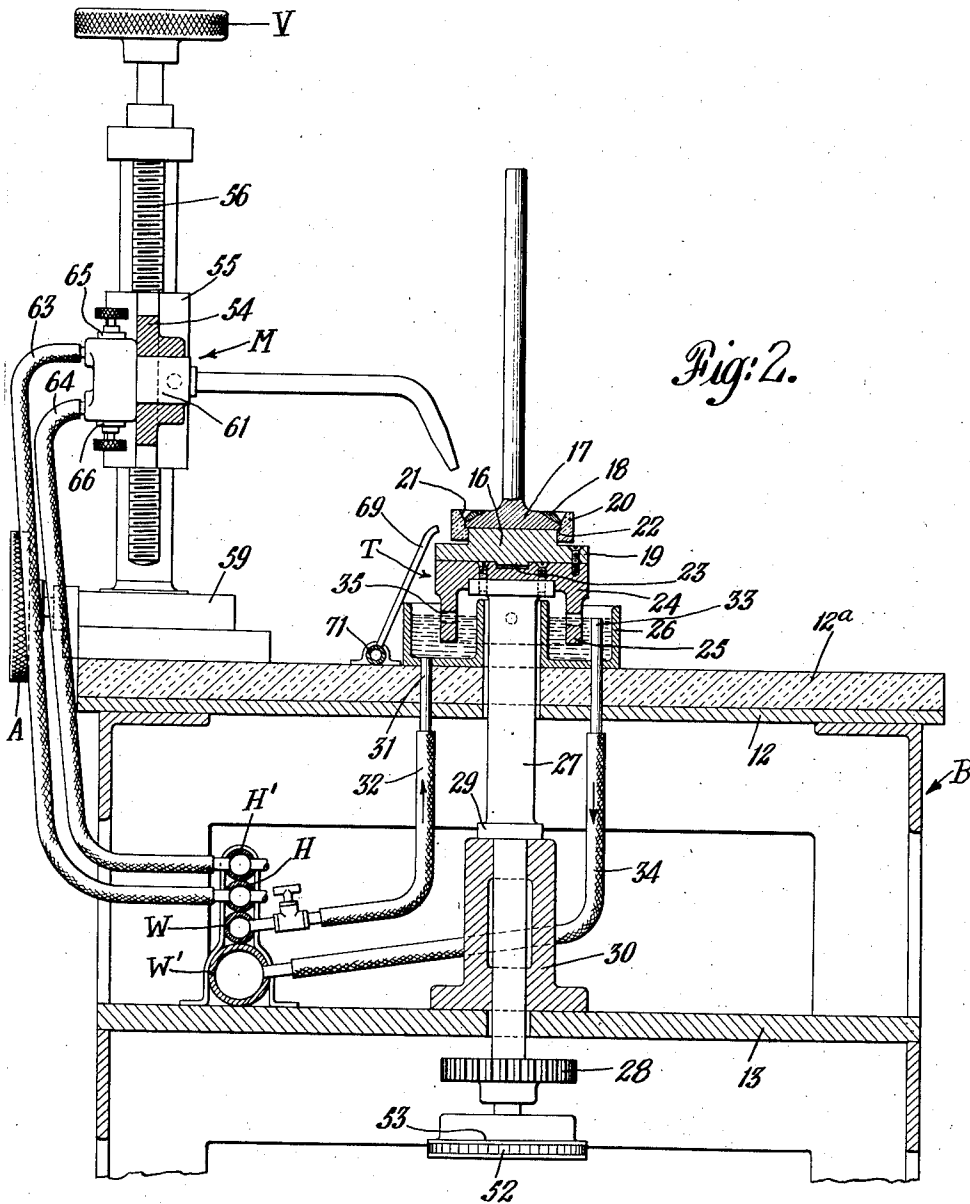


Fig. 2.

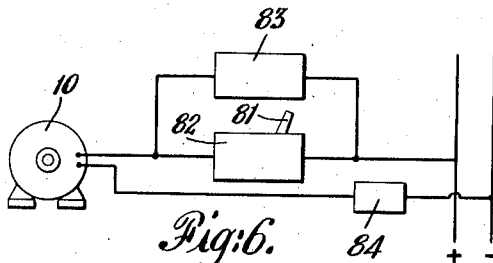


Fig. 6.

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## UNITED STATES PATENT OFFICE

2,301,909

PROCESS OF AND APPARATUS FOR  
CONDITIONING METAL DEPOSITS

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16 Claims. (Cl. 148—9)

This invention relates to the production of metal articles having wearing surfaces provided with welded-on surface overlays of protective metals or alloys. More especially it concerns a novel process and apparatus for treating and conditioning a deposit of a wear- and corrosion-resistant metal or alloy formed upon the wearing surfaces of articles, such as valves and valve parts, for the purpose of eliminating defects present in such deposited metal overlays, and for providing a smooth surface layer of protective metal that is uniform in thickness, and is intimately bonded to the matrix metal of which the article is composed, without excessive interalloying of the two compositions.

The invention has especial utility for the controlled remelting and improvement of the physical properties of the annular layers of non-ferrous alloys comprising cobalt, chromium and tungsten which, in present-day practice, are deposited upon the seating surfaces of valves and valve parts designed for use in the motors of airplanes and other apparatus where such parts are exposed to heavy wear at high temperatures, and to the action of corrosive and erosive influences during normal service.

To illustrate, in the manufacture of valves in which a layer of a fused wear-resistant alloy, such as one of the class of non-ferrous alloys composed of cobalt, chromium and tungsten, is deposited upon the wearing surfaces, that part of the valve upon which such alloy is deposited becomes highly heated during formation of the welded-on overlay. The interior portion of the body of alloy deposited upon the surface of the valve cools and solidifies very slowly. Consequently the surface portion of the deposited alloy exposed to the atmosphere is the first to solidify. It has been found that, partly for this reason, those underlying portions of the deposited alloy that solidify last in certain instances contain porous or relatively soft metal. The deposited material may appear sound, even after a grinding or other surface finishing operation, but the defects, particularly in the case of local soft spots in the overlay of surfacing metal, may be clearly observed after subjecting the deposited metal to sand blasting or similar treatment.

For the purpose of inhibiting formation of zones of porous or soft metal within a wear-resistant coating of a metal article, it has been proposed to contact a portion of the article with cooling members so that a portion of the article protrudes beyond the cooling members, while depositing a layer of a surfacing metal upon the

protruding portion of the article by means of a gas welding flame.

The last-named procedure is effectively used for many purposes, such as for the deposition of high-speed steel on the tip or cutting portion of a steel shank, while preventing the formation of a "pipe" in the fused-on metal. However, in the deposition of smooth welded-on metal overlays of selected thickness upon the annular wearing surfaces of valves, valve seats, and the like, many practical difficulties are presented that are not encountered in the deposition of overlays upon articles intended for services where a smooth continuous layer of homogeneous overlay metal is not required.

It often is desirable, particularly in mechanized operations employing automatic or semi-automatic apparatus for applying overlays of protective metal on such articles, to fuse and apply the entire deposit of overlay metal upon the prepared surface of a valve during a single brief interval of time, rather than to deposit progressively successive portions of the metal from a rod thereof, as in manual welding. Especially in such an operation, if the valve is water-cooled in the manner described above at the time the protective metal is deposited thereon, the excessive heat necessarily applied to melt the protective metal and bond it to the valve metal often damages the latter by burning it, due to the light section of the valve. If less drastic local cooling is employed, as by means of a stream of air, such cooling has generally proved insufficient to prevent or inhibit undesirable segregation of the metal components, while it may oxidize or burn the metal; and local zones of soft or porous metal may appear in the overlay metal. Since defects in the finished valve generally are latent, and appear only during destructive examination of the valve, or in actual service, there is great need for a practicable procedure and apparatus insuring the production of a succession of valves or other articles having wear-resistant surface layers uniformly free from these defects.

Among the more important objects of the present invention are: To provide a novel process and apparatus for treating and conditioning composite metal articles, such as valves, having a welded-on overlay of protective metal; the production of a composite metal article having a wearing surface provided with a smooth layer of a wear- and corrosion-resistant metal, which has a smooth surface and uniform thickness, and is intimately bonded with the base metal without excessive interalloying of the two compositions;

and to provide in novel manner for producing composite metal articles having wearing surfaces covered with welded-on overlays of protective metal or alloy free from porosity and soft spots. These and other objects will be apparent as the following description proceeds.

In the practice of the present invention, a composite metal article, a wearing surface of which has been provided with an overlay of a protective metal by any suitable procedure, such as that described in the copending application, Serial No. 211,367 of Robert L. Wagner, filed June 2, 1938, and the article then cooled to a temperature below the critical range, is subjected to a controlled local reheating and remelting treatment, preferably by means of one or more oxy-fuel gas flames, while the metal of the article is cooled by conduction or other suitable means under conditions allowing the deposited metal or alloy thus remelted to cool progressively from the surface thereof contacting the foundation metal toward the free surface of the protective metal.

Thus, according to one form of the invention, a composite metal article having thereon a continuous overlay of protective metal has a melting flame directed upon said overlay along a progressively shifting portion of a narrow zone that embraces substantially all parts of said overlay in said zone, thereby progressively and successively melting, smoothing and thereafter resolidifying the overlay metal in said shifting zone. The main body of the metal concurrently is maintained below its softening temperature, i. e., that at which it softens and deforms under slight load. After all of the overlay metal in said zone has been remelted and smoothed, the melting flame is directed progressively along said shifting zone under conditions supplying heat continuously to said overlay metal while preventing the melting of any portions of said overlay metal. A slow regulated reduction in temperature of the overlay metal occurs progressively toward the free surface of the latter, thus maintaining the smooth surface conformation of the overlay metal while isolating any porous or soft metal present in the overlay within a thin surface layer thereof. This surface layer may then be removed by a light grinding operation.

This procedure progressively smooths the surface of the overlay metal and eliminates porous or soft metal zones in the latter, except possibly in a zone so close to the surface of the overlay metal that the usual light grinding step removes it. Consequently, in the original preparation of the composite article, by applying the overlay metal to the article, it generally becomes necessary to use only sufficient heat to bring to a superficial or surface melting or sweating temperature merely a thin surface layer of the metal of the article, and to produce an intimate bond between the foundation metal and the overlay metal. Thus, all danger of overheating the metal during the surfacing of the article, with the resultant excessive interalloying of the overlay metal with the foundation metal may be avoided. The problem of providing at that time a uniform, smooth surface upon the overlay is unnecessary, since this may be accomplished by a subsequent application of the present invention to the coated article. By the use of the present invention, one operator may provide welded-on overlays of protective metal upon at least 40 to 50 valves per hour, as contrasted with a production rate of 5 to 7 valves per hour when such valves

are prepared manually in a single operation by an experienced operator.

In a preferred practice of the invention, utilizing apparatus of the type hereinafter described, one or more composite valves, each having an annular overlay of protective metal on its wearing surface, are placed upon corresponding rotatable tables; and each valve rests upon metal heat-transfer members of high heat conductivity having portions extending within a body of circulating cooling fluid. Each valve and support are rotated at a uniform selected rate beneath a remelting and smoothing flame suitably directed upon the valve at the annular zone of overlay metal. During rotation of each valve the corresponding welding torch progressively melts successive portions of the deposited metal. Thereafter the metal gradually solidifies as it moves from the torch. After all of the overlay metal of each valve has thus been treated, the rate of rotation of the table is selectively increased to such degree that said welding flame no longer melts the deposited metal during the brief exposure of the latter to the action of the flame. Solidification of the metal occurs progressively in the direction from the cooled surface of the valve to the free surface of the deposited metal under action of a cooling fluid which withdraws heat from the lower portion of the valve head through the heat-transfer members. This has been found to eliminate or to drive into the upper surface layers of the deposited metal the objectionable imperfections determinable by known physical tests and present in the composite valve prior to the treatment of the invention.

In the accompanying drawings, illustrating a modification of the invention adapted for the conditioning of protective metal overlays on the seating surfaces of valves,

Fig. 1 is a front view of the apparatus, parts being broken away, and other parts shown in section;

Fig. 2 is a transverse section taken along the line 2—2 of Fig. 1, on a somewhat larger scale, parts being omitted;

Fig. 3 is a section taken along the line 3—3 of Fig. 1, looking in the direction of the arrows, parts being omitted;

Fig. 4 is a plan view of the mechanism for intermittently changing the speed of the work tables, parts being shown in section;

Fig. 5 is a diagrammatic view of a portion of the system for conducting fuel gas and oxygen to the welding torches; and

Fig. 6 is a wiring diagram showing one form of electric motor-control circuit.

Referring to Figs. 1 and 2 of the drawings, the apparatus comprises a bench or frame B having respective upper, intermediate and lower platforms 12, 13, 14, supported on legs 15. A sheet or body 12A of heat-insulating material such as transite board covers platform 12.

A plurality of identical work supports or tables T for respective surfaced articles to be conditioned are disposed in parallel along a longitudinal midsection of platform 12. For convenience, only one support T and associated parts will be described. In the form shown, each support T includes a metal work-centering plate 16, having a raised, centrally-disposed midportion adapted to contact and support the major portion of a valve head 17 on the side thereof opposite the annular deposit 18 of protective metal. An outer flange 19 on plate 16 supports an annular ring or dam 20 of heat-refractory material

which fits around the raised portion of said plate.

The upper surface of ring 20 is provided with a tapered portion 21 and with a grooved annular portion 22 at its inner periphery for preventing escape of molten metal during the conditioning operation. Secured to plate 16 by screws, and centered thereon by the projection 23, is a heat-transfer table 24 having a depending annular skirt or flange 25 extending downwardly within an annular cup 26 on platform 12. Each plate 16 and each table 24 is made of a metal of high heat conductivity, such as aluminum or copper. Each cup 26 has a central walled passage through which freely extends a shaft 27. The latter has its upper end secured to table 24 by screws or the like, and has a pinion 28 secured at its opposite end. The shaft 27 and parts carried thereby are supported for rotation upon platform 13 through the shoulder 29 and a co-operating thrust bracket 30, as shown in Fig. 2.

For maintaining a body of cooling liquid such as water in each cup 26, each thereof has an inlet 31 connected by valve-controlled conduit 32 with a header W for a cooling liquid under pressure; and each has an overflow outlet 33 connected by a conduit 34 with a fluid discharge line W'. A plurality of spaced passages 35 in annular skirt 25 permit free circulation of cooling fluid and prevent overheating of the latter within the skirt.

For rotating said supports T as a unit, a vertically-disposed shaft 37 of a speed-reduction gear R' is driven at a selected speed by an electric motor 39 through a belt 41, the driven sheave 42 and driving sheave 43 of a speed-regulating device S of standard construction, a belt 44, the driven sheave and driving sheaves 45, 46 of a speed reduction gear R, a belt 47, the driven and driving sheaves 48, 49 of a second speed-regulating device S', a belt 50, and the driving sheave 50a of the speed reduction gear R'. A sprocket 51 secured on shaft 37 is connected by driving chain 52 with a sprocket 53 mounted on one of the shafts 27. Idler pinions 68, mounted upon shafts suitably supported on platform 13, are disposed between adjacent pinions 28 and mesh with each of the latter at all times. The arrangement of parts is such that, during operation of motor 39, all of the work supports T are rotated in unison at the same selected speed.

Each speed-regulating device is of well-known type, consisting of two variable interlocking grooved pulleys or sheaves, mounted upon a single shaft that may be pivoted toward or away from the driving sheave and the driven sheave of the associated speed reduction gear by movement of a control lever L. As the distance between the shaft of the device and the driving and driven sheaves of the reduction gear respectively are changed by the control lever, the resulting tension in one belt and slack in the second belt automatically adjust the interlocking sheaves to give a new ratio between their pitch diameters. This mutual compensation equalizes the belt tension.

For directing a remelting flame upon the metal overlay upon each valve head 17, a plurality of spaced remelting torches M are respectively mounted in parallel alignment upon a supporting plate 54. The latter is secured at its respective ends to members 55, 55, which have portions threaded to cooperate with threaded members 56, controlled by handwheels V, for vertical sliding movement along guides 57, 57. The latter are mounted on members 58, 58, slideable trans-

versely of plate 54 in grooves in horizontal guides 59, 59 under action of adjusting screws 60, 60 having handwheels A associated therewith. Each torch M may be of standard construction, and comprises a torch body 61, and an elongated torch tip 62 having the discharge end directed upon a portion of the annular zone of protective metal on the valve.

As shown in Figs. 2 and 5, flexible conduits 63, 64, having therein needle valves 65, 66, respectively conduct oxygen and a fuel gas to the torches M from suitable sources of supply, through the corresponding regulating valves N, N', a quick-acting cut-off valve Q hereinafter described, branch lines B, B' and headers H, H'. A pressure gauge 67 conveniently is placed in the oxygen conduit. Pilot light tubes 69 respectively lead from a gas header 71 to points adjacent the corresponding torch tips 62. (See Fig. 2).

For cutting off the flow of electric current to motor 39, following each successive cycle of operations, a vertical rotatable shaft 73 on reduction gear R has its upper end bracketed upon the underside of platform 13. A cam 75 on shaft 73 has a depending flange 76 adapted to contact a roller 77, mounted upon an end of a lever 78. The latter is pivotally secured at 79 upon a bracket 80 supported on platform 14. The slotted opposite end of lever 78 is pivotally connected with the arm 81 of an electric switch 82 mounted on bracket 80. As shown in Fig. 6, the switch 82 is disposed in the circuit operating motor 10. The arm 81 is adapted, in one position, to close the motor-operating circuit in usual manner and operate the motor and, when in the other position, under action of cam 75, to stop the motor.

Since the cam shaft 73 comes to rest with cam flange 76 holding switch 82 in open position, there is provided, for restarting the apparatus a delayed action switch 83, disposed in parallel with the switch 82 in the motor-operating circuit. Switch 83 is of well-known design, adapted to be closed manually, and thereafter to open automatically after a preselected period of time, and to remain open until again closed manually. Upon completion of each cycle of rotation of cam shaft 73, cam 75 actuates switch 82 and stops motor 39. When the work tables have been reloaded actuation of switch 83 starts another cycle of operations. A main switch 84 permits cutting off of the motor, when desired, at any stage of the cycle.

For discontinuing the remelting of the overlay metal at a selected stage in the flame treatment of the composite articles having thereon the overlay of protective metal, and for concurrently initiating a high temperature conditioning treatment involving a slow cooling of the exposed surface of the overlay metal, and a more rapid regulated chilling of the portions of the article adjacent the opposite surface of said overlay metal, there is provided, as best shown in Fig. 4, a lever 87 pivoted at 88 upon a member 89 secured to frame B. Lever 87 has its free end slideable between guides 90, 90 supported upon platform 13. The operating handle 91 of speed-regulating device S' is connected with lever 87 through longitudinally-adjustable connections including clevises 92, 93, and turnbuckle 94. Clevis 93 is secured to lever 87 by means of a bolt slideable in a longitudinal slot 95 in lever 87. A cam 96 mounted on cam shaft 73 is adapted pressingly to contact a roller 97 mounted on lever 87, under action of a spring 98. The latter is operatively interposed between lever 87 and frame B. The

arrangement of parts is such that, during a brief selected portion of each revolution of cam shaft 73, cam 96 moves lever 87, actuates handle 91, and increases the rate of rotation of shaft 37 and of each work table T.

For quickly cutting off the flow of combustible gas mixture to each of the torches at a selected point at the end of each cycle of remelting and conditioning operations, there is provided in the oxygen and fuel gas lines, as shown in Figs. 1, 3, 5, a quick-acting cut-off valve Q of well-known design, mounted upon a plate P secured to platform 13, and having oxygen inlet and outlet connections 99, 99', and fuel gas inlet and outlet connections 100, 100'. A handle 101 concurrently opens or closes both the oxygen and fuel gas valves. A lever 103 pivoted upon a pin 104 carried by frame B has a latch at one end adapted to releasably engage a latch on handle 101. The opposite end of lever 103 is adapted to be tripped by a cam 105 on cam shaft 73 once during each revolution of the latter, thereby releasing handle 101. A spring 106 then quickly moves the handle to the right in Fig. 3, cutting off all flow of fuel gas and oxygen. For cutting off gas flow at any stage in the cycle of operations, a pull rod 107 having a handle 108 is connected with lever 103 adjacent the end engaged by cam 105, and extends through an aperture in the frame B, as shown in Fig. 3, whereby a pull on the knob releases handle 101, whereupon spring 106 closes valve Q.

In the preferred operation of the apparatus described, circulating water is supplied to cups 26 through lines 32 to an elevation at least as high as the apertures 35 in the flanges of member 24. The pilot burners 59 are lighted, and switch 84 is closed. Composite valves upon which a body of protective metal or alloy has been deposited are placed upon the work tables T in the position shown in Figs. 1 and 2. Motor 39 then is started by closing delayed action switch 83; and oxygen and fuel gas are supplied to the torches M by opening valve Q by handle 101, and the torches adjusted, if necessary, as to flame characteristics and positioning thereof. The gas mixture is ignited by the pilot flames. The work tables T revolve at a rate sufficiently slow to permit the torches to melt successive portions of the deposited metal during passage thereof past the torches. Rates of relative movement of the torch and overlay of between 2 and 6 lineal inches per minute conveniently may be used at this reheating step of the process. A rate of around  $\frac{1}{2}$  revolution per minute has proved satisfactory for smoothly remelting the protective overlays of wear-resistant alloys on valves designed for use in airplane motors. Under these conditions, in a short time each flame begins to melt the deposited metal upon the annular portion of the valve upon which that flame impinges, while heat is conducted rapidly from the underside of the valve through the aluminum members to the cooling water in cups 26. The tables T continue to rotate at the slow speed during their travel through a preselected angular distance, and until the entire deposit has been progressively melted at least once, and has resolidified in the form of a smooth surface layer under action of the localized cooling medium. Thereafter, cam 96 causes actuation of speed changing device S' to progressively increase the rate of rotation of shaft 37 and work tables T.

This increased rate of movement of the successive portions of the remelted and solidified

protective metal past the torch prevents remelting of the overlay metal by the torch flames, but maintains the uppermost portions of the overlay at a suitable high temperature for a fixed period of time while continuing to remove heat from the lowermost portion of the deposited metal by rapid heat transfer through the underlying metal of the valve or other article; the rotating heat-transfer members 16, 24; and the circulating water or other medium.

At this stage of the process, rates of movement of the overlay metal relative to the torch of between 12 and 36 lineal inches per minute, measured along the angular path of the overlay, are generally effective. Conveniently, when conditioning overlays on valves two inches in diameter, the initial relative movement between the torch and overlay during the reheating step may be at a rate around 2 lineal inches per minute. This rate is gradually accelerated to around 12 lineal inches per minute during the slow cooling step, which is maintained to the end of the cycle of operations. When processing valves of larger or of smaller diameter than 2 inches, the cycle time is correspondingly increased or reduced. The relative surface speed of the work and torch may remain approximately the same, or may be varied in accordance with such factors as the kind of metal being conditioned, and the thickness of the body of overlay metal. In one commercial embodiment of the invention, the rate of rotation of tables T is accelerated from  $\frac{1}{2}$  revolution per minute to a maximum speed of around 3 revolutions per minute in about fifteen seconds, and thereafter maintain that speed to the end of the cycle.

After each work table has traveled a preselected angular distance, following the increase in rate of rotation of the work tables T past the torches, cam 105 functions to close valve Q; and cam 75 functions to open switch 82 and stop motor 39. The conditioned valves are then removed from the work tables and replaced with others to be conditioned. The switch 83 is then closed, quick-acting valve Q is opened by means of lever 101, the torches ignited, and the series of operations is repeated.

It will be observed that the succession of steps in each cycle of operations occurs during one complete revolution of cam shaft 73. By shifting the handle L of speed-regulating device S the period required for a complete cycle of operations can be adjusted. By similarly shifting the handle of speed-regulating device S', the rate of rotation of the work tables can be adjusted independently of the rate of rotation of cam shaft 73, and caused to change selectively at a desired point in the cycle of operations, for controlling the heat input into the overlay metal.

Although the invention has been specifically described in connection with the smoothing and conditioning of metallic overlays upon the wearing surfaces of valves, it may be used, likewise, for treating such overlays upon the surfaces of a wide variety of conical, frusto-conical and other tapered articles, as well as of flat or curved plates, or any other surface that may be caused to move uniformly beneath the torch unit.

The torches M preferably are of the oxy-fuel gas type using mixtures of oxygen and acetylene. The proportions of fuel gas and oxygen flowing to the respective torches are preferably adjusted to provide a gas mixture or mixtures in which the volume of oxygen is less than that required for complete combustion of the fuel gas. The

flames produced by the combustion of such mixtures are designated "carburizing flames" and "excess fuel gas flames." Suitable oxy-acetylene mixtures are described in the United States Patent No. 1,973,341 of Harry S. George.

The invention is susceptible of modification within the scope of the appended claims.

We claim:

1. Process for conditioning the metal overlay portion of a metal article having the general shape of an article of revolution and having a surface provided with a continuous overlay of wear-resistant metal, which comprises directing an oxy-fuel gas flame upon said overlay along a progressively shifting zone at the free surface of said overlay, for progressively and successively melting and solidifying said overlay metal in said shifting zone, while maintaining the main body of metal of said article below its softening temperature; thereafter applying an oxy-fuel gas flame progressively along said shifting zone while preventing melting of said overlay metal by the flame and effecting a slow regulated cooling of the overlay metal progressively in the direction toward the free surface of the latter, thereby isolating any porous or soft metal present in said overlay metal within a thin surface layer of said overlay metal, and removing said surface layer from the article.

2. Process for remelting and conditioning the metal overlay portion of a metal article having a surface provided with a continuous body of wear-resistant overlay metal, which comprises directing an oxy-fuel gas melting flame upon successive portions of an annular overlay of protective metal upon a metal article of revolution, while supporting said article upon a rotating support of heat-conductive metal having a portion thereof continuously immersed in a cooling liquid, thereby progressively and successively melting and solidifying portions of said overlay metal while maintaining the main body of the metal of said article below its melting point, thereafter increasing the rate of rotation of said article support to a rate at which said flame is incapable of melting the overlay metal, while continuing to direct heat upon the exposed surface of said annular overlay of protective metal and while continuing to conduct heat from the surface of the article in contact with said support, and discontinuing the application of said flame and the rotation of said support after a selected rotational travel of the latter.

3. Process for conditioning the metal overlay portion of a metal article having the general shape of an article of revolution and having a surface provided with a continuous overlay of wear-resistant metal, which comprises directing a high temperature flame upon said overlay along a progressively shifting zone at the free surface of said overlay, for progressively and successively melting, smoothing and solidifying said overlay metal in said shifting zone, while conducting heat rapidly from the main body of metal of said article remote from said overlay metal, thereby maintaining the last-named metal at all times below its softening temperature and quickly solidifying said overlay metal after the latter leaves the zone of influence of said high temperature flame; thereafter applying a high temperature flame progressively along said shifting zone while preventing melting of said overlay metal by the flame and while effecting a slow regulated cooling of the overlay metal progressively in the direction toward the free surface of the latter,

thereby isolating any porous or soft metal present in said overlay metal within a thin surface layer of said overlay metal, and removing said surface layer from the article.

4. Process for conditioning the metal overlay portion of a metal article having the general shape of an article of revolution and having a surface provided with a continuous overlay of wear-resistant metal, which comprises directing a high temperature flame upon said overlay along a progressively shifting zone embracing substantially all portions of said overlay, for progressively and successively melting, smoothing and solidifying said overlay metal in said shifting zone, while conducting heat rapidly from the main body of metal of said article remote from said overlay metal, thereby maintaining the last-named metal at all times below its softening temperature and quickly solidifying said overlay metal after the latter leaves the zone of influence of said high temperature flame; thereafter applying a high temperature flame progressively along said shifting zone while preventing melting of said overlay metal by the flame and while effecting a slow regulated cooling of the overlay metal progressively in the direction toward the free surface of the latter, thereby isolating any porous or soft metal present in said overlay metal within a thin surface layer of said overlay metal, and lightly grinding the surface layer of overlay metal, thereby removing from the latter any zone of porous or soft metal present therein.

5. Apparatus for conditioning the welded-on overlay of protective metal upon a metal article of revolution, which comprises means for supporting such an article for rotation on its axis of revolution; means for rotating the article on said axis; torch means for directing a melting and surface-smoothing flame upon successive portions of an annular zone of said article during rotation of the latter; a reservoir for a cooling liquid; article-supporting means of high heat conductivity having an element thereof extending within said reservoir; and means associated with the article support-rotating means for increasing the rate of rotation of said article supported after the latter has moved through a preselected angular distance.

6. Apparatus for conditioning the welded-on overlay of protective metal upon a metal article of revolution, which comprises means for supporting said article for rotation on its axis of revolution; means for rotating the article on said axis; torch means for directing an oxy-fuel gas melting and surface-smoothing flame upon successive portions of an annular zone of said article during rotation of the latter; a reservoir for a cooling liquid; article-supporting means of high heat conductivity having an element thereof extending within said reservoir; and automatic means associated with the said support-rotating means for rendering said torch means ineffective for melting the overlay metal while continuing to direct said flame upon overlay metal in said annular zone.

7. Apparatus for conditioning the welded-on overlay of protective metal on a metal article of revolution, which comprises means for supporting said article for rotation on its axis of revolution; means for rotating the article on said axis; torch means for directing an oxy-fuel gas melting and surface-smoothing flame upon successive portions of an annular body of protective metal on said article during rotation of said article; means for discontinuing the flow of oxygen

and fuel gas to said torch means after said article support has traveled through a preselected angular distance; a reservoir for a cooling liquid; article-supporting means of high heat conductivity having an element thereof extending within said reservoir; and means associated with the article support-rotating means for rendering the melting torch ineffective for melting the overlay metal but effective for heating the latter after said support has traveled a preselected angular distance.

8. Apparatus for conditioning the welded-on overlay of protective metal on a metal article of revolution, which comprises means for supporting said article for rotation on its axis of revolution; means for rotating the article on said axis; torch means for directing an oxy-fuel gas melting and surface-smoothing flame upon successive portions of an annular body of protective metal on said article during rotation of said article; means for discontinuing the flow of oxygen and fuel gas to said torch means after said article support has traveled through a preselected angular distance; a reservoir for a cooling liquid; article-supporting means of high heat conductivity having an element thereof extending within said reservoir; means associated with the article support-rotating means for increasing the rate of rotation of said article support at a selected point in its path of travel; and means for cutting off the flow of oxygen and fuel gas to said torch means and for discontinuing the rotation of said article support after said support has traveled a preselected angular distance.

9. Apparatus for remelting and conditioning the welded-on overlay of protective metal upon a metal article of revolution, which comprises a plurality of article supports of heat-conductive metal respectively rotatable upon spaced axes; interconnected means for rotating said supports in unison at a uniform selected rate; a plurality of reservoirs for a cooling liquid, each provided with an inlet and an outlet; each of said article supports having a portion extending within a corresponding reservoir; means for increasing the speed of rotation of said supports after the latter have moved through a selected angular distance; respective adjustable torch means operatively associated with each of said article supports and adapted to direct a melting and surface-smoothing flame upon the exposed surface of an article carried on a corresponding one of said article supports; and operating mechanism for actuating said means for rotating said supports, said mechanism being rendered inoperative after a preselected time interval of operation.

10. Apparatus as defined in claim 9, wherein said torch means are adjustable as a unit relative to said article supports.

11. Apparatus for conditioning the welded-on overlay of protective metal upon a metal article of revolution, which comprises means for supporting said article for rotation on an axis of revolution; means for rotating the article on said axis; torch means for directing an oxy-fuel gas melting and surface-smoothing flame upon successive portions of an annular zone of said article during rotation of the latter; a reservoir for a cooling liquid; article-supporting means of high heat conductivity having an element thereof extending within said reservoir; means associated with the article support-rotating means for increasing the rate of rotation of said article support after the latter has moved through a preselected angular distance; and operating mechanism

for actuating said means for rotating the article support, said mechanism becoming inoperative after a preselected time interval of operation.

12. Apparatus for conditioning an overlay of protective metal formed on a metal article of revolution, which comprises a metal supporting member of high heat conductivity adapted to support such metal article for rotation on its axis of revolution; a reservoir for a cooling fluid; said supporting member having a portion extending within a body of cooling fluid in said reservoir; mechanism for rotating said supporting member at a uniform selected rate; automatic means operatively associated with said mechanism, for increasing the rate of rotation of said supporting member; means for restoring the previous rate of rotation of said supporting member; means for directing a melting flame upon the metal overlay on said article; and means for rendering said flame inoperative for melting said metal while continuing to direct the flame upon the overlay metal.

13. Apparatus for conditioning an overlay of protective metal formed on a metal article of revolution, which comprises a metal supporting member of high heat conductivity adapted to support such a metal article for rotation on its axis of revolution; a reservoir for a cooling fluid; said supporting member having a portion extending within a body of cooling fluid in said reservoir; mechanism for rotating said supporting member at a uniform selected rate; automatic means operatively associated with said mechanism, for increasing the rate of rotation of said supporting member after travel of the latter through a selected angular distance; means for actuating said supporting member-rotating mechanism and adapted to be rendered inoperative after a preselected time interval of operation; and adjustable torch means directed within an annular zone upon the surface of the article mounted on said supporting member.

14. A support for a metal article having thereon an overlay of protective metal; said support being formed of a metal of high heat conductivity; means for rotating said support on a vertical axis; a reservoir for a cooling fluid associated with said support; said support having an annular skirt adapted to extend within said reservoir; passages through said skirt establishing communication between the cooling fluid on the respective sides of said skirt; and means associated with said support for centering a metal article thereon and for preventing escape of molten metal from said article during melting of portions of the latter.

15. Metal-conditioning apparatus comprising a rotatable member of heat-conductive metal adapted to support a metal article having a surface provided with a continuous overlay of wear-resistant metal; means for rotating said member on its axis of rotation; means for directing an oxy-fuel gas flame upon a progressively shifting zone on said surface of the article for locally melting the metal of the latter and the overlay metal in said shifting surface zone; means operative concurrently with said heating means for maintaining the main body of metal of said article below its softening temperature, and for progressively cooling said overlay metal in the direction toward the free surface of the latter and for isolating any porous or soft metal present in said overlay metal within a thin surface layer of such overlay metal.

16. Process for conditioning the metal overlay

portion of a metal article having the general shape of an article of revolution and having a surface provided with a continuous overlay of wear-resistant metal, which comprises heating said overlay along a progressively shifting portion of an annular zone at the free surface of said overlay, thereby progressively and successively melting and solidifying said overlay metal, while maintaining the main body of metal of said article below its softening temperature; and thereafter 10

heating said overlay progressively along said shifting zone while preventing melting of said overlay metal and while effecting a slow regulated cooling of the overlay metal progressively in the direction toward the free surface of the latter, thereby isolating any porous or soft metal present in said overlay metal within a thin layer at the free surface of said overlay metal.

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