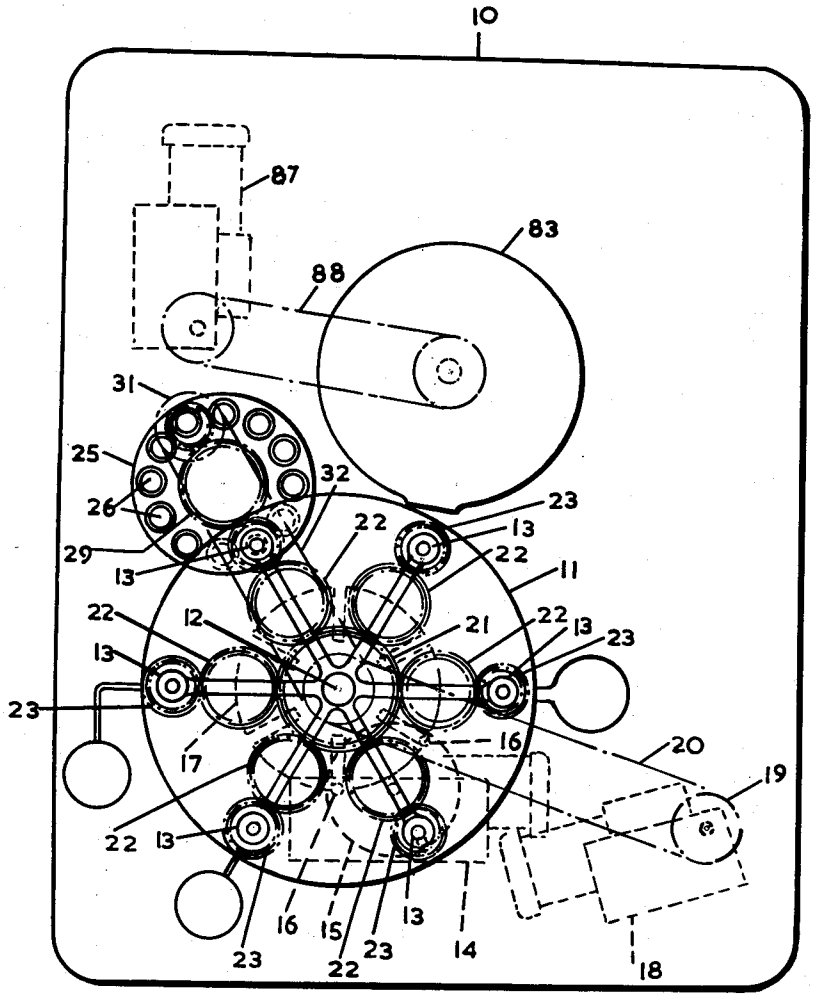
May 1, 1956 F. W. W. HIGHFIELD 2,744,032

METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

Filed July 13, 1953 7 Sheets-Sheet 1

FIG. 1.



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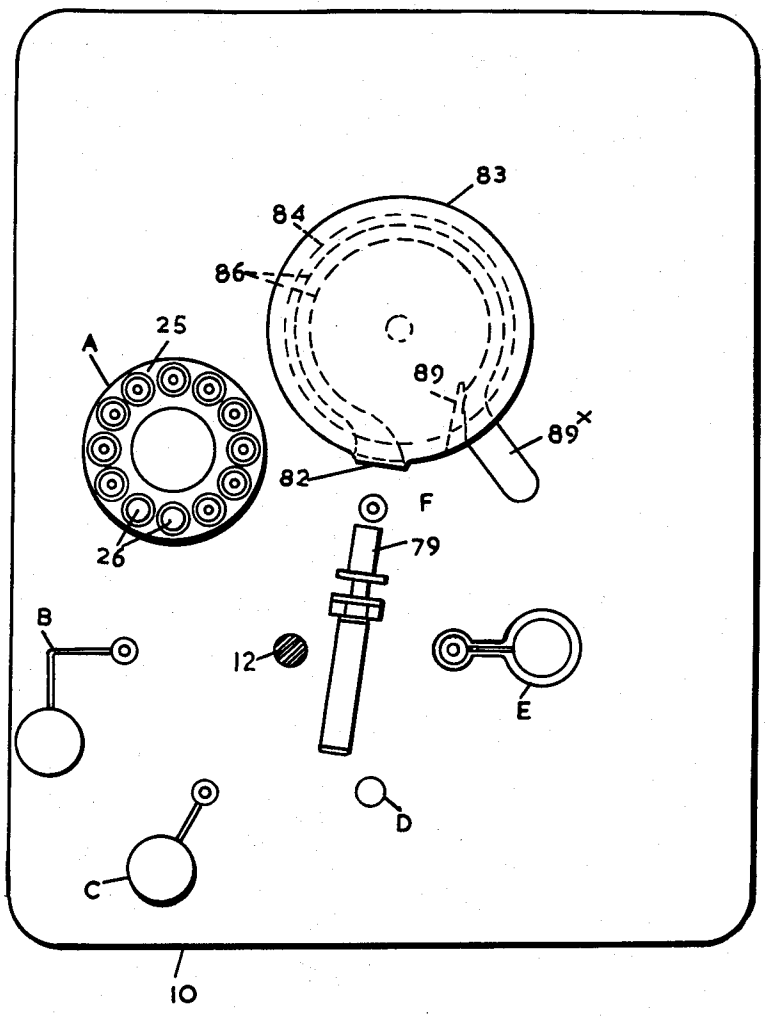
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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

Filed July 13, 1953 7 Sheets-Sheet 2

FIG.2.



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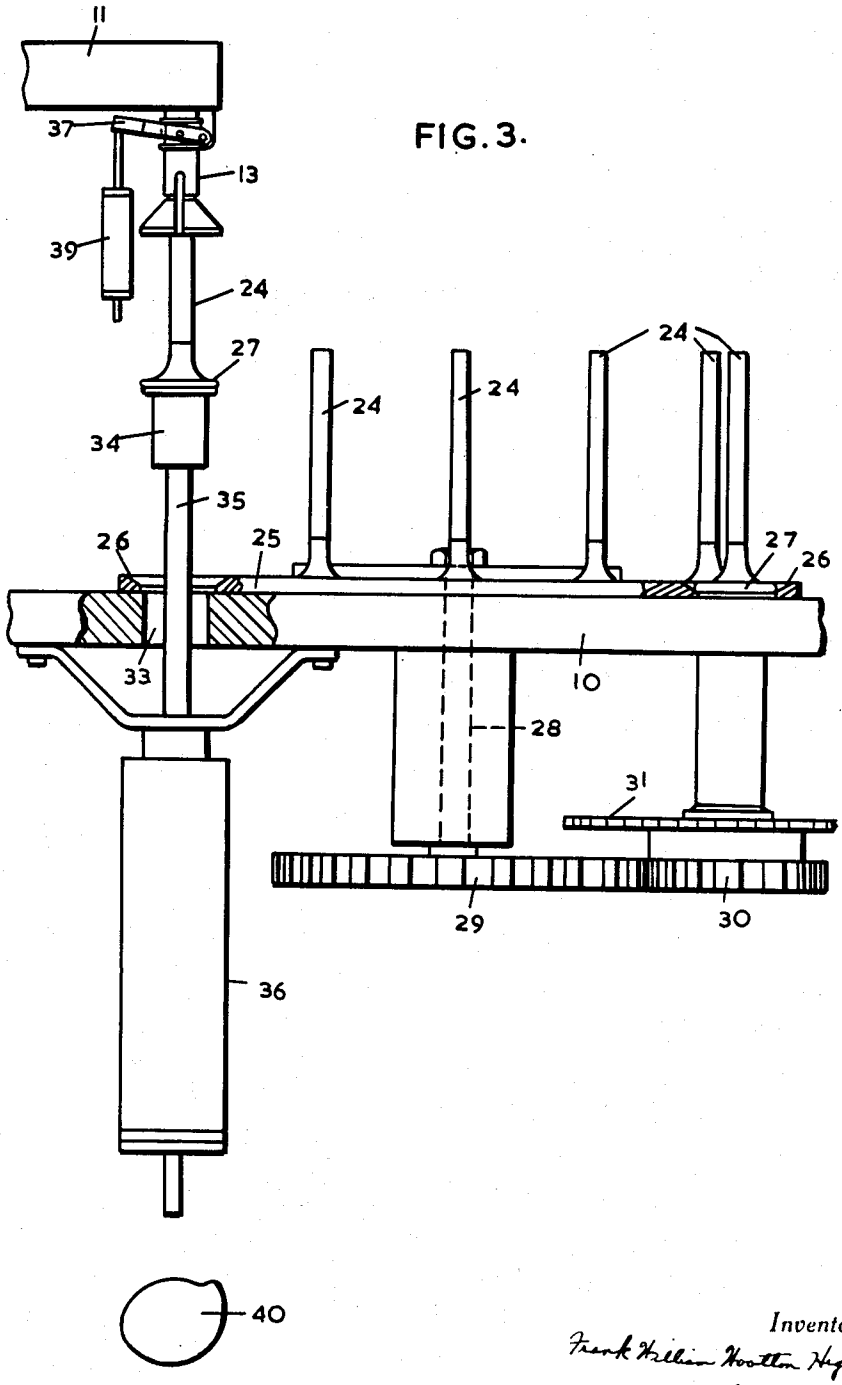
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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

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FIG. 3.



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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

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FIG. 4

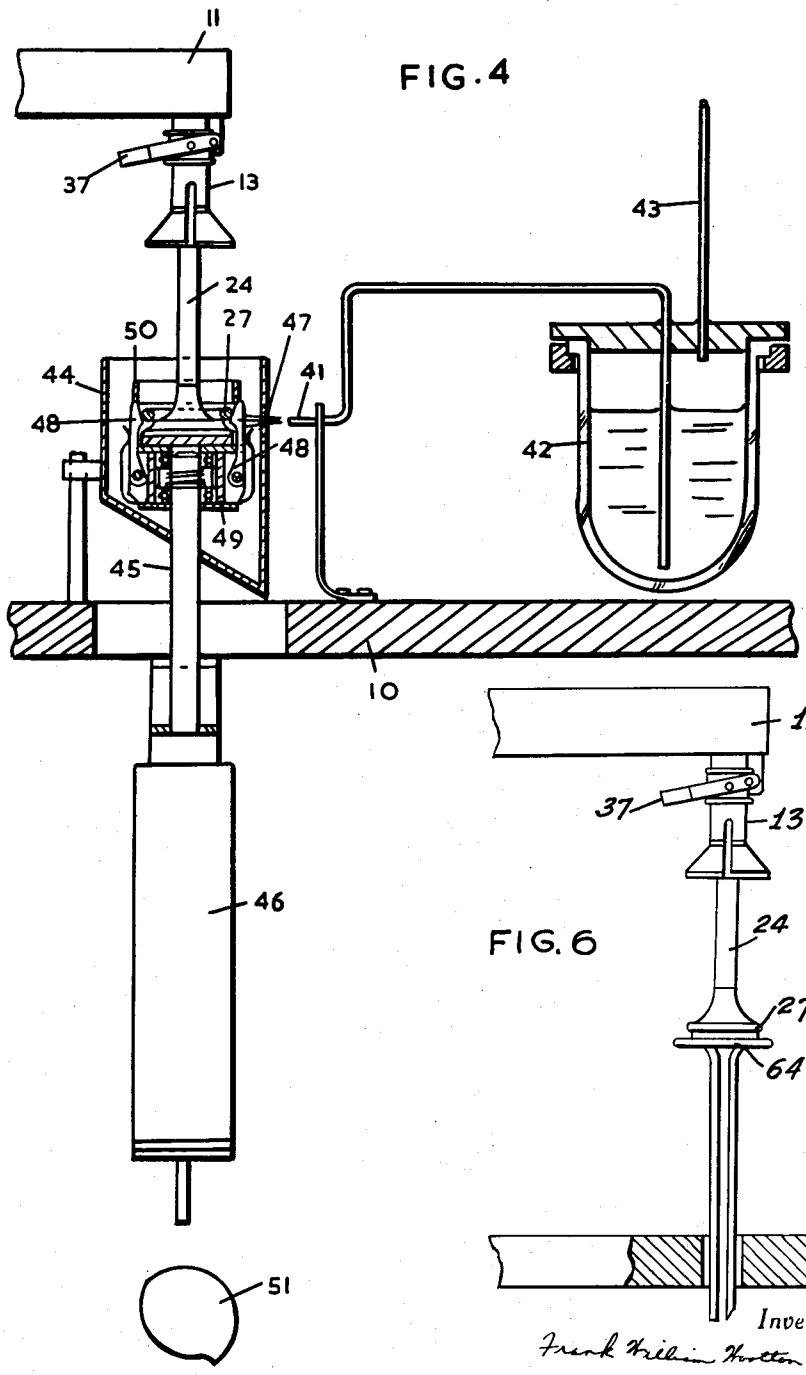


FIG. 6

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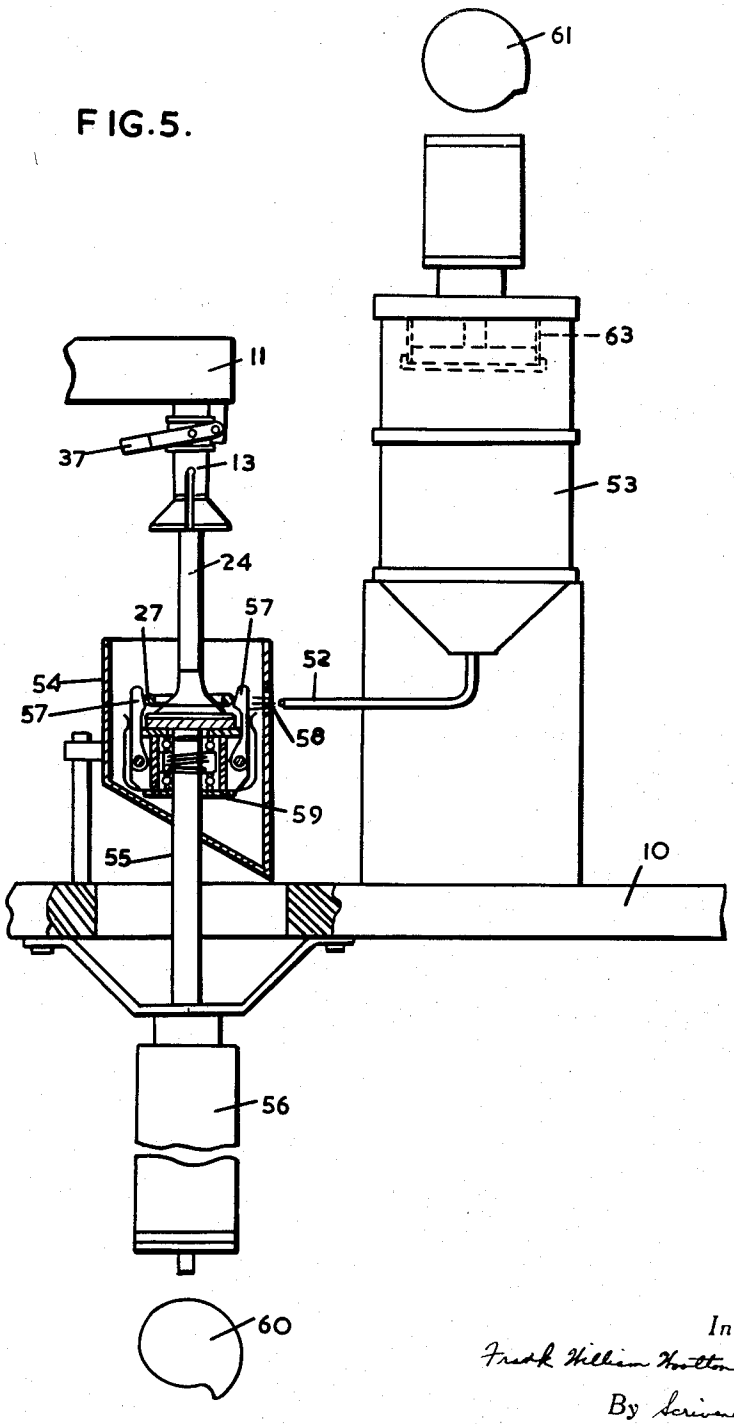
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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

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FIG.5.



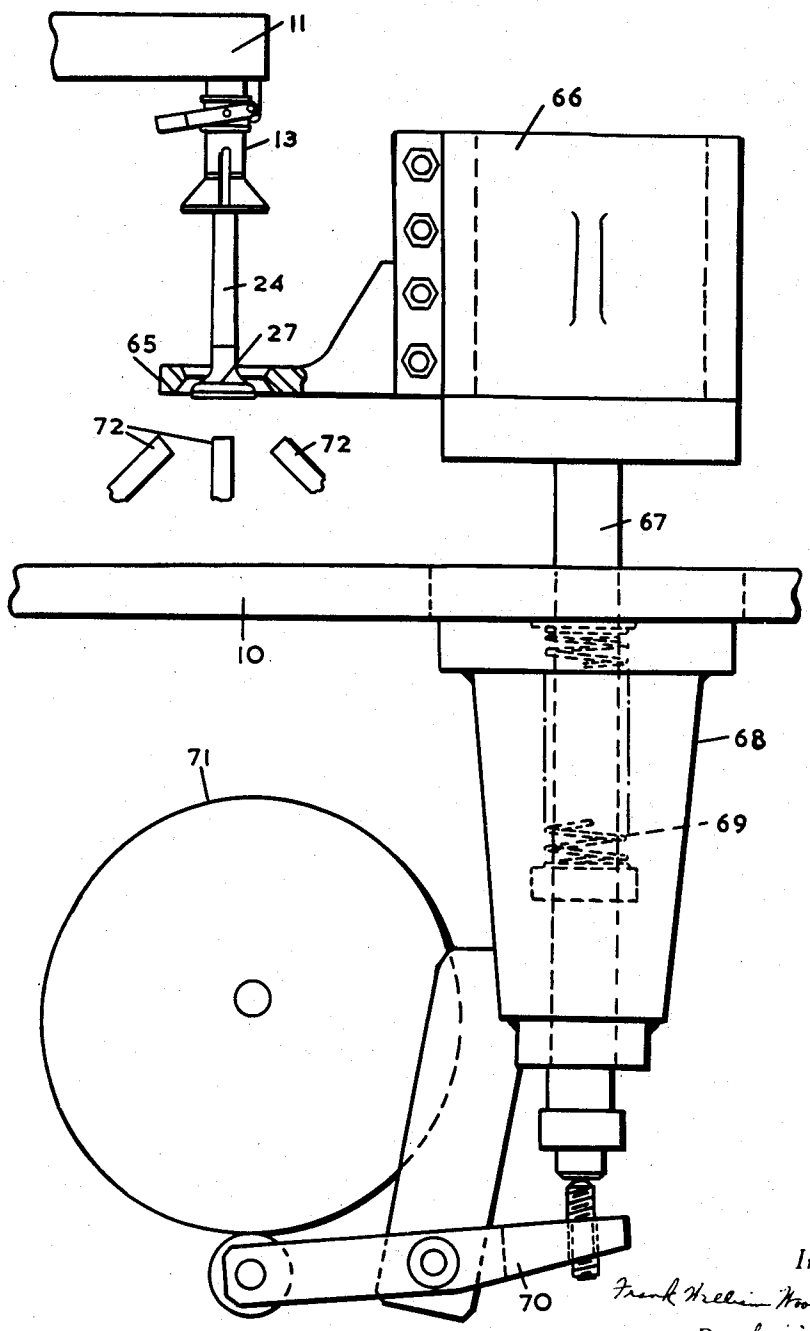
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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

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FIG. 7.



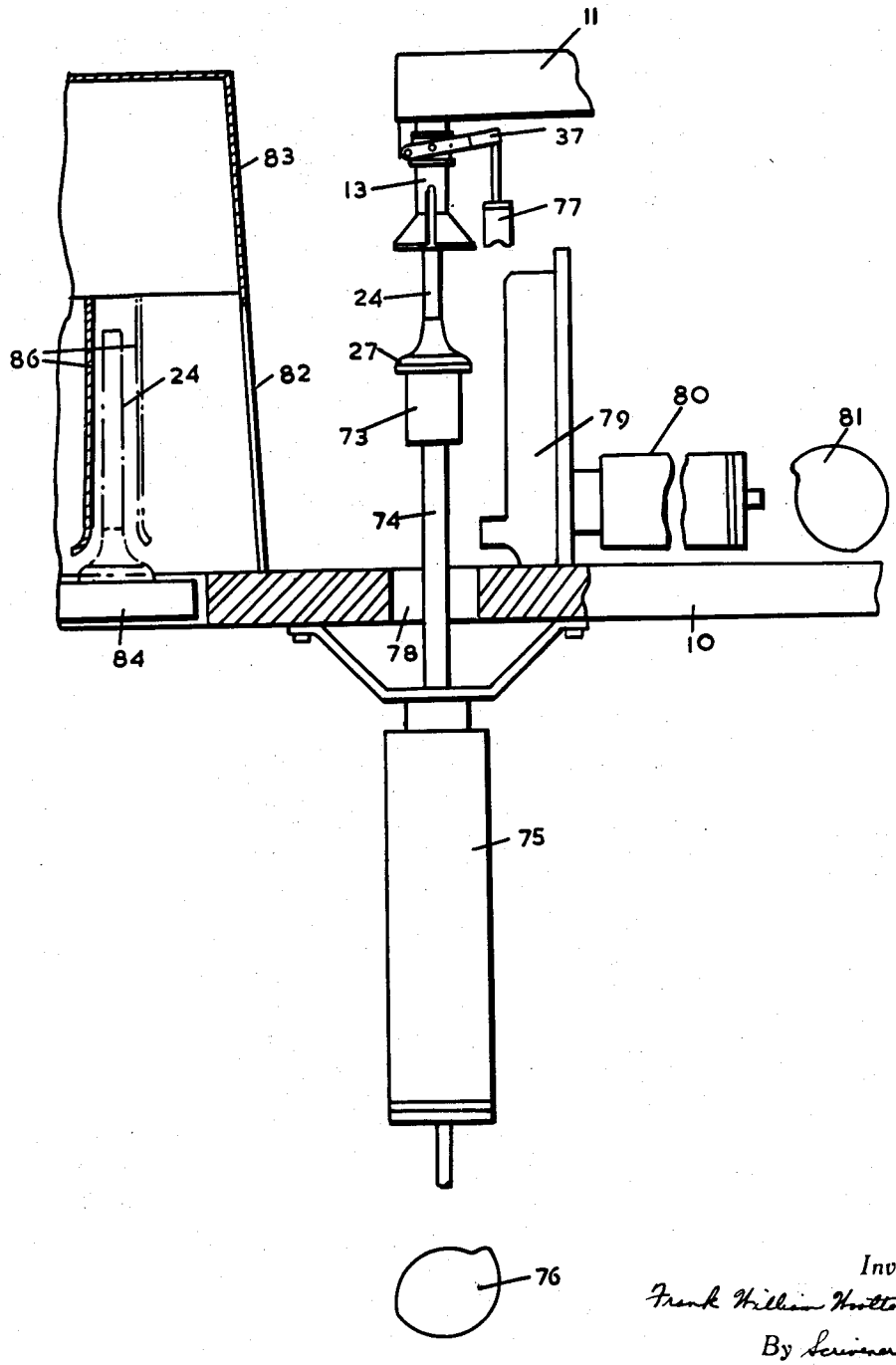
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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

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FIG.8.



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METHOD OF AND APPARATUS FOR APPLYING A HARD ALLOY COATING TO THE SEATING SURFACES OF VALVES FOR INTERNAL COMBUSTION ENGINES

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Application July 13, 1953, Serial No. 367,606

Claims priority, application Great Britain July 23, 1952

6 Claims. (Cl. 117—43)

This invention has for its object the provision of a new or improved method of and apparatus for applying a hard alloy coating to the seating surfaces of internal combustion engine valves, more particularly exhaust valves, so as to enable them to resist heat and corrosion arising from the products of combustion.

It is already the practice to coat the seating surfaces of exhaust valves with a cobalt-chromium alloy, such as that known under the Trademark "Stellite," by melting a rod of the alloy and allowing the molten alloy to drop on to the seating surface of the valve whilst the latter is heated in a reducing atmosphere and is rotated so as to cause the drops of molten alloy to coalesce and form a smooth coating on said seating surface. In this known method gas jets are used for heating the seating surface of the valve, whilst the latter is mechanically rotated, and for melting the extreme tip or leading end of the alloy rod whilst said rod is automatically fed forward, at a rate corresponding to that at which shortening of the rod takes place as a result of the melting, so as to maintain said tip in the dropping position immediately over the seating surface of the valve.

The new or improved method, according to the present invention, is characterised in that the hard alloy in solid form is applied to the seating surface of the valve, and is then melted thereon by electric high frequency heating to a temperature such as will cause fusion or welding to take place between the metal of the valve seating surface and the molten alloy.

Preferably the valve will be rotated during the melting and fusion of the alloy upon the seating surface so as to form a smooth alloy coating on said surface. Preferably also the melting and fushion of the alloy upon the seating surface of the valve will be carried out in an appropriate reducing atmosphere so as to prevent surface oxidation and give clean results.

Where the hard alloy is applied to the seating surface of the valve in a pre-shaped solid form, the form will preferably be that of a ring of suitable diameter, and of circular or other cross section of sufficient size and volume to afford, when molten, the full coating of said seating surface.

The invention will now be further described with reference to the accompanying drawings, which illustrate in diagrammatic form an automatically operating machine for putting the method of the invention into practice, and in which:

Fig. 1 is a diagrammatic plan view of the machine.

Fig. 2 is a further diagrammatic plan view, showing the disposition of operating stations.

Fig. 3 is a diagrammatic elevation, partly in section of the mechanism comprising the first operating station.

Figs. 4–8 are similar views to Fig. 3, showing mechanisms at the further operating stations.

Referring to Fig. 1 of the drawings, above the machine bed plate 10 is mounted a carrier 11, which is rotatable upon and supported by a central shaft 12. The carrier 11 supports six equally spaced chucks indicated generally

at 13, and the carrier 11 is rotated intermittently in steps of 60° by a suitable driving mechanism indicated in the drawing as an electric motor 14 which actuates a Geneva mechanism comprising a disc 15 constantly rotated by the motor, said disc having pins 16 which effect intermittent rotation of a slotted Geneva wheel 17 coupled with the carrier 11.

A further electric motor 18 drives a sprocket 19 and chain 20 to effect rotation of a pinion 21 freely rotatable on the central shaft 12. The pinion 21 transmitting its rotation, by way of six idler pinions 22, to six chuck rotating pinions 23, so that the said chucks 13 are constantly rotated during the step-by-step rotation of the carrier 11, and during each full rotation of the said carrier 11 each chuck 13 is indexed at, and undergoes a dwell period at six positions angularly spaced apart by 60°.

The chucks 13 are thus adapted to convey valves from one to another of six "operating stations" indicated generally in Fig. 2 as A, B, C, D, E and F respectively, said operating stations being constituted each by a mechanism for performing a specific operation on a chuck-supported valve indexed there, as will be described in detail hereafter. Briefly: station A comprises a mechanism for loading the valves in the chucks; station B comprises a mechanism for spraying oil on each valve indexed thereat; station C comprises a mechanism for blowing powdered flux on the oiled valves; stations D and E comprise high frequency electrical induction heaters for effecting preheating and main heating, and station F comprises a mechanism for unloading the valves from the chucks.

Referring now to Fig. 3 of the drawings, which illustrates the mechanism comprising station A of Fig. 2, the valves 24 are placed by hand in a magazine in the form of a rotating plate 25 journalled in the machine bed plate 10. The magazine has twelve apertures 26 (see also Figs. 1 and 2) adapted to receive the valves 24 positioned head downwards, each with a ring 27 of hard alloy resting on the valve seating surface. Said rings 27 are dropped over the stems of the valves 24 during the loading of the magazine plate 25, and said plate is secured at the upper end of a shaft 28, the lower end of which carries a pinion 29 (see also Fig. 1). Pinion 29 is in mesh with a further pinion 30 which rotates with a co-axial sprocket 31, the latter being rotated by a chain drive, indicated at 32 in Fig. 1, from the Geneva wheel 17. The gear ratio between Geneva wheel 17 and magazine plate 25 is two to one, so that the magazine rotates intermittently in steps of 30° to align each recess 26, in turn, over an aperture 33 (Fig. 3) in the bed plate 10, which aperture 33 is normally filled by a vertically movable plunger 34 shown in the drawing in its raised position. Thus the magazine plate 25 indexes a valve over aperture 33 every time the carrier 11 indexes an empty chuck 13 vertically above said aperture. During the dwell period of the chuck 13 and magazine plate 25, plunger 34 is raised to the position shown by a pressure fluid operated piston 35, the cylinder 36 of which is mounted beneath the bed plate 10, and said plunger 34 picks up and elevates the valve 24 which was indexed above it, and presents said valve 24 with the ring 27 thereon to the chuck 13. The chuck 13 is opened automatically as the stem of valve 24 approaches it, said automatic opening being represented diagrammatically by the chuck-opening lever 37 which is shown as being raised to open the chuck 13, by means of the piston rod 38 of a pressure fluid cylinder 39. Piston rod 38 will retract to release the lever 37 and allow it to fall, and chuck 13 to close, before the plunger 34 is lowered back into aperture 33. Automatic timed operation of the pressure fluid cylinder 36 is represented by the cam 40, but it will be appreciated that the present invention does not concern structural details of the machine described,

which details are only matters of design and are readily variable. Pressure fluid cylinder 39 will also operate automatically in correct timing, and it will also be appreciated that cam 40, and similar cams mentioned hereafter, would in practice be, for example, mounted on a rotating shaft and be adapted to operate a slide valve controlling supply and exhaust of pressure fluid to cylinder 36, in manner well known in remote control systems, cylinder 39 also operating in like manner.

Referring now to Fig. 4, which illustrates the mechanism comprising station B of Fig. 2, the chuck 13 and valve 24 carried thereby are indexed with the head of the valve in alignment with an oil spray nozzle 41 which is in communication with an oil reservoir 42. Compressed air fed to the reservoir by the pipe 43 ejects an oil spray from the nozzle 41 upon the seating surface of the head of the valve 24, and also upon the alloy ring 27.

The oil spray is confined to the valve head by a cylindrical shroud 44, which is mounted upon a vertically movable piston rod 45 actuated by a pressure fluid cylinder 46. The shroud 44 is shown in its raised position, the oil spray entering by an opening 47 in the side wall, a clearance hole in the machine bed plate 10 being provided for the shroud to enter when it is lowered. The piston rod 45 carries upon its upper end a mechanism for raising the ring 27 clear of the seating surface of the valve 27, to allow the oil spray to reach said surface. Said mechanism comprises spring-loaded pivotal fingers 48, which ride over the valve head and support and raise the ring 27 as shown in the drawing. The spring-loaded pivotal fingers are housed in a carrier 49 which is rotatably mounted in the end of the piston rod 45, so that said carrier and fingers rotate with the valve 24. Said carrier also incorporates a circular sleeve 50 of slightly greater internal diameter than the outside diameter of the ring 27, which sleeve serves to re-position the ring 27 correctly upon the valve head in the event of it having become misplaced thereon.

The sequence of operations is that the chuck 13 and valve 24 index in position when shroud 44 is down, and during the dwell period of the valve at this station B, the shroud 44 rises into the position shown, the oil spray functions, and the shroud is lowered again, descending below the valve head. The cam 51 depicts automatic and timed operation of the cylinder 46, as previously explained.

Referring now to Fig. 5, which illustrates the mechanism comprising station C, the chuck 13 and valve 24 carried thereby are indexed with the valve head in alignment with a flux applying nozzle 52, which is in communication with a hopper 53 containing powdered flux, and also vertically above a second shroud member 54 (shown in the raised position).

The shroud 54 is mounted upon a piston rod 55 movable vertically by means of the pressure fluid cylinder 56, in like manner as is the shroud 44 of Fig. 4. Similarly, spring-loaded fingers 57 raise the ring 27 off the seating surface of the head of the valve 24 before the powdered flux is blown on to both the oiled valve and ring 27 from the nozzle 52 through an opening 58 in the shroud 54, and said fingers 57 are mounted in a carrier 59 rotatable on the piston rod 55, so that said carrier 59 rotates bodily with the valve 24.

In similar manner to the mechanism at station B, the sequence of operations of the mechanism at station C is that the chuck 13 and valve 24 index in position when the shroud 54 is down, a clearance hole being provided in the bed plate 10 for the shroud to enter when it is lowered, and during the dwell period of the valve the shroud 54 first rises into the position shown in the drawing, the flux spray functions, and the shroud is lowered again, descending below the valve head. The cam 60 depicts automatic and timed operation of the cylinder 56 for shroud raising and lowering, and the further cam 61 depicts automatic and timed operation of a pressure cylinder 62, which cylinder reciprocates a flexible diaphragm 63 in the upper part of the flux hopper 53 to puff powdered flux from the nozzle 52.

Referring now to Fig. 6, which illustrates the mechanism comprising station D of Fig. 2, the chuck 31 and valve 24 are indexed at this station with the head of the valve above a stationary high frequency inductor coil 64, and during the dwell period of the valve at this station, the valve head and ring 27 are heated slowly to a low temperature.

In Fig. 7 is illustrated the mechanism comprising station E of Fig. 2, which is the main heating station, comprising a vertically movable high frequency inductor 65, shown in the drawing in its raised position in which it encircles the head of the valve 24 and the ring 27, so as to melt the hard alloy ring 27 and effect skin heating of the seating surface of the valve head to the requisite welding temperature.

The inductor 65 is supported by a carrier 66 mounted upon the upper end of a rod 67 slidable vertically in a bracket 68 secured to the bed plate 10. The rod 67 is moved upwardly against the action of a return spring 69 by means of a rock lever 70, the latter being actuated by a rotating cam roller 71. The sequence of operations is that the chuck 13 and valve 24, already preheated at station D, index with the valve above the lowered inductor 65, which then raises to the position shown during the dwell period of the valve to effect the melting of the ring 65, the inductor then lowering below the head of the valve.

Burner nozzles are indicated at 72, for curtaining the valve head with reducing gas, for example acetylene, during the ring melting operation, so as to reduce oxidation to a minimum.

On leaving station E, the chuck 13 and valve 24, with the ring 27 now fused upon the seating surface of the valve, are indexed at station F illustrated in Fig. 8, which is the final station at which the valves are unloaded from the chucks.

A vertically movable plunger 73, in all respects similar to the plunger 34 of Fig. 3, effects lowering of the valve 24, indexed vertically above said plunger, down to the level of the plate 10. The plunger 73 is shown in the drawing in its raised position, and is mounted upon the upper end of a piston rod 74 actuated by the pressure fluid cylinder 75, a cam 76 depicting automatic and timed operation of the cylinder 75. A further pressure fluid cylinder is indicated at 77 as actuating the chuck release lever 37.

In operation the chuck and valve index vertically above the plunger 73, which is down in the recess 78 therefor in the plate 10. During the dwell period of the chuck 13 at this station the plunger 73 rises to the position shown, and cylinder 77 then operates to release the valve 24 from the chuck 13. The plunger 73 then lowers to bring the valve 28 to the level of the plate 10.

The valve 24 is then moved laterally, and off the plunger 73 by a pusher 79 (see also Fig. 2), the latter being operated by a pressure fluid cylinder 80, automatic and timed actuation of which is depicted by the cam 81.

The valve 24 is conveyed by the pusher 79 through a door 82 in the wall of a circular cooling chamber 83, which is provided with a revolving floor 84, and guide walls 86 which keep the valve upright while the valve is conveyed through the chamber 83 in a circular path defined by said guide walls 86, as seen most clearly in Fig. 2. In Fig. 1 is indicated an electric motor 87, which drives the revolving floor of the cooling chamber 83 by means of a chain drive 88. In Fig. 2 is indicated a deflector plate 89 which functions to eject the valves from the chamber 83 and into a delivery chute 89^x for conveyance to a suitable collecting receptacle (not shown).

Preferably the chamber 83 is heated as by electrical heaters, at least at that portion thereof near the door 82 first traversed by the valves therein, so as to avoid too

rapid cooling of the valves after their heat treatment at station E.

Referring again to Fig. 2, the complete cycle of operations commences with an operator loading valves into empty recesses **26** in the rotating magazine plate **25** at station A, and placing upon each valve a hard alloy ring, the valves being fed one at a time into the chucks **13** as they index at the station.

The valves are then conveyed by the chucks and rotating carrier **11** through the successive stations B, C, D and E, with a dwell at each station, where the steps of oiling, fluxing, preheating and the melting of the ring **27** upon the valve seating surface are carried out whilst the valve is being continuously rotated, in accordance with the method comprising the invention.

It will be appreciated that the present invention does not comprise the machine per se, constructional details of which could be varied to suit requirements, being matters of machine design only.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. The method of applying a hard alloy coating to the seating surface of an internal combustion engine valve, which comprises applying the hard alloy in solid form to the seating surface of the valve, and then applying heat by electric high frequency induction heating to said alloy and to said valve to melt said alloy and to effect skin heating of the seating surface of said valve to cause fusion or welding to take place between said alloy and said seating surface of said valve.

2. The method according to claim 1, and including the step of rotating the valve at least during the period of melting and fusion of the alloy upon the seating surface so as to form a smooth alloy coating on said surface.

3. The method according to claim 1 including the step of curtaining the valve head with a reducing atmosphere during the step of melting and fusion of the alloy ring upon said surface.

4. The method of applying a hard alloy coating to the seating surface of an internal combustion engine valve which comprises applying the hard alloy to the seating surface in the form of a ring, conveying said valve successively to a number of operating stations and continuously rotating said valve during the conveying, preheating the valve and ring by electrical induction heating to a low temperature, and then applying heat by electrical high frequency induction to the valve and alloy ring to melt said ring and to effect skin heating of the seating surface of said valve to cause fusion or welding to take place between the metal of the valve seating surface and said alloy.

5. The method according to claim 4 which includes in addition the steps of subjecting the alloy ring and the valve seating surface to an oil spray and thereafter applying flux in powdered form immediately prior to preheating said ring and said valve.

6. The method according to claim 4 including the step of curtaining the valve head with a reducing atmosphere during the step of melting and fusion of the alloy upon said surface.

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