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VALVE TIP HARDENING MACHINE

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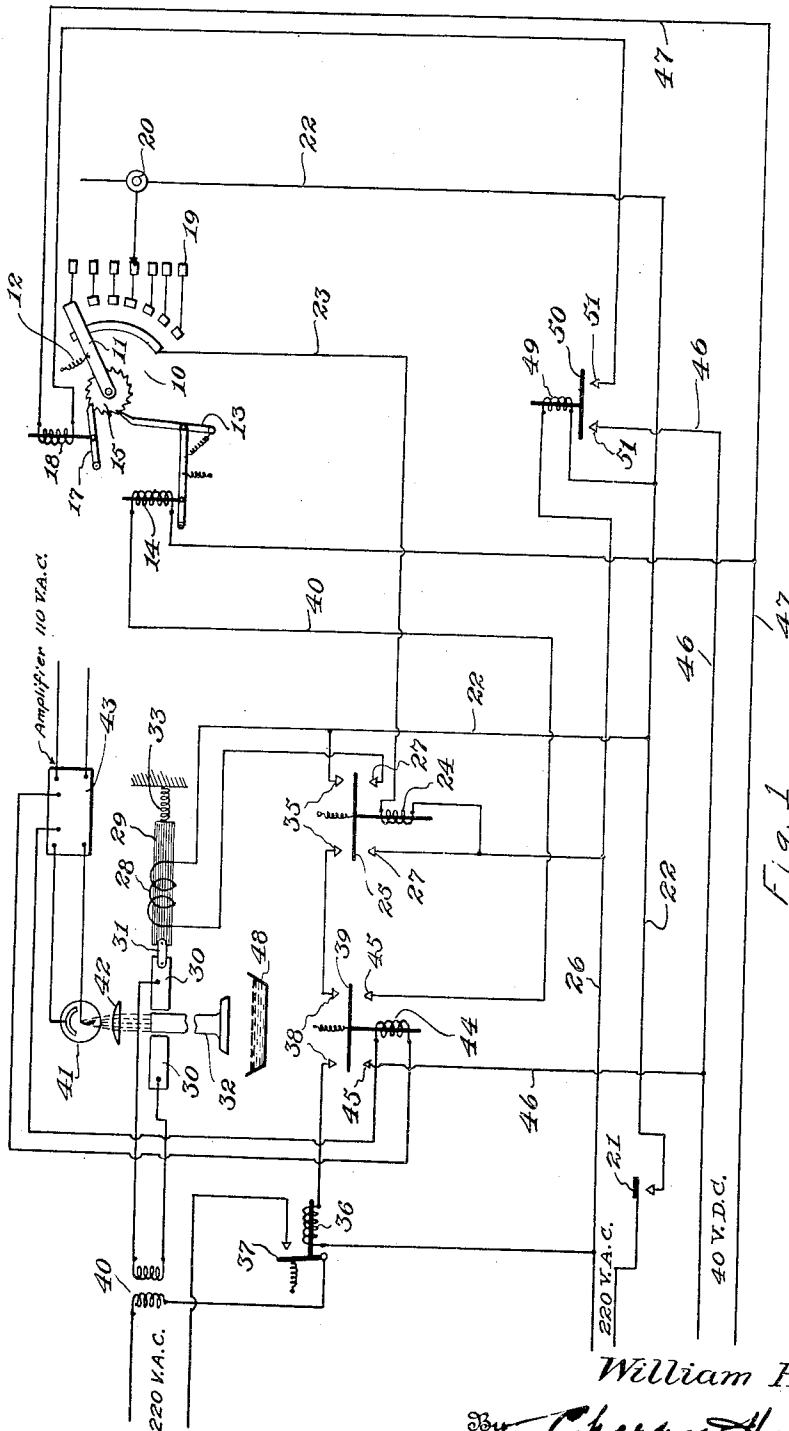


Fig. 1

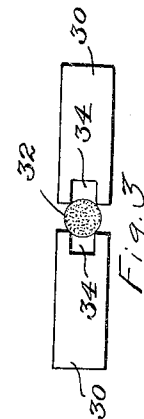


Fig. 2

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VALVE TIP HARDENING MACHINE

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13 Claims. (Cl. 219—11)

This invention relates to means for heat treating the tips of the stems of poppet valves, such as are used in internal combustion engines, and is a division of my copending application Serial No. 562,482, filed September 12, 1931, for Valve tip hardening machine and method.

The means disclosed are not limited in their application to the heat treatment of valve stems, and many other applications of my invention will readily suggest themselves.

The tips of that end of a poppet valve stem that engages the valve operating mechanism of internal combustion engines is usually given a final heat treatment following the mechanical operations that give the valve its form.

The end of the stem is placed between a pair of opposed electrodes, current is sent through the tip of the stem to raise it to a desired temperature, and then the valve is placed in a quenching bath.

It is obvious that the opposed jaws of the clamping electrodes must be spaced apart to prevent their shortcircuiting the path of the current through the clamped valve stem, and it follows that the current flowing from electrode to electrode through the stem will tend to follow one short and relatively narrow path,—with consequent overheating of the metal in that path,—due to the magnetostriction of the current path. The electrodes do not clamp each succeeding specimen in precisely the same way; previous mechanical treatment of the stem tip variously affects its conductivity to current, so to produce similar heating effect of the current in the same time would require extraordinary skill on the part of the operator of the machine, and tedious adjustment of the current intensity.

It will be evident that when the major portion of the current, and of the heat energy, flows along a definite and relatively narrow path, the metal in that path will flow and adjust itself within the cross-section of the stem in a manner different from that of the colder metal bordering it, and that when the stem is quenched in the hardening bath, the final condition of the periphery and of the internal structure of the cell cannot be satisfactory.

I have heretofore sought to overcome the disadvantages mentioned by turning the stem on its longitudinal axis, but this necessitated repeatedly opening and closing the clamping electrodes and the current supply, and was unsatisfactory because of the labor involved, and time consumed, the increased wear of the electrodes and switching mechanism, and the fact that the thermal and electrical conductivity of each succeeding

path was affected by what happened in previous applications of the current.

It is an object of my invention to provide a machine for imparting heat treatment to the tips of valve stems so that a uniformly good product may be obtained by an unskilled operator.

Other and further important objects of my invention will appear in the description of my invention.

On the drawing:

Figure 1 is a schematic diagram of the instrumentalities embodying my invention.

Figures 2 and 3 are end views indicating heat flow through the end of a heated valve stem during the operation of my machine.

In the drawing:

The numeral 10 indicates, generally, a conventional step-by-step switch mechanism, which comprises a wiper arm 11 urged forward against a spring 12 by a pawl 13 engaging the teeth of a ratchet 15 and actuated by a magnet 14. The wiper arm successively makes contact with a plurality of spaced contacts 16. Retraction of the wiper arm is prevented by a detent 17, and the arm is restored to its original position when the detent is raised by a releasing magnet 18.

The contacts 16 are extended, or are connected to a row of contacts 19 so that a manually operated switch 20 may be moved to make connection with any of them.

When the machine is first put in service to treat a batch of valve spindles, the operator moves selector switch 20 to the zero position in contact with the contact indicated by zero. The wiper arm should then be in its initial position.

The operator now closes a foot-switch 21, thereby causing current to flow from the alternating current supply mains along wire 22, through switch 20, through wiper arm 11, along wire 23, through solenoid 24, of switch 25, and back to main wire 26. Current flowing through solenoid 24 moves switch 25 to close contacts 27, thereby providing a circuit from wire 22 through solenoid 28, to retract a core 29 thereof, and thereby retract one of a pair of jaws of the electrodes 30, through a connecting link mechanism 31.

It is a simple matter to arrange things so that both of the jaws are retracted at the same time, and this is usually done.

The tip portion of the stem of a valve 32 is now inserted between the electrodes 30, and the foot-switch 21 is now opened, whereupon the jaws 30 close to clamp the valve under the urging of a spring 33, or similar means.

The jaws of the electrodes 30 are recessed, as indicated by numerals 34 on Figures 2 and 3, so that the jaws may readily accommodate themselves to the clamping of round stems of several different diameters, and also to define definite current paths through the cross-section of the stem adjacent opposed margins of the stem.

The operator now moves the selector switch to, say, contact 3, and again closes the foot switch 21.

There is now, at the outset, no current path through the selector switch, and switch 25 is in its normal position, closing contacts 35. Current now flows from wire 26, through solenoid 36 of switch 37, through contacts 38 of switch 39, through contacts 35 of switch 25, and back to wire 22. Current flowing through solenoid 36, closes switch 37, and thereby energizes the heating transformer 40 which is connected to the electrodes 30. When the current flows through the electrodes 30 and the tip of the stem of the valve 32, the tip becomes heated, and when the tip is viewed from above the two paths of greatest current intensity are clearly indicated by two transversely extending white regions with a duller region between, as indicated on Figure 2.

Positioned above the heated stem is a photoelectric cell 41, of a conventional type, with a lens 42 to direct rays from the heated material to its light-sensitive electrode. The cell 41 is suitably connected to a power source through a conventional amplifier 43, to amplify the current flow of the cell. Connected to the cell 41 is a solenoid 44 of the switch 39, so that upon the current through the cell 41 attaining a predetermined intensity, indicating a predetermined temperature of the heated work, the solenoid 44 causes switch 39 to interrupt contacts 38, thereby de-energizing solenoid 36, and causing interruption of the heating current.

Solenoid 44 also causes switch 39 to close its contacts and thereby establish a circuit from a direct current source, through wire 46, contacts 45, magnet 14, and wire 47 to advance the wiper arm 11 one step forward.

When the supply circuit of transformer 40 is interrupted by this action of cell 41, the heat energy in the heated work diffuses uniformly over the cross-section of the material, and the whole end takes on the appearance of that of the intermediate strip of Figure 2, as is indicated in Figure 3. Immediately upon this uniform distribution of the heat energy taking place, the current through the cell 41 decreases slightly, and in consequence of this current decrease, switch 39 returns to its normal position to close contacts 38 and thereby close the circuit through solenoid 36 to close the transformer supply switch 37. The aforementioned cycle, changing the appearance of the heated end from that indicated in Figure 2 to that indicated in Figure 3, is repeated, with the wiper arm 11 advancing a step when the cell 41 breaks the heating current through switch 39.

When the wiper arm 11 has advanced to make contact with a contact that is connected to the selector switch 20, a circuit is again closed through wire 22, wire 23, solenoid 24, to wire 26, to move switch 25 to close contacts 27 and thereby energize solenoid 28 to retract an electrode jaw and drop the valve 32 into a hardening bath 48.

The operator now inserts another valve between the open jaws, and then momentarily releases the foot switch 21 to de-energize a solenoid 49, connected in parallel with wires 22 and 26, to

release a switch 50, to close contacts 51, and thereby establish a circuit through the detent releasing magnet 18 and wires 46 and 47. The wiper arm 11 returns to its original position, and now, without any effort of the operator other than to keep the foot switch 21 closed, the machine automatically gives the stem the desired number of heat cycles and then drops the valve into the hardening bath.

The proper number of cycles of alternate heating and heat flooding of the stem is determined, naturally, by the history of previous mechanical treatment given to it, but when a batch of formed valves are put through the machine they are usually inserted only a few seconds apart.

It is a simple matter to adjust the responsivity of the cell and of the associated amplifier and relays to obtain any reasonable variation in the heat application and heat flooding periods to properly treat stems of different diameters and of different materials.

It will be understood that the conventional step-by-step mechanism described may be variously modified while retaining, in substance, its function in causing interruption of the heating current at the end of a predetermined number of heating cycles.

When a batch of material comprises stems or rods which are substantially alike in their history of previous treatment, in diameter, and in composition, a given number of heating cycles usually takes place in a fairly definite period of time, so it would then be possible to arrange things so that the heating current is interrupted and the jaws opened to drop the rod or stem at the end of a certain period following the closing of the foot switch.

I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the prior art:

What I claim is:

1. A machine for heat-treating the tips of valve stems, or the like, said machine comprising spaced stem-clamping electrodes, heating current supply circuits including switch means connected to said electrodes to heat a stem-tip clamped therebetween, means responsive to the temperature of the heated tip to govern movement of said switch means, and a step-by-step switch mechanism cooperable with said heating circuit means and said temperature responsive means to produce cyclic variations in the flow of heating current through the heated tip.

2. A machine for heat-treating the tips of valve stems, or the like, said machine comprising spaced stem-clamping electrodes, heating current supply circuits including switch means connected to said electrodes to heat a stem-tip clamped therebetween, means responsive to the temperature of the heated tip to govern movement of said switch means, a step-by-step mechanism cooperable with said heating circuit means and said temperature responsive means to produce cyclic variations in the intensity of the heating current through the heated tip, and to cause release of the clamped stem at the end of a predetermined number of heating cycles.

3. A machine for heat-treating the tips of valve stems, or the like, said machine comprising stem-clamping electrodes, heating current supply circuits including switch means connected to said

electrodes, means to cause successive cyclic variations in heat flow in the heated tip for a predetermined number of cycles, said means comprising means responsive to the temperature of the heated tip to alternately close and open the heating current circuit, and means cooperable with said temperature responsive means to interrupt said heating current supply circuit after a predetermined number of cycles.

4. A machine for heat-treating material to produce alternate periods of heat application and heat diffusion through the material, said machine comprising spaced electrodes, heating current supply circuits including switch means connected to said electrodes to send current through said electrodes and material positioned therebetween for heat treatment, temperature responsive means cooperable with said current supply circuits to produce alternate periods of heat application and heat diffusion through the heated material, and means cooperable with said temperature responsive means and said heating current supply circuits to interrupt the heating circuit upon the termination of a number of heat application and heat diffusion cycles.

5. In combination, spaced electrodes, heating current supply circuits including switch means connected to said electrodes, said electrodes including portions for clamping material to be heated disposed between said electrodes, temperature responsive means responsive to the temperature of the heated material cooperable with said current supply circuits to produce alternate heat application and heat diffusion through the heated material, and means cooperable with said temperature responsive means and said current supply circuits to interrupt the heating current and to cause movement of said electrodes to release the material clamped therebetween upon the termination of a number of heat application and heat diffusion cycles.

6. In combination, spaced electrodes, one of said electrodes having a recess in its working face thereby defining spaced current conducting fingers on the working face of the electrode, heating supply circuits including switch means connected to said electrodes, said fingers being adapted to clampingly engage material to be heated positioned between said electrodes, temperature responsive means responsive to the temperature of the heated material cooperable with said current supply circuits to produce alternate heat application and heat diffusion through the heated material, and means cooperable with said temperature responsive means and said current supply circuits to interrupt the heating current upon the termination of a number of heat application and heat diffusion cycles.

7. In combination, spaced electrodes for clamping material to be heated, heating current supply circuits including switch means connected to said electrodes, means to define spaced current paths of relatively high current intensity through the material, said means comprising spaced conducting fingers on the clamping face of said electrodes, means to produce periodic variations in the current intensity whereby the heated material is alternately subjected to relatively high heat transfer along spaced parallel paths and diffusion of heat at a substantially uniform level, said means comprising temperature responsive means responsive to the temperature of the heated

material cooperable with said supply circuits to produce cyclic variations in current intensity, and means cooperable with said temperature responsive means to interrupt the current supply circuits upon the termination of a number of cyclic variations in the current intensity.

8. A machine for heat-treating a member to be heated, a heating current supply circuit connected to heat the member, means to selectively condition said supply circuit and thereby produce alternate heating and heat diffusion in the member, means to selectively condition said supply circuit and thereby produce alternate heating and heat diffusion in the member, said conditioning means comprising means responsive to the temperature of the member, and timed means cooperatively connected to said temperature responsive means and to said circuit.

9. A machine for heat-treatment of a member to be heated, movable means to hold the member during treatment, a current supply circuit to heat the member, means to selectively condition said supply circuit and thereby produce alternate heating and heat diffusion in the member, said conditioning means comprising means responsive to the temperature of the member and timed means cooperatively connected to said temperature responsive means and to said circuit, and means operably connected with said temperature responsive means to effect movement of said movable means.

10. In combination, means for heat-treating a metal which is part of a heating circuit to produce cyclic heating of and diffusion of heat in the metal, said means comprising a heating current circuit, switch means in said circuit, means responsive to the temperature of the heated metal, and timed means in circuit connection with said switch means and with said temperature responsive means and cooperable therewith to alternately close and open said circuit, respectively.

11. In combination, means for heat-treating a metal which is part of a heating circuit to produce heating of and diffusion of heat in the metal, said means comprising a heating current circuit, means responsive to radiant energy emitted by the heated metal, and timed means connected to said heating circuit and to said energy responsive means arranged cooperable with said energy responsive means to determine the length of the heat-treating period.

12. In combination, means for heat-treating a metal which is part of a heating circuit to produce heating of and heat diffusion in the metal, said means comprising a heating current circuit, means responsive to radiant energy emitted by the heated metal, and means adapted to vary the intensity of the current in said heating circuit connected to said radiant energy responsive means to maintain the temperature of the heated metal within predetermined limits.

13. In a machine for heat treating a metallic rod which is part of a heating circuit to produce heating of and diffusion of heat in the rod, a heating current circuit, electrode means movable to retain the rod in the circuit during the heat treatment, means responsive to radiant energy emitted by the rod, and means connected cooperable with said electrode means and said energy responsive means to effect movement of said electrode means.

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