Jan. 17, 1950 J. J. CROWE 2,495,055

METHOD AND APPARATUS FOR FLAME HARDENING AND ANNEALING

Filed Nov. 7, 1944

Fig. 1.

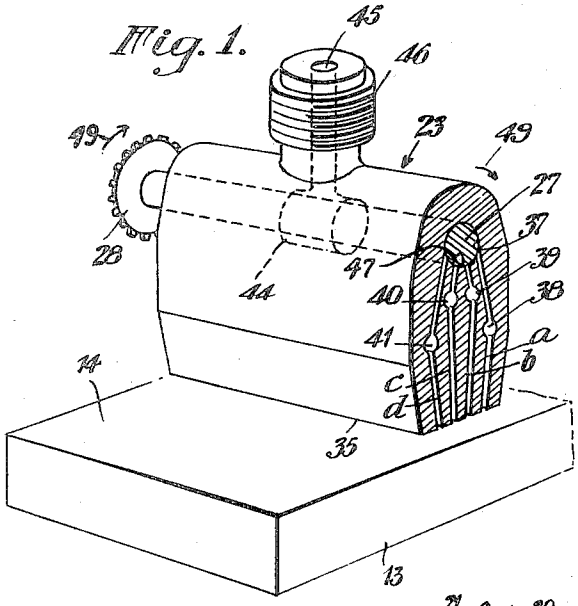



Fig. 4.

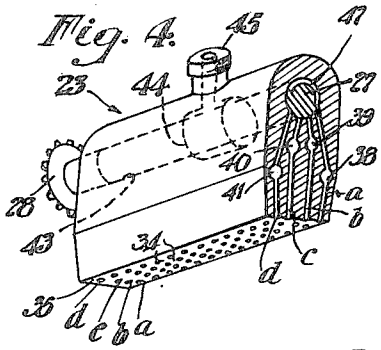



Fig. 7.

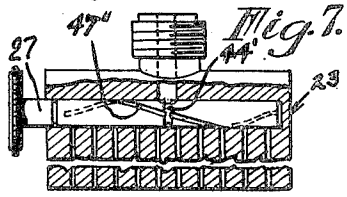



Fig. 5.

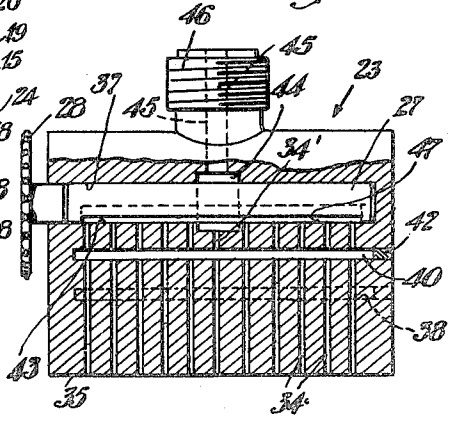



Fig. 2.

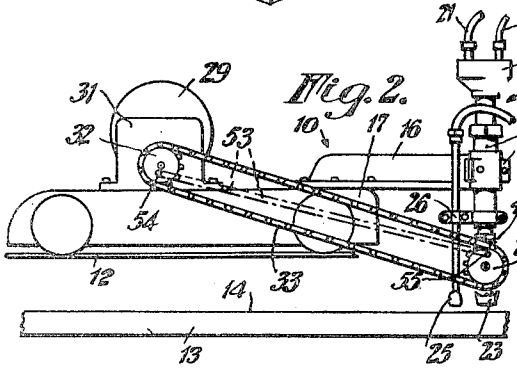



Fig. 3.

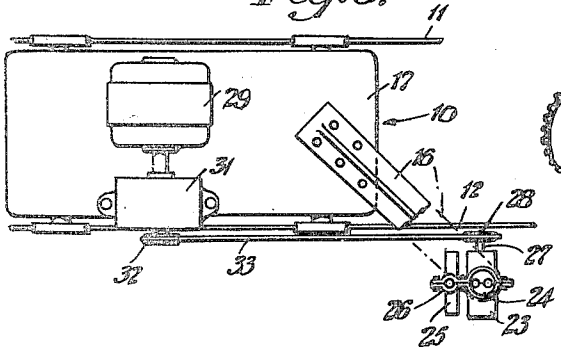
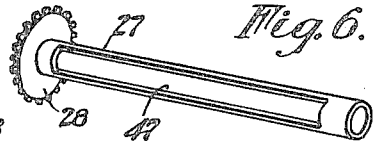



Fig. 6.




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## METHOD AND APPARATUS FOR FLAME HARDENING AND ANNEALING

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8 Claims. (Cl. 263—9)

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This invention relates to a method and apparatus for heat-treating metal surfaces with heating flames.

It is the usual procedure in heat-treating metal surfaces to bring the surface metal to the desired heat by a single pass of the flame over the surface. When deep penetration is attempted, the flame is often retained on a given area of the metal surface a length of time such that the surface is melted or burned and control of the depth of penetration is thereby lost. Thus, prior procedure was found unsuitable for deep penetration of metal surfaces. In my application Serial No. 523,682, filed February 24, 1944, now Patent No. 2,480,287, and co-pending herewith, there is disclosed a method of obtaining deep penetration of a metal surface by effecting intermittent application of the flames to a given area of the metal surface. Heat is thus delivered in separate amounts with time intervening to allow the preceding heat delivery to soak into the metal before the next heat delivery is made. By such procedure, control of the depth of penetration of the heat is had and the smooth metal surface is preserved. Also, apparatus is disclosed in my application for carrying out the method by which the oxy-acetylene torch which projects the heating flames upon the metal surface is given a sweeping motion as the torch is advanced over the metal surface. The resultant effect is a long forward sweeping stroke and a short rearward sweeping stroke. A given area on the surface is thus supplied with heat intermittently or with several passes of the flame. The disadvantage with this apparatus is that, because of the difference in the lengths of the stroke, uneven heating will result, thereby limiting the use of the apparatus. Further, with this apparatus, the flame pattern cannot be readily changed.

It is one object of the present invention to provide a method and apparatus for intermittently applying heat to a metal surface wherein more even heating of the surface areas will be obtained.

It is another object of the present invention to provide apparatus for intermittently applying heat to a metal surface which can be readily altered to give several different flame patterns.

It is another object of the invention to provide an apparatus for intermittently applying heat-treating flames wherein the torch projecting these flames remains stationary and need not be bodily moved while it is advanced over the metal surface.

According to the present invention, the torch

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is kept stationary on the advancing wheeled carriage, while the heating gas for the flames is introduced consecutively into spaced rows of orifices within the torch tip. The flames are applied to the metal surface in consecutive order while relative movement is effected between the torch tip and the metal surface. A rotatable valve element is provided in the torch tip for controlling the flow of gas to the different rows of orifices. The valve element extends out of one end of the nozzle tip and is either rotated or oscillated, as the flame pattern may require, by a motor and reduction gear arrangement on the carrier. The valve element has a recess always containing the mixed gases which registers with the different orifice rows. The recess can be of such width to span only one row at a time, as in one form of the invention, or several rows, as in another form of the invention.

For a better understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawing, in which

Fig. 1 is an enlarged perspective view of the torch tip in position over a metal surface to be heat-treated, and of the form of the invention using the narrow recessed valve element;

Fig. 2 is a side elevational view of the apparatus showing the chain drive connection for rotating the valve element in full lines and the link drive for oscillating the valve element in dotted lines;

Fig. 3 is a plan view of the apparatus shown in Fig. 2;

Fig. 4 is a perspective view of the torch tip looking up from its bottom and with a section taken in a vertical plane to show one full orifice of each of four rows and with a valve element recess of such width as to span all of the rows of surfaces;

Fig. 5 is a large elevational view of the same opened up and in section to show the valve element and one full row of orifices;

Fig. 6 is a perspective view of the rotatable valve element removed from the torch tip with drive sprocket attached;

Fig. 7 is a side elevational view, partly in section, of a torch tip having a valve element with a spiral recess.

Referring now particularly to Figs. 1, 2, 3, there is shown the complete apparatus which comprises a wheeled carriage or support 10, adapted to be moved over tracks 11, 12. A metal work-piece 13 having a top surface 14 to be heat-treated lies adjacent the tracks and beneath a gas torch

15 carried on a bracket 16 extending laterally from carriage body 17. A clamping plate 18 secures the torch to bracket 16 which, upon being released, permits the torch 15 to be vertically adjusted on the bracket.

Torch 15 includes a mixer 19 to which oxygen and acetylene are separately delivered through hoses 21, 22, a torch tip 23, and a pipe connection 24 coupling the torch tip 23 with the mixer 19. A quenching nozzle 25 is connected by a clamp 26 to the torch 15. The torch, if desired, can be designed to be water-cooled.

A rotatable shaft element 27 extends from one end of the torch tip 23 to the other end and has a sprocket 28 thereon. A motor 29 and reduction gear 31 drive a sprocket 32 which is, in turn, connected by chain 33 to a sprocket 28. In this manner, the valve element 27 is rotated.

Torch tip 23 has four parallel rows, *a*, *b*, *c*, *d* of orifices 34 in tip bottom face 35. These orifices 34 extend vertically to valve chamber 37 which contains the rotatable valve element 27. Distributing chambers 38, 39, 40, 41 are respectively provided in rows *a*, *b*, *c*, *d* to insure good distribution of the mixed gases between the orifices of a given row. The valve chamber 37 and these distributing chambers may be formed in the tip body by drilling one large hole and four small holes into the tip body. The small holes are closed with plugs 42, Fig. 5. The rotatable valve element 27 closes off the large hole. The orifices 34 enter bottom wall 43 of the valve chamber so that outer rows *a* and *d* are within 180 degrees from each other.

Valve chamber 37 includes a depressed annular recess 44 which is supplied continually with the heating gases from central passage 45 in threaded inlet portion 46. An orifice portion 34', Fig. 5, opens into annular recess 44 to bleed therefrom sufficient gas to maintain small non-heating flames at times when recess 47 of the valve element 27 is not in registry with the orifice rows. Should there be insufficient gas to supply all of the orifices at this time, those orifices which are supplied will serve to provide a pilot flame for the unlighted orifices when the greater supply of gas is delivered. Coupling nut 48, Fig. 2, on torch pipe connection 24 fits the threaded inlet portion 46 of the torch tip to connect the tip and pipe connection together.

In the form of the invention shown in Fig. 1, the valve element recess 47 supplies gas to only one row of orifices at a time. As the valve element is rotated in the direction of the arrow 48 by chain 33, the orifice rows are supplied with large quantities of the mixed gases to produce heating flames in the rows in the consecutive order *a*, *b*, *c*, *d*, *a*, *b*, etc. The resulting flame pattern is comparable with the flame pattern shown in the above-mentioned application with the forward stroke omitted. In other words, there is a succession of rearward strokes, and, if the torch remained stationary, intermittent heat would be applied to one section of the work-piece. The relative movement between the carriage and workpiece during the repeated application of the flames causes the heating of successive and overlapping portions of the surface. Since the torch is progressed along the metal surface, intermittent heat is applied to the entire path of the torch providing that the number of revolutions of the valve element is not reduced to less than two while the torch travels a distance equal to the distance from row *a* to row *d*. If the revolutions were so reduced, portions of the metal surface would be untouched by the flames.



If, instead of rotating the valve element 27 of Fig. 1, the valve element 27 is oscillated, as by a link 53, Fig. 2, in lieu of the chain 33, connected between points 54, 55, on respective sprockets 32, 28 with the point 55 being of longer arm distance from the center of rotation than point 54 on sprocket 32 to effect only the reciprocation of sprocket 28, back and forth sweeping motion of the flames is obtained. The flame pattern here will be *a*, *b*, *c*, *d*, *d*, *c*, *b*, *a*, etc., or the same as that obtained by bodily moving the torch back and forth. This flame pattern does not give as even heat applications as the rotating valve element because the forward stroke travels faster than the rearward stroke. However, for some applications, uneven heating may be desirable.

When the valve element having a wide recess 47', Figs. 4, 5, 6, which can span all of the orifice rows at one time, is rotated, a longer consecutive exposure of an area to the flame than when the narrow recessed valve element is rotated, is had. The flame pattern will be *a*, *ab*, *abc*, *abcd*, *a*, *ab*, etc. Still another flame pattern can be obtained by oscillating this same valve element by the link 53.

In Fig. 7, the valve element 27 has a spiral recess 47'' extending once around the valve element and there are no distributing chambers connecting the torch tip passages in a given row. Mixed gases are continually received by the spiral recess 47'' from an annular recess 44' of the valve element 27 and, since the recess 47'' extends one full turn about the element the gases are continuously fed to the torch tip passages. Consequently, there are always some flames burning all the time. A separate pilot flame is thus unnecessary. A further advantage is that the gas flow is more uniform because all of the flames are not extinguished at the same time.

The valve element 27 is either rotated by chain 33, Fig. 2, or oscillated by link 53, the same as with valve element having the straight recesses 47, 47'.

It will now be apparent that numerous flame patterns can be obtained with slight alteration of the parts and that this is effected without having to bodily reciprocate the torch tip.

What is claimed is:

1. Apparatus for intermittently and progressively applying heat to a metal surface including a movable carriage, a torch tip mounted thereon having an inlet passage for a combustible gas mixture and a discharge face and a plurality of gas delivery passages terminating in discharge orifices in the discharge face arranged in rows spaced apart in the direction in which the heating is to progress, a movable valve element mounted in said tip having gas passage means adapted upon movement of the valve element to place said inlet passage in communication with said delivery passages in an order such that gas jets for heating flames will be discharged from orifices in said spaced rows in consecutive order, motor driven means mounted on said carriage for operating said valve element, and means for effecting relative movement between the torch tip and the metal surface in the direction in which said rows of orifices are spaced apart.

2. Apparatus for progressively heat-treating a metal surface comprising a carriage, a torch tip mounted thereon having an inlet passage for a combustible gas mixture and a discharge face and a plurality of gas delivery passages termi-

nating in discharge orifices in the discharge face arranged in rows spaced apart in the direction in which the heating is to progress, a movable valve element in said tip having gas passage means adapted upon movement of the valve element to place said inlet passage in communication with said delivery passages in an order such that gas jets for heating flames will be discharged from orifices in said spaced rows in consecutive order, means for causing movement of the carriage with respect to the metal surface in the direction in which said rows of orifices are spaced apart, and means mounted on the carriage for moving said valve element at a speed which is coordinated with the speed of movement of the carriage.

3. Apparatus for progressively heat-treating a metal surface comprising a carriage, a torch tip mounted thereon having an inlet passage for a combustible gas mixture and a discharge face and a plurality of gas delivery passages terminating in discharge orifices in the discharge face arranged in rows spaced apart in the direction in which the heating is to progress, a rotatable valve element mounted in the tip having gas passage means adapted upon movement of the valve element to place said inlet passage in communication with said delivery passages in an order such that gas jets for heating flames will be discharged from orifices in said spaced rows in consecutive order, means for causing movement of the carriage with respect to the metal surface in the direction in which said rows of orifices are spaced apart, and drive means on the carriage for turning the valve element.

4. Apparatus for heat-treating a metal surface comprising a carriage, a torch tip mounted on the carriage having a discharge face and also having a valve chamber and a plurality of gas passages leading from the valve chamber to the discharge face of the tip, a valve element rotatable in the valve chamber and having an annular depression and also a spiral recess adapted to continually receive gas from said annular depression, and means for turning the valve element to pass heating gases consecutively to said passages to disperse heating flames upon different surface areas.

5. The method of progressively heat-treating a metal surface by flames which issue from orifices arranged in rows spaced apart in the direction in which the heating is to progress, which comprises effecting relative movement in said direction between the flame orifices and the metal surface, and throughout the extent of relative movement required to heat treat the desired surface area, directing flames upon the metal surface from the orifices of the different rows consecutively in said direction and repeating said application of the flames to consecutive portions of the metal surface throughout the extent of said relative movement, whereby consecutive sweeping motions of the flames are applied to the surface of the metal in a direction in which the heating is to progress.



6. The method of progressively heat-treating a metal surface by flames which issue from orifices arranged in rows spaced apart in the direction in which the heating is to progress, which comprises effecting relative movement in said direction between the flame orifices and the metal surface, and throughout the extent of relative movement required to heat treat the desired surface area, directing flames upon the metal surface from the orifices of the different rows consecutively in said direction and repeating such application of the flames to successive overlapping portions of the metal surface throughout the extent of said relative movement, whereby consecutive sweeping motions of the flames are applied to the surface of the metal in a direction in which the heating is to progress.

7. The method of progressively heat-treating a metal surface as defined in claim 6 in which there are at least two applications of the flames from each row of orifices for a relative movement between the orifices and metal surface equal to the distance between the first and last rows of orifices.

8. The method of progressively heat-treating a metal surface as defined in claim 5 in which the flames from the orifices are moved across a stationary work surface.

JOHN J. CROWE.


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