Jan. 30, 1945. J. O. BISHOP ET AL 2,368,087

APPARATUS FOR FLAME HARDENING

Filed Feb. 8, 1941 5 Sheets-Sheet 1

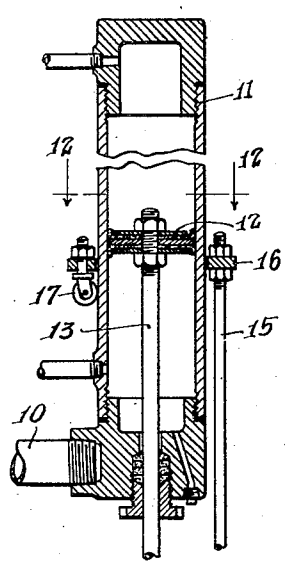


Fig. 11

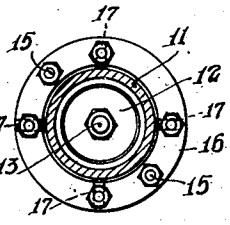


Fig. 12

Fig. 1

Inventors
James O. Bishop
Lloyd L. Babcock

By Lyon & Lyon Attorneys

Jan. 30, 1945. J. O. BISHOP ET AL 2,368,087

APPARATUS FOR FLAME HARDENING

Filed Feb. 8, 1941 5 Sheets-Sheet 2

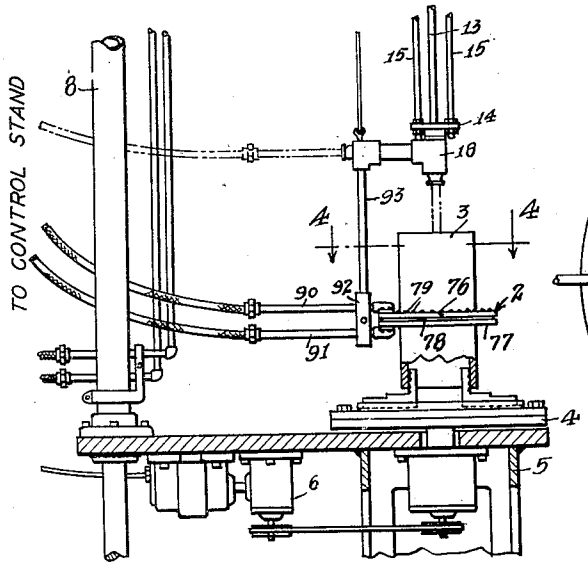


Fig. 2

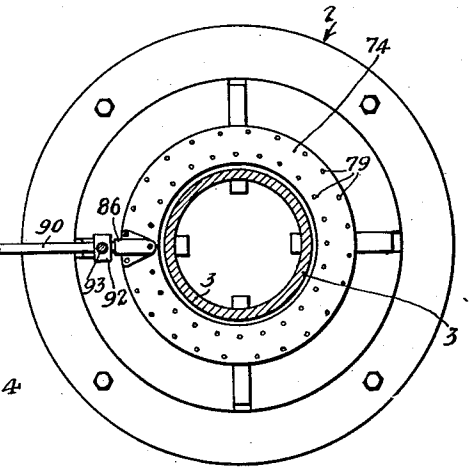


Fig. 4

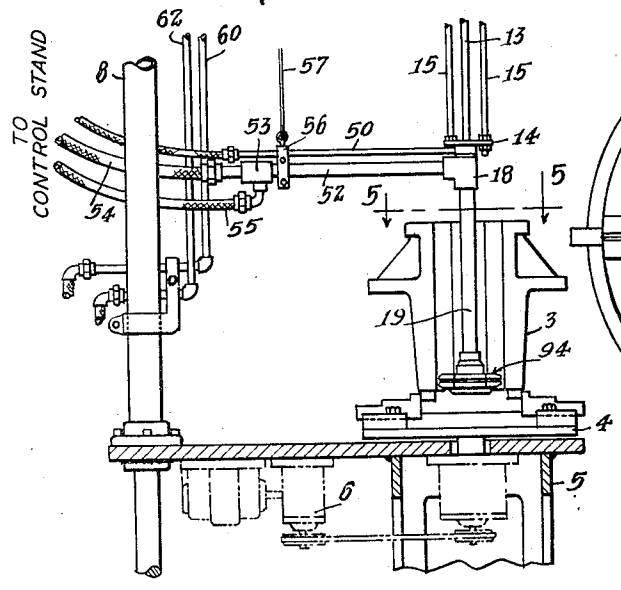


Fig. 3

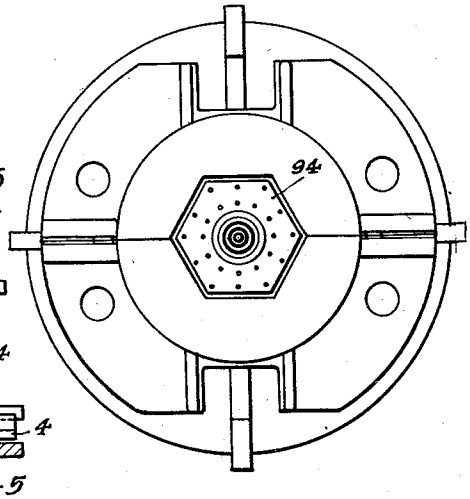


Fig. 5

Inventors

James O. Bishop

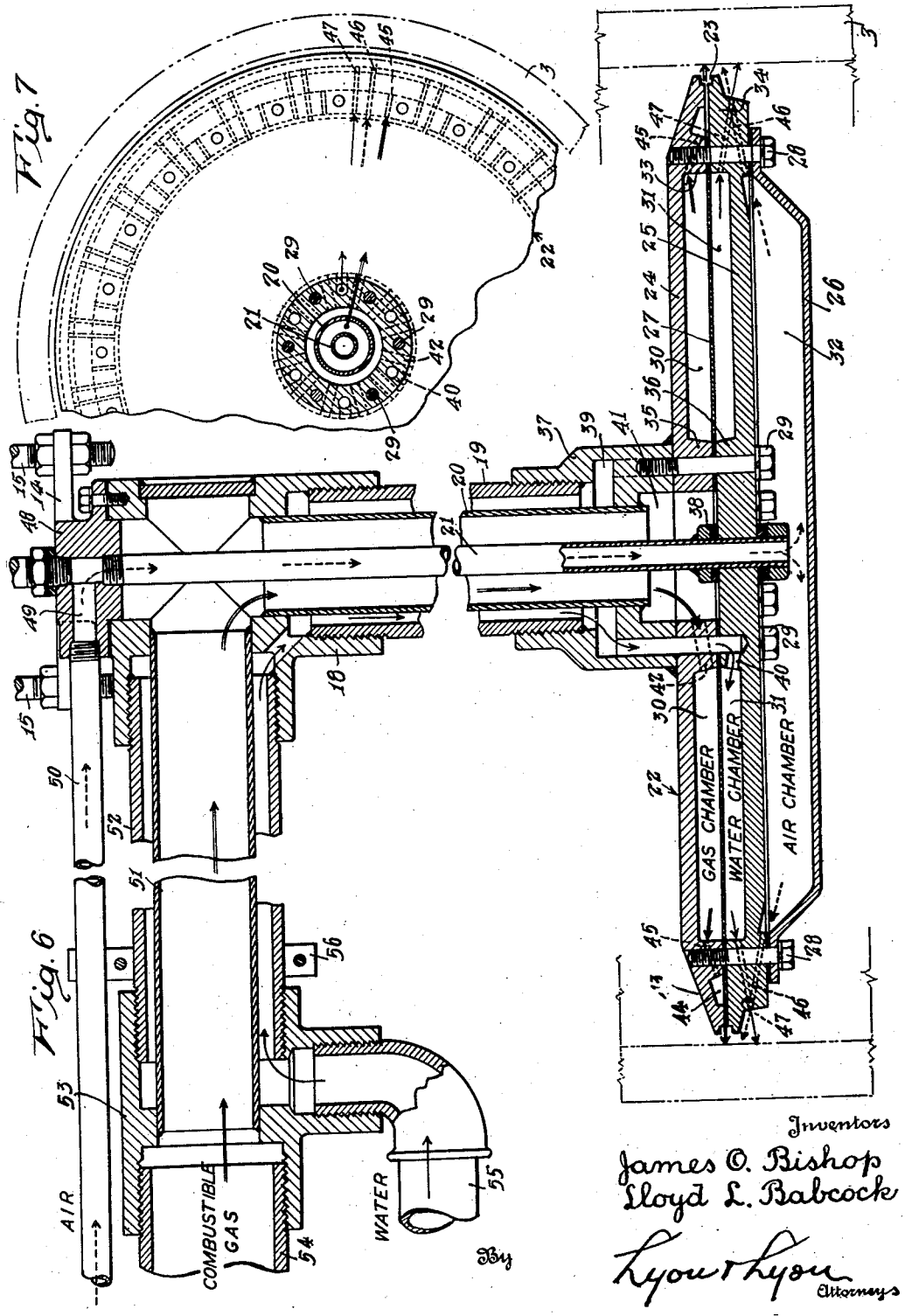
Lloyd L. Babcock

By Lyon & Lyon Attorneys

Jan. 30, 1945. J. O. BISHOP ET AL 2,368,087

APPARATUS FOR FLAME HARDENING

Filed Feb. 8, 1941 5 Sheets-Sheet 3



Inventors
James O. Bishop
Lloyd L. Babcock
By Lyon & Lyon
Attorneys

Jan. 30, 1945. J. O. BISHOP ET AL 2,368,087

APPARATUS FOR FLAME HARDENING

Filed Feb. 8, 1941 5 Sheets-Sheet 4

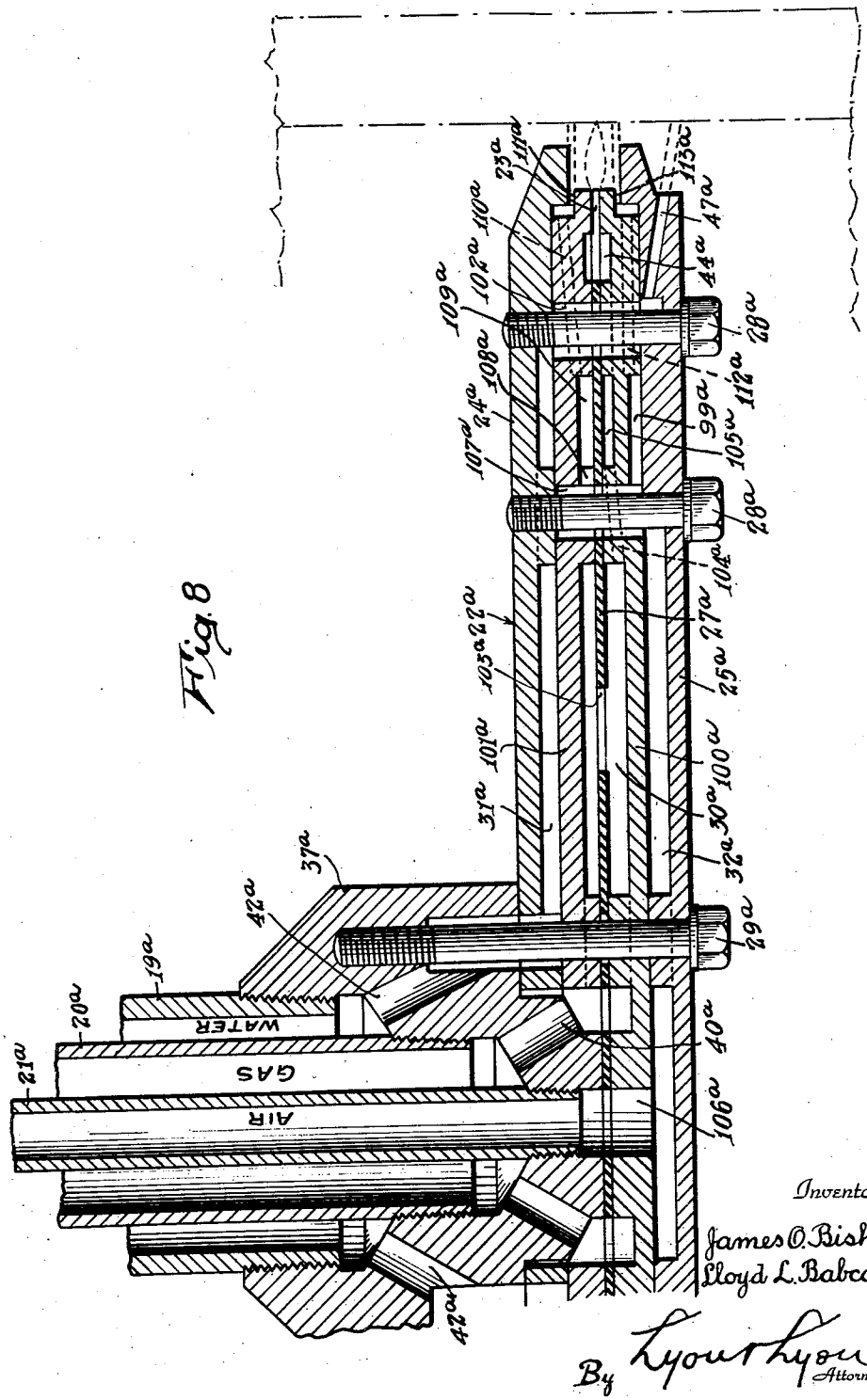


Fig. 8

Inventors
James O. Bishop
Lloyd L. Babcock
By Lyon & Lyon Attorneys

Jan. 30, 1945. J. O. BISHOP ET AL 2,368,087

APPARATUS FOR FLAME HARDENING

Filed Feb. 8, 1941 5 Sheets-Sheet 5

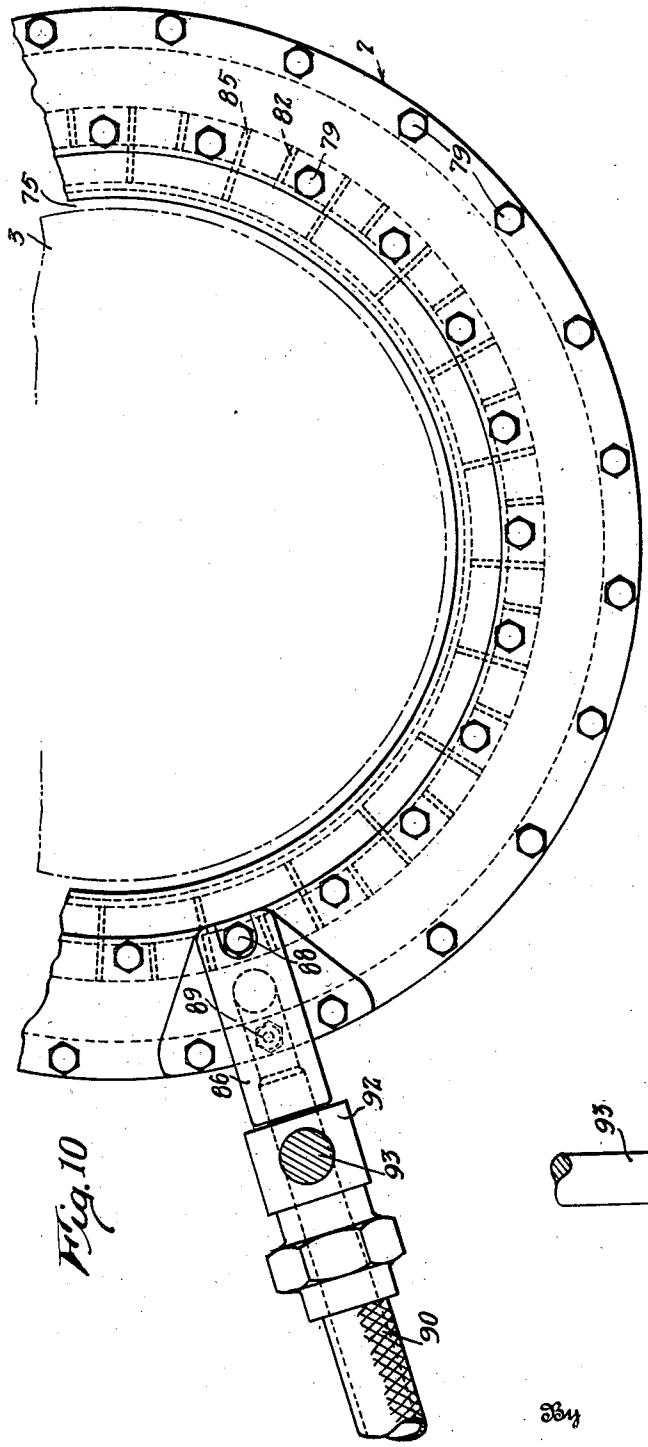


Fig. 10

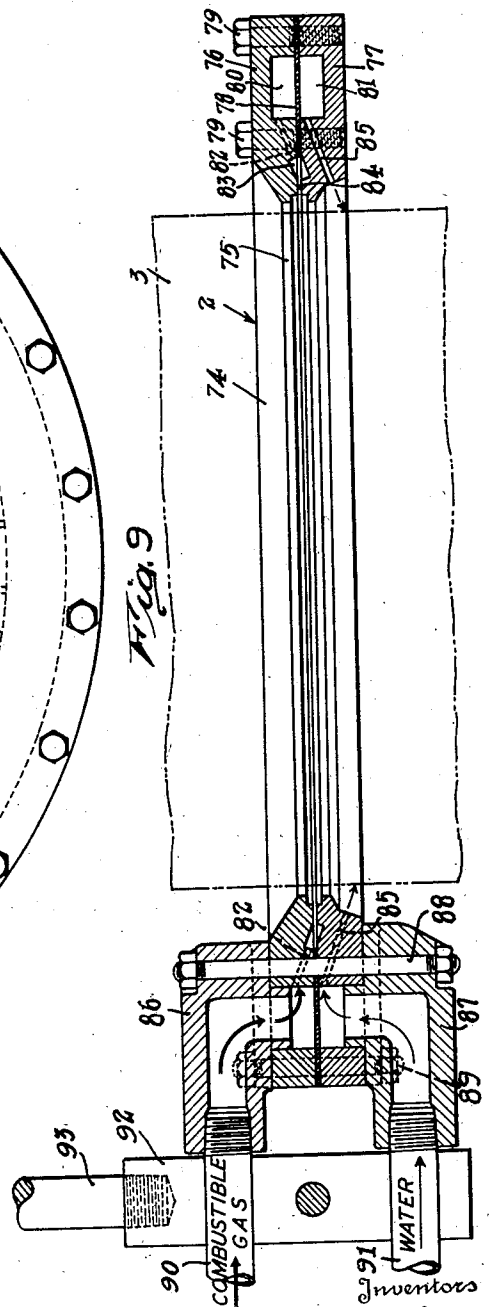


Fig. 9

Inventors
James O. Bishop
Lloyd L. Babcock

By Lyon & Lyon Attorneys

Patented Jan. 30, 1945

2,368,087

UNITED STATES PATENT OFFICE

2,368,087

APPARATUS FOR FLAME HARDENING

James O. Bishop, Torrance, and Lloyd L. Babcock, Compton, Calif., assignors to The National Supply Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application February 8, 1941, Serial No. 378,028

2 Claims. (Cl. 158—27.4)

This invention relates to an apparatus for surface hardening metal by local application upon the surface to be hardened of heat preferably derived by the directing of a flame against the said surface.

It is an object of this invention to provide an apparatus for directing a continuous ribbon flame against a curved or polygonal surface while causing relative transverse movement between the flame and the surface, that is, transverse to the direction of the ribbon or strip of flame.

Another object of this invention is to provide an apparatus for flame hardening internal and external annular or angular surfaces, including the directing of a continuous ribbon flame along the extent of the said surface while maintaining relative motion of the flame and surface in a direction transverse of the said ribbon flame.

Another object of this invention is to provide an apparatus for flame hardening a surface which includes the steps of directing a ribbon flame against the surface and simultaneously directing supplementary air against the surface from both edges of the ribbon flame.

Another object of this invention is to provide an apparatus for flame hardening the annular or angular surfaces which includes the provision of means for the production of a continuous ribbon of flame extending for the full extent of the annular or angular surface to be flame-hardened.

Other objects and advantages of this invention it is believed will be apparent from the following detailed description of a preferred embodiment thereof as illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a view diagrammatic in character of an apparatus utilized in carrying out my invention.

Figure 2 is a diagrammatic view partially in section showing a portion of the apparatus and illustrating its application in the use as an external flame hardening device.

Figure 3 is a view similar to Figure 2 illustrating the same in use as an internal flame hardening apparatus.

Figure 4 is an enlarged sectional view taken substantially on the line 4—4 of Figure 2.

Figure 5 is an enlarged sectional end view taken substantially on the line 5—5 of Figure 3.

Figure 6 is an enlarged fragmental sectional elevation of the internal torch means embodied in our invention.

Figure 7 is a fragmental plan view of the torch illustrated in Figure 6.

Figure 8 is a fragmental sectional elevation of a modified form of internal torch means.

Figure 9 is a sectional elevation of the external torch means illustrated in Figure 2.

Figure 10 is a fragmental plan view of the torch means illustrated in Figure 9.

Figure 11 is a broken sectional elevation of the means provided for raising or lowering the torches.

Figure 12 is a sectional end view taken substantially on the line 12—12 of Figure 11.

In the preferred embodiment of our invention as illustrated in the accompanying drawings and as illustrated for carrying out the method embodying our invention, there is shown internal and external ribbon flame-producing means 1 and 2 which produce a relatively narrow ribbon flame which is directed against the entire surface to be flame-hardened covering an entire band of that surface simultaneously. In order to effect the desired flame hardening of the surface either internally or externally of the member acted upon, means are provided for effecting relative movement between the ribbon flame producing means and the work as indicated at 3. The relative movement is in the direction to cause the surface to move transversely of the ribbon of flame produced. To accomplish this end, either the work 3 or the flame-producing means 1 and 2 may be moved relative to the other of said members.

While we have illustrated our invention as particularly applied to members which are generally of cylindrical form, it will be apparent that the invention is equally applicable to use in connection with members having angular surfaces or of generally polygonal shape.

As our invention is illustrated in the accompanying drawings, the work 3 is supported upon any suitable form of supporting plate 4 from a base structure 5.

Means are provided preferably for rotating the work 3 as it is supported upon the plate 4, and means as generally illustrated at 6 are provided for rotating the work supporting plate 4 to which the work 3 is removably clamped as illustrated at 7.

The ribbon flame producing means are also supported preferably from the base 5 upon a post 8 in such manner as to permit their movement toward or away from the base structure 5.

Supported upon the column or post 8 is a sleeve 9 carrying a supporting arm 10 on the

outer end of which there is mounted a cylinder 11. Within the cylinder 11 is a piston 12 connected with a piston rod 13. The piston rod 13 is secured to a supporting plate 14, which plate 14 is in turn secured to guide rods 15. The guide rods 15 are secured to a guide plate 16 guided along the outer periphery of the cylinder 11 by guide rollers 17. The plate 14 is secured to an elbow fitting 18 which provides for the support of concentrically disposed fluid-conducting pipes 19, 20, 21 (Figure 6). At the lower end of these concentrically positioned pipes there is supported the circular torch 22.

The torch 22, as illustrated in Figure 6, is an annular torch having an annular flame orifice 23 producing a continuous annular ribbon flame operative in conjunction with the torch raising and lowering means to flame harden the interior surface of a cylindrical or polygonal member as illustrated at 3.

The torch 22 is constructed of an upper concave disc 24, an intermediate concave disc 25, and a lower concave pin 26. A dividing plate 27 is interposed between the discs 24 and 25 and as the assembly is secured together by means of the cap screws 28 and 29, the torch is divided into a gas chamber 30, the water chamber 31, and the air chamber 32.

At the outer extremity of the gas and water chamber the discs 24 and 25 are provided with annular ribs 33 and 34, the faces of which contact the dividing plate 27. At the inner extremity of the chambers 30 and 31, discs 24 and 25 are provided with the annular ribs 35 and 36 through which the cap screws 29 are extended to secure the torch to the manifold member 37 mounted at the lower end of the concentrically disposed pipes 19 and 20. The inner of the concentrically disposed pipes 21 is the air conduit and extends through the discs 24 and 25 with its end open in the air chamber 32, and is suitably secured as indicated at 38 to the intermediate disc 25. The outer pipe 19 is secured to the manifold member 37 which provides a passage 39 extending through the annular rib 35 and through lateral ports 40 into the water chamber 31. The intermediate concentric pipe 20 extends in the manifold member 37 beyond the passage 39 into the gas chamber 41 formed within the manifold member 37 and within the annular disc 24 discharging through the series of gas ports 42 into the gas chamber 30.

Directing ports are formed through the annular ribs 33 and 34 leading from the gas, water and air chambers, respectively, for properly directing the fluids with respect to the annular orifice 23.

Formed in the lip 43 of the annular disc 24 is an annular gas chamber 44 to which gas is delivered from the chamber 30 by means of a plurality of downwardly extending directing ports 45. Air is directed from the air chamber 32 by upwardly directing ports 46 formed through the annular rib 34 directing the air for supporting combustion of the flame produced at the annular orifice 23. The air is discharged preferably below the flame as the air as it is heated tends to rise through the flame.

In order to provide for the proper flame hardening and cooling of the heated surface during the flame-hardening process, water or other suitable quenching fluid is directed from the water chamber 31 outwardly against the surface of the work 3 at a point slightly spaced away from the point of contact of the ribbon flame produced from the annular orifice 23. The quenching fluid or water is directed from the water chamber 31 by the circumferentially spaced ports 47.

Any suitable or desirable means may be provided for properly conducting the desired fluids into the concentrically disposed pipes 19, 20 and 21 and as herein illustrated, this means includes the elbow fitting 18 which is suitably secured to the upper ends of the concentric pipes 19 and 20 and through which the inner concentric pipe 21 extends from a suitable header 48 secured to the elbow fitting 18 and provided as an extension of the plate 14 and providing the passage 49 for connection to a suitable air conduit 50.

The lateral branch of the elbow fitting 18 is connected to the concentrically disposed gas and water conduits 51 and 52, respectively. The pipes 51 and 52 are connected to the coupling 53 through the medium of which the concentrically disposed conduits are separated for individual connection with the gas and water conduits 54 and 55, respectively. Additional supporting means may be provided for the outer ends of the conduits 50, 51 and 52, as indicated by the clamp 56 supported by means of the cable 57 from the upper guide disc or plate 16.

Fluid under pressure is supplied to the cylinder 11 above and below the piston 12 so that the torch 22 may be raised and lowered to move the annular ribbon flame axially of the work 3, or in a direction transverse of the direction of extent of the annular ribbon flame.

Means are provided for alternately supplying the fluid under pressure to the opposite sides of the piston 12 within the cylinder 11, whch means may be of any suitable or desirable construction and is herein illustrated as including a pair of manually controlled valves 58 mounted in the parallel feed pipes 59 which connect with the line 60 leading to one end of the cylinder 11. Also mounted in the parallel feed lines 59 are the electrically operated shut-off valves 61.

The conduit 62 connected with the cylinder 11 on the opposite side of the piston 12 is connected through the medium of a cross-fitting 63 having a four-way valve 64 mounted therein with a pressure supply conduit 65 and a discharge or vent line 66. The parallel supply pipes 59 are connected with an opposite branch of the cross-fitting, that is, opposite to the point of connection for the supply line 62. In addition to the connection of this branch of the cross-fitting with the parallel supply lines 59, there is provided a by-pass conduit 67 connected through the medium of the T 68 so that the valves 58 and 61 may be by-passed for emergency use. Normally this by-passed line is closed by means of a valve 69. An electrical control panel 70, including an on-and-off switch 71 and speed control switches 72 and 73 is provided for actuating the electrical connections to the valves 61 and to the electric motor provided for driving the drive connection 6 to the work-supporting platform or plate 4.

Assuming that fluid is delivered under pressure through the pipe 65 and the handle of the valve 64 has been moved to the position to admit pressure to the T fitting 68, actuation of one of the switches 72 or 73 results in one of the electrically operated valves 61 opening to allow fluid to pass through the corresponding control valve 58 to the line 60. Fluid pressure in the line 60 is admitted into the lower end of the cylinder 11, forcing the piston 12 upward, raising the torch 22.

At the same time fluid in the cylinder above the piston 12 is expelled through the line 62 and passes through the valve 63 to the discharge or vent line 66. When it is desired to change the direction of movement of the torch, i. e., lower it relative to the work 3, it is only necessary to change the position of the handle of the valve 64. This action serves to connect the supply line 65 with the conduit 62, reversing the direction of flow and causing the piston 12 to move downwardly, at which time fluid in the lower part of the cylinder 11 is expelled through the flow line 60 back through one of the parallel lines 59 to the valve 63 and vent or discharge line 66. The purpose of providing the parallel mains 59 is to enable the use of two electrically controlled switches 61 for the slow or fast feed of the fluid pressure to one side of the piston 12; thus one of the regulating valves 58 is set for a relatively small opening and the other may be set for a relatively large opening, so that when one of the electric shut-off valves 61 is open, the rate of flow of fluid under pressure is determined by the setting of the regulating valve 58 in that main.

It will thus be apparent that the control system for the hydraulic system 11 just described enables the piston 12 to be moved at either one or two preselected rates and in either direction. It may be moved downwardly at a low rate and then retrieved upwardly at a faster rate if desired, and the only controls that need be manipulated by the operator to obtain the desired sequence of motion are the electric switches 72 and 73 and the handle for the valve 64.

On the control board the switch 71 controls the supply of current to the electric motor driving the transmission connection 6 for rotating the work support 4.

The operation of the torch 22 in conjunction with the apparatus as described for moving the said torch and the work 3 is: The motor operating the transmission drive 6 is set in operation to revolve the work support 4 and hence the work 3. During this operation, the torch 22 is lowered to a point below the lower end of the work 3. Gas, air and water are then admitted to the torch and the gas is ignited at the peripheral flame orifice 23. This forms a complete circular ribbon sheet of flame. The handle of the valve 64 is shifted to the position which causes upward movement of the torch 22 and the switch 72 is actuated to produce a slow even hydraulic feed. The torch 22 then moves upwardly through the bore of the work 3 at a uniform preselected rate.

The circular ribbon sheet of flame which emanates from the annular flame orifice 23 heats the rotating inner wall of the work 3 uniformly and efficiently.

During the heating, supplementary air issues from the ports 46 in quantity sufficient to insure substantially complete combustion. During this operation, quenching water is directed outwardly and downwardly by the ports 47, thus rapidly chilling the inner surface of the work 3 as the torch 22 moved upwardly. By this process a uniform surface hardness is produced on the inner surface of the work 3 without changing the physical properties of the base metal which underlies this surface.

The modified form of torch is illustrated in Figure 8 and is similar to the torch 22, so that similar numerals have been utilized to designate the structural components of this torch with the addition of an exponent *a* thereto. The structural differences of this torch and its certain differentiating features are that the torch 22a comprises a pair of upper and lower concave discs 24a and 25a and a pair of intermediate plates 100a and 101a held in position by means of the cap screws 28a and 29a. Interposed between the plates 100a and 101a is a dividing plate 27a.

The cap screws 29a are threaded into the distributor 37a into which the air, gas and water conduits 19a, 20a and 21a are respectively threadedly connected.

Cooling water from the pipe 19a enters the distributor 37a and passes through the ports 42a into the cooling water chamber 31a and down through the vertical annular passage 102a and downwardly directed discharge orifices 47a.

Combustible gas enters the distributor 37a from the pipe 20a and passes through the ports 40a into the annular gas chamber 30a. The dividing plate 27a is cut away as indicated at 103a in the gas chamber 30a so that gas in this chamber extends both above and below the dividing plate 27a. The gas flows from the chamber 30a through the ports 104a into an auxiliary gas chamber 105a formed within the plate 100a below the dividing plate 27a. The gas or combustible gas mixture flows from the chamber 105a into the annular gas recess 44a from which it escapes through the completely annular flame orifice 23a.

Air under pressure reaches the distributor 37a through the central pipe 21a, which pipe extends into the distributor 37a to connect with the port 106a leading to the air chamber 32a. The air leaves the air chamber 32a in such manner that its passage is divided to deliver the air both above and below the annular ribbon flame produced at the annular flame orifice 23a.

The bore holes for the cap screws 28a formed through the plates 100a and 101a are enlarged to provide the passage 107a from which ports 108a lead into an auxiliary air chamber 109a. From chamber 109a air passes through the ports 110a to the upper air orifices 111a. Air also leaves from the bore holes 107a through the chamber 99a formed in the plate 100a and through the ports 112a and hence out through the air orifices 113a formed below the flame orifice 23a.

It will be observed that the ports 111a and 113a are complete annular orifices to which the air is admitted from the ports 110a and 112a and that because of this construction, the air is delivered in two flat sheets both above and below the annular gas orifice 23a.

It will be apparent from the foregoing that this type of construction insures very complete supplemental air supply for insuring very complete and efficient combustion of the gas emitted from the flame orifice 23a. It has been found that this insures a completely circular flame, the temperature of which is extremely high.

As in the case of the previously set forth description of operation, when the torch 22a is progressed upwardly, the cooling water from the ports 47a quenches the previously heated surface, thereby producing a hardened surface.

As will be apparent from Figure 1, the flame hardening means utilized in carrying out our invention may be of either the internal or external flame directed type so that if desired both the inner and outer surfaces of the work 3 may be simultaneously hardened or either of such surfaces may be hardened or they may be hardened sequentially.

The internal flame producing means 2 includes the torch 74 which in this case is provided with

a central circular opening 75 for the reception of the work 3. The torch 74 comprises a pair of annular ring members 76 and 77 separated by a dividing plate 78 and held assembled by means of cap screws 79. There is thus formed within the torch annular gas and water chambers 80 and 81, respectively.

A plurality of ports 82 extend from the gas chamber 80 into an annular recess 83 formed between the rings 76 and 77.

A completely circular flame orifice 84, of the slit type, leads from the annular recess 83.

As in the case of the external torch, the gas when ignited at this orifice 84 forms an annular ribbon sheet of flame which completely encircles the work 3.

Ports 85, of which there are a multiplicity around the interior of the ring 77, are directed downwardly from the water chamber 81 for directing water against the previously heated surface of the work 3. A pair of cooperating fittings 86 and 87 are clamped together by means of the bolts 88 and 89 and serve as the means for introducing the gas and water into their respective chambers from the supply conduits 90 and 91, respectively.

A clamp 92 engages the conduits 90 and 91 and this clamp is supported from a rod 93 which depends from the pipe 52. (See Figure 1.)

As this torch 74 is not operated within a confined space, it has been found that atmospheric air is generally sufficient to produce proper combustion and it is therefore not essential to provide a supplementary air means in the torch 74. It will be apparent, however, that if it is found necessary or desirable to introduce secondary air in the internal type of torch as thus defined, that the same may be introduced in substantially the same manner as described in connection with the torch 22.

In some cases it has been found that it is desirable to apply heat to the outside of the work 3 and to quench it from the inside. Obviously as the structure is illustrated, this may be accomplished utilizing the interior directing torch means 74 as the heating means and introducing the quenching fluid at the interior of the work 3 from the torch 22. Obviously interior heating and exterior quenching may also be accomplished through the reverse use of these torches.

The types of torches above described have been designed for flame hardening cylindrical surfaces.

As an example of a torch for flame hardening polygonal-shaped surfaces, Figures 3 and 5 show a hexagonal torch 94 adapted to enter a hexagonal bore. The construction of this torch 94 may be identical with either torch heretofore described with the exception that its exterior configuration is hexagonal rather than circular. The operation of this torch is similar to the other torches with the exception that the work is not rotated during the flame hardening process.

In each case the air, water and gas supply conduits may be connected to any suitable sources of air, water or gas, for example, they may be connected to a control stand of the type illustrated in Figure 1 of the drawings of the copending application of James O. Bishop, et al., Serial No. 350,196, now Patent No. 2,321,645, June 15,1943, by which device the proper pressures, rates of flow and combustible mixtures may be provided and maintained.

Having fully described our invention, it is to be understood that we do not wish to be limited to the details herein set forth, but our invention is of the full scope of the appended claims.

We claim:

1. In a torch device of the class described, the combination of upper and lower plate-like discs, an annular spacer means between said discs and forming with the discs and annular seal, the outer diameter of the spacer means being smaller than the diameter of the discs, whereby there is formed an annular recess defined by the periphery of the spacer means and by the portions of the discs extending therebeyond, which recess forms a combustion chamber, the spacer means being formed to provide a combustible gas passage terminating in an annular slit through which combustible gas is delivered at the periphery of the spacer means in said recess, said spacer means providing with the disc members ports within the annular discs for the delivery of a combustion supporting gas in annular sheets above and below the combustible gas slit and within the annular recess, whereby the combustible flame produced by the torch burns within the annular recess.

2. In an annular torch device, the combination of upper and lower plates, a spacer means positioned between the plates and forming with the plates a seal, the spacer means defining an annular slit for the discharge of combustion gases, the spacer means being of a diameter less than the plates so that its periphery defines the inner wall of an annular recess defined by the projecting edges of the disc, means for delivering combustion gas to the spacer means to be discharged through the annular slit thereof at the base of the annular recess, and means between the discs for conducting combustion supporting gas to the upper and lower surfaces of the annular recess, annular combustion supporting gas discharge passages defined between the discs and the spacer means at the upper and lower surfaces of said recess and through which said passages combustion supporting gases may pass in sheets upon opposite sides of the combustible gas slit.

JAMES O. BISHOP.
LLOYD L. BABCOCK.