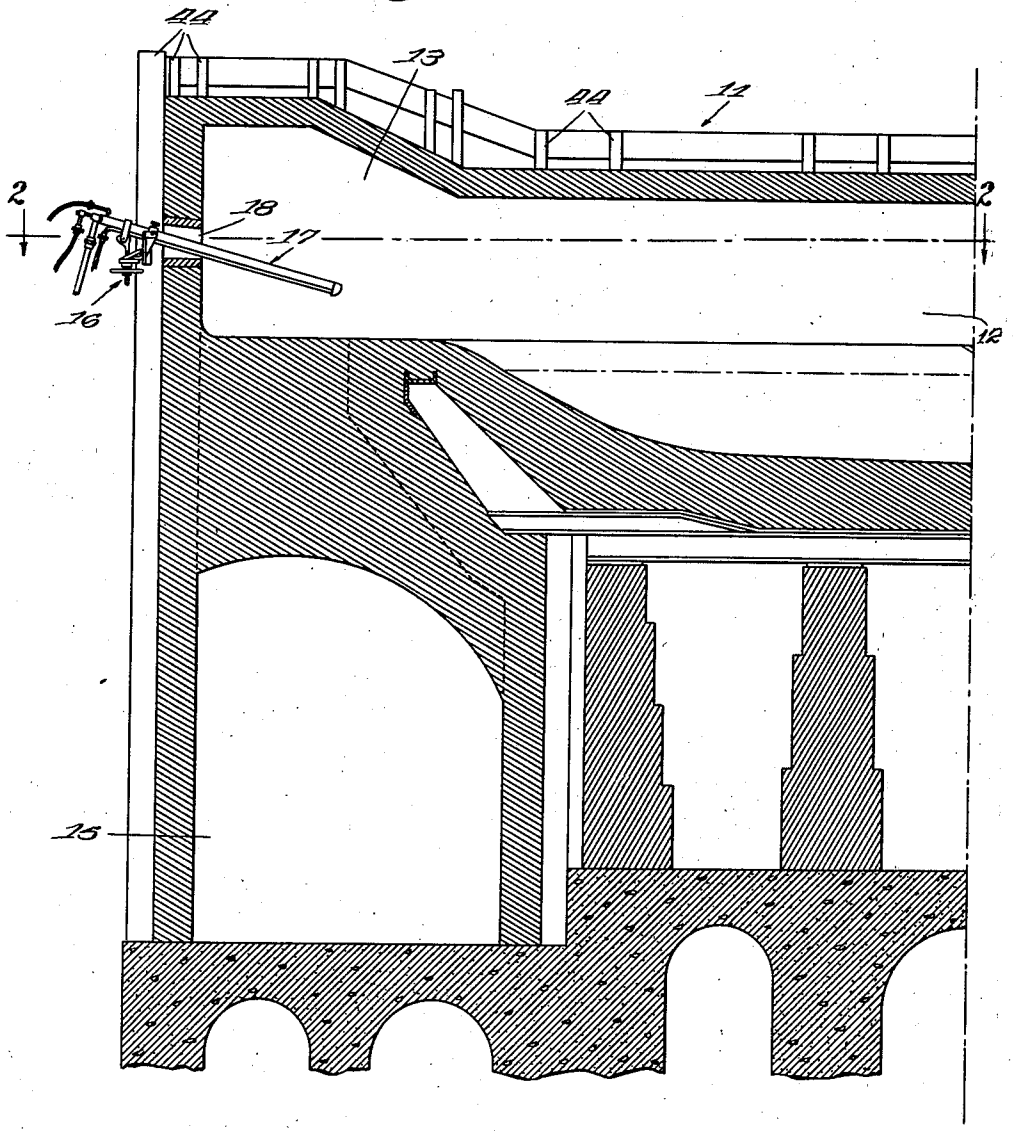
Oct. 19, 1943. L. B. LUELLEN 2,331,989

BURNER CONSTRUCTION

Filed July 26, 1940 3 Sheets-Sheet 1

Fig. 1.



Inventor:
Leland B. Luellen.
By Chrittor, Wiles, Davis, Hirschl & Dawson.
Attys.

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BURNER CONSTRUCTION

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Fig. 2.

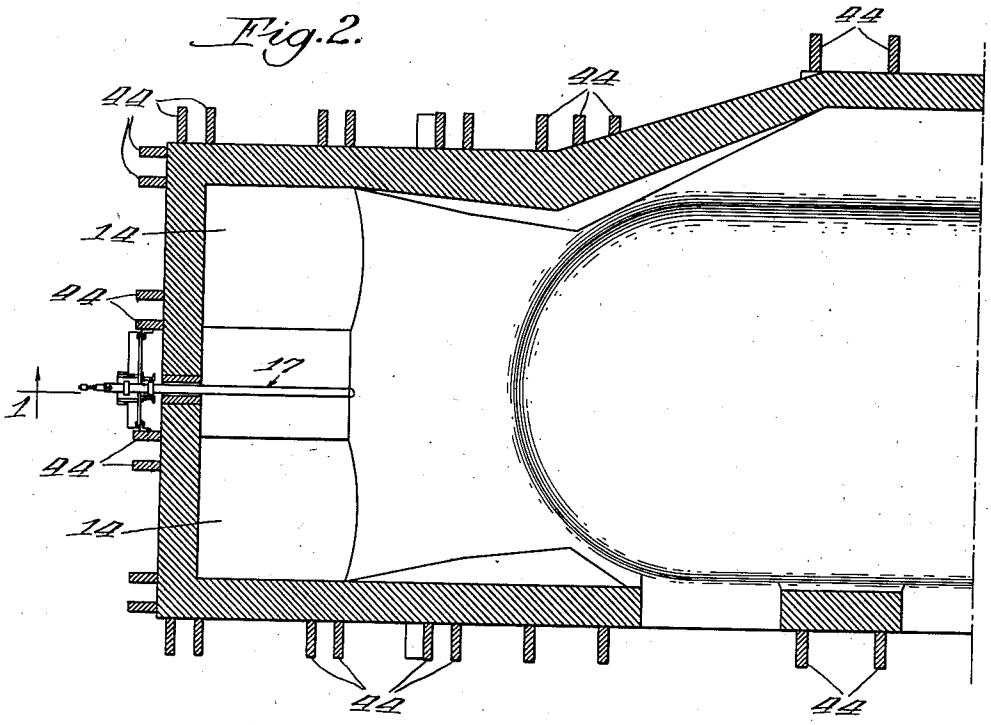
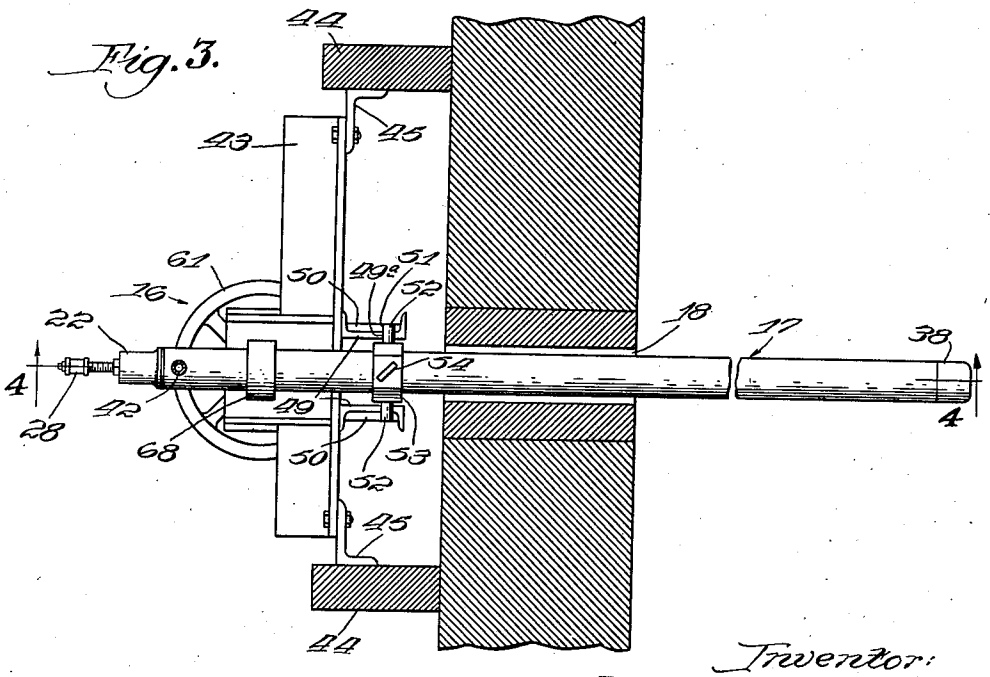


Fig. 3.



Inventor:
Leland B. Luellen.
By Chritton, Wiles, Davies, Hirschl & Dawson.
Atty's.

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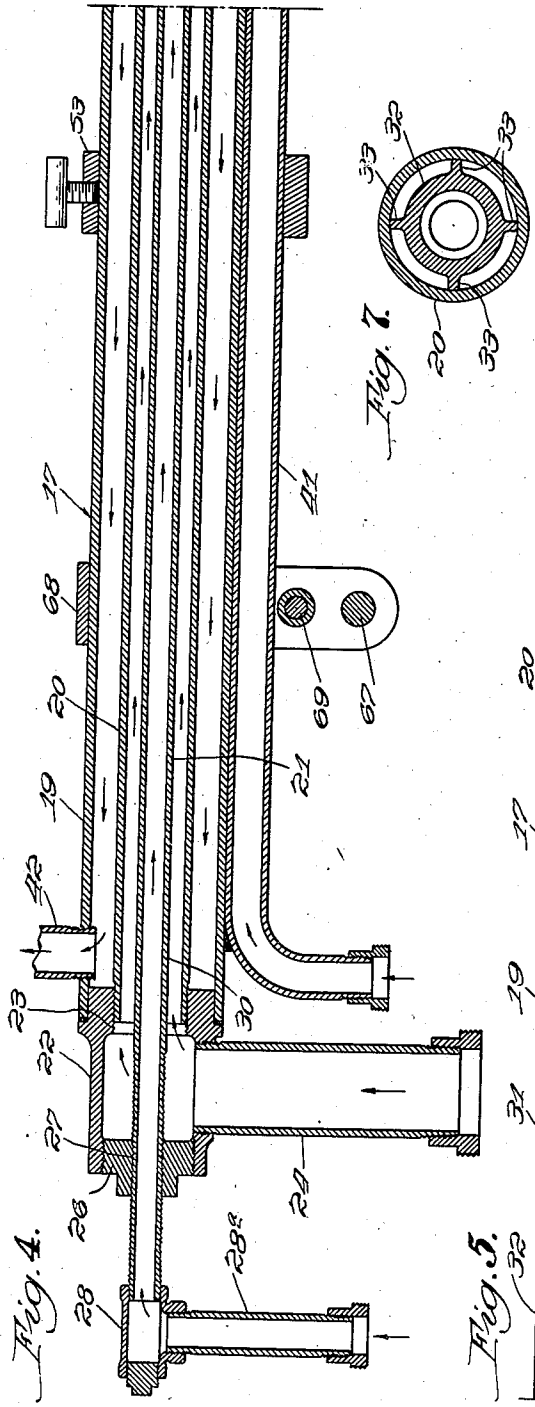


Fig. 4.

Fig. 7.

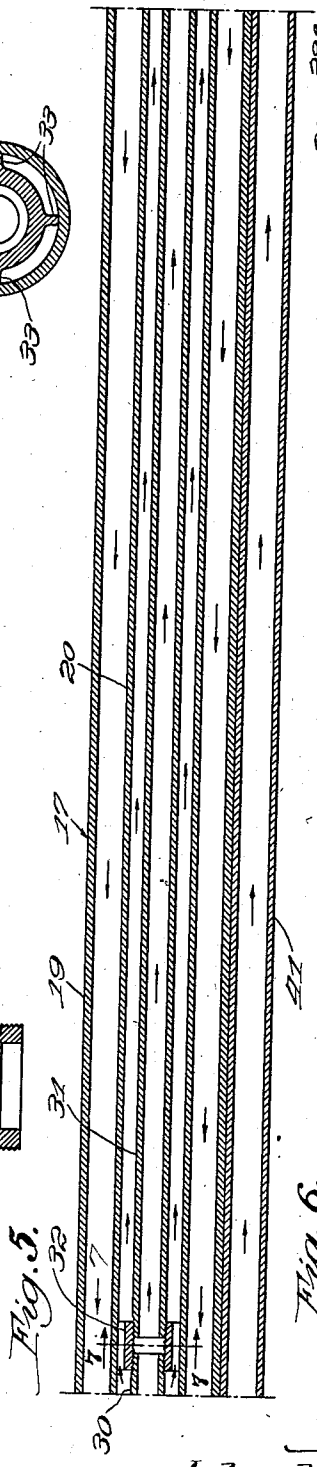


Fig. 5.

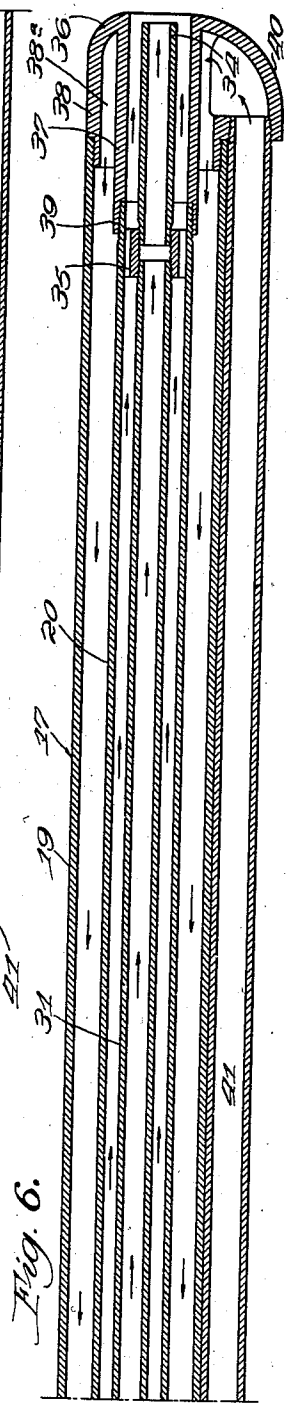


Fig. 6.

Inventor:
Leland B. Luellen.
By Chilton, Wills, Davies, Hirschl & Dawson. Attys.

Patented Oct. 19, 1943

2,331,989

UNITED STATES PATENT OFFICE

2,331,989

BURNER CONSTRUCTION

Leland B. Luellen, Lansing, Ill., assignor to Inland Steel Company, Chicago, Ill., a corporation of Delaware

Application July 26, 1940, Serial No. 347,736

2 Claims. (Cl. 158—73)

My invention relates to burner constructions for use generally in the firing of furnaces and particularly high temperature furnaces, as for example and more especially open-hearth furnaces used for the production of steel and involving the heating of the furnaces to temperatures of or about 3000° F., with actual flame temperature in excess of 3000° F., though certain features of my improved burner construction may be incorporated in burner constructions for furnaces heated to both lower and higher temperatures.

In open hearth and other high temperature furnaces, a large variety of fuel burners have been and are currently being applied. There are a number of problems and certain inherent difficulties connected with the introduction and application of fuel to such furnaces. Because of the basic design of an open hearth furnace a considerable distance exists between the exterior end wall of the furnace and the "hearth," or combustion chamber, in which the actual melting and refining processes of steel manufacture take place. It is desirable that the actual ignition or combustion point of the fuel shall be near the end of the hearth section. This in turn means that the fuel must not be introduced to the combustion supporting air or gases until it reaches a point adjacent to the desired area, and therefore, it is necessary that fuel ports or burners be used to conduct the fuel to tne desired point within the furnace proper before it is discharged.

To attain the end described above the common practice has been to construct so-called doghouses, and in other cases fuel ports, comprising temperature resisting brick built about a water cooled box, such constructions existing within the areas between the end walls and the hearth and acting as a housing and protection for the fuel passage or fuel burner. Due to the temperatures that exist these brick constructions melt and wash away making frequent repairs necessary, causing consequent accumulation of material within the furnace system and alterations to the contours of the interior surfaces of the furnace construction.

Because of the many disadvantages connected with the so-called doghouse constructions, attempts have been made in the past to eliminate them and to substitute furnace burners of liquid cooled construction which would be able to withstand the high temperatures without other protection. These attempts have not hitherto been commercially successful. In each and every instance these previous water cooled burners have had to be given brickwork (or other refractory material) protection or else they have had to be withdrawn from the furnace chamber to such an extent that the desirable point for the fuel discharge has had to be relinquished. An additional problem of importance, but which has been overshadowed by the failure to cool the burners adequately, has been the matter of keeping the burners clean. With the removal of all auxiliary protection the temperature load, especially upon the fuel discharge sections or nozzles, has increased with consequent increasing of combustion product deposits. Likewise, in their entirely exposed position, the burner noses have been subject to greater accumulations from furnace atmosphere and furnace internal temperature reactions. Previous liquid cooled burner designs have failed to provide good practical means by which necessary cleaning could be accomplished.

In accordance with one aspect of the present invention, the improved method of liquid cooling a burner construction extending into the interior of a furnace to be heated to at least substantially 3000° F. having passages for fuel and a cooling liquid, comprises supplying the cooling liquid to the cooling liquid passage in such volume per second that the ratio between the volume of cooling liquid located in that portion of the burner construction which is subjected to the heat within the furnace and the volume of cooling liquid supplied to the burner construction per second is not greater than substantially 5 to 1.

In one form of the present invention the improved method of liquid cooling a burner construction extending into the interior of a furnace and having passages for fuel and a cooling liquid, comprises maintaining the cooling liquid in the cooling liquid passage in the form of a hollow body of substantially uniform radial cross-section at any cross-section thereof.

The present invention also contemplates a burner construction adapted to carry out the method of liquid cooling a burner construction as hereinbefore set forth.

From the above description it is obviously a primary object of the present invention to provide a method of liquid cooling which is of such efficiency that otherwise unprotected furnace burners may be continuously exposed to temperatures of 3000° F. and in excess thereof.

A secondary object is to provide a construction in which the burner pipes and nozzles can be readily cleaned with a minimum of time and

labor without interference with furnace operation or with previously established burner positionings.

I accomplish the primary object by making certain improvements in the method by which the water cooling is applied, these said improvements advancing the art to such a degree that the causes of previous failures are eliminated.

In accordance with one phase of my invention, I provide a liquid cooled burner construction for use under high temperature conditions of about 3000° F. or even exceeding 3000° F., which will not require for maintaining it unimpaired over long periods of operation, any protective means other than its self-contained liquid cooling arrangement, thereby avoiding the necessity of providing protective means such as have been needed for burner constructions as hitherto provided, with the manifest advantages.

I have discovered that, to accomplish this result, it is necessary where water is used as the cooling medium, that the ratio between the total volume of cooling liquid contained within that portion of the burner construction which is exposed to the heat within the furnace, including that portion of the feed-in pipe which is exposed to said heat, and the volume of cooling liquid fed per second to such exposed portions of the burner construction (viz., the replacement volume), must not be greater than substantially 5 to 1 in the case of working furnace temperatures of approximately 3000° F.

Such ratio is provided for by suitably proportioning the size of the lead-in pipe to the size of the liquid cooling space within the portion of the burner construction exposed to the heat of the furnace including the portion of the lead-in pipe exposed to the heat of the furnace, and the pressure at which the cooling liquid is supplied to the lead-in pipe; it being understood that for any given burner construction the less the burner proper, in adjusting it, extends into the furnace interior, the lower the cooling liquid pressure at which the cooling liquid need be forced to the burner construction to establish the ratio referred to, and the farther the burner proper extends into the furnace interior, the greater must be the pressure at which the cooling liquid is supplied to the burner construction.

Further objects are as follows:

To provide for the prolongation of the life of the fuel nozzles of the burner construction.

To provide a burner construction the burner proper of which may be readily cleaned of accumulations and especially the fuel burner proper and nozzles in which accumulations result by deposition from furnace atmosphere and from the passage of fuels of a character tending to result in accumulations, such as for example, oil and coke oven gas, in which cases the portion of the structure surrounding such fuel burner proper and nozzles may remain in fixed position, and furthermore cause no interference with the functioning of the cooling liquid nor the impairment of any of the joints of the liquid cooling course.

To provide a burner construction in which the desired discharge point relationship between the liquid and gaseous fuels, when employed, may be obtained, and preferably readily varied to accommodate the burner for use regardless of variations in density of either one of the fuels employed and so fixed as desired, to the end of producing an inspirating effect of the liquid on the gas and a more effective application of gaseous fuel.

To provide a burner construction in which the distance of fuel discharge point, inside the furnace may be easily controlled by adjustment of the burner proper relative to its mounting mechanism, as conditions may require and preferably without changing the angle at which the burner proper is set thus avoiding disturbance of the angle of flame impingement.

To provide a burner construction in which the nozzle parts or sections of the fuel burner proper are readily accessible for repair or replacement without the necessity of interfering with the mounting and operating position of the burner proper.

To provide a liquid-cooled burner construction for use in firing high temperature furnaces and employing preheated liquid fuel, whereby objectionable cooling of the oil by the cooling liquid will be avoided.

To provide a liquid-cooled burner construction which shall be of compact form, not only making for ease and flexibility of adjustment when provided as an adjustable structure, but also minimizing the cost of the construction.

To provide a liquid-cooled burner construction which may be used over long periods of operation in high temperature furnaces, such as for example open-hearth furnaces for producing steel, without requiring the use of protective means for the burner construction (such as for example masses of brick work (dog houses) usually associated with burners in accordance with common practice, to protect them, or liquid-cooled brick work coolers extending into the furnace at the burners with their tendency to hidden leaks) to prevent injury to the burner construction by the intense heat at the discharge end of the burner construction and within or adjacent to the combustion chamber of the furnace.

I have chosen to illustrate my novel burner construction and my novel method of liquid-cooling a burner construction as applied to a liquid-cooled type of burner construction employing, by way of example, both a liquid fuel, such, as for example, any one of the liquid fuels as commonly used in burner constructions of open hearth furnaces as for instance heavy oil as commonly used in such constructions, and a gaseous fuel such as, for example, any one of the gaseous fuels commonly used in burners for such open-hearth furnaces, the burner construction shown being incorporated in one of the end walls of an open-hearth furnace for producing steel.

Referring to the accompanying drawings:

Figure 1 is a view in longitudinal sectional elevation of one of the similar end portions of an open-hearth regenerative furnace for producing steel, the general features of which are of well known construction, showing incorporated therein a burner construction embodying my invention and suitable for the burning of two kinds of fuel simultaneously, or either kind independently of the other, and by which my improved method may be practiced, the section being taken at the line 1 on Fig. 3 and viewed in the direction of the arrow.

Figure 2 is a plan sectional view of the portion of the furnace shown in Fig. 1, the section being taken at the line 2 on Fig. 1 and viewed in the direction of the arrow.

Figure 3 is a view like Fig. 2, but enlarged, of the burner-equipped portion of the furnace.

Figure 4 is a view in longitudinal sectional elevation of the back end of the burner construction.

Figure 5 is a similar view of the intermediate portion of the burner construction.

Figure 6 is a similar view of the front, or nozzle, end of the burner construction; Figures 4, 5 and 6 considered together illustrating the full length of the burner construction shown; and

Figure 7, an enlarged section taken at the line 7 on Fig. 5 and viewed in the direction of the arrow.

In the arrangement shown the open-hearth furnace of well known construction as to its general features is represented at 11 and comprises, generally stated, a furnace combustion zone 12 into which the materials to be melted for the making of steel are charged in accordance with common practice; similar zones, or passages, at opposite ends of the combustion zone and in communication, respectively, with such ends, the zone or passage at the furnace-end shown being indicated at 13; pairs of up-take passages at opposite ends of the furnace opening upwardly into the zones 13, respectively, the up-takes at opposite ends of the furnace opening downwardly into cross passages, respectively, at opposite ends of the furnace, the pair of up-takes and the cross passage at the furnace end shown being represented at 14 and 15, respectively; the cross passages 15 at opposite ends of the furnace communicating with ends of two checker chambers (not shown), respectively.

The furnace shown is fired, in accordance with common practice, from its opposite ends alternately by burners hereinafter described, the hot products of combustion, when one of the burners is operating, discharging through one of the checker chambers and when the other burner is operating, through the other checker chamber, to heat these chambers to high temperature, and hot combustion supporting air is supplied to the operating burner through the adjacent up-takes 14 from the checker chamber heated as stated in the operation of the other burner.

The burner construction at the furnace end shown is represented at 16, it being understood that the burner construction at the opposite end of the furnace would be of the same construction.

The burner construction 16 comprises two major mechanical sections, one of which is the burner proper 17 which in the applied position for use extends into the zone 13 through an opening 18 in an end wall of the furnace, and the other of which is mounting mechanism for the burner proper and is located exteriorly of the furnace.

The burner proper 17 in the particular construction shown comprises three cylindrical telescoped sections 19, 20 and 21 arranged concentrically with relation to each other and in spaced relation.

The section 19, which forms an outer shell or barrel section, is telescoped at its back end with one end of a T 22 having an internal screw thread 23 at which it is screwed upon the back end of the pipe section 20 which forms with the pipe section 21 an annular passage for any suitable gaseous fuel supplied to its back end through a pipe 24 connected at one end with, and opening into, the T 22 and at its opposite end with a flexible hose line 25 leading from the source of gas supply.

The T 22 at its back end is provided with a screw plug 26 having an internally threaded opening 27 therein in which the back, threaded, end of the pipe-section 21 is screwed. The pipe section 21 which forms a liquid fuel passage extends rearwardly beyond the plug 26 and is provided with a T 28 connected, by a pipe 28a attached to the T, with a flexible hose line 29 which would lead from any suitable source of liquid fuel.

The pipe section 21 is shown as formed of two alined pipes 30 and 31 connected together by a coupler 32 having radial fins 33 which insure the concentric spacing of the pipe sections 20 and 21.

The pipe section 21 also comprises a nozzle 34 at its front end secured to the pipe 21 by a spacing coupler 35 like the coupler 32.

The burner proper also comprises a hollow nose or end member 36 at its front end, having a tubular partition-forming portion 37 open at its opposite ends and spaced throughout its circumference from the wall 38 of the member 36 and having an internal left-hand thread 39 upon which the front end of the pipe-section 20 is screwed, the liquid-fuel nozzle 34 extending into the tubular partition 37 and being concentrically spaced therefrom.

The wall 38 of the member 36 connects with the tubular partition 37 throughout the circumference of the latter at its front end and forms therewith a space 38a which entirely surrounds the partition 37 and opens throughout its circumference into the annular space between the pipe sections 19 and 20, the wall 38 of the member 36 at its underside being expanded as shown at 40 for a purpose hereinafter set forth.

The space 38a and the annular space between the pipe sections 19 and 20 are provided for the circulation therethrough of any suitable cooling liquid, such as for example water, supplied thereto from any suitable source, through a pipe 41 shown as extending lengthwise of, and along the under side of, the barrel section 19 and secured thereto in any desirable way, the pipe 41 being connected at its front end with the expanded portion 40 of the member 36 and opening into the space 38a. At the back end of the barrel-section 19 is an outlet pipe 42 through which the cooling liquid discharges from the burner.

The cooling liquid passage is of substantially the same cross-sectional area throughout substantially the entire extent of said passage. Thus the cooling liquid passage may be of substantially uniform radial cross section at any cross section thereof, for example in the form of an annulus of substantially uniform radial cross section at any cross section thereof.

The mounting mechanism for the burner proper 17 comprises a substantially horizontal angle plate 43 located in the space between those of the metal vertical buck stays shown at 44 and forming the exterior binding and framework portion of the furnace construction in accordance with common practice, which are disposed at opposite sides of the burner-receiving opening 18 in the furnace end wall. The angle plate 43 is connected at its opposite ends with vertical flanged-plates 45 secured to the buck stays 44 at opposite sides of the burner-receiving opening 18, the connections shown comprising bolts 46 which extend through elongated openings in the ends of the plate 43 and into horizontally elongated equidistantly spaced openings in the plates 45 provided in vertical series, to adapt the plate 43 to be secured in place at different elevations as desired, and to allow variation in dimensional

relationship between the longitudinal center lines of hearth and burners, respectively.

Secured to the plate 43 are upwardly extending spaced-apart channels 49 carrying trunnion blocks 50. The upper edges of the channels 49 and the blocks 50 have trunnion-receiving grooves 49a and 51, respectively, in which trunnions 52 on the burner proper 17 are mounted, the trunnions 52 being provided on a collar 53 surrounding the burner proper and in which the burner proper is longitudinally slidably adjustable, the burner proper being clamped to the collar 53 by a set screw 54 thereon.

A strap-hanger 68 surrounds the burner proper 17 in which the latter is longitudinally slidably adjustable, a clamping bolt on the hanger 68 adapting the hanger to be clamped to the burner proper 17 in the various positions of adjustment of the burner proper in the hanger.

Other desired or known adjustments for the burner construction can also be provided, such as adjustment of the burner proper into different angular positions in a vertical plane and swinging adjustment of the burner proper in a horizontal plane. However, these adjustments form no part of the present invention and accordingly need not be described herein in detail.

The operation of the burner construction is as follows:

Liquid and gaseous fuels are supplied under pressure to the liquid fuel pipe and gaseous fuel pipe 21 and 20, respectively, and at the same time cooling liquid is supplied through the pipe 41 for passage through the member 36 and the cooling passage between the pipe sections 19 and 20, from which passage the cooling liquid discharges through the outlet 42, combustion-supporting air being simultaneously supplied from the checker chamber through the heated-air uptakes, to the zone of the furnace into which the burner proper 17 projects.

The distance (depth) to which the burner proper projects into the furnace may be regulated as desired by reason of the lengthwise adjustability of the burner proper 17 in the collar 53 and strap 68 and without disturbing the adjustments of the plate 43 and the adjusting screw 63. This feature of adjustment is desirable particularly as thereby the adjustment and variation of the fuel discharge point in relation to incoming air supplied through the uptakes, to hearth, to furnace port design and dimensions, as well as other conditions which may vary in different furnaces as built, or develop during the operation of the furnaces, may be made.

Furthermore, the burner proper may be bodily removed from its mounting mechanism, as for example for repair or substitution of a new burner proper.

Removal of the liquid fuel pipe 21, together with its nozzle 34, as for example for cleaning the same, may be readily effected, as these parts may be drawn out of the burner construction at its back end upon unscrewing the plug 26 from the T 22. This also renders the gas burner pipe 20 readily accessible for cleaning, or replacement of any special nozzle inserts should any such be provided, without removing it from the burner proper construction, all of these being accomplished while the major structure of the burner proper remains mounted and in operating position within the furnace.

The telescopic arrangement of the liquid fuel and gaseous fuel pipes, the gaseous fuel pipe surrounding the liquid fuel pipe, and with the liquid supplied under pressure, causes the liquid to exert an inspirating effect on the gas thereby holding the gas against its natural tendency to rise as it travels away from the burner construction, and producing such directional effects on the gas as to prevent objectional spreading of the gas stream after leaving the burner-proper, the construction shown permitting of the varying of the relationship of the nozzle 34 to the point of outlet of the gas from the burner construction to suit different conditions by rotating the pipe 21, with its nozzle, at its screw threaded connection with the plug 26, the flexible pipe 29 having been previously disconnected from the pipe 28a. Thus the confining, siphoning or directional effects of fuel, or steam or air which may be used for directional or atomizing purposes, introduced through the pipe 21 may be varied in accordance with the densities of the fuel whether it be liquid, gaseous, or powdered, supplied through the pipe 20.

This feature has proved to be of particularly great value in a burner construction for firing an open hearth furnace for steel production as it permits of the use of liquid and gaseous fuels simultaneously throughout the firing cycle including the refining stages of the heat process when gaseous fuel application has heretofore been ineffective.

The feature of the telescopic arrangement of pipes as shown and described presents, among many advantages, those of compactness of structure and the production of such highly effective insulation between the cooling liquid passage in the burner construction and the liquid fuel pipe 21 as to avoid objectionable cooling of the liquid fuel supplied in the desired preheated condition to the burner construction, even should the structure be operated without gas flow through the pipe section 20.

A factor required to be given consideration in the designing of a satisfactory liquid-cooled burner construction for high temperature is the low capacity of water to conduct heat through its own body. This means that a minimum dependency must be placed upon the conduction of heat away from the shell to less exposed portions of the cooling water body. In previous liquid-cooled burner constructions neglect of this factor has resulted in the temperature overloading of the water adjacent to the shell and the temperature unloading of other parts of the cooling liquid.

It has been demonstrated that under any given conditions the effective cooling being supplied to the shell is more dependent upon the amount of hot surface contact per unit volume of the cooling liquid than it is upon the total volume of cooling liquid contained in the shell at any time.

In devising my burner construction I have provided for a more direct and greater amount of hot surface contact per unit volume of cooling liquid than hitherto provided. This is accomplished by the provision within the barrel and in substantially concentrically spaced relation thereto of a cylindrical member, in the particular construction shown this member being the gas-pipe section 20, which serves as a core thereby displacing cooling liquid from its least effective to a more uniformly effective cooling position, resulting in the increasing of the amount of hot surface contact per unit volume of cooling liquid and maintaining a uniformly decreased distance through which heat must travel to be distributed through the cooling liquid. As a result convection currents in

the body of cooling liquid with consequent non-uniform temperature conditions are minimized.

The feed-in pipe 41 preferably opens into the front end or nose of the burner proper as shown and described inasmuch as preferably this pipe would be of relatively small diameter and the cooling-liquid-flow therein would be very rapid under such conditions, whereby the cooling liquid enters the hottest part of the burner proper at a much lower temperature than it would if it opened into the back end of the burner proper.

It has been found that a liquid cooled burner construction in accordance with my invention for satisfactory use in high temperature furnaces may be provided of very compact form—as for example for a 150 tone capacity open hearth furnace for producing steel such as commonly provided, one such burner being used at each end of the furnace and the burners being fired alternately, even when using a gas and liquid fuel simultaneously, the outside diameter of the barrel 19 may be as small as approximately four inches—resulting in not only economy of construction, but also in ease of installation, adjustment to meet the various conditions presented, and removal of its several parts or bodily for repair and replacement, or substitution.

The permissible ratio between the total volume of cooling liquid contained within that portion of the burner construction which is exposed to the heat within the furnace and the volume of cooling liquid fed per second to such exposed portions of the burner when the working furnace temperatures are substantially 3000° F. is substantially 5 to 1 as a maximum and 1 to 1 as a minimum, the particular ratio being applied being dependent upon local conditions, as for example where the water supply is limited the higher ratio would be used even though the total life of the barrel section would be lessened but final costs more favorable.

For furnace temperatures greater than substantially 3000° F. the maximum ratio referred to would be reduced depending on the increase in the furnace temperature, but regardless of the temperature to which the furnace is fired such ratio would not be less than 1 to 1.

It will be noted that the space for cooling liquid between tubes 19 and 20 is free of obstructions of any kind such as would result if spacing spiders were employed or if the supply pipe 41 was housed in this space. This freedom from obstruction provides a shell of cooling liquid which is unimpaired by anything that would set up differentials in resistance or section or cause eddies which would interfere with the uniform flow of the liquid body. Eddies tend to cause "gaps" or stagnant points, while differences in resistance or section lead to delayed flow or locally inadequate volumes, all of which conditions have been found to inaugurate temperature overloading and the generation of steam with prompt burning of the outer tube and failure of the burner.

Another advantage due to the compactness of the burner construction is that it permits installations to be made on furnaces where clearances at the outside of the steel work of the furnace at its ends are at a minimum.

While I have made more specific reference to the use of both liquid and gaseous fuel simultaneously, it will be understood that various features of the invention may also be utilized in a burner construction in which only a single fuel passage for liquid fuel only or gaseous fuel only, is employed.

While I have illustrated and described a particular construction embodying my invention and have shown a particular construction by which my novel method may be practiced, I do not wish to be understood as intending to limit the invention thereto, as the construction shown may be variously modified and altered and the invention embodied in other forms of structure and my novel method practiced by the use of other constructions without departing from the spirit of my invention.

What I claim as new and desire to secure by Letters Patent is:

1. A liquid cooled burner comprising, in combination: coaxial fuel delivery tubes opening at a burner nozzle; an outer tube coaxial with and substantially uniformly spaced from the outermost fuel tube and free from connection therewith from said nozzle to a point adjacent the rear end of the burner, providing an unimpaired cooling liquid receiving annular space throughout the exposed-to-heat portion of the burner; a nozzle connecting a cylindrical end portion of said outermost fuel tube and the end of said outer tube at a nozzle wall curving outwardly and rearwardly from said cylindrical fuel tube portion to the end of said outer tube whereby to close the end of said annular space while providing for open and direct flow of cooling liquid in contact with said nozzle wall; a cooling liquid supply conduit exterior of said outer tube communicating with said nozzle at a passageway forming a forwardly and inwardly curving extension of the conduit; the forward wall of said passageway constituting a smooth curve with the space closing nozzle wall; and said outer tube adjacent the rear end of the burner formed with a discharge port.

2. A liquid cooled burner having at least one fuel delivery tube formed with a fuel discharge opening at the forward extremity of the burner; said burner also formed with a cooling-liquid passage internally free of structure, of substantially uniform cross section, and providing an unimpaired uniformly free liquid passage from said fuel discharge opening to the rear of the burner; the outer wall of the cooling-liquid passage constituting the outer wall of the burner; a universally curved forward end wall which closes said liquid passage and serves to curve the liquid rearwardly; a cooling-liquid supply conduit entirely external of said passage and opening thereinto substantially coincident with said curved wall to provide direct and open flow of cooling liquid across said wall and about said discharge opening; said passage having a cooling-liquid discharge port adjacent the rear of the burner.

LELAND B. LUELLEN.