

May 15, 1945.

R. A. EKSTROM, JR

2,375,840

LIQUID HEATING APPARATUS

Filed Dec. 23, 1941

5 Sheets-Sheet 1

Fig. 1.

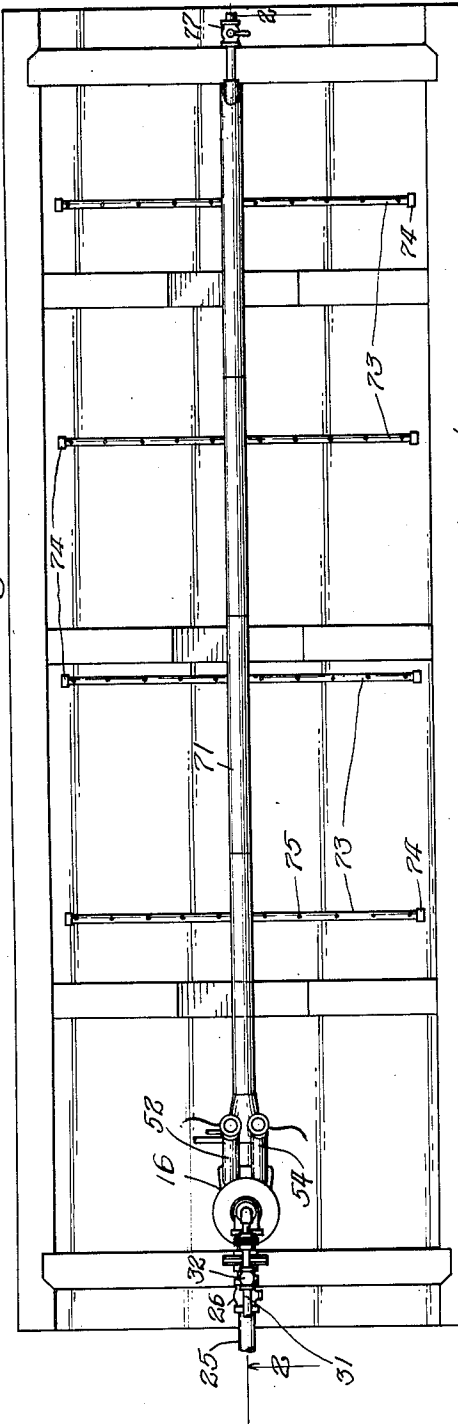
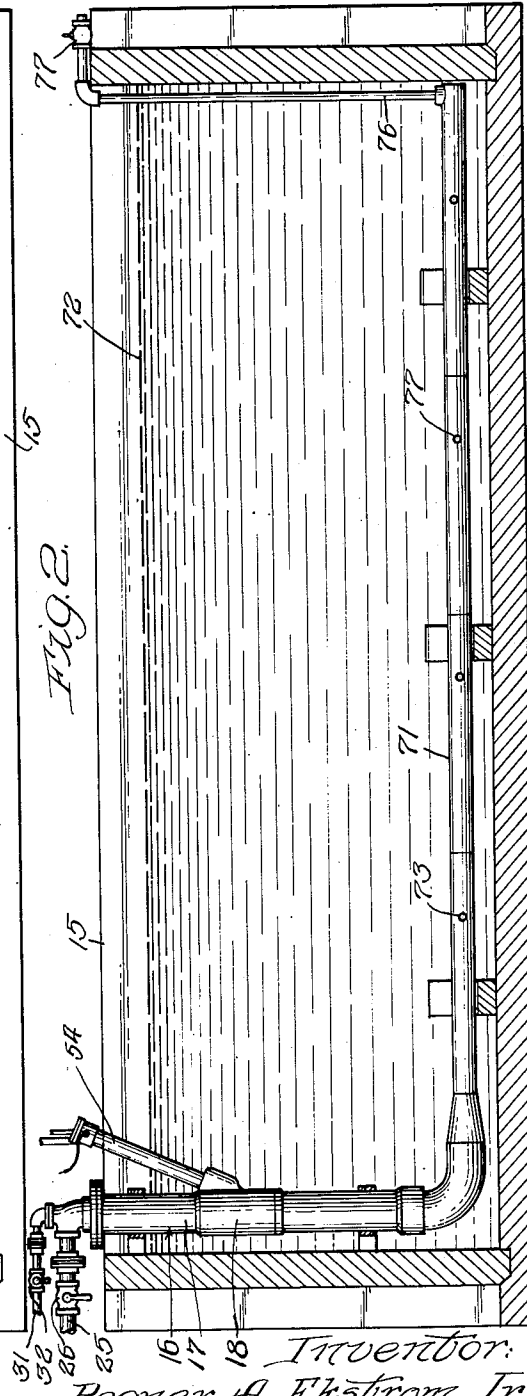


Fig. 2.



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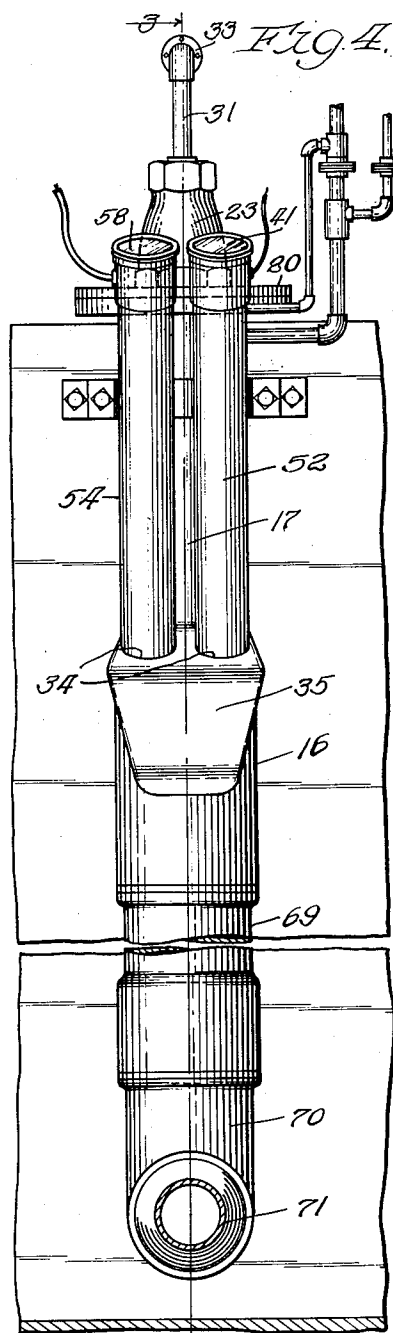
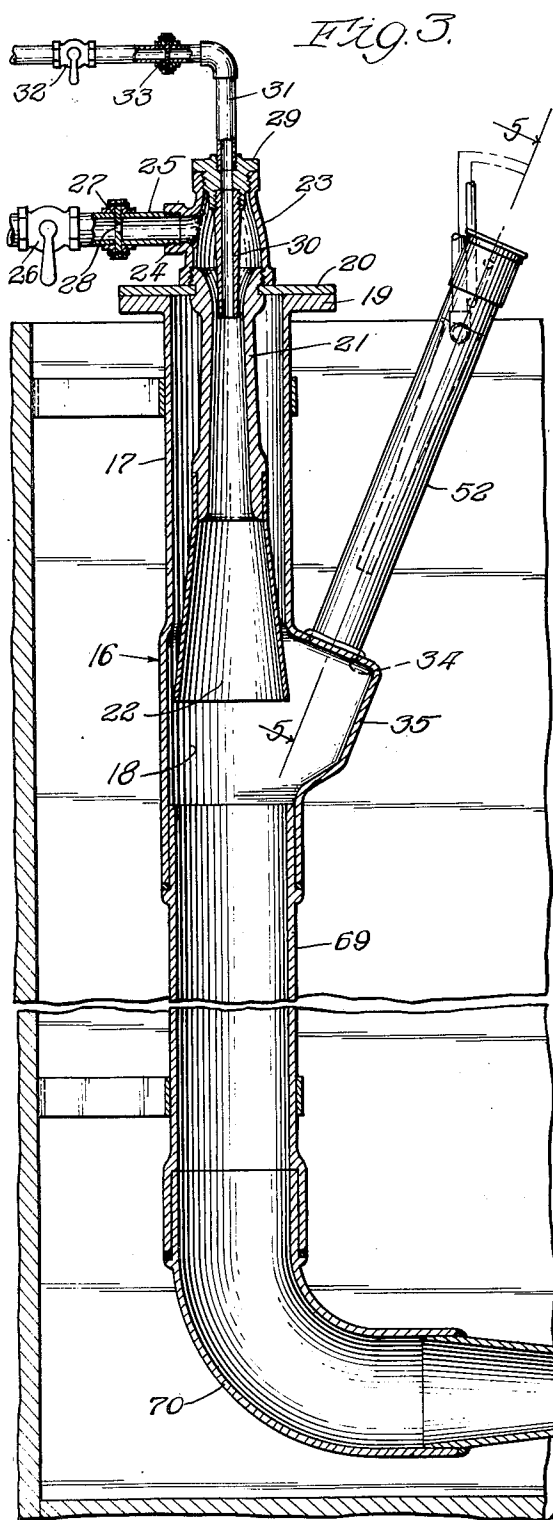
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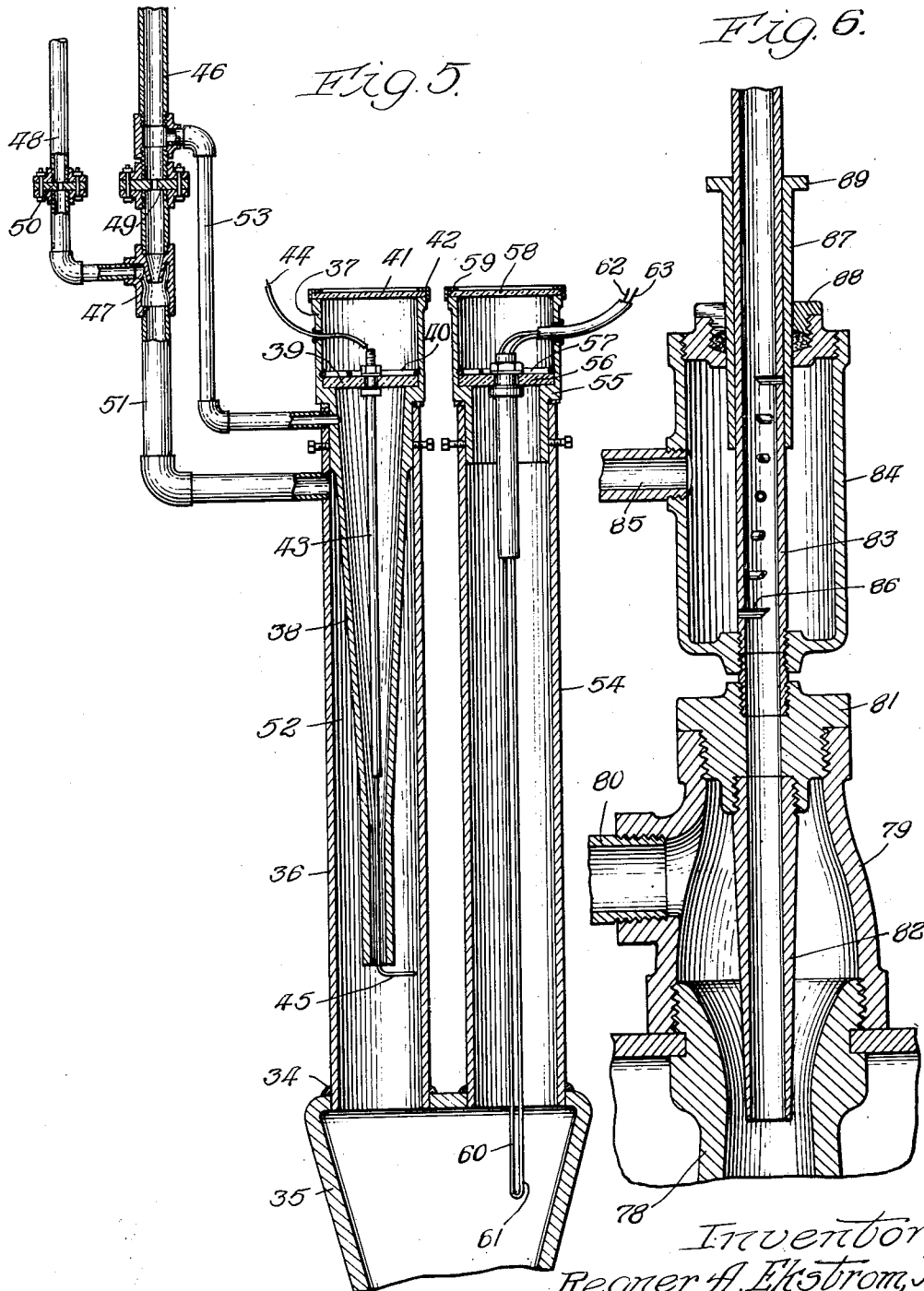
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5 Sheets-Sheet 3



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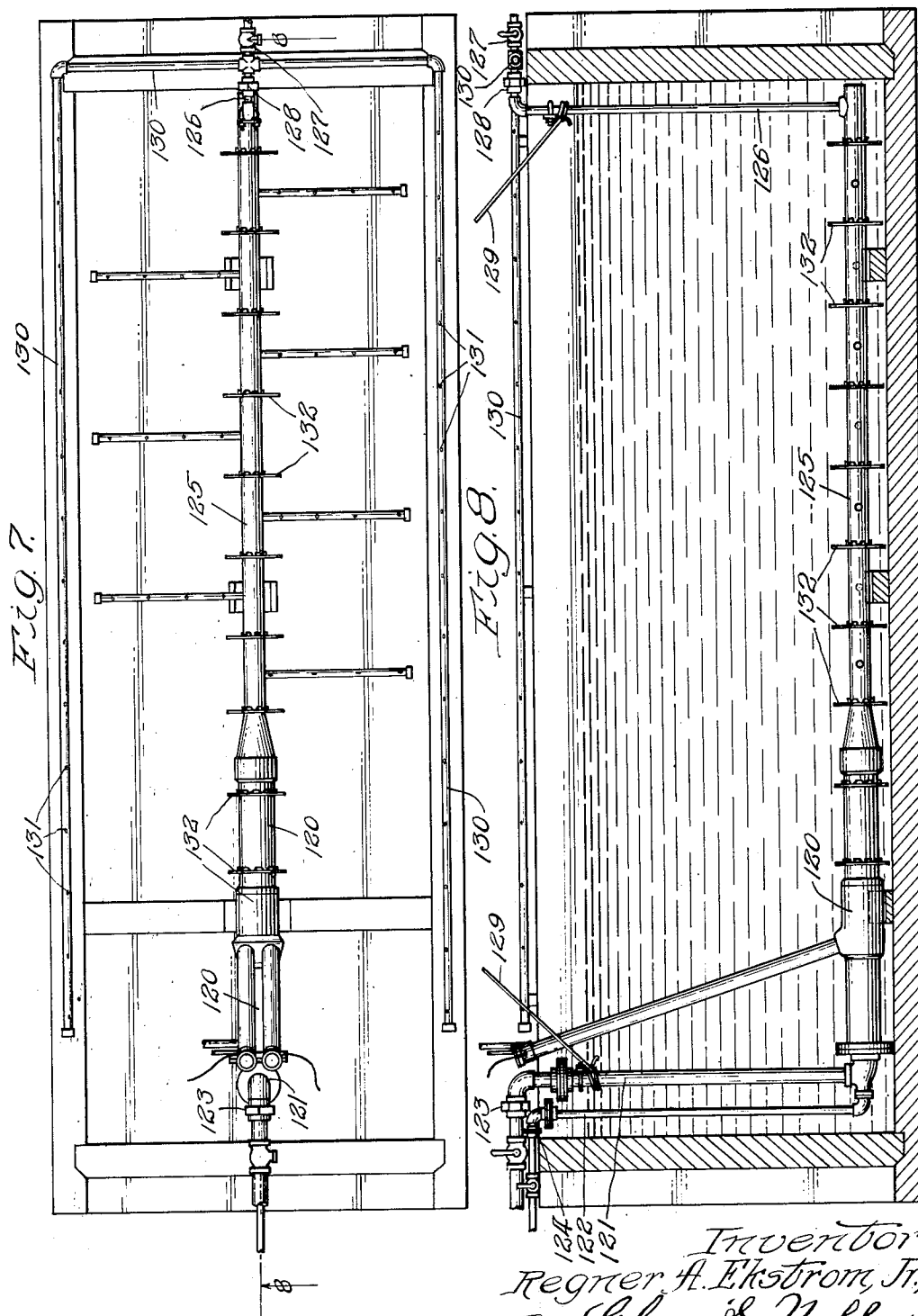
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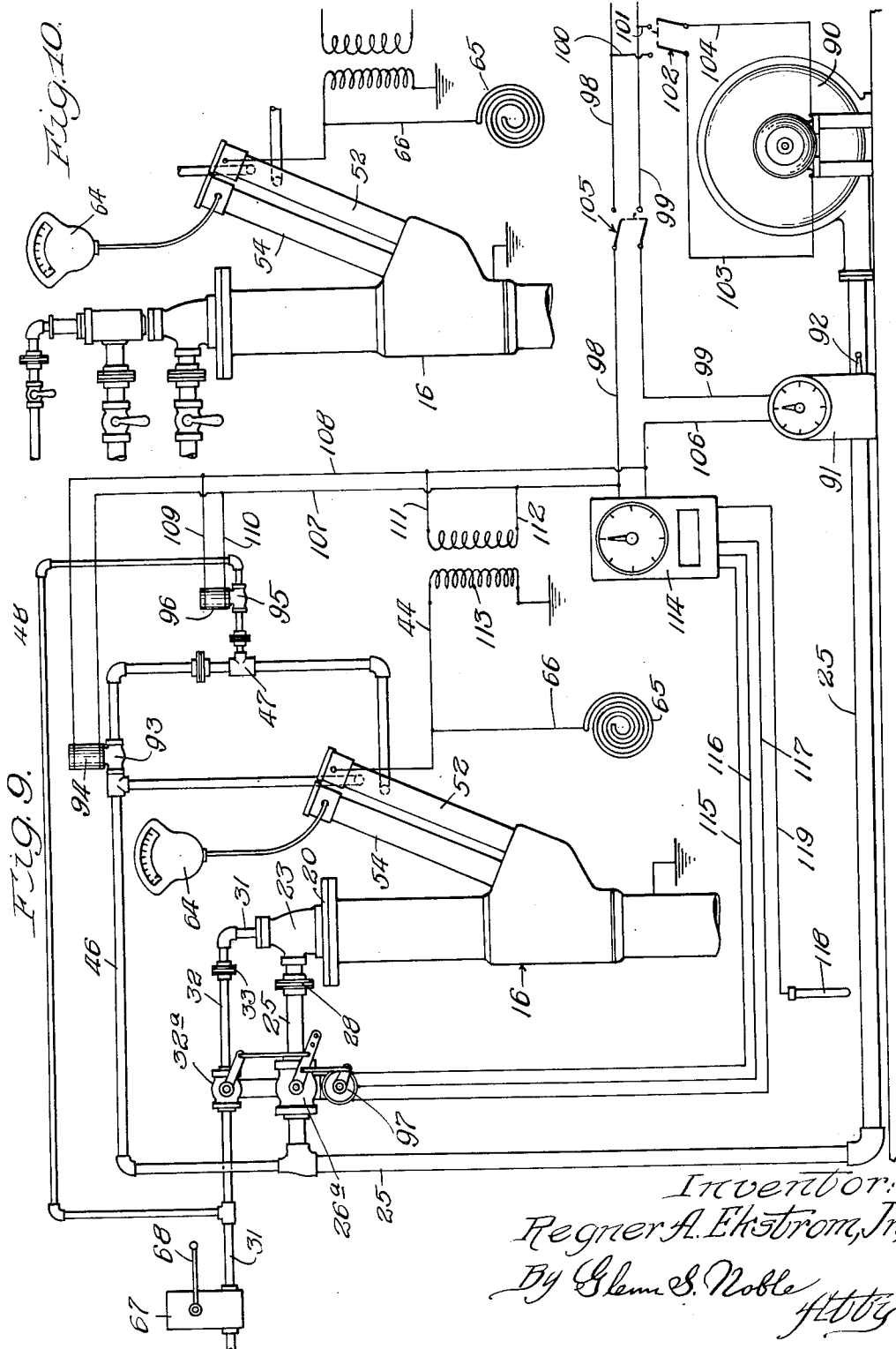
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LIQUID HEATING APPARATUS

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5 Sheets-Sheet 5



UNITED STATES PATENT OFFICE

2,375,840

LIQUID HEATING APPARATUS

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5 Claims. (Cl. 126—360)

This invention relates to an apparatus for heating liquids by means of a gas burner in which the burner or portions thereof are submerged or extend into the liquid and some or all of the products of combustion are preferably discharged into the liquid causing agitation of the same.

The principal objects of the invention are to provide an improved burner or apparatus of the character indicated which will be particularly simple in construction and durable and efficient in operation.

Other objects are to provide improved means for controlling the input of the gases to the burner; to improve the combustion characteristics of the burner and to distribute and control the output or exhaust of the gases of combustion; to provide improved means for mixing the gases and preventing danger from back-firing; to provide an improved pilot light and ignition therefor; to provide means for continuous indication of the efficiency of the flame or combustion; to provide means for visually observing the combustion or flames in the burner; to provide means for dispensing the heated or exhaust gases throughout the area of the liquid whereby the gases will be discharged at temperatures close to that of the surrounding liquid; to provide an exhaust pipe or conduit with fins to dissipate the heating; to provide an improved flame sleeve enclosing the flame which becomes heated sufficiently to maintain combustion after the burner has been started; to provide means for automatically controlling the temperature of the liquid; to provide means for increasing the temperature of the liquid without undue agitation thereof; to provide means for automatically shutting off the supply of gases to the burner if the flame becomes extinguished; to provide an improved spark ignition electrode and means to observe the operation of the spark and the flame produced adjacent thereto; to provide a neon indicator which will give continuous indication of the presence of the electric spark in the igniter and whereby the operator will know that the combustible mixture will be fired upon admission; to provide a burner which may be readily lifted out of the tank or liquid as for changing or repairs; to provide certain protective features; and to provide such other advantages and improvements as will be described more fully hereinafter.

While my improved apparatus may be used for various purposes and for heating various liquids, one of the particular uses for which it is intended is the heating of liquids used for pickling

metals such as the sulphuric acid solution used for pickling steel, and the description will be directed mainly to the burners installed for such uses.

In the accompanying drawings illustrating this invention,

Fig. 1 is a plan view of a tank such as used for pickling steel with my improved apparatus positioned therein;

Fig. 2 is a vertical sectional view taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged vertical sectional view of a portion of the tank and burner taken substantially on the line 3—3 of Fig. 4;

Fig. 4 is an elevational sectional view taken from the right hand side of Fig. 3;

Fig. 5 is an enlarged sectional view taken substantially on the line 5—5 of Fig. 3;

Fig. 6 is a sectional detail of a gas mixing and protective device;

Fig. 7 is a plan view of a tank with a modified form of the burner mounted therein;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7;

Fig. 9 is a diagrammatic view illustrating the burner and certain control, indicating, and protecting features; and

Fig. 10 is a detail showing a modified form of gas feeding means.

The tank 15 shown in the drawings represents a pickling tank but may indicate any suitable container for holding liquid to be heated. The burner indicated generally by the numeral 16 is of the Venturi type, although I prefer to use gas under substantial pressure instead of the zero or low pressure commonly used in such burners. The burner has a body portion 17 with an enlarged combustion chamber 18. The body portion has a flange 19 which is engaged by a closure disc 20 secured thereto in any suitable manner. The venturi 21 is carried by the disc or plate 20 and projects into the cylindrical part of the body portion 17 as shown in Fig. 3. The inner end of the venturi has a burner sleeve 22 secured or affixed thereto. This sleeve is preferably made of cast stainless steel and is of conical form with its larger end terminating in the combustion chamber. This sleeve is intended to attain a red heat when the burner is in operation which is sufficient to maintain combustion, and it also tends to properly form the flame.

The venturi 21 is engaged by a T or coupling head 23 having a branch or inlet 24 for the air inlet pipe 25. This pipe is controlled by the valve 26 and is also preferably provided with a trans-

verse disc or closure 27 having a reduced orifice 28. The purpose of the orifice is to prevent any undue back pressure in the supply pipe which might cause injury to the air pump or other parts.

The outer end of the coupling head 23 has a plug or closure 29 which carries the gas jet or nozzle 30 that projects into the venturi as shown. Gas is supplied to the jet by a supply pipe 31 having a controlling valve 32. This supply pipe is also preferably provided with a reduced orifice device 33 for preventing undue back pressure. In a commercial installation of my apparatus, the air is supplied at a pressure of approximately five (5) pounds per square inch, and the gas is supplied at approximately five (5) pounds per square inch, although, of course, these gases may be introduced under any desired pressures.

The combustion chamber 18 has an inlet opening 34 in the wall of a bulge or projection 35 which is preferably slightly above the inner end of the sleeve 22. One end of a pilot tube 36 engages with the inlet 34 as shown in Fig. 5. The outer end of this tube has a head 37 with a conical or tapered tubular portion or extension 38 that projects into the tube 36 as shown and terminates adjacent to the inlet 34. The outer end of the tubular portion is closed by a disc 39 preferably formed of glass or transparent material and held in position by an expansion ring 40. The outer end of the head 37 is also closed by a disc 41 preferably formed of glass or transparent material, held in position by a ring 42. The disc 39 carries an electrode or terminal 43 which is supplied with high tensioned electricity through the supply wire 44 receiving current from any suitable source.

The ignition sparks are formed between the inner or exposed end of the electrode and the adjacent walls of the extension 38 as indicated at 45.

Air is supplied through a pipe 46 to a mixing chamber 47 where it is mixed with gas supplied through a pipe 48. These pipes are preferably provided with the reduced orifice devices 49 and 50 respectively for protecting the main lines and apparatus connected therewith. The mixed gases pass from the chamber 47 through a pipe 51 which connects with the tube 36 at a point just below the head 37 as shown in Fig. 5. It will be noted that the space 52 between the tube 36 and the conical extension 38 gradually increases so that the gas mixture is progressively expanded toward the end of the extension where it is ignited by the electric spark which is preferably maintained in constant operation while the burner is in use. The burning gases pass into the combustion chamber 18 and ignite the mixture in the main burner which is supplied with air and gas as above described. After the main burner is in operation for a short time, the sleeve 22 becomes red hot and will maintain combustion in the main burner even if the electrode ceased to function. The glass discs 39 and 41 provide windows so that the operation of the ignition and pilot light may be readily seen. A branch pipe 53 leads from the air pipe 46 to the cone or extension 38 slightly below the disc 39 and provides a stream of air which is introduced to the inside of the cone to keep the insulating glass disc dry and free from moisture.

I also provide means for indicating or measuring the intensity of the gas flame in the burner. For this purpose, a tube 54 is mounted adjacent to the tube 36 with its inner end connected with the bulge or projection 35 as shown in Fig. 5.

The other end of the tube is closed by means of a head 55 which is secured therein in any suitable manner. A glass disc 56 is mounted in the head 55 and held against a shoulder therein by means of an expansion ring 57. The end of the head 55 is closed by means of another glass or transparent disc 58 which is held in position by a ring 59. The disc 56 serves as an insulating support for a pair of thermocouple wires 60 and 61 which preferably extend into the projection 35 for a short distance beyond the end of the tube as shown. The thermocouple wires are connected in the usual manner by means of wires 62 and 63 to an instrument 64 (Fig. 9) of the type commonly used for pyrometers but which is preferably calibrated to indicate the burner efficiency. The thermocouple wires preferably do not extend into the main flame of the burner but are adapted to measure the confined heat in and around the burner. This heat is directly proportional to the amount of gas and air being properly burned. The instrument 64 serves as a "B. t. u." indicator and shows when the flame is hottest for any given setting of the air and gas and in this way is a true indicator of burner efficiency. The sight opening provided by the discs 56 and 58 permits visual inspection of the flame in the main burner whereby the operator may readily see the actual conditions of combustion.

As a further means for readily indicating the spark or ignition operation, I provide a neon tube 65 (Fig. 9) which may be mounted on an instrument panel and is preferably of spiral form. One end of this tube is connected to the high tension terminal or circuit by means of a wire 66 while the opposite end is not connected. When the ignition is operating, the gas in the neon tube is thereby excited, causing a progressive undulating light around the spiral which is readily visible to the operator from a considerable distance. If the current is flowing and the electrode does not spark, the neon spiral will glow uniformly. If the spark electrode circuit fails or is short-circuited, the neon spiral will fail to glow or be illuminated. The use of a neon tube for indicating the condition of an ignition system provides a particularly desirable feature and is entirely novel.

The gas inlet pipe 31 may also be provided with an additional safety device comprising an automatic valve 67 which will close automatically upon failure of the gas pressure and which can only be opened manually as by means of a lever 68, such automatic valves being of well known construction.

The combustion chamber or body of the burner connects with a pipe or burner housing extension 69 which in turn is connected by means of an elbow 70 with a horizontal discharge pipe 71. The discharge pipe is supported adjacent to the bottom of the tank as shown in Fig. 2 and may be provided with holes for discharging the heated gases or gases of combustion directly into the liquid to be heated as shown at 72. When the burner is to be used for pickling tanks for pickling steel, in which the liquid is dilute sulphuric acid, I have found that such direct discharge into the liquid is apt to be objectionable as causing too great agitation for ebullition and that it is preferable to distribute the discharge more uniformly throughout the bottom of the tank. For this purpose, I provide branch pipes or ducts 73 which lead from the main discharge pipe 71 outwardly or to the sides of the tank. These pipes are closed at their outer ends by caps or plugs 74

and are provided with large number of small discharge holes 75 whereby a small quantity of gas will be discharged from each opening and the gas will be uniformly distributed throughout the area of the tank. This will tend to permit cooling of the gases or transfer the heat to the liquid so that the gases will be at substantially the same temperature as the liquid when they escape to the atmosphere.

The outer end of the pipe 71 is connected with a riser pipe 76 which extends to the top of the tank and is provided with a valve 77 for controlling the exhaust from the pipe to the atmosphere. This exhaust pipe and valve serves to control the agitation in the tank as by opening the valve, the pressure in the outlet ducts will be reduced and by closing the valve, the pressure will be increased, thereby increasing the volume of the gas which escapes into the liquid. This control outlet also serves to regulate the B. t. u. output of the burner and serves to exhaust the products of combustion over and above the amount required for agitation and permits the combustion of larger quantities of gas and air to raise the temperature of the liquid. It is important to know that in an apparatus of this type, the temperature ceiling is limited by the agitation for the reason that as a hotter flame is produced, the products of combustion are increased and if allowed to discharge through the liquid causing excess agitation, the increased amount of evaporation absorbs the heat gain, thus limiting the attainable heat to about 150° F. regardless of the amount of combustion. By means of my atmosphere exhaust, air and gas can be burned to the full capacity of the burner and the main portion of the products of combustion exhausted directly into the air using only a small portion for agitating the liquid. In this way, the temperature can be raised to approximately the boiling point or any desired degree and the amount of agitation easily controlled. Undue agitation caused by excess exhaust in pickling tanks is also hazardous as the liquid is apt to be thrown out with a possible causing of acid burns to the workmen. My cooling and dispersing ducts permit control of the size of the bubbles rising from the distribution pipes, keeping them small in size and in intimate contact with the solution, thereby transferring the greatest amount of heat possible to the solution.

It will be particularly noted that a large portion of the burner and the pipes of the exhaust system are subjected to intense heat and also to the action of the dilute sulphuric acid when the burner is used in a pickling tank and the acid will flow back into the system when the burner is not in operation, so that the inside as well as the outside will be subjected to such action. For this reason, it has been found difficult to secure suitable material for such parts. I have, however, discovered that a composition containing chromium 15%, nickel 50%, molybdenum 20% and in some cases, tungsten, manganese, silicon, carbon or iron. These alloying elements are adjusted or varied as desired, and in some cases, aluminum bronze may also be used.

When the burner is to be operated, the valve 26 will be opened and air will be forced into the system, thereby driving the liquid out of the burner and parts connected therewith. Current will be supplied to the ignition electrode preparatory to introducing the combustible mixture to the pilot. When such mixture is admitted

through the pipe 51, it will be ignited and the flame will extend down into the combustion chamber 18. Thereupon the main gas supply will be admitted through the pipe 31 and combustion will occur in the burner to the products being exhausted through the exhaust system above described. When the pilot light and burner are in operation, the combustion may be observed through the sight openings provided by the tubes 36 and 54 and the neon tube will also indicate the condition of the spark so that the entire operation is well under the observation and control of the operator. This is particularly important in view of the comparatively large amount of gas used and the consequent possibility of danger in the event of failure of operation.

In the pickling of steel, it has been found that the proper agitation of the pickling liquid will greatly expedite the pickling operation. The action is also particularly effective when the liquid is heated to the desired temperature which may be effectively and economically done with my improved burner.

In the arrangement shown in Figs. 6 and 10, the mixture of gas and air is supplied to the burner nozzle and a secondary stream or supply of air is also provided which enters the burner head around the nozzle. As shown in these figures, the venturi 78 which is similar to the venturi 21 is connected with a burner head 79 having an air inlet pipe 80. The burner head is closed at its upper end by a plug or closure 81 which carries the nozzle 82 that projects down into the venturi in the usual manner. A pipe 83 extends upwardly from the plug 81 as shown in Fig. 6 and passes through the chamber 84 which is supplied with gas through an inlet pipe 85. The gas passes from the chamber 84 into the pipe 83 through a series of jets 86, the ends of which are beveled or tapered as shown. The amount of gas entering the pipe may be regulated by means of an adjustable sleeve 87 which fits closely over the pipe 83 and extends outwardly through a gland or packing 88 and has a flange 89 at the upper end thereof. Air at high pressure is supplied to the pipe 83 and as it passes inwardly over the tapered ends of the jets 86, will entrain the desired amount of gas for proper combustion which amount may be regulated by opening or closing more or less of the jets by means of the sleeve 87. The auxiliary or additional air supply through the pipe 80 is in excess of the air required for combustion and its purpose is to keep the burner ducts clear when the combustible mixture of air and gas is shut off. In actual practice, the secondary stream supplies some of the air for combustion and will dilute the mixture if it is too rich. This will effect more perfect and dependable ignition and combustion. The beveled ends of the jets which extend into the high pressure air stream, provide a low pressure on the lower or feed side, so that the gas will be drawn in and be thoroughly mixed with the air. These small ports also prevent or eliminate back pressure which might cause explosive concussions to carry back to the gas pressure regulator and compressor. Such back pressure would be apt to cause damage to these devices.

While Fig. 10 shows the main operating parts of the burner of the gas mixer just described, arranged for manual control or operation, Fig. 9 illustrates the form first described but provided with automatic control and safety devices.

This figure shows a motor driven blower or compressor 90 which supplies air to the supply pipe 25. This pipe is provided with a control device 91 commonly known as a pressurestat which will open the circuit in the main supply line if the air pressure falls below a predetermined point. This device has a lever 92 for manually closing the circuit.

The air supply pipe 46 which leads to the mixing T 47 has a shut off valve 93 which is operated by a solenoid 94. The gas pipe 48 is provided with a shut-off valve 95 which is actuated by a solenoid 96.

The gas intake valve 32^a and the air intake valve 26^a are operatively connected with a motor 97 which is adapted to simultaneously open and close the valves, such motor operated valves being in common use.

Current is supplied for all of the electro-responsive devices from main supply wires 98 and 99. Branch wires 100, 101 lead from the main wires to a switch 102 which is adapted to open and close the circuit through the wires 103 and 104 to the motor of the blower or turbine 90. A switch 105 is positioned beyond the motor switch and controls the main circuit. The wire 99 leads directly to the pressurestat 91 and the circuit is continued from the pressurestat through wire 106. Wires 107 and 108 lead from the wires 98 and 106 respectively to the solenoid 94. Branch wires 109 and 110 lead to the solenoid 96 as shown. Branch wires 111 and 112 lead to the transformer 113 which supplies current for the ignition electrode. The wires 98 and 106 lead to a thermostatic controlled instrument 114 which is of common or well known construction and which serves to control the operation of the motor 97. Three wires 115, 116 and 117 lead from the thermostatic instrument 114 to the motor. A bulb 118 is inserted in the liquid in the tank and operates the thermostat through a suitable connection 119. This arrangement is such that when the temperature in the bulb reaches a predetermined amount, the thermostat instrument will close the circuit to the motor 97 which causes the same to close the valves 26^a and 32^a, thus cutting off the supply to the main burner. When the temperature of the bulb falls to a predetermined degree, another circuit to the motor is closed, causing the motor to again operate and open the valves, thus again supplying gases to the main burner. The solenoids 94 and 96 will hold their respective valves open when current is supplied, but in the event of failure of current, these valves will automatically close, thus providing a desirable safety feature for the pilot.

The apparatus shown in Figs. 7 and 8 is substantially the same as that just described, but in this form of the invention, the entire burner 120 is positioned horizontally on the bottom of the tank and the air supply pipe 121 and gas pipe 122 lead up to the top of the tank where they are provided with couplings 123 and 124 so that they may be readily disconnected. The burner is connected directly with the discharge or outlet pipe 125 as shown. The outer end of this pipe or conduit is connected with a riser pipe 126 having a control valve 127 and also having a coupling 128 so that it may be readily disconnected. In the event that any repairs or replacements are needed, the couplings to the several pipes may be disconnected and the entire burner and parts connected therewith may be raised out of the tank by means of ropes or cables 129 fastened to the pipes 121 and 126.

The steam which is formed when water is heated in tanks such as used for various commercial purposes often becomes highly objectionable. In the operation of pickling tanks or other tanks for cleaning or treating metals, the steam or vapor is often particularly objectionable and destructive as it may contain some of the acid or alkali used in the bath. While my improved apparatus will prevent excessive discharge of steam or vapor, there will, of course, always be some formed when the liquid is heated to operating temperatures. I have discovered that such steam or vapor may be reduced or dissipated by subjecting the same to a blast or current of dehydrated air or hot gases such as the gases of combustion. When a blast of such gases is directed against the vapor rising from the evaporation, the vapor is dissipated. This apparently is caused by the greater absorptive quality of the heated and dried gases, but in any event the dissipation of such vapor is highly desirable. In utilizing this principle in the present apparatus, I provide the pipe 126 with branches or extensions 130 which will be around the top of the tank and are provided with holes 131 directed inwardly over the liquid. Any moisture or vapor arising from the liquid may be subjected to the dehydrated air and gases of combustion being discharged through the pipe 126 and will be dissipated as by absorption, or the like.

The discharge pipe 125 is shown in Figs. 7 and 8 as being provided with radiation fins or discs 132 which may be cast integrally therewith or may be applied thereto in any well known manner. These fins or such additional radiation or heat transfer devices are intended particularly for use in heating cleaning baths, or the like, containing various chemicals or cleaning compositions. The fins tend to quickly dissipate the heat from the pipe or conduit and keep its temperature close to that of the surrounding liquid thereby preventing chemical disassociation of the constituents dissolved in the liquid.

I claim:

1. In an apparatus of the character set forth, the combination of a combustion chamber, a pipe for conducting the gases of combustion below the surface of a liquid to be heated, means for discharging some of the gases of combustion from said pipe into the liquid, an outlet pipe extending from the first named pipe above the surface of the liquid, a valve for said outlet pipe and means for directing the discharge gases from the outlet pipe over the surface of the liquid for dissipating vapor caused by the heating of the liquid.

2. In an apparatus for heating liquids, the combination of a burner having a combustion chamber, a pilot tube leading from the combustion chamber to a point above the level of the liquid which is being heated, an electric spark igniter for lighting fuel in the pilot tube and keeping it lighted, and means for indicating the operation of the spark, comprising a neon tube and a wire connecting one end of the tube with the igniter circuit whereby the gas in the tube will be caused to produce a light when the igniter is in operation.

3. A burner of the character set forth, particularly adapted for heating large quantities of liquids including a body portion having a combustion chamber and closed at one end, a venturi secured to the closed end and projecting inwardly into the body portion and having a sleeve portion extending into the combustion chamber, said

sleeve portion being adapted to become sufficiently heated when the burner is in operation, to maintain combustion, means for supplying air to the venturi, a gas nozzle projecting into the venturi, means for supplying gas to said nozzle which is mixed with the air in the venturi, electric ignition means for igniting the gas and air in the combustion chamber and a discharge conduit leading from the chamber beneath the liquid to be heated, the arrangement being such that after the burner has been lighted, the projecting sleeve portion will become sufficiently hot to maintain combustion without the use of the electric ignition means.

4. A submerged burner for heating and agitating liquids comprising in combination a combustion chamber, a conduit leading from the combustion chamber for a substantial distance along below the surface of the liquid to be heated, outlet orifices spaced apart along the conduit for discharging gases of combustion into the liquid

to heat and agitate the same, an outlet pipe extending upwardly from the end of the conduit farthest from the combustion chamber to a point above the surface of the liquid, a valve for said outlet pipe, and means for carrying the gases discharged from the upper end of said pipe over the surface of the liquid and discharging them over said surface to dispel the vapor caused by the heating of the liquid.

5. The combination with a burner having a combustion chamber, of means for supplying fuel and air to said chamber, a pilot tube opening into said chamber, means for supplying air and fuel to said pilot tube to maintain a pilot light, an electric spark igniter coacting with the pilot tube for igniting the fuel in said tube and keeping the pilot lighted, means for supplying electric current to the igniter, and a gas tube having one end connected with the circuit to the igniter and serving to indicate the operation of the igniter.

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