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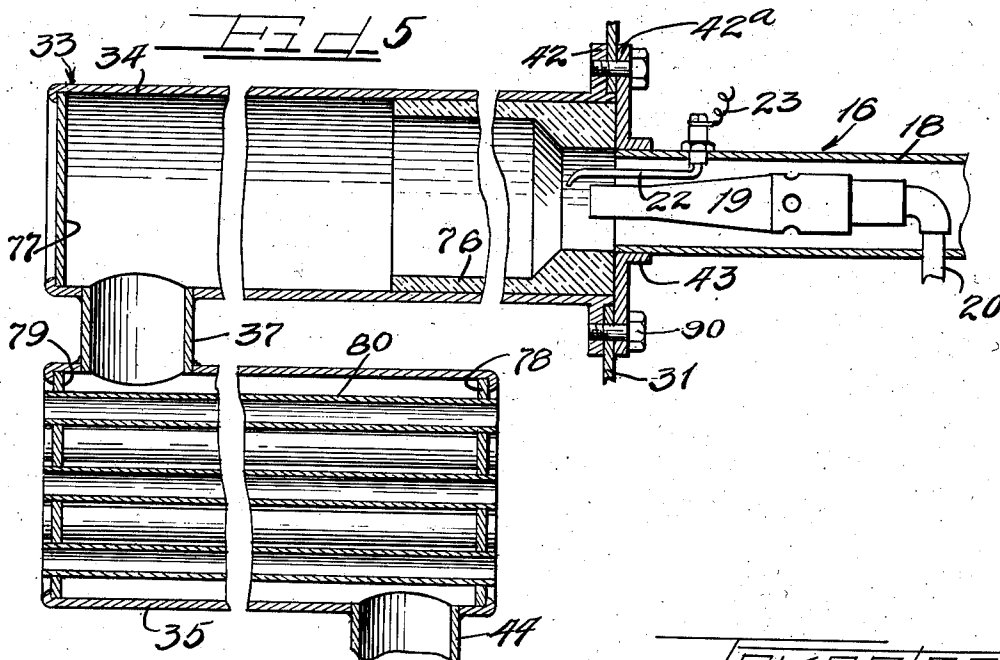
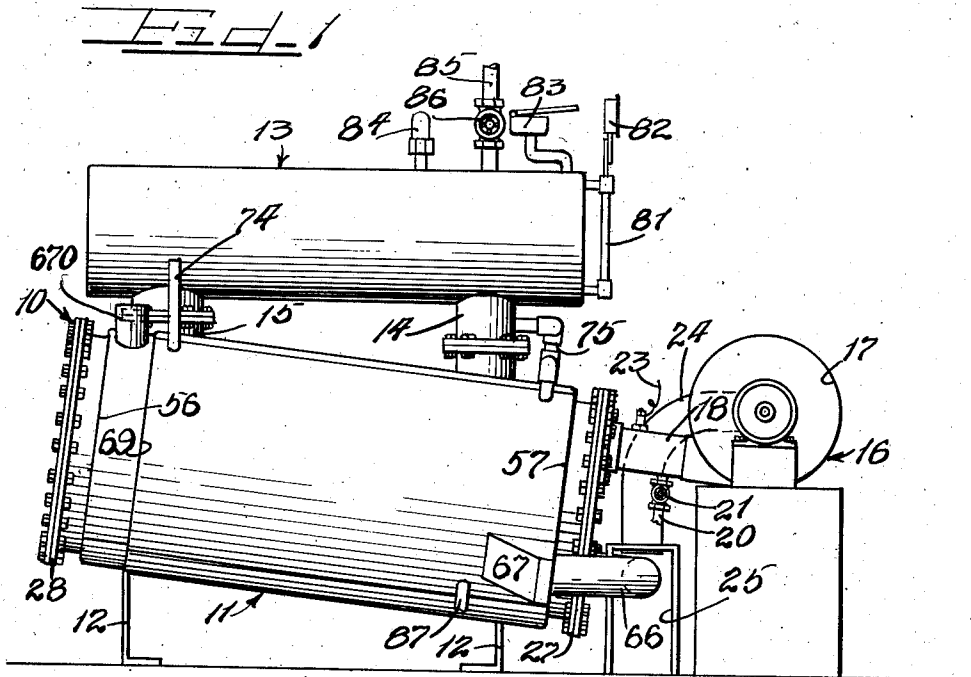
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2,232,546

INTERNALLY FIRED WATER TUBE TYPE BOILER

Filed Feb. 6, 1939

4 Sheets-Sheet 1



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Feb. 18, 1941.

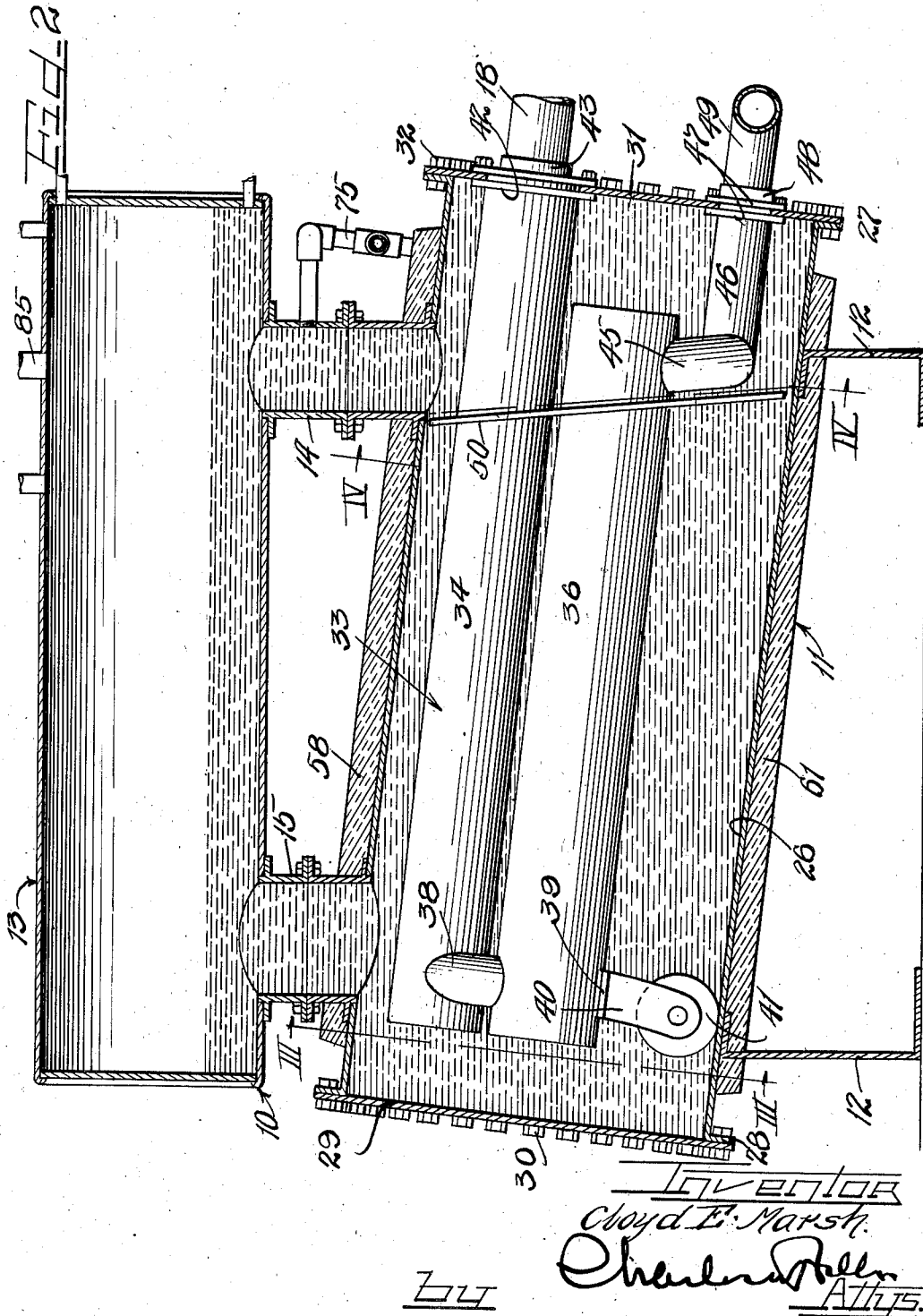
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INTERNALLY FIRED WATER TUBE TYPE BOILER

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Feb. 18, 1941.

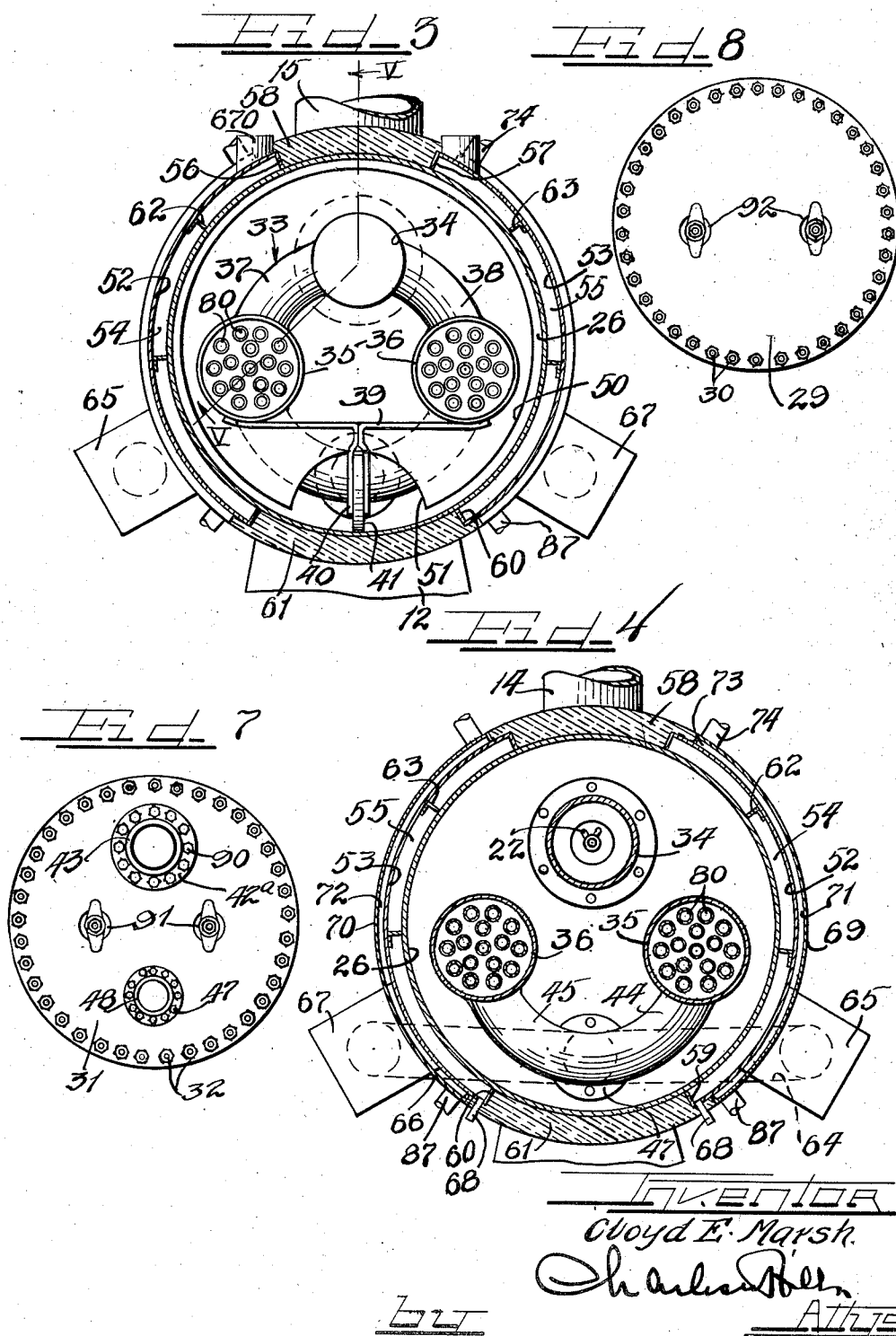
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INTERNALLY FIRED WATER TUBE TYPE BOILER

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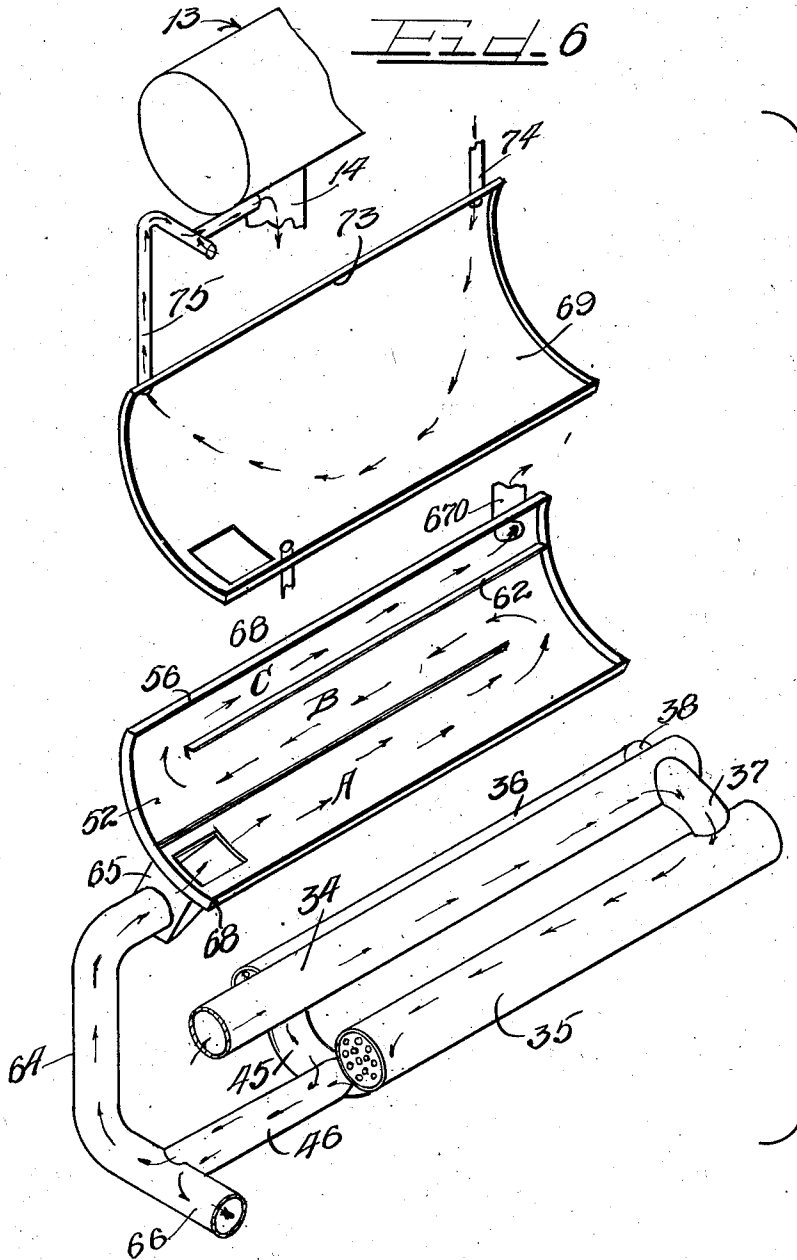
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INTERNALLY FIRED WATER TUBE TYPE BOILER

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,232,546

INTERNALLY FIRED WATER TUBE TYPE
BOILERCloyd E. Marsh, Wichita, Kans., assignor to The
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Application February 6, 1939, Serial No. 254,815

5 Claims. (Cl. 122—148)

This invention relates to an internally fired water tube type boiler, and more particularly to certain improvements over the construction of boiler disclosed in the Watson Patent No. 2,110,432, dated March 8, 1938.

Through extended research on the effect of constructional changes, I have been able greatly to increase the efficiency and practicability of the type of boiler shown in that patent. One of the novel features of construction embodying my present invention is the provision of a removable unitary heating element assembly mounted from the front head of the boiler shell and having at its rear end a dependent roller resting directly upon the shell. This arrangement makes it possible to roll out the entire heating element assembly by simply unbolting the front head of the boiler. However, even this simple operation is rendered unnecessary in most instances, because of other novel features of construction that permit the cleaning and replacement of the water tubes without removal of the heating element assembly.

A feature contributing to the high heat efficiency of my boiler is the provision of a plurality of concentric shells, or jackets, about the boiler shell to define an intermediate gas space for the passage of waste flue gases and an outer water space within which feed water for the boiler may be preheated by absorption of the residual heat of the flue gases before being vented to a stack. By this arrangement the temperature of the flue gases entering the stack is brought to a very low point, such that a very large proportion of the latent heat of vaporization of the steam resulting from the combustion of hydrogen in the fuel can be utilized in the preheating of the boiler feed water. To the best of my knowledge, it has not heretofore been possible in steam boiler construction to utilize such a large proportion of the sensible and latent heat of the gaseous products of combustion as is accomplished by the operation of my boiler.

I have also been enabled, by positioning the combustion chamber above the water tube casing and by a novel baffle arrangement, to increase greatly the velocity of convectional flow of water through the boiler system, and hence the heat efficiency of the boiler.

It is therefore an important object of this invention to provide an internally fired water tube type boiler of improved construction embodying the novel features to which reference has been made above.

Other and further important objects of this in-

vention will be apparent from the disclosures in the specification and the accompanying drawings.

This invention (in its preferred form) is illustrated in the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is a side elevational view of a boiler installation embodying the principles of my invention.

Figure 2 is a longitudinal sectional view of the boiler shown in Fig. 1, with parts broken away and parts in elevation.

Figure 3 is a sectional view taken substantially along the line III—III of Fig. 2.

Figure 4 is a sectional view taken substantially along the broken line IV—IV of Fig. 2.

Figure 5 is an enlarged, broken sectional view taken substantially along the broken line V—V of Fig. 3, with parts in elevation.

Figure 6 is an exploded, or diagrammatic view, illustrating the path of flow of combustion gases and of boiler feed water.

Figures 7 and 8 are elevational views of the front and rear heads, respectively, of the boiler shell.

As shown on the drawings:

The reference numeral 10 (Figs. 1 and 2) indicates generally an internally fired water tube type of boiler embodying the principles of my invention. Said boiler 10 comprises a lower steam generating unit 11, mounted in a rearwardly and upwardly inclined position upon supporting members 12, and an upper steam separating unit 13, connected to said steam generating unit 11 by a downtake pipe 14 adjacent the front end of the boiler and an uptake pipe 15 adjacent the rear end of the boiler.

The boiler of my invention is particularly adapted to burn liquid or gaseous fuels, such as oil or gas. As illustrated, the boiler 10 is shown with an oil burner, indicated generally by the reference numeral 16. Said oil burner 16, which may be of conventional or any suitable construction, comprises an air blower 17 having a discharge connection into an air duct 18, which latter also serves as a housing for a burner nozzle 19, into which oil is introduced through a pipe 20 having a valve 21. A pair of electrodes 22, connected to a suitable source of electrical current by means of leads 23, serves to ignite the air-fuel mixture when starting up the burner. The air intake for the blower 17 comprises a conduit 24 extending into a housing 25 positioned at the front end of the boiler and serving a purpose that will later be explained.

The steam generating unit 11 comprises an inner cylindrical boiler shell 26 (Fig. 2) having flanged ends 27 and 28 at the front and rear of the boiler, respectively. A plate 29 is bolted to the rear flange 28, as by means of bolts 30, to constitute a closed head therefor. At the front end, a similar plate 31 is bolted to the flange 27 by means of bolts 32 to constitute a removable front head for the boiler.

Within the shell 26 is mounted a removable unitary heating element assembly, indicated generally by the reference numeral 33. Said assembly 33 comprises a cylindrical combustion tube or casing 34 and a plurality of water tube casings, such as the pair of casings 35 and 36 (Figs. 3 and 4). In large installations, two combustion tubes may be employed and the number of water tube casings may be increased as required. Said water tube casings 35 and 36 are connected near their rear closed ends to the combustion tube 34 by means of relatively short, curved conduits 37 and 38, respectively. Said conduits enter the cylindrical walls of said water tube casings at points spaced slightly from their rear ends so that the hot combustion gases do not impinge directly against the tube ends. The life of the water tubes is lengthened by my arrangement. The water casings 35 and 36 are at a lower level than that of the combustion tube casing 34 and the axes of all three are preferably symmetrically arranged with respect to a common center. The rear end of the heating assembly 33 is supported upon a carriage 39 having a dependent forked bracket 40 in which is journaled a roller 41 that rests directly upon the inner wall of the shell 26.

At its front end, the combustion casing 34 extends through the front head 31 (Fig. 5) and is provided with an integral inner annular flange 42. Said flange 42 abuts against the front head 31 and is secured thereto by bolts 90 passing through an outer flanged fitting 42a, the head 31 and said flange 42. Said outer fitting 42a has a flanged opening 43 adapted to telescopically receive the end of the air duct 18 of the burner 16. Each of the water tube casings 35 and 36 is connected by means of branch conduits 44 and 45, respectively, with a main conduit 46 that extends outwardly through the front plate 31 and is secured in said plate 31 by means of inside and outside flanges 47. The projecting end 48 of said outside flange 47 is adapted to telescopically receive a return bend conduit 49, which will later be described.

From the foregoing description it will be apparent that the unitary heating element assembly 33 may readily be removed, either entirely or partially, for inspection or repairs by merely unfastening the bolts 32 and rolling the assembly out over the interior of the shell 26. However, it is not generally necessary for most purposes even to remove the heating element assembly. As shown in Figs. 7 and 8, both the front and rear heads are provided with pairs of removable man-hole covers 91 and 92, respectively, which are in alignment with the water tube casings 35 and 36, so that it is a relatively simple matter to insert rotary tube cleaners through the openings provided when said covers are removed and clean out the water tubes. If a water tube has to be removed, the rear head 29 can be unbolted and removed, and a worker can enter the boiler shell through the rear end. Alternatively, or in addition to removing the rear head, the front head 31 and the flanged fittings 42a and 47 may be unbolted, and the front head moved away suffi-

ciently to permit entrance of a worker through the opening so provided.

When in position within the boiler, the rear end of the assembly unit 33 is entirely supported by the roller 41 from the shell 26. This arrangement compensates for expansion and contraction of the unit without any strain upon the metal. The front end of the assembly unit 33 is secured in and supported by the front head 31 of the boiler so as to be removable therewith, as already described. No other means for supporting the heating element assembly 33 is required, but a baffle 50 is provided that does, in some measure, serve to support the forward ends of the water tube casings 35 and 36 from the combustion casing 34.

Said baffle 50 comprises a circular plate having openings for receiving said casings 34, 35 and 36 and having a lower cut out portion 51. The baffle 50 is preferably positioned at a slight inclination downwardly and forwardly so that its top edge is rearwardly of the downtake pipe 14 and its lower edge is rearwardly of the conduits 45 and 44. The cut out portion 51 permits the convective flow of water through the boiler from the front to the rear, as will be more fully described hereinafter.

As best shown in Figs. 3, 4 and 6, a pair of segmental cylindrical plates 52 and 53, concentric with the inner boiler shell 26, are mounted upon opposite sides thereof in spaced relation to said shell 26 to form gas spaces 54 and 55, respectively. Said plates 52 and 53 do not extend for the full length of the boiler shell 26 but terminate near the rear end as at 56 and near the front end as at 57 (Fig. 1). As a matter of economy in the construction of the boiler, the plates 52 and 53 do not extend completely about the circumference of the shell 26 but are spaced apart at the upper side of the shell by a distance somewhat greater than the diameters of the downtake pipe 14 and uptake pipe 15, and are similarly spaced apart at the lower side of the shell by a distance somewhat greater than the width of the supporting stand 12. The plate 52 is provided along its upper edge with a spacing flange 56, and the plate 53 with a spacing flange 57, between which a layer 58 of heat insulating material protects the otherwise exposed portion of the boiler shell 26. Similarly, the plate 52 is provided along its lower edge with a spacing flange 59 and the plate 53 along its lower edge with a spacing flange 60, between which there is applied a layer 61 of insulation material to protect the boiler shell 26.

Each of the plates 52 and 53 carry a plurality of longitudinally extending ribs 62 and 63, respectively, which may suitably be angle irons welded to said plates 52 and 53. Said angle irons 62 and 63 have radially projecting legs of sufficient width to project against the outer surface of the boiler shell 26 and thus partition off the gas spaces 54 and 55 into parallel channels. As best shown in Fig. 6, the ribs 62 do not extend the full length of the plate 52, but are so arranged as to provide a serpentine path for the flow of gases from one end of the boiler to the other and back again in a plurality of horizontal passes. The ribs 63 are similarly arranged with respect to the plate 53.

The return bend conduit 49, which was previously described as being connected to the main gas conduit 46 from the water tube casings 35 and 36, is provided with two branches, one branch 64 being connected into a fitting 65 mounted externally upon the lower front face of the plate 75.

52, and the other branch 66 connected to a similar fitting 67 mounted upon the lower front face of the plate 53. Since the arrangement is symmetrical with respect to the vertical plane passing through the axis of the boiler, only one of the gas conduit connections need be explained. As best shown in Fig. 6, the gas conduit 64 enters the external fitting 65, which opens into the lower horizontal path, designated by the letter A, formed by the lower rib 62 within the gas space 55. The flow of gases is in the direction of the arrows, around the end of the lower rib 62 and along the intermediate path B toward the forward end of the boiler, and thence around the forward end of the upper rib 62 and back along the horizontal upper path C to the rear end of the boiler, where there is a vent 670 leading to a stack for the exhaust flue gases. In order to maintain substantially the same velocity of flow of gases, the width of the horizontal passes A, B, C are progressively less to compensate for the contraction of the gases due to cooling during their passage from the entrance fitting 65 to the vent 670. A condensate drain pipe 68 is positioned at the lowermost forward corner of the plate 52 to drain any water from the gas space 54 that may be condensed out of the flue gases.

A second pair of concentric plates 69 and 70 are positioned about the plates 52 and 53, respectively, in spaced relation thereto to provide water spaces 71 and 72, respectively (Fig. 4). The plates 69 and 70 being identical, the construction of plate 69 alone will be explained. Said plate 69 (Fig. 6) is provided with a marginal intumed flange 73 extending around all four edges thereof and arranged to fit tightly against the outer surface of the plate 52. A feed water intake pipe 74 enters the plate 69 near the rear upper corner thereof for the introduction of boiler feed water into the water space 71. The cold feed water passes into the water space in a generally downward direction, as indicated by arrows in Fig. 6, and thence, as it becomes heated, flows upwardly toward the forward end of the boiler, from which a pipe 75 serves to conduct the preheated water into the downtake pipe 14. The pipe 75 is branched and the other branch connected to the water space on the other side of the boiler shell. Owing to the relatively low temperature to which the feed water is preheated in the outer jacketed water spaces, it is not necessary to insulate the body of the steam generating unit, although this may be done if desired, and particularly where there is a return condensate feed to the boiler.

Returning now to a more specific description of the heating element assembly, the combustion casing 34 (Fig. 5) is provided at its front end with a lining 76 of refractory material. Said lining 76 extends for a sufficient distance from the front end of the casing to protect the metal of the casing from the high temperatures developed within the primary combustion area of the fuel. The inside diameter of the combustion casing 34 is of sufficient dimension, and the casing of sufficient length, for substantially complete combustion of the fuel to take place before the gaseous products of combustion leave the rear end of the combustion tube through the connecting conduits 37 and 38. The rear end of the combustion casing 34 is closed by a plate 77, which may suitably be welded therein.

Each of the water tube casings 35 and 36 being identical, only one need be described. The water tube casing 35 (Fig. 5) comprises a cylindrical casing headed at its front and rear ends by means

of plates 78 and 79, respectively, which plates are apertured to receive water tubes 80. Said water tubes 80 extend through the plates 78 and 79 and are suitably secured therein. The gaseous products of combustion entering the water tube casings 35 and 36 through the pipes 37 and 38 traverse the full length of such water tube casings and are discharged from the front ends thereof through the connecting conduits 44 and 45 and collected in the main gas conduits 46 extending through the front head 31 of the boiler.

The external return pipe bends 64 and 66, for a portion of their length, are encased within the housing 25 (Fig. 1) and there serve indirectly to preheat the air within said housing 25 that is drawn into the blower 17 and mixed with the fuel within the combustion chamber 34. A higher efficiency of combustion is thus obtained by this provision for the preheating of the air going to the combustion chamber.

The upper steam separating unit 13 is provided with the usual accessories, such as a water glass 81, a gauge 82 mounted thereabove, a pressure control device 83 and a safety valve 84 for indicating when the pressure in the unit becomes excessive. Steam is drawn off from the steam separating unit 13 through a pipe 85 having a valve 86 therein.

The operation of the boiler is as follows:

The blower 17 is started up and oil admitted through the pipe 20 under sufficient pressure to effect atomization in passing through the burner nozzle 19. Ignition of the oil is accomplished by the sparks set up between the terminals of the electrodes 22. Primary combustion of the fuel takes place within the refractory lined portion of the combustion tube 34. Under the light pressure of the blower, the gaseous products of combustion are caused to pass from the combustion chamber 34 through the gas conduits 37 and 38 into the interiors of the water tube casings 35 and 36. The casings and connecting conduits are so proportioned that there is no substantial reduction in the velocity of the combustion gases as they pass from the combustion casing through the gas conduits 37 and 38 into the water tube casings 35 and 36.

The combustion gases flow through said water tube casings 35 and 36 in a direction counter to that of the flow of water through the tubes 80. The rapidity of flow of the water through said tubes 80 is increased by reason of the inclination of the heating element assembly upwardly toward the rear of the boiler, and also by reason of the fact that the gaseous products of combustion are at their highest temperature when they enter said water tube casings at their higher, rear ends.

From the water tube casings 35 and 36, the gaseous products of combustion flow outwardly at the front ends of said casings through the branch pipes 44 and 45 into the main gas conduit 46 and thence through the external return bends 64 and 66 into the fittings 65 and 67. The waste gases then pass through the baffled gas spaces 54 and 55 in the series of horizontal passes A, B and C that extend substantially the full length of the boiler shell, before being discharged through the vents 670 to the stack.

Boiler feed water is introduced into the water spaces 71 and 72 through the feed intake pipes 74 into heat exchange relationship with the exhaust gases passing through the gas spaces 54 and 55. The flow of the feed water is downwardly and rearwardly through the water spaces 75

71 and 72 and thence upwardly into the pipes 75 that join and enter the downtake pipe 14. Drain pipes 87 are provided for draining the water spaces 71 and 72.

5 Within the boiler, the general flow of water is downwardly through the downtake conduit 14 into the front end of the lower steam generating unit 11 and rearwardly through the cut-away portion 51 of the baffle 50. As the water passes 10 beyond the baffle 50 toward the rear end of the boiler, it flows upwardly around the several casings 34, 35 and 36 of the heating element and is heated thereby. An even more rapid flow of water, however, occurs through the tubes 80 of 15 the water tube casings 35 and 36, the water entering at the front ends of said tubes and flowing upwardly and rearwardly into the space between the rear head 29 of the boiler and the rear ends of said water tube casings. From this rear 20 space, the heated water rises through the uptake conduit 15 into the stream separating unit 13. There is a general forward flow of water within the steam separating unit 13 toward the downtake pipe 14. The water within said separating 25 unit 13 is maintained at substantially the level indicated in Fig. 2. Steam is withdrawn through the pipe 85 as required.

Although the boiler has been described in connection with the generation of steam, it will be 30 understood that it can be used as a hot water boiler, or for the heating or evaporation of other liquids. The boiler is, however, particularly designed for the generation of steam and for this purpose exhibits a very high degree of efficiency.

35 It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise 40 than necessitated by the scope of the appended claims.

I claim as my invention:

1. In an internally fired water tube type boiler, a unitary removable heating element assembly 45 comprising a combustion casing, a plurality of water tube casings having headed ends and water tubes extending therethrough, gas conduit means connecting the inner ends of said casings to position said water tube casings at a lower level than 50 said combustion casing, means supporting the inner ends of said casings for rolling movement over the interior of said boiler, a plate constituting a head for said boiler supporting the outer end of said combustion casing, a branched gas 55 conduit connected to and extending from the outer ends of said water tube casings through said plate and secured therein to support said

outer ends from said plate and a baffle plate carried by said casings adjacent the outer ends thereof and positioned inwardly of said branched gas conduit connection, said baffle having a lower cut-out portion to facilitate the convection flow 5 of water through said boiler.

2. In a boiler of the internally fired water tube type, a cylindrical boiler shell, concentrically curved plates spaced outwardly about said shell to define a gas space and longitudinally extending 10 ribs spacing said shell and plates and arranged to create a serpentine path for the gases through said space, each of said plates having openings for the introduction of gases into the lowermost rim of said serpentine path. 15

3. In a boiler of the internally fired water tube type, a cylindrical boiler shell, concentrically curved plates spaced outwardly about said shell to define a gas space and longitudinally extending 20 ribs spacing said shell and plates and arranged to create a serpentine path for the gases through said space, said ribs being more closely spaced toward the gas exit end of said path to afford a gas path of progressively decreasing cross-sectional area to thereby maintain a sub- 25 stantially constant velocity of flow of said gases while said gases undergo contraction due to cooling.

4. An internally fired water tube boiler, comprising a lower steam generating unit, an upper 30 steam separating unit, a water uptake joining the rear ends of said units, a water downtake joining the front ends of said units, said steam generating unit having jacketed walls providing an intermediate gas space and an outer water 35 space, a pipe connection for introducing feed water into said water space to be preheated and a conduit for conducting preheated water therefrom into said downtake.

5. An internally fired water tube boiler, comprising a lower steam generating unit, an upper 40 steam separating unit, a water uptake joining the rear ends of said units, a water downtake joining the front ends of said units, said steam generating unit having jacketed walls providing an intermediate gas space and an outer water 45 space, a pipe connection for introducing feed water into said water space to be preheated, a conduit for conducting preheated water therefrom into said downtake, a heating element assembly within said steam generating unit, a conduit for conducting heated gases therefrom into 50 said gas space at a point remote from said feed water pipe connection and a vent for said gases positioned adjacent said feed water pipe connection. 55

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