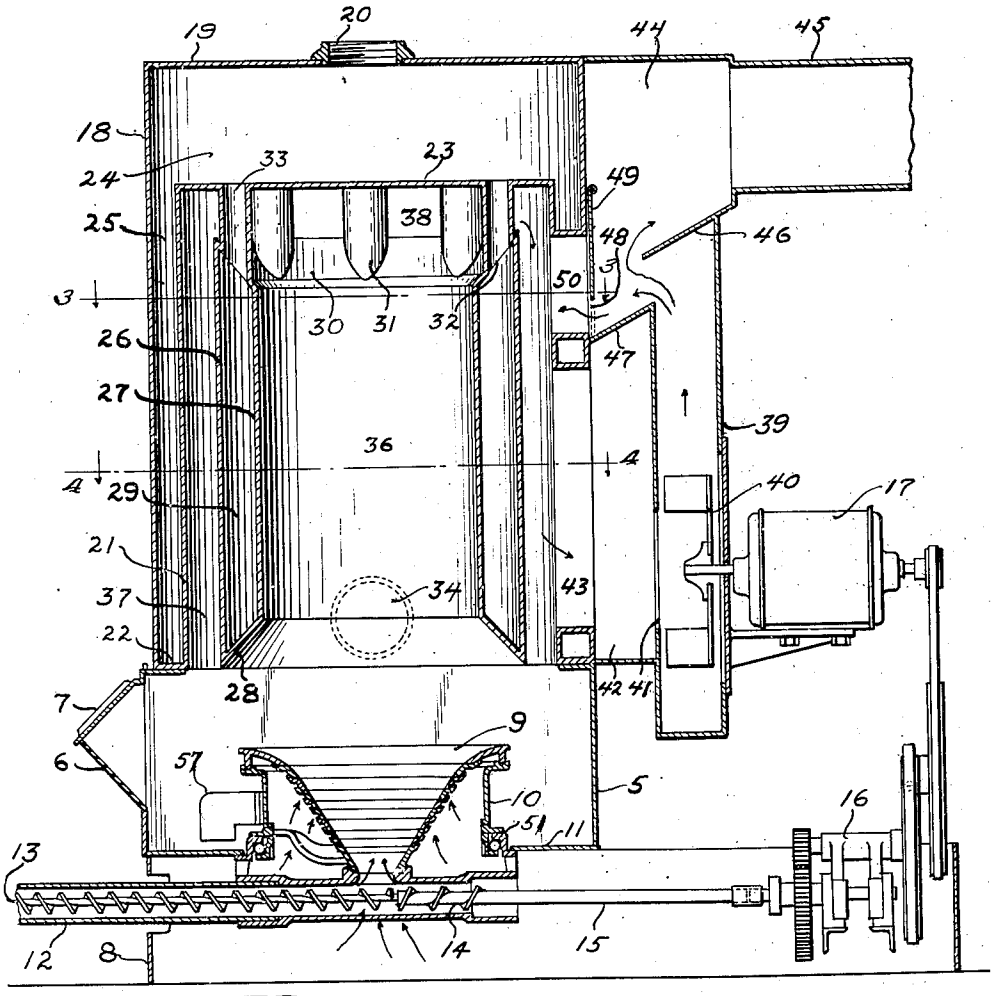
March 8, 1949. J. F. FISHER 2,463,958

INDUCED DRAFT HEATER

Filed Jan. 29, 1947 2 Sheets-Sheet 1

Fig. 1.



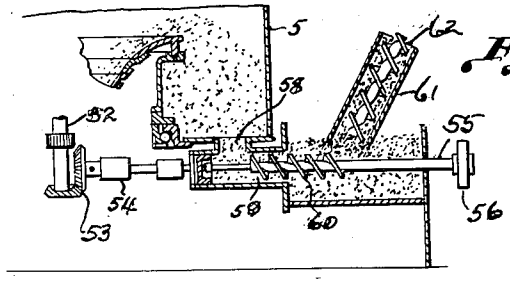


Fig. 5

Inventor.
John Farley Fisher

By. Pennie Edmonds, Morton & Barrows

Attorneys

March 8, 1949. J. F. FISHER 2,463,958

INDUCED DRAFT HEATER

Filed Jan. 29, 1947 2 Sheets-Sheet 2

Fig. 2.

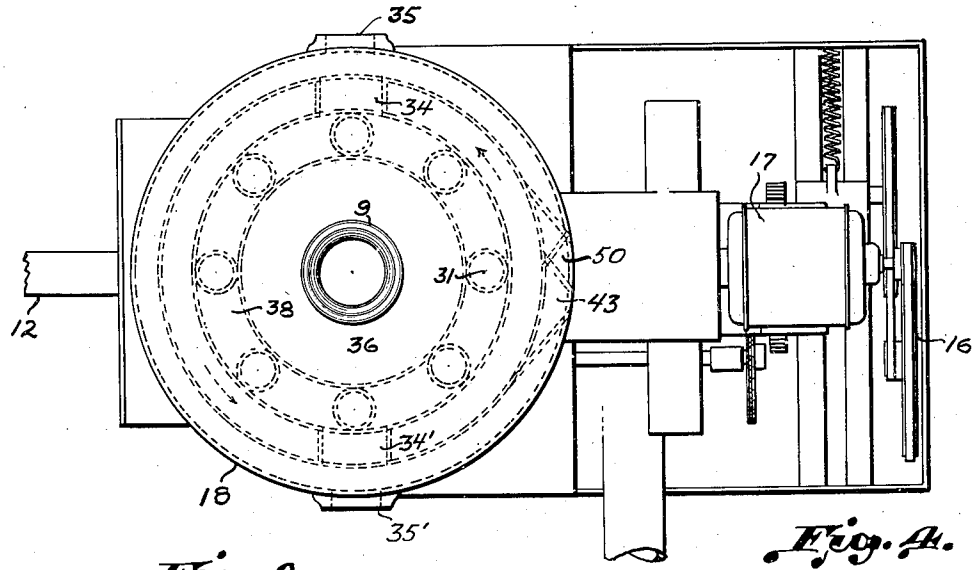
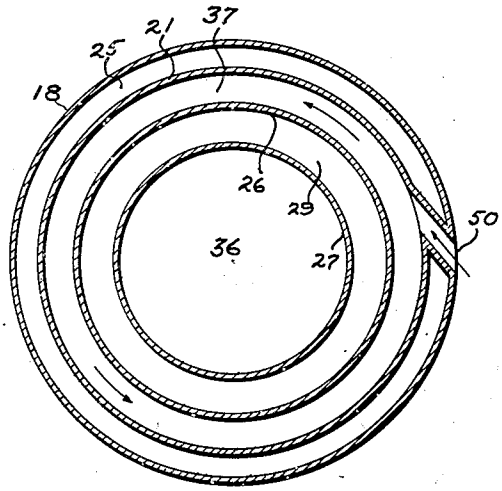
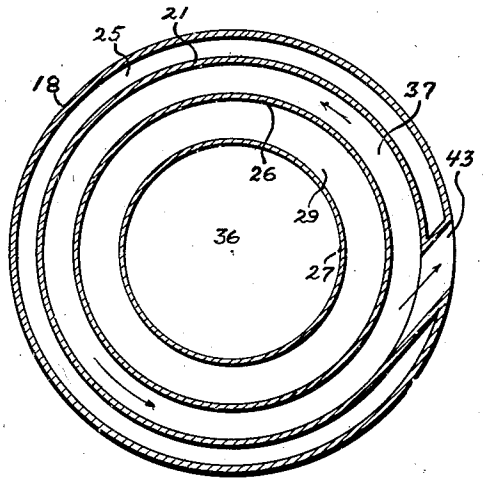


Fig. 4.

Fig. 3.





Inventor.
John Farley Fisher

By.
Pennie, Edmonds, Morton & Barrows
Attorneys

Patented Mar. 8, 1949 2,463,958

UNITED STATES PATENT OFFICE

2,463,958

INDUCED DRAFT HEATER

John Farley Fisher, Manheim, Pa., assignor to Hershey Machine & Foundry Company, Manheim, Pa., a corporation of Pennsylvania

Application January 29, 1947, Serial No. 725,001

8 Claims. (Cl. 122—155)

1

This invention relates to a heater or furnace especially adapted for use in mechanically operated heating systems providing heat and hot water supply for buildings, and in industrial operations in which relatively small quantities of heat or steam are required. More particularly, the invention is concerned with a new form of heater of the induced draft type in which a portion of the flue gases is returned to the heat exchange zone to produce therein a novel effect and provide a more efficient heat exchange between the boiler and the products of combustion resulting from the burning of a carbonaceous fuel. The mechanically operated apparatus of the invention, which is adaptable to hot air, hot water or steam heating systems, may be automatically controlled and may be fired with liquid, gaseous, or solid fuel. When solid fuel is employed, the new heater affords particular advantages over other types of heaters now available by providing a dustless heating system. The invention further includes within its scope a new form of boiler or heat exchange apparatus for use in a heating system which produces an efficient heat transfer between hot gases supplied to it from any source and a heat conveying medium.

In the heating systems of the domestic class heretofore proposed or employed, the attainment of high heat exchange efficiency has been a major problem, and in spite of signal advances, heat recovery expressed in terms of potential heating power of the fuel has not achieved a high level. Many different arrangements of firebox and combustion zone in combination with complex boiler or hot air circulating systems have been designed to produce a maximum area of heat exchange surface. In producing such increased surfaces, in a necessarily confined space, however, the path of travel of the heated gases becomes tortuous with an attendant decrease in velocity, which is undesirable, since heat transfer is proportional to the velocity of hot gases across the heating surfaces. An increase in permissible pressure at the burner to increase velocity of flow of combustion products is limited because of the danger of building up too great a back pressure in the firebox and causing products of combustion to escape to the atmosphere, a condition which cannot be tolerated in domestic units. Furthermore, such an increase in pressure would involve an unwarranted complexity in the burner and air supply equipment. In heating systems involving coal stokers, difficulties are often encountered due to soot and "fly ash" formation and deposition on the internal heat exchange

2

surfaces with resulting loss in heat transfer efficiency.

The present invention is accordingly directed to the provision of a heater or furnace which is simple in construction and operation, which involves a principle of operation different from those previously employed, and which eliminates or minimizes the disadvantages of the prior types. In the new heater of my invention, combustion supporting air is drawn into the firebox adjacent the burner by an induced draft produced by a fan situated beyond the heat exchange zone and outside the body of the furnace. A controlled portion of the gases withdrawn by the fan is returned to the hot gases within the heat exchange zone to increase their velocity. The control of the volume of recirculated gas also serves to control the intake of combustion air at the burner.

The preferred form of the new heater includes a drum forming the principal reservoir for the heat conducting medium, and inner and outer spaced walls extend downwardly from the drum and are connected at their lower ends to form an outer annular leg in communication at its top with the interior of the drum. Another pair of inner and outer walls lead downwardly from the drum within the outer leg and are connected at their lower ends to form an inner annular leg in communication at its top with the interior of the drum. The inner leg defines a combustion chamber open at the bottom, and the hot gases of combustion from fuel burned in a firebox below the lower ends of the legs, flow upwardly through the combustion chamber and are deflected outwardly by the bottom of the drum to flow through openings in the inner leg into the annular gas space between the legs. A gas outlet passage and a gas inlet passage extend through the outer leg near the bottom and top thereof, respectively, and the inlet passage and, preferably, also the outlet passage, are tangential to the inner surface of the outer leg and at an angle to one another. The heater includes means, such as a fan, for withdrawing gases through the outlet passage, and a controlled portion of the gases is returned through the inlet passage. The gases so returned mix with the deflected hot gases and flow therewith spirally downwardly along the inner surface of the outer leg to the outlet passage.

A simpler form of the new heater is of the construction above described, except that the inner leg is omitted and the combustion chamber is defined by the outer leg. In this construction,

as in the preferred form, the hot gases flowing upwardly through the combustion chamber are deflected outwardly by the bottom of the drum toward the inner wall of the leg and mix with return gases entering the chamber through the tangentially disposed inlet passage. The mixture of gases then flows spirally downwardly along the inner surface of the leg to the outlet passage.

In order that my invention may be clearly understood, it will be described with reference to the accompanying drawings showing a preferred form of apparatus in accordance with the invention in which heat is supplied by an underfed rotating coal stoker similar to that disclosed in the G. M. Peltz, U. S. Patent No. 2,127,933.

Fig. 1 is a vertical sectional view showing the complete assembly of parts;

Fig. 2 is a top plan view of the apparatus of Fig. 1;

Fig. 3 is a sectional view on the line 3—3 of Fig. 1;

Fig. 4 is a sectional view on the line 4—4 of Fig. 1; and

Fig. 5 is a fragmentary section through the firebox showing the ash removal system.

In the form of apparatus illustrated, a vertically disposed firebox 5, having an opening 6 closable by a transparent plate 7, rests upon an open base 8. An underfed burner or retort 9 surrounded by skirt member 10 is situated in the firebox and passes through the floor 11 to connect with a fuel supply pipe 12, through which the coal is conveyed by a screw or worm conveyor 13 from a bin or hopper (not shown). A short extension screw 14 mounted on a common drive shaft 15 and having flights pitched in the opposite direction from those on the conveyor, cooperates to force the coal upwardly through the retort. Drive shaft 15 is actuated by intermediate driving means 16 which is connected to electric motor 17 which also provides power for the other moving parts of the equipment. The operation of this motor may be controlled by thermostatic means responsive to the air temperature in a room or to the water temperature in the system in accordance with well known principles.

The boiler portion of the heater includes a cylindrical casing 18 supported on the top of the firebox 5 and closed at the top by circular plate 19 having outlet connection 20. An annular partition 21 lies concentric with and spaced inwardly from casing 18 and is connected thereto at its lower end by a closure 22. A horizontal plate 23 closes the top of the combustion chamber and serves as a floor for a drum or reservoir for the heat conveying medium, ordinarily water. The interior of the drum is in communication with the space 25 between the casing and partition 21, and the space thus serves as a water leg.

Spaced concentric partitions 26 and 27 extend downwardly within partition 21 from the floor of the drum and are connected at their lower ends by an inwardly and upwardly sloping wall 28 to form an inner annular water leg 29. The partitions are closed at their upper ends by an upwardly and outwardly sloping wall 30 and the water leg 29 is connected to reservoir 24 by a plurality of spaced pipes 31 leading from openings 32 in wall 30 to openings 33 in floor 23. The water legs 25 and 29 are in communication in their lower portions through diametrically located connections 34 and 34', thus permitting good circulation of water through the two circular legs and the reservoir. Return water from the outside system enters the boiler through connections 35 and 35' leading to the outer water leg near the lower end thereof, and the heated water or steam leaves the boiler through outlet connection 20. Annular partition 27 defines a central vertical cylindrical combustion zone 36 open at its bottom to form an extension of the firebox 5 and situated directly over the burner 9. The combustion zone is connected with annular gas space 37 between the water legs via openings 38 located between the water pipes 31.

Outside of the boiler proper, a duct 39, which serves as a housing for fan 40 actuated by motor 17, is connected through restricted opening 41, breeching 42, and opening 43 in the outer water leg 25, to the annular gas space 37. As shown in Figs. 2 and 4, the outlet passage through opening 43 is substantially tangent to the annular gas space 37. Conduit 39 is connected through box 44 attached to outer wall 18, to a flue 45. At the bottom of space 44 is sloping baffle 46, which causes a change in direction of the gases impelled upwardly by fan 40, and the baffle, together with the sloping surface 47 at the bottom of box 44, directs them toward opening 48, the size of which is controlled by recirculation damper 49. This arrangement permits the return of a predetermined desired proportion of the products of combustion to the annular gas space 37 near the top thereof through a passage 50 through the outer water leg 25. Passage 50 is substantially tangent to the gas space 37, as shown in Figs. 2 and 3, and complementary to and above the tangential outlet passage 43.

Various other arrangements are possible in this part of the structure to control the proportion of gases from the fan discharge which are returned to the heat exchange zone near the top thereof. A flap damper, for example, may replace sliding damper 49 and this change may render the baffle 46 unnecessary.

In the heater illustrated, the retort or grate 9 is made up of a series of rings of increasing diameter mounted one upon the other and constructed to provide slotted air passages for admission of air uniformly to the bed of fuel in the retort. The retort is supported on a bearing 51 for rotation on a vertical axis by any suitable means, and may be driven through bevel gearing (not shown) by a vertical shaft 52 connected through bevel gearing 53 and a coupling 54 to an extension of a shaft 55 driven from motor 17 through a pulley 56. Ashes are discharged over the top edge of the retort and fall upon the floor 11, along which they are moved by a paddle 57, which propels them toward an ash outlet 58 through the floor. The ashes discharged through outlet 58 enter a chamber 59, through which shaft 55 extends, and the shaft is provided with screw flights 60, which advance the ashes through the chamber to the bottom of an upwardly inclined discharge chamber 61. A driven shaft provided with screw flights 62 within chamber 61 elevates the ashes through the chamber, so that they can be discharged in suitable containers.

In the operation of the heater illustrated, the fan causes a flow of atmospheric air upwardly through the tuyeres and the bed of the burner. Good operating conditions in a unit suitable for domestic use involve a reduced pressure at the burner of ¾ to 1½ inches measured on a water manometer. Due to the upward velocity of air

and expanding burning gases, the flow is substantially vertical into and through the combustion zone **36** with negligible by-passing of gas to the fan through the shorter route provided by the open bottom of annular gas space **37**.

The expanding hot gases from the firebox deliver heat through wall **27** to the heat conveying medium, which is circulating upwardly through inner annular leg **29**. When the gases reach the top of the combustion zone, they are deflected outwardly and pass through openings **38** into the top of gas space **37**, through which they start to travel downwardly. The returned gases, entering the gas space through the tangential opening **50**, mix with the hot gases and flow therewith along a spiral path downwardly through the gas space toward the outlet passage **43**. The mixture of the returned gases with the hot gases in the manner described causes a gas flow at increased velocity through the gas space **37** and, as a result, good heat exchange is obtained between the gases and the heat conveying medium within the inner and outer legs.

In some instances, it may be desirable to employ a plurality of gas inlet and outlet passages and, in that event, the passages will be relatively narrow and vertically elongated.

In the simpler form of the apparatus, in which only a single annular leg is employed, the hot gases of combustion, as in the apparatus illustrated, rise through the combustion chamber and are deflected outwardly by the bottom of the drum toward the inner surface of the leg. The gases thus deflected mix with those entering the chamber through the gas inlet passage and the gas mixture travels spirally downwardly along the inner surface of the leg to the gas outlet passage.

The increased velocity across the heat exchange surfaces resulting from the spiral movement as compared to a direct downward flow provides substantial improvement in heat transfer. Also the method of recirculation described causes the hot gases to pass over the same surface several times before being eliminated from the system and for this reason also gives an improved heat efficiency. The apparatus thus provides increased heat transfer while at the same time reducing the area of heat exchange surface to a minimum. A further advantage of the new mechanism resides in the control of the recirculated gases provided by the damper which also serves to control the induced draft applied to the burner, thus assuring the introduction of an air stream adequate to produce complete combustion.

A further outstanding advantage of the new apparatus resides in the elimination of difficulties due to "fly ash." In normal operation of mechanically fed coal stokers, fine ash particles blown from the burner deposit and build up on the boiler surfaces and in the flue causing a substantial reduction in heat transfer. During extended operation of my apparatus, I have found that the surfaces in contact with the spirally flowing gases remain clear of any deleterious deposit. In changing the direction of flow of the exit gases from the fan by a baffle, the major portion of the ash is thrown out of the gas stream and returns to the system where it drops through gas passage **37** into the firebox whence it is removed with the rest of the ash through outlet **52**.

During operation, all parts of my heater ahead of the fan are under reduced pressure. This feature is responsible for an additional important advantage, namely, that, at all points, where leakage might normally occur, the air flow will be into the system and the escape of dust or products of combustion into the building will thus be prevented. The ash removal exit is in effect sealed by the presence at all times of a solid body of ashes either in the conveying mechanism or in the discharge chamber leading therefrom. Such an ash seal insures that substantially all of the air entering the system will be through the burner and a delicate control of combustion by the damper **49** is thus provided. The conduit handling the fan discharge is in open communication with the flue and constant fan operation at full capacity is, therefore, permissible without producing any pressure in this portion of the apparatus.

The increased velocity of gaseous flow in the heat exchange system permits the use of relatively less heat exchange area than in other types of boiler construction. In one typical installation having a heat exchange surface of 38 sq. ft., 250,000 B. t. u. was transferred to the heating fluid with a flue temperature of approximately 500° F. and a fan temperature approximating 600° F.

In the various applications of the apparatus of the invention, any heat conveying medium suitable to accomplish the desired result may be circulated through my novel heat exchange system, either by natural circulation resulting from temperature differentials, or by forced circulation. Thus, in a hot air heating system, the circulating air connections are made to the furnace in a recognized way to produce an efficient circulation of heating air through the heat exchange system and a fan may be employed to increase circulation through the outside heating circuit. In hot water systems used for heat radiation or for a hot water supply, the inlet and outlet connections are arranged to produce a good liquid flow through the heat exchanger. In a boiler for producing steam, the outlet will normally be situated in the upper part of the drum, and the water feed or condensate return in the lower part of the system.

I claim:

1. In a heater, a heat exchanger which comprises a drum forming a reservoir for the heat conveying medium, spaced inner and outer walls extending downwardly from the drum and forming a hollow leg of generally cylindrical form in communication with the interior of the drum, the leg and drum defining a chamber open at the bottom for admission of hot gases, which rise through the chamber to be deflected outwardly at the bottom of the drum toward the inner surface of the leg, the leg having a gas outlet passage extending therethrough near the lower end thereof and a gas inlet passage extending therethrough near the upper end thereof, the inlet passage being substantially tangential to the inner surface of the leg, the leg being continuous except for said inlet and outlet passages, and means for withdrawing gases from said chamber through the outlet passage and returning a portion of the withdrawn gases through the inlet passage to mix with the deflected gases and flow therewith spirally downwardly along the inner surface of the leg to the outlet passage.

2. In a heater, a heat exchanger which comprises a drum forming a reservoir for the heat conveying medium, spaced inner and outer walls extending downwardly from the drum and having a hollow leg of generally cylindrical form in

communication with the interior of the drum, the leg and drum defining a chamber open at the bottom for admission of hot gases, which rise through the chamber to be deflected outwardly by the bottom of the drum toward the inner surface of the leg, the leg having a gas outlet passage extending therethrough near the lower end thereof and a gas inlet passage extending therethrough near the upper end thereof, the inlet and outlet passages being substantially tangential to the inner surface of the leg and extending in directions at an angle to one another, the leg being continuous except for said inlet and outlet passages, and means for withdrawing gases from said chamber through the outlet passage and returning a portion of the withdrawn gases through the inlet passage to mix with the deflected gases and flow therewith spirally downwardly along the inner surface of the leg to the outlet passage.

3. In a heater, an induced-draft heat exchanger which comprises a drum having a reservoir for heat conveying medium, a downwardly-extending outer double-walled leg, the space between the walls of the leg being in upper communication with the drum, an inner double-walled leg within and spaced from the outer leg to form therebetween an annular gas space, the space between the walls of the inner leg being in communication at its top with the drum and the spaces between the walls of the two legs being connected near the lower ends of said legs, the inner leg and drum defining a chamber open at the bottom to permit the upward entrance of hot gases centrally thereof, the inner leg having a plurality of gas passages therethrough between the upper parts of the chamber and the annular gas space, the outer leg having an outlet passage extending therethrough near the lower end thereof for the passage of gases from the annular space and an inlet passage extending therethrough near the upper end thereof for the passage of gases into the annular space, the outer leg being continuous except for said inlet and outlet passages, and means for withdrawing hot gases from the annular gas space through said outlet passage and for returning a portion of said gases to the annular space through said inlet passage, said inlet passage extending substantially tangential to the inner surface of the outer annular leg and said return gases producing a spiral downward gas flow through the annular gas space and inducing an upward gas flow through the chamber.

4. In a heater, an induced-draft heat exchanger which comprises a drum forming a reservoir for heat conveying medium, a downwardly-extending outer double-walled leg, the space between the walls of the leg being in upper communication with the drum, an inner double-walled leg within and spaced from the outer leg to form therebetween an annular gas space, the space between the walls of the inner leg being in communication at its top with the drum and the spaces between the walls of the two legs being connected near the lower ends of said legs, the inner leg and drum defining a gas combustion chamber open at the bottom to permit the upward entrance of hot gases centrally thereof, the inner leg having a plurality of gas passages therethrough between the upper parts of the gas combustion chamber and the annular gas space, the outer leg having a gas outlet passage extending therethrough near the lower end thereof and a gas inlet passage extending therethrough near the upper end thereof, the outer leg being continuous except for said inlet and outlet passages, a fan for producing an induced draft within the combustion chamber, means for conducting hot gases from the lower portion of the annular gas space and delivering them to the inlet of the fan, and recirculating means for returning a controlled portion of the hot gases from the outlet of the fan to the upper part of the annular gas space, through said gas inlet, said gas inlet extending substantially tangential to the inner surface of the outer annular leg whereby the hot gases returned to the upper portion of the annular gas space through the gas inlet spiral downwardly through the annular gas space.

5. An induced draft boiler as set forth in claim 4 in which the gas outlet passage extends in a direction substantially tangential to the inner surface of the outer annular leg and in a direction at an angle to the gas inlet passage.

6. An induced-draft boiler for heating water and producing steam which comprises a relatively shallow circular drum forming a water reservoir, an outer double-walled leg extending downwardly from the outer peripheral portion of the drum, the space between the walls of the leg being in upper communication with the space within the drum, an inner double-walled leg within and spaced from the outer leg to form therebetween an annular gas space, the space between the walls of the inner leg being in communication at its top with the space within the drum and the spaces between the walls of the two legs being connected near the lower ends of the legs, the inner leg and drum defining a gas combustion chamber open at the bottom to permit the upward entrance of hot gases centrally thereof, the inner leg having a plurality of gas passages therethrough between the upper parts of the gas combustion chamber and the annular gas space, the outer leg having a gas outlet passage extending therethrough near the lower end thereof and a gas inlet passage extending therethrough near the upper end thereof, the outer leg being continuous except for said inlet and outlet passages, a fan for producing an induced draft in the gas combustion chamber, a passageway for hot gases from the gas outlet to the inlet of the fan, a duct leading from the fan outlet, means for conducting a portion of the gases passing through said duct to said gas inlet so that a portion of the gases passing through the duct may be returned to the annular gas space, the gas inlet extending substantially tangential to the inner surface of the outer annular leg so that return gases passing therethrough to the upper portion of the annular gas space will produce a spiral downward flow of gases through the annular space, and adjustable damper means for regulating the proportions of gases passing through the duct which are returned to the annular space through the gas inlet.

7. An induced-draft heater which comprises a firebox, means within the firebox for burning fuel, an inlet for admission of air for combustion into the firebox, a heat exchanger for circulating heat conveying medium in heat exchange with the products of combustion including a drum forming a reservoir for the heat conveying medium, spaced inner and outer walls extending downwardly from the drum and forming a hollow leg of generally cylindrical form in communication with the interior of the drum, the leg and drum defining a combustion chamber open at the bottom for the admission of hot gases of combustion from the firebox, which rise through the chamber

to be deflected outwardly by the bottom of the drum toward the inner surface of the leg, the leg having a gas outlet passage extending therethrough near the lower end thereof and a gas inlet passage extending therethrough near the upper end thereof, the inlet passage being substantially tangential to the inner surface of the leg, the leg being continuous except for said inner and outer passages, and means for withdrawing gases from the combustion chamber through the outlet passage and returning a portion of the withdrawn gases through the inlet passage to mix with the deflected gases and flow therewith spirally downwardly along the inner surface of the leg to the outlet passage.

8. An induced-draft heater which comprises a firebox, means within the firebox for burning fuel, an inlet for introducing combustion air into the firebox, a boiler including a drum forming a water reservoir, a downwardly-extending outer double-walled leg, the space between the walls of the leg being in upper communication with the space within the drum and an inner double-walled leg within and spaced from the outer leg to form therebetween an annular gas space, the space between the walls of the inner leg being in communication at its top with the space within the drum and the spaces between the walls of the two legs being connected near the lower ends of the legs, the inner leg and drum defining a vertical combustion zone open at its lower end to the firebox to permit the upward entrance of hot gases from the firebox centrally thereof, the inner leg having a plurality of gas passages therethrough

between the upper parts of the combustion chamber and the annular gas space, the outer leg having a gas outlet passage extending therethrough near the lower end thereof and a gas inlet passage extending therethrough near the upper end thereof, the inlet passage being substantially tangential to the inner surface of the outer leg, the outer leg being substantially continuous except for said inlet and outlet passages, means for withdrawing by induced draft hot gases from the combustion chamber through the outlet passage, and recirculating means for returning a controlled portion of the withdrawn hot gases to the upper part of the annular gas space, through the gas inlet, to mix with the deflected gases and flow therewith spirally downwardly through the annular gas space.

JOHN FARLEY FISHER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
826,907	Stilwell	July 24, 1906
1,284,053	Briggs	Nov. 5, 1918
1,749,907	Dyar	Mar. 11, 1930
2,173,115	Hutto	Sept. 19, 1939

FOREIGN PATENTS

Number	Country	Date
3,811	Great Britain	Mar. 3, 1891