Feb. 26, 1929. 1,703,228

C. A. FRENCH

BOILER

Original Filed June 8. 1922 2 Sheets-Sheet 1

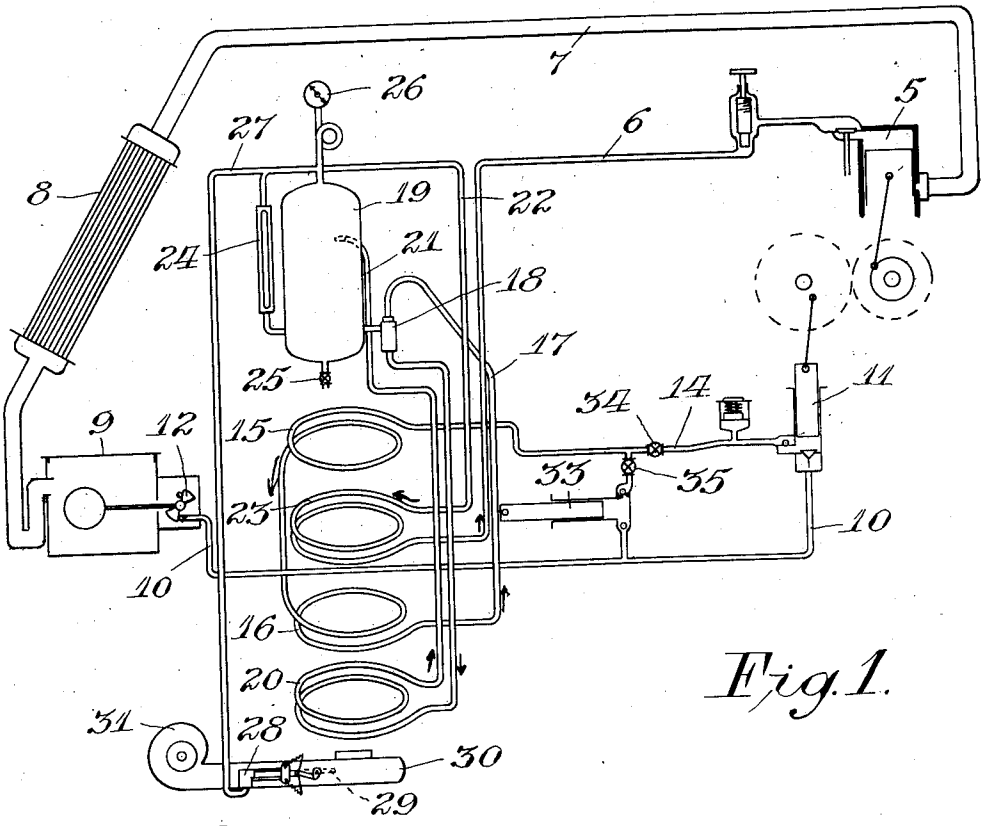



Fig. 1.

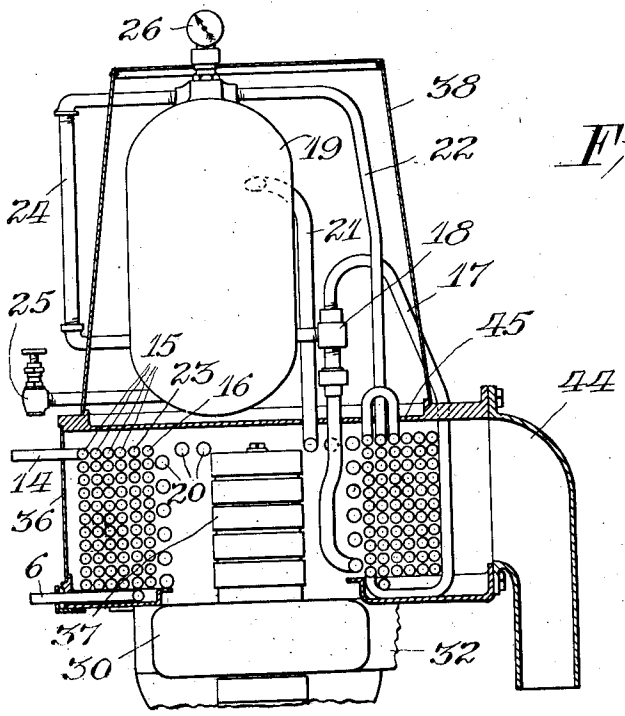



Fig. 3.

Inventor.
C. A. French,
By A. P. Davies
Atty.

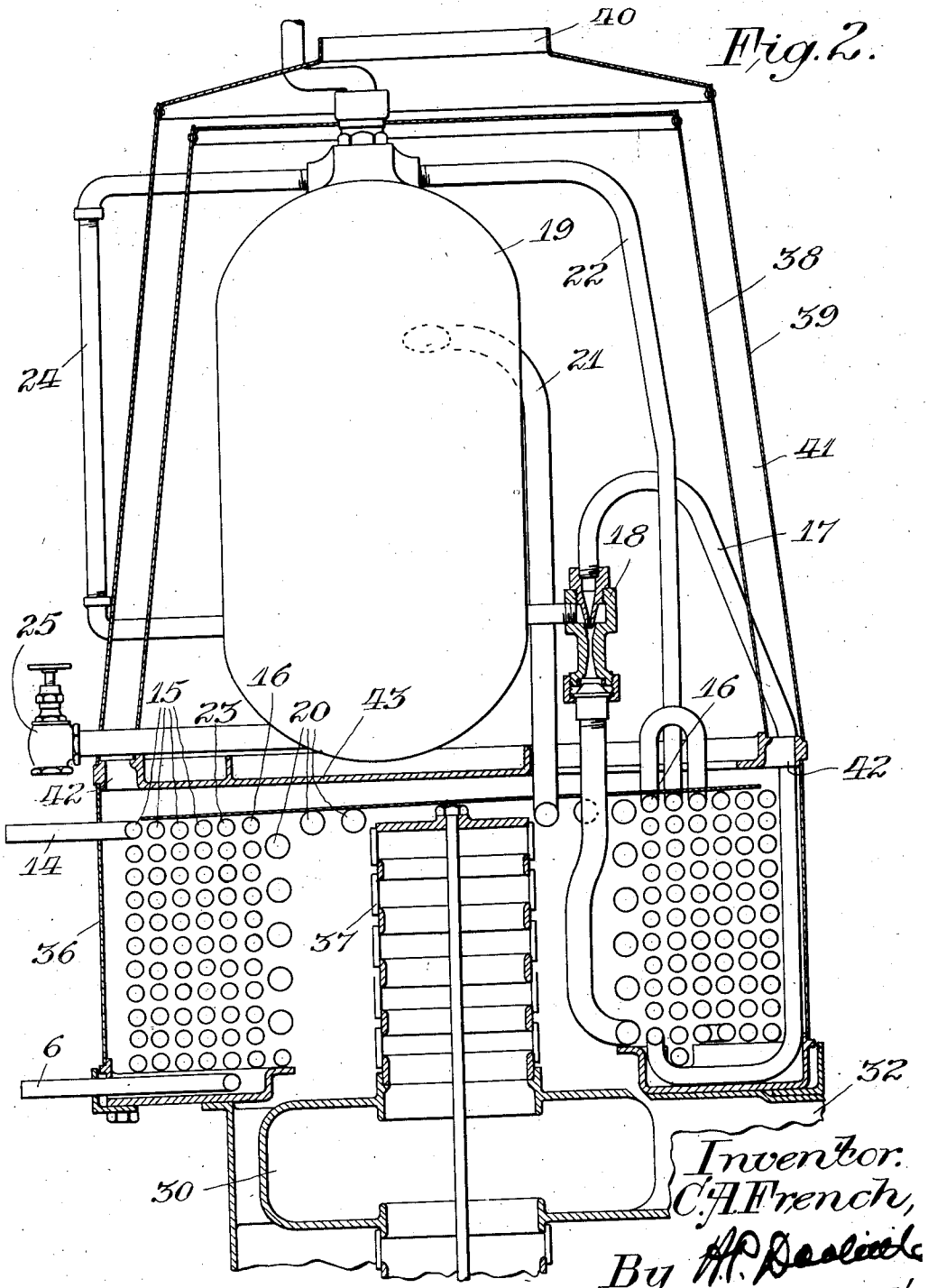
Feb. 26, 1929. 1,703,228

C. A. FRENCH

BOILER

Original Filed June 8. 1922 2 Sheets-Sheet 2

Fig. 2.




Inventor:
C. A. French,
By H. P. Daniels
Atty.

Patented Feb. 26, 1929. 1,703,228

# UNITED STATES PATENT OFFICE.

CHARLES A. FRENCH, OF CHICAGO, ILLINOIS, ASSIGNOR TO INTERNATIONAL HARVESTER COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF NEW JERSEY.

## BOILER.

Application filed June 8, 1922, Serial No. 566,710. Renewed November 7, 1928.

My invention relates to a steam power plant and particularly to an automotive steam power plant and a boiler to be used therein.

Steam driven automobiles, trucks and tractors are admitted to be very desirable on account of their ease of control and continuous operation under heavy loads but have not been widely adopted because of the complicated nature of the steam generating plant and its relatively short life.

The burner and boiler are the most frequent causes of shut-downs and failures. The burner must be cleaned frequently of the sooty and sticky carbon deposits that clog the nozzle and burner passages while failure of the boiler results from leaks due to unequal expansion of the tubes and headers and burning of the tubes due to deposits of scale and failure of the water supply.

In my Patent No. 1.466.709 granted Sept. 4, 1923, there is shown a burner that overcomes all the difficulties heretofore experienced with burners in automotive steam power plants and, in the present application I have disclosed a steam generating plant and boiler which obviates the troubles heretofore resulting from broken or burned boiler tubes.

In my improved steam generating plant, I employ a boiler having coils constituting preheater, evaporator and superheater zones connected to a storage drum without headers or tube sheets. Only the coils are exposed to direct heat from the burner, all joints and connections being out of the path of the flame. The coils may therefore contract and expand without straining any part of the boiler. My improved boiler is used in a closed system in which there is a fixed amount of water (liquid and steam) circulated through the coils and storage drum, steam from the boiler being led to the engine from which it is exhausted into a condenser, the condensed water flowing to a hot well or reservoir from which the boiler feed pump draws its supply. The coils of the boiler are heated by a burner which is automatically turned on and off by a pressure regulator in response to variations in the boiler pressure between predetermined maximum and minimum limits. The pump discharges into the preheater coil of the boiler at a point most remote from the burner, the water flowing through the coil toward the burner, the last coil being sufficiently close to the burner so that some steam may be generated therein. This last coil discharges into the nozzle of an ejector where it picks up an additional supply of hot water from the drum, forcing it into the evaporator coils which are closest to the burner. Some water is evaporated in the evaporating zone and a mixture of approximately 30% steam and 70% water discharges tangentially into the storage drum where the water content is separated and collects in the lower portion of the drum from where it is picked up by the ejector to be again circulated while the steam collects in the top of the drum from whence it flows through the superheater coil which is located between the evaporator and preheater coil. The superheater coil is connected to the steam main leading to the engine.

Referring to the drawings—

Fig. 1 is a diagrammatic view of my improved steam power plant;

Fig. 2 is a vertical sectional view of a steam boiler; and

Fig. 3 is a similar view of the same boiler but having a downward discharge flue.

In Fig. 1 I have shown a uniflow engine 5 receiving steam from the main 6 and exhausting into the exhaust main 7 which leads to the condenser 8. Water from the condenser flows into the hot well 9 from where it is drawn through the pump line 10 by the engine driven pump 11, the pump line being controlled by a float valve 12 in the hot well so that if the supply of water becomes low for any reason (as when the engine is not using steam as fast as the pump is supplying water to the boiler), the float will close the pump line to prevent the pump from drawing in air and becoming air bound. The pump discharge line 14 is connected to the preheater coil 15 which discharges into the final coil 16 of the preheater in which the water is heated up to the boiling point corresponding to boiler pressure and usually a small portion of it is transformed into steam. The mixture of steam and water is forced through the pipe 17 to the nozzle of the ejector 18 where it picks up hot water from the storage drum 19 and enters the coils 20 of the evaporator which is closest to the burner. The steam generated in the coils 20 contains a greater or less percentage of moisture depending on

operating conditions (such as engine load and intensity of the heat from the burner) and is discharged tangentially into the drum through pipe 21 which causes centrifugal separation of the moisture which collects in the bottom of the drum to be again taken up by the ejector 18 while the dry, saturated steam collects in the top of the drum from whence it flows through the pipe 22 to the superheater coils 23 between the coils 15 and 16 of the preheater. From the superheater, the steam enters the main 6 leading to the engine. The storage drum is provided with the usual water column 24, blow-off cock 25, pressure gage 26 and with a connection 27 leading to a pressure regulator 28 connected to a throttle valve 29 controlling the burner 30. The burner receives its supply of fuel and air from the blower 31 which discharges into the burner through passage 32 in which the throttle 29 is placed. The boiler is designed to operate under a normal pressure of 600 pounds per square inch and the regulator is adjusted to hold the valve 29 open until the pressure exceeds that amount when the valve will be closed and the burner shut off until the pressure drops to 500 pounds per square inch. Then the regulator automatically opens the valve and the burner starts up. The pressure regulator and burner are not shown in detail since they per se form no part of the present invention but they are shown and claimed in the copending application for pressure regulator of G. W. Engstrom, Serial No. 524,568, filed Dec. 24, 1921, patented Jan. 11, 1927, Patent Number 1,613,879, and my patent for vaporizing burner previously referred to.

As stated above, my steam power plant includes a closed system in which a definite quantity of water is continuously circulated, only enough water to make up for unavoidable leakage having to be added from time to time, and this may be supplied to the hot well 9 whenever necessary. The storage drum 19 is of considerable capacity so that if the feed pump 11 is supplying water to the boiler faster than the engine is using steam, the water level will rise in the drum but the capacity of the drum and the amount of water in the system are such that the drum cannot be filled above the level of the discharge end of the steam pipe 21 and also, before the drum becomes flooded, the float in the hot well will have closed the pump inlet because of failure of the supply of water from the condenser.

A hand pump 33 is connected to the pump intake and discharge pipes 10 and 14 and two valves 34 and 35 are placed in the pipe 14 and outlet of the pump 33 respectively. When the boiler is first fired up, the valve 34 is closed and valve 35 open. The hand pump is then operated until the preheater and evaporator coils are filled and water shows in the column 24. The valve 35 is then closed and valve 34 opened and the burner 30 started. In about one-half minute after starting the burner, sufficient steam will be generated to start the engine 5 and feed pump 11.

In Figs. 2 and 3 I have shown a preferred arrangement of the burner in its relation to the preheater, evaporator and superheater coils and steam drum, which parts are shown only diagrammatically in Fig. 1.

Referring first to Fig. 2, the preheater comprises the four outer concentric banks of coils inclosed within a circular casing 36 in the center of which the grate 37 of the burner 30 is located. The outer coils of the preheater discharge into the coils 16 which are between the evaporator coils 20 and the superheater coils 23. In the coils 16, the water is heated to the temperature of steam and some steam is formed therein which flows through the pipe 17 to the ejector 18 where it picks up additional water from the storage drum discharging it into the inner bank of coils 20 forming the evaporator. From the coils 20, the steam containing some moisture discharges into the drum 19 where the water is separated out, the dry steam then passing through the superheater coils 23 and finally into the steam main 6. The storage drum, ejector and connections to the several coils are covered by an inner casing 38 concentric with an outer casing 39 having an opening 40 at the top providing an outlet for the flue gases, the space 41 between the two casings forming an annular passage for the gases on their passage from the coils to the outlet 40. The hot gases from the burner pass radially outward first over the evaporator coils 20 where the greatest amount of heat must be absorbed to transform the water into steam, then over the inner preheater coil 16 in which some steam may be generated and the gases cooled sufficiently so that they will not burn the superheater coils 23 but will be hot enough to impart from 300 to 400 degrees superheat to the steam. The gases then pass successively over the remaining preheater coils until at the last coil they have given up all of their available heat and their temperature has been reduced to approximately 250 degrees F. The cool gases then pass upward into the annular space 41 through openings 42 in the cover plate 43 and finally out through the opening 40.

The boiler of Fig. 3 is identical with that of Fig. 2 except that the outer casing 39 is omitted and the flue gases are discharged through a downwardly turned flue 44 and the apertured cover plate 43 is replaced by cover 45 without passages for the flue gases. The burner 30 is concentric with the coils but the casing or jacket 36 is slightly eccentric being spaced farther from the coils

adjacent the outlet 44 than it is on the opposite side so that the space between the outermost coil and jacket increases uniformly to the outlet.

In actual practice, I have found that a boiler constructed according to my invention having an over-all height of approximately 38 inches and a diameter of approximately 26 inches with the preheater and superheater coils made from 3/8 inch pipe and the evaporator coils from 1/2 inch pipe, will, with the improved burner above referred to, generate sufficient steam at 600 pounds pressure per square inch and 300 to 400 degrees of superheat to operate continuously a uniflow engine developing 35 horse power and will supply the same engine for short periods while carrying loads up to 60 horse power and this without injury to the coils after more than one year's operation.

I attribute the remarkable steaming qualities of my boiler to the fact that the tubes always remain clean both externally and internally. The burner burns with a clean, short, blue flame without sooty deposits of any kind and, after one year's use, the tubes are just as clean as at the beginning and have not been burned since the blue flame is so short that combustion is complete before the flames reach the closest tubes. The velocity of the water and steam in the coils is relatively high which keeps the inside free from scale and greatly assists in the absorption of heat, I having found that the higher the velocity of a given amount of fluid over a given heating surface of fixed area, the greater will be the amount of heat absorbed. In the boiler just described, when supplying steam to an engine developing 25 H. P., the actual velocity of the water entering the preheater coils is 81 feet per minute and the velocity of steam leaving the superheater coils is 5,930 feet per minute while the velocity of water and steam in the evaporator coils will vary at all points due to the increasing amount of steam being formed therein. To attain these high velocities the pump 11 must deliver the feed water to the preheater coil at a pressure of approximately 200 pounds per square inch over the boiler pressure.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate preheater, evaporator and superheater coil section, each surrounding the burner, a combined storage and separating drum in the upper casing, intake connections from the drum to the superheater and evaporator sections, a discharge connection from the evaporator section to the drum, means for feeding water under pressure to the preheater section, and a discharge connection from the preheater section to the evaporator section.

2. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate preheater, evaporator and superheater coil section, each surrounding the burner, a combined storage and separating drum in the upper casing, a discharge connection from the evaporator to the drum, a steam intake from the drum to the superheater section, an ejector in the upper casing adjacent the drum, a connection from the drum to the ejector intake, a connection from the preheater section to the ejector nozzle, and a connection from the ejector outlet to the evaporator section.

3. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, separate concentric preheater, evaporator and superheater coil sections, each surrounding the burner, a drum in the upper casing and having an outlet near its lower end, means for supplying water under pressure to the preheater section, means in the upper casing outside the drum connecting the drum outlet and preheater section and discharging into the evaporator section, an outlet from the evaporator section discharging into the drum above said drum outlet, and a steam outlet at the top of said drum connected to the superheater section.

4. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate preheater, evaporator and superheater coil section, each surrounding the burner, means for supplying feed water to the preheater section, means for supplying all the water from the preheater section to the evaporator section, means in the upper casing for separating the steam generated in the evaporator section from the water, means for returning the separated water to the evaporator section with the water from the preheater section, and means for supplying the steam from the evaporator section to the superheater section.

5. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate concentric preheater, evaporator and superheater coil section, each surrounding the burner, means for supplying feed water under pressure to the preheater section, means for supplying all the water from the preheater section to the evaporator section, means in the upper casing for separating the steam generated in the evaporator section from the water, means for returning the separated water to the evaporator section with the water from the preheater section, and means for supplying the steam from the separating means to the superheater section.

6. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate concentric preheater, evaporator and superheater coil section each surrounding the burner, means for supplying feed water to the preheater section, means for supplying all the water from the preheater section to the evaporator section, a combined storage and separating drum disposed in the upper casing into which the evaporator section discharges tangentially to separate the steam from the water generated in the evaporator section, means for returning the separated water from the drum to the evaporator section with the water from the preheater section, and means for supplying the steam from the drum to the superheater section.

7. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate preheater, evaporator and superheater coil section, each surrounding the burner, means for supplying feed water under pressure to the preheater section, means for supplying all the water from the preheater section to the evaporator section, a vertically disposed cylindrical storage drum mounted in the upper casing into which the evaporator section discharges tangentially near its top to separate the water and steam generated in the evaporator section, means for returning the water from the bottom of the drum to the evaporator section with the water from the preheater section, and means for supplying the steam out of the top of the drum to the superheater section.

8. In a boiler, the combination of an upper and a lower casing, a burner disposed in the lower casing, a separate preheater, evaporator and superheater coil section, each surrounding the burner, a cylindrical storage drum mounted in the upper casing, a connection from the evaporator section discharging tangentially into the drum near its top end to separate the steam and water generated in the evaporator section, a steam intake from the top of the drum to the superheater section, an ejector adjacent the drum inside the upper casing, a connection from the lower part of the drum to the ejector intake, a connection from the preheater section to the ejector nozzle, and a connection from the ejector outlet to the evaporator section, whereby all the water in the preheater section goes directly into the evaporator section with the water from the storage drum.

In testimony whereof I affix my signature.

CHARLES A. FRENCH.