D. STARK & A. R. CARLYLE.

STEAM GENERATOR.

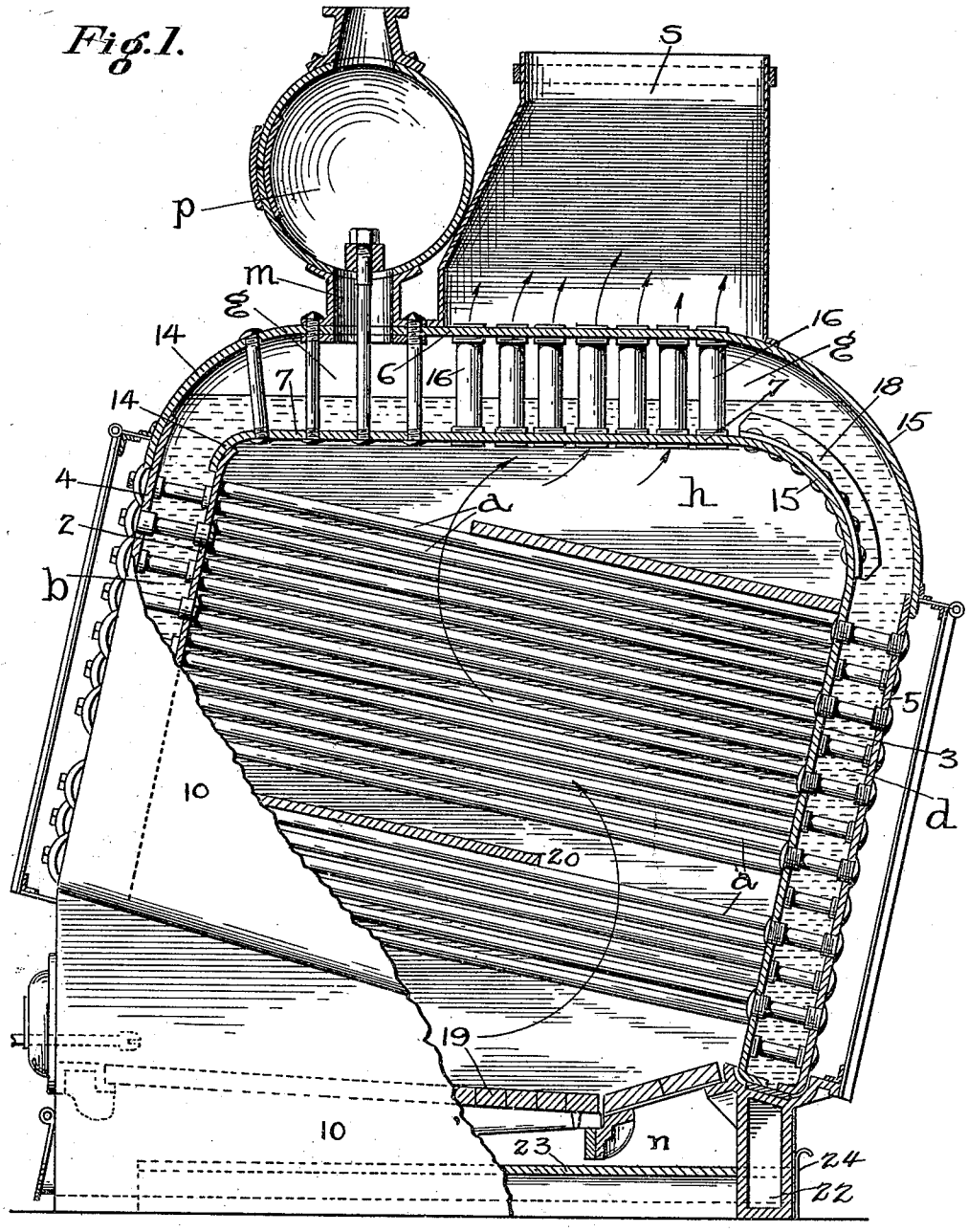
APPLICATION FILED JAN. 24, 1910.

1,004,706.

Patented Oct. 3, 1911.

3 SHEETS—SHEET 1.

Fig. 1.



WITNESSES.

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3 SHEETS—SHEET 2.

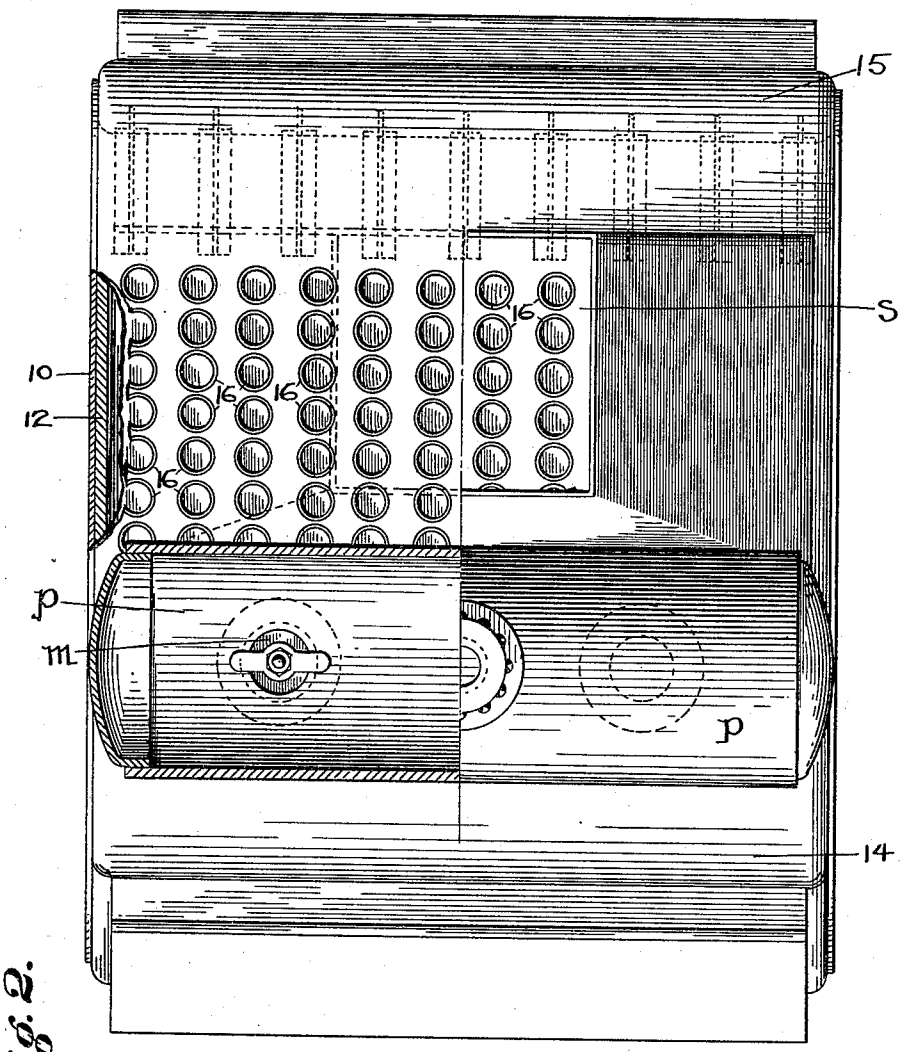

Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 3.

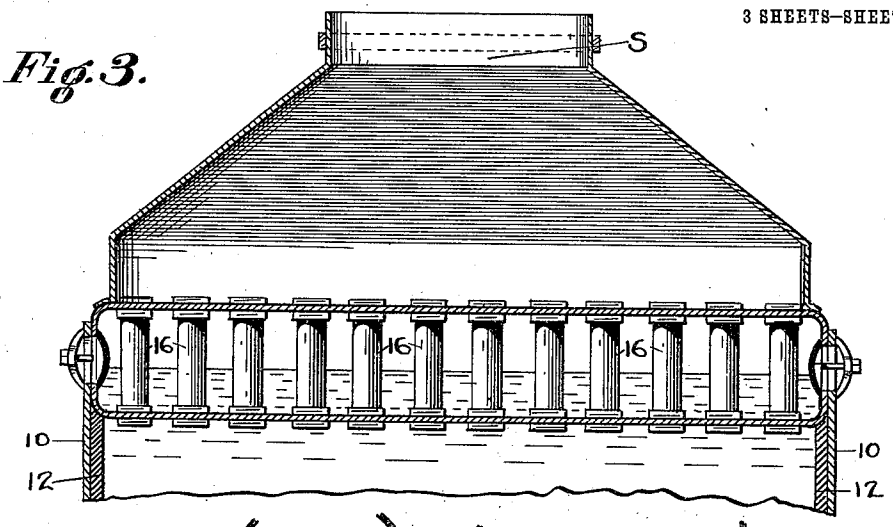
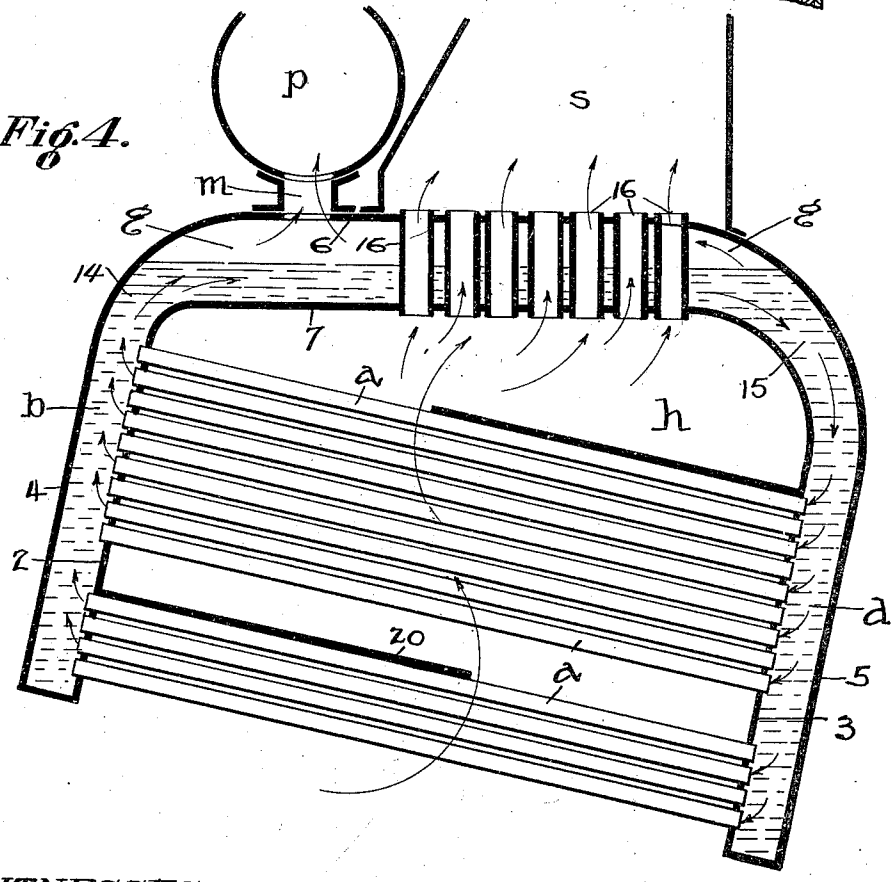


Fig. 4.



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UNITED STATES PATENT OFFICE.

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STEAM-GENERATOR.

1,004,706. Specification of Letters Patent. Patented Oct. 3, 1911.

Application filed January 24, 1910. Serial No. 539,792.

To all whom it may concern:

Be it known that we, DAVID STARK and ARTHUR R. CARLYLE, citizens of the United States, residing in the city and county of San Francisco, State of California, have invented new and useful Improvements in Steam-Generators, of which the following is a specification.

This invention relates to improvements made in steam generators of the type or description having a multiplicity of water tubes connected through headers or water-legs with the chamber in which the steam is collected for distribution. In steam generators of this type the arrangement of the tubes and water legs has heretofore been of such character that the communication between the water evaporating spaces and the steam liberating and collecting spaces is obstructed, or choked, to a greater or less extent, owing to the multiplicity of nipples and similar contracted passages connecting the same; with the result that while the generator may have a relatively large area of evaporating surface, yet the effective area of the circulating passages possible under the construction is so greatly reduced by reason of the nipples and like connections between the water legs and the steam liberating space, that the capacity of the generator is restricted and its working efficiency is materially reduced in consequence.

In the present invention we aim to provide in a generator of the multitubular type a steam liberating surface of large area having direct and unbroken or unrestricted communication with the water legs, and affording also a circulating space of ample superficial dimensions, in width equal to the transverse dimensions of the front and rear water legs, and in length to the longitudinal dimension of the combustion chamber.

The invention has as its object further to provide in a generator of the type described a continuous, connecting compartment between the front water leg and the rear water leg, of the full width of the water-legs and inclosing a steam liberating space having direct communication with the steam collecting chamber.

A further object of our invention is to provide in a steam generator of the water tube and water leg type or description a water top or compartment common to the front and rear water-legs and in direct communication therewith by connecting spaces or passages for the full width of the water legs.

To these and other objects pertinent to generators of this type our said invention consists in a peculiar and novel construction of steam generator of the water-tube type, having front and rear water legs joined by a water top or overhead compartment constituting by its form and position an evaporating chamber common to both water legs and a common steam conducting or delivering space connecting the two water-legs with the steam collecting chamber.

A steam generator of our invention consists further in a novel construction and arrangement of water tubes, front and rear water legs, a water top or overhead compartment formed as a continuation of the front and rear water legs over the top rows of water tubes and constituting a common steam liberating and conducting space between the water legs and the steam collecting chamber all as hereinafter described and illustrated in the accompanying drawing.

Figure 1 of the drawing referred to represents in side elevation a water tube steam-generator embodying our invention, showing the side of the shell partially removed to expose the internal construction, and the upper part including the steam collecting chamber, the stack and the water legs in longitudinal section. Fig. 2 is a plan or top-view, showing the steam collecting chamber and the stack in horizontal section on one side of the longitudinal center line. Fig. 3 is a vertical sectional view of the stack and the arch or compartment over the top of the combustion chamber, the section being taken through both parts. Fig. 4 is a diagrammatic representation of the water holding and steam generating and collecting spaces, showing the same in longitudinal section.

As embodied in the generator therein shown, the tubes *a* are united by a water leg or header *b* in which are fixed the front ends of the tubes *a*, and a similar water leg or compartment *d* at the rear, taking the opposite ends of the water-tubes and uniting them by a common water holding and evaporating space in the same manner as the front leg connects the tubes at the front ends.

Instead of being separate compartments connected together by or through the water tubes alone, and having connection sepa-

rately with the steam collecting space or chamber of the generator through nipples or other contracted passages, as heretofore, the headers or water-legs *b*—*d* in our new construction connect directly with or join a water top or compartment *g* that extends over and closes the top of the combustion chamber *h*, forming practically a continuation of the water-legs or compartments over the top of the chamber containing the tubes *a*. The inclosed space in this water top or compartment is in direct communication with the evaporating space inclosed between the tube sheet and the outer wall in each water leg, the remaining sides of the legs and the top compartment being formed of plates 10 and a non-conducting lining or inner facing 12 of brick or tile, of well known construction having proper fire proof qualities. The sides 10 of the combustion chamber close in the fire chamber *h* and the air conducting and controlling passages or chambers *n* beneath.

A further novel feature in a steam generator of our invention consists in carrying connecting passages or conductors for the waste gases or products of combustion from the combustion chamber *n* to the smoke stack *s* through the water evaporating and steam liberating compartment *g*, employing for that purpose a number of necks or upright tubular connections 16 forming a direct connection with the stack above through upright passages. It is evident that these tubular connections 16 will be heated by the gases to a temperature higher than the temperature of the liberated steam and as the water level is at about the middle of the compartment the effect of this higher temperature will be to superheat the liberated steam in the compartment *g* above the water and allow only dry and partially superheated steam to pass into the steam collecting chamber. On account of the large steam liberating surface the agitation of the surface of the water is greatly lessened and the tendency of the water to throw off fine particles of water which mix with the steam to form wet steam is greatly lessened thereby causing a comparatively dry steam to be liberated from the water. Any particles of water which may be held in suspension by the liberated steam are destroyed by the superheating effect of the connections 16, and only dry steam enters the steam collecting chamber.

In the present construction the tube sheets 2—3 and the plates 4—5 forming the outer walls of the legs are joined to the top sheet 6 and bottom sheet 7 of the water top or compartment *g* by the curved sections 14—15, instead of joining the top compartment at an angle. The water holding compartments or sections are preferably joined in that manner to provide between the water space inclosed by the water and the steam liberating space inclosed by the top compartment a direct communication for the entire width or transverse dimension of the water leg, unobstructed by the presence of nipples, stay bolts or other parts extending across the passage between the water-leg and the compartment inclosing the steam liberating surface.

By reason of the peculiarly strong and simple construction which we are able to employ, the number of stay bolts required to tie and stiffen the top and bottom walls of the steam liberating compartment is relatively small, and is confined to the vicinity of the connection *m* between the compartment *g* and the steam collecting chamber *p* above it; as the tubes or nipples 16 that connect the combustion chamber with the stack *s* serve also as stays between the top and bottom of the steam liberating compartments in which they are fixed.

Sufficient room is afforded on the flat top of the steam liberating compartment to place the steam collecting chamber, as well as to permit direct connection with the stack *s* of the tubes 16 for the waste gases. The former chamber or compartment is connected directly with the space in the water top either through one neck or connection *m* of large diameter, or by several of such connections at intervals apart where the dimensions of the generator and its steam producing capacity may require it.

The construction shown and described above has the advantage also of permitting the steam collecting chamber to be variously set or arranged with relation to the steam generating portion of the structure and at the same time have direct and full or unbroken communication with the steam evaporating and liberating space; for it may be placed in a longitudinal or fore and aft position, as well as transversely, and double or twin chambers placed on opposite sides of the stack may be substituted for a single chamber in producing a generator of larger capacity than the one here shown.

As embodied in the present construction of a multitubular generator, the front and rear water legs are inclined backward perpendicularly to the line of the water tubes, which follow by their inclination from front to rear the general arrangement of water-tubes in generators of this type. But the water top *g* to which the front and rear water legs are connected is set horizontally, with its top and bottom substantially flat and parallel to each other for the principal portion, thereby providing a steam liberating surface of large area and of a uniform depth over the bottom sheet or plate that closes over the top of the combustion chamber for the entire width and length of that chamber. In consequence of this arrange-

ment of the water-legs necessitated by the inclined position of the water tubes, the curved section 15 at the rear connecting the water top *g* and the rear leg *d* is of larger curvature than the similar connection 14 at the opposite end, but the section is sufficiently strengthened by a flanged rib 18 on the inner side of the curved bottom plate, thus avoiding the use of stay bolts.

The sheets forming the inner and outer walls of the water-legs are strengthened in the well known manner by screw-threaded stay-bolts preferably of the kind or description employed in generators of the best type of construction. In this part or feature the construction follows generally the most approved type of multitubular steam generators. Other old or well known features shown in the construction embodying our invention include the arrangement of the grate or fuel carrying surface 19 in the lower part and the deflecting tiles, baffle plates or partitions 20 placed between the rows of water tubes. The plates 20, by virtue of their disposition, coöperate with the legs to which they are attached and also with the surfaces adjacent to their remote faces, to perform several functions, to wit: The lower plate coöperates with the fire bed, to pocket the heated gases around one end portion of the tubes located beneath the plate, and also deflects the heated gases onto the front leg whereby the velocity of the water passing through the front leg is increased beyond what it would be otherwise. In fact, a circulation is set up in the front leg, since the heated surface at the lower end portion of the leg will cause an adjacent layer or layers of water to rise and mingle with the water flowing upwardly from the tubes, while the cooler water at the outer portion of the leg will descend. This will be especially true and most pronounced for a short period after the fire has been started. This action of the water in the front leg will be duplicated in the rear leg since the upper baffle plate will deflect the heated gases thereonto. With this construction, it will be manifest that the time ordinarily required to form steam in generators of this kind will be reduced to a minimum. It will be observed further that the upper baffle coöperates with the portion *g* to provide a pocket for the heated gases whereby expansion and consequent cooling of the same before passing through the members 16 will be prevented. Thus, the efficiency of the members 16, as superheaters, will be increased. Provision is made also for controlling and regulating the admission of air beneath the fuel chamber in the most effective manner to secure thorough combustion — particularly when a liquid hydrocarbon, as crude oil is used for fuel—by arranging an inlet 22 at the back to admit air under a floor or plate 23 standing above the bottom of the ash pit. The confined space under this plate communicates at the front or opposite end with the air-space under the grate, forming a heating as well as a conducting trunk for the air, by virtue of the large area of its top surface exposed directly to the heat of the fuel. A slide 24 covering the air-inlet at the back furnishes a simple means for regulating the supply of air.

An important feature of the boiler hereinbefore described is the form of the connection between the water legs and the water top. As shown such connections are curved whereby the shell of the boiler is adapted to withstand the pressure and strain to which it is subjected without being made undesirably heavy and thick.

Referring to Fig. 1 it will be seen that the inner wall of the right hand leg and the bottom of the water top *g* may be formed by a single plate which has one edge secured to the bottom frame and its opposite edge overlapping the upper portion of the plate forming the inner wall of the left-hand leg. The outer walls of said legs and chamber *g* preferably comprise three plates the one forming the top having its edges curved as shown in Fig. 1 and overlapping somewhat the plates forming the outer walls of the inclined water chamber or legs. Further it will be seen that by such a construction the upper ends of the water legs may be of as great cross sectional area as any other portion thereof, in fact said legs may be uniform in cross sectional form and area throughout their height. It is to be noted that the longitudinal central line of each of the passages connecting the top water evaporating chamber with the water legs has a curvature the radius of which is greater than the width of distance between the walls of the leg with which the passage communicates. By this construction the boiler is given the necessary rigidity and strength without employing any stay bolts or similar means in said passages. Therefore, the invention provides for a free, unobstructed circulation of water between the water evaporating chamber and both the front and rear legs.

We claim:—

1. A water tube boiler comprising inclined front and rear water legs having substantially parallel sides, a substantially horizontal steam and water chamber above said water legs and connected thereto by rounded corner portions having substantially concentric sides, water tubes connecting said water legs and arranged normal thereto and in a plurality of banks, a fire chamber below said water tubes, and a plurality of relatively small fire tubes extending through said steam and water chamber and adapted to convey the products of combustion to a

smoke chamber above said steam and water chamber.

2. A water tube boiler comprising inclined front and rear water legs having substantially parallel sides, a substantially horizontal steam and water chamber above said water legs and connected thereto by rounded corner portions having substantially concentric sides, water tubes connecting said water legs and arranged normal thereto, a steam drum above said steam and water chamber, tubular connecting members between said steam and water chamber and said steam drum, a fire chamber below said water tubes, and a plurality of relatively small fire tubes extending through said steam and water chamber and adapted to convey the products of combustion to a smoke chamber above said steam and water chamber.

3. A water tube boiler comprising inclined front and rear water legs having substantially parallel sides, a substantially horizontal steam and water chamber above said water legs and connected thereto by rounded corner portions having substantially concentric sides, the rear corner portion being of larger curvature than the front and the inner side thereof provided with reinforcements, water tubes connecting said water legs and arranged normal thereto, a transversely arranged steam drum above the front of said steam and water chamber, and tubular connecting members between said steam and water chamber and said steam drum, a fire chamber extending from the front to the rear water leg below said tubes, and a plurality of relatively small fire tubes extending through said steam and water chamber in the rear of said steam drum and spread over the major portion of the steam and water chamber and adapted to convey the products of combustion across the steam and water chamber to a smoke chamber above the same.

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Witnesses:
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