No. 844,343. PATENTED FEB. 19, 1907.

O. FLAMM & F. ROMBERG.

WATER TUBE BOILER.

APPLICATION FILED SEPT. 15, 1905.

3 SHEETS—SHEET 1.

Fig. 1.

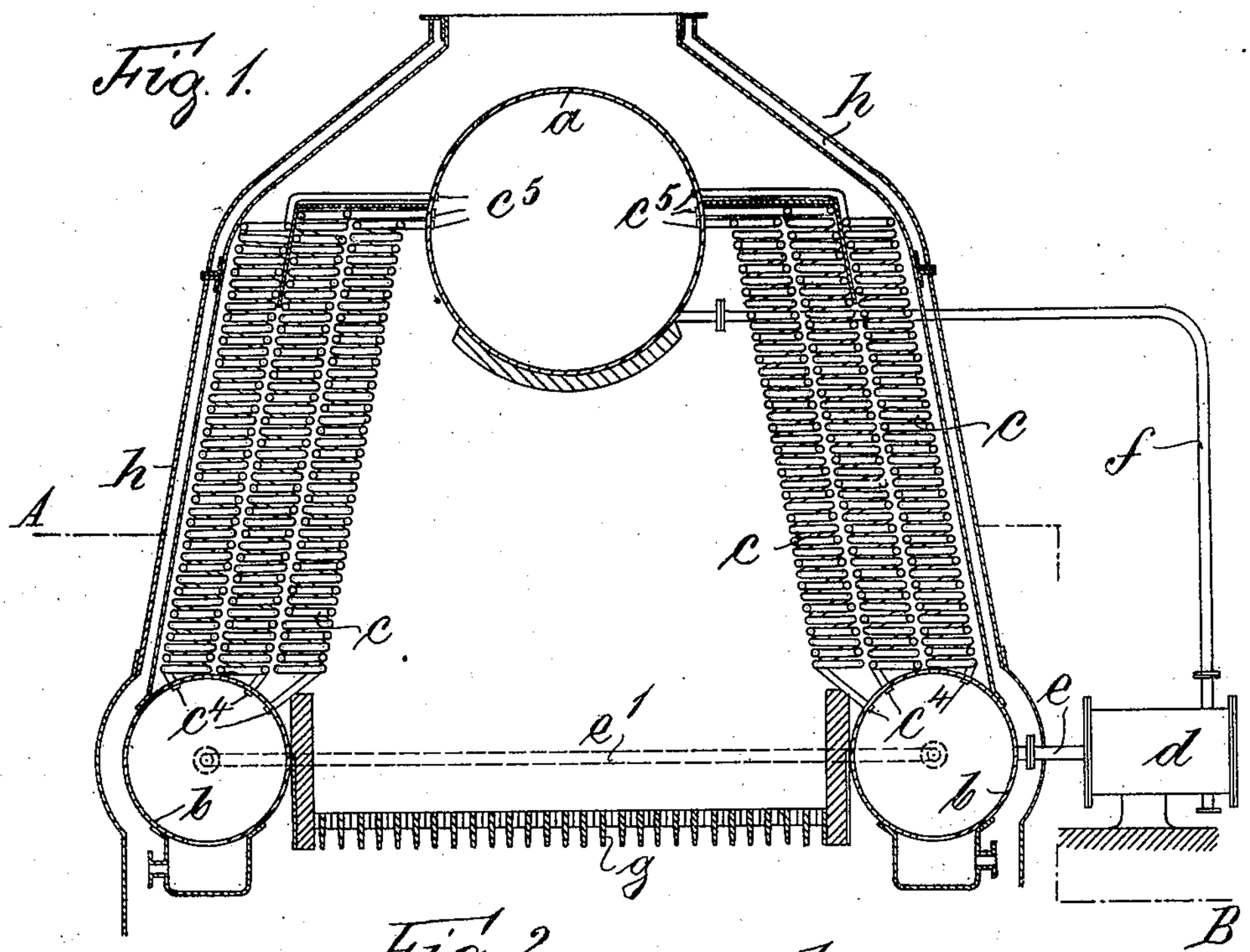
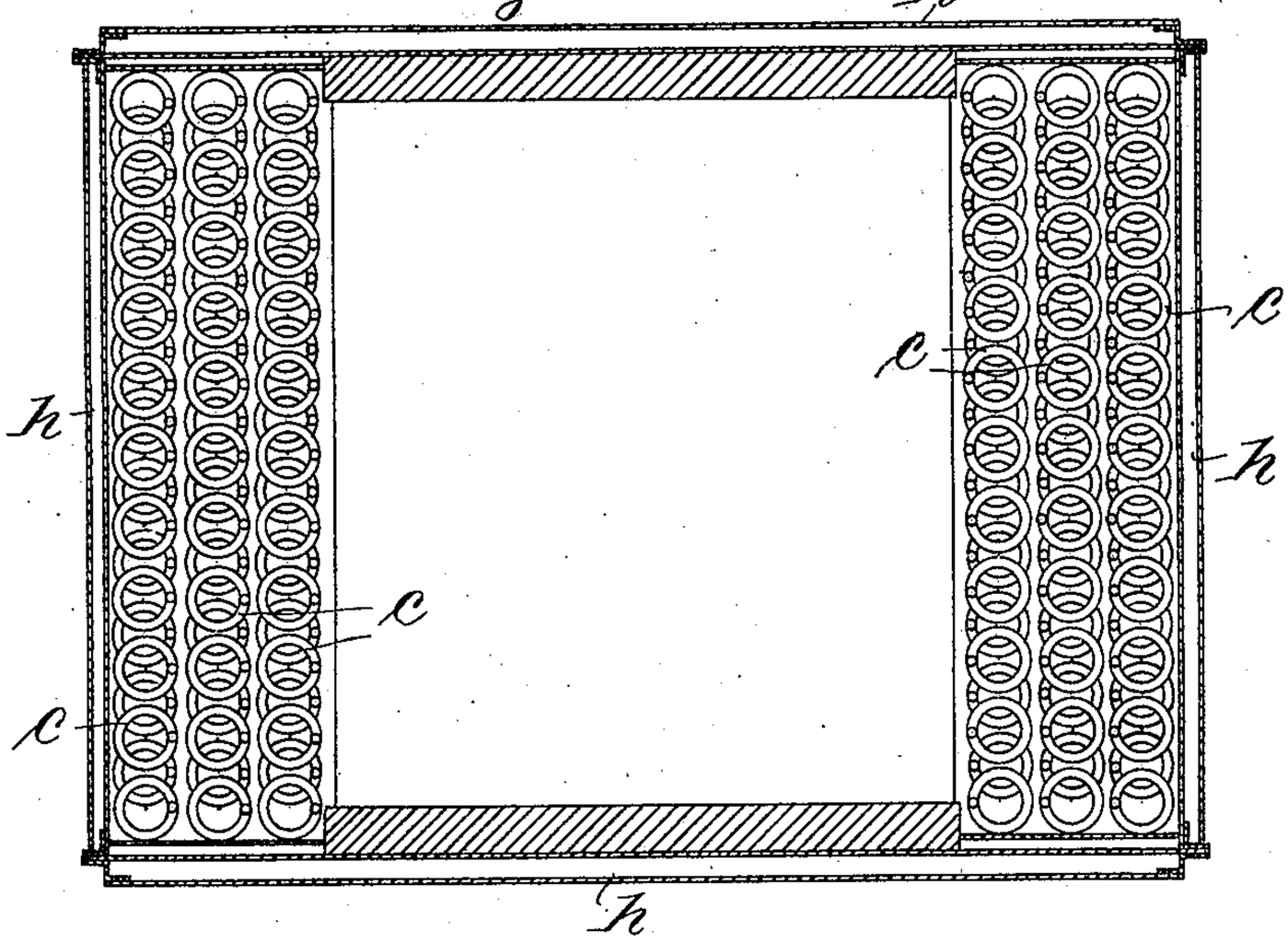


Fig. 2.



Witnesses:
Emil Kayser.
Carl Ruß.

Inventors:
Oswald Flamm
Friedrich Romberg
by Pouncefoot
Attorney.

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3 SHEETS—SHEET 2.

Fig. 3.

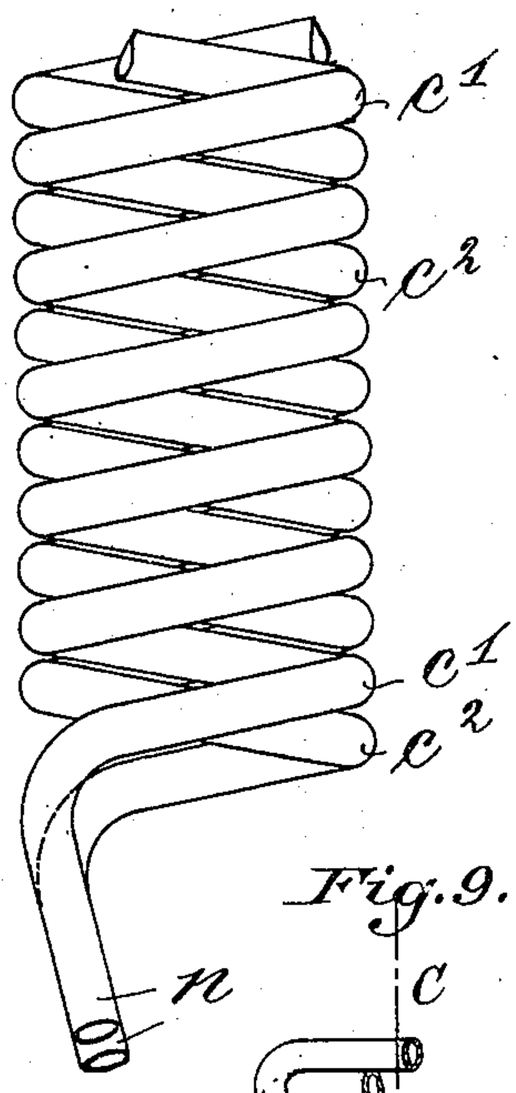


Fig. 4.

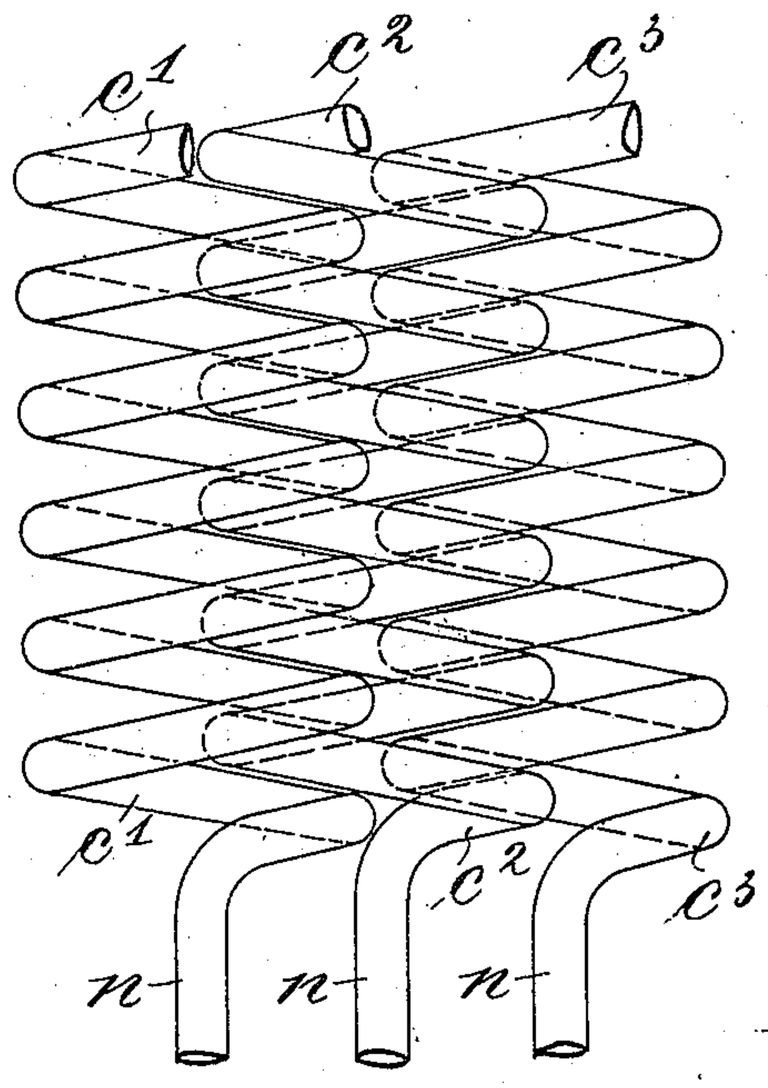


Fig. 9.

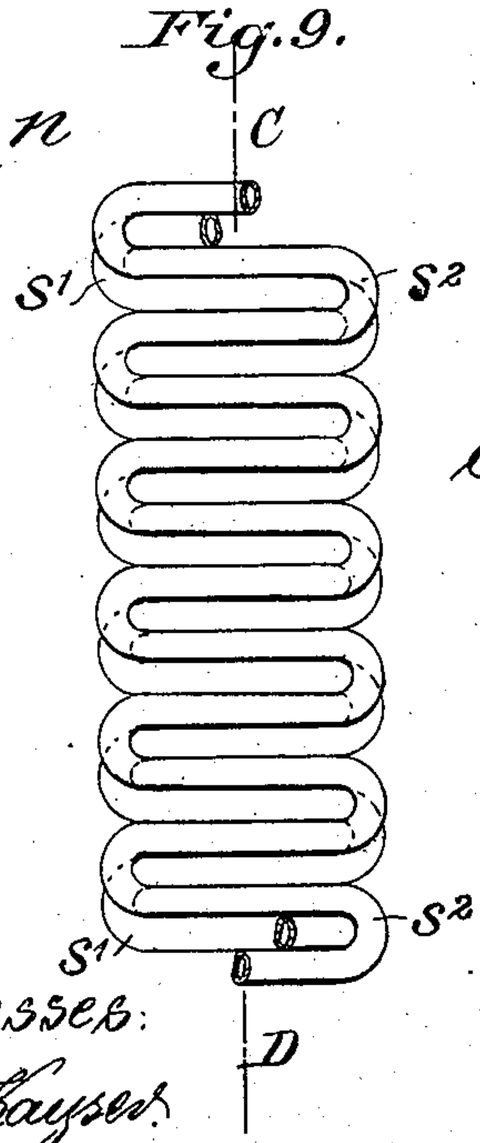


Fig. 5.

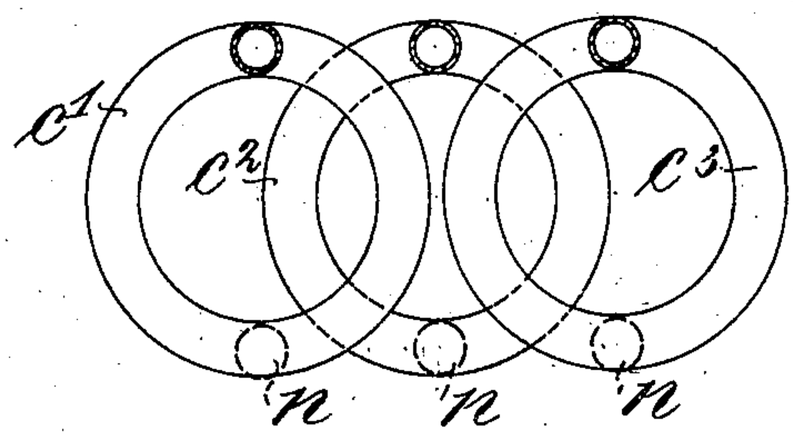
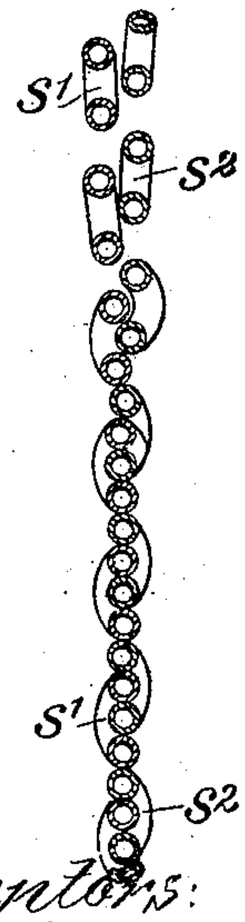


Fig. 10.



Witnesses:
Emil Kayser.
Carl Ruß

Inventors:
Oswald Flamm.
Friedrich Romberg
by Robert Dippler
Attorney.

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WATER TUBE BOILER.

APPLICATION FILED SEPT. 15, 1905.

3 SHEETS—SHEET 3.

Fig. 8.

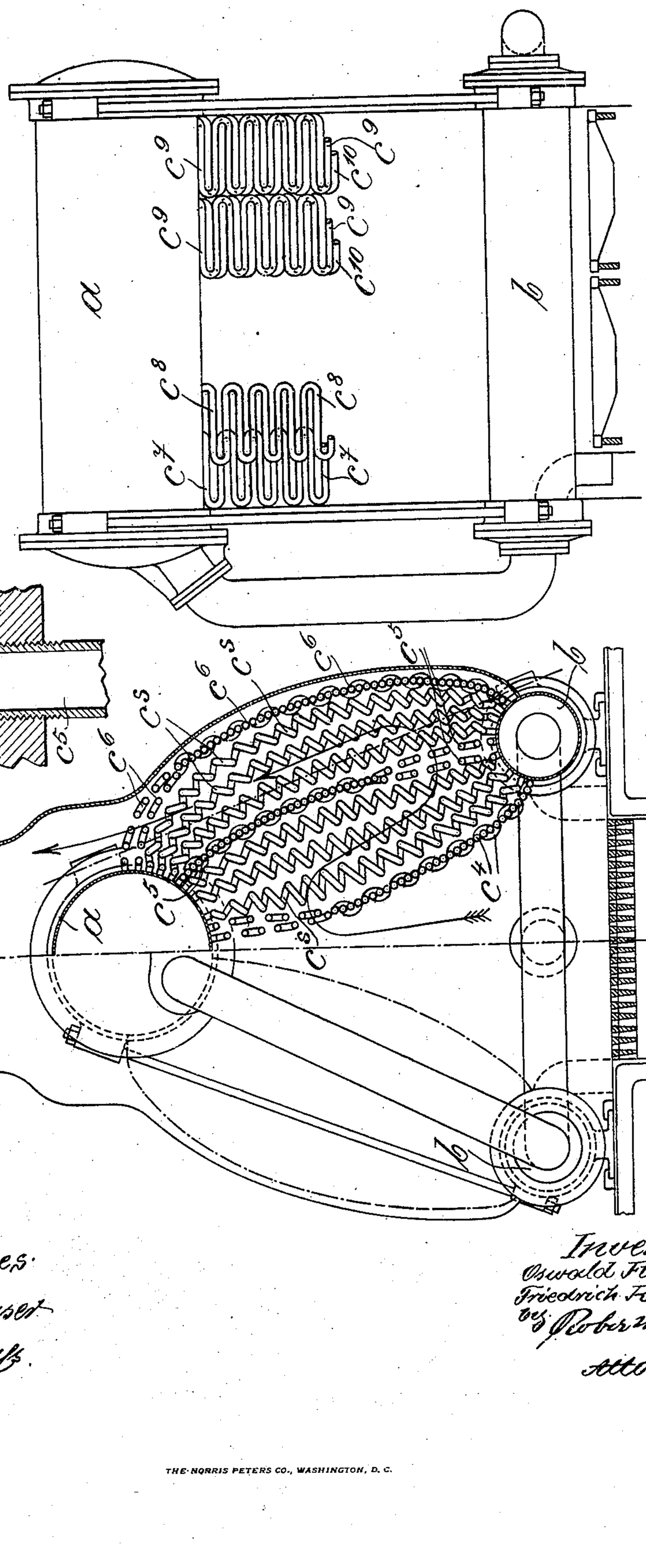

Fig. 6.

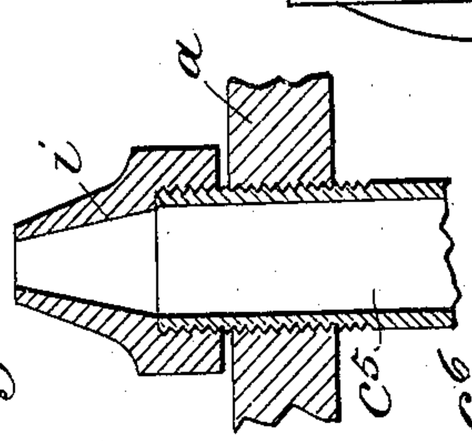

Fig. 4.

Witnesses:
Emil Kayser
Carl Ruß.

Inventors
Oswald Flamm
Friedrich Romberg
by Robert Seppler
Attorney.

UNITED STATES PATENT OFFICE.

OSWALD FLAMM, OF CHARLOTTENBURG, AND FRIEDRICH ROMBERG, OF NICOLASSE, NEAR WANNSEE, GERMANY.

WATER-TUBE BOILER.

No. 844,343. Specification of Letters Patent. Patented Feb 19, 1907.

Application filed September 15, 1905. Serial No. 278,688.

To all whom it may concern:

Be it known that we, OSWALD FLAMM and FRIEDRICH ROMBERG, both subjects of the King of Prussia, German Emperor, and residents of Charlottenburg, near Berlin, Kingdom of Prussia, German Empire, and of Nicolasse, near Wannsee, Germany, respectively, have jointly invented certain new and useful Improvements in Water-Tube Boilers, of which the following is an exact specification.

Our invention relates to water-tube boilers consisting of one or more lower boilers, one or more upper boilers, and a number of long narrow tubes situated between the upper and under boilers.

In boilers of the above-mentioned type the diameter of the said water-tubes should not be below a distinct minimum, and in length these tubes should not surpass a distinct maximum length in order to maintain a good water circulation to prevent the tubes from burning and the passages therethrough from being obstructed by furring.

For obtaining the advantages of very narrow and long tubes, whereby a particularly large heating-surface and an excellent exchange of heat are insured, and, on the other hand, for avoiding burning and choking of the tubes, we employ according to our invention an artificial accelerated water circulation for boilers of this type. For this purpose one or several pumps are inserted between the upper and the lower boiler for the purpose of forcing feed-water, as well as circulating water, through the tubes. We are thus enabled to use very narrow and long water-tubes and to obtain the above-mentioned advantages, and the considerable defects usually experienced with such tubes when natural circulation is used are overcome. It has been heretofore proposed to employ a plurality of short straight water-tubes in communication with a water-drum, the water being forced through such tubes by a propeller, or to employ very long tubes connected between steam and water chambers. It has not, however, been proposed to employ long and narrow tubes in connection with such a pump.

In order that the fur-stone may be precipitated, receptacles or any suitable devices are provided behind, as well as before, the circulating-pump and arranged either in or at the upper or the lower boiler and in such a way that the fur-stone and other impurities deposited in that receptacle can be removed therefrom while the burner is working.

The boilers constructed according to our invention can be used in large sizes, and they permit of obtaining a large heating-surface and good exchange of heat, while saving much space and weight.

In order to make our invention more clear, we refer to the accompanying drawings, in which—

Figure 1 is a cross-section of our improved boiler. Fig. 2 is a horizontal section on line A B in Fig. 1. Fig. 3 is a partial front elevation of the water-tubes to a larger scale. Fig. 4 is a side view. Fig. 5 is a plan view in part of the water-tubes in a larger scale. Fig. 6 is a cross-section of a nozzle provided at the ends of the water-tubes. Fig. 7 shows in diagrammatical manner another constructional form of our improved tube-boiler, partly in front elevation and partly in cross-section. Fig. 8 is a side view. Figs. 9 and 10 show details of water-tubes as used in the construction according to Figs. 7 and 8.

In the figures, *a* shows the upper boiler; *b b*, the lower boilers, and *c c* are the water-tubes, having a particular form and having in consequence of our improvements a very small diameter and a great length.

d is a pump by which the water circulation in the under boilers, the water-tubes, and in the upper boiler is maintained.

e is a forcing-pipe leading to the lower right-hand boiler, from which a forcing-pipe *e'* passes to the lower left-hand boiler *b*. The upper boiler *a* is connected with the lower boiler by means of water-tubes arranged in the example Figs. 1 to 5 in three sets between the boilers. The upper boiler *a* is connected by the suction-pipe *f* with the pump *d*, through which the superfluous water not evaporated is drawn off from the pump in order to pass for a second time the periodical return.

g is a fire-grate which is surrounded by walls *h*.

The water-tubes are of special form, as illustrated in Figs. 3, 4, and 5. The single water-tubes have the form of a helical line having in

all parts the same pitch and connected with the lower boiler with the ends n n, while the upper ends of the tubes discharge into the upper boiler a in the same manner. In order to obtain a good exchange of heat, the inner tube set lying next to the fire-gases may be made of a larger diameter, while the outer tube sets may have diameters gradually decreasing. The water-tubes c' c^3 form a right-hand helical line, and in order to permit them to be put together with the tube c^2 the latter must have the form of a left-hand helical line, while its pitch is the same as that of the water-tubes $c'c^3$. By this arrangement water-tubes are combined having a considerable length and occupying only a small space. Each set of water-tubes is made in this way and the single screw-shaped water-tubes forming the single sets are connected at c^4 and c^5 with the lower and upper boilers, respectively.

In order to obtain in the present boiler a regulation of pressure and speed of the water and the steam in the narrow water-tubes, the ends c^5 of the water-tubes are provided with nozzles i, screwed upon the tube end c^5, as indicated in Fig. 6. According to the diameter of the nozzle it is possible to alter the pressure in the tubes when water is pumped through and the speed of the water is constant.

In the construction illustrated in Figs. 7 and 8 a modified form and arrangement of the water-tubes is provided.

The same reference-letters designate the same parts as in Figs. 1 and 2. The lower boilers b are connected with the upper boiler a by means of serpentine-shaped water-tubes c^3, and for the formation of fire-passages by the water-tubes themselves series of serpentine-shaped tubes, being combined in the manner indicated by Figs. 9 and 10, are arranged outside and in the midst of serpentine-shaped tubes c^3. The tubes of the series c^4 are divided or drawn from each other, so as to form a passage for the heating-gases coming from the fire-grate of the boiler. The middle tube series c^5 is arranged in an inverse manner as compared with c^4, and an outer tube series c^6 is provided, having the same construction as the inner tube series c^4, so that the heating-gases flow first upward, meet transversely the serpentine tubes c^s, arranged between the inner and the middle tube series, flow then downward and pass through the middle tube series c^5, and go then again upward, as indicated by the arrows. The upper and lower ends of these tube series are connected with the upper and the lower boilers in the manner described before.

In Fig. 8 the arrangement of the tubes situated between the series c^4 and c^5 or c^5 and c^6 is illustrated by the water-tubes c^7 c^8, and, furthermore, the arrangement in example of the tube series c^5 is illustrated by the tubes c^9 c^{10}, the latter forming in this way a tight wall and forcing the combustion-gas to flow in the manner before described and indicated by the arrows.

In Figs. 9 and 10 the inner tube series c^4 is illustrated in side view and in cross-section on line C D of Fig. 9, on a larger scale, from which can be seen that the serpentine tube s' is combined with the serpentine tube s^2, the tubes being laterally drawn off from each other in the upper part for forming the above-mentioned passage for the fire-gases.

In Figs. 7 and 8, t and t' are tubes which may be employed if a natural water circulation shall be maintained between the upper and lower boiler. In case of an artificial circulation the valve v is to be shut off. The circulating-pump (not shown in the figure) is connected to the boiler arrangement by means of the branch pipe t^2.

Having thus fully described the nature of our invention, what we desire to secure by Letters Patent of the United States is—

1. A water-tube boiler comprising in combination: lower boilers, a connecting-pipe joining the said lower boilers, a circulating-pump in communication with said connecting-pipe and forcing water into said connecting-pipe and said lower boilers for producing a rapid water circulation, long and narrow water-tubes being joined with their lower ends to said lower boilers, an upper boiler in communication with the upper ends of said long narrow water-tubes, and a pipe in communication with the upper boiler and the circulating-pump for the purpose of conveying the water not evaporated to the pump.

2. A water-tube boiler comprising in combination a lower boiler, a connecting-pipe joining the said lower boilers, a circulating-pump in communication with said connecting-pipe and forcing water into said connecting-pipe and said lower boilers for producing a rapid water circulation, long and narrow water-tubes being joined with their lower ends to said lower boilers, nozzles provided at the tube ends, an upper boiler into which said nozzles discharge, a pipe in communication with the upper boiler and the circulating-pump for the purpose of conveying the water not evaporated to the pump.

3. A water-tube boiler comprising in combination lower boilers, an upper boiler, long and narrow water-tubes situated between said boiler and formed of helical tubes alternatingly right-hand and left-hand threaded, and put together with their windings, a circulating-pump forcing water into said boilers and water-tubes for producing a rapid water circulation, and a pipe in communication with the upper boiler and the circulating-pump for the purpose of conveying the water not evaporated to the pump.

4. A water-tube boiler comprising in combination lower boilers, a connecting-pipe joining said lower boilers, a circulating-pump

in communication with said connecting-pipe and forcing water into the connecting-pipe and said lower boilers for producing a rapid water circulation, long and narrow water-tubes joined with their lower ends to the lower boilers and formed of serpentine tubes c^4 c^5 c^6 forming gas-passages, and of serpentine tubes c^8, an upper boiler in communication with the upper ends of said water-tubes, and a pipe in communication with the upper boiler and the circulating-pump for the purpose of conveying the water not evaporated to the pump.

In witness whereof we have hereunto set our hands in the presence of two witnesses.

OSWALD FLAMM.
FRIEDRICH ROMBERG.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.