

No. 774,334.

PATENTED NOV. 8, 1904.

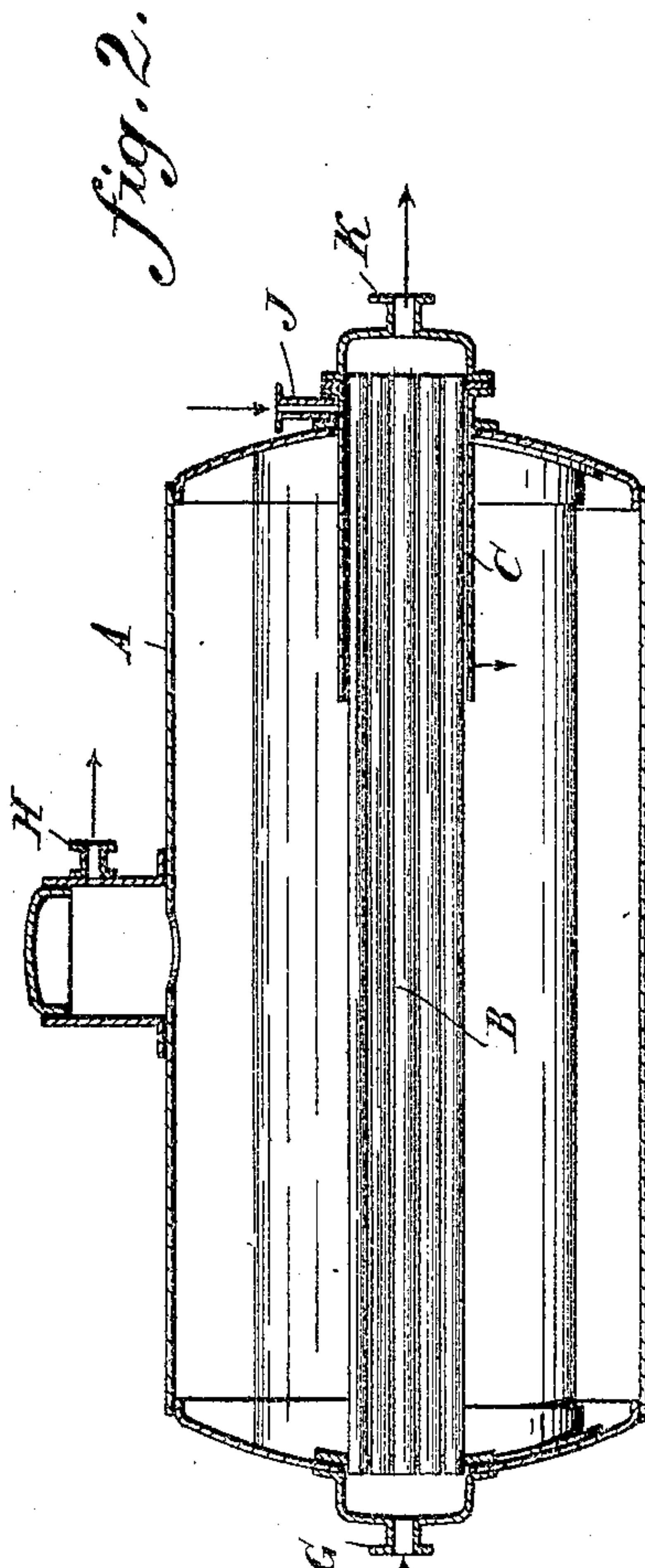
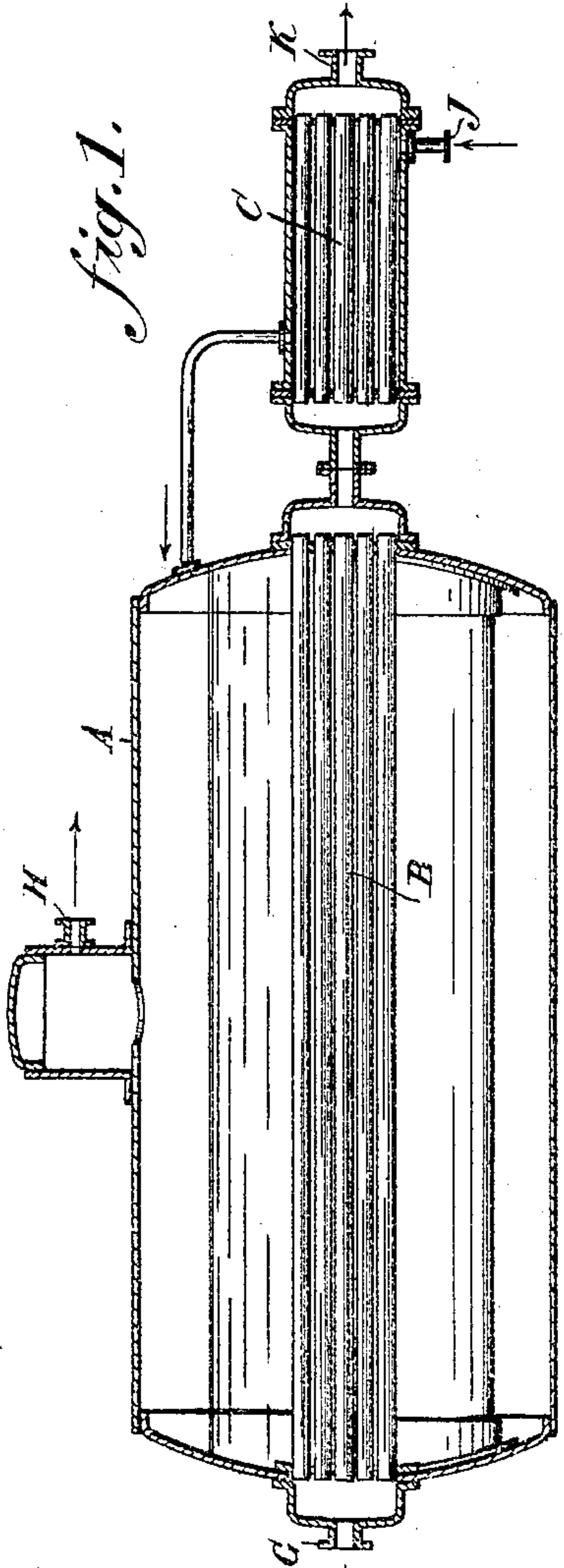
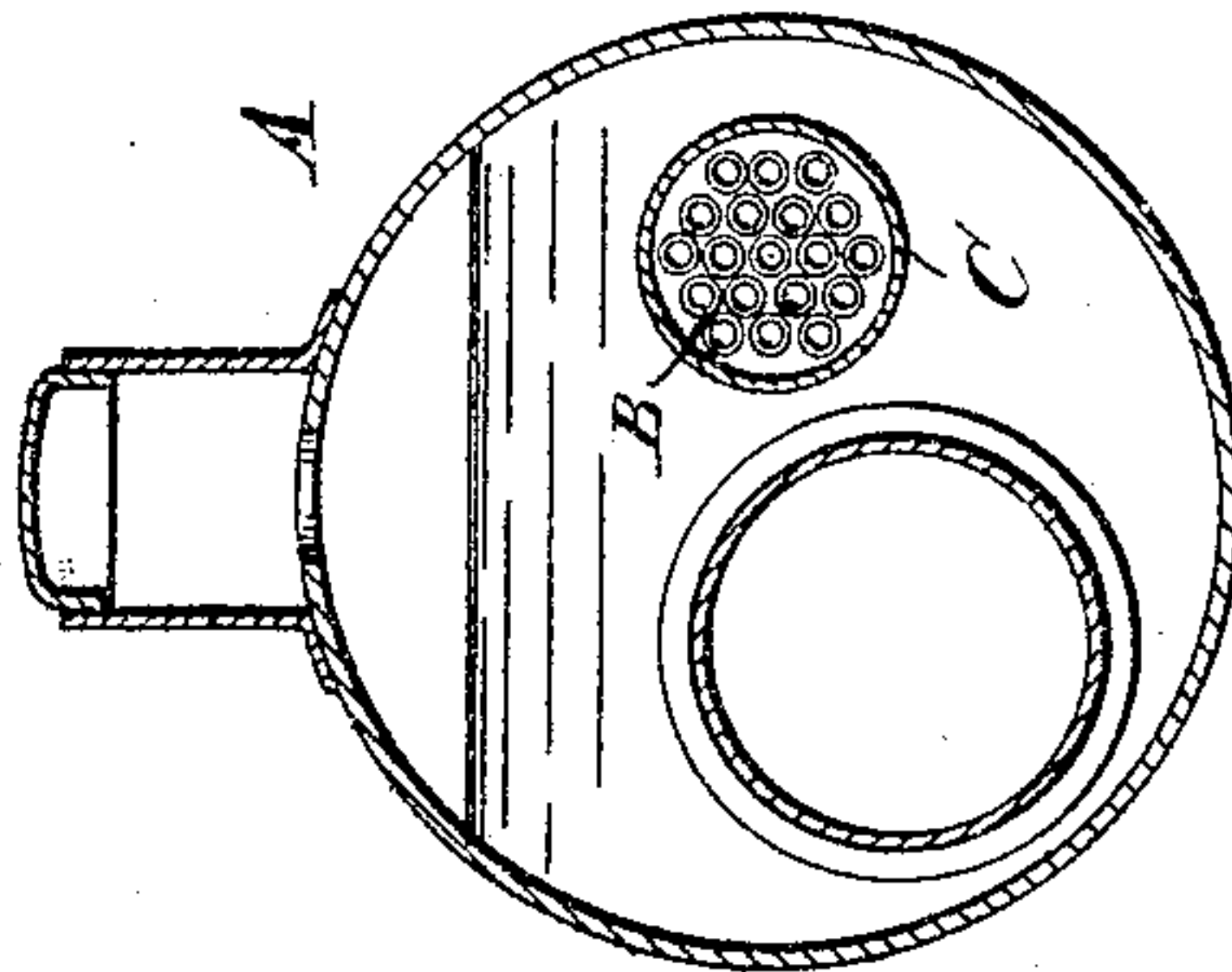
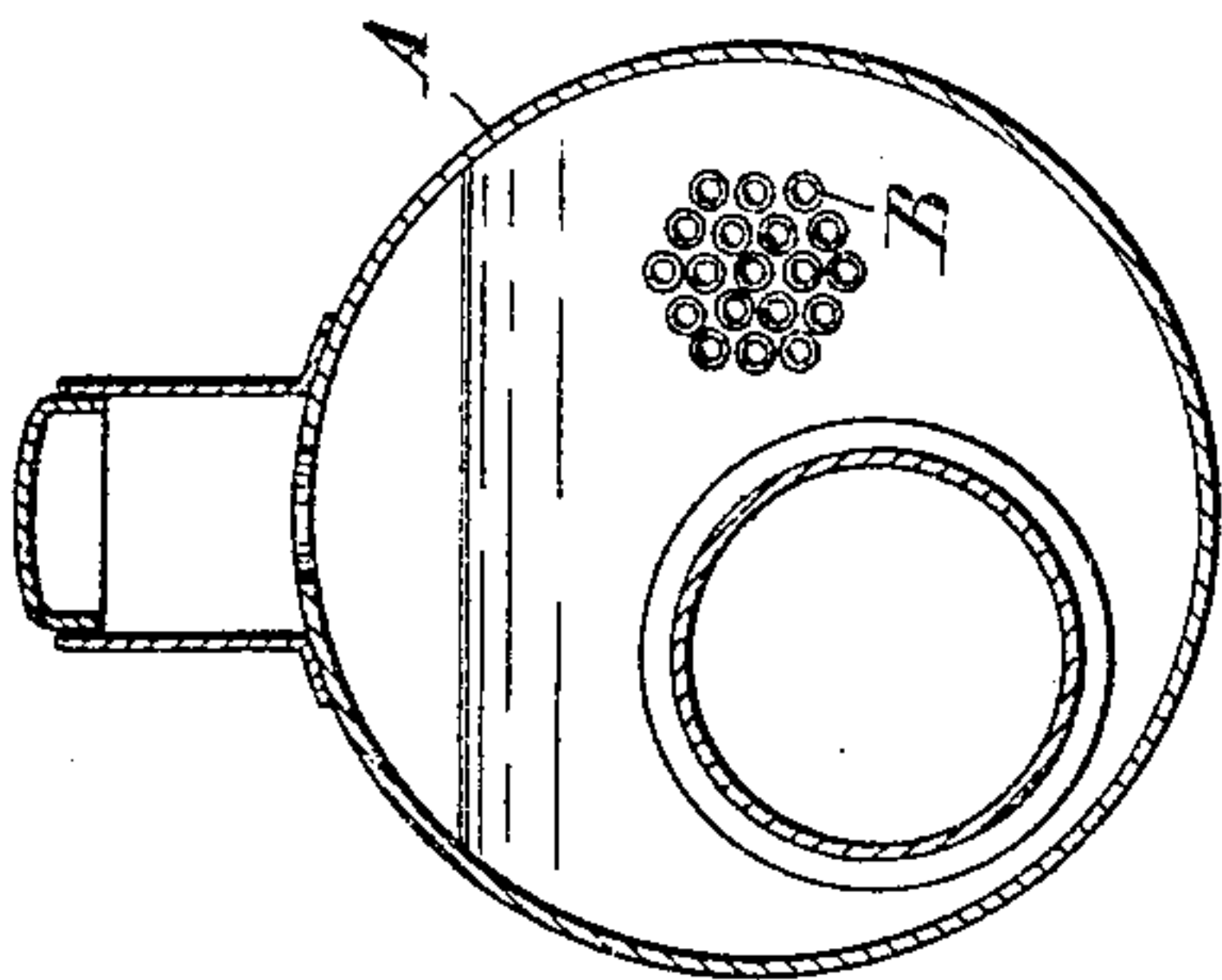
J. NADROWSKI.

SYSTEM OF HEATING BOILERS BY EXHAUST STEAM.

APPLICATION FILED SEPT. 24, 1900.

NO MODEL.

3 SHEETS—SHEET 1.



Witnesses.  
St. C. Yarnum.  
*John A. Adams*

Inventor:  
Johannes Nadrowski  
*By Thight Co.*  
Attorneys.

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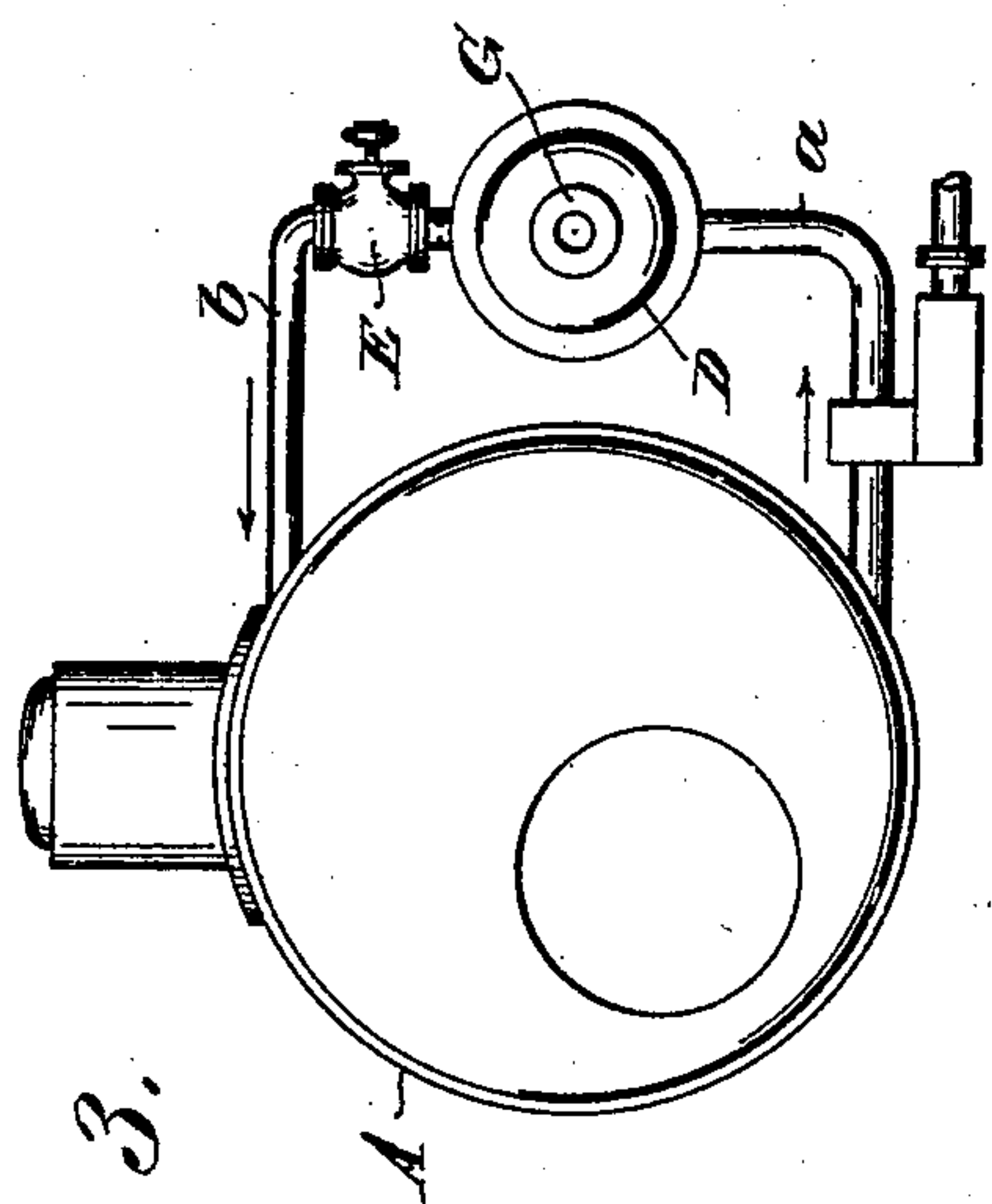


Fig. 3.

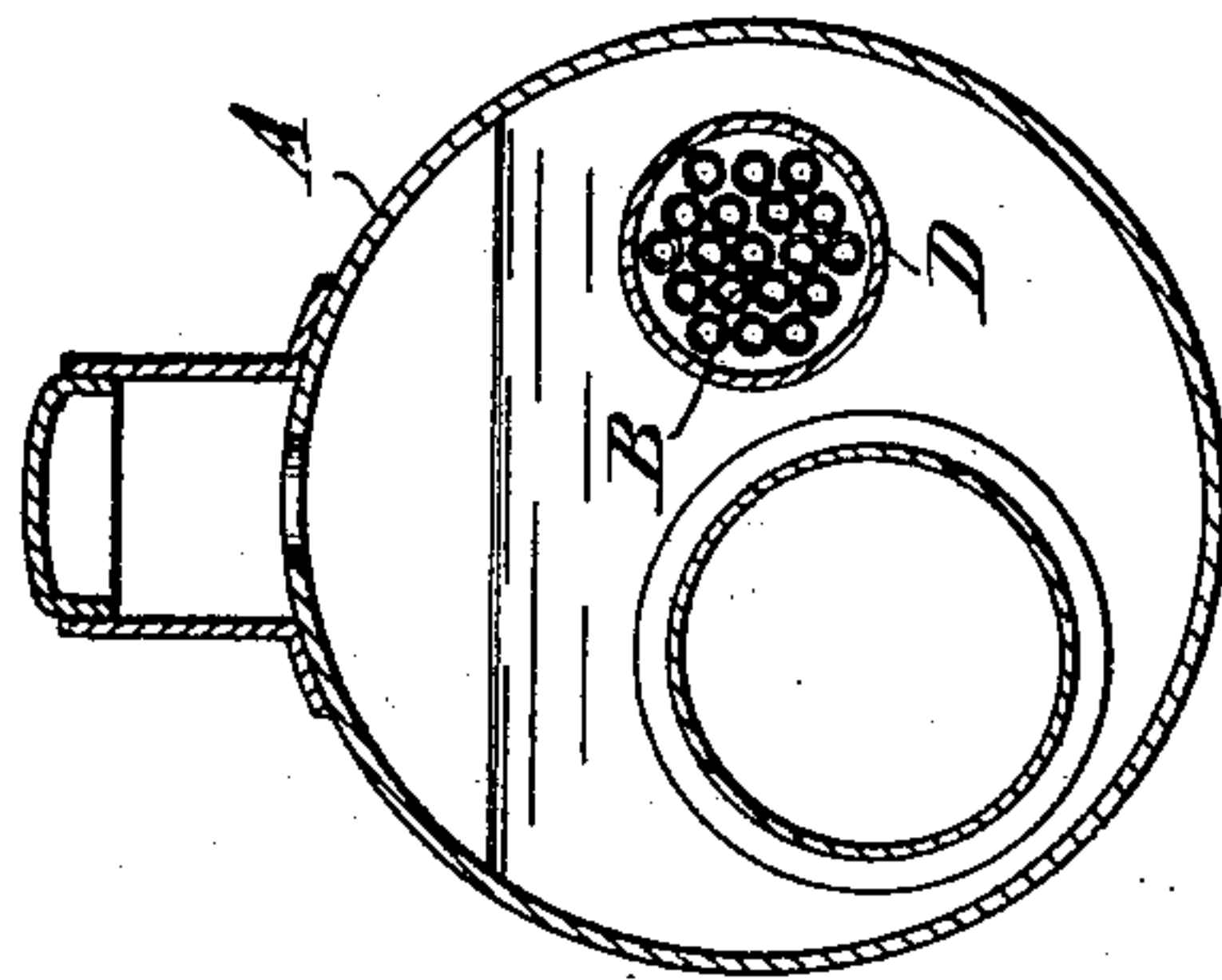
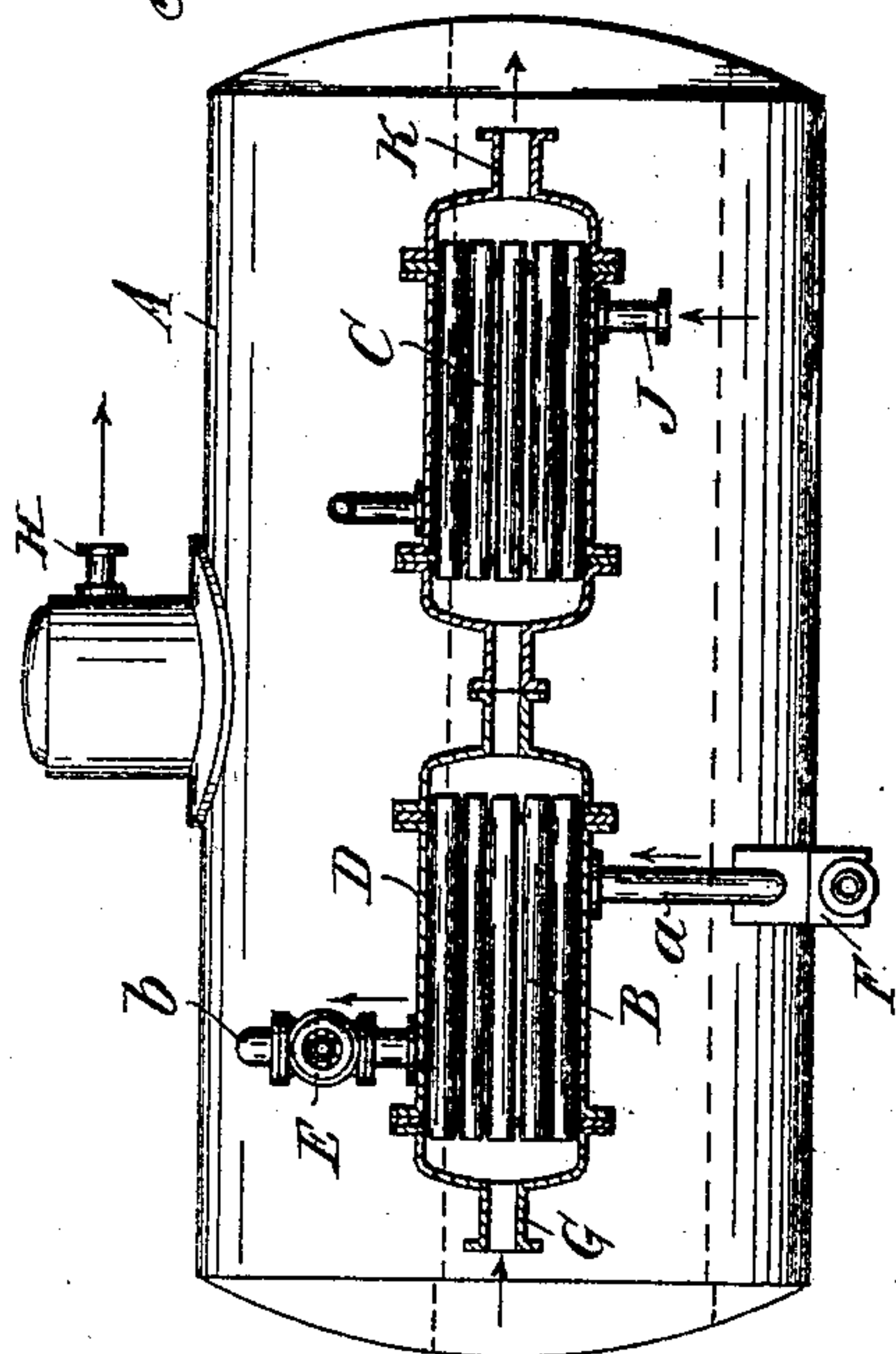
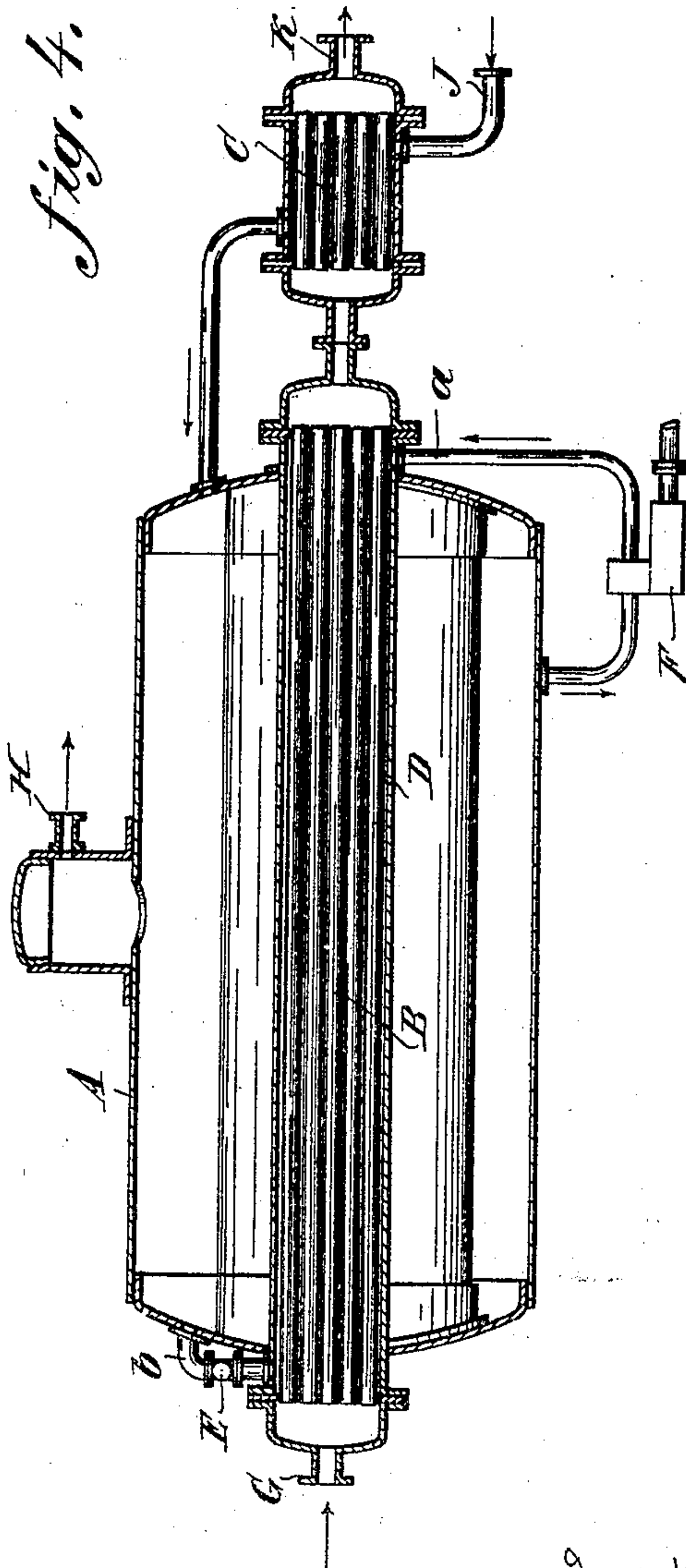


Fig. 4.



Witnesses:  
W. E. Manning  
Jno R. Hume

Inventor:  
Johannes Nadrowski  
By Wright & Co.  
attorneys



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3 SHEETS—SHEET 3.

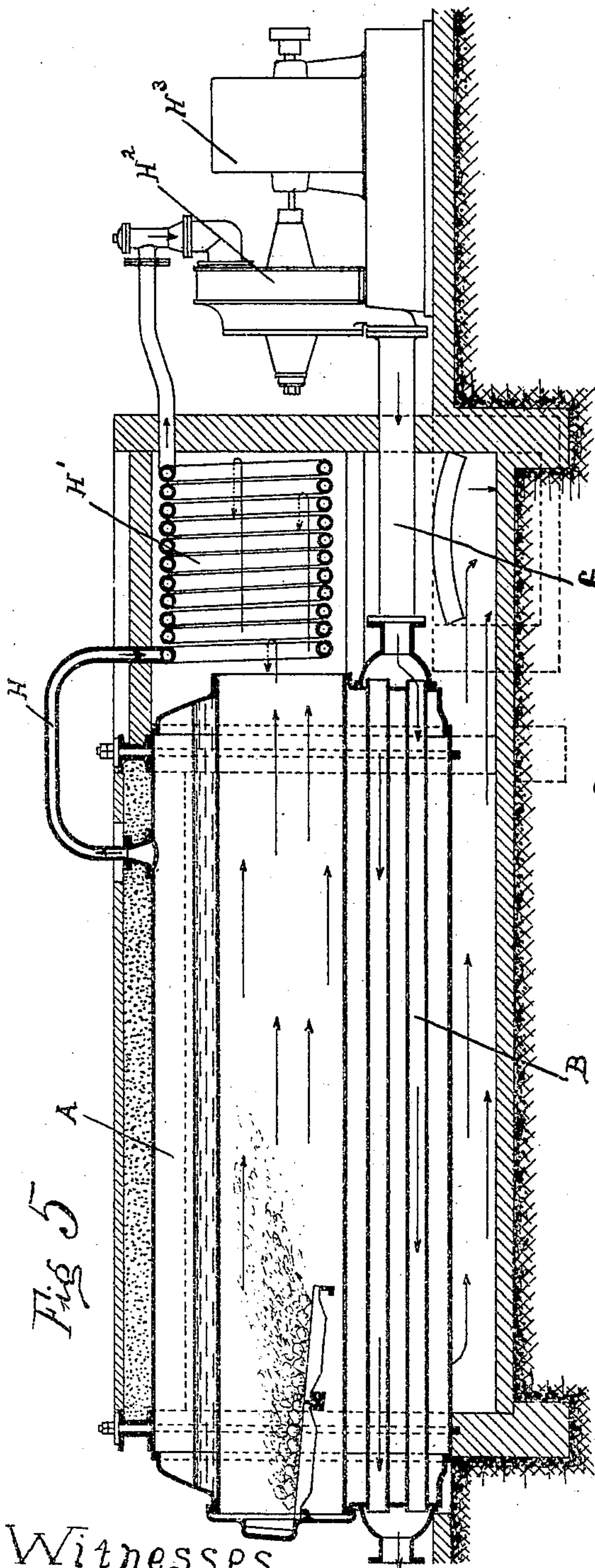


Fig 5

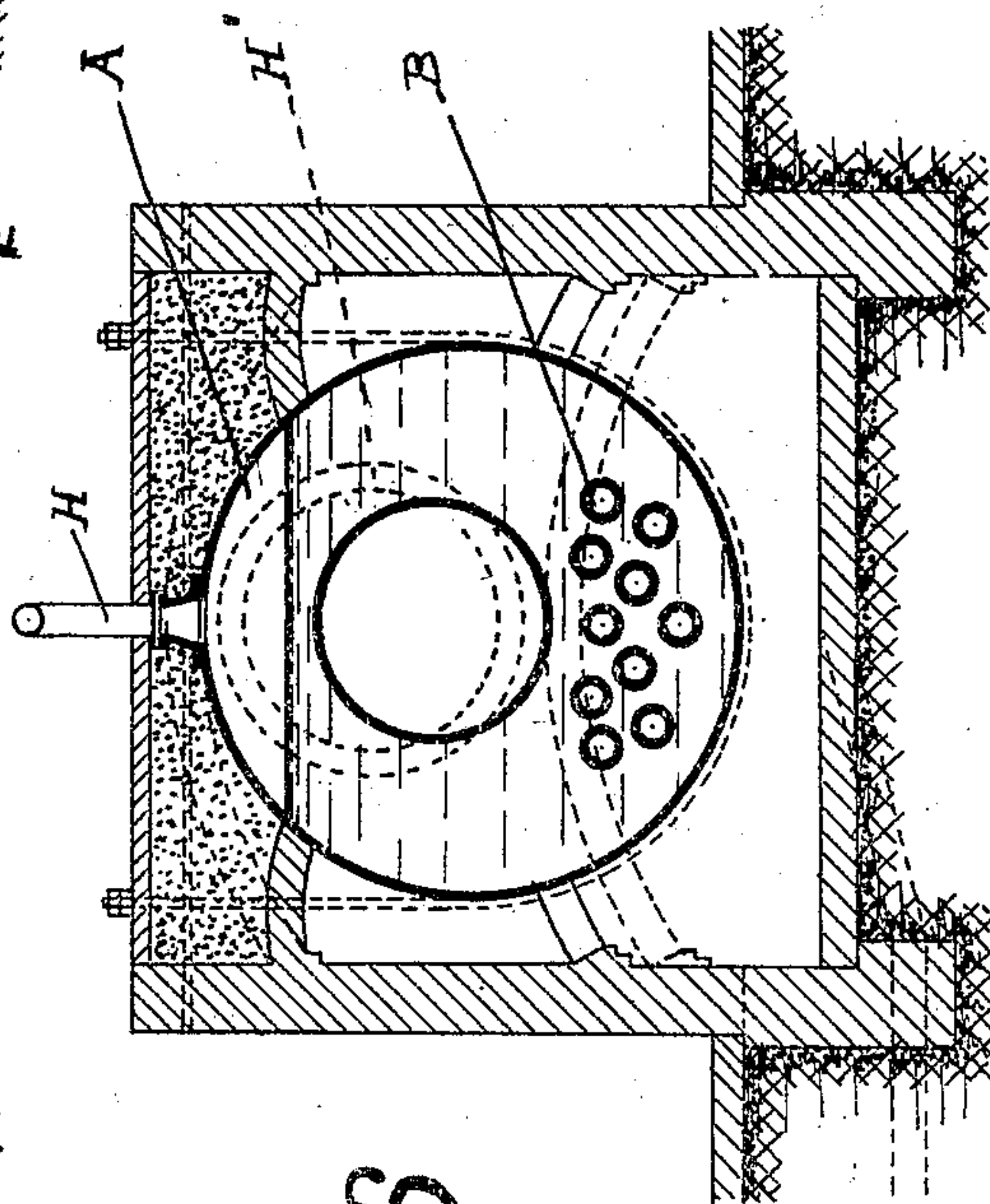


Fig 6

Witnesses

O. Knight, Jr.  
H. J. Simmons

Inventor  
Johannes Nadrowski

By his attorneys  
Knight & Co.



# UNITED STATES PATENT OFFICE.

JOHANNES NADROWSKI, OF DRESDEN, GERMANY.

## SYSTEM OF HEATING BOILERS BY EXHAUST-STEAM.

SPECIFICATION forming part of Letters Patent No. 774,334, dated November 8, 1904.

Application filed September 24, 1900. Serial No. 30,986. (No model.)

*To all whom it may concern:*

Be it known that I, JOHANNES NADROWSKI, a subject of the King of Prussia, Emperor of Germany, residing at No. 3<sup>e</sup> Hüblerstrasse, Dresden, Kingdom of Saxony, German Empire, have invented a new and useful System of Heating Boilers by Exhaust-Steam, of which the following is a specification.

In engines driven by superheated steam the exhaust-steam, which is more or less superheated, possesses a temperature which is frequently higher than that of the water in the boiler. This is more especially the case with turbines in which the superheating of the steam can, as demonstrated by experiments, be carried much higher than in piston-engines, for the reason that in turbines the steam does not come in contact with parts sliding against each other and requiring to be lubricated. In piston-engines the lubricant necessarily limits the superheat imparted to the steam to about 350° centigrade, according to present experiences. The turbine-shaft, which is the only part of the turbine which is in frictional contact with the other parts, is only exposed to heat of the exhaust-steam, which has generally a temperature much lower than that of the superheated steam. In a steam-turbine the upper limit of temperature can in consequence be raised much above that which is admissible in piston-engines, so that the heat can be better utilized than has hitherto been the case, if only care is taken to recuperate the heat of the exhaust. This recuperation of the heat of the exhaust-steam is in the case of turbines driven by highly-superheated steam, facilitated by the fact that such exhaust-steam is, as experience shows, still to a superheated state, and it can in consequence raise the temperature of a liquid much higher than saturated exhaust-steam from a piston-engine. If now the temperature of the superheated exhaust-steam is higher than the temperature in the boiler, (with the de Laval steam-turbines, the following temperatures were observed: admission temperature, 350° centigrade; exhaust, 260°; boiler, 140°,) the heat of the exhaust, which in this example exceeds by 120° centigrade the heat of the boiler,

can be recuperated by making use of the same for evaporation of the water.

The accompanying drawings show how the said invention may be conveniently and advantageously carried into practice.

In the drawings, Figure 1 illustrates a longitudinal and cross section of a boiler fitted with the device for utilizing the superheat of the exhaust-steam. Fig. 2 is a longitudinal and cross section of a modification in which the feed-water heater is located inside the boiler. Fig. 3 is a side view and front view of a modification in which the system of heating-tubes and feed-water heater are arranged outside of the boiler. Fig. 4 is a longitudinal and cross section of a modification of the arrangement shown in Figs. 1 and 3. Fig. 5 is a longitudinal vertical sectional view of a boiler-furnace, showing the turbine connected to the same. Fig. 6 is a transverse vertical sectional view of the furnace shown in Fig. 5.

Like letters of reference indicate like parts throughout the figures of the drawings.

The steam of the boiler A is led through the pipe H to a steam-superheater H' and from the superheater to a turbine H<sup>2</sup>, which runs a generator H<sup>3</sup> or other suitable apparatus. From the turbine superheated exhaust-steam is led through the pipe G in a system of heating-tubes B, which is surrounded by the boiler water, and from there to the ordinary feed-water heater C, so that with a well-proportioned superficial area of this system of tubes the exhaust-steam reaches the ordinary feed-water heater with a temperature nearly equal to that of the boiler, and may from there escape through the pipe K into a condenser or the atmosphere. Through the pipe I the water for the boiler is conducted into the heater C.

The system of tubes B, which takes up the superheated exhaust-steam, is in the arrangement shown in Fig. 1 located entirely in the water-space of the boiler A and connected to the ordinary feed-water heater C outside of the boiler.

To reduce the external cooling of the feed-water heater, this latter may, as shown in Fig. 2, be inclosed for the greater part in the



boiler, so that a part of the system of tubes B forms also the feed-water heater.

In the arrangement shown in Fig. 3 the heater-tubes B are located outside the boiler  
5 A. In this case the water-space of the boiler is connected to the barrel D, which surrounds tubes B, by a pipe *a*, the water which has taken up the superheat of the exhaust-steam returning to the boiler by the pipe *b*. In this  
10 case, however, as the boiler-water, which is under boiler-pressure, cannot attain a temperature higher than that of the boiler a part of this water will be evaporated and flow as steam into the boiler steam-space. In order to ren-  
15 der it possible to raise the steam flowing through *a* into D to a temperature higher than that of the boiler and then to cause it to take from the exhaust-steam a larger amount of heat, a throttle-valve E is provided in the  
20 pipe *b* and a pump F in pipe *a*, which pump serves for forcing the water from the boiler into barrel D. *c* is an ordinary feed-water heater, similar to the one shown in Fig. 4.

Fig. 4 shows the arrangement illustrated in  
25 Fig. 1, but modified in such a manner that the water-space of the boiler is connected by a

pipe *a* to the casing of the system of heating-pipes, a pump F being provided in the said pipe for forcing the water to the system of pipes and also a throttling-valve E in the pipe, which  
30 connects the system D with the steam-space.

Boilers built in accordance with this invention may be called "regenerator-boilers."

Having thus described my invention, what I claim, and desire to secure by Letters Pat-  
35 ent, is—

In a system for heating boilers by exhaust-steam, the combination with the boiler, of a superheater for heating the steam from the boiler, a turbine run by the superheated steam,  
40 and means for conveying the exhaust from the turbine through the boiler at a greater temperature than the water of the boiler to produce steam from the water in the boiler.

In testimony whereof I have hereunto set  
45 my hand in presence of two subscribing witnesses.

JOHANNES NADROWSKI.

Witnesses:

HERNANDO DE SOTO,  
PAUL ARRAS.