(No Model.) 3 Sheets—Sheet 1.

# A. YOUNG.

## SUPERHEATING STEAM GENERATOR.

No. 401,239. Patented Apr. 9, 1889.

*Fig. 1*

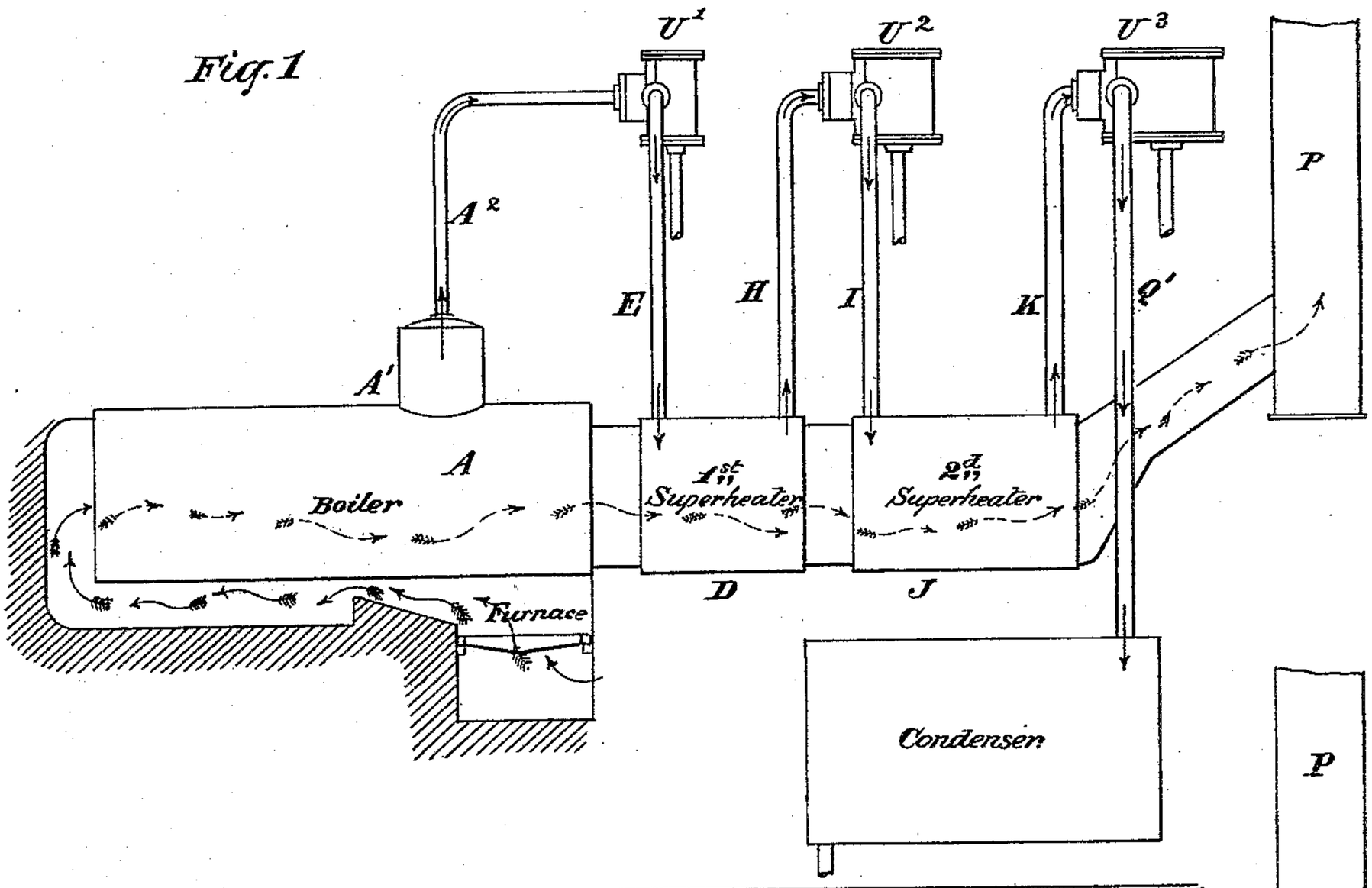
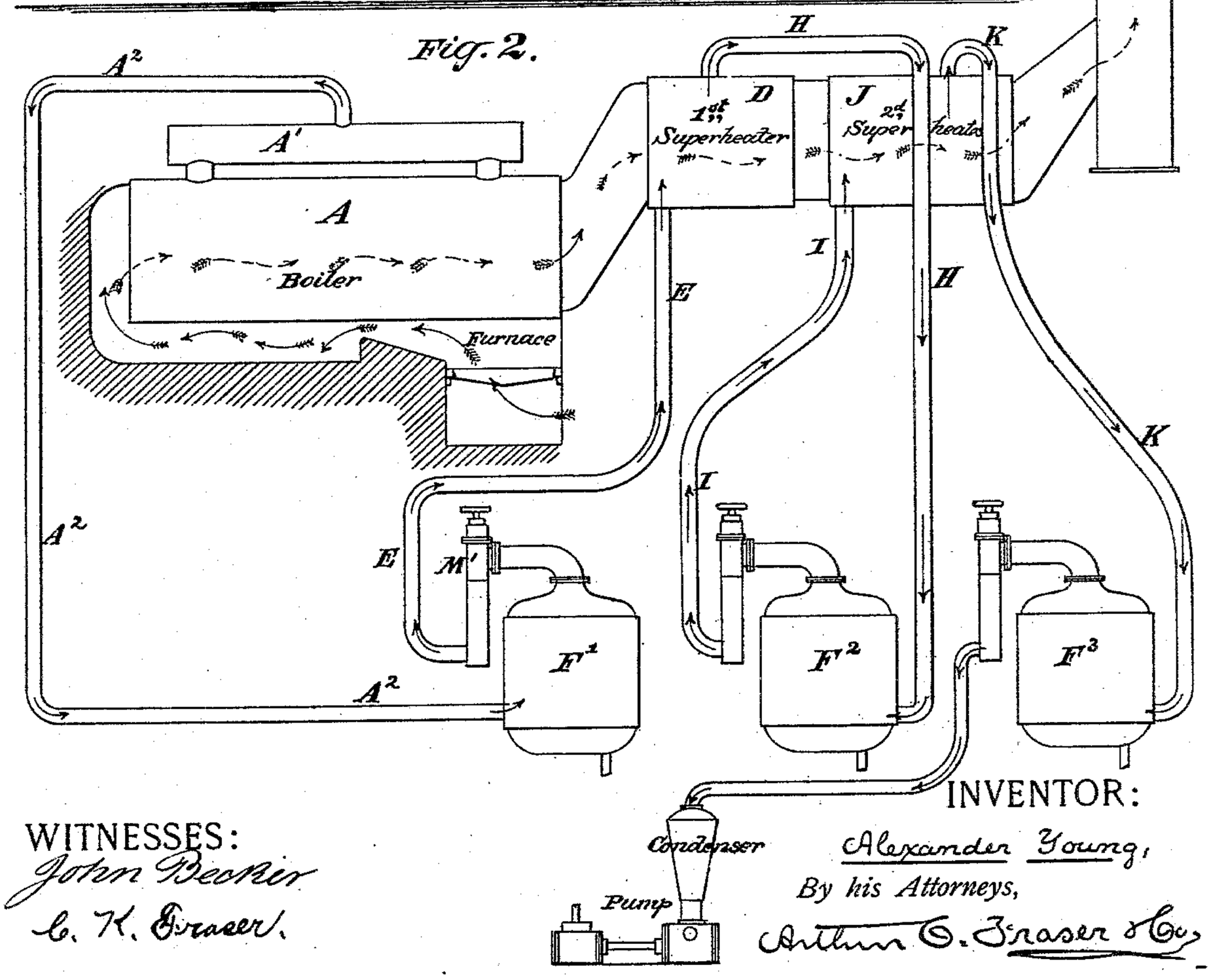



*Fig. 2.*




WITNESSES:
John Becker
C. K. Fraser.

INVENTOR:
Alexander Young,
By his Attorneys,
Arthur G. Fraser & Co.

(No Model.) 3 Sheets—Sheet 2.

# A. YOUNG.

## SUPERHEATING STEAM GENERATOR.

No. 401,239. Patented Apr. 9, 1889.

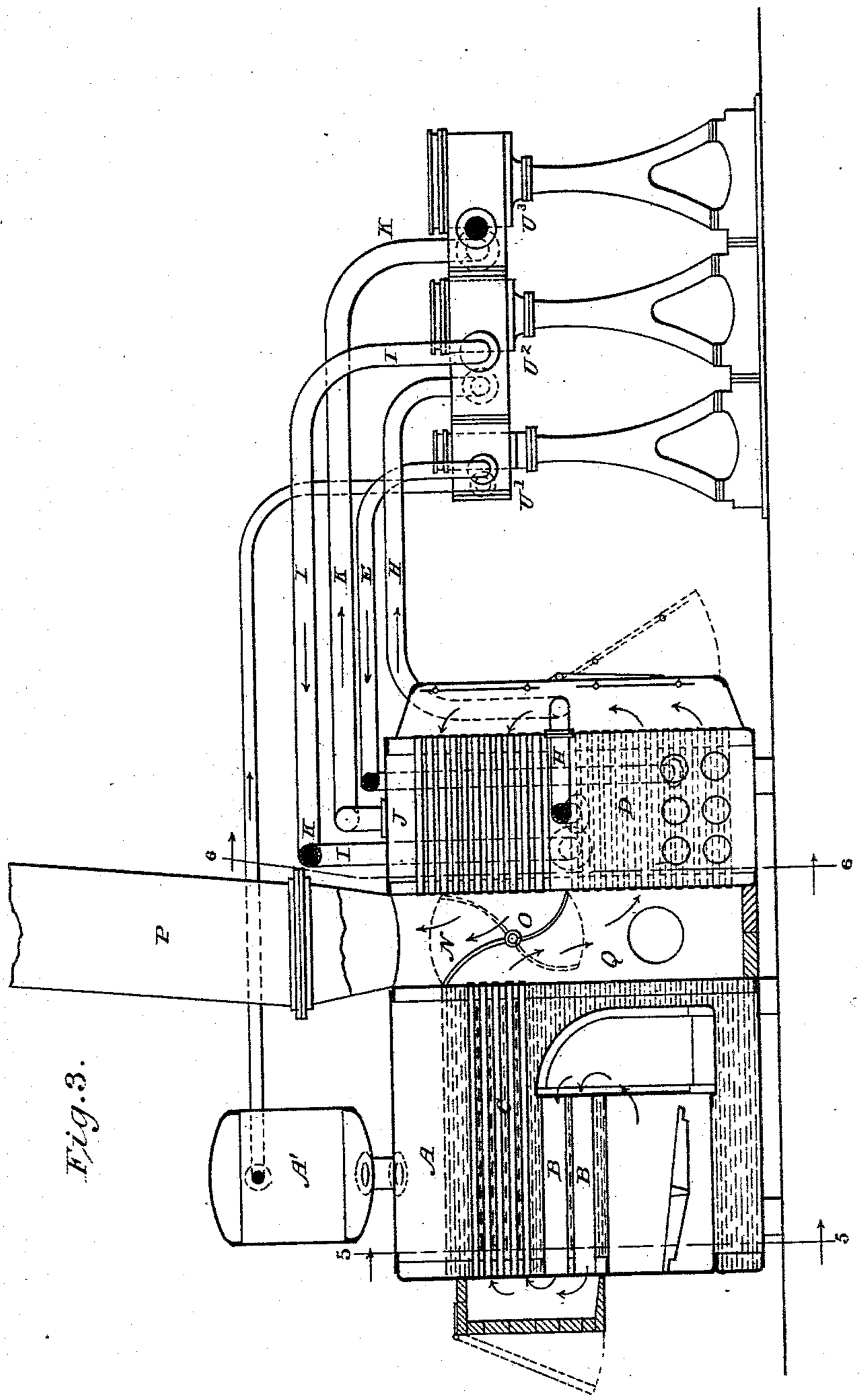



Fig. 3.

WITNESSES:
Jos. S. Latimer
Maude M. Howlett

INVENTOR:
Alexander Young
By his Attorneys,
Arthur B. Fraser and Co.

(No Model.) 3 Sheets—Sheet 3.

# A. YOUNG.

## SUPERHEATING STEAM GENERATOR.

No. 401,239. Patented Apr. 9, 1889.

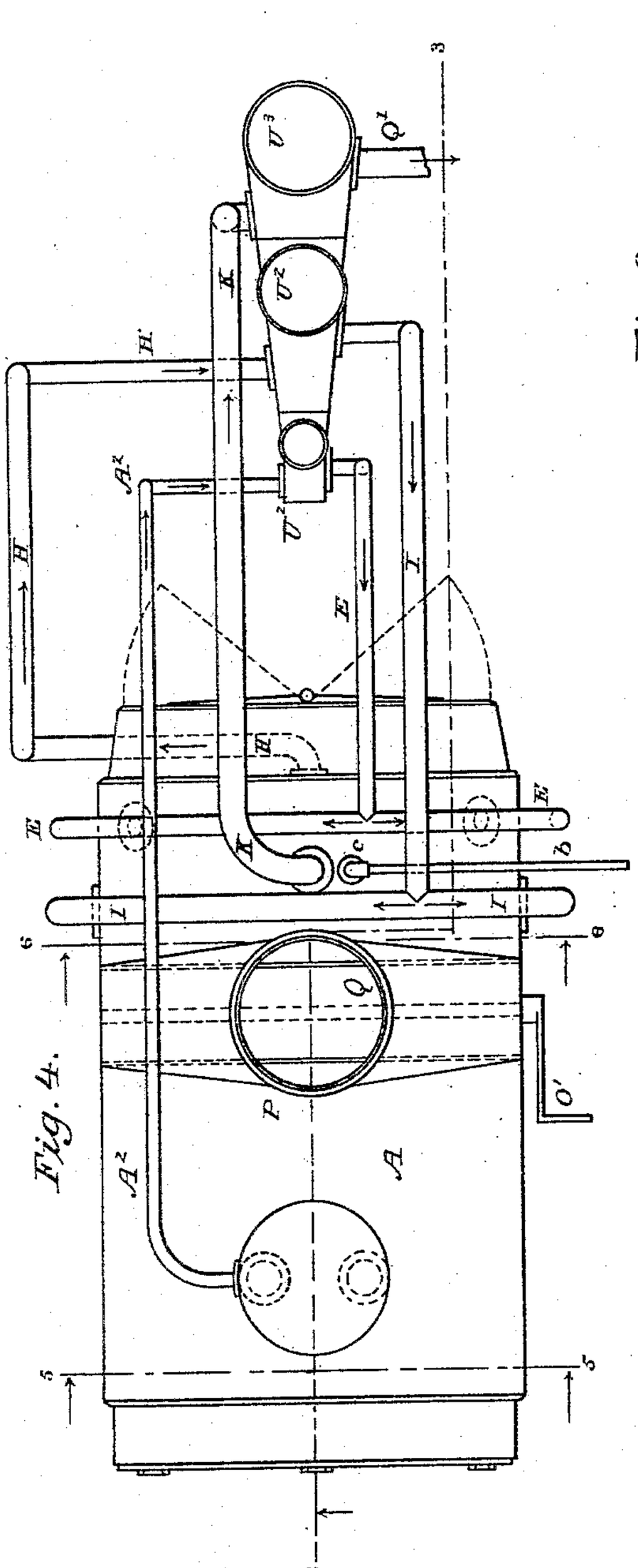



Fig. 4.

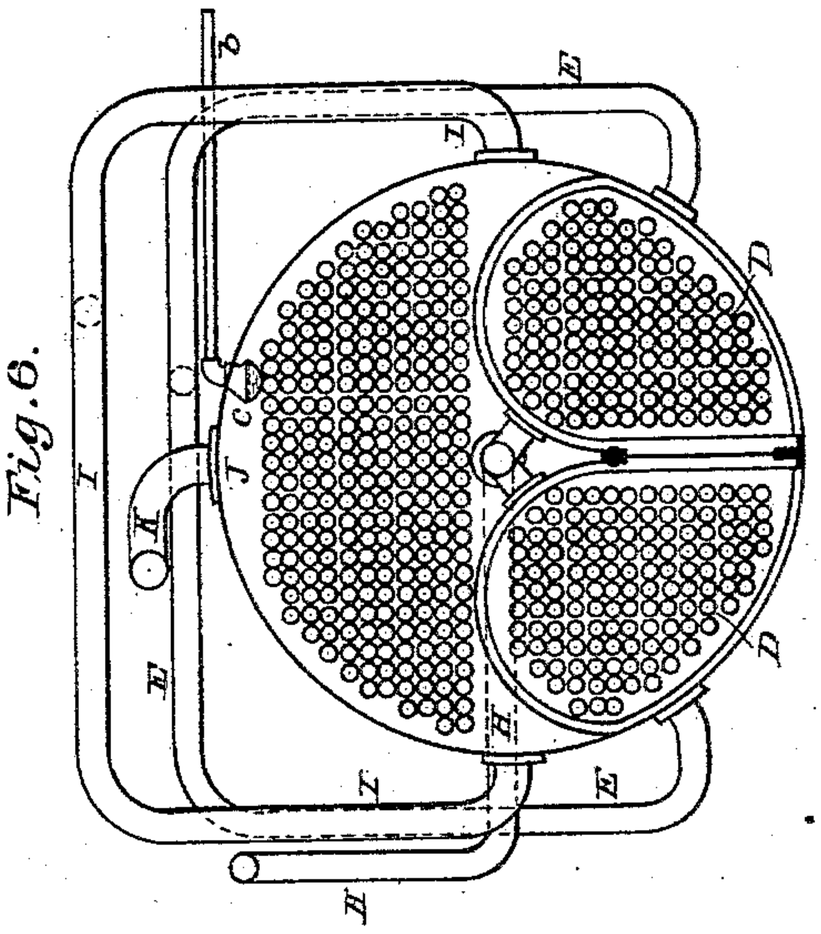



Fig. 6.

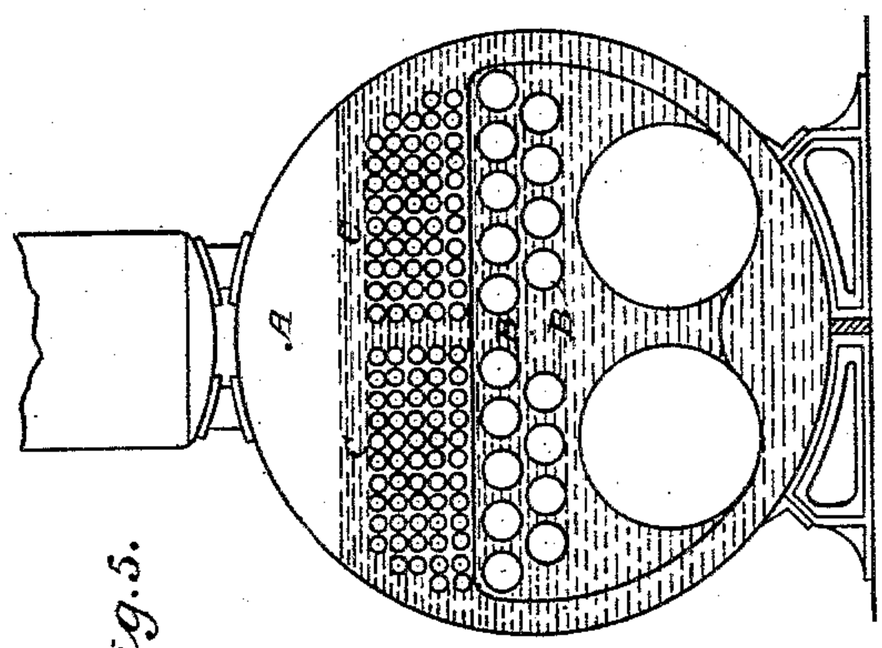



Fig. 5.

WITNESSES:
Jos. S. Latimer
Maude M. Howlett.

INVENTOR:
Alexander Young.
By his Attorneys,
Arthur O. Fraser & Co.

# UNITED STATES PATENT OFFICE.

ALEXANDER YOUNG, OF HONOLULU, HAWAII.

## SUPERHEATING STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 401,239, dated April 9, 1889.

Original application filed July 5, 1888, Serial No. 279,071. Divided and this application filed December 12, 1888. Serial No. 293,384. (No model.)

*To all whom it may concern:*

Be it known that I, ALEXANDER YOUNG, a subject of the King of Hawaii, residing at Honolulu, on the Island of Oahu, Hawaiian Islands, have invented certain new and useful Improvements in Superheating Steam-Generators, of which the following is a specification.

My invention relates to improved means for utilizing the heat contained in the gases of combustion after they have done their usual duty in generating steam and are on their way to the chimney. This waste heat I utilize in superheating exhaust steam or vapor.

According to my invention I construct or provide the steam-boiler with one, two, or more superheaters or superheating-compartments, to which the partially used or expanded steam is returned from the initial cylinder of a multiple-expansion steam-engine or other place of first use of the steam, and in which it is superheated before its passage to the next successive place of use or further expansion, and from which it is subsequently returned and again superheated before being passed to the next successive place of use. Thus in the case of a compound engine the steam which is first generated in the boiler is used in the high-pressure cylinder and the exhaust therefrom is returned to the boiler and passed through one of the superheaters thereof, wherein its temperature is raised, and whence it passes to the low-pressure cylinder of the engine; and in the case of a triple-expansion engine the exhaust from the second cylinder is returned to the boiler and passed through another of the superheating-compartments, from which it passes to the third cylinder of the engine; or, in the case of a series of evaporating-pans—such as a "multiple effect" for concentrating liquids in vacuum—the steam which is first generated is used in the first pan or cell and the exhaust therefrom is returned to the boiler and passed through one of the superheaters thereof, and is thence conducted to the second pan or cell, and on its passage from the second pan or cell it is again returned to the boiler and superheated in another superheater. The steam or vapor which is thus returned and superheated may be the same steam which was originally generated in the boiler, or it may be other steam or vapor—as, for example, the vapor drawn off from the liquid being boiled in a vacuum-pan. The superheating is effected as many times as the steam is used or expanded. The hot gases from the furnace are first utilized in the ordinary manner for the generation of steam, after which they traverse the successive superheaters and are made effective for superheating the partly-used steam circulating through them. Each of the superheaters is provided with a large heating-surface, upon which the hot gases from the boiler act, and through which surfaces the heat is transmitted to the exhaust steam or vapor to be superheated.

It is characteristic of my invention that the superheaters are so arranged that the waste gases are made to act first, when their temperature is highest, upon the heating-surface of the superheater or portion of the superheater through which passes the highest pressure of exhaust steam or vapor, and to act last, when their temperature is lowest, upon the heating-surface of the superheater or portion of the superheater through which passes the exhaust steam or vapor of lowest pressure, whereby the greatest practicable difference of temperature is maintained between the superheating medium and the steam or vapor to be superheated. Thus the waste gases act very effectively, since in each superheater or portion thereof they are of much higher temperature than the exhaust steam or vapor to be superheated, and their superiority of temperature over the steam or vapor to be superheated is maintained in each case as nearly as possible the same.

In the accompanying drawings, Figure 1 is an elevation in the nature of a diagram illustrating the boiler and superheaters, the cylinders of a triple-expansion engine, and the connecting steam-pipes arranged to show the paths of the gases of combustion and of the steam. Fig. 2 is a similarly-diagrammatic view showing my invention as applied in connection with the cells of a multiple-effect vacuum-pan. Fig. 3 is a longitudinal section cut in the plane of the line 3 3 in Fig. 4, showing my improved superheating-boiler in connection with a triple-expansion engine, the

latter being shown in elevation. Fig. 4 is a plan of the boiler and engine. Fig. 5 is a transverse section through the steam-generating portion of the boiler in the plane of the lines 5 5 in Figs. 3 and 4. Fig. 6 is a transverse section through the superheating portion of the boiler in the plane of the lines 6 6 in Figs. 3 and 4.

Referring first to Fig. 1, let A designate a steam-boiler, and D and J two superheaters or superheating-compartments arranged to be traversed successively by products of combustion after the latter have passed through the flues of the boiler A and before they are discharged into the chimney or stack P.

U′, U², and U³ are the first, second, and third cylinders, respectively, of a triple-expansion engine.

The steam generated in the boiler A is collected in the dome A′ and passes by the pipe A² to the first cylinder, U′. From this cylinder the exhaust-steam returns by the pipe E, which conducts it to the superheater D. The steam in passing through this superheater is reheated and passes out therefrom by means of the pipe H, which extends to the second cylinder, U². From this cylinder the exhaust-pipe I extends back and conducts the exhaust-steam to the superheater J, by which the steam is again reheated, and is returned through the pipe K to the third cylinder, U³. The exhaust from this cylinder is conducted by a pipe, Q′, to the condenser in the usual manner.

The superheaters D and J are constructed after the manner of a multitubular boiler, the hot gases passing through the tubes or flues and the steam circulating around the tubes; but obviously the reverse construction might be used, or any other construction by means of which an efficient heating-surface can be secured may be adopted.

The hot gases or products of combustion after doing their work in the generating-boiler A and in the condition in which ordinarily they are discharged to the chimney, are passed through the respective superheaters in succession, and thereby give up a considerable portion of their heat, (by transmission through the tubes or other heating-surface of the superheater,) and this heat is taken up by the steam or vapor which is passing through the superheater. The hot gases or products of combustion are employed, first, while their temperature is highest, for superheating a comparatively low grade of steam or vapor, and subsequently, when their temperature is reduced, for superheating a higher grade of vapor, or a vapor or steam at a lower pressure. Thus in each superheater the greatest practicable difference of temperature is maintained between the superheating medium or gases and the steam or vapor to be superheated, or, in other words, the hot gases after having been used for generating steam are utilized, while their temperature is highest, to superheat the steam or vapor which has already the highest temperature, and when their temperature has become reduced they are utilized for superheating steam or vapor which has primarily a lower temperature.

Fig. 2 shows after the manner of a diagram how my invention may be applied to the heating of evaporating-pans, such as the triple-effect vacuum-pans used in concentrating saccharine liquids.

The steam generated in the boiler A is conducted from the steam-dome A′ thereof by a suitable steam-pipe, A², either to a steam-engine or other steam-user, (not shown,) and thence back to the first superheater, or is conducted directly to the heating coil or surface beneath the first cell, F′, of the triple effect, as shown. The vapor rising from the liquid being boiled in this cell passes off into the save-all M′, and thence is conducted by the pipe E to the first (or second) superheater, D. The reheated steam from this superheater is conducted by the pipe H to the heating-surface of the second cell, F², of the triple effect. The vapor rising from the liquid boiled in this cell then passes through the save-all and through the pipe I to the next superheater, J. The reheated steam from this superheater is carried by the pipe K to the heating-surface of the third cell, F³, the vapor rising from which is conducted through the save-all to the condenser and vacuum-pump. The several valves for controlling the passage of the steam or vapor are omitted from the drawings.

As applied to the heating of evaporating-pans, my invention effects a considerable economy by the utilization of a greater portion of the heat generated from the fuel for effective use in the heating of the liquid in the vacuum pans or cells. In practicing my invention the superheating of different grades of vapor may be continued through any number of cells and superheaters. Further, the exhaust-steam from the heating pipes or drums of each cell or pan of a multiple effect may be resuperheated as many times as there are cells by having a sufficient number of superheaters for that purpose; also, instead of superheating the vapor from the boiling liquid the exhaust-steam from the heating pipes or drums of each cell of the multiple effect may be superheated by passing it through a superheater and thence to the heating pipes or drums of the following cell, and so on throughout all the cells of the apparatus consecutively, in which case the vapor rising from the boiling liquid in all the cells will pass directly to the condenser, so that the vacuum in all the cells will be of the same degree.

I will now proceed to describe more in detail the preferred construction of my improved superheating-boiler as adapted for multiple expansion-engines, referring for that purpose to Figs. 3 to 6, inclusive.

The boiler is constructed with a compartment, A, in which steam is generated in the

usual manner, the products of combustion passing from the grate-surface of each furnace backward, thence forward through flues B B, and thence back through flues C C, whence they enter a smoke-box, Q, containing a damper, N, mounted on a shaft, O, and operated by a crank, O′, on the outer end of said shaft or by other means. When the damper end is turned to the position shown in dotted lines in Fig. 3, the products of combustion pass directly upward to the stack P; but when the damper is turned to the opposite position, as shown in full lines in Fig. 3, the products of combustion are deflected downwardly in the smoke-box Q, and are compelled to pass rearwardly through the tubes of the superheating-compartments D D, and thence forwardly through the tubes of the superheating-compartment J above, on emerging from which they pass up to the stack. The smoke-box Q is thus divided by the damper N into two portions, between which the damper stands as a separating-partition.

The live steam passes from the dome A′ to the first cylinder, U′, of the triple-expansion engine. The exhaust returning from this cylinder by the pipe E is conducted into the two superheating-compartments D D by reason of the branching of this pipe to both sides, as shown in Figs. 4 and 6. The steam in passing through these compartments is superheated and passes out therefrom by means of the pipe H, which reunites the two currents of steam, Fig. 6, and extends to the second cylinder, $U^2$. The exhaust-pipe I, leading back from this cylinder, branches in both directions, as shown in Figs. 4 and 6, and conducts the exhaust-steam to the opposite sides of the upper superheating-compartment, J. The steam superheated in this compartment is conducted by the pipe K to the third cylinder, $U^3$.

In starting the fires the damper N is opened by turning it to the dotted-line position. When, however, steam has been raised to the proper pressure for use, the damper N is closed and the flow of gases directed through the superheating-compartments D and J.

In each successive superheating-compartment the temperature of the superheating medium or products of combustion is reduced, and the steam or vapor to be superheated is initially at a lower pressure and lower temperature, so that there is maintained approximately an equal difference of temperature between the superheating and superheated mediums in each superheating-compartment.

The principle of my invention is applicable to any number of cylinders and superheaters which may be found desirable.

Some advantages to be derived from my invention are that with existing engines a much earlier cut-off may be adopted in the high-pressure cylinder, in consequence of fortifying the various grades of spent steam with increased heat and volume for use in the intermediate and low-pressure cylinders, that in new constructions a smaller high-pressure cylinder may be used for the same power of engine than would be possible without my invention, and that in the evaporation of liquids in vacuum a large addition of effective service of fuel is made.

If it should be found that the temperature of the superheated exhaust-steam is so high as to be objectionable, or that an increase of volume would be advantageous, a spray of water may be introduced into the superheater or into the pipes conveying the superheated exhaust-steam therefrom for the purpose of reducing the temperature and increasing the volume of the superheated exhaust-steam prior to its entrance into the next cylinder. As a means of introducing such a spray into the superheater J, I have shown in Figs. 4 and 6 a water-pipe, *d*, entering the top of the compartment and terminating therein in a rose or sprinkler, *c*. If the waste gases after passing through the final superheater are of too low a temperature to produce a good natural draft, a forced draft may be used.

Different arrangements of superheaters may be made to suit the requirements of different purposes, localities, or circumstances.

Doors or man-holes should be placed in the superheaters through which to remove any dirt which may accumulate in them.

I do not claim the superheating of direct steam, nor by itself the superheating of exhaust-steam, nor the construction or arrangement of superheaters for either of these purposes, as I am aware that it has been before proposed to superheat the steam on its passage from the high-pressure cylinder of a compound engine to the low-pressure cylinder thereof.

I am also aware that superheaters have been arranged in connection with boilers to be traversed by the spent gases of combustion.

My present application for patent is a division and renewal of my application for patent for a "graduated compound steam-boiler," filed July 5, 1888, Serial No. 279,071.

I make no claim in this application to anything now claimed in that application, which has been limited to apparatus for evaporating saccharine and other liquids.

I claim as my invention the following novel features or combinations, substantially as hereinbefore specified, namely:

1. The combination, with a steam-boiler and its furnace, of two or more superheaters arranged to be traversed by the products of combustion after they have traversed the boiler, and pipes or conduits adapted to return spent steam or vapor to said superheaters to be reheated, arranged to conduct the steam or vapor of the highest temperature to that superheater or portion of the superheater which is acted on by the hottest gases and to conduct the steam or vapor of the lowest

temperature to that superheater or portion of the superheater which is acted on by the gases when their temperature has been reduced.

2. The combination, with a steam-boiler and its furnace, of two or more superheaters arranged to be traversed by the products of combustion after they have traversed the boiler, and pipes or conduits adapted to return spent steam or vapor to said superheaters to be reheated, arranged to conduct the steam or vapor of the highest temperature to that superheater which is being traversed by the hottest gases and to conduct the steam or vapor of the lowest temperature to that superheater which is being traversed by the gases the temperature of which has been last reduced before passing to the stack.

3. The combination, with a multiple-expansion engine, of a steam-boiler and its furnace, and two or more superheaters arranged to be traversed successively by the products of combustion after they have traversed the boiler, a steam-pipe conducting live steam from the boiler to the first cylinder, a pipe conveying the exhaust-steam from this cylinder to the superheater which is traversed by the hottest gases, a pipe conveying the reheated steam from this superheater to the second cylinder, a pipe conveying the exhaust-steam from this cylinder to a superheater which is traversed by the gases after they have passed the first superheater, and a pipe conveying the reheated steam from this superheater to the third cylinder.

4. The combination, with a boiler, of a superheater divided into compartments, a smoke box or passage for conducting the products of combustion from the boiler to one of said compartments, a smoke-box for conducting the products of combustion emerging from one of said compartments to the other compartment in order that they may return in the opposite direction through the latter and the stack, arranged to receive the products of combustion after they issue from said second compartment, and pipes for conveying steam to and from said compartments, arranged to conduct the steam or vapor of the highest temperature to that compartment which is first traversed by the gases and the steam or vapor of the lowest temperature to that compartment which is last traversed by the gases before they pass to the stack.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ALEXANDER YOUNG.

Witnesses:
DAVID KORNIKI,
JONA. AUSTIN.