C. J. SNOW.

CONDENSER.

APPLICATION FILED MAY 5, 1909.

956,210.

Patented Apr. 26, 1910.

3 SHEETS—SHEET 1.

Fig. 1.

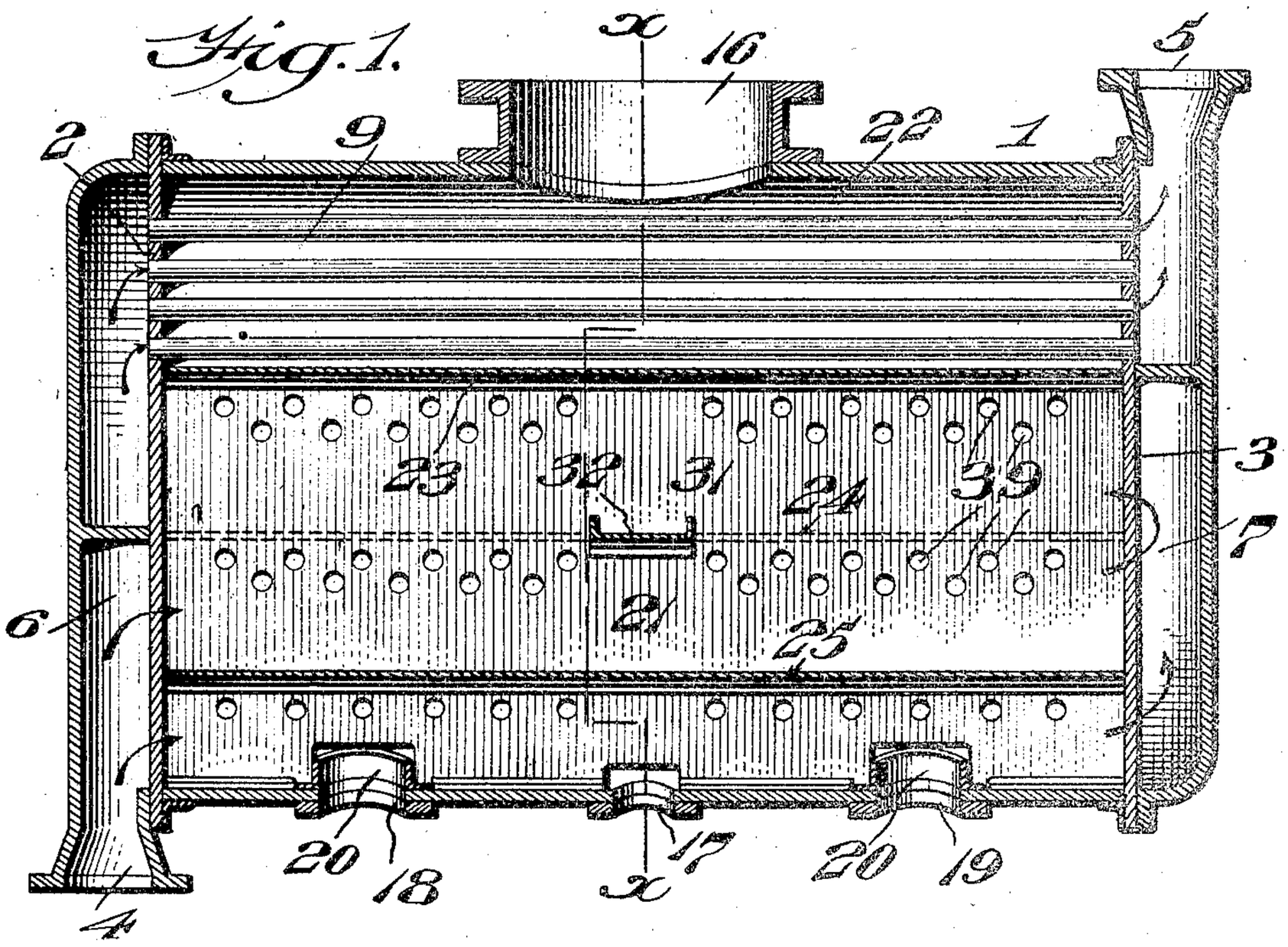
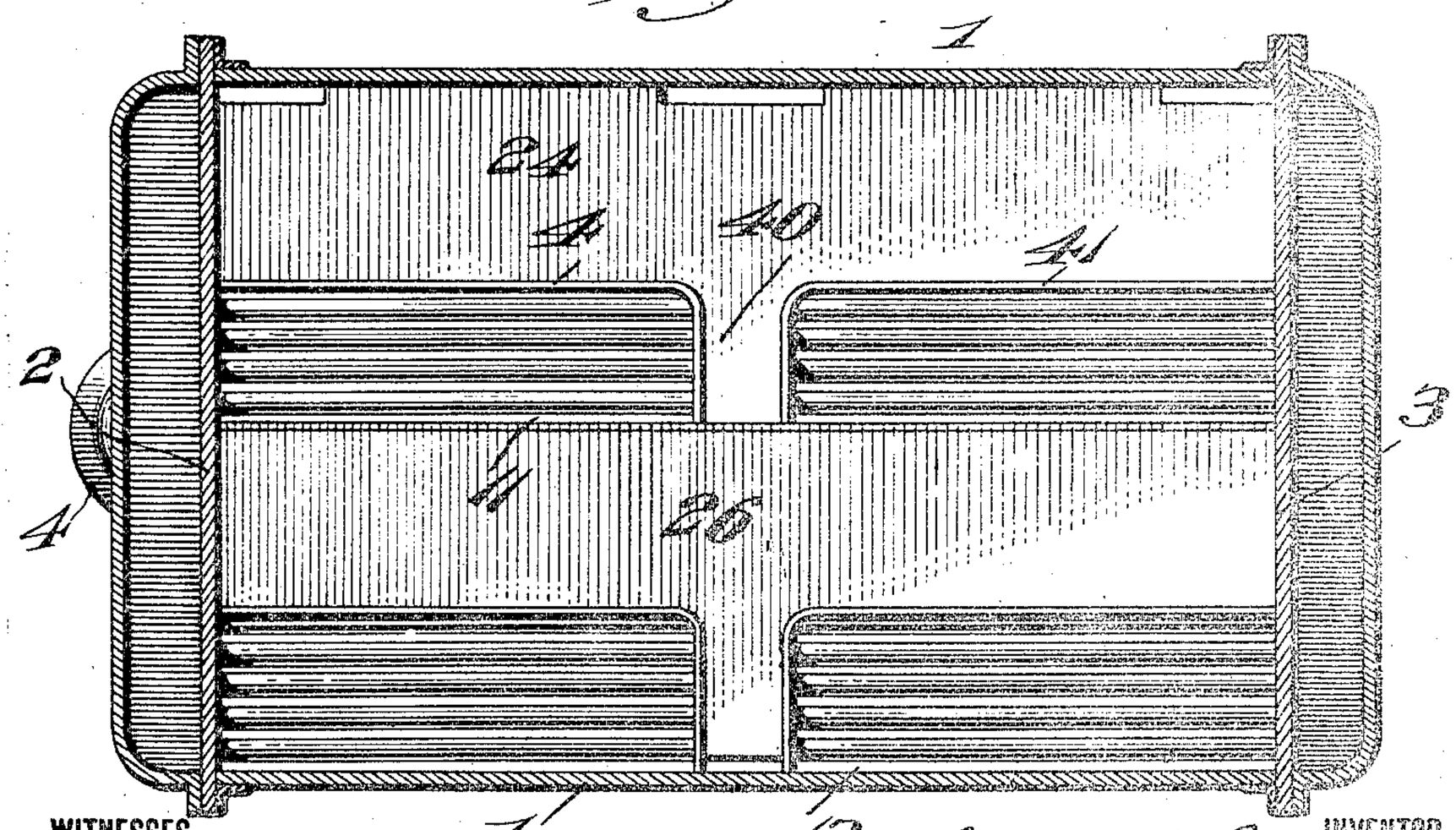


Fig. 3.



WITNESSES

H. C. Dieterich

L. Douville.

INVENTOR

Charles J. Snow.

BY Wiedersheim & Fairbanks

ATTORNEYS

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3 SHEETS—SHEET 2.

Fig. 2.

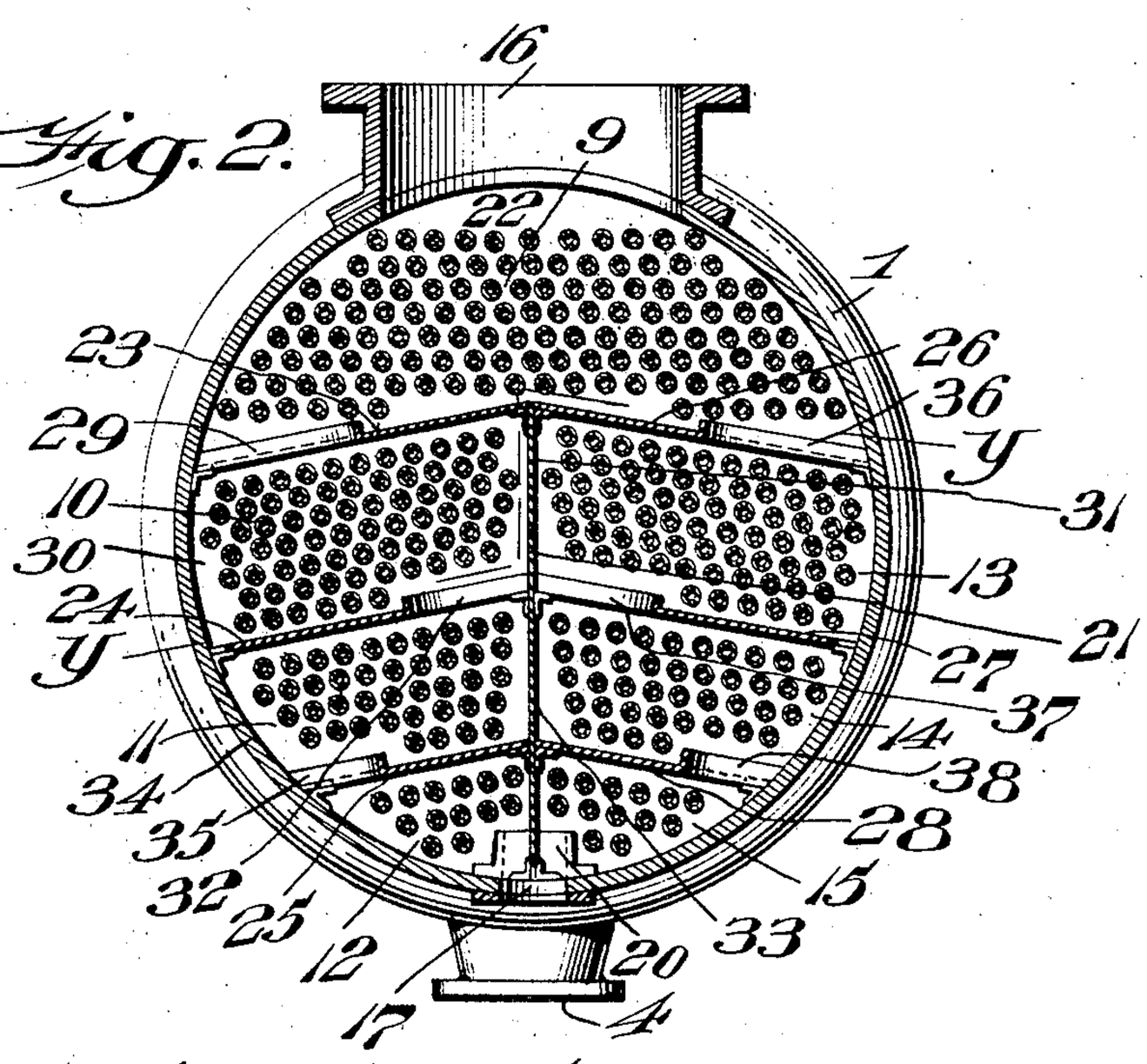
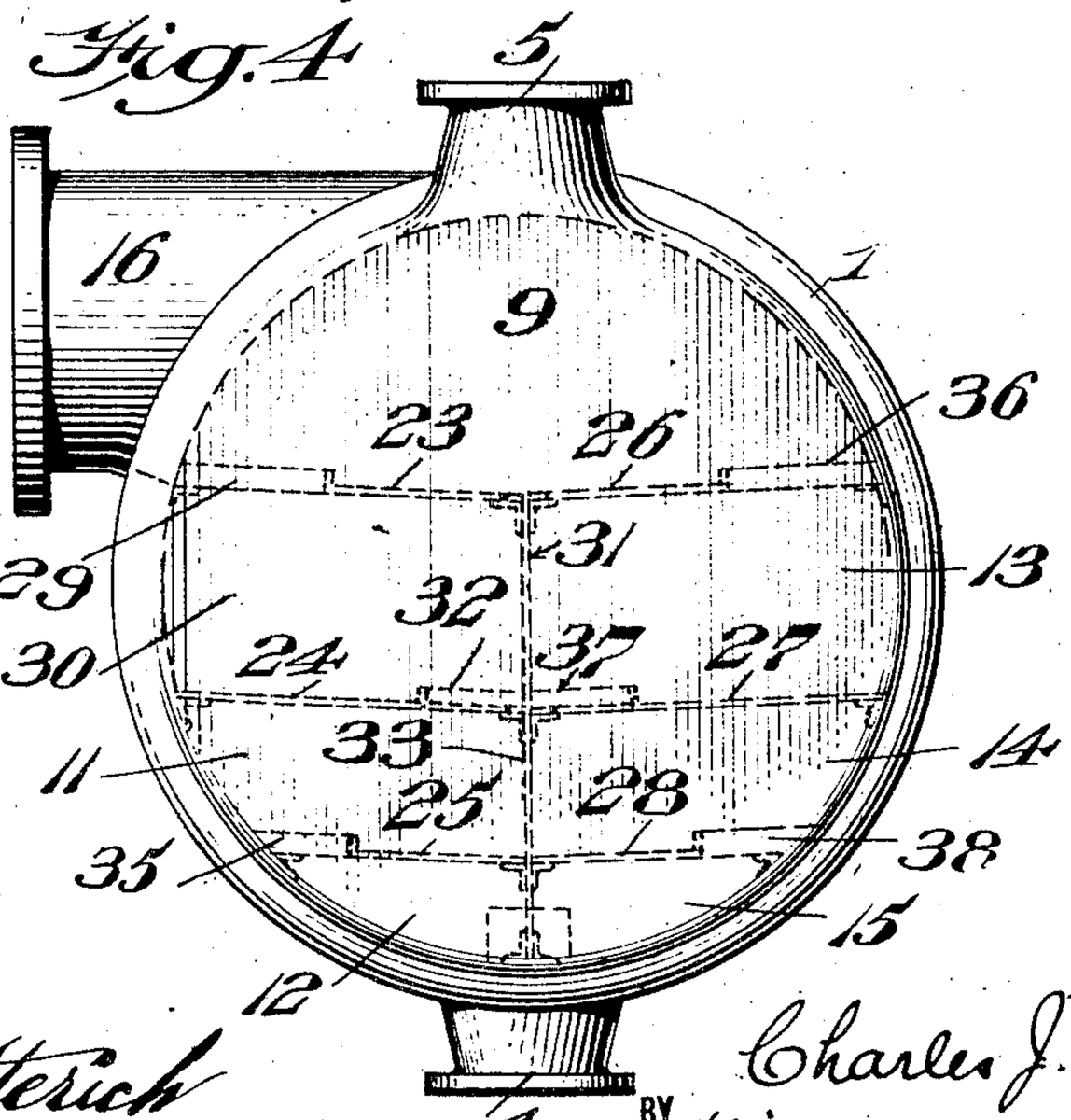


Fig. 4



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L. Conville.

INVENTOR

Charles J. Snow.

BY Wiedersheim & Laubaum.

ATTORNEYS

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3 SHEETS—SHEET 3.

Fig. 5

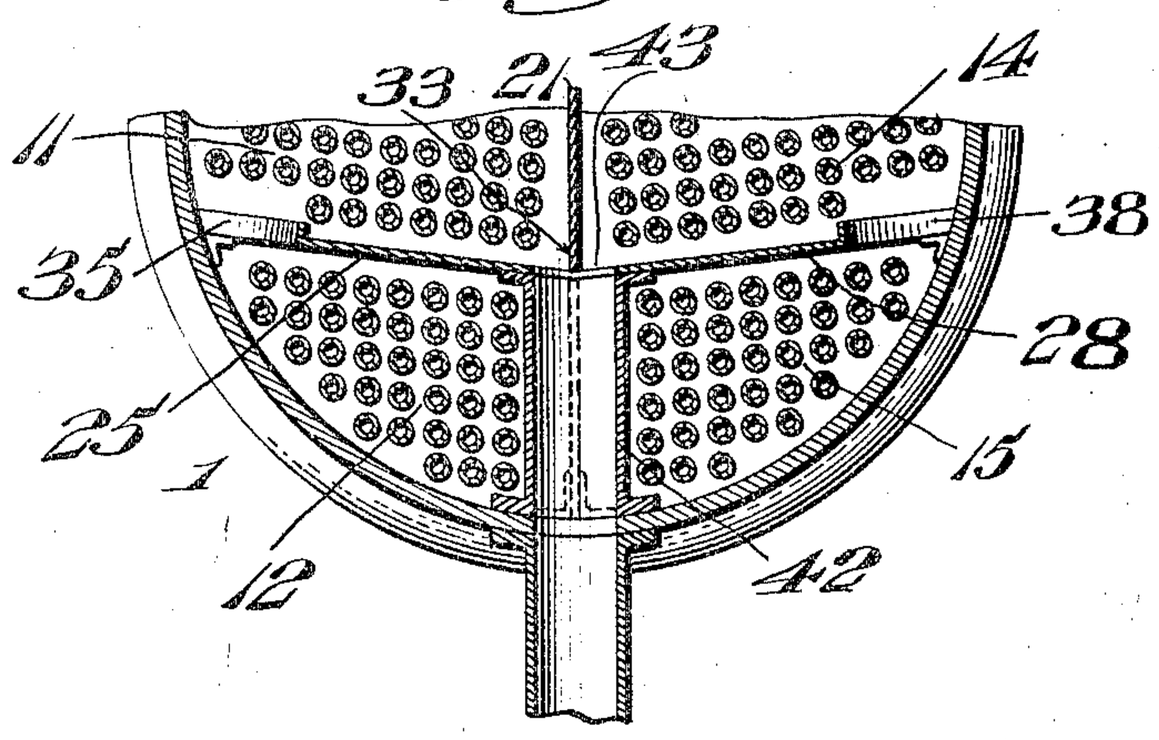
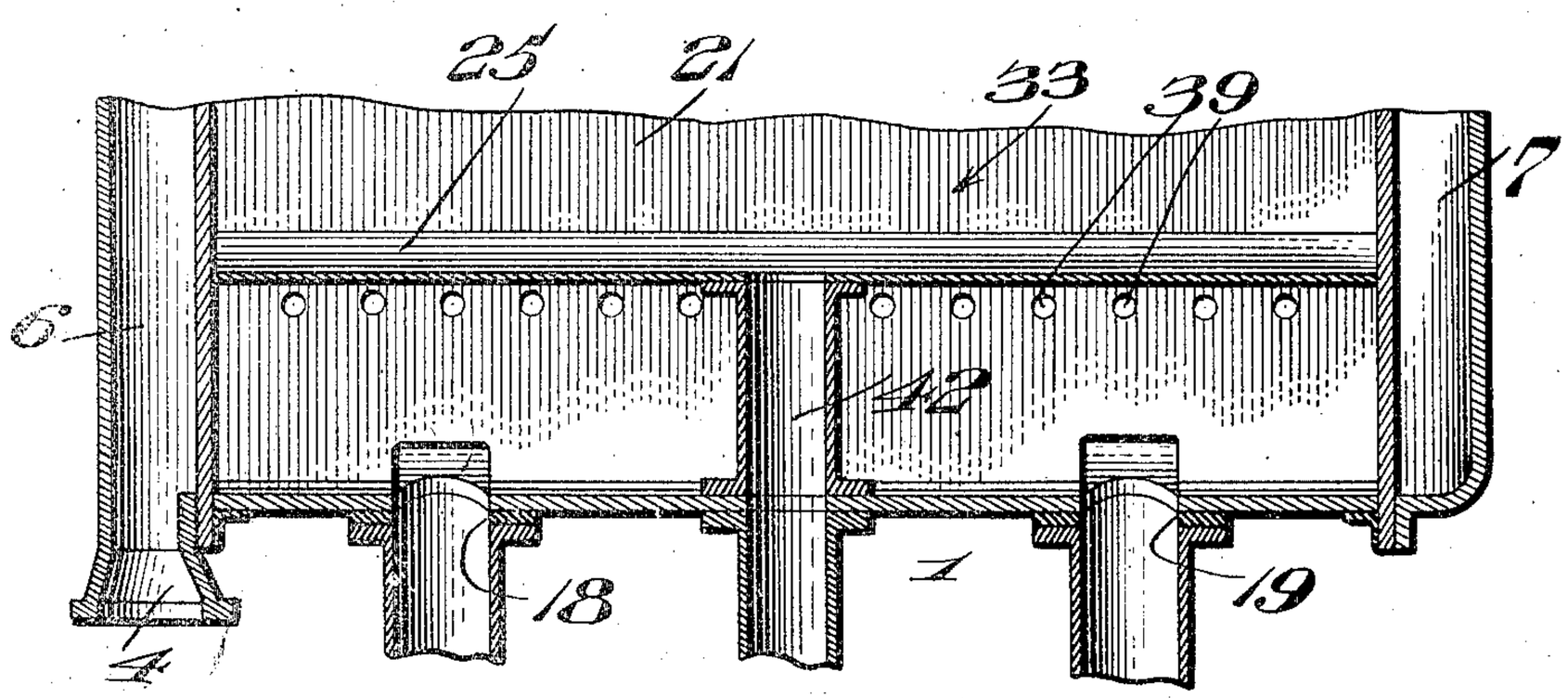


Fig. 6.



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H. G. Dieterich

L. Donville.

INVENTOR

Charles J. Snow.

BY Widenstein & Fairbanks.

ATTORNEYS

UNITED STATES PATENT OFFICE.

CHARLES J. SNOW, OF LANSDOWNE, PENNSYLVANIA.

CONDENSER.

956,210. Specification of Letters Patent. **Patented Apr. 26, 1910.**

Application filed May 5, 1909. Serial No. 493,993.

To all whom it may concern:

Be it known that I, CHARLES J. SNOW, a subject of the King of Great Britain, residing at Lansdowne, county of Delaware, State of Pennsylvania, have invented a new and useful Condenser, of which the following is a specification.

The purpose of my invention is to reduce the length of flow of the steam in condensers for steam engines, turbines, etc., to remove the water therefrom at short space intervals by means other than the cooling surfaces and to provide for drainage of the water so removed.

A further purpose of my invention is to divide a condenser longitudinally into two or more compartments and direct the steam transversely within these compartments.

A further purpose of my invention is to most advantageously collect the water by means of baffle plates and walls of condenser from the steam being condensed, the baffles serving the additional function of determining the direction of steam flow.

A further purpose of my invention is to make use of the momentum of the steam to deposit water therefrom upon surfaces other than the condensing surfaces.

A further purpose of my invention is to supply a highly effective structure for keeping the cooling pipes as dry as possible for the purpose of increasing their efficiency.

It further consists of other novel features of construction, all as will be hereinafter fully set forth.

For the purpose of illustrating my invention I have shown in the accompanying drawings one form thereof which is at present preferred by me, since the same has been found to give satisfactory and reliable results, although it is to be understood that the various instrumentalities of which my invention consists can be variously arranged and organized and that my invention is not limited to the precise arrangement and organization of these instrumentalities as herein shown and described.

Figure 1 is a longitudinal section of a condenser embodying my invention. Fig. 2 represents a transverse section of the structure of Fig. 1 upon line *x*—*x* thereof. Fig. 3 represents a longitudinal staggered section at substantial right angles to the section of Fig. 1 and upon the line *y*—*y* of Fig. 2. Fig. 4 represents an end elevation of a modified form of my invention. Fig. 5 represents a broken transverse section of a further modification. Fig. 6 represents a broken longitudinal section of the structure shown in Fig. 5.

It is generally known that small condensers are relatively more efficient than large ones due chiefly to the correspondingly short length of flow of the steam through the tubes or any section of tubes and to the smaller area of tube surface per volume contained, allowing generally a better distribution of steam over the surface. Now by splitting up a condenser as is done in my invention by longitudinal partitions and baffles into a number of parts which are small as compared to the whole, the results obtainable in small units are more nearly duplicated in a large unit than heretofore.

My invention relates to the condensation of exhaust steam from engines and steam turbines in which the condensation is produced by contact of exhaust steam with metallic surfaces cooled by water.

I divide the condenser longitudinally and make use of baffles such that the containing walls of the condenser and the baffles present surfaces approximately at right angles to the general line of flow taken by the steam. Furthermore, the steam after impinging on the first baffle or baffles interposed in its path is deflected and divided and is compelled to take two or more separate and distinct sinuous lines of flow toward final outlets at the bottom of the condenser.

In surface condensers of the ordinary types, the steam is usually compelled to take long paths of flow, such as either the whole length of the condenser between the tube plates and parallel with the tubes or completely across the condenser from wall to wall and at right angles to the tubes, meeting no baffles or obstructions whatever in such longitudinal or transverse movement other than cooling surfaces. By placing obstructions in the manner described and illustrated by me, the path taken by the steam in any one direction is very considerably shortened and the definite impinging action of the steam secured sets free the moisture carried forward by the steam, so that the steam on leaving one compartment and entering another is in a less saturated state and therefore, in a condition to be acted on

most advantageously by the cooling surfaces. This results in a more rapid transmission of heat from the steam through the metallic surfaces to the cooling water. The particles of condensed steam do not drop vertically downward as they are formed on or between the tubes, and as they would if they were influenced by gravity alone, but have a tendency to follow a line which is the resultant of two forces, viz., that of gravity and that due to the momentum of the steam in motion. As the velocity of flow is many times greater than that of initial fall due to gravity (a condition particularly the case in upper compartments where velocity is greatest) the particles of condensed steam deviate but little from the line of flow of the steam and are carried forward until the steam in which they are suspended is deflected by a baffle, a partition or the interior wall of the condenser at which time said particles are deposited upon the deflecting surface.

It will be seen from the drawings that I employ ducts, channels or holes for conveying condensed steam in the form of water to the walls or partition of the condenser and this water then follows this surface to the condenser bottom or collecting surface without again coming in contact with the tubes. I illustrate two means for obtaining this result, such as shown in Figs. 2 and 5 where the baffles are inclined differently. In each, holes or ports are provided through which the water flows. I may use a combination of both methods.

Although I have illustrated a circular condenser only, this invention can be embodied in one of rectangular or other shape.

While I find it desirable to withdraw the water of condensation or the greater part thereof from the condenser by a separate pump it may be withdrawn by the air pumps and where the static head necessary for the efficient action of pump when discharging water from a vacuum is restricted by locality, I may appreciably increase the available head by connecting a water receiving surface in the condenser with the pump by a pipe, connections for which appear in Figs. 5 and 6; and I may run branch pipes to the shell of the condenser for connection with said pump. Owing to the very efficient separation obtained by the baffles and the long aggregate length of the path of steam, the latter when it enters the last compartment is in a less saturated condition than could otherwise be attained and the densifying effect of the cooling surfaces therein upon the other gases is correspondingly intensified. Both the steam and the other gases traverse the tortuous separate paths provided by my distinct lines of flow and are alike diffused over the cooling surfaces with great advantage. The last compartment or gas densifier on each side has a very beneficial influence on the capacity of the vacuum pump for by reducing the temperatures of the gases so are the volumes reduced.

Since under some circumstances, unequal temperature might exist in compartments adjoining each other, I provide equalizing ports or passages in the vertical baffle partition or division wall which is common to both and all compartments. While said ports are of ample size to permit rapid temperature equalization, the baffling effect is not reduced to any great extent.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings, 1 designates a condenser which I have illustrated as of cylindrical form but which may evidently be square or of other rectangular or preferred form having end walls 2, 3, water inlet passage 4 and water outlet passage 5 connecting with the heads 6 and 7 respectively and pipes arranged in sets the circulation within the pipes being that used in counter current condensers. I have shown the sets as seven in number but recognize that the arrangement, number, etc., may be greatly varied. I will designate the sets which I have illustrated as 9, 10, 11, 12, 13, 14 and 15. At the top of my condenser I admit steam through inlet 16 and at the bottom thereof I withdraw the water at 17 by hot well pump or any other suitable arrangement. I attach a vacuum pump at any desired point or points such as 18, 19 in the bottom of the condenser preferably forming ferrules or collars 20 to protect against the withdrawal of water from the condenser by vacuum pumps. It will be understood that I may use the same pump and passages for withdrawal of air and water under the wet system, if desired.

A prominent feature of my invention, both independently and in combination with other elements, lies in my provision of a longitudinal wall or walls which I have shown as a single wall 21, preferably extending from the approximate bottom and terminating some distance short of the top of the condenser, which wall or walls serve to divide the steam during its treatment in the condenser into two or more separate paths, each part having one wall in common with another with provision for equalization of temperature between but otherwise independent of every other part. As I have stated, a number of such divisions may be formed with advantage under certain conditions though I prefer and shall illustrate and describe in detail but a single division wall and two such paths of flow of the steam determined by it. The space above the division wall is preferably occupied by the set of cooling pipes 9 which I

prefer to arrange in horizontal rows and so located as to permit a free space immediately beneath the steam inlet port 16.

Taking up now the particular description of the form of the invention illustrated in Figs. 1, 2 and 3, with a single longitudinal division or partition wall, and remembering that the description would differ but slightly, and that in the number and intermediate arrangement of the pipes and baffles where more than one partition wall is used, differing in no particular in principle in such form, I provide for two complete tortuous or sinuous paths of flow for the steam from the upper compartment 22 within which it has come in contact initially with the cooling pipes 9. I divide the paths by means of the partitions and make these paths tortuous by a series of baffle plates which, with the interior of the cylinder and partition perform the triple function of guiding the steam removing water therefrom, and guiding the water clear of the cooling pipes. In the form illustrated I make use of three baffle plates upon each side, namely 23, 24, 25 on the one side and 26, 27 and 28 upon the other side, these baffles extending but part of the way between the side of the condenser and the central division wall, the remainder of the distance being open to provide passage for the steam excepting for channels acting as supports hereinafter described. These baffles and passages are so staggered as to form a sinuous path for the steam through the successive divisions and across the intermediate sets of cooling pipes. The direction of flow upon each side is as follows:—The steam from the upper port 16 passes on one side through the passage 29 against the inner part 30 of the wall of the condenser by which and the baffle 24 it is reversely directed and the water from it collected so that relatively dry steam is forced across the intervening set 10 of pipes and almost directly toward the part 31 of the division wall. The baffle 23 and the portions 31 and 33 of the division wall 21 here reverse the direction of flow of the steam again removing water therefrom and the steam passes down through the passage 32. The steam is directed in part also by baffle 25 and passes across set 11 of the pipes toward the portion 34 of the interior wall of the condenser by which and by the baffle 24 the steam is downwardly directed through the passage 35, the water from the steam being deposited upon the portion 34 of the inner wall of the condenser. The steam thus dried and the uncondensable gases which have of course followed the path of the steam are directed across the set 12 of the pipes to the outlets 18, 19, while the water gravitating to the bottom of the condenser is withdrawn at 17. Upon the other side a corresponding passage of the steam and the gases takes place through passage 36 across set 13 of pipes, through passage 37, reversely directed across set 14 of pipes, through passage 38, across set 15 of pipes to the outlets at 18 and 19. During this progress of the steam upon this side of the condenser there is the same deposit of water upon the different metal surfaces as is true of the other path. I accomplish equalization of temperatures by means of a plurality of openings 39 of any suitable character in the division wall 21. For the purpose of support it is desirable to connect the baffles both to the division wall and to the inner surface of the wall of the condenser itself, and such connection conventionally I have shown. In order to drain the several sections of the division wall and support the baffles additionally, I provide a combined chamber and supports which consist of extensions 40 of the baffle plates. I make use of a flange 41 adjacent the edge of the baffle to retain water on the baffle and prevent it being drawn through the passage by the flow of the steam.

In the device shown in Fig. 4, I slope the baffles toward the longitudinal wall 21, the baffles being otherwise of the same character, preferably, as those shown in the other figures, for which reason I have given them the same numerals of reference. The result of this is that I drain the baffles against the interior division wall instead of against the interior of the outer wall.

In Figs. 5 and 6 I show how with the general form of Fig. 4, I collect the water from my condenser almost wholly in the shed formed by baffles 25 and 28 withdrawing the water directly from this shed and adding the height of the shed from the bottom of the outer wall to the head of water available at the hot-well. For this purpose I make use of pipe 42 connecting with the shed referred to through aperture 43 and since the small amount of moisture which passes through the passages 35 and 38 is in this form removed along with the air by the vacuum pump, I omit the collars 20 preferably used in the form shown in Fig. 1 so that no water is allowed to collect in the bottom of the condenser. In the form of Figs. 5 and 6 I also prefer to form apertures to insure perfect equalization, the temperatures upon the two sides of the division wall or in adjoining compartments at the same height from the bottom of the condenser where more than two longitudinal partitions or division walls are used.

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

1. In a device of the character stated, an outer wall apertured for admission of steam and exhaust of air and water, longitudinally

disposed cooling pipes therein, chambers at the ends of the device for admission and removal of cooling fluid, a substantially plane longitudinal division wall, and a plurality of baffle plates on each side of the longitudinal division wall and oppositely apertured to provide a tortuous steam passage therethrough.

2. In a device of the character stated, an outer condenser wall, means for cooling the interior thereof, a substantially plane longitudinal partition therein, and baffles upon each side of the partition between it and the outer wall, apertured in alternate position to provide duplicate tortuous steam passages on opposite sides of the partition.

3. In a device of the character stated, an outer wall, water inlet and outlet chambers at the ends thereof, longitudinally extending pipes between these chambers, a longitudinal partition wall extending part of the height of the condenser and permitting unbroken rows of pipes thereabove and baffle plates on each side of the partition between it and the outer wall breaking up the pipes below the top of the partition into pairs of sets, side by side between the baffles, said baffles being alternately apertured to stagger with respect to each other.

4. In a device of the character stated, an outer wall having a steam inlet aperture at the top and air outlet at the bottom thereof, reversely apertured baffles on each side thereof, and a central longitudinal division wall, the compartments formed beneath the lowest of said apertured baffles and against said division wall having duplicate transverse lines of vapor flow and common outlets therefor at the bottom of the condenser and free from water of condensation.

5. In a device of the character stated, an outer condenser casing, a substantially plane longitudinal division plate therein, apertured baffles upon each side of the division plate, a water collector within the condenser, and a water drain pipe connecting the bottom of the condenser with said collector to supply a head of water corresponding to the height of the water collector, the chambers below the water collector and upon opposite sides of the water drain pipe having duplicate transverse lines of vapor flow free from water of condensation.

6. In a device of the character stated, an outer condenser wall, a substantially plane longitudinal division-plate therewithin, oppositely apertured baffles between it and the outer wall on each side of the plate, and means for collecting and draining the water of condensation from the lowest of said baffles in proximity to the division plate, the tubes below said lowest baffles being thus freed from water of condensation.

7. In a device of the character stated, an outer condenser casing, a substantially plane longitudinal central division plate therein, oppositely apertured baffles upon each side of the division plate, means to drain the water from the lowest of said baffles in proximity to the division wall and cooling tubes in said condenser both above and below said lowest baffle.

8. In a device of the character stated, an outer condenser casing, a substantially plane longitudinal division wall therein, and baffles upon each side of said division wall apertured to provide duplicate sinuous lines of steam flow upon opposite sides of the division wall.

9. In a device of the character stated, an outer condenser wall, baffles provided with means for forming duplicate. sinuous, transverse lines of steam flow, and a longitudinal division wall between said baffles apertured to equalize temperatures and pressures between the compartments formed by said baffles upon opposite sides of the wall.

CHARLES J. SNOW.

Witnesses:
W. T. JACKSON,
C. D. MCVAY.