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Patented Nov. 25, 1902.

C. ORDWAY.
VACUUM EVAPORATING APPARATUS.

(Application filed Nov. 9, 1901.)

(No Model.)

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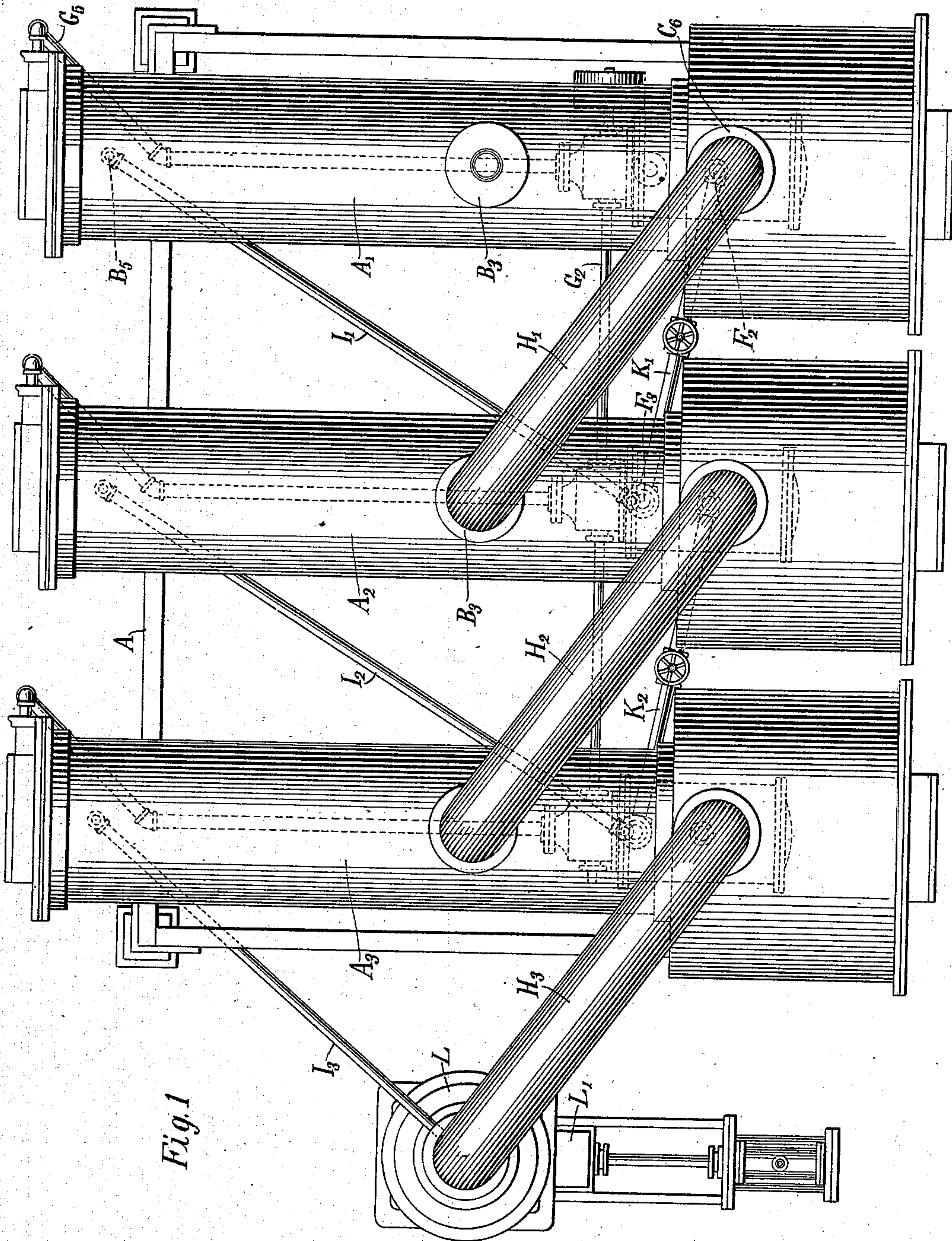


Fig. 1

Witnesses:

Raphael Ketter
Jessie B. Ray

Inventor

Charles Ordway
by Robt. H. Duncan Att'y

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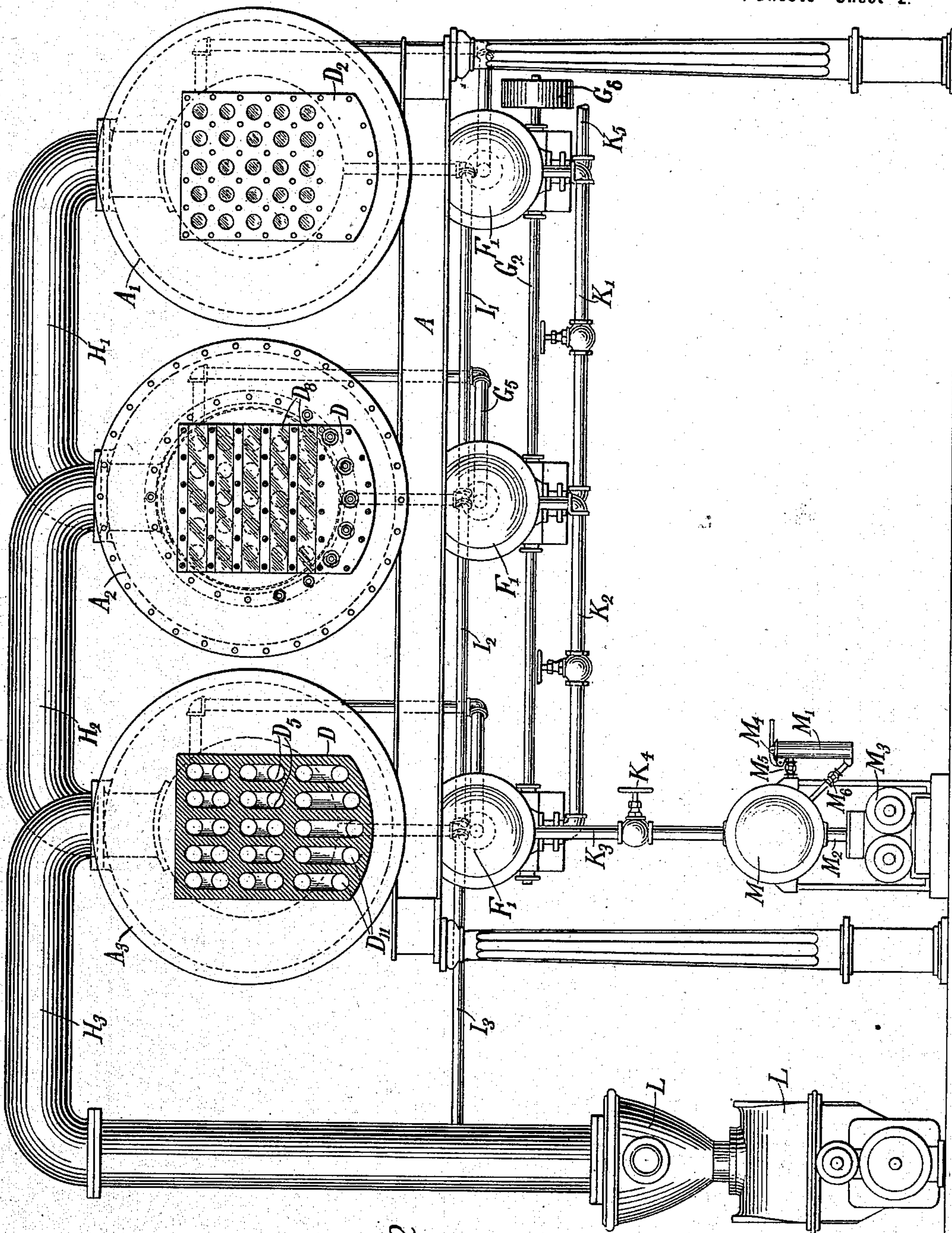


Fig. 2

Witnesses:

Raphael Ketter
Jessie B. Ray

Inventor

Charles Ordway
by Robt. H. Duncan Atty

No. 714,513.

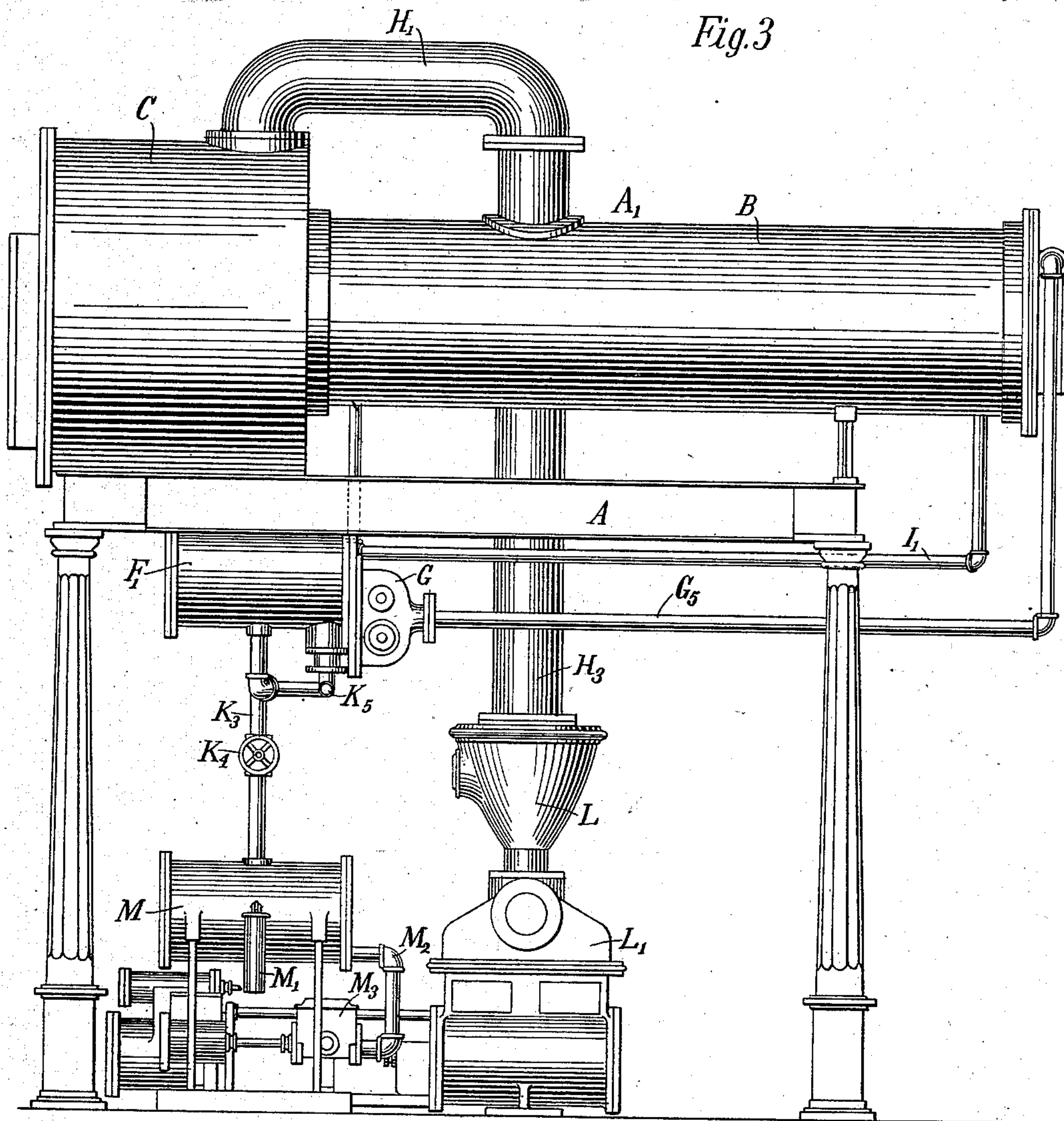
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Witnesses:

Raphael Ketter
Jessie B. May

Inventor

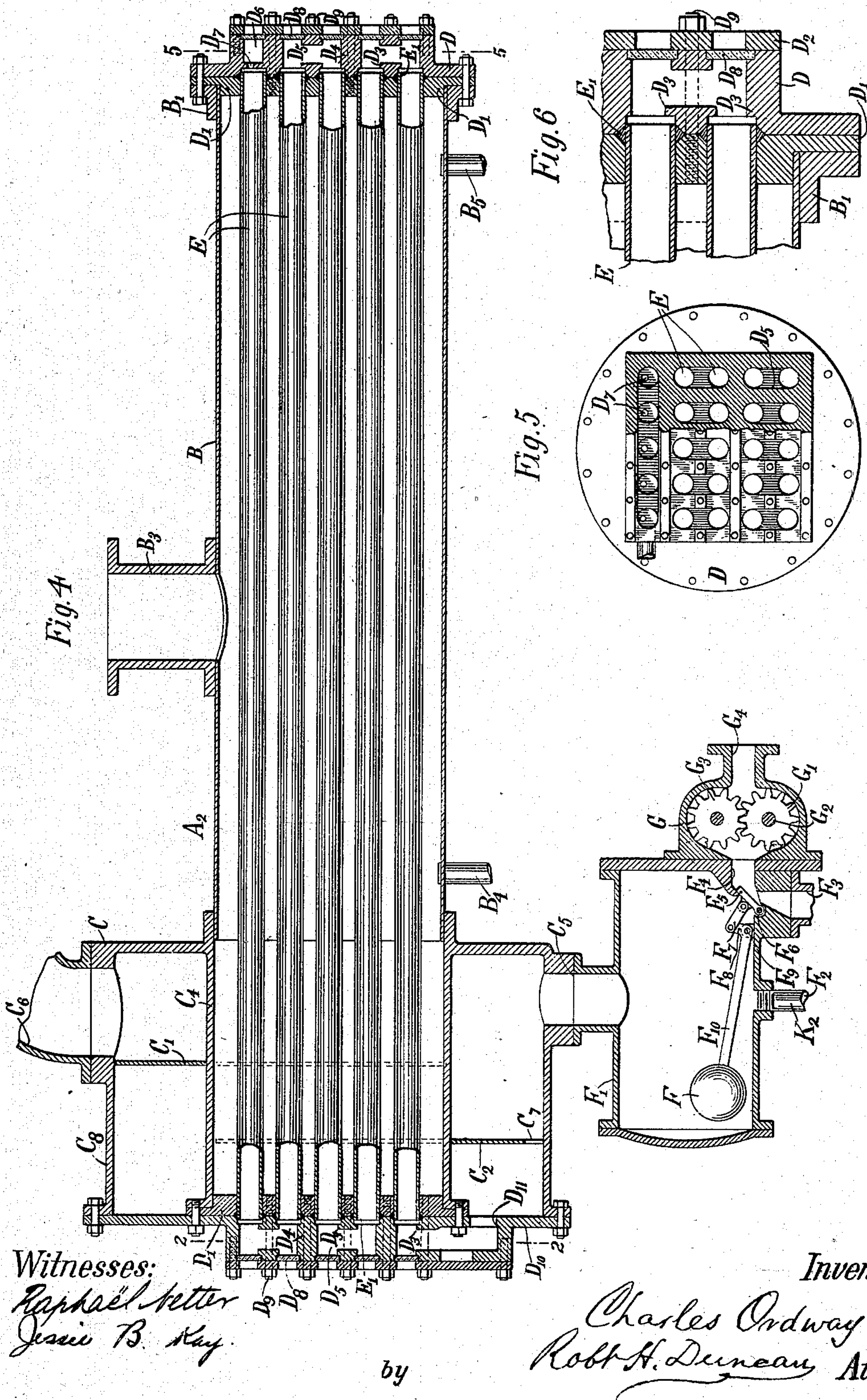
Charles Ordway
by *Robt H. Duncan* Att'y

C. ORDWAY.
VACUUM EVAPORATING APPARATUS.

(Application filed Nov. 9, 1901.)

(No Model.)

4 Sheets—Sheet 4.



Witnesses:
Raphael Peter
Jessie B. Kay.

by

Inventor
Charles Ordway
Robt H. Duneau Atty

UNITED STATES PATENT OFFICE.

CHARLES ORDWAY, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE
YARYAN COMPANY, A CORPORATION OF NEW YORK.

VACUUM EVAPORATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 714,513, dated November 25, 1902.

Application filed November 9, 1901. Serial No. 81,681. (No model.)

To all whom it may concern:

Be it known that I, CHARLES ORDWAY, a citizen of the United States, and a resident of New York, borough of Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Vacuum Evaporating Apparatus, of which the following is a specification, reference being had to the accompanying drawings, forming a part of the same.

This invention relates to vacuum evaporating apparatus of the type disclosed in patents to Homer T. Yaryan, No. 355,289, December 28, 1886, and No. 383,384, May 22, 1888; and it consists in certain improvements hereinafter described and claimed.

The accompanying drawings illustrate a form of apparatus embodying these improvements, in which the same reference characters refer to similar parts of the various figures.

Figure 1 is a plan view of the evaporating apparatus. Fig. 2 is an end elevation, parts on the line 2 2 of Fig. 4 being shown in section. Fig. 3 is a side elevation. Fig. 4 is a transverse sectional view of one of the effects. Fig. 5 is an end view of the same, the cover-plate being removed and parts on the line 5 5 of Fig. 4 being shown in section. Fig. 6 is an enlarged sectional view showing the mounting of the tubes.

This evaporating apparatus is composed of a number of effects, three effects, A^1 , A^2 , and A^3 , being shown in the drawings as mounted upon a suitable framework A. Each of the effects comprises a series of coils of tubes inclosed in a shell, a chamber for separating the vapor from the liquor, and suitable connections for producing a partial vacuum in the effects and for conveying steam and liquor. These effects are connected by vapor-pipes H^1 and H^2 , and a pipe H^3 communicates with the jet-condenser L, which is operated in connection with the vacuum-pump L' to maintain a partial vacuum in the several effects. Each of the effects is of substantially the same construction, and attention is specially directed to the middle effect A^2 of the series, which will be described in detail. The shell B, as indicated in Fig. 4, is tubular and is secured at one end to the flange B', to which the tube-

sheet D' is bolted. The shell B is secured at its other end to the separating-chamber C, the inner shell C^4 of this chamber forming a continuation and a part of the shell B, so that the shell of the effect, comprising the portions B and C^4 , incloses the tubes throughout their entire extent. If desired, this shell may be constructed of a single piece of metal. The front return-head D^{10} , which is bolted to the outer shell C^8 of the separating-chamber, forms, together with the tube-sheet D' at this end of the effect, the inclosed annular separating-chamber C around the tubes and shell of the effect. It will be noted that the two dash-plates C^1 and C^2 , which are staggered, are arranged in the separating-chamber to prevent the entrainment of the liquor. The tube-sheet D' is formed with a series of holes to support the evaporating-tubes E, made of suitable heat-conducting material, and the tubes are arranged in the sheet to form a series of coils, as is indicated in Fig. 5, the five tubes in each vertical row being joined to form a single coil in such manner that the liquor passes back and forth throughout the entire length of the coil. It will of course be understood that instead of using the exact number of tubes in a coil or coils in an effect as here disclosed any other practical number may be employed. Furthermore, the tubes in a coil need not always be arranged in a vertical line, and the several coils need not be alined horizontally, although it is advantageous to have the feed-head D^6 horizontal. The tubes are packed in the tube-sheet by forming the outside of the tube-sheet D' with an annular tapered recess about each of the tubes. The return-head D, which fits over the tube-sheet, is provided with suitable holes to accommodate the projecting ends of the tubes, and about each of these holes is formed an annular tapered recess to coact with the corresponding recess in the tube-sheet. Packing-rings E' are fitted around the tubes, and when the return-head is clamped upon the tube-sheet each of these packing-rings is forced home to make a tight joint about each of the tubes. It will be noted that in this way all of the tubes are packed simultaneously, since the return-head forces home the packing for each of the tubes. It will be

noted that the tube-sheets and the return-heads at both ends of the effect are formed in a substantially similar way and that the tubes are packed in a similar manner.

5 The back return-head D is formed with a series of partitions D^4 , which form the communicating channels D^5 between the adjacent tube ends, as indicated. The front return-head D^{10} is formed with similar partitions and
10 channels D^5 , so that the liquor is directed in a single coil from the back return-head in the upper tube E to the front return-head, then back through the second tube in this coil, and the liquor passes back and forth
15 until it finally issues from the opening D^{11} in the front return-head into the separating-chamber. It will be seen by reference to Fig. 6 that the return-heads are formed with the projections D^3 adjacent to the ends of
20 each of the tubes and that the tubes are countersunk in the heads. These projections serve to guide the liquor as it enters and leaves the tubes, so as to prevent its impinging upon the ends of the tubes themselves at
25 this point. This prevents the excessive erosion of the tubes at their ends and is very advantageous in practice.

The back return-head D is provided at its upper end with a transverse feed-head D^6 ,
30 which communicates with the top tubes of each coil of the effect by means of feed-openings D^7 , aligned horizontally in the wall of the feed-head, through which the liquor is fed into the top tube of each coil, the feed-head
35 of course being filled with liquor at all times. These feed-openings are considerably reduced as compared with the diameter of the tubes, as is shown in Fig. 5, and in this way the feed of liquor through the various coils
40 of an effect is kept substantially uniform. This is because the liquor is supplied to the feed-head under pressure and is forcibly discharged through the reduced or throttling openings into the various coils. These feed-
45 openings, it will be noted, are preferably located near the top of the tube, so that the liquor cannot readily return through them into the feed-head.

In order to make it possible to observe the
50 action of the liquor in each of the tubes, a series of eyeglasses D^8 are set in the return-heads. These glasses, as will be seen from Figs. 2, 5, and 6, each extend across the head and are clamped in suitable grooves in the
55 head D by the cover-plate D^2 , which is secured in position by the bolts D^9 . Any suitable packing may be used for these glasses to make a tight joint between the glasses and the return-head. The front return-head is
60 provided with eyeglasses in a similar manner, so that it is possible to look entirely through each of the tubes E while the evaporation is going on.

The liquor which has passed through the
65 coils of the effect and issues from the opening D^{11} into the separating-chamber passes

through the hole C^7 , formed in the lower part of the dash-plate C^2 , and escapes from the opening C^5 in the bottom of the separating-chamber into the receiving-chamber F' . This
70 receiving-chamber communicates through the liquor-inlet F^2 to the next succeeding effect, and the liquor-inlet F^3 receives liquor that has passed through the next preceding effect. A mixing-valve F^5 is pivoted about
75 the point F^6 in the receiving-chamber and automatically controls the circulation of liquor through the effect. This valve is connected by the link F^7 with the float F. This float is mounted on the bell-crank lever F^{10} ,
80 pivoted about the fulcrum F^9 , and the short arm F^8 of this lever is connected to the link F^7 . The circulating-pump G is connected to the receiving-chamber and takes the liquor from the discharge-passage F^4 and forces it
85 through the opening G^4 , through the pipe G^5 , to the return-head D^6 , where it is fed through all the coils of this effect. This circulating-pump consists of the two meshing gears G' and G^3 , the gear G' being mounted on the
90 driving-shaft G^2 , which is operated by a suitable belt on the pulley G^6 .

The operation of the automatic mixing-valve is as follows: The evaporation takes place in the tubes E of the effect in a man-
95 ner well known in this art, and the concentrated liquor passes down into the receiving-chamber. The valve is arranged to operate relatively to the openings from both the receiving-chamber F' and the liquor-inlet F^3
100 into the discharge-passage F^4 , so as to regulate the quantity of liquor fed through these openings, and thereby maintain enough liquor in the effect to insure its proper operation. Normally the valve is slightly open on its
105 seat at the chamber-opening and permits some of the concentrated liquor to flow from the chamber into the discharge-passage, and when thus open it partially closes the opening of the inlet F^3 and diminishes the flow of
110 the thinner liquor from preceding effect. Whenever the liquor in the receiving-chamber falls below the desired quantity, the float F drops, the valve is closed upon its chamber-seat, and the opening of inlet F^3 is unob-
115 structed to admit an increased flow of liquor from the preceding effect. The liquor from the preceding effect, together with the liquor from the receiving-chamber, which flows into the passage F^4 , passes through the circulat-
120 ing-pump and is fed to the feed-head D^6 of the effect. It is important that the liquor from the receiving-chamber be thoroughly mixed with the thinner liquor from the preceding effect before it is fed from the feed-
125 head through the coils, and this is effected by means of the circulating-pump.

The shell of the effect is provided, as indicated in Fig. 4, with the vapor-inlet B^3 , and the vapor-discharge C^6 is connected with the
130 separating-chamber. The drip-inlet B^4 and the drip-outlet B^5 communicate with the in-

terior of the shell. It will be understood that the other effects A' and A³ are substantially identical with the effect A², which has been described in detail.

5 The three effects are arranged as indicated in Figs. 1, 2, and 3 and are connected by the vapor-pipes H', H², and H³ and by the drip-pipes I', I², and I³, which pass from the drip-outlet B⁵ of one effect to the drip-inlet B⁴ of the next succeeding effect. The last drip-pipe I³ leads into the condenser, as indicated. The liquor-pipes K' and K², provided with valves, as indicated, connect the liquor-outlet F² of one effect with the liquor-inlet F³ of the next succeeding effect. The liquor-pipe K³, leading from the liquor-outlet F² of the last effect A³, is provided with the valve K⁴ and communicates with the pump and receiver formed as is well known in this art. The receiver 20 M is provided with the usual test-cup M', having the cover M⁴, into which the hydrometer may be inserted for testing the density of the liquor, and the two cut-off valves M⁵ and M⁶ connect the cup with the receiver. The pump 25 M³ is connected by the pipe M² with the receiver and serves to discharge the liquor in a well-known manner.

The steam to operate the evaporating apparatus is supplied to the shell of the first effect 30 A' through the vapor-inlet B³. This steam, as is well known in this art, circulates around the tubes E and heats and evaporates the liquor contained therein. The liquor fed to the first effect A' passes through the supply-pipe K⁵, through the liquor-inlet F³ and circulating-pump of this effect, and thence through feed-pipe G⁵ to the feed-head D⁶, whence it is uniformly delivered to the several coils of the effect. As it issues from the tubes the vapor is 40 separated from the liquor in the separating-chamber and passes out at the vapor-discharge C⁶ into the shell of the next succeeding effect and serves to heat the tubes of that effect. The liquor passing into the receiving-chamber F' 45 passes out at the liquor-outlet F² to the next succeeding effect and also to some extent passes through the passage F⁴ and mixes with the liquor entering at the liquor-inlet F³ and is circulated again through the same effect 50 by the circulating-pump. This is because the mixing-valve is usually open slightly to admit some liquor from the receiving-chamber to the discharge-passage F⁴. It will be noted that with this improved construction 55 the separating-chamber is formed around the tubes of an effect, and the return-head may be formed with eyeglasses adjacent to the ends of the tubes, so that it is possible to look through each one of the tubes. This 60 construction also gives a very much more compact and easily-accessible form of evaporating apparatus and allows the ready removal of the tubes.

Many modifications may be made in this 65 evaporating apparatus by those familiar with the art, and parts of this invention may be

used without employing all of the same. I do not, therefore, wish to be limited to the disclosure which I have made in this case; but

What I claim as new, and what I wish to secure by Letters Patent, is set forth in the appended claims. 70

1. In evaporating apparatus, a number of effects joined together in series, each effect comprising a shell, a separating-chamber surrounding the shell at one end of the same, 75 tube-sheets at either end of the effect secured to the shell and formed with annular tapered recesses around each of said tubes, a return-head formed with similar coacting recesses 80 around each of said tubes, packing-rings around each of the tubes secured in position by clamping said tube-sheets and said return-heads together, eyeglasses in said heads in line with each of said tubes, one of said 85 heads being provided at its upper part with a horizontal feed-head communicating with the top tube of each coil, a receiving-chamber connected to said separating-chamber provided with a mixing-valve, a liquor-outlet, a liquor-inlet and a circulating-pump to receive the mixed liquor and to force the same into said feed-head. 90

2. In evaporating apparatus, an effect comprising a tubular shell, a separating-chamber 95 encircling said shell at one end of the same, dash-plates in said separating-chamber, tube-sheets secured at either end of said shell, tubes mounted in said tube-sheets to form vertical coils, the tubes of each coil being 100 alined horizontally, return-heads packing each of said tubes secured to said tube-sheets and provided with communicating channels to conduct the liquor back and forth through the tubes of each coil, one of said return-heads being provided with a horizontal feed-head having a horizontal row of feed-openings communicating with the upper tube of each coil. 105

3. In evaporating apparatus, an effect comprising a tubular shell, tubes mounted in said shell to form coils, a separating-chamber secured to and adjacent said shell and out of line with said tubes and removable heads formed with passages to direct the liquor 110 from one tube to another and with eyeglasses in line with said tubes secured to said shell at either end of the same to give ready access to the ends of said tubes. 115

4. In evaporating apparatus, an effect comprising a tubular shell, tube-sheets secured to either end of said shell, tubes mounted in said sheets, there being annular tapering recesses formed in said tube-sheets around each of said tubes and a return-head secured to 120 each of said tube-sheets to simultaneously pack all of the tubes in said sheets, said heads being formed with passages to connect the ends of said tubes to form a series of coils. 125

5. In evaporating apparatus, an effect comprising a cylindrical shell, tube-sheets secured to said shell, tubes mounted in said 130

tube-sheets, return-heads secured to said tube-sheets to pack said tubes in said tube-sheets and eyeglasses mounted in said return-heads opposite each of said tubes to observe the inside of said tubes.

5 6. In evaporating apparatus, a tubular shell, tube-sheets secured to said shell, return-heads provided with eyeglasses in line with each of said tubes secured to said tube-sheets and a separating-chamber provided with dash-plates encircling said shell and said tubes at one end of the same.

7. In evaporating apparatus, an effect comprising tubes, a cylindrical shell surrounding
15 said tubes, an annular separating-chamber encircling said shell and tubes, return-heads secured to the ends of said tubes and provided with eyeglasses opposite said tubes.

8. In evaporating apparatus, a series of effects connected together each effect comprising tubes, a separating-chamber and a receiving-chamber, said receiving-chamber being provided with a float, a mixing-valve operated by said float to admit liquor from said
25 receiving-chamber to the discharge-passage from said receiving-chamber, a liquor-inlet controlled by said mixing-valve connected to the preceding effect and communicating with said discharge-passage, a circulating-pump
30 communicating with said discharge-passage to feed liquor through the tubes of said effect and a liquor-outlet connected to the succeeding effect.

9. In evaporating apparatus, a series of effects connected together, each effect comprising tubes, a separating-chamber and a receiving-chamber, said receiving-chamber being provided with a liquor-outlet connected to the succeeding effect, a liquor-inlet connected to the preceding effect and a valved discharge-passage communicating with said receiving-chamber and said liquor-inlet and a pump communicating with said discharge-passage to force liquor through the tubes of
45 said effect.

10. In evaporating apparatus, a series of effects, each effect comprising tubes, a separating-chamber, and a receiving-chamber, the latter provided with a float, a mixing-valve
50 operated by said float controlling the discharge-passage from said receiving-chamber, a liquor-inlet connected to the preceding effect and communicating with said discharge-passage, a circulating-pump communicating
55 with said discharge-passage to feed liquor through the tubes of said effect and a liquor-outlet connected to the succeeding effect and communicating with said receiving-chamber.

11. In evaporating apparatus, an effect
60 comprising tubes, a separating-chamber and a receiving-chamber, said receiving-chamber

being provided with a liquor-outlet, a liquor-inlet and a valved discharge-passage communicating with said receiving-chamber and said liquor-inlet and a pump communicating
65 with said valved passage to force liquor through the tubes of said effect.

12. In evaporating apparatus, an effect comprising a receiving-chamber, said receiving-chamber being provided with a liquor-outlet, a discharge-passage and a liquor-inlet adjacent said discharge-passage, and an automatic valve simultaneously controlling said discharge-passage and said liquor-inlet to reduce the flow of liquor from said receiving-chamber into said discharge-passage and to increase the flow of liquor from said liquor-inlet into said discharge-passage as the liquor in said receiving-chamber is reduced.

13. In evaporating apparatus, an effect
80 comprising a tubular shell, tube-sheets secured to said shell, tubes mounted in said tube-sheets, return-heads secured to said tube-sheets formed with passages to conduct the liquor from one tube to another, there
85 being projections formed in said return-heads to provide axial passages in line with said tubes to direct liquor into said tubes without impinging upon the ends of the same.

14. In evaporating apparatus, an effect
90 comprising a shell, tubes mounted in said shell, return-heads secured to said tubes formed with passages to conduct liquor from one tube to another, said passages adjacent the ends of the tubes being axially in line
95 with and of less diameter than the tubes to direct liquor axially into said tubes.

15. In evaporating apparatus, an effect comprising tubes, return-heads secured to said tubes formed with passages to conduct
100 the liquor from one tube to another, there being projections in said return-heads adjacent said tubes to provide axial passages in line with said tubes to direct liquor into said tubes without impinging upon the ends of
105 the same.

16. In evaporating apparatus, an effect comprising a shell, tube-sheets secured to said shell, tubes mounted in said tube-sheets, return-heads closely encircling each of said
110 tubes secured to said tube-sheets to simultaneously pack all of said tubes in said sheets.

17. In evaporating apparatus, an effect comprising a shell, tubes mounted in said shell, return-heads closely encircling each of
115 said tubes secured to said tubes and means acting in connection with said return-heads to simultaneously pack all of said tubes.

CHARLES ORDWAY.

Witnesses:

JOHN N. MOORE,
HARRY L. DUNCAN.