B. S. HUGHES.

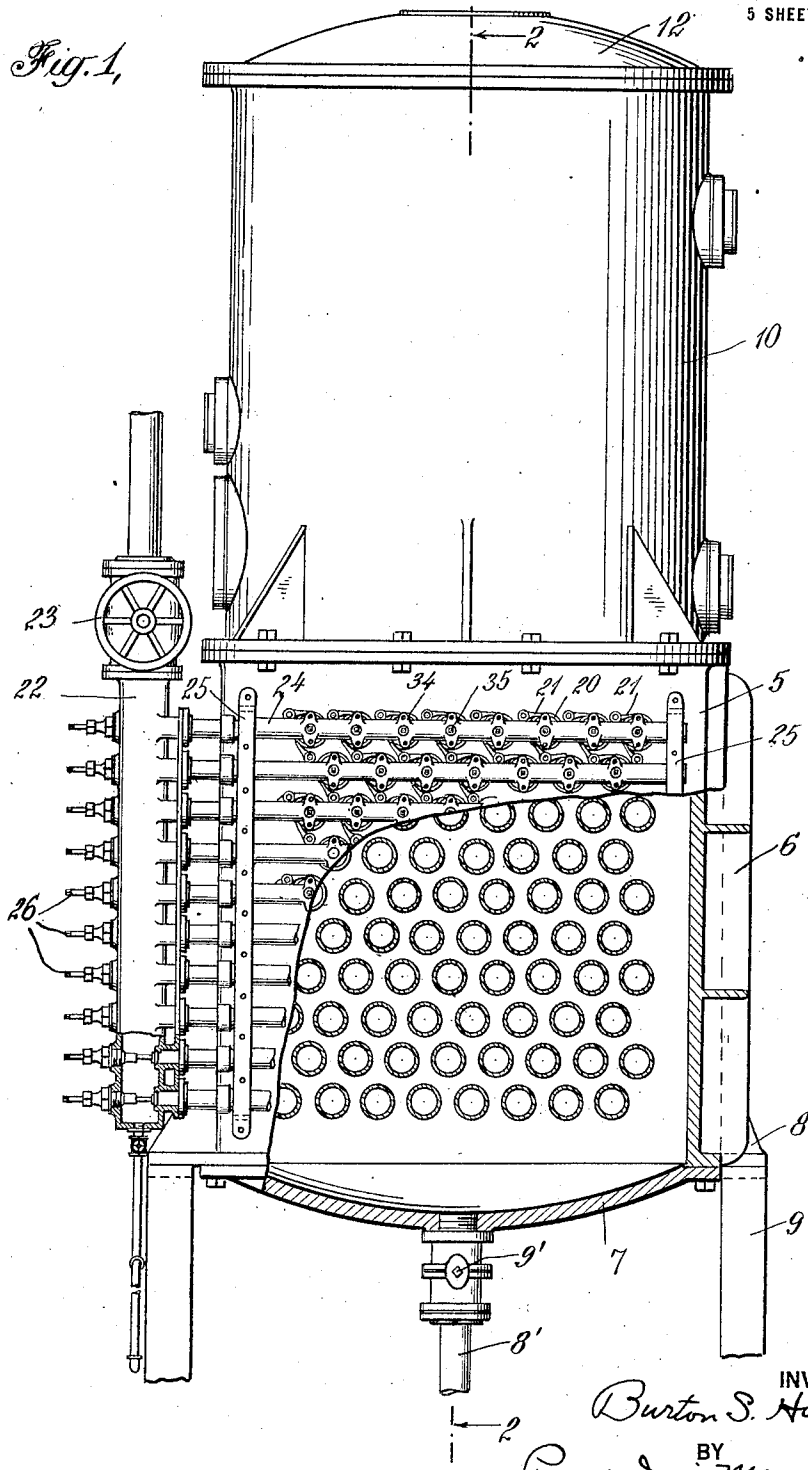
EVAPORATOR.

APPLICATION FILED JULY 5, 1919.

1,393,221. **Patented Oct. 11, 1921.**

5 SHEETS—SHEET 1.

Fig. 1.



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EVAPORATOR.

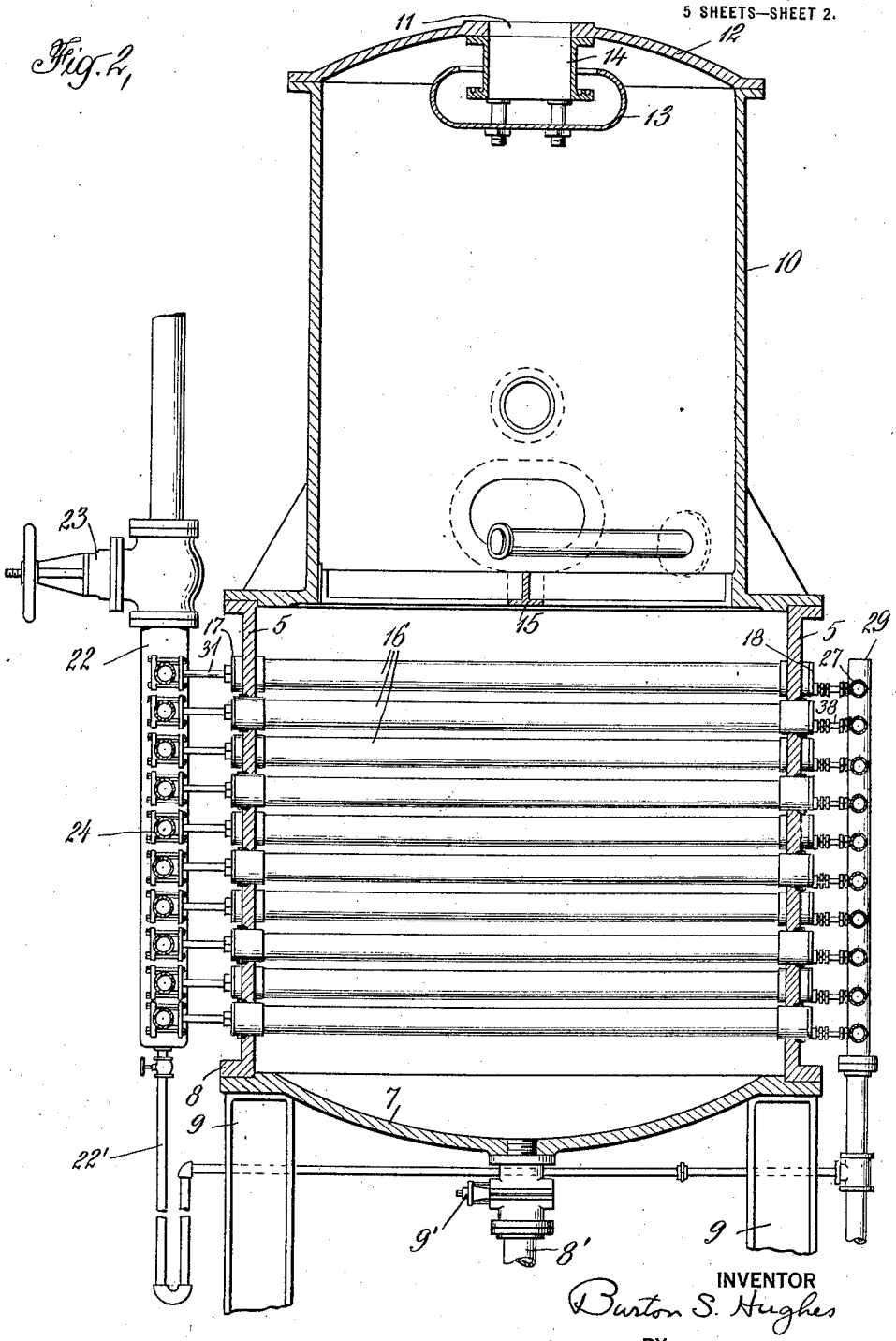
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5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 3,

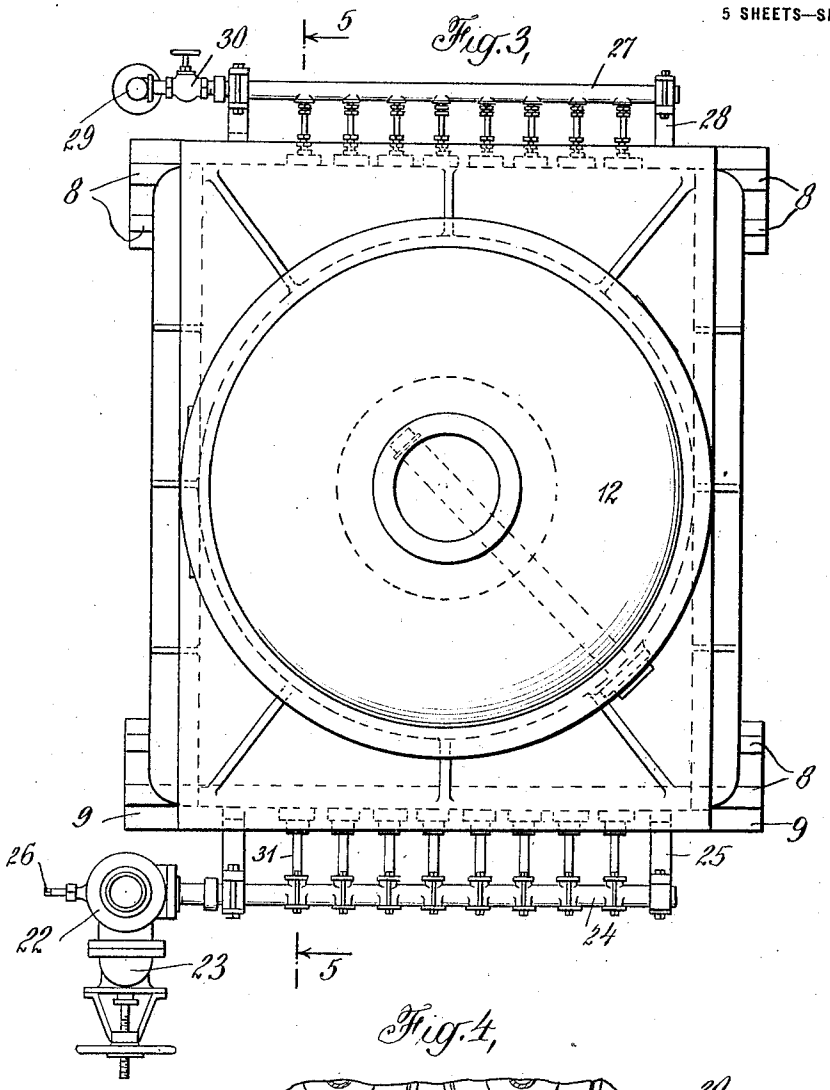
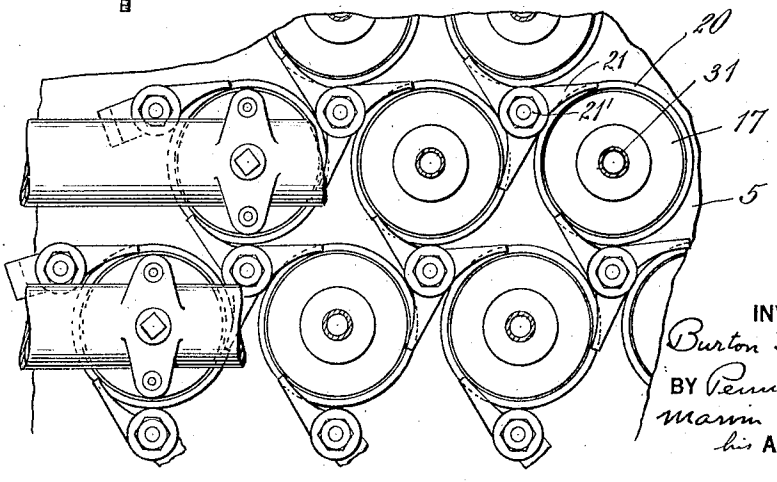


Fig. 4,



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APPLICATION FILED JULY 5, 1919.

1,393,221. **Patented Oct. 11, 1921.**

5 SHEETS—SHEET 4.

Fig. 5,

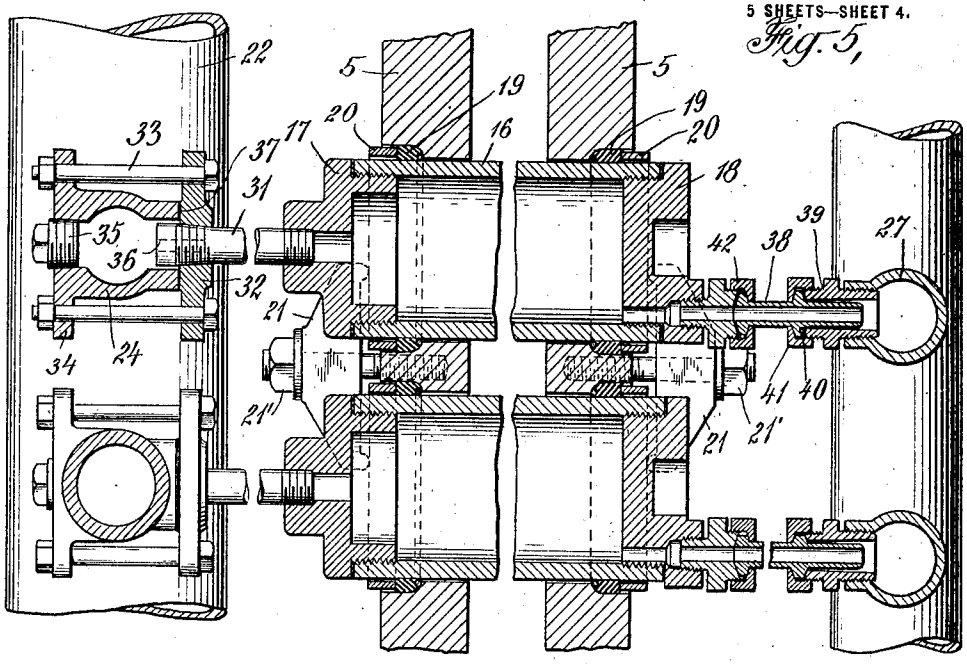


Fig. 7,

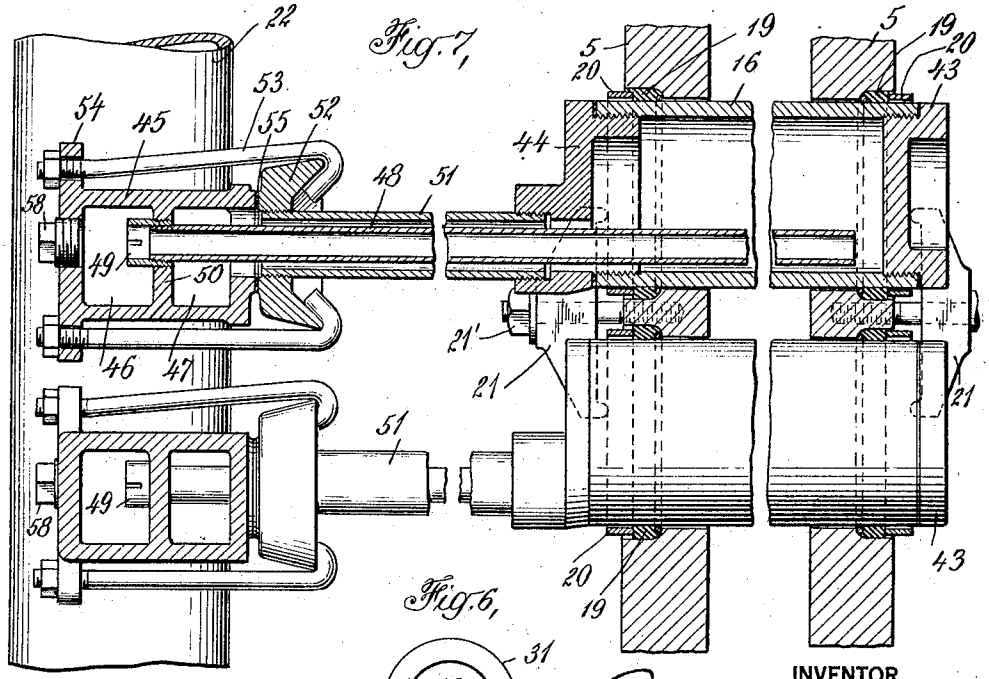
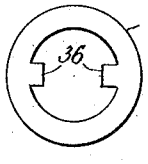


Fig. 6,



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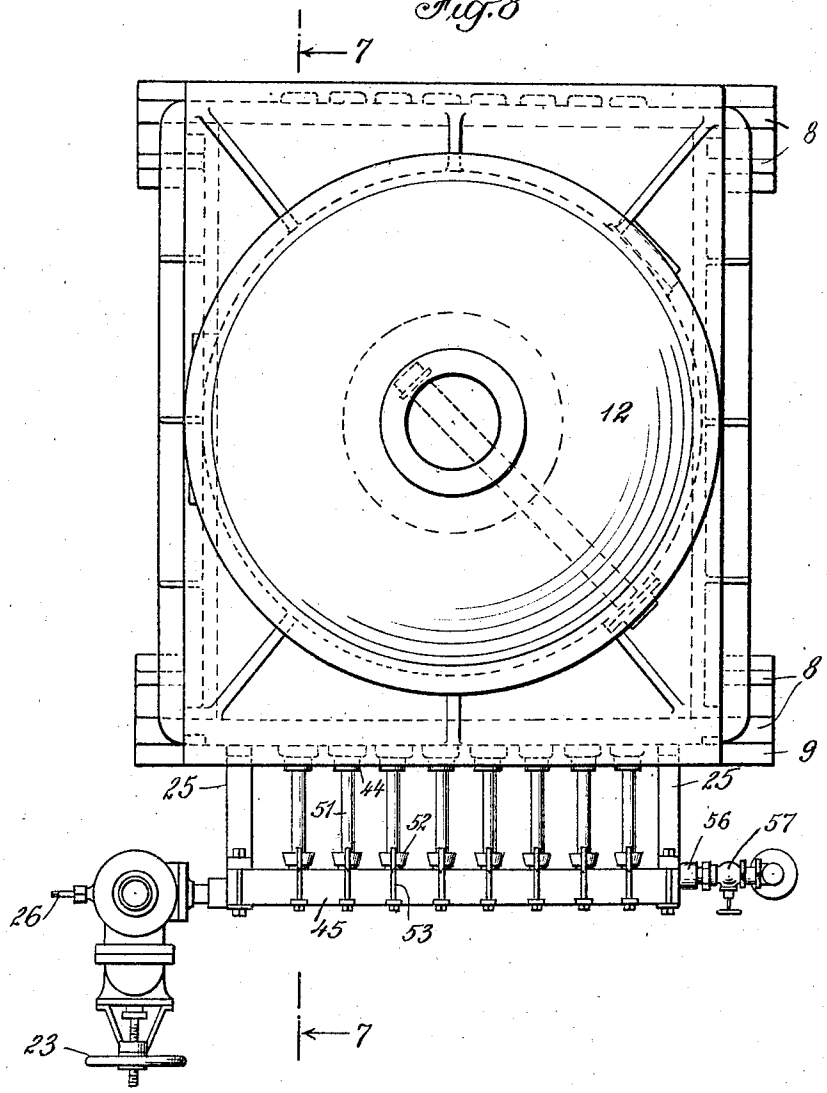
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5 SHEETS—SHEET 5.

Fig. 8



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UNITED STATES PATENT OFFICE.

BURTON S. HUGHES, OF BUFFALO, NEW YORK, ASSIGNOR TO ZAREMBA COMPANY, OF BUFFALO, NEW YORK, A CORPORATION OF MAINE.

EVAPORATOR.

1,393,221. Specification of Letters Patent. Patented Oct. 11, 1921.

Application filed July 5, 1919. Serial No. 308,898.

To all whom it may concern:

Be it known that I, BURTON S. HUGHES, a citizen of the United States, residing at Buffalo, in the county of Erie, State of New York, have invented certain new and useful Improvements in Evaporators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to evaporators wherein liquids are subjected to heat interchange with fluids at relatively high temperatures and particularly to that type of evaporator in which a partial vacuum is maintained within the vacuum chamber and the heating fluid is supplied under a considerable pressure.

Evaporators operating under partial vacuum and with heating fluids under pressure have been heretofore constructed and used; but they have not been adapted to employment with steam at the pressures necessarily used to obtain high temperatures. Such evaporators are for example, not available for concentration of solutions having very high boiling points. Thus, in concentrating caustic soda above 50% solid, it is necessary to use steam at 150 or even 175 pound pressure. The excessive cost of constructing evaporators of well known types, capable of use with such high pressures, has heretofore limited the possible commercial concentration of caustic soda and other solutions of a like character.

Vacuum evaporators have, moreover, been subject to certain disadvantages, for example, the necessity of partially dismantling the structure to remove the tubes, employed to convey steam or vapor in contact with the liquid to be evaporated. No provision has been made for cutting out defective tubes without affecting the operation of the evaporator and it has been necessary, therefore, when leakages developed in one or more tubes to shut down the evaporator for a considerable period while the defective tubes were replaced. Relative expansion and contraction of the tubes has not been permitted in common types of evaporators, which frequently develop serious leakage about the connections, resulting in high operating costs.

It is the object of my invention to provide an evaporator adapted to withstand high pressures both of the heating fluid and of the external atmosphere and to overcome the disadvantages enumerated by providing for the removal and replacement of tubes without dismantling the structure, for cutting out a series of tubes, one or more of which may be defective, without affecting the operation of the evaporator, and by so arranging the connections between the steam manifold and tubes and between the latter and the drain manifold that expansion and contraction of the tubes may occur without permitting the escape of the heating fluid.

Further objects and advantages of the invention will be apparent as it is better understood by reference to the following specification when read in connection with the accompanying drawing, in which,

Figure 1 is a front elevation of an evaporator according to my invention, parts being broken away for purposes of better illustration;

Fig. 2 is a vertical section through the evaporator;

Fig. 3 is a plan view of the evaporator;

Fig. 4 is an enlarged detail in vertical section of a portion of the structure;

Fig. 5 is an enlarged detail in section on the line 5—5 of Fig. 3;

Fig. 6 is an end elevation of one of the nipples;

Fig. 7 is an enlarged detail in section on the line 7—7 of Fig. 8; and

Fig. 8 is a plan view of a form of my invention slightly different from that illustrated in Fig. 3.

While my invention is hereinafter described with particular reference to the use of steam at high pressure, it is to be understood that the structure may be employed with low pressure steam, with heated gases and with heated liquids circulating through the tubes in place of steam. It is frequently desirable to employ liquids which can be heated to temperatures above 600° F. where the concentration of solutions requires temperatures higher than those obtainable by using steam.

Referring to the drawing, 5 indicates the tube sheets and 6 the ribbed side plates forming, with the dished bottom 7 when the parts are bolted together, a rectangular shell adapted to be substantially filled with liquid to be concentrated. The tube sheets 5 and

side plates 6 are independently supported by brackets 8 resting upon columns 9 thus permitting removal of the dished bottom or of the side plates by removing the bolts without otherwise dismantling the structure. A liquid outlet 8′ having a valve 9′ is connected to the dished bottom 7.

A cylindrical vapor chamber 10 is secured to the shell and provides space for the vapor which escapes through an outlet 11, in a dished head 12 closing the end of the vapor chamber. Baffles 13 and 14 are arranged adjacent the outlet 11 to prevent escape of liquid with the vapor from the evaporator. The cylindrical form of the vapor chamber insures sufficient resistance to external pressure, as when a high vacuum is maintained within the evaporator. A four armed strut 15 is preferably secured within the cylindrical vapor chamber 10 to insure the maximum resistance to pressure at the junction of the shell and cylindrical vapor chamber.

The tube sheets 5 are provided with openings to receive tubes 16 which are loosely disposed therein and are closed by front and rear caps 17 and 18. Gaskets 19 are disposed about the ends of the tubes and are held in place by packing rings 20. The latter are caused to compress the gaskets to provide a steam tight joint by crabs 21, fastened by bolts 21′ to the tube sheets 5.

The heating fluid such as steam is delivered to the tubes through a vertical manifold 22, having a control valve 23, and connected to a plurality of horizontal manifolds 24 corresponding in number to the rows of tubes in the evaporator. The manifolds 24 are supported on the shell by brackets 25. Valves 26 are provided in the vertical manifold 22 to control each of the horizontal manifolds 24, so that the supply of heating fluid to either of the horizontal manifolds may be cut off at will. Thus, if a tube becomes defective, the corresponding row of tubes may be cut out without affecting the operation of the evaporator.

Corresponding horizontal manifolds 27 are supported on brackets 28 at the rear of the evaporator to receive the condensate, and communicate with a drain 29 through which the condensate is wasted. Valves 30 are provided to control a connection between each of the horizontal manifolds 27 and the drain 29. A trapped drain pipe 22′ connects the vertical manifold 22 to the drain 29.

To connect the tubes 16 to the horizontal manifolds 24, I provide nipples 31 threadedly secured to the caps 17 and carrying flanges 32. The flanges 32 are secured by bolts 33 to the manifolds 24, the latter being provided with flanges 34 to receive the bolts and with threaded plugs 35 closing openings in the manifolds alining with the nipples 31. These nipples are provided internally with lugs 36 adapted for engagement with a special wrench (not shown) when the plugs 35 are removed so that the nipples may be disconnected from the caps 17 without dismantling the horizontal manifold. Gaskets 37 are provided between the flanges 32 and the horizontal manifolds 24 to insure a steam tight joint.

At the rear of the evaporator, the tubes 16 are connected, by nipples 38 threadedly supported in the caps 18, with slip joints 39 on the horizontal manifolds 27. Suitable packing 40 is held by packing nuts 41 in the slip joint 39 to insure a tight connection. The nipples 38 are made in two parts connected by couplings 42 thus permitting separation of the nipples when a tube is to be withdrawn. The slip joints permit expansion and contraction of the tubes relative to the manifolds when the evaporator is in operation. It will be noted that at the inlet end the heating fluid is delivered centrally to the tubes 16 and that the condensate is withdrawn from the lower portion of the tube thus insuring proper drainage. This arrangement also permits insertion of the caps 17 and 18 without the necessity of alining the nipple openings.

The removal of a defective tube is accomplished by first removing the corresponding plug 35 in the manifold 24. The nipple 31 is withdrawn from the cap 17 and the crabs 21 are loosened to release the tube gaskets. The nipple 38 is then disconnected and the defective tube may be withdrawn from the evaporator and replaced. This simple operation is accomplished without dismantling the front manifolds, cutting the tubes or in any manner disarranging the remainder of the structure except by the removal of the corresponding rear manifold. Obviously this permits of quick repair in case of necessity and facilitates the operation of the evaporator at its highest capacity.

In Figs. 7 and 8 of the drawing, I have illustrated a slightly different form of my invention in which the heating fluid is delivered and the condensate is withdrawn from the same end of the tubes. In this form of my invention the tubes 16 are closed at their rear ends by solid caps 43 and at their forward ends by caps 44. The horizontal manifolds 45 are provided with two chambers 46 and 47, the former to supply the heating fluid and the latter to receive the condensate. Pipes 48 are threadedly supported in bushings 49 mounted in the walls 50 which separate the chambers 46 and 47. The pipes 48 convey the heating fluid to the rear end of the tubes 16, passing through openings in the caps 44 somewhat larger than the pipes 48. Pipes 51 are threadedly connected to the caps 48 and to flanges 52 held in assembled relation with the manifolds 45 by hook bolts 53 mounted in flanges

54 on the manifolds. Gaskets 55 are provided between the flanges 52 and the manifolds to insure a steam tight joint. The condensate is thus withdrawn from the tubes 16 and delivered to the chamber 47 from which it escapes through drains 56 controlled by valves 57.

Plugs 58 are provided in the manifold 45 giving access to the chambers 46 and to the bushings 49. When a defective tube is to be withdrawn the pipe 48 is removed through the corresponding plugged opening in the manifold. The crabs are then loosened to relieve the tube gaskets and the flanges 52 are released from the hook bolts 53. The tube is then withdrawn through the opening in the rear tube sheet, the pipe 51 and flange 52 being still connected thereto.

Because of the relatively slight area of the steam connections which is subjected to the steam pressure as contrasted with evaporators employing steam chests, high pressures may be employed without prohibitively increasing the weight and cost of the evaporator. When a single tube becomes defective the evaporator may still be retained in service by cutting off the corresponding horizontal manifold from the vertical manifold. As has been noted the side plates and bottom may be removed without dismantling the structure thus permitting access to the interior of the evaporator for quick repairs. Defective tubes may be rapidly removed and replaced without disturbing the remaining tubes. The facility with which repairs are accomplished reduces the upkeep of the evaporator and insures longer and more continuous service than is possible with evaporators of usual construction. These and other advantages render the improved evaporator extremely desirable for general evaporator purposes. The availability of high pressure steam in the apparatus permits higher concentration of liquids having high boiling points and it is thus possible to carry the concentration of many liquids to a higher degree than has been heretofore possible.

Obviously various changes may be made in the details of construction and the arrangement of the parts within the scope of the appended claims without departing from the invention or sacrificing any of its material advantages.

I claim:

1. In an evaporator the combination of a shell comprising side plates and tube sheets, means for supporting the side plates and tube sheets independently, a bottom secured to said shell, a vapor chamber above and communicating with said shell and means within said shell for heating liquid contained therein.

2. In an evaporator the combination of a shell comprising side plates and tube sheets, means for supporting the side plates and tube sheet independently, a bottom removably secured to said shell and wholly supported thereby, a vapor chamber above and communicating with said shell and means within said shell for heating liquid contained therein.

3. In an evaporator, the combination of a rectangular shell comprising side plates and tube sheets, means for supporting the side plates and tube sheets independently, a bottom removably secured to said shell, a cylindrical vapor chamber mounted above and communicating with said shell and means within said shell for heating liquid contained therein.

4. In an evaporator the combination of a plurality of columns, oppositely disposed side plates and tube sheets having brackets resting on said columns and forming a rectangular shell, a bottom secured to said shell, a vapor chamber supported on and communicating with said shell and means within said shell for heating liquid contained therein.

5. In an evaporator the combination of a plurality of columns, oppositely disposed side plates and tube sheets resting on said columns and forming a rectangular shell, a bottom removably secured to said shell, a vapor chamber supported on and communicating with said shell, a plurality of tubes supported in said tube sheets and means for supplying a heating medium to said tubes.

6. In an evaporator the combination of a support, oppositely disposed side plates and tube sheets independently mounted on said support and forming a rectangular shell, a bottom removably secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets and arranged in parallel rows, means for supplying a heating medium to said tubes and means for cutting off the heating medium from selected rows of tubes.

7. In an evaporator the combination of a support, oppositely disposed side plates and tube sheets independently mounted on said support and forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets and arranged in parallel rows and means for supplying a heating medium to said tubes including a horizontal manifold connected to each row of tubes and a vertical manifold connected to each of said horizontal manifolds.

8. In an evaporator the combination of a support, oppositely disposed side plates and tube sheets independently mounted on said support and forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said

shell, a plurality of tubes supported in said tube sheets ad arranged in parallel rows and means for supplying a heating medium to said tubes including a horizontal manifold connected to each row of tubes and a vertical manifold connected to each of said horizontal manifolds and a valve at the inlet from said vertical manifold to each horizontal manifold.

9. In an evaporator the combination of oppositely disposed side plates and tube sheets independently supported and forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets and arranged in parallel rows, manifolds connecting the tubes of each row and a group manifold for supplying a heating medium to the first mentioned manifolds.

10. In an evaporator the combination of oppositely disposed side plates and tube sheets forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets, a manifold, nipples connecting each tube to said manifold, said nipples being adapted for separation from said tubes to permit removal of the latter from said tube sheets and means for supplying a heating medium to said manifold.

11. In an evaporator the combination of oppositely disposed side plates and tube sheets independently supported and forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets, a manifold, nipples connecting said tubes and manifold, openings in said manifold opposite the ends of said nipples, removable plugs in said openings permitting access to said nipples and means for supplying a heating medium to said manifold.

12. In an evaporator the combination of oppositely disposed side plates and tube sheets independently supported and forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets, a manifold, caps in the ends of said tubes, nipples threadedly engaging said caps, flanges on said nipples, means for connecting said flanges to said manifolds whereby said nipples are held in communicating relation with said manifolds and means for supplying a heating medium to said manifolds.

13. In an evaporator the combination of a shell including oppositely disposed tube sheets, a vapor chamber above said shell, a plurality of tubes supported at opposite ends in said tube sheets, caps in the ends of said tubes, a manifold, nipples threadedly engaging said caps, a flange on said nipples and means for securing said flanges to said manifold whereby said nipples are held in communicating relation therewith.

14. In an evaporator the combination of a rectangular shell having oppositely disposed tube sheets and side plates secured together in independently removable relation, a cylindrical vapor chamber supported above and in communicating relation with said shell, a plurality of tubes supported at opposite ends in said tube sheets and arranged in parallel rows and means for independently supplying a heating medium to each row of tubes.

15. In an evaporator the combination of a rectangular shell having oppositely disposed tube sheets, a cylindrical vapor chamber supported above in communicating relation with said shell, a plurality of tubes supported at opposite ends in said tube sheets, and arranged in rows, means for independently supplying a heating medium to each row of tubes and means for independently withdrawing condensate from each row of tubes.

16. An evaporator including oppositely disposed tube sheets, tubes supported at opposite ends in said tube sheets, packing surrounding the ends of said tubes and permitting expansion and contraction of said tubes relative to said tube sheets, inlet and drain manifolds, nipples connecting each of said tubes and said manifolds, the nipples connecting said tubes to one of said manifolds having a slip joint permitting movement relatively thereto.

17. In an evaporator the combination of oppositely disposed side plates and tube sheets forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of rows of tubes supported in and extending through said tube sheets to the outside of the shell, a manifold for each row of tubes, removable nipples connecting the tubes of each row to the corresponding manifolds and means for supplying a heating medium to said manifolds.

18. In an evaporator the combination of oppositely disposed side plates and tube sheets forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plurality of tubes supported in said tube sheets and extending through the tube sheets to the outside of the shell, a manifold at each end of and outside said shell, removable nipples independently connecting each tube to said manifolds and means for supplying a heating medium to one of said manifolds.

19. In an evaporator the combination of oppositely disposed side plates and tube sheets forming a rectangular shell, a bottom secured to said shell, a vapor chamber above and communicating with said shell, a plu-

rality of tubes supported in and extending through said tube sheets to the outside of the shell, a manifold at each end and outside of said shell, nipples independently connecting each of the tubes to said manifolds, the inlet manifold nipples communicating with the tubes axially thereof and the outlet manifold nipples comunicating with the tubes below the axes thereof and means for supplying a heating medium to the inlet manifold.

20. In an evaporator the combination of a shell including oppositely disposed tube sheets, a vapor chamber above said shell, a plurality of parallel rows of tubes supported in and extending through said tube sheets to the outside of the shell, a plurality of manifolds outside the shell, a removable connection between each of the tubes and a manifold, and means for supplying a heating medium to said manifolds.

21. In an evaporator the combination of a shell including oppositely disposed tube sheets, a vapor chamber above said shell, a plurality of rows of tubes supported in and extending through said tube sheets to the outside of the shell, a plurality of manifolds outside the shell, a removable connection between each of the tubes and a manifold, means for supplying a heating medium to said manifolds, and means for independently disconnecting each manifold from the means for supplying the heating medium.

22. In an evaporator the combination of a shell including oppositely disposed tube sheets, a vapor chamber above said shell, a plurality of parallel rows of tubes supported at opposite ends in and extending through said tube sheets, a plurality of manifolds outside the shell, a removable connection between each of the tubes and a manifold, means for supplying a heating medium to each inlet manifold, and a drain for condensate connected to each outlet manifold.

23. In an evaporator the combination of a shell including oppositely disposed tube sheets, a vapor chamber above said shell, a plurality of tubes supported at opposite ends in and extending through said tube sheets to the outside of the shell, inlet and drain manifolds outside the shell, and removable nipples connecting each of said tubes to a manifold.

24. In an evaporator the combination of a rectangular shell having oppositely disposed tube sheets forming the opposite exterior walls of the shell, a plurality of rows of tubes supported at opposite ends and extending through the tube sheets to the outside of the wall, inlet and drain manifolds and separable nipple connections between said manifolds and each of said tubes.

25. In an evaporator the combination of a shell including oppositely disposed tube sheets, a plurality of rows of tubes supported at opposite ends in and extending through said tube sheets to the outside of the shell, inlet and drain manifolds, and removable nipples connecting each of said tubes to a manifold.

26. In an evaporator the combination of a shell including oppositely disposed tube sheets, a vapor chamber above said shell, a plurality of tubes supported at opposite ends in and extending through said tube sheets to the outside of the shell, packing means about the ends of said tubes to prevent leakage into and from said shell, said packing means being adapted to be released to permit removal of the tubes, inlet and drain manifolds and removable nipples connecting each tube with a manifold.

27. In an evaporator the combination of a rectangular shell having oppositely disposed tube sheets forming the opposite exterior walls of the shell, a vapor chamber supported above and in communication with said shell, a plurality of rows of tubes supported at opposite ends in and extending through said tube sheets to the outside of the wall, inlet and drain manifolds and separable nipple connections between said manifolds and each of the tubes.

28. An evaporator including oppositely disposed tube sheets, forming the opposite exterior walls of a shell, tubes supported at opposite ends in and extending through the tube sheets to the outside of the shell, gaskets surrounding the end of the shell, packing rings engaging said gaskets and crabs secured to the tube sheets and engaging said rings, manifolds for supplying the heating medium and withdrawing condensate and removable nipples connecting each of said tubes with a manifold.

29. An evaporator including oppositely disposed tubes forming the opposite exterior walls of a shell, tubes supported at opposite ends and extending through said tube sheets, gaskets surrounding the ends of said tubes, packing rings engaging said gaskets, means for adjusting the rings, caps in the ends of said tubes, manifolds arranged exteriorly of the shell for supplying a heating medium to and withdrawing condensate from said tubes and removable nipples supported in said caps and connecting each of said tubes with a manifold.

30. An evaporator including oppositely disposed tube sheets forming the opposite exterior walls of a shell, tubes supported at opposite ends and extending through said tube sheets, caps on the ends of said tubes, manifolds arranged outside the shell for supplying the heating medium to and withdrawing condensate from said tubes and removable nipples supported in said caps and providing communication between said manifolds and each of said tubes.

31. An evaporator including oppositely disposed tube sheets forming the opposite exterior walls of a shell, tubes supported at opposite ends in and extending through said tube sheets to the outside of the shell, packing surrounding the ends of said tubes and permitting expansion and contraction of said tubes, inlet and drain manifolds arranged outside the shell, and removable nipple connections between each of said tubes and said manifolds.

In testimony whereof I affix my signature.

BURTON S. HUGHES.

Corrections in Letters Patent No. 1,393,221.

It is hereby certified that in Letters Patent No. 1,393,221, granted October 11, 1921, upon the application of Burton S. Hughes, of Buffalo, New York, for an improvement in "Evaporators," errors appear in the printed specification requiring correction as follows: Page 3, line 67, for the word "sheet" read *sheets;* page 4, line 2, for "ad" read *and;* same page, line 83, claim 15, after the word "sheets" insert the words and comma *and side plates secured together in independently removable relation,;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22d day of November, A. D., 1921.

[SEAL.]

WM. A. KINNAN,

Acting Commissioner of Patents.