Oct. 27, 1925. 1,558,957

C. WHITE

VACUUM PAN

Filed March 18, 1925 2 Sheets-Sheet 1

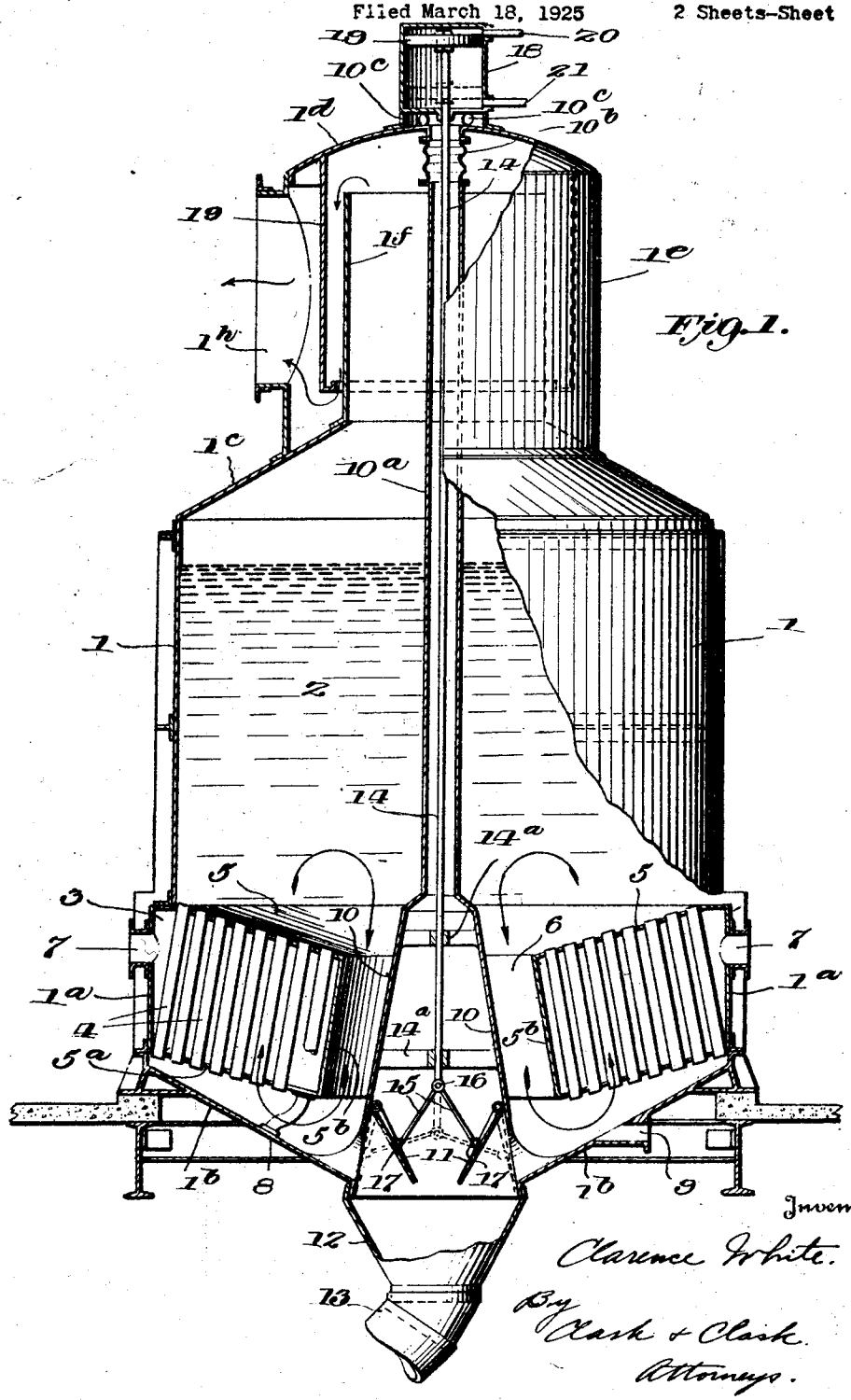


Fig. 1.

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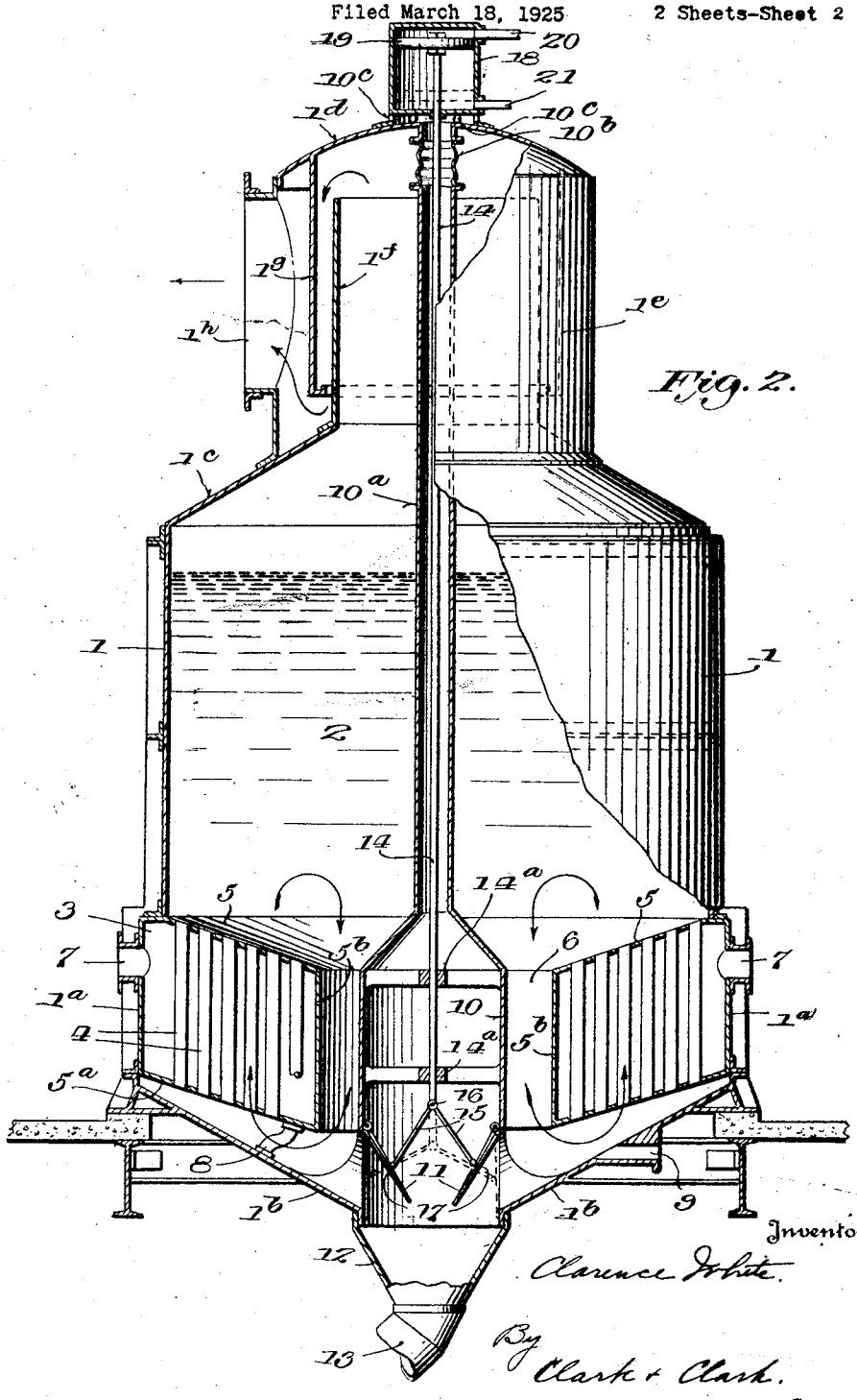


Fig. 2.

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UNITED STATES PATENT OFFICE.

CLARENCE WHITE, OF SAN FRANCISCO, CALIFORNIA.

VACUUM PAN.

Application filed March 18, 1925. Serial No. 16,463.

To all whom it may concern:

Be it known that I, CLARENCE WHITE, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented new and useful Improvements in Vacuum Pans, of which the following is a specification.

This invention relates to evaporating apparatus and pertains particularly to improvements in calandria vacuum pans used in that stage of sugar manufacture in which sugar liquor is largely converted to grain sugar.

In the operation of vacuum pans, and in the graining steps particularly, a pan is supplied with liquor of approximately 40 per cent water and 60 per cent sugar, the pan being filled to any desired height. Steam is turned into an internal heater within the pan to boil the liquid content, and as the liquor thickens after a short period, a grain of sugar begins to form and by this time the original batch of liquor has been reduced in volume until it barely covers the internal heating element. Up to this point the grain of sugar is not fully grown, that is, not of a commercial size, though probably the number of grains in the original batch is the same as in the complete "strike," as the finished batch is commonly termed. When the crystals have reached their proper size it will usually be found that the pan is quite well filled.

For a grain of sugar to grow it must be fed by mother liquor, that is, a sugar solution which will provide supplemental sugar material to build on to the sugar grain and permit it to grow to the proper size. The original batch which has been brought to a state of concentration where a barely perceptible grain is formed is augmented from time to time as the treatment progresses by "drinks" of fresh liquor, (additional liquor introduced) which are in turn concentrated to a point where the sugar is given up and attaches itself to the grains formed in the original batch. It will be seen that with each "drink" the grain increases in size and the volume of the batch is increased. Finally, after many "drinks," the last of which has been brought to the proper concentration the grain is of the desired size and the pan is full. The batch is finished and the pan is emptied, after which the operation is repeated.

During the evaporation to grain, outlined above, it is of importance to prevent the lowering of the liquid level to the upper surface of the heater element inasmuch as caramelizing, burning of the sugar batch, takes place immediately as soon as the heater is uncovered or not properly submerged. One of the objects of the invention is to provide a calandria vacuum pan having such a general shape and interior construction that the heating element may be positioned in the lowermost part of the pan and yet be sufficiently large to function satisfactorily.

Heretofore, in calandria vacuum pans it has been common to provide a large deep pocket at the central point of the pan bottom, usually leading to an outlet pipe. Such construction usually places the lowermost point of the pan far below the heating element and often necessitates the installation of a mechanical propeller in the lower part of the pan to aid in the circulation of the liquid. One of the objects of the present invention is to provide for improved circulation, and this is effected by means of an upwardly projecting bulge extending from the floor of the pan centrally upwardly so as to provide a central core substantially the height of the walls of the encircling heating element. This central core serves the dual function of assisting the circulation and reducing by its own size the volume of the total amount of liquid required to submerge the heating member. This latter feature is particularly important because it makes it possible to heat a relatively small batch of sugar liquor and to concentrate it likewise down to a comparatively small amount without danger of uncovering the heating element and possibly ruining by burning that particular batch of sugar.

One of the objects of the invention is to provide an upwardly projecting central core the side walls of which slope in the same general direction as the encircling walls of the heating member and in the same general direction as the pipes through the heating member. The invention contemplates the use of an annular heater located adjacent the lower floor of the pan and which is peculiar in that the upper and lower walls slope centrally downwardly, thus providing an inner central well wall the upper opening of which is smaller than the lower opening. The circulating pipes adapted to conduct fluid through the heater, are inclined up-

wardly and centrally with the result that the tubes are installed substantially at right angles or nearly so, to the upper and lower walls of the heating element, which feature lends ease for installing them by expanding them in the upper and lower sheets of the heater element.

Another feature of the invention relates to the provision of an annular steam channel around the outer circulating pipes and just within the shell of the steam belt portion of the vacuum pan. This feature makes it possible for the heating steam to pass freely around the entire assembly of circulating tubes and to move inwardly to the central point where it is drawn off at the lowermost point of the heating element.

Another feature of the invention is the provision of a central core which is open at both ends to the atmosphere and which projects from the central lower point of the pan floor throughout the height of the pan and is open to the space above the pan. This central relatively cool core promotes the circulation movement of the liquor within the pan. The central core provides also for the use of a control rod, operable from above the pan, which projects downwardly through the central core to open or close the drain valves or outlet valves which are opened whenever the "strike" is complete.

The above and other details and advantages will be described and claimed in the following specification and claims and illustrated in the accompanying drawings, in which:

Figure 1 shows in elevation, partly in vertical section and partly broken away, a calandria vacuum pan embodying the features of this invention and in which the central core is illustrated as having sloping walls, tapered upwardly, substantially the height of the heater element; and

Figure 2 is a view of a modification in which the central core and the wall of the well of the heater element are substantially vertical, the central core being substantially the height of the heating element and being continued in the upper reduced tube which communicates with the space above the vacuum pan.

Like reference characters in each of the figures denote like parts.

Referring in detail to the several views of the drawings, 1 is the cylindrical shell of the vacuum pan having the interior liquor chamber 2. The lower portion of the cylindrical shell has an outwardly flared bulge with an encircling wall 1^a which accommodates the heater portion of the apparatus as will be described. The bottom floor of the vacuum pan is indicated at 1^b, extending with a sloping surface downwardly and centrally. The roof of the vacuum pan extends from the encircling cylindrical shell with an upwardly and centrally inclined surface 1^c. The topmost cover of the roof portions is indicated at the curved surface 1^d which caps an upper cylindrical portion 1^e. In this cylindrical portion 1^e is a tortuous trap-like outlet passageway formed by an upwardly projecting extension 1^f leading from the upper edge of the roof 1^c and terminating close to the inner under surface of the top cap 1^d. A complementary downwardly projecting baffle member 1^g hangs from the under surface of the cap 1^d and encircles member 1^f with the result that vapors led off from the vacuum pan in order to escape must go over the top of the baffle member 1^f, thence downwardly between 1^f and 1^g and thence upwardly again to escape out through discharge opening 1^h.

The heater portion at the bottom of the vacuum pan provides the bulge mentioned above as having the outer encircling wall 1^a. Just within this wall 1^a is an annular space 3 which extends completely around the interior surface of the wall 1^a and is provided as result of the inclination of the circulating tubes 4 through which latter the sugar liquor passes from the under surface of the heater element through the heater to the upper surface of the heater element. The heater element includes a top plate 5, also complementary lower plate 5^a, both of which are of the general shape of truncated cones having their smaller ends downward. 5 and 5^a are positioned parallel to each other and thus spaced apart by the distance of a connecting well wall 5^b which connects with the inner marginal edge of the upper and lower members. As shown in Fig. 1 the heater element is peculiar in that the upper opening is smaller than the lower opening and the well wall 5^b thus slopes centrally upwardly. In Fig. 1 also it will be noticed that the circulating tubes 4 are inclined obliquely with respect to the outer vertical cylindrical walls 1^a but are substantially parallel with the well wall 5^b. In this position the circulating pipes 4 have almost a right angle fit in the upper plate 5 and the lower plate 5^a of the heater element which makes it possible to flare over and fasten with comparative ease the opposite ends of the individual pipes into the upper and lower plates of the heating element. The central well wall 5^b provides the well space 6. Steam for heating the heater member is led in through the openings 7 through the wall 1^a, and spent steam is led off at the lowermost point of the heater through the pipe 8 which projects downwardly through the floor of the vacuum pan.

Material for treatment in the vacuum pan is supplied or drawn in through the pipe 9.

The central displacement core or bulge in the bottom of the pan is indicated at 10 as having a fluid-tight connection with the margin of an opening in the floor 1^b. The

core 10, as shown in Fig. 1, projects upwardly substantially as a cone with its side walls substantially parallel to the well wall 5^b. The core at a point about at the top of the heater element is reduced in size and is extended as a tube 10^a upwardly throughout the height of the vacuum pan and is in ported communication with the atmosphere above the pan. In order to provide for differences in expansion the tube 10^a is provided with a short corrugated section of relatively light metal as indicated at 10^b. Outlet openings are provided at 10^c.

Two foot valves are shown at 11 positioned at the lowermost point of the vacuum pan, also at the lowermost point of the central core 10 and closing outlet openings formed in the lower portion of the wall of the core 10. At the bottom of the vacuum pan is a catchall in the shape of a funnel-like member 12 through which the material of the "strike" is discharged downwardly into a pipe or discharge spout 13.

Operating means for controlling the outlet valves of the pan is provided by a rod 14 which extends downwardly from above the pan, through the length of the tube 10^a to a point adjacent the bottom of the pan where it branches with short extensions 15. The extensions 15 are pivoted to the lower end of the rod as indicated at 16 and in turn the lower ends of the extensions are pivotally connected at 17 to their respective valves 11. The closed position of the valves 11 is indicated in dotted lines, the solid lines showing the valves in their open position. The rod 14 is journalled in bearing members 14^a which extend across the bore of the core 10 and aid in centering the rod 14 within the tube 10^a and within the core 10.

Power means for moving the rod 14 is provided by a cylinder and a piston mounted on the top cap 1^d of the vacuum chamber. The cylinder 18 is a small extension projecting upwardly and having in it a piston 19 mounted on the upper end of the rod 14 and by which the rod is actuated. A pipe 20 communicates through the cylinder wall 18 to the upper surface of the piston and a pipe 21 at the lower end of the cylinder 18 communicates with the under side of the piston. Steam or compressed air applied alternately as the case may require to the pipes 20 and 21 will provide sufficient power to open or close the foot valves 11.

The same control apparatus is illustrated in Fig. 2. The apparatus of Fig. 2 differs from that of Fig. 1 in that the central well wall is vertical and parallelling the cylindrical sides of the central core. In this view also the circulating tubes 4 do not meet the upper and lower sloping surfaces of the heater at right angles, which arrangement results in a construction somewhat more tedious to manufacture than the arrangement shown in Fig. 1. An important feature of advantage in both forms of heater element resides in the sloping upper surface of the heater whereby the flow of heated liquid emerging from the several tubes 4 is directed centrally and downwardly to the relatively cool core, thence to be led down through the well 6 and re-circulated through the heated tubes.

In the operation of the apparatus a vacuum is created in the pan usually by means of a vacuum pump, and the required amount of liquor to be concentrated is drawn into the pan through the pipe 9. Such amount, when boiled down to grain or to crystal, is found by experience in sugar factories, to give the best results when it is 25 per cent or 30 per cent of the total finished contents of the pan, but under no conditions should the initial charge fail to submerge the heating element.

Steam is admitted through the pipe 7 into the chamber 3 around the tubes and thus it heats the exterior of each of the pipes 4, causing the heated liquid within the pipes to boil up through the pipes and to flow downwardly in the well space 6, and along side of the center core. The relative coolness of the wall of the core promotes this particular circulation. Vapor arising from the boiling liquor passes upwardly and through the upper trap to a condenser, not shown, and usually attached to the upper vapor outlet.

Additional liquor is added and concentrated until the pan is filled to a prescribed level, after which the steam is shut off, the vacuum broken, and the contents discharged.

From the foregoing it will be observed that the apparatus provides a construction permitting a minimum amount of liquor to submerge the heating element, also that the heating element and its cooperating core are of such a size and shape as to offer the least resistance to the natural circulation of the boiling contents of the pan. The core has eliminated to a large extent the deep pockets beneath the heating element.

Further, it will be noted that by virtue of the displacement core 10 being relatively cool and in communication with the atmosphere at the bottom of the pan, and extending a considerable distance up into the body of the vacuum pan, a natural thermo-siphon effect is created aiding the circulation of the contents downwardly through the well and up through the tubes.

This application is a continuation in part of an application Serial Number 422,072, filed November 5, 1920.

I claim:—

1. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above

the floor thereof and having a central open space extending upwardly therethrough and constituting a well having an upper and a lower opening with a closed side wall, and an upwardly extending core projecting from the casing floor lengthwise of said well and with its upper end adjacent the top of said well, said core constituting a displacement member whereby the volume of liquid within the well is reduced by the space occupied by the core.

2. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above the floor thereof and having a central open space extending upwardly therethrough and constituting a well having an upper and a lower opening with a continuous side wall, said upper opening being smaller than the lower opening and said side wall sloping outwardly toward its lower end, and an upwardly extending core projecting from the casing floor and into said well, and having the shape of a cone, the axis of which extends lengthwise of the height of the well and the apex of which is substantially adjacent the top of said well.

3. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above the floor thereof and having a central open space extending upwardly therethrough and constituting a well which is smaller at the top than at the bottom and which has an enclosing continuous side wall, said heater element including a plurality of inclined tubes arranged around said well and sloping toward a common central axial line at the top so that their upper ends project toward each other and providing for communication between the space above and the space beneath said heater element, and an upwardly extending portion of the casing floor projecting as a core into said well and within the center of said heating element, the upwardly projecting core constituting a displacement member positioned in said well whereby the fluid content necessary to fill the height of the well is reduced by the volume displaced by that portion of the core within the well, and whereby the circulation of material over the surface of said core substantially parallels the movement in the inclined tubes.

4. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above the floor thereof and having a central open space extending upwardly therethrough and constituting a well, the side wall of which well is approximately the shape of the truncated side wall of a cone with the smaller end at the top, said heater element including a plurality of inclined tubes arranged around said well and sloping toward a common central axial line at the top so that their upper ends project toward each other and providing for communication between the space above and the space beneath said heater element, and an upwardly extending portion of the casing floor projecting as a cone into said well and within the center of said heating element and with its apex adjacent the top of said well, the upwardly projecting cone constituting a displacement member positioned in said well whereby the fluid content necessary to fill the height of the well is reduced by the volume displaced by that portion of the cone within the well.

5. In a calandria vacuum pan for treating sugar solutions, a casing having a floor sloping downwardly and centrally, a heater element extending annularly around the interior of the casing and adjacent but spaced above the floor thereof and providing a central open space upwardly through the heater element, an upwardly extending portion of the casing floor projecting as a core into said central open space and within the center of said heating element, and a discharge outlet with a closure therefor located in the side of said upwardly extending core and next adjacent said floor and at the lowermost point thereof.

6. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above the floor thereof and having a central open space extending upwarlly therethrough and constituting a well having an upper and a lower opening with a closed side wall, and a tubular displacement member extending upwardly as a continuation from the casing floor and the floor being open beneath said displacement member, axially lengthwise and upwardly as a central core within said well and of considerable area in cross section at a substantial distance up in the well, and constituting means whereby the space for liquid within the well walls is lessened by the space occupied by the central core, all points on the axial side of said core being in open communication with the exterior of said pan through the open bottom of said floor beneath said core.

7. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above the floor thereof and having a central open space extending upwardly therethrough and constituting a well having an upper and a lower opening with a closed side wall, and a tubular displacement member extending as a continuation from the casing floor, axially lengthwise and upwardly as a central core within said well, and

projecting beyond the heater element and throughout the height of said pan and having its opposite ends open, whereby circulation of air is permitted centrally through the tubular member and through the height of the liquid undergoing concentration in the pan.

8. In a vacuum pan for treating sugar solutions, a casing with the floor sloping downwardly and centrally, a heater element within the casing and adjacent but spaced above the floor thereof and having a central open space extending upwardly therethrough and constituting a well having an upper and a lower opening with a closed side wall, and a tubular displacement member extending as a continuation from the casing floor, axially lengthwise and upwardly as a central core within said well, and projecting beyond the heater element and throughout the height of said pan, said tubular member being relatively large in cross section throughout the height of the well and thereafter and above the well being relatively small.

9. In a vacuum pan for treating sugar solutions, a casing having a closed floor and closed roof, a tubular member extending through the height of the casing and having its lower end and its upper end open to the atmosphere, valve means located at the lower end of said casing for controlling the discharge of material from the casing, actuating means for controlling said valve means and located on the exterior of said casing, and power transmitting means extending lengthwise of said tubular member and within said tubular member, and connected to both said valve means and said actuating means.

10. In a vacuum pan for treating sugar solutions, a casing having a floor and a closed roof, a tubular displacement member connected at its lower end to the floor of the casing and at its upper end with the roof, both ends being open to atmospheric pressure, and an expansion member located in the length of said tubular member whereby influence of temperature changes in the tubular member and in the casing will not change the total length of the tubular member within the pan.

In testimony whereof I affix my signature.

CLARENCE WHITE.