

March 15, 1932.

W. C. SHIELD

1,849,252

VACUUM REGULATOR

Filed Jan. 16, 1929

2 Sheets-Sheet 1

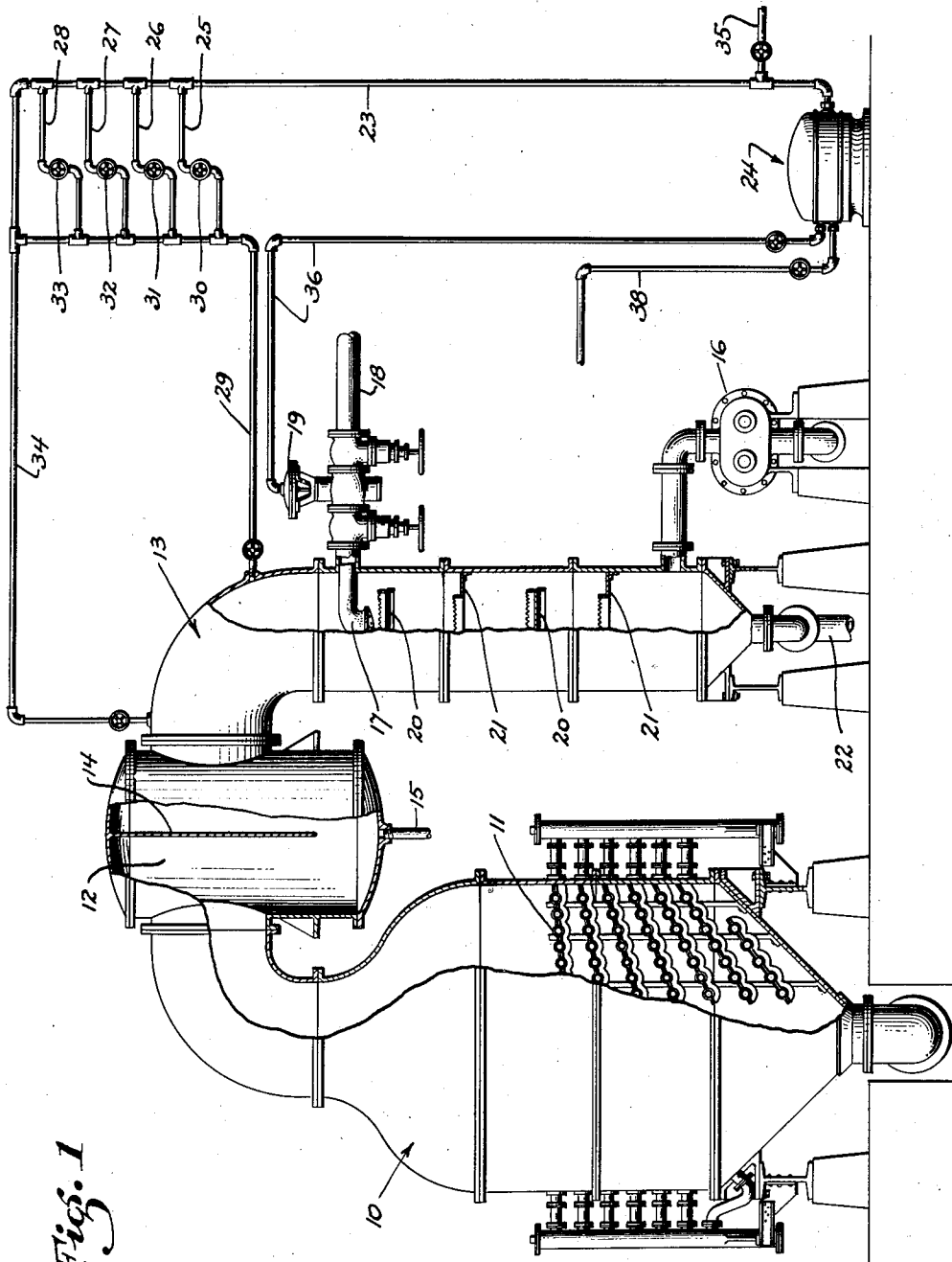


Fig. 1

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2 Sheets-Sheet 2

Fig. 3.

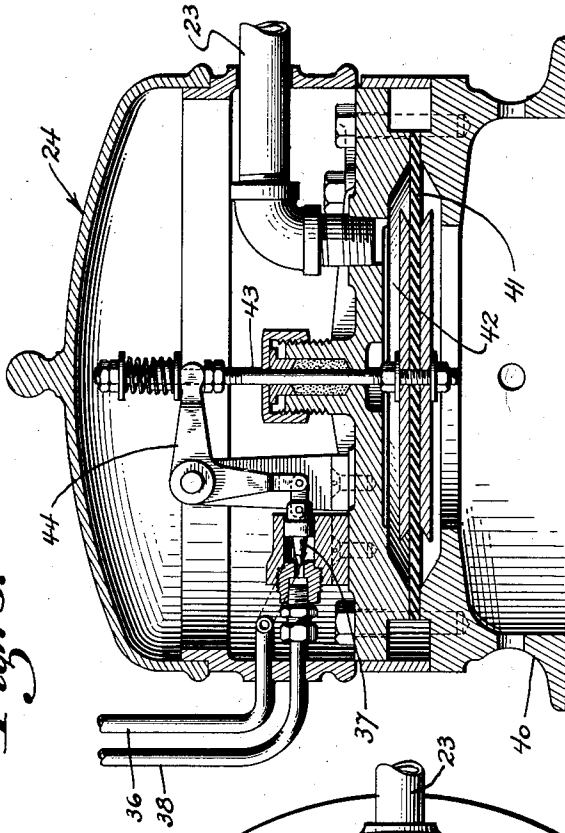


Fig. 2.

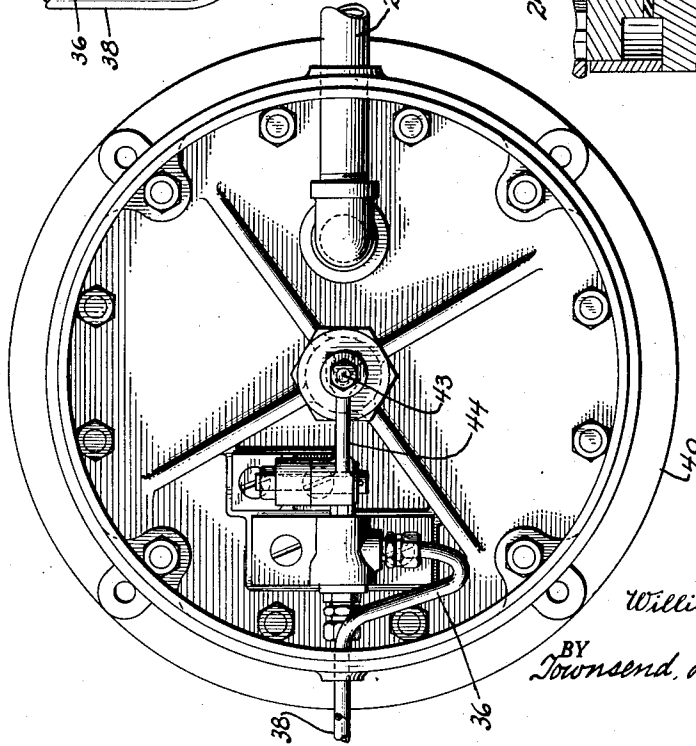
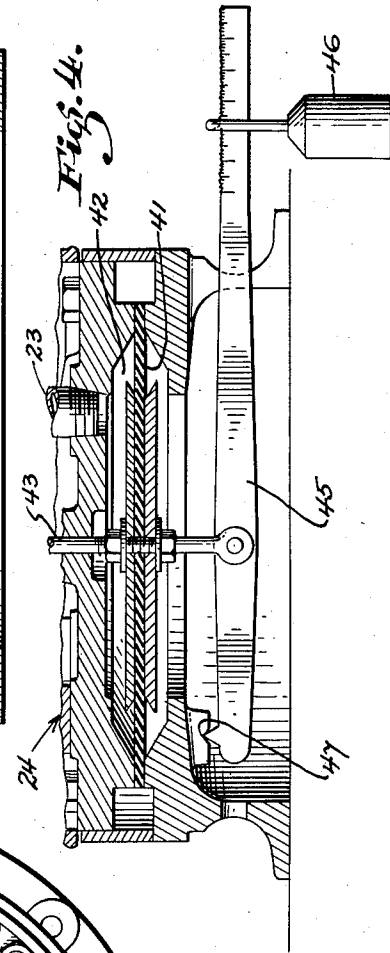


Fig. 4.



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VACUUM REGULATOR

Application filed January 16, 1929. Serial No. 332,852.

My present invention relates to apparatus and a method of operation for maintaining a vacuum in evaporating apparatus in an entirely automatic manner and more particularly to apparatus and means of operation for maintaining a vacuum in sugar crystallizing and evaporating apparatus such as is used in the refining of raw sugar.

An object of my invention is to provide apparatus which will operate in an entirely automatic manner to maintain a substantially uniform vacuum in evaporating apparatus.

Another object of my invention is to provide a new and improved apparatus for the evaporation of sugar producing massecuite.

A further object of my invention is to provide a new and improved method of operation and apparatus for maintaining a vacuum in evaporating apparatus which will compensate for changes in the vacuum resulting from vaporization within the evaporator.

Another object of my invention is to provide means in connection with my improved apparatus which will permit of adjustment so that the range of operation thereof may be varied.

A further object of my invention is to provide in combination with a condenser for use in connection with evaporating apparatus, a means for automatically controlling the condensing action thereof in response to change in the vacuum due to vaporization occurring within the evaporator.

In connection with the evaporation and crystallization of sugar, it is desirable, in order to avoid a scorching thereof, to carry out the evaporation at a comparatively low temperature and, since it is well known that the boiling point of the liquor may be reduced by boiling the same under a reduced pressure, it is the present practice to maintain a vacuum within the evaporating pan during the evaporating operation. This is accomplished by providing a suitable vacuum producing pump for evacuating the evaporator. Under ordinary circumstances, however, due to the vapors given off during the boiling process, it has been found difficult to maintain this vacuum with a pump

alone and resort has therefore also been had to a condenser which functions to condense these vapors and thereby assist the pump in maintaining the vacuum. With apparatus of this type, it has been found difficult to maintain a proper and uniform vacuum within the evaporating pan and I have therefore, in order to overcome these difficulties, provided by my invention apparatus which will control in an entirely automatic manner the operation of the condenser in response to the vacuum existing within the evaporator so that the condensing action thereof will be maintained substantially proportional to the change in pressure occasioned by the vaporization occurring within the evaporating pan.

For a better understanding of my invention, reference should be had to the accompanying drawings, wherein I have shown by way of illustration and not of limitation certain apparatus which represents my present preferred embodiment thereof.

In these drawings—

Fig. 1 is a view in elevation with parts broken away showing the general arrangement and construction of apparatus built in accordance with my invention.

Fig. 2 is a plan view, with the cover removed, of a fluid pressure responsive device for controlling a flow of fluid.

Fig. 3 is an elevation in section showing the construction of the fluid pressure device illustrated in Fig. 2, and

Fig. 4 is a fragmentary, sectional view of a modified form of pressure responsive valve controlling means.

In order to facilitate an understanding of my invention, I have shown one embodiment of my invention in Fig. 1 of the drawings as applied to an evaporator of the type particularly well suited to use in connection with the evaporation and crystallization of sugar. The evaporator proper is designated by the numeral 10. This evaporator is provided with a heating means in the form of coils of pipe 11 which are adapted to be heated by the admission of steam thereto from any suitable source. The top of the evaporator pan 10 communicates with a suit-

able trap 12 and communicating with the other side of the trap 12 I have shown a condenser 13 which is particularly well suited to the carrying out of my invention. The trap 12 is shown as having a baffle 14 which obstructs the passage of heavy vapors from the evaporator 10 to the condenser 13 and a drain 15 is provided below the baffle 14 for carrying away any accumulation of liquid within the trap 12. Connected near the bottom of the condenser 13 for the purpose of creating a vacuum within the evaporator 10 and condenser 13, there is provided a suitable vacuum pump 16. The condenser 13 is also shown as provided with a spray producing nozzle 17 which is connected to a source of cooling water supply 18. Interposed in the water supply source there is provided a normally open pneumatically operated valve 19. This valve is adapted to control the flow of condensing water to the condenser and will be controlled in an automatic manner by means of the pressure responsive valve controlling means to be described hereinafter. Arranged below the nozzle 17 there is also provided within the condenser 13, a series of alternately arranged baffles 20 and 21 which serve to maintain a substantially uniform distribution of the spray throughout the length of the condenser 13. A discharge outlet pipe 22 is also shown as connected to the bottom of the condenser 13 which serves to carry away the condensed vapors and condensing water from the condenser. The outlet of this discharge pipe, it is to be understood, operates in connection with a water seal arranged a sufficient distance below the condenser so as not to interfere with the maintenance of a vacuum therein. In connection with the above, it will be understood that under ordinary circumstances, when the above described apparatus is in operation, it will be possible, by means of the pump 16, to maintain a vacuum within the evaporating pan 10, but, owing to the fact that as a result of the evaporation which takes place in the evaporator 10, vapors will be given off which will seriously interfere with the successful operation of the pump 16, it is necessary to provide some means to compensate for this vaporization and assist the pump in maintaining the vacuum. It is at this point that the condenser 13 comes into operation as it assists the vacuum pump during the evaporating operation by condensing the hot vapors given off from the evaporating pan in a manner well known in the art. In order that the condensing action of the condenser 13 may be controlled in a entirely automatic manner, I propose to provide a fluid column supporting pipe 23 which communicates with the interior of the condenser 13. The water column supporting pipe 23 is of such a height that the water contained therein will have a weight corresponding to the vac-

uum desired to be maintained within the condenser 13 and connected at the lower end thereof I provide a suitable automatically operated pressure responsive valve controlling mechanism 24 which will be described in more detail in connection with sheet 2 of the drawings.

In the drawings the water column retaining pipe 23 is shown as having a plurality of conduits 25, 26, 27 and 28 leading therefrom at different heights and communicating with the condenser 13 through a pipe 29. These conduits serve to cut off the liquid column at heights above the pressure responsive mechanism 24 so as to produce a water column corresponding in weight, respectively, to 23, 24, 25, and 26 inches of mercury, or, in other words, at substantially the following heights in feet, respectively, 26.03, 27.16, 28.29 and 29.42. Each of the conduits 25, 26, 27, and 28 is shown as provided respectively with valves 30, 31, 32, and 33 and connected to the pipe 23 above these conduits there is also provided an additional pipe 34 which communicates with the condenser 13 for the purpose of preventing the formation of a siphon within the conduits 25, 26 and 27 which might interfere with the proper functioning of the water column maintained within the pipe 23. In order to insure against a diminution of the water in the water column pipe 23, I provide a source of water supply which enters the bottom of the column through a pipe 35. This source of water supply for the liquid column is so regulated that water will flow thereto slowly in a continuous manner and thus maintain the height of the column uniform, the excess water flowing over one of the by-pass conduits and into the condenser, where it is discharged from the outlet thereof.

Connected between the pneumatically operated valve 19 and a valve 37 which is to be described in more detail in connection with the pressure responsive device 24, I show an air line pipe 36. Another air line pipe 38 is also shown as connected between a suitable source of pneumatic pressure and the valve 37.

By referring now to Figs. 2 and 3 of the drawings, it will be seen that the fluid pressure responsive valve controlling means 24 consists of a base member 40 upon which there is mounted a suitable diaphragm 41. This diaphragm is exposed at its under side to the atmosphere and located thereabove there is provided a sealed chamber 42 with which the lower end of the water column pipe 23 communicates so that it may be said that the diaphragm is operated upwardly by reason of atmospheric pressure and downwardly by reason of pressure exerted thereupon by the weight of the water column in the pipe 23. Connected to the diaphragm 41 there is provided a piston rod 43 which is

adapted to engage and operate a bell crank 44 as the diaphragm 41 is flexed up and down. The bell crank 44 is in turn connected with the valve 37 so that as the diaphragm is flexed, the valve 37 will be opened and closed to respectively permit or prevent a flow of air from the source of pneumatic pressure through the pipe 38 to the pneumatically operated valve 19 via the pipe 36.

The modification of my invention which is illustrated in Fig. 4 contemplates a variation in the pressure responsive controlling device 24. This variation consists in providing a fulcrumed balance arm 45 which is adapted to carry a weight 46. This arm 45 is pivotally attached to the underside of the diaphragm 41 and is fulcrumed at its end upon a knife edge 47 and the weight 46 is arranged so as to be adjustable along the arm 45 for the purpose of varying the forces exerted by the weight downwardly on the diaphragm 41. With this change in the construction of the pressure responsive valve controlling means 24, it will be possible to dispense with the water column previously described as contained within the pipe 23. Under these conditions the pipe 23 will communicate with the chamber 42 immediately above the diaphragm 41 and will be connected directly to the condenser so that as the vacuum within the condenser increases, the tendency will be to pull the diaphragm 41 upwardly. During this operation, instead of the vacuum acting against the weight of the water column, it will act against the forces applied to the diaphragm by means of the lever 45 and the weight 46. From the above, it will be evident that by providing for an adjustment of the weight 46 upon the arm 45, as described, I have accomplished the same result as was obtained by means of the by-pass conduits previously referred to in connection with the water column. In connection with this embodiment of my invention, it should be stated that in every other respect I contemplate using apparatus similar to that described in connection with the water column arrangement illustrated in Fig. 1 of the drawings.

In describing the operation of my invention, it will be assumed that the evaporator 10 shown in Fig. 1 is in operation and that the pump 16 and condenser 13 are functioning to maintain a vacuum corresponding to 24 inches of mercury within the evaporator and condenser. Under these conditions the valve 31 in the by-pass conduit 26 will be opened and thus a water column will be established in the pipe 23 which will, in this instance, be 27.16 feet in height. As long as the vacuum within the evaporator 10 and condenser 13 remains at this value, i. e., equal to 24 inches of mercury, the water column in the pipe 23 will be held in suspension and, as a result, it will exert no downward pressure upon the diaphragm 41 located within the pressure responsive means 24. This will allow the diaphragm 41, under the influence of atmospheric pressure against the bottom thereof, to assume the position shown in Fig. 3 and, as a result, the valve 37 which is actuated by the diaphragm 41 will be held open so as to permit air under pressure to flow to the condensing water supply valve 19. The application of air pressure to the valve 19 in this manner will close the latter and thereby shut off the spray of cooling water within the condenser 13. As a result, the condenser 13 will be rendered ineffective and thus throw the responsibility of maintaining the vacuum upon the pump 16 alone. Under these conditions and as long as the pump 16 is capable of maintaining the desired vacuum, the valve 19 will remain closed. Should the vacuum fall off, however, either due to inability of the pump or from vaporization within the apparatus, it will be evident that the force which is sustaining the water column in the pipe 23 will be reduced and, as a result, the water column will exert a force downwardly upon the diaphragm 41 and thus close the air controlling valve 37 and permit the cooling water supply valve 19 to open and establish a condensing spray within the condenser 13. This will render the condenser 13 effective to assist the pump 16 in maintaining the vacuum and, as a result, the vacuum will be again built up to the desired value. It will be understood that this cycle of operation will be carried out in a continuous manner during the time the evaporator is in operation.

It is believed that from the above the operation of the embodiment of my invention illustrated in Fig. 4 will be clearly understood. However, in this connection it might be stated that, with the pipe 23 connected directly to the condenser 13, the vacuum created therein will act directly upon the diaphragm 41 rather than upon the column of water which is dispensed with in this instance, and will, with the arrangement illustrated in this figure of the drawings, act against the force applied to the diaphragm 41 by the weight 46; or, in other words, in this embodiment of my invention the weight 46 with its balanced lever arm operates to perform the same function as did the water column in the previously described modification.

From the above it will be seen that I have provided a simple and practical means for automatically controlling the vacuum within a condenser or an evaporating apparatus and, while I have illustrated in the drawings embodiments which now appear to be of the preferred form, I desire to have it understood that I aim in the appended claims to cover all embodiments thereof which fall within the spirit and scope of the claims appended hereto.

Having thus described my invention, what

I claim and desire to secure by Letters Patent is—

1. A regulator for vacuum maintaining condensers of the barometric type comprising
 5 a fluid column communicating with the interior of the condenser corresponding in weight to the vacuum desired, and means responsive to the pressure exerted by said fluid column adapted to control the admission of cooling
 10 water into said condenser.

2. A regulator for barometric vacuum producing condensers comprising a source of cooling water for said condenser, an automatically operated valve for controlling the
 15 flow of said cooling water, a fluid column connected to said condenser corresponding in weight to the vacuum desired, and means responsive to the pressures exerted by said fluid column adapted to control the operation of
 20 said valve and thereby maintain a substantially constant vacuum within said condenser.

3. A regulator for vacuum maintaining condensers of the barometric type comprising a water column communicating with the
 25 interior of the condenser corresponding in weight to the vacuum desired, means responsive to the pressure exerted by said water column adapted to control the admission of cooling water into said condenser, and means
 30 for compensating for evaporation in said water column and maintaining it at a constant weight.

4. A regulator for barometric vacuum producing condensers suitable for use with
 35 evaporating apparatus comprising a source of cooling water for said condenser, a valve for controlling the flow of said cooling water to the condenser, a fluid column connected to said condenser corresponding in
 40 weight to the vacuum desired, and means responsive to the pressure exerted by said fluid column adapted to control the operation of said valve to thereby maintain a substantially
 45 constant vacuum within said condenser.

5. In sugar refining apparatus of the type employing an evaporating pan having suitable heating means and a pump for creating a vacuum therein the combination of, a
 50 condenser of the barometric type adapted to be connected to said pan and receive the vapors formed therein, a source of cooling water for said condenser, automatic valve operating means for controlling the flow of said cooling
 55 water to said condenser, a fluid column communicating with said condenser for controlling the operation of said valve controlling means, and means whereby the height of said fluid column may be varied to thereby change
 60 its range of operation.

6. In sugar refining apparatus of the type employing an evaporating pan having suitable heating means and a pump for creating a vacuum therein the combination of, a
 65 condenser adapted to be connected to said pan

and to receive the vapors formed therein, a source of cooling water for said condenser, automatic valve operating means for controlling the flow of said cooling water to said
 70 condenser, a fluid column communicating with said condenser for controlling the operation of said valve controlling means, by-pass conduits between said column and said condenser whereby the height of said fluid
 75 column may be varied to thereby change its range of operation, and means cooperating with said by-pass conduits for preventing the formation of a siphon by said fluid column.

7. A regulator for vacuum maintaining
 80 condensers of the barometric type comprising, a diaphragm adapted to be influenced by the pressure existing within the condenser, a fluid column communicating with the condenser and associated with said diaphragm
 85 adapted to counteract the effect of the pressure in the condenser on said diaphragm, and means operated by said regulator for controlling the admission of cooling water to said condenser.
 90

8. A regulator for vacuum producing condensers suitable for use with evaporating apparatus comprising a source of cooling water for said condenser, a valve for controlling the flow of said cooling water to the
 95 condenser, a diaphragm having one side communicating with the interior of said condenser and adapted to move in response to the pressure existing therein, a fluid column communicating with the interior of the
 100 condenser cooperating with said diaphragm adapted to exert a pressure thereupon equal and opposite to the pressure exerted by the vacuum of said condenser, and means operated by movement of said diaphragm for
 105 opening and closing said valve as the pressure rises and falls in the condenser.

9. A regulator for vacuum producing condensers suitable for use with evaporating apparatus comprising a source of cooling
 110 water for said condenser, a valve for controlling the flow of said cooling water to the condenser, a diaphragm having one side communicating with the interior of said condenser and adapted to move in response to the
 115 pressure existing therein, a fluid column interposed in the communicating connection between said diaphragm and said condenser cooperating with said diaphragm adapted to exert a pressure thereupon equal and opposite
 120 to the pressure exerted by the vacuum of said condenser, means operated by movement of said diaphragm for opening and closing said valve as the pressure rises and falls in the condenser, and means whereby
 125 adjustments may be made to vary the effect of said fluid column to control the vacuum in the condenser.

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