Nov. 21, 1961 E. V. JUNG 3,009,412

METHOD AND MEANS FOR PRESSING LIQUID OUT OF VEGETABLE SUBSTANCES

Filed Nov. 19, 1956 5 Sheets-Sheet 1

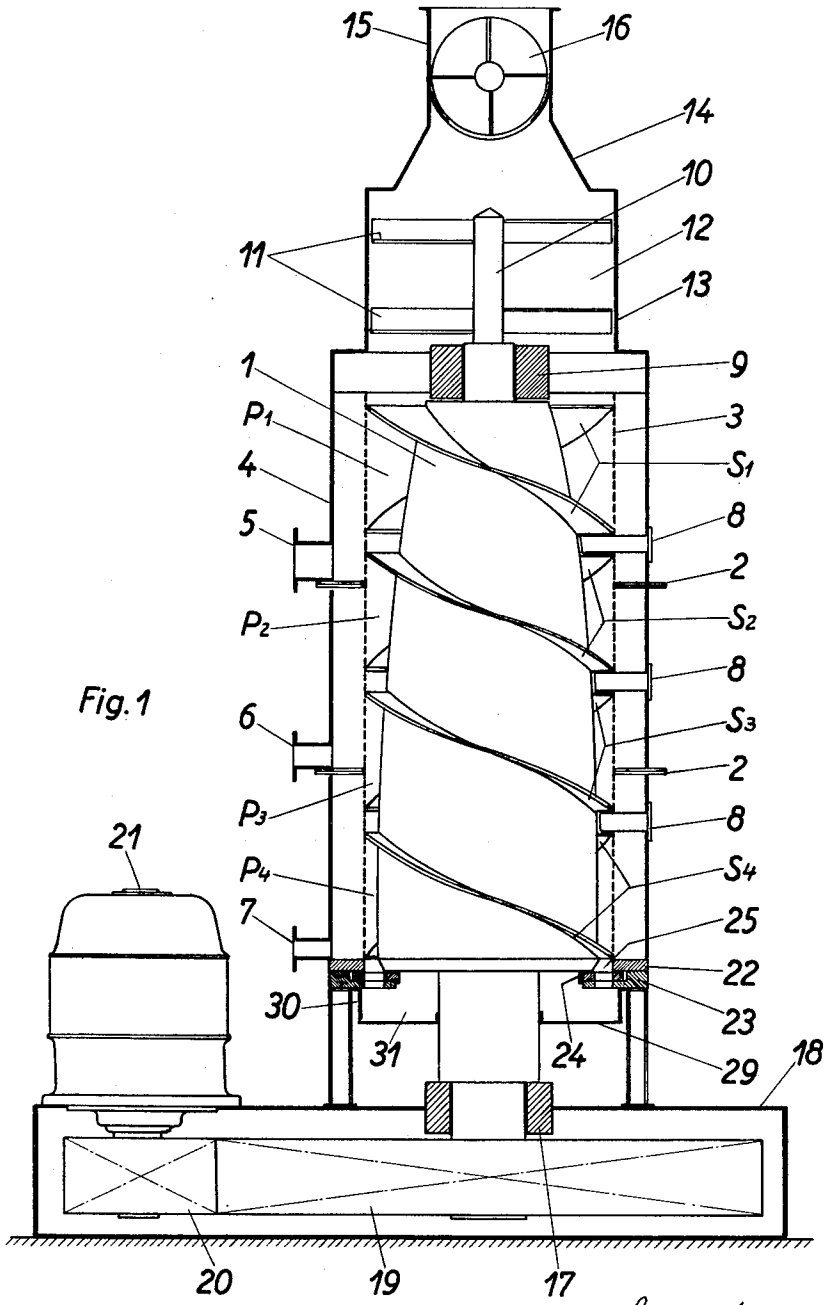

Fig. 1

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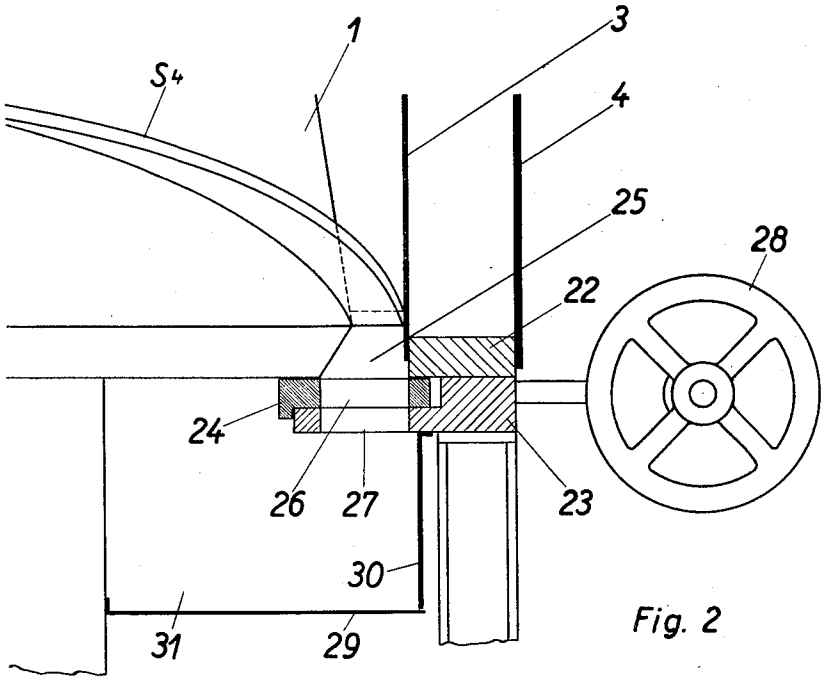

Fig. 2

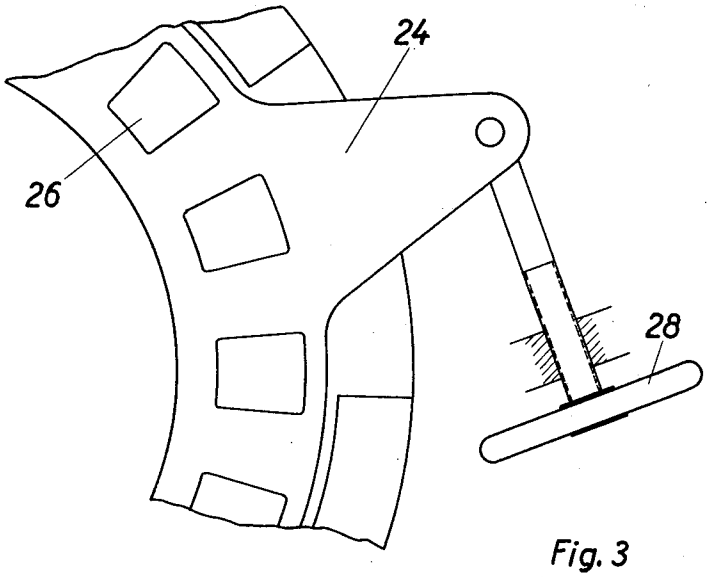

Fig. 3

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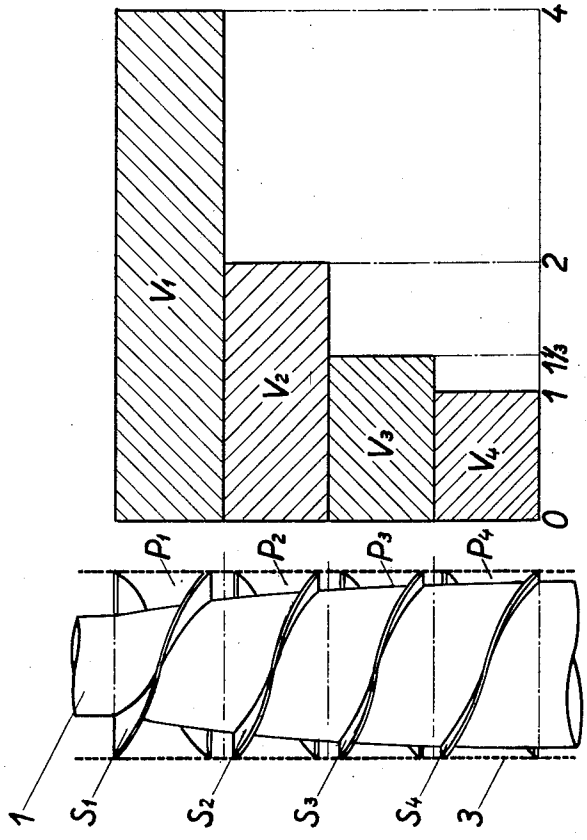

Fig. 5

Fig. 4

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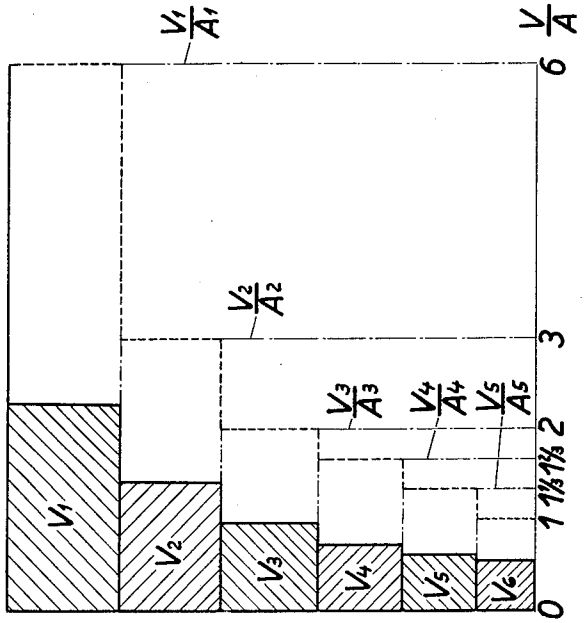

Fig. 7

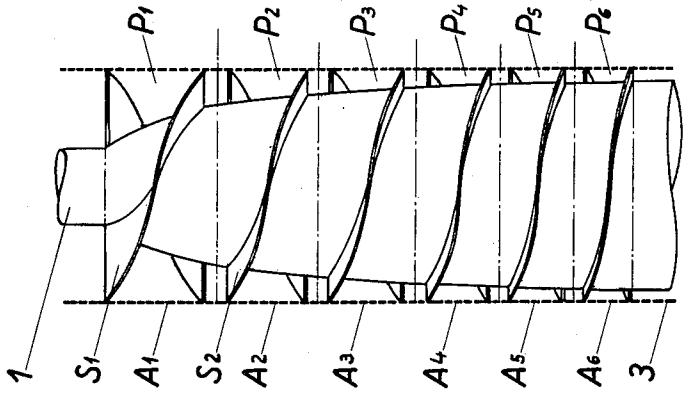

Fig. 6

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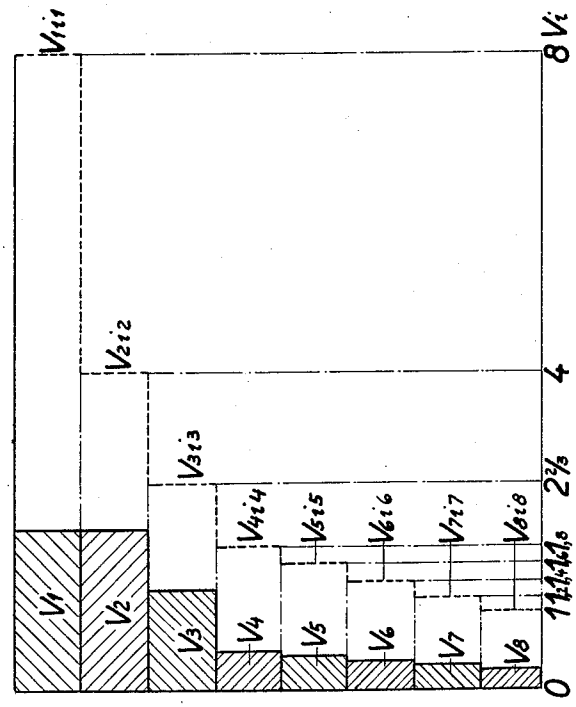

Fig. 9

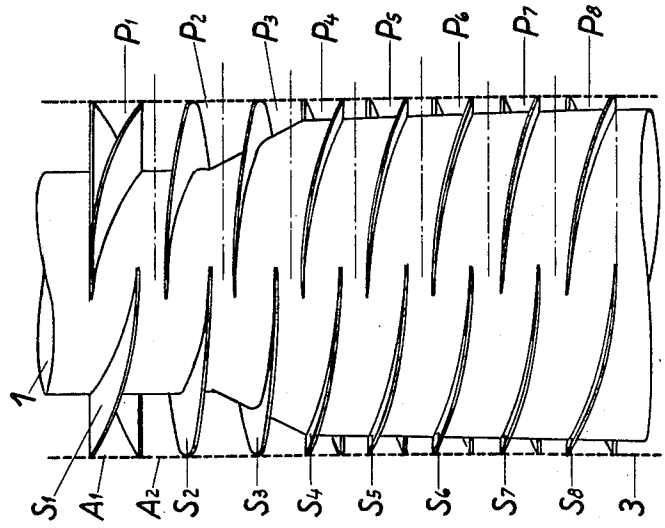

Fig. 8

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3,009,412

METHOD AND MEANS FOR PRESSING LIQUID OUT OF VEGETABLE SUBSTANCES

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Claims priority, application Sweden Nov. 23, 1955
6 Claims. (Cl. 100—148)

The invention refers to extraction of liquid by pressing vegetable substances, such as beet pulp, cellulose pulp, and fruits.

In the sugar industry the juice in beet pulp is usually removed by means of presses of different kinds. It is thus common to use for this purpose spindle presses, in which the pulp is passed through successive press chambers with walls forming drainage screens, which chambers are provided between a spindle with outwardly projecting flights and a surrounding jacket. The chambers are separated from one another by intermediate resistors for preventing the pulp from rotating with the spindle. In these presses it has been possible to attain a dry substance content of at the most about 18 percent by weight but as the beet pulp after the pressing operation often has to be dried to a dry substance content of 85 to 90 percent by weight considerable amounts of water must be evaporated which makes the drying operation expensive.

An object of the invention is to attain an increased liquid extraction in such spindle presses, and the invention is based on the conception made by experiments that essentially higher dry substance contents can be attained in spindle presses, if the compression steps during the passage of the beet pulp through the press chambers are chosen in a certain proportion to one another, and if the pressure in the last press chamber and in dependence thereof also in the other press chambers is regulated in a certain way.

The invention is more clearly described hereinafter reference being made to the accompanying diagrammatic drawing, in which:

FIGURE 1 is a vertical sectional view of a press according to one form of the invention,

FIGURE 2 is a partial sectional view of the valve device,

FIGURE 3 is a partial top view of the valve disk on an enlarged scale,

FIGURE 4 is a side elevation of the spindle shown in FIGURE 1, and

FIGURE 5 a corresponding diagram,

FIGURES 6 and 7 and FIGURES 8 and 9 show in a similar way as FIGURES 4 and 5 two modified spindles for obtaining a greater dry substance content.

A vertical and downwardly widening, rotatably mounted body or spindle **1** is according to FIGURES 1–5 provided with four pairs of screw blades or flights S_1, S_2, S_3, and S_4 which are closely surrounded by a stationary, cylindrical screen jacket **3** within an outer cylindrical casing **4**. The space between the cylinders is by intermediate partitions **2** divided into three compartments, from which the juice extracted from the beet pulp and pressed through the screen area is drained off through outlets **5**, **6**, and **7**. Between the pairs of flights **3** resistors in the form of short guide plates **8** are provided and removably fastened to the outer casing so that the chamber within the screen cylinder **3** is divided into four press chambers P_1, P_2, P_3, and P_4 with the volumes V_1, V_2, V_3, and V_4 respectively.

The spindle is mounted in an upper bearing **9** and has an upper extension **10** carrying stirring members **11**. This stirring device penetrates the beet pulp contained in a

hopper **12** which has a cylindrical wall **13** of the same diameter as the screen cylinder **3**. The hopper is tapered at **14** and continues upwards to form a feed channel **15** with a feed worm **16**.

The lower end of the spindle is mounted in a bearing **17** in the upper wall of a housing **18** serving as a base plate for the press and containing a gear transmission **19**, **20** connecting the spindle with a motor **21**.

The two cylinders **3**, **4** are connected at their lower ends to an end ring **22** resting on a supporting disk **23**, and between them a rotatable valve disk **24** is mounted for varying the discharge opening **25** for the beet pulp and in dependence thereof also the pressure in the different press chambers. As shown in FIGURES 2 and 3 the valve disk has substantially rectangular openings **26** and the supporting disk corresponding openings **27**. By means of a hand wheel **28** and a threaded shaft screwed through a fixed support, the valve disk **24** can be rotated so that the discharge opening **25** between the spindle **1** and the screen cylinder **3** can be varied from fully open and down to zero, as the total area of the openings **26** corresponds to the ring-shaped opening between the spindle **1** and the screen cylinder **3**. Below the valve device a ring-shaped bottom **29** is connected to a stationary cylindrical wall **30** and extends to the spindle so as to form above the bottom a bottom room for collecting the beet pulp.

The press described above operates in the following manner. Beet pulp is introduced by the feed worm **16** into the hopper **12**, where it is distributed by the stirring members **11** for further feeding into the screen cylinder. The hopper should have such a large volume that it cannot be entirely emptied if the feed of beet pulp through the worm **16** is uneven. Thus it has proven to be sufficient in normal plants that the hopper has such a volume that the beet pulp remains in the hopper at least **7** minutes when the press operates with its maximum capacity. The hopper can in such a case not be emptied at occasional irregularity in the supply of beet pulp to the press. From the hopper **12** the beet pulp enters into the press chamber P_1 where it is caught by the two flights S_1 and pressed downwards and against the screen cylinder **3**. The liquid passing the screen flows through the pipe **5**. In order to prevent the beet pulp in the press chamber P_1 from rotating too much with the spindle **1** the resistors **8** are provided immediately below the flights and the resistors thereby break the rotating motion and guide the pulp to follow a slightly helical path downwards. From the press chamber P_1 the pulp proceeds under continuous liquid extraction through the remaining press chambers P_2, P_3, and P_4 between which the pulp is guided by four resistors. From the press chamber P_4 the pulp passes through the valve device **22**, **23**, to the collecting room **31**, from which it is removed by means not shown, such as a rake.

FIGURE 4 shows diagrammatically a form of the press spindle **1** with screen cylinder **3** and four press chambers P_1, P_2, P_3, P_4 each one with two screw blades or flights S_1, S_2, S_3, S_4 and a volume V_1, V_2, V_3, and V_4 respectively. These volumes would be the same as the volumes of the beet pulp passing through the press chambers for each revolution of the spindle, if the displacement of the beet pulp were exactly axial and if in each press chamber only one flight with a pitch equal to the height of the chamber were present.

With the two flights with the double pitch, however, the volume of beet pulp passed during each revolution of the spindle will be twice as large as the volume of the press chamber compared with the use of only one flight. If the number of flights generally is denoted "*i*," the flights in the different chambers correspond in this case to $i_1=i_2=i_3=i_4=2$. As the press chambers in this

example all have the same screen area, it is obvious that the quotients

$$Q=\frac{V.i}{A}$$

for the different press chambers stand to one another as the volumes V.

The ratio of the quotients Q for the different press chambers is of special importance to the invention, but in the spindle shown in FIGURE 4 the ratios between the quotients are equal to the ratios between the volumes V. In FIGURE 5, therefore, the volumes of the press chambers have been illustrated graphically as the areas of the rectangles V_1, V_2, V_3, and V_4. As the rectangles further have the same height, the relation between their areas is equal to the relation between their horizontal extension or breadth.

The quotient of $V_1:V_4$ should in this example according to the invention be at least 4, and the quotient of $V_1:V_2$ shall be more than $V_3:V_4$, and it appears from the drawing that the spindle corresponds to this requirement.

In the different press chambers the volume V, the screen area A and the number of flights i may vary, and the general construction rule will then be that the quotient Q_1 of the volume V_1 of the substance in the first press chamber P_1 multiplied by the number i_1 of flights in this chamber divided by the screen area A_1 of the chamber should be at least four times as great as the corresponding quotient Q_n for the last press chamber P_n, and that the ratio of the quotients $Q_1:Q_2$ for the two first press chambers P_1 and P_2 should be greater than the corresponding ratio of the quotients $Q_{n-1}:Q_n$ for the two last press chambers P_{n-1} and P_n. According to the invention the quotient Q_1 is preferably at least twice as great as Q_2 and at least three times as great as Q_3.

When such a press is to be constructed the number of press chambers may first be determined. A suitable screen casing, such as a cylinder, is then designed, and the variable diameter of the screw spindle is then determined in such a way that the desired volumes of the press chambers are obtained.

The quantity of extracted liquid is dependent on the pressure in the last press chamber, and the best result has been obtained, if this pressure amounts to at least 2.5 atmospheric overpressure. It is further of advantage that the pressure, in case all press chambers have the same number of flights, increases from chamber to chamber at first substantially linearly and towards the end more rapidly than linearly, which result can be attained in a press according to the invention by control of the discharge by means of the valve.

FIGURE 6 illustrates a similar press spindle for six press chambers P_1, P_2, P_3, P_4, P_5, and P_6 with a constant number of flights S_1, S_2, S_3, S_4, S_5, and S_6, but contrary to FIGURE 4 the height of the press chambers is not constant but decreases as well as the screen areas A_1, A_2, A_3, A_4, A_5, and A_6 towards the discharge end. The requirements as to the relation between the volumes as stated in connection with the example shown in FIGURE 4 are here applicable to the quotients:

$$\frac{V_1}{A_1}, \frac{V_2}{A_2}, \frac{V_3}{A_3}, \frac{V_4}{A_4}, \frac{V_5}{A_5}, \frac{V_6}{A_6}$$

For the illustration thereof FIGURE 7 shows hatched rectangles, the areas whereof correspond to the volumes V_1, V_2, V_3, V_4, V_5, and V_6, respectively. These rectangles have been extended to vertical dashed lines, the distances of which from the vertical axis of the diagram correspond to the quotients of

$$\frac{V_1}{A_1}, \frac{V_2}{A_2}, \frac{V_3}{A_3}, \frac{V_4}{A_4}, \frac{V_5}{A_5}, \frac{V_6}{A_6}$$

which can be read on the horizontal axis of the diagram. The following ratios between the quotients of Q or

$$\frac{V}{A}$$

can also be obtained from the diagram:

$$\frac{V_1}{A_1}:\frac{V_6}{A_6}=6$$

and thus more than 4;

$$\frac{V_1}{A_1}:\frac{V_3}{A_3}=3;\ \frac{V_1}{A_1}:\frac{V_2}{A_2}=2$$

FIGURES 8 and 9 show in the same manner a further modified press with 8 press chambers P_1–P_8. These chambers have the same height and the same screen areas, but the spindle has a varying number of flights S_1–S_8 in the different chambers. The number of flights is thus with beginning from the entrance $i_1=4$, $i_2=2$, $i_3=2$, and i_4–$i_8=4$. The volumes of the press chambers correspond to the areas of the rectangles V_1–V_8, and these rectangles have been extended to vertical dashed lines, the distances of which from the vertical axis represent $V.i$. From the diagram it appears that the ratio between the values $V.i$ of the chambers being equal to the ratios between their values of Q, corresponds to the figures 8:4:2.7:1.8:1.6:1.4:1.2:1, whereas the ratios between the real volumes V are 8:8:5.3:1.8:1.6:1.4:1.2:1. It has been found that this relation between the values of $V.i$ of the chambers involves a very good extraction of the liquid, and if the valve is regulated so as to cause a pressure in the chamber P_8 of at least 2.5 atmospheric overpressure, the beet pulp may be pressed to a dry substance percentage of 30 to 50 percent by weight or more.

If now the volume V as well as the number of flights i and the screen area A varying in a press with n press chambers, the following ratios should preferably amount according to the invention to at least the stated values:

$$\frac{V_1i_1}{A_1}:\frac{V_ni_n}{A_n}=4$$

$$\frac{V_1i_1}{A_1}:\frac{V_3i_3}{A_3}=3;\ \frac{V_1i_1}{A_1}:\frac{V_2i_2}{A_2}=2$$

The examples of the performance of the invention described above can, however, be modified in different ways within the scope of the invention. Thus, e.g., three and up to ten or more press chambers can be used. Especially in connection with a great number of press chambers a greater value of the ratio of

$$\frac{V_1i_1}{A_1}:\frac{V_ni_n}{A_n}$$

may be of advantage, such as 12 to 18. Although in the examples only the cylinder **3** has been shown perforated for use as a screen wall it is obvious that also the body of the spindle **1** may be perforated for the same purpose and in such a case the efficiency or capacity of the press will be still more improved.

What I claim is:

1. A press for pressing liquid out of vegetable substances, comprising a vertical rotary spindle, a surrounding perforated jacket forming a drainage screen and having the upper end open for receiving vertically fed vegetable substances, a plurality of resistors extending inwardly from said jacket and dividing the space between the spindle and the jacket into successive press chambers, a plurality of flights on the spindle in each chamber extending into the space between two axially spaced resistors and each flight having an axial length corresponding to that of the one of said chambers in which it is located, respectively, and a peripheral extent of 360° divided by the number of flights in the chambers, the volumes of the chambers varying so that the quotient between the volume of the first press chamber multiplied by the number of flights in said first chamber, divided by the screen area of the said first chamber is at least four times as great as the corresponding quotient for the last press chamber, and that the ratio of the corresponding quotients for the first two press chambers is greater than the

corresponding ratio of the corresponding quotients for the last two chambers, and a valve for control of the discharge from, and the pressure in, the last press chamber.

2. A press as defined in claim 1, wherein the valve comprises a fixed ring-shaped disk with a series of valve openings, a ring-shaped valve disk mounted rotatably on said fixed disk and provided with a series of corresponding valve openings, and a gear mechanism for rotating said valve disk.

3. A press as claimed in claim 2, wherein a hopper is located axially above the first press chamber and a stirrer is mounted on an upper extension of the spindle within said hopper and extends substantially to the side wall thereof.

4. A press for pressing liquid out of vegetable substances, comprising a rotary spindle, a surrounding perforated jacket forming a drainage screen, a plurality of resistors extending inwardly from said jacket and dividing the space between the spindle and the jacket into successive press chambers, a plurality of flights on the spindle in each chamber extending into the space between two axially spaced resistors and each flight having an axial length corresponding to that of the one of said chambers in which it is located, respectively, and a peripheral extent of 360° divided by the number of flights in the chambers, the volumes of the chambers varying so that the quotient between the volume of the first press chamber multiplied by the number of flights in said first chamber, divided by the screen area of the said first chamber is at least four times as great as the corresponding quotient for the last press chamber, that the quotient for the first press chamber is at least twice as great as the quotient for the second press chamber and at least three times as great as the quotient for the third press chamber, and that the ratio of the corresponding quotients for the first two press chambers is greater than the corresponding ratio of the corresponding quotients for the last two chambers, and a valve for control of the discharge from and the pressure in the last press discharge.

5. A press for pressing liquid out of vegetable substances, comprising a rotary spindle, a surrounding perforated jacket forming a drainage screen, a plurality of resistors extending inwardly from said jacket and dividing the space between the spindle and the jacket into successive press chambers, a plurality of flights on the spindle in each chamber extending into the space between two axially spaced resistors and each flight having an axial length corresponding to that of the one of said chambers in which it is located, respectively, and a peripheral extent of 360° divided by the number of flights in the chambers, the volumes of the chambers varying so that the quotient between the volume of the first press chamber multiplied by the number of flights in said first chamber, divided by the screen area of the said first chamber is at least four times as great as the corresponding quotient for the last press chamber, that the ratio of the quotients for any two successive chambers is greater than the ratio of the quotients for any two subsequent and successive chambers, and that the ratio of the corresponding quotients for the first two press chambers is greater than the corresponding ratio of the corresponding quotients for the last two chambers, and a valve for control of the discharge from and the pressure in the last press chamber.

6. A press as defined in claim 5 wherein the quotients for eight successive press chambers are to one another substantially as 8:4:2.7:1.8:1.6:1.4:1.2:1.

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