United States Patent

Berge

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[54] **DEVICE FOR CONTINUOUS FILTERING OF CHEESE CURD, IN PARTICULAR CURDLED MILK**

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Nov. 6, 1969 France.....6938274

[52] **U.S. Cl.**.....**31/46**

[51] **Int. Cl.**.....**A01j 25/12**

[58] **Field of Search**.....31/46, 49, 89

[56] **References Cited**

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Primary Examiner—Hugh R. Chamblee

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[57] **ABSTRACT**

The device of the invention comprises a frame, a roll track, filtering elements adapted to move on said roll track, presses each of which is composed of a pair of vertical press elements movable with said filtering elements from the upstream end of said roll track to its downstream end, said roll track being divided into several sections, means of relative displacement of the elements of each press nearer to one another in some of said sections to press the filtering elements contained between said press elements, and means for feeding and dispensing cheese curd in said filtering elements.

13 Claims, 15 Drawing Figures

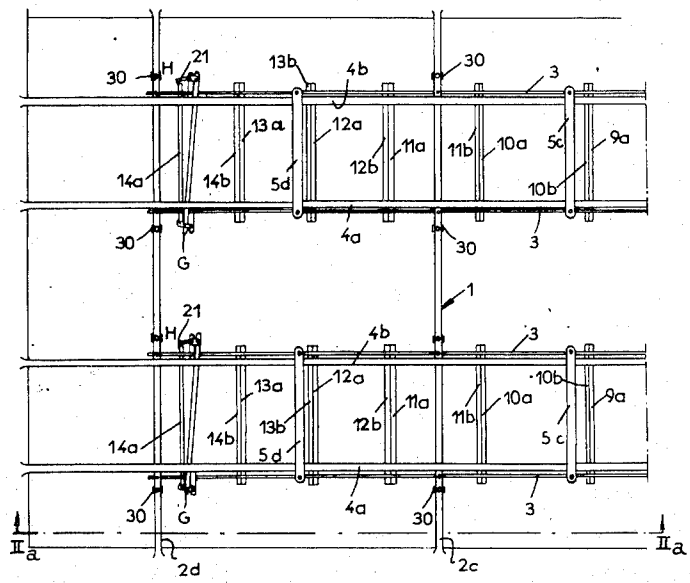

Fig: 2a

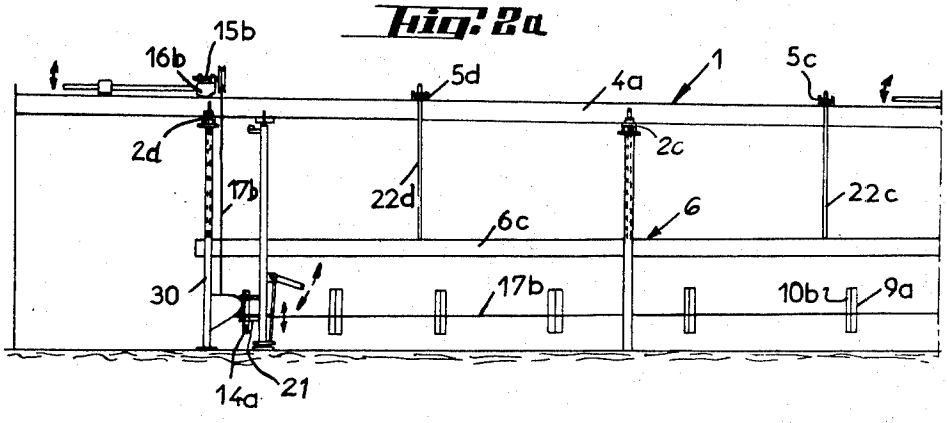

Fig: 1a

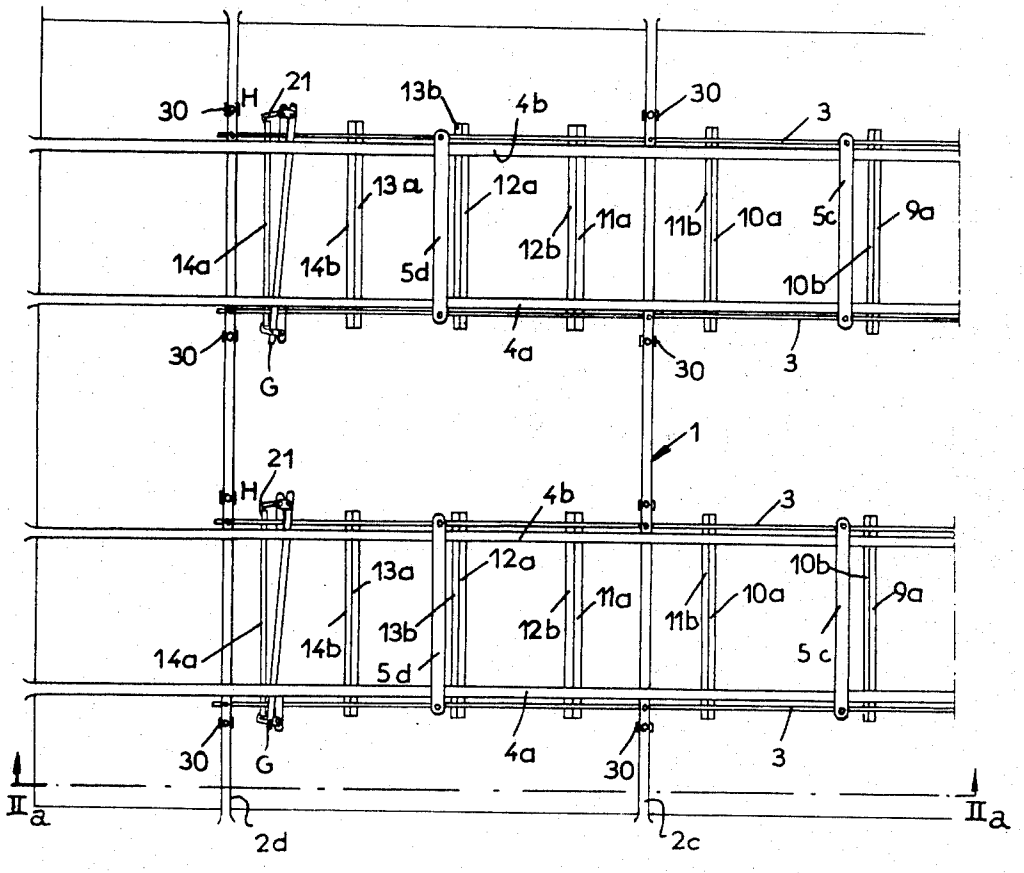

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Fig: 2b

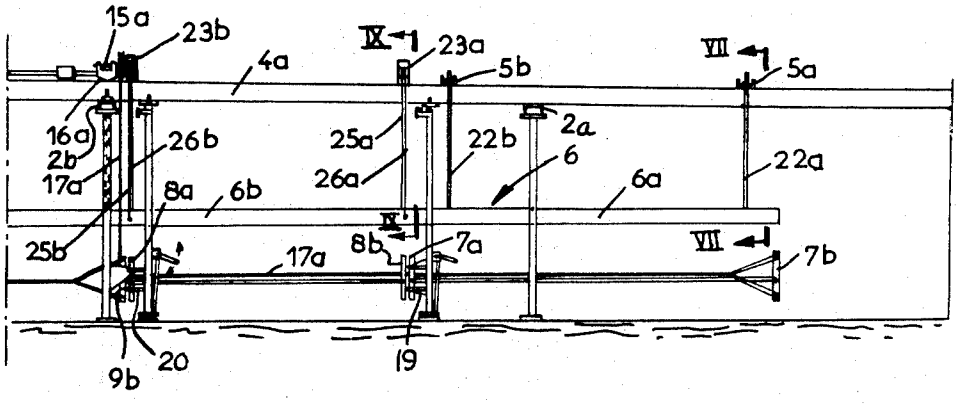

Fig: 1b

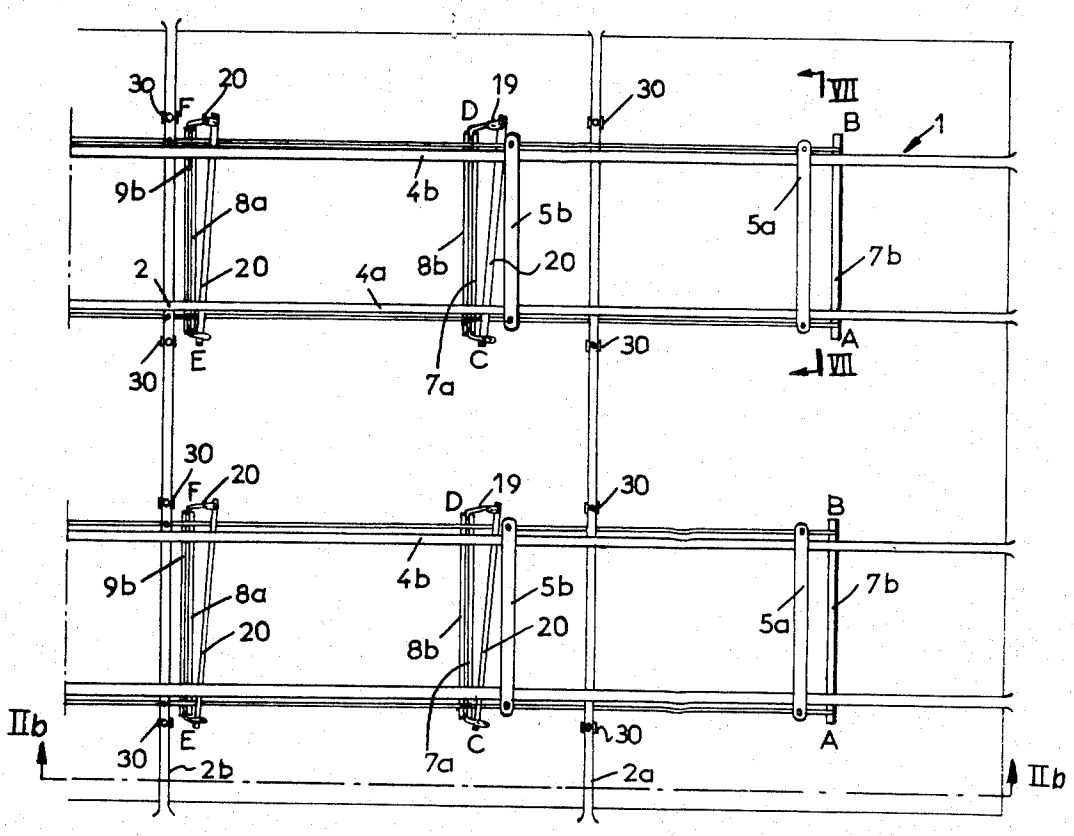

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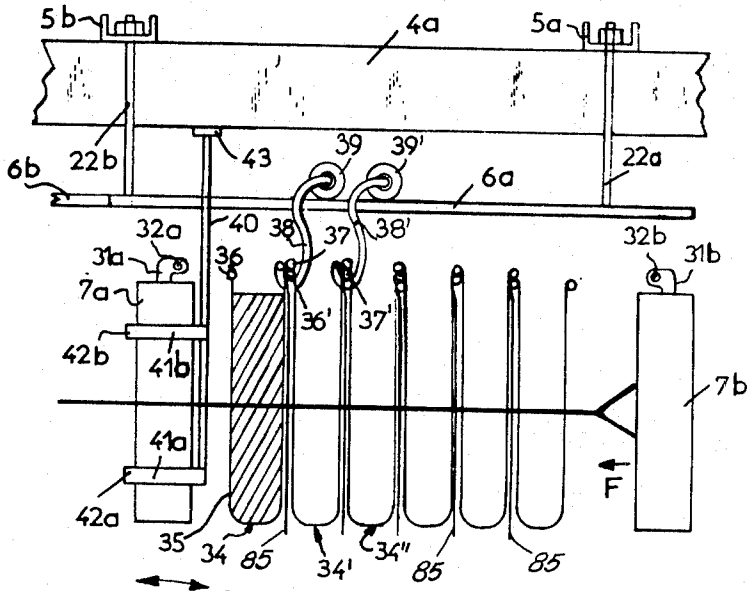
Fig: 3.



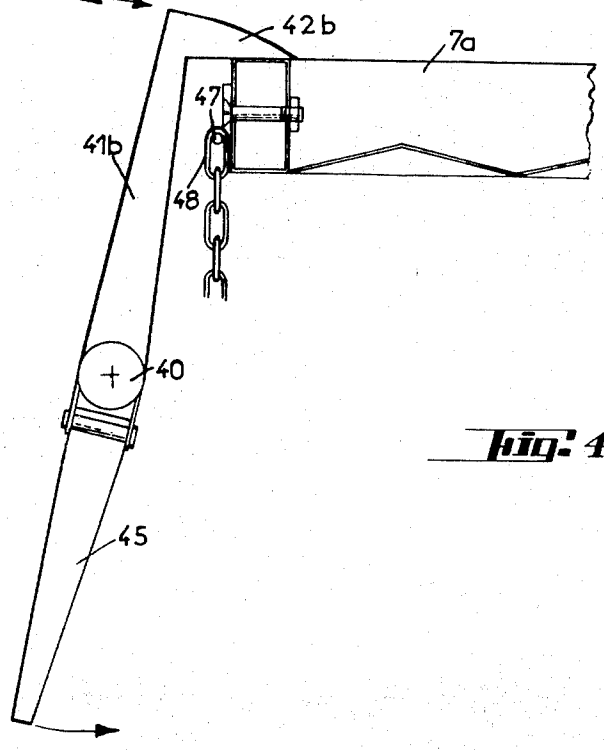


Fig: 4.

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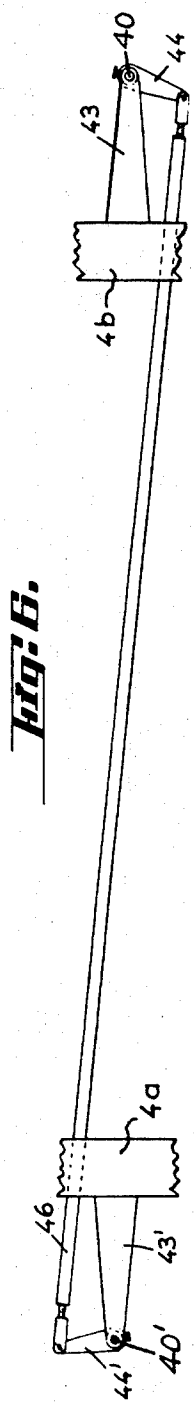

Fig. 6.

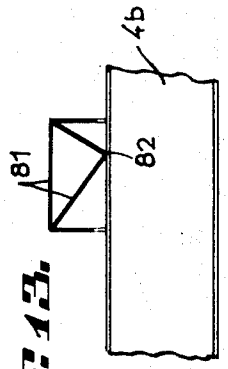

Fig. 13.

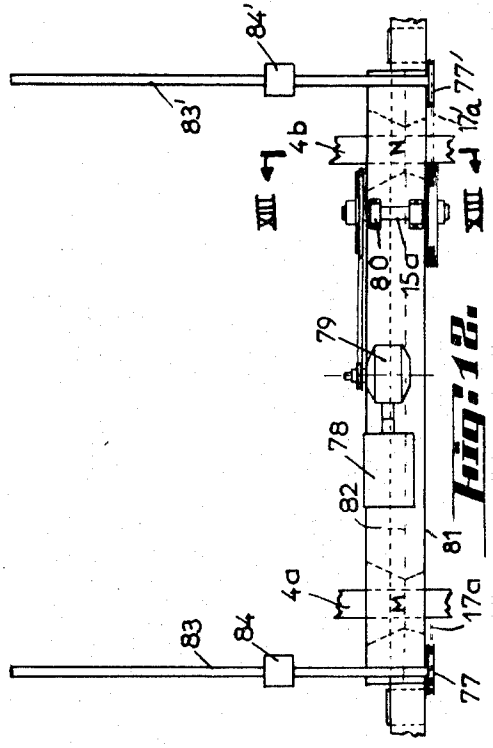

Fig. 12.

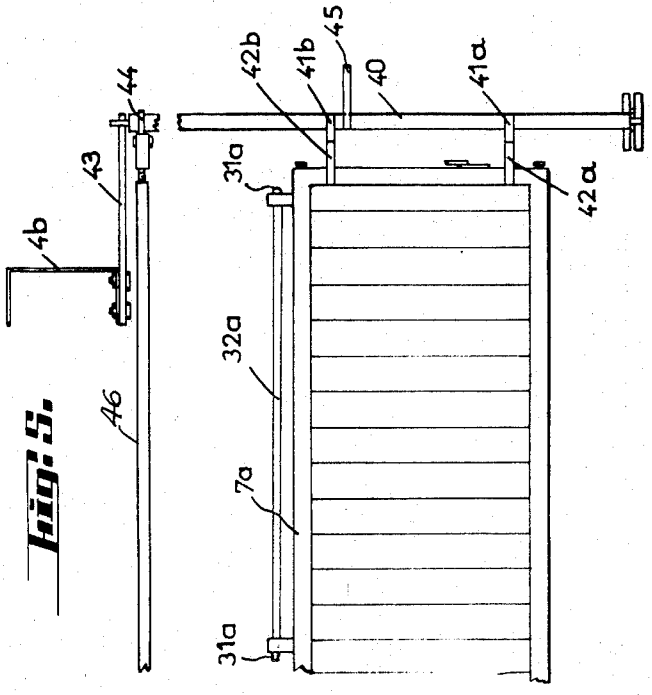

Fig. 5.

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Fig: 7.

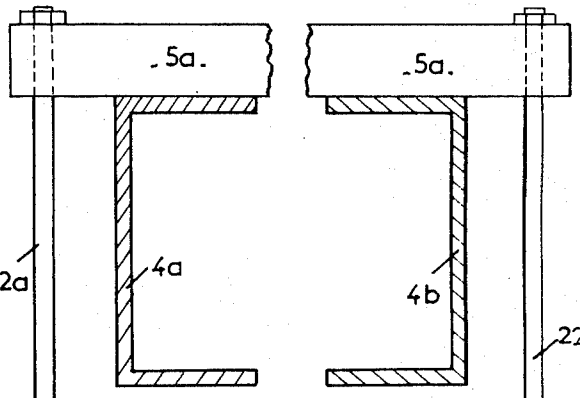


Fig: 8.

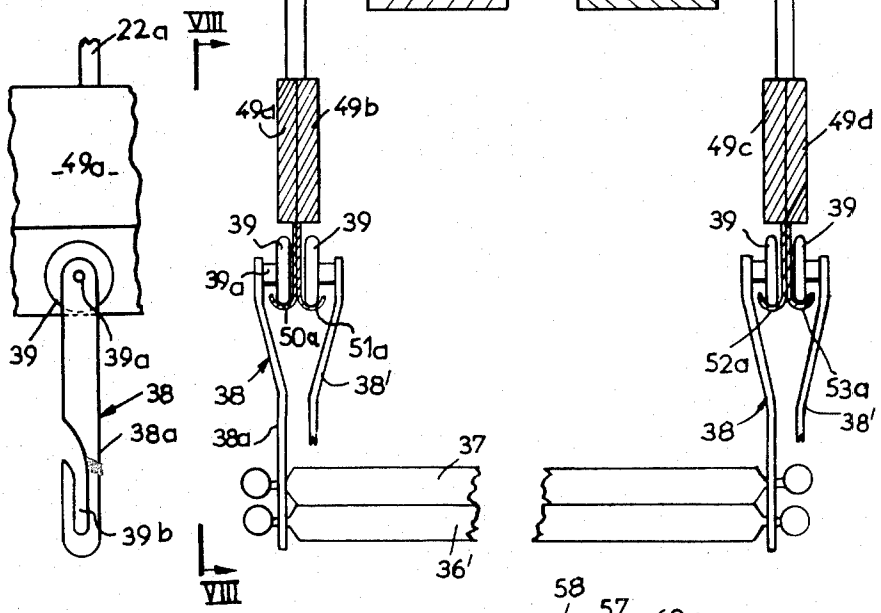
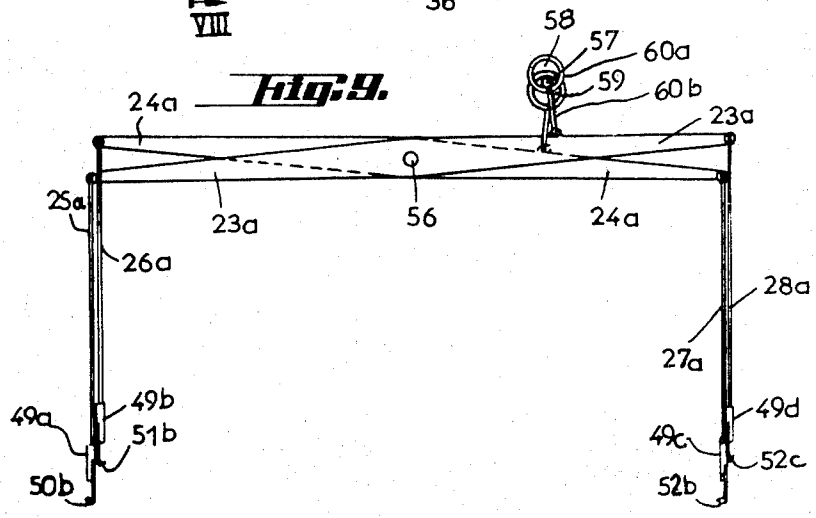


Fig: 9.



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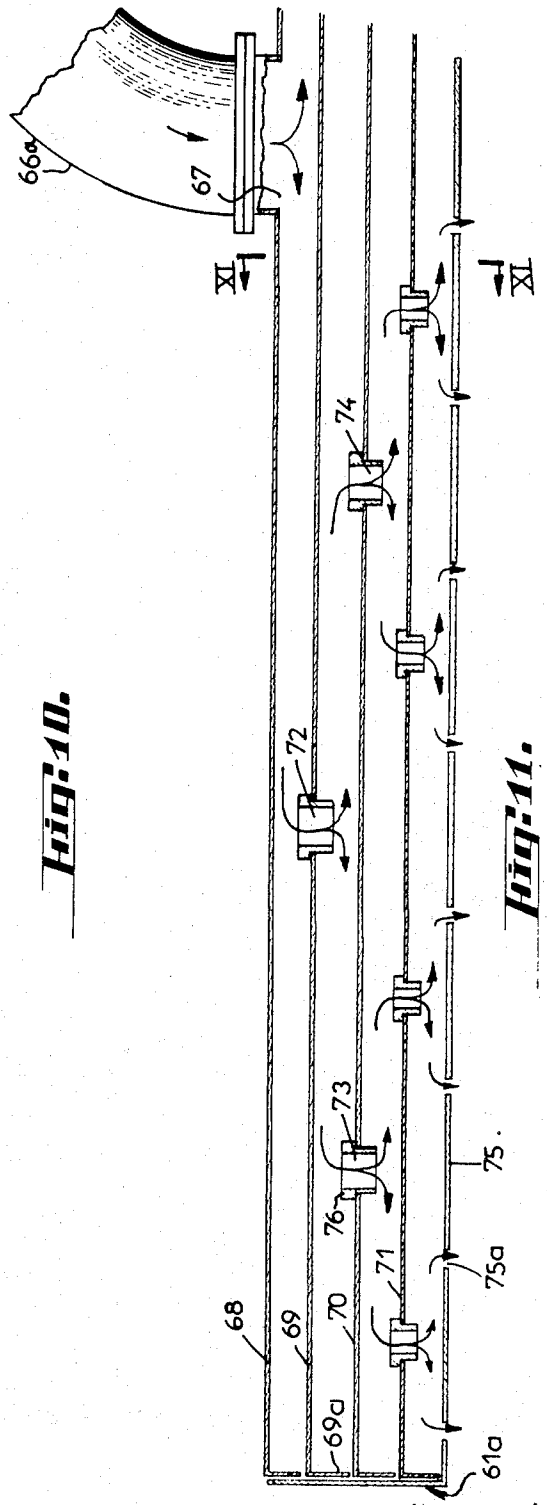

Fig. 10.

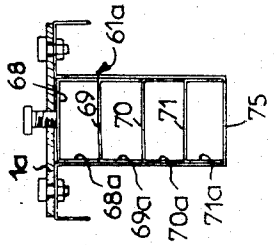

Fig. 11.

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DEVICE FOR CONTINUOUS FILTERING OF CHEESE CURD, IN PARTICULAR CURDLED MILK

The present invention has for its object a device for continuous filtering of cheese curd.

There are already known a great number of methods and devices for filtering curd obtained through coagulation of milk for the production of bodies of cheese. In some of such devices use is made in particular of filtering elements comprising a filtering fabric forming a sack open at its top and both upper edges of which are retained by supporting rods or the like which are sometimes associated with oscillation means and compression means promoting the filtering, i.e., reducing the duration of the latter and increasing the quantity of extracted liquid phase.

However, the devices used hitherto are not adapted for continuous operation ensuring very high outputs. It was therefore desirable to design a device wherein the empty filtering elements would be conveyed to one end of a production line, filled, subjected to a filtering process, discharged at the other end of the production line and then emptied.

Moreover, it was highly desirable to prepare directly, through filtering, bodies of cheese having a relatively high dry-matter content, in order to be able to produce directly, by way of moulding subsequent to filtering, cheese of the so-called "soft" type. It should be pointed out in this respect that direct moulding of bodies of such type is a very difficult operation which has been overcome by the Applicant by using a moulding machine operating in a continuous or semi-continuous manner. It is therefore understood that the provision of a filtering device capable of feeding such a moulding machine in a continuous or semi-continuous manner is of great interest.

It should also be pointed out that where curdled milk is concerned it is difficult to obtain bodies of cheese having the said sufficiently high dry-matter content. Numerous tests have shown the necessity of using curd of this type when it is desired to make cheese of the "soft" type in the aforementioned manner; now the devices used hitherto do not allow to obtain a sufficiently high dry-matter content when curdled milk is used.

In addition, in the filtering devices used hitherto the location of each filtering unit remains unchanged while the filtering fabrics used are progressively compressed, and this leads to excessive dimensions of the said devices.

The device according to the invention, which pertains to the type using filtering elements of the aforementioned type and compression means, enables to resolve simultaneously all the problems stated above and offers the following advantages: labor saving, extremely high yields, high dry-matter content, uniform weight and amount of dry matter in the bodies of cheese when such a filtering device is associated with a continuous moulding machine of the said type, reduced dimensions.

Such a filtering device is of the type comprising a frame, a roll track constituted by a pair of substantially horizontal and parallel roll paths suspended from the said frame and maintained in spaced relationship to one another, filtering elements suspended from rollers or the like adapted to move on the said roll paths, the said elements being of a type known per se comprising

a filtering fabric forming a sack open at its top and both upper edges of which are retained by supporting rods or the like, the said rods being arranged transversely with respect to the said roll paths, the said elements being suspended from the said roll paths by means of the end of the said supporting rods which, to this end, are removably retained by suspension and guiding hooks on which are mounted the said rollers, means for compressing or pressing the said filtering elements, the said filtering device being characterized in that the said compression means are presses each of which is composed of a pair of substantially vertical and transverse press elements or plates associated with guiding and suspension or support means, the said filtering elements and the said presses being adapted to be moved by suitable driving means from the upstream end of the said roll path to the downstream end thereof, a plurality of filtering elements being arranged one after the other between the two press elements of each pair so as to form a working unit, in that the length of the said roll path is sufficient to contain a plurality of working units arranged one after the other, the said roll path being divided longitudinally into several sections each of which is adapted to receive at least one working unit, some of the said sections comprising means for relative displacement, one towards the other, of both press elements of each pair of press elements, and in that it comprises means for periodically conveying the said working units in the empty state to the upstream end of the roll path, means for periodically discharging the said units from the downstream end of the said path, and means for feeding and dispensing the cheese curd into the various filtering elements of each working unit at the upstream end of the said roll path, the said feeding and dispensing means being arranged above the most upstream working unit.

According to a preferred form of embodiment of the present invention, the said sections comprise at least two endmost compression sections, the roll paths of which are at a fixed height, and an intermediate oscillating section provided with oscillation means adapted to raise one of the supporting rods of each filtering element while the other rod thereof is lowered and vice versa.

Each roll path of the said roll track is preferably constituted, in a manner known per se, by two twin rails upon each of which bears one end of one of the supporting rods of each filtering element, the said oscillation means being adapted, in the said intermediate section, to raise one of the twin rails and simultaneously lower the rail twinned thereto.

According to a significant feature of the present invention, the means for driving the press elements and the filtering elements as well as the means of relative displacement of the press elements comprise means of cable traction of the element located upstream of each pair of press elements and means for locking and unlocking the downstream displacement of the downstream element of the said pair.

The compression of the filtering elements of a working unit may thus be achieved by locking the position of the press element located at one of its ends and by exerting on the other press element a traction effort tending to move it nearer to the first press element; according to a modified form of embodiment, the press ele-

ment which is locked may be located upstream. According to another modified form of embodiment, the position of one of the press elements may be locked and a thrust force may be exerted on the other, tending to move it nearer to the first element. In all cases, upon completion of the compression which is effected at one of the said two stationary sections of the roll path, the whole of the working unit together with its two press elements is moved in the downstream direction to another section of the roll path where a further treatment is carried out, the latter being preferably a stirring treatment resulting from the oscillation of the supporting rods of the filtering elements; at this other section there may possibly be carried out an additional compression treatment without oscillation following the oscillation treatment without compression; the compression and oscillation treatments may also be carried out simultaneously. When such treatment is completed, the working unit is again moved in the downstream direction so as to be placed at a further roll path section where a further compression is carried out; this last compression may advantageously be effected by grouping a certain number of working units one against the other, by locking one of the endmost elements of the assembly thus formed and by exerting on the other press element of the said assembly a thrust or traction in the manner described above.

According to another feature of the invention, the said oscillation means comprise at each end of the said oscillating intermediate section a pair of transverse rock arms adapted to oscillate in phase opposition about a substantially horizontal, common medial pivot placed on the upper portion of the said frame, the left-hand end of one of the said rock arms being connected to the left-hand roll-path twin rail which supports one of the supporting rods of the filtering elements and the right-hand end thereof being connected to the right-hand roll-path twin rail which supports the other supporting rods of the said filtering elements, whereas the left-hand end of the other rock arm is connected to the other twin rail of the left-hand roll path, which supports the said other supporting rod, and whereas the right-hand end of the said other lock arm is connected to the other twin rail of the right-hand roll path, which supports the supporting rod mentioned in the first place.

The invention is also characterized by the particular nature of the means for distributing and dispensing the cheese curd upstream of the device. Such means are so adapted that all the filtering elements of a working unit receive one and the same amount of curd having one and the same composition as regards dry matter and fatty matter; it is therefore necessary, while the cheese curd is being conveyed, to distribute the latter equally between all the filtering elements and avoid any segregation of the curd components which would result in non-uniform conditions from one filtering element to the other, thus leading to heterogeneous cheeses.

Consequently, the feeding and dispensing means are constituted by at least one container of substantially rectangular cross-section, the length of which extends in the direction of the roll path, the said container comprising superposed horizontal perforated plates maintained in spaced relationship to one another, in non-sealing contact along the side walls of the said container, each of such plates being provided with openings arranged so that the number of openings of each plate be doubled from one plate to the plate located directly below, whereas the cross-section area of the said openings is reduced substantially by half, each opening of a plate being located in the medial vertical plane of two consecutive openings of the plate located directly below the same, the bottom of the said container being provided with openings which are dimensioned and distributed according to the aforesaid law, the said bottom constituting, as it were, an additional perforated plate supplying the cheese curd directly into the various filtering elements of a working unit, and the said container being connected at its top to a cheese-curd feed duct or to several feed ducts aligned transversely.

The said container may be placed directly on the supporting rods of the filtering elements. However, in order to avoid any displacement of the said container during the replacement of one working unit by the following one at the filling station, it is preferably stationarily suspended above the working unit being filled.

The Applicant has further observed that it is preferable to confer to the cross-sections of the filtering elements during the filling thereof the shape of relatively narrow channels instead of the known shapes such as those of a trough or a cradle, each said channel being for instance substantially from 100 to 130 mm in width and from 400 to 600 mm in height. Such a configuration as well as the configuration of the aforesaid container involves the maintenance of a pre-determined spaced relationship between the two, upstream and downstream press elements of the working unit being filled, as well as the maintenance of the spaced relationship between the two fabric layers of each filtering element, this being advantageously obtained by using means for locking the rollers. Such locking means may for instance consist of removable stops placed on either side of the rollers on the roll paths, all the stops of the working unit being filled, being actuated by one and the same control device. Thus, the bottom of the dispensing container has its openings always placed along the axis of the various filtering elements.

The aforesaid feeding and dispensing means enable to supply into each filtering element identical volumes of curd having one and the same dry-matter content and one and the same percentage of fatty matter. Moreover, owing to simultaneous feeding into the various filtering elements, they enable to obtain constantly identical levels of curd in all the said elements, so that the internal pressures acting upon the side walls of the said elements counter-balance one another and the channels defined between the latter retain identical widths not only during the filling but also during the subsequent stages.

The said interval pressures are at a maximum at the end of the filling. Subsequently, the filtering of the curd and the continuous flow of serum resulting therefrom progressively reduce the mass contained in each filtering element, thus tending to lower the level in each element as well as the internal pressure; the effect of the compression resulting from the motion of the presses nearer to one another is precisely to restore both the level, so as to keep the filtering surface constant and at a maximum, and the internal pressure. However, it should be noted that as the dry-matter content in-

creases, the viscosity of the mass increasingly opposes its deformation, so that a moment occurs when it becomes practically impossible to raise the level of the mass if increasing forces of compression are not used in the downstream direction.

It is readily understood that such a device enables to obtain a very high dry-matter content, since it is possible to readily proceed from the relatively low forces of compression necessary at the beginning of the process in order to prevent the initially fluid curd from overflowing the filtering elements, to much higher forces of compression, the use of which is possible when the curd becomes sufficiently firm. Such a result is therefore obtained by operating at low pressure in the sections located upstream and at high pressure in the sections located downstream.

On the other hand, before moving the two elements of one and the same press nearer together, the filtering elements of the working unit located in the most upstream position may be allowed to drain subsequent to filling, for instance during 30 to 60 minutes.

Other features and advantages of the present invention will appear as the following description proceeds.

In the appended drawings given solely by way of example:

FIG. 1*a* is a diagrammatic top view of the downstream part of a device according to an embodiment of the invention;

FIG. 1*b* is a diagrammatic top view of the upstream part of said device;

FIG. 2*a* is a diagrammatic elevational view of the downstream part of said device upon line II*a* — II*a* of FIG. 1*a*;

FIG. 2*b* is a diagrammatic elevational view of the upstream part of said device upon line II*b*—II*b* of FIG. 1*b*;

FIG. 3 is a diagrammatic side view, to a larger scale, of the compression section of the device of FIGS. 1*a* to 2*b*;

FIG. 4 is a sectional top half-view of an upstream press element of the device of FIGS. 1*a* to 2*b* and of the associated locking means located at the level of the said element;

FIG. 5 is a semi-elevational front view, from the downstream side, of the upstream press element of FIG. 4 and of the corresponding locking means;

FIG. 6 is a top view of the control means for the locking means of the upstream press element of FIG. 4;

FIG. 7 is a semi-sectional view across a stationary section of the device of FIGS. 1*a* to 2*b* upon the line VII—VII Of FIGS. 1b and 2b;

FIG. 8 is a side view, upon the line VIII—VIII of FIG. 7, of a detail of the stationary section shown in the said figure;

FIG. 9 is a diagrammatic view of the oscillation means connected to the oscillating intermediate section of the device of FIGS. 1*a* to 2*b* upon the line IX—IX of FIG. 2*b*;

FIG. 10 is a vertical longitudinal semi-sectional view of the feeding and dispensing means of the device of FIGS. 1*a* to 2*b*;

FIG. 11 is a vertical sectional view across the said feeding and dispensing means along the line XI—XI of FIG. 10;

FIG. 12 is a top view of the means of traction of the cables drawing a press element;

FIG. 13 is a cross-sectional view of the said means upon the line XIII—XIII of FIG. 12.

Referring now to FIGS. 1*a* to 2*b*, there is shown the whole device according to the present invention. The frame 1 of this device comprises four cross-members 2*a*, 2*b*, 2*c* and 2*d* which are secured to walls at their ends and are supported by tubes denoted by the number 3 and placed outwardly of the roll path, which is not shown in FIGS. 1*a* and 1*b* but is located substantially below longitudinal members 4*a* and 4*b*; also the latter are part of the frame 1 and bear at their ends upon the other walls of the room in which is mounted the device; moreover, the said longitudinal members bear upon the cross-members 2*a* to 2*d*; the frame also comprises tie-beams 5*a* to 5*d* which serve as a support for the roll path in both endmost sections of the latter.

The roll path comprises a stationary upstream section, an intermediate section adapted to oscillate and a stationary down stream section, in the example described with reference to FIGS. 1 to 11; the upstream section extends between the vertical planes AB and CD (FIG. 1*b*), the intermediate section between the vertical planes CD and EF (FIG. 1*b*), and the downstream section between the vertical planes EF (FIG. 1*b*) and GH (FIG. 1*a*).

The roll path is shown diagrammatically over its whole length in FIGS. 2*a* and 2*b* by the reference number 6; this roll path has a slight slope descending in the downstream direction, of the order of for instance 1 percent, in order to facillitate the rolling through traction of the working units suspended therefrom. This slope also enables to create a static pressure promoting the compression; a slope of non-uniform profile more accentuated in its lower portion may be provided so as to create a static pressure increasing in the downstream direction. The roll path comprises a stationary section 6*a* extending between the zones AB and CD, a section 6*b* constituted by a plurality of rails, each of which is adapted to be raised and lowered in a parallel direction to its own, under the action of oscillation means which will be described later, and a stationary section 6*c*; each of the rails of the section 6*b* may be brought into correspondence to the level of the rails of the section 6*a* or the section 6*c*, the moments of correspondence to the sections 6*a* and 6*c* being either simultaneous as appears in FIGS. 2*a* and 2*b*, or, according to a variant, non-simultaneous, the stationary section 6*a* being brought to a height considerably different from that of the section 6*c*, even in the absence of any slope on each section.

Referring to FIGS. 1*a* and 1*b*, it is further seen that at a given moment eight working units may be treated simultaneously by the device, between its upstream end AB and its downstream end GH; in these figures, only the press elements enclosing each working unit have been shown, whereas the filtering elements contained therebetween are not visible for the sake of clarity of the figures; such filtering elements are for instance thirty two in number; the working unit located in the most upstream position occupies the whole stationary section comprised between AB and CD and is shown by its downstream press element 7*a* and its upstream press element 7*b*; the working unit following it is shown by its downstream press element 8*a* and its upstream press element 8*b*; this working unit is located at the level of

the oscillating intermediate section comprised between CD and EF. At the level of the stationary section located between EF and GH is located a succession of six working units shown solely by the pair of press elements surrounding each of them, i.e., (considering them in the downstream direction) the pairs of press elements **9***b*–**9***a* **10***b*–**10***a*, **11***b*–**11***a*, **12***b*–**12***a*, **13***b*–**13***a* and **14***b*–**14***a*. It will be noted that the spaces occupied by each working unit decrease progressively in the downstream direction, this being due to progressive elimination of the liquid phase of the curd contained in the filtering elements.

As seen in FIGS. **2***a* and **2***b* two winches **15***a* and **15***b* are mounted, in a manner which will be described later, rockingly on cross-members **16***a* and **16***b* secured transversely to the longitudinal beams **4***a* and **4***b;* on each of the said winches are wound two cables, only one of which is seen in these figures, i.e., the cable **17***a* for the winch **15***a* or the cable **17***b* for the winch **15***b;* these cables pass on suitable angle pulleys and are removably attached to press elements; in the position illustrated in those figures, the cables of the winch **15***a* are attached to each of the lateral edges of the press element **7***b*, while the cables of the winch **15***b* are attached to the lateral edges of the press element **9***b*.

As also seen in FIGS. **1***a* to **2***b*, the means for locking the press plates are arranged stationarily at **19**, **20** FIG. **1***b* and **21** FIG. **1***a* and, in the position illustrated in these FIGS. **1***a* to **2***b*, respectively lock the downstream press plates **7***a*, **8***a* and **14***a*, thus enabling, as a result of the traction which may be exerted by the winches **15***a* and **15***b*, to compress the only working unit of the stationary section located between AB and CD and the whole of the six working units located between EF and GH.

The tie-beams **5***a*, **5***b*, **5***c* and **5***d* support the stationary sections **6***a* and **6***c* of the roll path through the medium of vertical suspension rods such as **22***a* and **22***b*, **22***c* and **22***d*.

As also appears from FIG. **2***b*, the means of suspension and oscillation of the oscillating section **6***b* of the roll path comprise a system of rocking arms **23***a* or **23***b* at each end of the said oscillating section, each of the said rocking arms comprising four vertical suspension rods, only two of which, **25***a*, **26***a* or **25***b*, **26***b*, are seen in FIG. **2***b*. Lastly, as shown in the same figure, the frame is also supported by pillars such as **30** supporting the cross-beams **2**.

Referring now to FIG. **3**, there is shown the whole of the compression section of the device; the stationary section **6***a* of the roll path is supported by rods such as **22***a* and **22***b* suspended from the tie-beams such as **5***a* and **5***b* supported by the longitudinal beams such as **4***a;* for the sake of clarity, only six filtering elements are shown between the press elements **7***a* and **7***b*, while in fact 32 filtering elements are usually used between the said press elements, so that the working unit thus defined which extends prior to compression over practically the whole length of the stationary secton **6***a*, comprises 32 filtering elements of a total capacity of about 5,000 liters. It is seen that each filtering element such as **34** comprises a filtering fabric **35** secured to two horizontal supporting rods **36** and **37**; for the sake of clarity, the suspension means for the rods **36** and **37** of the filtering element **34** at the roll path **6***a* are not shown, but the suspension means for the filtering element **34''** are shown as comprising hooks such as **38**, **38'** in which the supporting rods **36**, **36'** are respectively engaged, and rollers **39**, **39'** rotating respectively on the hooks **38**, **38'** and adapted to roll along the roll path **6***a*. The filtering elements **34''**, **34'''** etc., are shown as not connected to their suspension means for the sake of clarity. The press elements **7***a* and **7***b* are also suspended from the said hooks through the medium of brackets **31***a*, **31***b* and rods **32***a*, **32***b;* thus the rod **32***a* of the element **7***a* is engaged in those of the said hooks where the rod **36** is engaged.

Referring now to FIG. **3**, fabrics or the like **85** are placed between adjacent filtering elements; the fabrics, which are for instance secured to the fabric of one of the adjacent filtering elements, constitute wicks or the like which allow, through capillarity, to discharge downwardly the serum which tends to be expelled towards the top of the said elements under the action of the compression exerted subsequent to filling, and, possibly, to draining under compression.

Such means enable to reduce by half the total duration of the filtering, owing to the fact that during the first stages of compression the phenomenon of displacement of the serum towards the top of the filtering elements is more and more accentuated.

In FIG. **3** there is also seen a pivot **40** arranged vertically and adapted to rotate at its upper portion in a lug **43** secured to the longitudinal beam **4***a;* to the pivot **40** are secured two curved brackets **41***a* and **41***b* whose ends form retaining hooks **42***a* and **42***b*, thus enabling to lock the press element **7***a* during the traction of the press element **7***b* by the cable **17***a* in the direction shown by the arrow F.

Referring now simultaneously to FIGS. **4**, **5** and **6**, there is shown more particularly the detail of the means for locking the downstream press element such as **7***a*. It will be noted that the pivot **40** is coupled to the pivot **40'** through the medium of a coupling rod **46** and two links **44** and **44'**, so that when the pivot **40** is made to rotate in one direction, for instance by means of the hand lever **45** shown, the pivot **40'** is driven in rotation in the other direction. According to a variant, the coupling of the pivot **40** and **40'** may be effected through the medium of an X-belt or chain transmission passing on wheels or pinions solid with the said pivots; this enables to effect either the simultaneous locking on both sides of the press element, through rotation of the curved brackets such as **41***b* inwardly, or the unlocking thereof through rotation of the said brackets outwardly. It is preferable to provide means for locking the curved brackets in the locked position and in the unlocked position of the press element. Such locking is obtained for instance by lowering the pivot **40**, thus lowering a stud solid with the lower end of the latter and decentered with respect to the said pivot into either one of the two stationary sockets determining the said locked and unlocked positions. The transition from one position to the other is therefore obtained by raising the lever **45** so as to unlock the pivot **40**, and then by rotating it in the appropriate direction by a given angle corresponding to the angular distance between the said two sockets, and finally by lowering the lever **45** in order to effect a further locking of the pivot **40** in a new angular position. According to a vari-

ant, the rotation of the pivot 40 may be controlled automatically. It also appears from FIG. 4 that the press element 7*a* is provided on its sides with fixing pins such as 47 in which may be engaged the chain rings 47 which are also engaged on similar pins secured on the lateral sides of the press element of the said working unit, i.e., the element 7*b* in the case considered; this enables, during the displacement of the working units in the downstream direction, when the tension of the traction cables of the winches 15*a* or 15*b* is released and when the curved brackets of the locking means are turned inwardly, to avoid the moving apart of the press elements under the action of the internal pressure present in the filtering elements.

The means of suspension of the upstream end of the stationary section 6*a* of the roll path, which are shown in FIGS. 7 and 8, comprise, in addition to their longitudinal beams 4*a* and 4*d*, the tie-beam 5*a* and the vertical suspension rods 22*a* and 22'*a*, longitudinal uprights 49*a*, 49*b*, 49*c* and 49*d* supporting respectively the rails 50*a*, 51*a*, 52*a* and 53*a*, each rod such as 22*a* supporting two twin rails such as 50*a* and 51*a* through the medium of two juxtaposed uprights such as 49*a* and 49*b*.

The filtering elements are suspended from the said twin rails through the medium of hooks, each of which is adapted to move from one end of the roll track to the other, owing to the fact that each one of the said four twin rails continues along the various sections 6*a*, 6*b* and 6*c*; each suspension and guiding hook such as for instance 38 is constituted by a small bar 38*a* provided with a slot 39*b* adapted to receive one end of one of the supporting rods of a filtering element as well as one end of one of the supporting rods of an adjacent filtering element, the roller 39 being rotatably mounted on an axis pin 39*a* secured to the upper end of the said small bar 38*a*. FIG. 7 shows one of the supporting rods 36' of the filtering element 34' of FIG. 3 and one of the supporting rods 37 of the filtering element 34; it is seen that the left-hand end of the supporting rod 36' is engaged in the hook 38 co-operating with the outer twin rail 50*a* of the left-hand roll path; the right-hand end of the same rod 36 is engaged in the hook 38 co-operating with the inner twin rail 52*a* of the right-hand roll path; for the sake of clarity, the two other hooks 38' are not completely illustrated, but it is readily understood that the other rod 37' (FIG. 3) of the same filtering element 34' has its left-hand end engaged in the hook 38' co-operating with the inner twin rail 51*a* of the left-hand roll path, whereas its other end is engaged in the hook 38' co-operating with the outer twin rail 33*a* of the right-hand roll path; moreover, the ends of the rod 36' of the filtering element 34'' are also engaged in the hooks 38' below the rod 37'.

Although all the said twin rails are at the same level in the intermediate section 6*a* of the roll track shown in FIG. 7, it is readily understood that specific movements may be imparted to the supporting rods of the filtering elements by imparting in a specific manner ascending and descending movements to each one of the twin rails 50, 51, 52 and 53.

Referring now to FIG. 9, it is seen that the oscillation means located at one end of the oscillating section 6*b* of the roll track comprise two rocking arms 23*a* and 24*a* pivotally mounted about a substantially horizontal, common medial pivot 56 secured to the frame 1, by means which are not shown in FIG. 9; at the ends of the said rocking arms 23*a* and 24*a* are hingedly connected suspension rods 25*a*, 26*a*, 27*a*, 28*a* which respectively support rails 50*b*, 51*b*, 52*b* and 52*c* through the medium of the aforesaid longitudinal uprights 49*a*, 49*b*, 49*c* and 49*d*; both rocking arms actuated by drive means which enable them to oscillate in phase opposition, the said drive means comprising a shaft 57 moved by a reducer and journaled in the frame (not shown in this figure) and two eccentrics 58 and 59 mounted in phase opposition on the shaft 57, each of the latter comprising a peripheral ring such as 60*a* adapted to slide on the eccentric considered and rigidly secured to a bracket such as 60*b* which is itself secured to the associated rocking arm 23*a* (or 24*a*). Such a mechanical structure enables to obtain concomitant ascending and descending motions of the rails, so that for each filtering element one of the supporting rods is raised while the other is lowered and vice versa. Mechanical control by means of a cam enables, at the desired moment, to move the four rails of the oscillating section into exact prolongation of the four rails of the stationary sections 6*a* and 6*c* of the roll track. It also enables to use electrical means for automatically stopping the oscillation of the rocking arms such as 23*a* and 24*a* in the said position.

Referring now to FIGS. 10 and 11, the means for feeding and dispensing the cheese curd upstream of the device, are constituted by two containers such as 61*a* of prismatic shape, rectangular vertical section and rectangular horizontal section elongated in the longitudinal direction of the device, over a length which is substantially equal to that of the compression section, so that the said two containers which are placed end to end in the longitudinal direction may feed, through their bottom provided with judiciously distributed openings, all the filtering elements contained in a working unit placed in the upstream stationary compression section; in the example illustrated in FIGS. 10 and 11, each of the said containers feeds 16 filtering elements; the containers such as 61*a* (FIG. 11) are stationarily suspended from the upper portion 1*a* of the frame 1, so as to avoid interference with the operation of the means of compression, oscillation and displacement of the filtering elements; such containers are fed at their lower portion through a common feed duct which is divided into two ducts, each of which feeds one of the said containers: one of the ducts 66*a* feeds the container 61*a* opening into the orifice 67 of a plate 68 constituting the cover of the said container 61*a*. Within this container are arranged a plurality of superposed perforated plates (four in number in the example illustrated), which are preferably equidistant owing to suitable tie or cross means (either secured or forming the flanges such as 69*a* of the said plate, as appears from FIG. 11), the said plates 69, 70 and 71 as well as the said cover 68 being fitted in the container 61*a* with a small play between the periphery of the said plate and the side walls of the container; thus, the said plates may readily be withdrawn and remounted periodically for cleaning purposes, the viscosity of the curd being such that the latter cannot pass through the narrow slits corresponding to the said plate, but can only pass through the openings of the perforated plates.

It is seen in FIG. **10** that the opening **67** supplies a flow of curd which passes through the plates **68** and **69** and which is uniformly distributed between the opening **72** and another opening of the plate **69**, the latter opening being symmetrical to the opening **72** with respect to the opening **67**; the same occurs for any curd flow supplied through an opening of any plate and which must flow through the plate located directly below it; thus, the opening **72** feeds the openings **73** and **74**; the same also occurs for the curd flow supplied by the last plate **71** which is supplied through the openings **75***a* of the bottom **75** of the container **61***a*. This particular arrangement of the openings enables to distribute the curd in an extremely uniform manner at the level of the openings of the bottom **75**; in the example illustrated, the duct **66** feeds 16 openings **75***a*, i.e., 16 filtering elements; generally, 2^n filtering elements may be fed from a single duct, *n* being the number of stages of plates, including the covers **68** and the bottom **75**; thus, the feeding of the filtering elements is extremely uniform and the weight as well as the composition of the curd remain constant from one filtering element to the other. Of course, the diameters of the openings of the said perforated plates decrease progressively owing to the reduction of supply at the level of each opening, from the cover to the plate located below, from a plate to another plate located at a lower level and from the last plate to the bottom of the container; moreover, each opening of the perforated plates is provided with nozzles or the like such as **76** projecting from the opposite faces of the perforated plates, so that the curd flows are always transformed into vertical flows in proximity to the openings of the perforated plates; in addition, such a structure enables to determine accurately the diameter of the openings of the perforated plates, by using nozzles with calibrated internal passageways.

FIGS. **12** and **13** show the means of traction of a press element such as the element **7***b* (FIG. **2***b*). Such means, in addition to the cables **17***a* and **17**'*a* passing respectively on the upper angle pulleys **77** and **77**' and the winch **15***a*, also comprise a motor **78** and a reducer **79**. The motor-reducer set **78–79**, the axis pins of the pulleys **77** and **77**' and the support **80** of the winch **15***a* are secured to a transverse beam **81** adapted to rotate according to a transverse horizontal axis **82**, on the upper faces of the longitudinal beams **4***a* and **4***b*, in the zones M and N respectively. The magnitude of the rotation is determined by those portions of the said beam **81** which form stop members co-operating with the said upper faces of the longitudinal beams **4***a* and **4***b*. The axis pins of the pulleys **77** and **77**' extend far beyond the portion **81** in the form of horizontal levers **83** and **83**' respectively, provided with sliding, manually movable counter-weights **84** and **84**' respectively. The winch **15***a* is thus rockingly mounted on the frame **1**, the positions of the counter-weight **84** and **84**' being adjusted manually (or, according to a variant, automatically) depending on the program of tension to be exerted on the cable, so as to exert upon the beam **81** a descending force opposing the ascending force resulting from the traction of the cables on the pulleys **77** and **77**'. Such a rocking arrangement ensures good responsiveness of the point of equilibrium of forces; moreover, an end switch is provided to stop or operate the winch at moments which are very near to the desired force.

It will be noted that the winch **15***a* has a winding drum which is limited laterally by plates which are placed at a distance from one another slightly superior to the diameter of the cables, in order that the winding may take place in superposition, so that the wound or unwound lengths are the same for both cables **17***a* and **17**'*a*.

The operation of the device of the present invention will now be explained.

In the upstream portion of the device, below the dispensing containers such as **61***a*, the filtering fabrics are secured to or engaged onto the supporting rod, then the ends of the latter are engaged in the suspension hooks such as **38** and **38**' which have been previously placed and locked, by means of removable stops immobilizing the rollers; the feeding containers are designed to fill 32 filtering elements (16 filtering elements for each container), the total capacity of which is for instance of the order of 5.000 liters. In order to facilitate the positioning of the presses and the fabrics, use may be made of carriages on which upstream and downstream press elements and, between the latter, the filtering elements with the supporting rods, will have been placed beforehand. The carriage is then brought under the roll track and the said press elements and filtering elements are hooked, in the same order of succession as on the carriage, to the suspension hooks placed beforehand at suitable locations; thereafter the carriage is withdrawn.

When the filtering elements are full, the suspension hooks are unlocked by removing the said stops, then the downstream press element is locked by closing the brackets such as **41***b*, and a traction is thereafter exerted on the upstream press element by means of the winch **15***a*. At the end of a compression lasting from 30 to 60 minutes, the chains **48** are placed so as to maintain the spacing between the said two press elements; the winch is then inversely operated during a few seconds in order to interrupt the traction. The curved brackets of the locking means are then rotated outwardly so as to free the downstream press element. The winch is thereafter operated in the traction direction, so that the working unit which has just been subjected to compression will now be driven to the level of the oscillating section. In a similar manner, the locking of the downstream press element is effected by means of the locking means placed in the downstream portion of this section. Then the traction on the upstream press element is continued. Simultaneously, the eccentrics acting upon the rocking arms of the oscillation means for the four rails of the said oscillating section are actuated; the traction effort exerted on the cable may be more or less considerable and reduced or increased at will during the oscillation stage which lasts about from 30 to 60 minutes. At the end of this stage, the rails of the oscillating section are placed in prolongation of the stationary rails of the compression sections **6***c*. The chains **48** are adjusted so as to maintain the spacing then existing between the upstream and downstream press elements; the winch **15***a* is operated inversely in order to interrupt the traction, the cable of the winch is then unhooked from the upstream press element and the cable of the winch **15***b* is hooked to this press element. The curved brackets of the locking means are thereafter brought to their open position and the working unit is then driven under the action of the winch

15*b* into the stationary section 6*c*, the said working unit thus coming into contact with the other identical working unit still contained in the section 6*c*. The unit which is located in the most downstream position has its downstream press elements locked by the curved brackets of the locking means located in the downstream zone of the said section. The upstream press element of the working unit located in the upstream portion of the said stationary section 6*c* is then drawn by the cables of the winch 15*b* in a continuous manner; the traction force applied may be progressive in order to obtain an increasing degree of pressure. Upon completion of this last pressing operation, which lasts about from 6 to 20 hours, the horizontal cross-section of each filtering element is reduced to about one-fifth of its initial value, a fact that shows the considerable gain in length for the whole of the filtering device as compared to the prior-art device, since each working unit occupies at any moment a minimum length depending on the degree of compression already effected. The press element maintained by the said curved brackets is then unlocked and the various filtering elements are received by progressive traction on the winch cable, unhooked manually and emptied separately into suitable receptacles.

Therefore, all the operations effected by means of the device correspond to semi-continuous filtering, the operation of the device taking place night and day.

Of course, depending on the nature of the curd and the amount subjected to filtering in each filtering element, and also depending on the type of treatment subsequent to filtering, the following parameters may be varied: number and nature of the various sections of the device enabling to carry out the desired combination of pressing or compression treatments and oscillation treatments, possibly including the stages of draining without oscillation or pressing, duration of maintenance of the working unit in each section, frequency of oscillations, traction force of cables, etc.

Of course, the invention is by no means limited to the forms of embodiment described and illustrated, which have been given by way of example only. In particular, it comprises all the means constituting technical equivalents to the means described as well as their combinations, should the latter be carried out according to the spirit of the invention.

What is claimed is:

1. In a device for filtering of cheese curd, comprising a longitudinal frame, a longitudinal roll track having a downstream end and an upstream end and being constituted by a pair of substantially horizontal and parallel roll paths suspended from the said frame and maintained in pre-determined spaced relationship to one another, filtering elements removably suspended by the intermediary of the ends of supporting rods transversely arranged with respect to said roll paths from guiding hooks solid with rollers adapted to move on said roll paths, each said element comprising a filtering fabric forming a sack open at its top, and both upper edges of which are held by said supporting rods, compressing means for pressing said filtering elements, the said compressing means comprising vertical and transverse press elements associated with guiding and supporting means and actuated by an associated winch and cable assembly, a plurality of said filtering elements being placed one after the other between said press elements and feeding means comprising a container, placed above said filtering elements for individually delivering curd in said filtering elements, the improvement wherein:

said roll track contains a plurality of working units each composed of a pair of said press elements comprising an upstream press element and a downstream press element and of a constant number of filtering elements placed therebetween longitudinally with respect to said frame and roll track, the said roll track being divided longitudinally into several sections, each of which contains at least one working unit;

drive means provided for longitudinally displacing simultaneously and periodically said working units from said upstream end to said downstream end, said drive means comprising a plurality of winches placed along said longitudinal frame and pertaining to said assembly the cables of which are removably secured to the upstream press elements of at least some of said pairs; a plurality of removable locking means provided for simultaneously and periodically locking the downstream press elements of at least some of said pairs with respect to said longitudinal frame and roll track;

the container of said feeding means extending along all the length of the upstream working unit and comprises a plurality of superimposed perforated plates horizontally disposed, the upper side of the uppermost of said plates being adapted to receive the cheese curd to be distributed and the lowermost of said plates being adapted to deliver equal amounts of said cheese curd in each of the filtering elements of said upstream working unit, the number of openings of said plates being doubled from one plate to the consecutive plate located below it while their cross-sectional area is reduced substantially by half.

2. Device according to claim 1 characterized in that the said sections comprise at least two endmost compression sections, the rolls path of which are at a fixed height and an intermediate oscillation section provided with oscillation means adapted to raise one of the supporting rods of each filtering element and to simultaneously lower the other rod of the latter.

3. Device according to claim 2, characterized in that each roll path of the said stationary sections is constituted by two stationary twin rails, the structure of which is identical to that of the twin rails of the roll path of the oscillating intermediate section, the twin rails of the said intermediate section being adapted to be positioned in prolongation of the twin rails of each stationary section, for particular positions of the said twin rails of the said intermediate section, the said particular positions allowing the working units to periodically pass from the upstream stationary section onto the intermediate section and allowing the said units to periodically pass from the said intermediate section onto the downstream stationary section.

4. Device according to claim 1, characterized in that each roll path of the said roll track includes an intermediate section and is constituted by two twin rails, on each of which bears one end of one of two supporting rods of each filtering element, and oscillation means adapted, in the said intermediate section, to raise one

of the twin rails and simultaneously lower the rail twinned thereto.

5. Device according to claim 4, characterized in that it comprises chain fixing studs on either side of the said upstream and downstream press elements, and removable chains adapted to connect the said upstream element to the said downstream element while at the same time maintaining the latter in pre-determined maximum spaced relationship to one another.

6. Device according to claim 4, characterized in that the said oscillation means comprise at each end of the said oscillating intermediate section a pair of transverse rocking arms adapted to oscillate in phase opposition about a substantially horizontal, common medial pivot placed at the upper portion of the said frame, the left-hand end of one of the said rocking arms being connected with the left-hand roll-path twin rail which supports one of the supporting rods of the filtering elements and the right-hand end being connected to the right-hand roll-path twin rail which supports the other supporting rods of the said filtering elements, whereas the left-hand end of the other rocking arm is connected to the other twin rail of the left-hand roll path, which supports the said other supporting rod and the right-hand end of the said other rocking arm is connected to the other twin rail of the right-hand roll path, which supports the supporting rod mentioned in the first place.

7. Device according to claim 6, characterized in that each twin rail of each roll path is connected to the end of a given working arm, through the medium of vertical suspension rods hingedly connected to the said rocking arm.

8. Device according to claim 1, characterized in that said press elements are supported by hooks solid with rollers adapted to move on the said roll paths.

9. Device according to claim 1, characterized in that said compressing and drive means comprise, for each pair of press elements, two cables, each of which is attached to one transverse end of the said upstream element, a winding winch for the said cables, mounted at the upper portion of the said frame, the said winch comprising two winding drums limited laterally by plates which are separated from one another by a distance slightly superior to the diameter of the cables, in order that the winding may take place in superposition, so that the wound lengths are the same for both cables.

10. Device according to claim 1, characterized in that said compression and drive means comprise, for each pair of press elements, two cables, each of which is attached to one transverse end of the said upstream element, a single winding winch for the said cables, mounted at the upper portion of the same frame, the said winch being rockingly mounted on the said frame and comprising, on the side opposite the side of intake of the cables onto the said winch, at least one lever provided with a counterweight, the position of which on the said lever is adjustable, the said lever being horizontal and longitudinal and the said rocking being horizontal and transversal so that the said counter-weight exerts on the winch a descending force opposing the ascending force resulting from the traction of the cable and from the position of counter-pulleys placed on the path of the cable between the said upstream press element and the winch.

11. Device according to claim 1 characterized in that each said removable locking means consist of two curved brackets forming retaining hooks and which are swingingly mounted about vertical pivot pins, of stationary positions, on either side of the said roll tracks, the said locking means being placed in the downstream zone of each one of the said sections.

12. Device according to claim 11, characterized in that the two curved brackets are coupled by means of a coupling rod enabling them to rotate in opposite directions, the pivot pin of only one of the said curved brackets being driven in rotation.

13. Device according to claim 1, characterized in that the said openings are provided with nozzles having a calibrated internal passageway, the wall of which projects from the opposite faces of the said perforated plates so that said cheese curd always vertically flows in proximity to the said openings.

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