No. 785,818. PATENTED MAR. 28, 1905.

G. TER MEER.

CENTRIFUGAL MACHINE.

APPLICATION FILED MAR. 4, 1904.

4 SHEETS—SHEET 1.

Fig. 1.

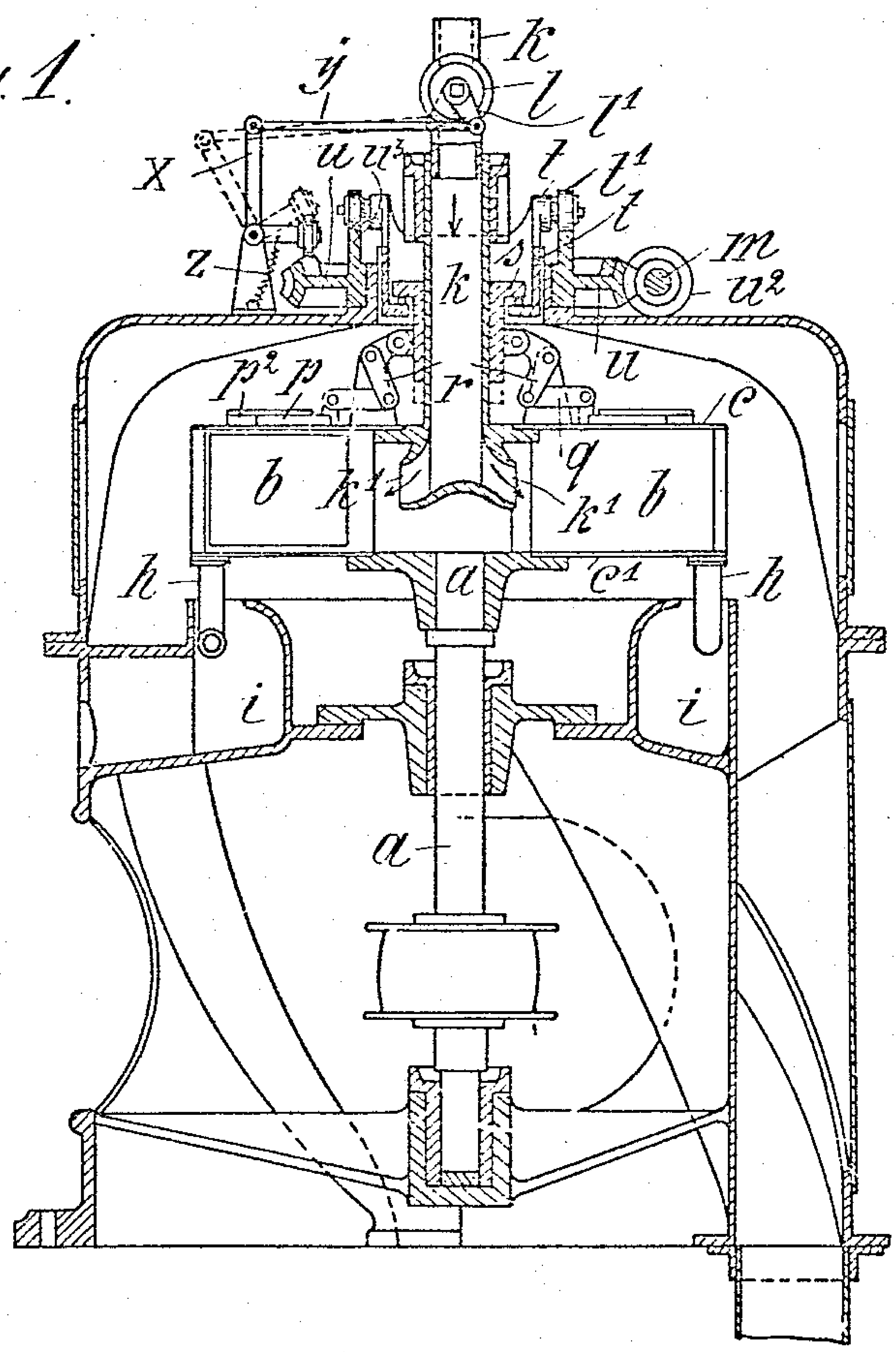


Fig. 8.

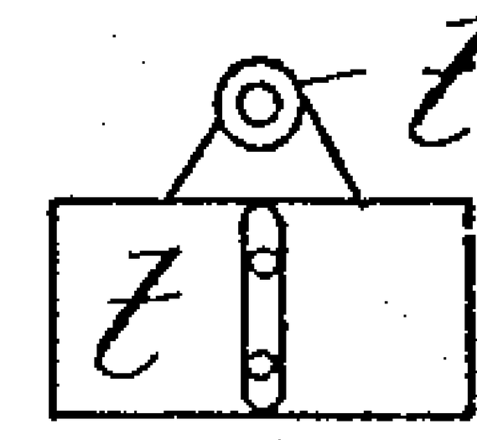


Fig. 2.

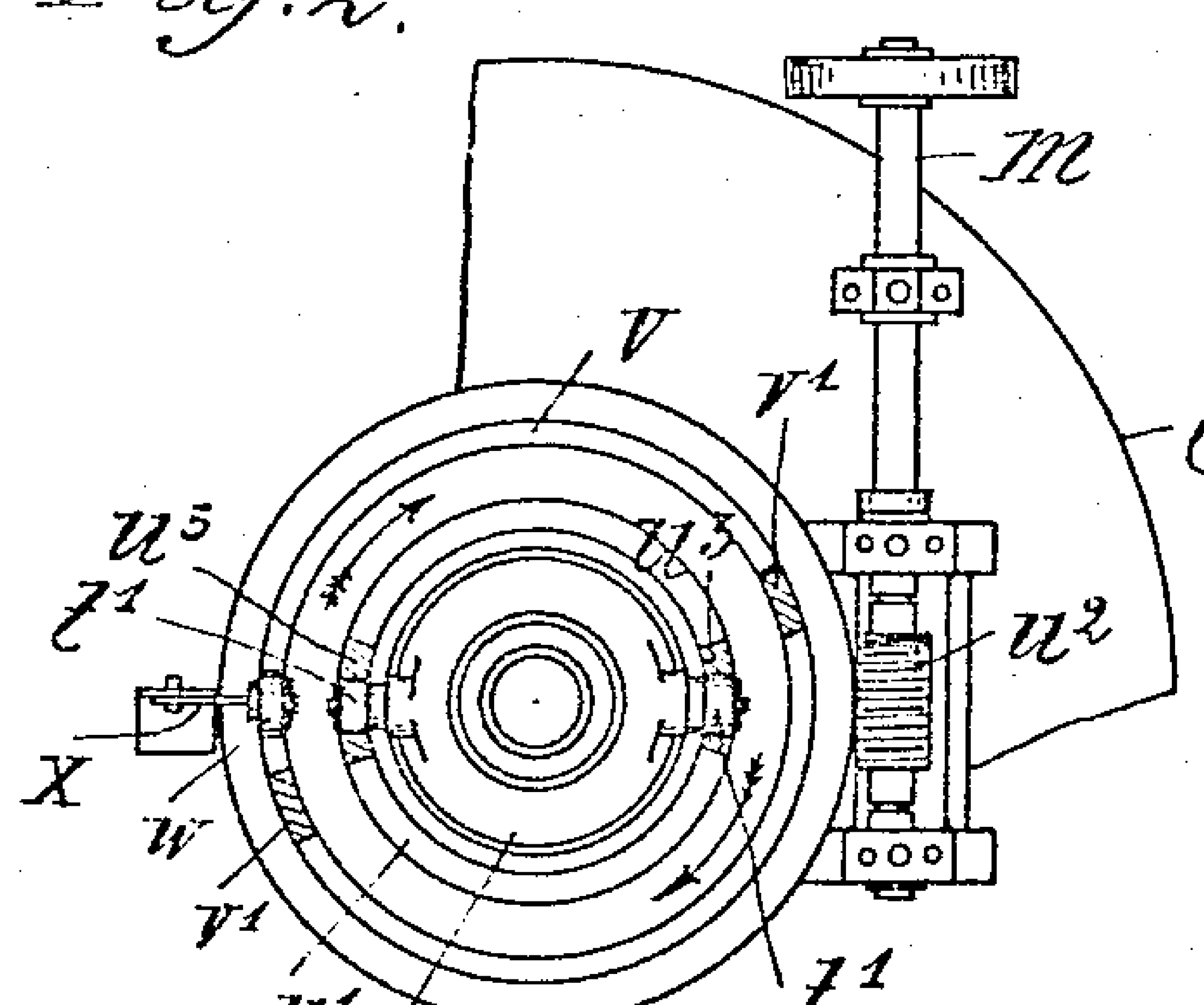


Fig. 9.

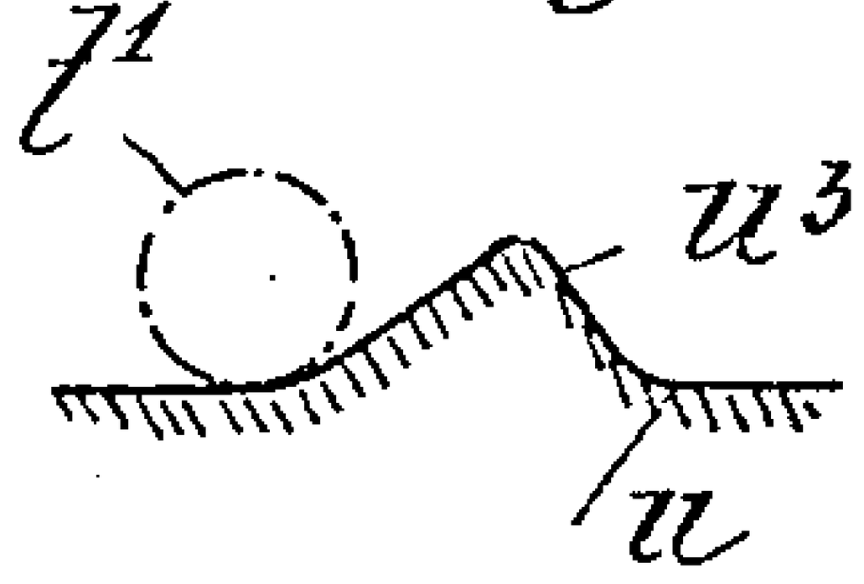
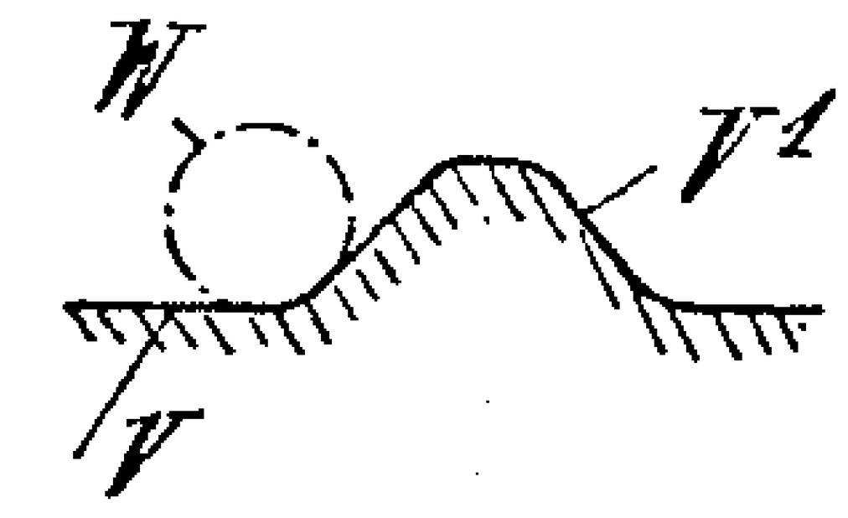


Fig. 10.



Witnesses
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No. 785,818. PATENTED MAR. 28, 1905.

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4 SHEETS—SHEET 2.

Fig. 3.

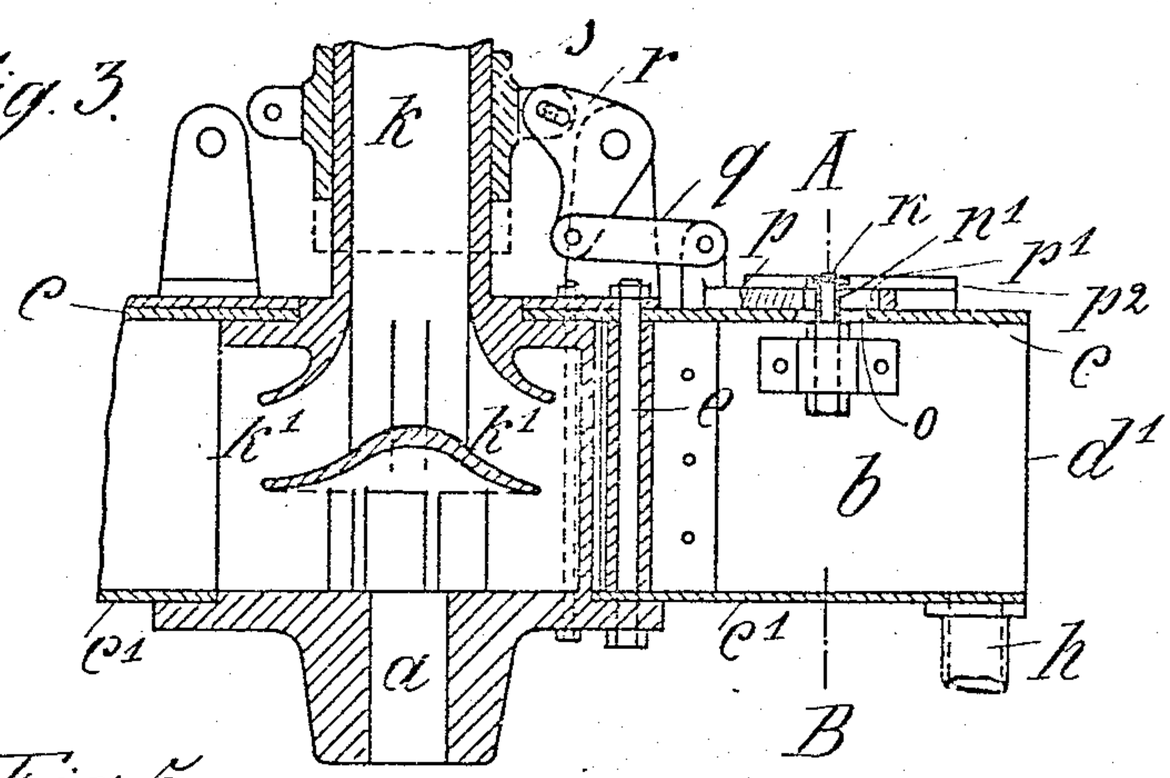


Fig. 5.

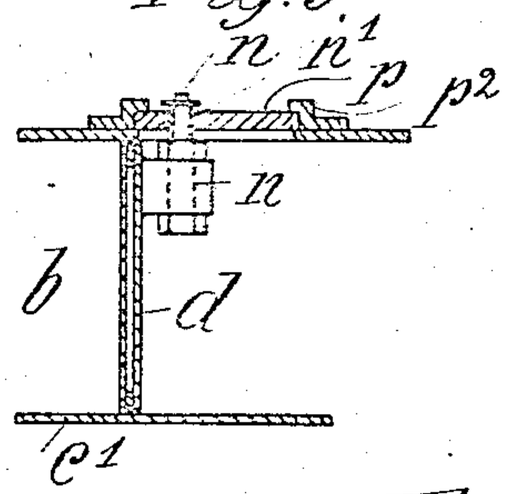


Fig. 4.

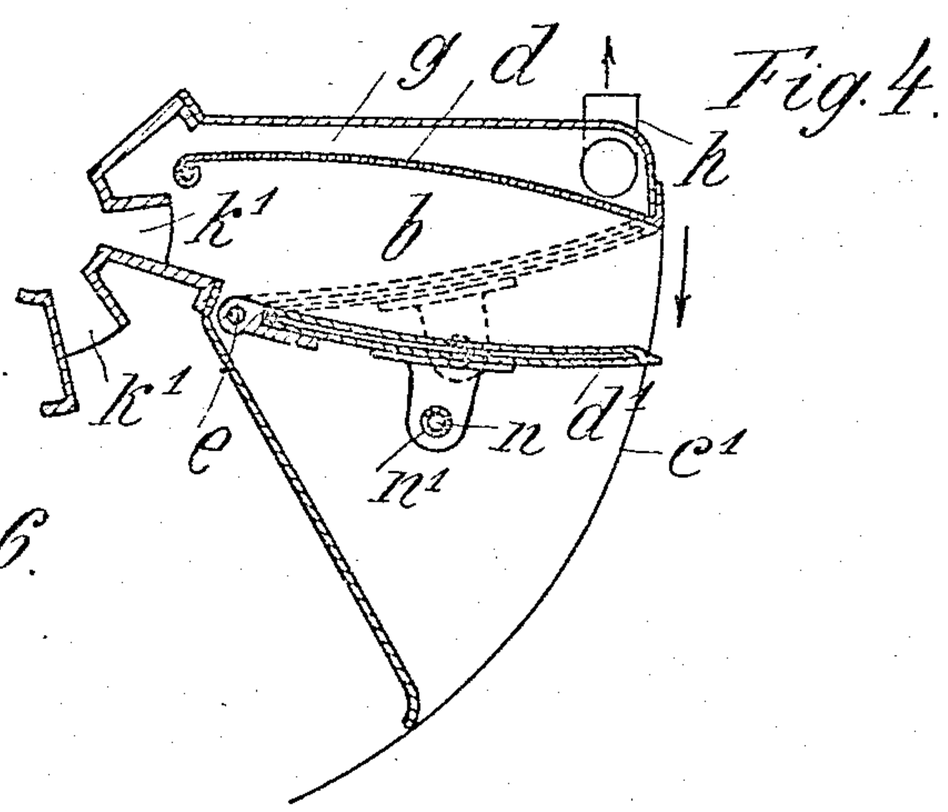


Fig. 6.

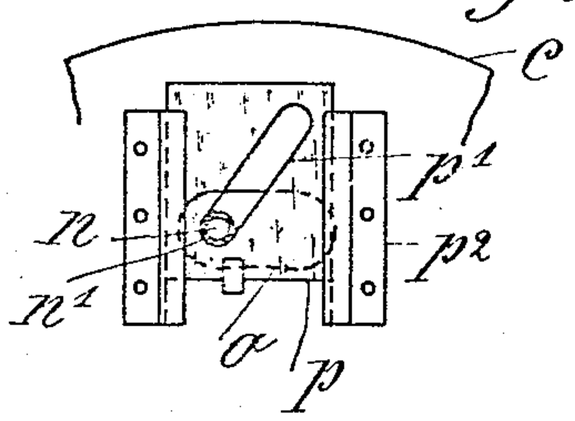
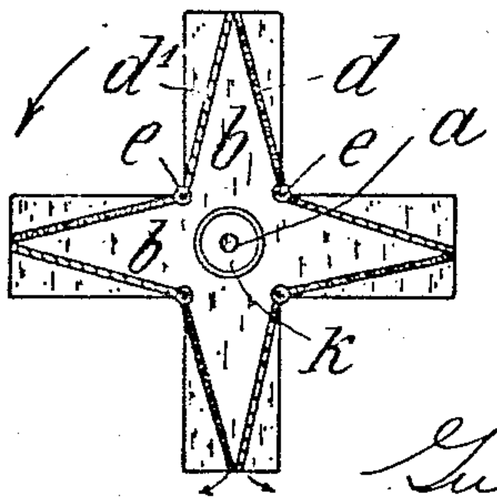


Fig. 7.



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No. 785,818. PATENTED MAR. 28, 1905.

G. TER MEER.

CENTRIFUGAL MACHINE.

APPLICATION FILED MAR. 4, 1904.

4 SHEETS—SHEET 3.

Fig. 13

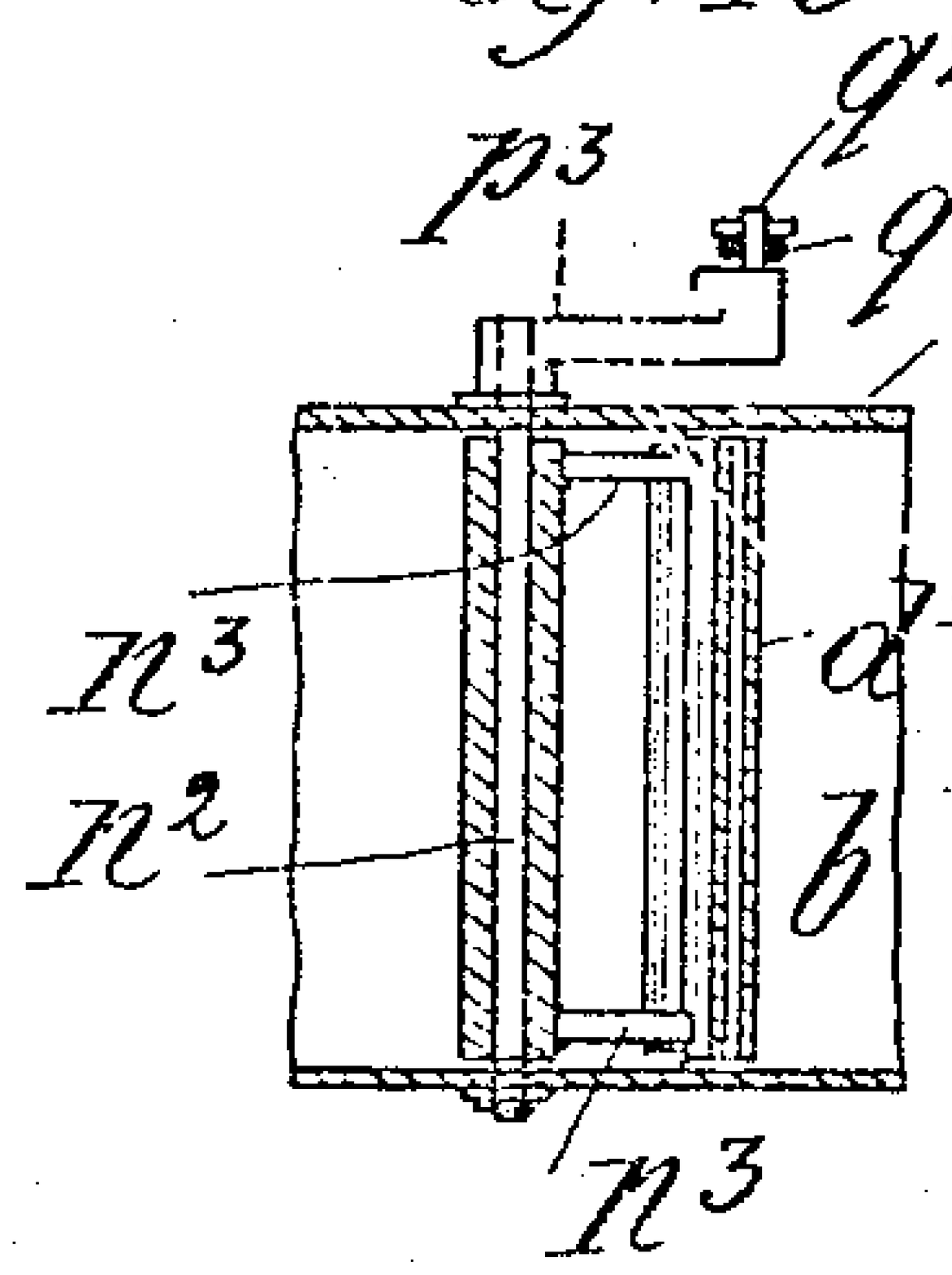


Fig. 11.

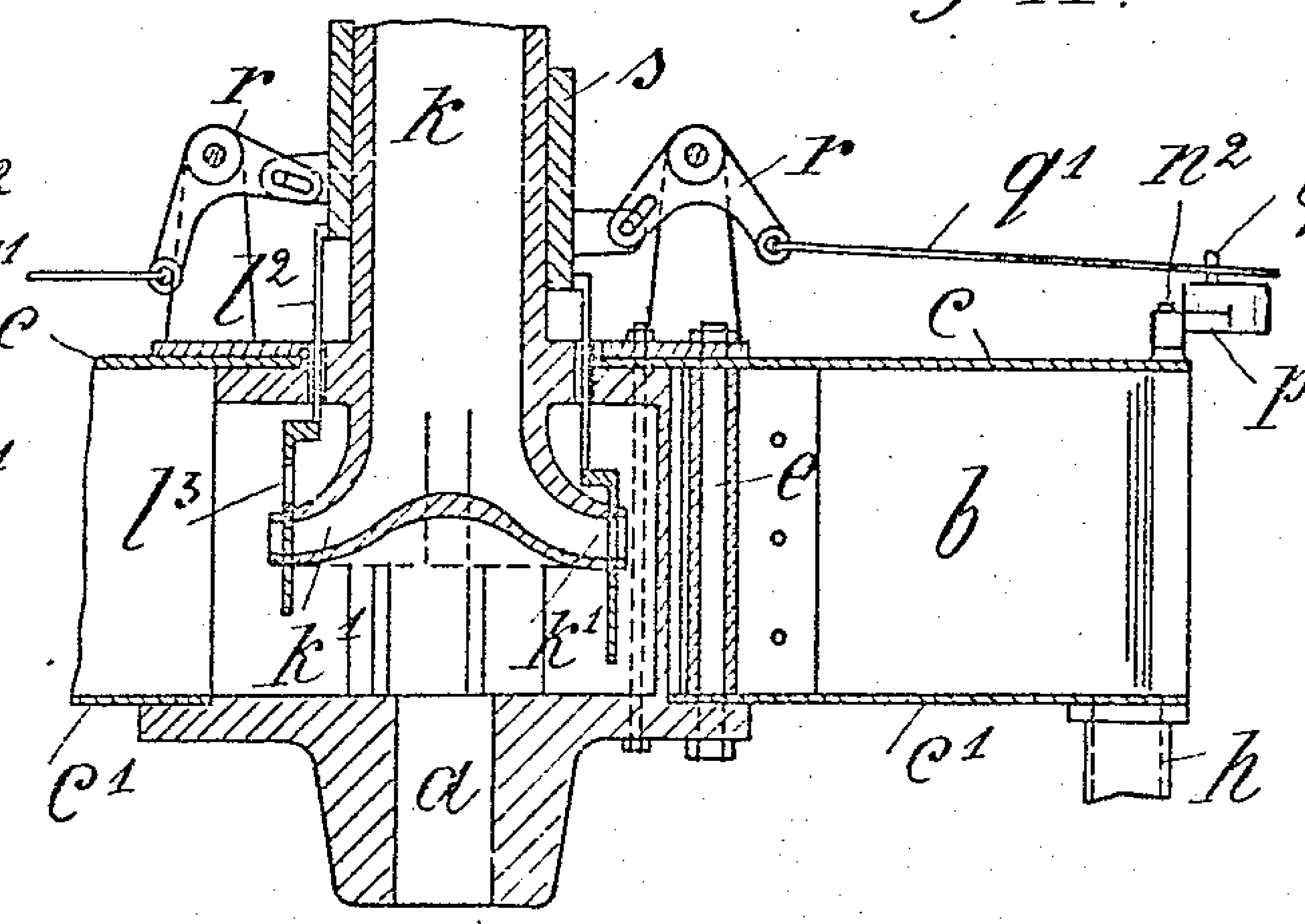
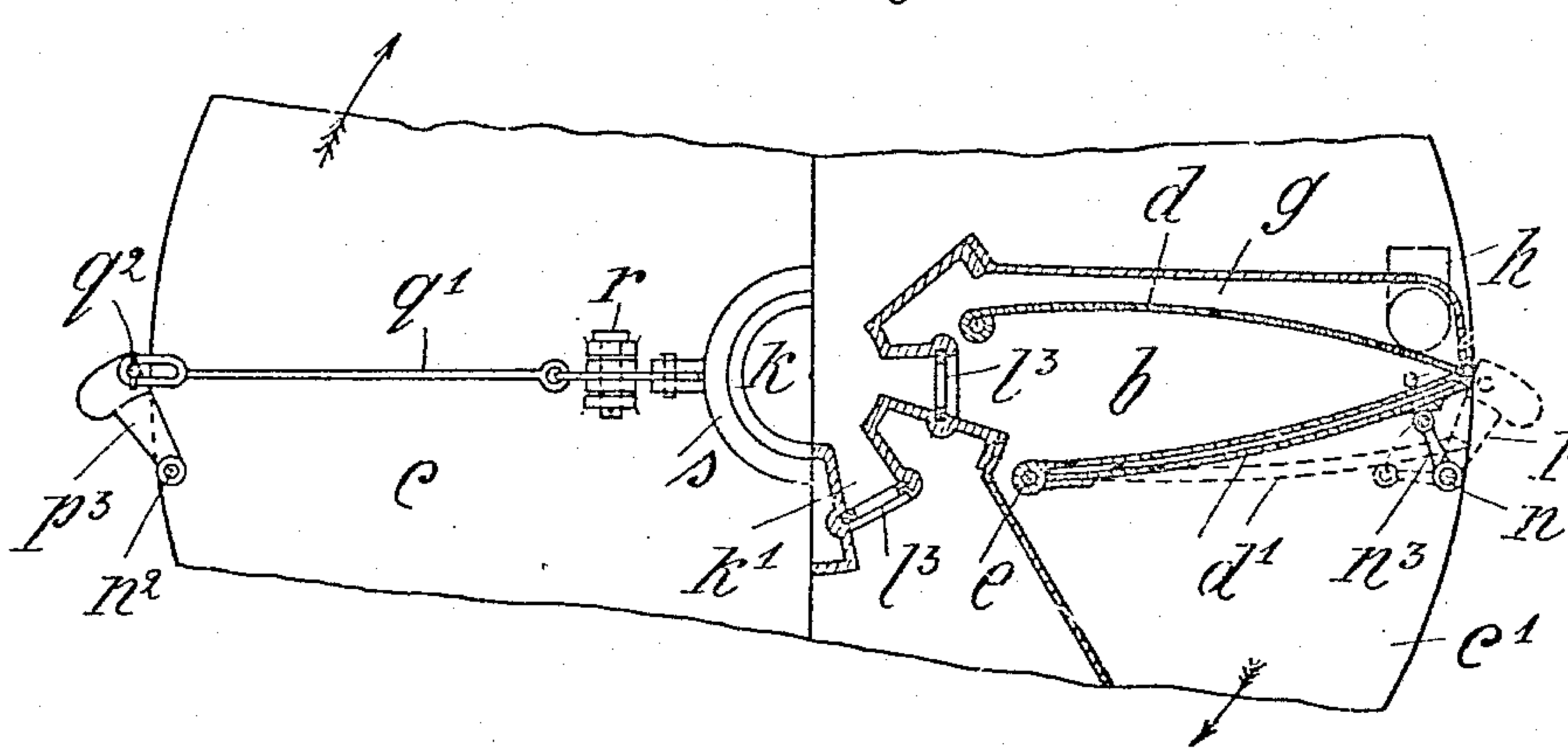


Fig. 12.



Witnesses:

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APPLICATION FILED MAR. 4, 1904.

4 SHEETS—SHEET 4.

Fig. 14.

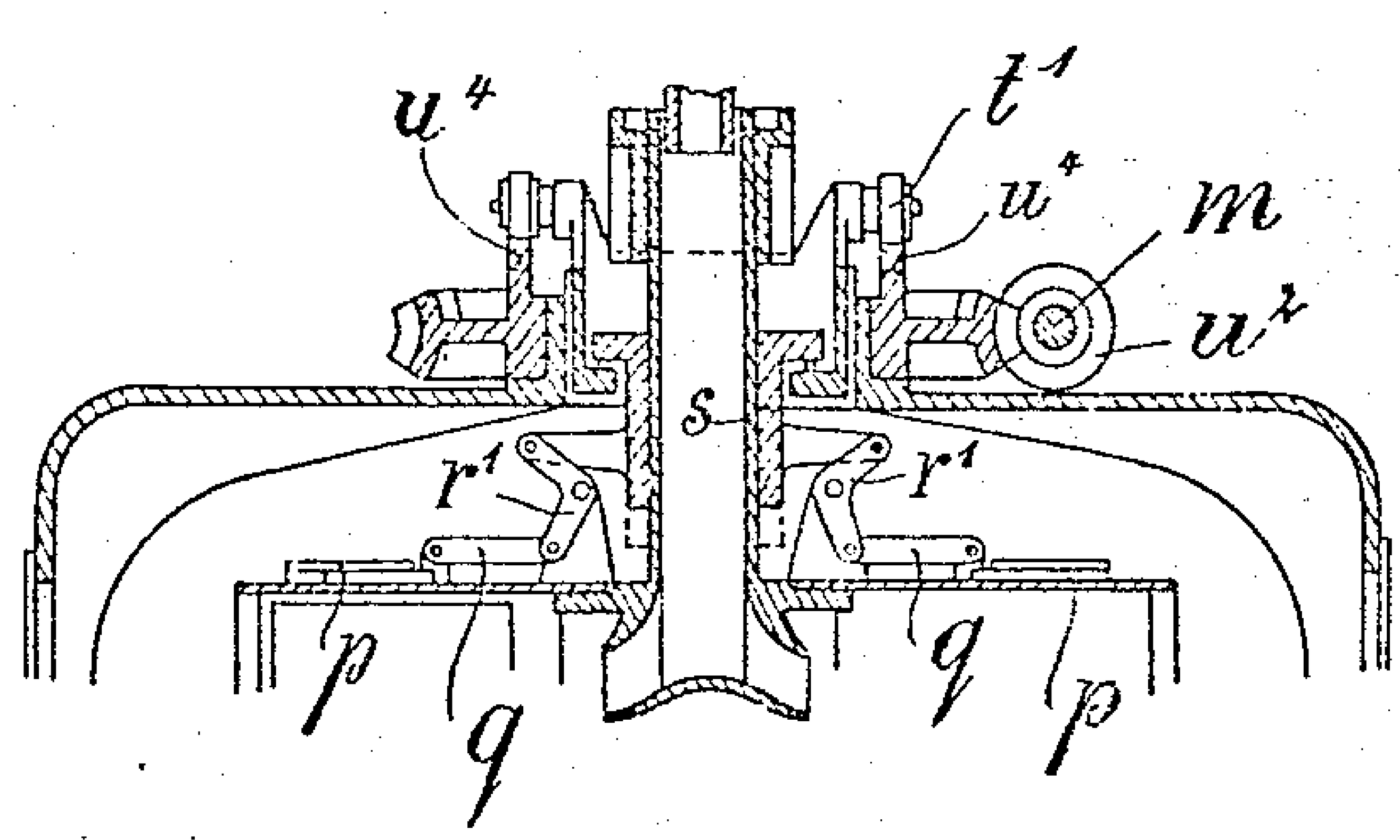
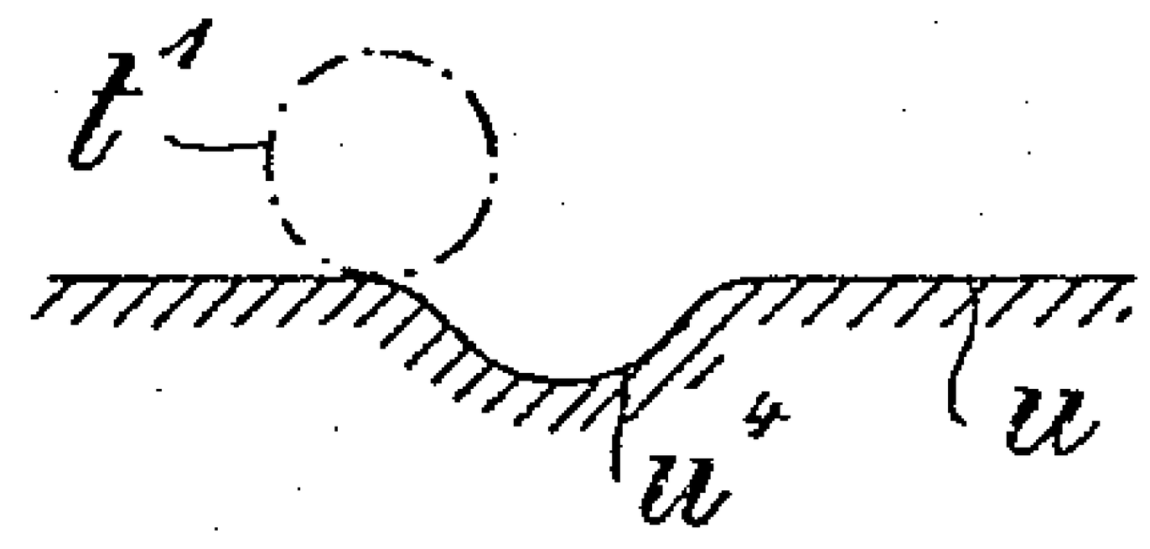


Fig. 15.



Witnesses:

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Inventor:

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By Wm. E. Boulter,

Attorney.

No. 785,818. Patented March 28, 1905.

UNITED STATES PATENT OFFICE.

GUSTAV TER MEER, OF HANOVER, GERMANY.

CENTRIFUGAL MACHINE.

SPECIFICATION forming part of Letters Patent No. 785,818, dated March 28, 1905.

Application filed March 4, 1904. Serial No. 196,589.

To all whom it may concern:

Be it known that I, GUSTAV TER MEER, a subject of the German Emperor, residing at Hanover, Germany, have invented certain new and useful Improvements in or Relating to Centrifugal Machines, of which the following is a specification.

This invention is intended for use in centrifugally drying various materials, more particularly liquid or pasty masses—such as, for instance, town sewage—whereby the drying is effected very efficiently owing to the material being treated not in a single annular, but in several separate, independently-acting centrifugal chambers.

The invention also relates to the automatic regulation of the supply and to the discharge of the above-mentioned specially-arranged chambers during continuous working. While the feeding and the discharge of the solid matter are effected periodically, the liquid separated is continuously and separately discharged.

It is true that suggestions have already been made to use independent chambers; but such proposals relate to centrifugal machines in which no filters are used and in which the discharge of the dried mass takes place in a continuous manner through a narrow slot of constant size. In the centrifugal machine according to this invention, however, the use of filters is an essential feature, the walls of the separate chambers tapering outward in the shape of a wedge, being completely or partially constituted by filter-surfaces. The discharge of the centrifugal machine is effected by a suitable movement of one or more limiting-walls of the chambers or of a portion of a limiting-wall, said movement taking place when the drying process in the chamber in question has been completed.

Examples of the construction according to this invention are given in the accompanying drawings, in which—

Figure 1 is a vertical section through the centrifugal machine; Fig. 2, a partial plan view; Fig. 3, a vertical section, in front elevation, of one part of the machine on an enlarged scale; Fig. 4, a horizontal cross-section through one of the centrifugal chambers; Fig. 5, a vertical section on the line A B of Fig. 3 seen from the left-hand side, and Fig. 6 a corresponding plan view. Fig. 7 is a modification of a centrifugal machine in horizontal section. Figs. 8, 9, and 10 are details. Fig. 11 is a vertical section; and Fig. 12 is a horizontal view, partly in section, of a modified device for charging and discharging the centrifugal chamber. Fig. 13 is a vertical section through the centrifugal chamber, showing a portion of the above-mentioned device. Fig. 14 is a sectional view of a modified form of the chamber-opening mechanism, Fig. 15 being a detail view of a modified form of roller-track.

With special reference to Figs. 1, 3, 4, 7, 11, and 12 the centrifugal chambers *b* are arranged radially about the driving-spindle *a*. *c* is the upper, and *c'* the lower, limiting-wall of the centrifugal chambers *b*. These limiting-walls *c c'* are preferably constituted by two parallel horizontal plates rigidly bolted or secured to the spindle *a*, Figs. 1, 3, 11, and 12. In the construction illustrated in Figs. 1 to 6 the side walls *d d'*, Fig. 4, are curved in order to increase the space of the chambers. One of the side walls *d'* is pivoted about a spindle *e*, Figs. 3 and 4, the fixed but detachable wall *d* constituting a filter. In the construction shown in Fig. 7 both lateral walls *d d'*, converging outward in the shape of a wedge, are hinged by means of hinges *e*, the wall *d* forming a filter-surface. Instead of being radial the centrifugal chambers can be made oblique or tangential. The upper and the lower limiting-walls *c c'* of the chambers can be arranged, of course, at an angle to each other and the lateral walls *d d'* parallel, or all the limiting-walls may be made inclined outward, so as to produce a pyramidal or conical chamber which may be of round, oval, or other cross-section. A special reduction or contraction may be made at the end of the centrifugal chambers nearest to the spindle *a*. The driving-spindle *a* could of course be arranged in a horizontal position. The material to be dried, which is introduced into the separate chambers in the manner hereinafter more fully described, passes, owing to the action of the centrifugal force, into the outer-

most end of the wedge-shaped chambers *b*, the number of which can of course vary, and owing to the combined action of centrifugal force and to the wedge-shaped form is strongly compressed, the liquid being expressed and passing through the filtering or sieve-openings of the chamber-walls. A clogging of the filter-openings cannot take place, as the particles of the material having the greater specific gravity always press outward, while the liquid having smaller specific gravity, which remains behind the heavier particles or is forced back by them, always finds an opportunity for escaping through the free filter-openings, whence it passes to a separate outlet. Owing to the sliding movement which the material treated effects along the filtering-surface, any filter-openings that may have become clogged are cleaned again during the feeding, but chiefly during the discharge of the dried material. As may be seen in Figs. 4 and 12, at the back of the sieve or filtering-walls *d* of the centrifugal chambers is arranged a collecting-chamber *g* for receiving the liquid expressed. This collecting-chamber is provided with a branch *h*, forming a spout under which is provided a draining-chamber *i*, Fig. 1. The separation of the liquid is greatly assisted if the sieve or filter-openings for the passage of the liquid are arranged in the wall of the chamber *b* situated at the rear relatively to the direction of rotation, as shown in Figs. 4, 7, and 12. According to experiments made the escape of the liquid takes place, even when all the walls of the centrifugal chambers are made in the form of sieves, exclusively through the rear wall of the centrifugal chamber relatively to the direction of rotatien, because at that surface or plane there is not only no excess of air-pressure, as at the front plane, but, on the contrary, there is a certain amount of depression or vacuum. The escape of the liquid will therefore be facilitated or greatly assisted by the suction due to the depression of air if the sieve or filter-openings intended for the passage of the liquid are arranged at the back relatively to the direction of rotation of the centrifugal chamber. Filters arranged on the other sides of the centrifugal chambers have only a secondary importance as regards the escape of the liquid. In certain kinds of material to be treated it is, however, advisable to arrange filter-openings of a certain shape in the front walls, because owing to the air entering through these openings the drying is more complete, and no particles of water are held back by the formation of a vacuum at the front wall. The clogging of the filtering-openings, which frequently occurs in the well-known centrifugal machines, does hot occur when the main filtering-surfaces are arranged in the wall of the centrifugal chamber situated at the rear with reference to the direction of rotation, for the following reasons: The process taking place during the separation of liquid goes on in such manner that the first particle of solid material settles in the outermost portion of the chamber. The heaviest particles will settle outside and the lighter liquid inside. As fresh solid particles come in the liquid is forced out as the solid particles settle in the outer portion of the wedge-shaped chamber. The liquid always remaining behind the specifically heavier particles finds an opportunity of escaping at the filtering-surfaces. There is no tendency in this case on the part of the solid particles to pass through the filtering-wall, as owing to the influence of the action of centrifugal force they have the tendency to rush outward in radial direction. On the contrary, the sliding movement executed by the material along the filtering-surface helps to clean any filter-openings that might have become clogged.

The device for the automatic regulation of the discharge or of the feeding of the centrifugal chambers is shown in Figs. 1 to 6 or 8 to 13. At certain time intervals (according to the capacity of the centrifugal machine or to the nature of the material treated) the supply must be interrupted and the centrifugal chambers opened in order to allow the dried material to be discharged by centrifugal force. The supply must be discontinued until the chamber opened has discharged the whole of its contents and been closed again. The above objects are attained by providing a cam action, so that the parts operating the opening and closing devices for the feed and for the centrifugal chamber are only operated at certain definite times. The "dead" movement is limited by projections, recesses, or stops of given size, which limit the time of action of the closing or opening parts.

The introduction of the material is effected through a central chute or pipe *k*, which is provided at the bottom with a number of outlet-branches *k'*, the number of which corresponds to the number of the chambers, said outlets distributing the material to be treated among the various chambers.

The organs for opening and closing of the centrifugal chambers *b* are constituted by the already-mentioned oscillating chamber-walls *d'*. For opening and closing the pipe *k* a cock *l*, Fig. 1, is provided. These parts *d'* and *l* are automatically operated from a continuously-rotating driving-shaft *m* in the following manner, Figs. 1 and 2: The closing part *d'* of the centrifugal chamber *b* is provided with a pin *n*, rigidly secured to it and carrying rollers *n'*, Figs 3 to 6, said pin projecting through a sufficiently-wide opening *o* in the upper wall *c* of the centrifugal chamber and is guided in a slot *p'* of a slide *p*, which is movable in the longitudinal direction of the centrifugal chamber. This slide, guided in guides p^2, is connected by a link *q* with one arm of a bell-crank lever *r*, mounted on the upper chamber-wall *c*, Figs. 1 and 3. The other arm of the bell-

crank lever is connected by pin and slot with a sleeve *s*, adjustable on the inlet-pipe *k*, said sleeve resting with its upper flange, preferably with interposition of balls, Fig. 1, on a non-rotatable but longitudinally-adjustable carrier *t*, Fig. 8, provided at the top with pins for receiving-rollers *t'*. A circular track *u'* for the rollers *t'* is provided on a worm-wheel *u*, Figs. 1 and 2, independently supported below. With the teeth of the worm-wheel *u* engages a worm u^2, secured to the driving-shaft *m*.

The above-mentioned roller-track *u'* is provided at two opposite points with projections u^3. (See also Fig. 9.)

The working of the apparatus is as follows: The worm-wheel *u* is rotated by the driving-shaft *m*, so that the roller-track *u'* rotates under the rollers *t'*. As soon as the projections u^3 arrive within reach of the rollers the latter, as well as the carrier *t*, are raised. As the carrier *t* (see Fig. 8) can only be reciprocated vertically in the stationary centrifugal-machine frame by a vertical spline and groove or the like, it cannot turn, but will raise the sleeve *s*, which rotates together with the centrifugal chamber, and the inlet-conduit *k*, and operate the bell-crank lever *r*, thus causing the slide *p* to move toward the center. Owing to the arrangement of the oblique slot *p'* in the slide *p*, this movement of the slide causes the wall *d'* of the centrifugal chamber, which engages, by means of its pin *n* or roller *n'*, with the oblique slot, to open. Fig. 6 shows the position of the slide before the opening of the chamber-wall, while Figs. 1, 2, 3, and 4 show the position in which the wall *d'* of the centrifugal chamber is opened, and therefore the dried material can be automatically discharged by centrifugal force. During the emptying of the chamber the supply of material to be treated must be interrupted. The part that effects such closing is operated for this purpose in connection with the above-described opening mechanism in the following manner: On the already-mentioned worm-wheel driven from the driving-shaft is another concentric roller-track *v*, which is also provided at two opposite places with projections *v'*, Figs. 2 and 10. Over the roller-track in question is arranged a roller *w*, Figs. 1, 2, 11, supported by an arm of a bell-crank lever *x*, mounted on the centrifugal-machine frame, the other arm of the said lever being connected, by means of a link *y*, Fig. 1, to the lever or handle *l'*, operating the valve *l*. When one of the projections *v'* of the roller-track *v* comes in contact with the roller *w*, the bell-crank lever is caused to move and pulls the lever of the closing-valve *l* to the left-hand side in opposition to the action of a spring *z*, and thus opens the inlet-pipe *k*. According to the width of the projections *v'* on the roller-track *v* (see also Fig. 10) the valve *l* will be maintained open for a longer or shorter period of time, and after the projection *v'* has left it it is returned automatically to its closed position by the action of the spring *z*. The relative position of the rollers *t'* and *w* or of the projections u^3 and *v'* must be such that the roller *w*, which actuates the valve *l*, should not be raised until the centrifugal chamber *b* has been closed—that is to say, until the projections u^3 have passed under the rollers *t'*. On the other hand, the closing of the chambers *b* must be completed before the opening of the valve *l* is started. It follows, therefore, that the projections arranged on the roller-tracks *u'* and *v* must be displaced radially relatively to one another. It is essential that the slide for effecting the opening of the centrifugal chambers should be arranged in such manner that it shall have the tendency, under the influence of centrifugal force acting on it, always to maintain the centrifugal chambers closed. It will be seen that the slide has the tendency, under the influence of centrifugal force, to move away from the spindle—that is to say, automatically to come into the closing position shown in Fig. 6. This action insures that no accidental opening shall take place at an undesirable moment and that if the slide is made of suitable weight the movable wall will be held closed so fast as to prevent the escape or leakage through the closing-joints of the liquid material introduced. According as the worm-wheel is caused to move at a greater or smaller speed automatic feed and discharge will follow each other more or less quickly in a given unit of time. The number of revolutions of the spindle *m* can be regulated for the purpose. The return of the chamber wall *d'* to the closed position takes place automatically under the influence of the weight of the part *t*, which has the tendency always to move down, as well as of centrifugal force, which has the tendency to drive the slide *p* outward. Springs of course could be provided, which would be put in tension on the opening of the chambers and would have the tendency to close them subsequently. Finally, both the opening and the closing of the chambers could be effected in a positive manner by providing, say, a cam that would depress the roller. This form of apparatus is illustrated in Figs. 14 and 15. Recesses u^4 are arranged in a position diametrically opposite to one another on the roller-track *u*, so that the rollers *t'*, and with them the sleeve *s*, sink and the chambers are opened by the movement of the slide operated through the levers *r'* and *g*.

Besides centrifugal force and wedge action the pressure of the material to be treated supplied under pressure could be utilized.

In certain cases it may be required to have either the feed alone or the discharge alone automatic in the manner described.

Instead of a common inlet *k* for the centrifugal chambers separate inlets could be pro-

vided for each chamber, each being accordingly provided with a separate regulating device. Separate closing organs could also be provided in front of the mouths of the inlet branches *k*.

As far as the broad invention is concerned it is of course immaterial what be the shape, kind, arrangement, and number of the parts serving to close and to open the chamber. In the same way instead of the valve shown in the drawing for regulating the feed any other suitable device can be used.

The means for transmitting the driving motion from the driving-shaft *m* to the organs for opening and closing the centrifugal chambers and the supply or feed conduit can of course be any desired.

Instead of the projections u^3 v' suitable recesses could of course be used. In the same way the parts driven from the driving-shaft could be provided with stops, tappets, and the like of any desired kind, which could actuate at the desired moments the parts operating the closing parts.

A modification is shown in Figs. 11, 12, and 13. This modification relates to the means for opening and closing the centrifugal chambers *b* or the inlet *k* and its operation. To move the centrifugal-chamber wall *d'*, which is capable of oscillation, levers n^3, carrying rollers, are provided. The roller bears against the whole height of the wall *d'*, so that a uniform pressure is exerted against this wall. The lever or frame n^3 is rigidly connected to a pivot n^2, which is journaled in the upper and lower chamber cover *c c'*. Rigidly secured to an extension of the pivot n^2, projecting beyond the upper-chamber wall *c*, is a lever p^3, which at its end is provided with a weight. A pivot or pin q^2 on this lever extends into a slot in a rod *q'*, the other end of which is connected to a bell-crank lever *r*, which is attached to the slide *s*, as in the construction shown in Figs. 1, 2, and 3. This slide *s* is operated in a similar manner to that in the above-mentioned construction. The mechanism for opening and closing the inlet *k* in the present modified construction is arranged in front of the inlet-openings *k'* and is constituted by a slide l^3, directly connected by a rod l^2 with the sleeve *s*. The operation is as follows: The slide l^3 being open, (Figs. 11 and 12, on the right,) one end of the slot of the link *q'* bears against the pivot q^2 of the lever p^3. Consequently the frame n^3 bears against the chamber-wall *d'* along the whole height of the wall. Owing to the action of centrifugal force, the weight arranged at the free end of the lever p^3 acts to the same end. If, however, the sliding sleeve *s* is raised in consequence of the projection u^3, already described, Fig. 2, the slide l^3 is first drawn up and closed, (Figs. 11 and 12, on the left,) while the chamber-wall *d'* remains closed, owing to the play allowed by the slot in the link *q'*. On further raising the sleeve *s* it carries with it the pivot q^2, and consequently actuates the lever p^3 and the frame n^3, so that the chamber-wall is opened under the influence of centrifugal force upon the contents of the chamber. The slide l^3, however, remains closed during this time, owing to its being provided with a downward extension. The arrangement of the closing mechanism l^3 immediately before the opening *k'* has the advantage that in case the mass to be treated is supplied under pressure this pressure is caused to act fully on the material in the centrifugal chamber, whereby the centrifugal action is supported.

Suitable devices are provided for collecting and conveying away the material dried as well as the liquid expelled.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A centrifugal machine comprising a series of wedge-shaped chambers, one at least of the lateral walls of each chamber being formed of a pivoted plate and one at least of said walls having a sieve-surface, in combination with means for opening said chambers while the machine is running, substantially as set forth.

2. A centrifugal machine comprising a series of wedge-shaped chambers, the lateral walls of each chamber being formed of one fixed plate and one pivoted plate, one at least of said plates having a sieve-surface, in combination with means for operating the pivoted plate, substantially as set forth.

3. A centrifugal machine comprising a radially-compartmented drum, an expansible filter-wall chamber within each compartment and a liquid collecting and discharge space outside each of said chambers and within its respective compartment, substantially as set forth.

4. A centrifugal machine comprising a series of radial compartments, an expansible filter-chamber within each compartment, said chamber having a fixed perforated lateral rear wall, substantially as set forth.

5. A centrifugal machine comprising a series of radial compartments, a filter-chamber within each compartment and a movable wall for each of said chambers, in combination with automatic means for cutting off supplies of liquid to said chambers and for opening the same, substantially as set forth.

6. A centrifugal machine comprising a series of radial compartments, an expansible filter-chamber within each of said compartments, a central liquid-supply tube, a vertically-movable sleeve around said supply-tube combined with mechanism for simultaneously cutting off the central liquid-supply and opening said expansible filter-chamber substantially as set forth.

7. A centrifugal machine comprising a series of radial compartments, an expansible filter-chamber within each compartment, a central liquid-supply tube, automatic means for periodically cutting off the central liquid-supply and automatic means for simultaneously opening the expansible chambers comprising a rotatory cam-device, a vertically-movable central sleeve, a lever-arm q' operated from said sleeve and a slide and pin operating the movable wall of each expansible chamber, substantially as set forth.

8. In a centrifugal machine of the kind described, expansible filter-chambers, supply-pipes for said chambers, a worm-wheel, a wheel-disk operating said chambers and controlling said supply-pipes, and circular cam-tracks on said disk, in combination with mechanism for opening and closing the liquid-supply pipes and expansible filter-chambers respectively from said tracks, substantially as set forth.

9. In a centrifugal machine of the kind described, expansible filter-chambers, supply-pipes for said chambers, a worm-wheel, a wheel-disk operating said chambers and controlling said supply-pipes, circular cam-tracks on said disk and mechanism for opening and closing the liquid-supply pipes and expansible filter-chambers, in combination with a hand-operated cam-disk-adjusting worm, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GUSTAV TER MEER.

Witnesses:
LEONORE RASCH,
H. HALL HALL.