6 Sheets—Sheet 1.

A. DREVERMANN.

Filter-Press.

No. 215,108. Patented May 6, 1879.

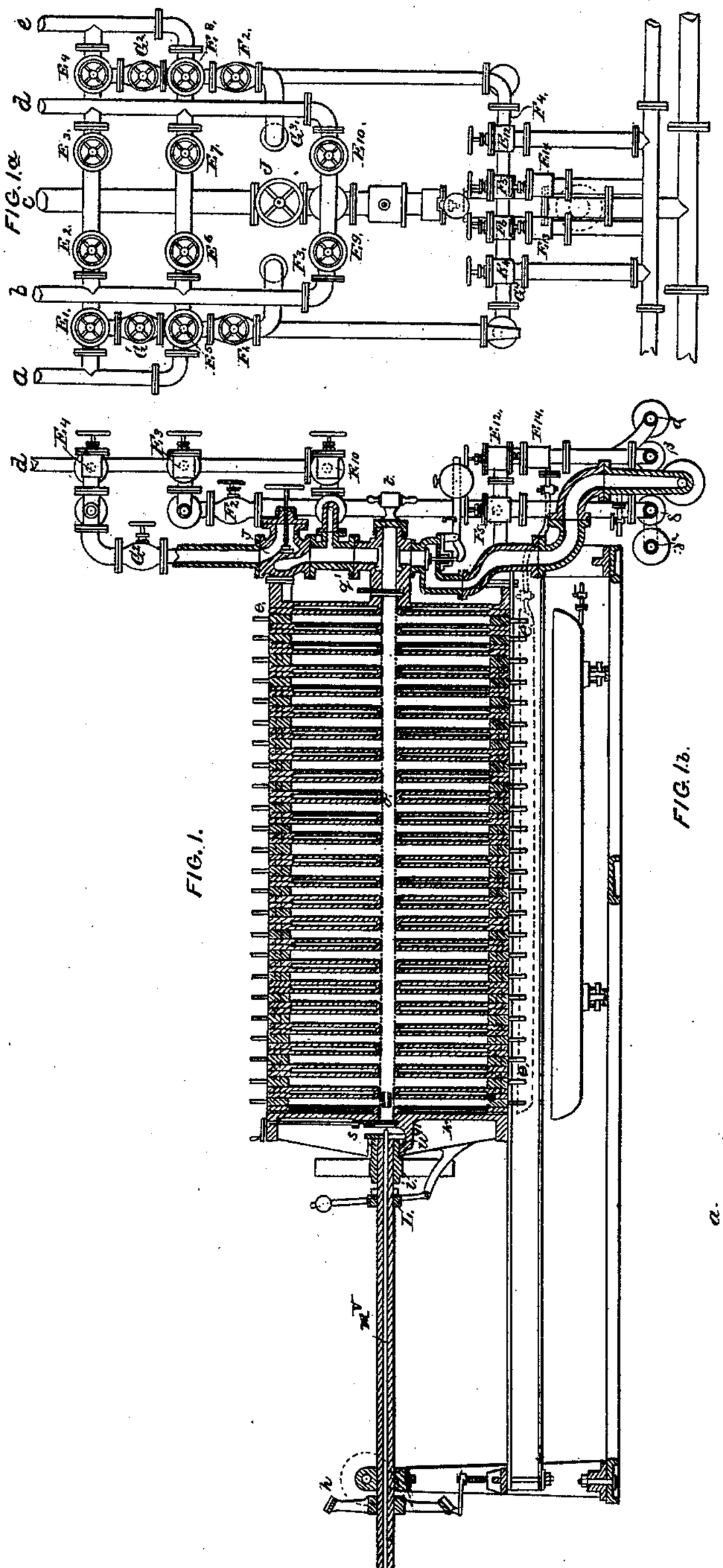

FIG. 1.

FIG. 1a.

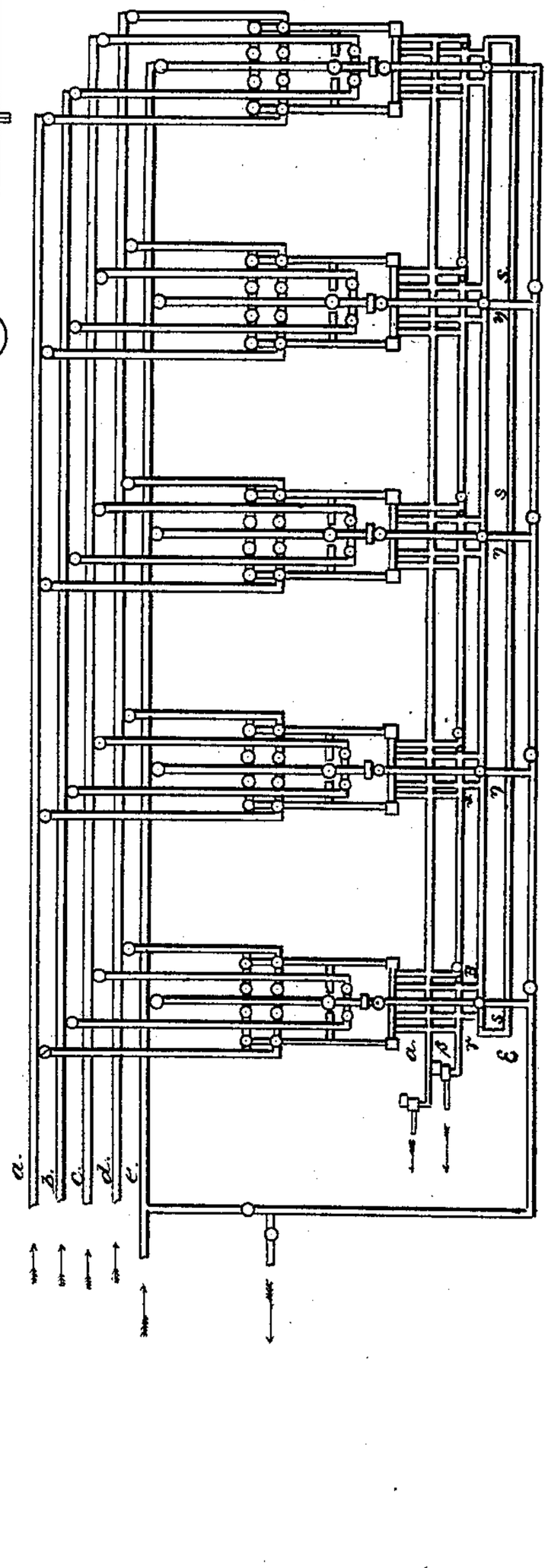

FIG. 1b.

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A. DREVERMANN.

Filter-Press.

No. 215,108. Patented May 6, 1879.

FIG. 38.

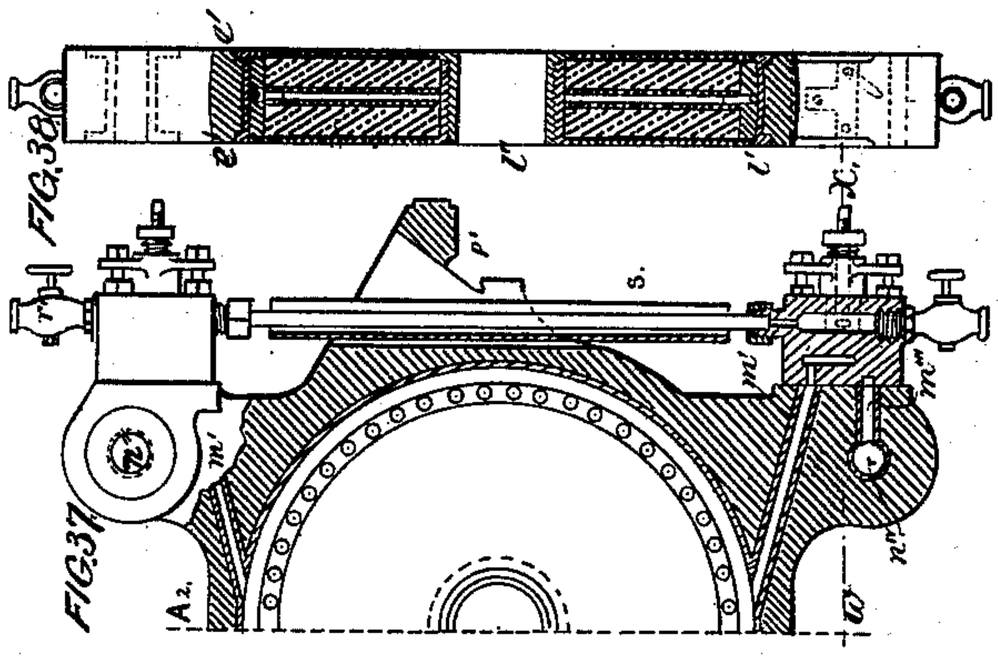


FIG. 39.

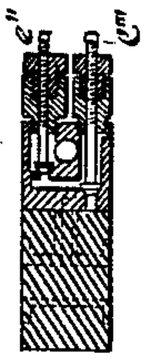


FIG. 37.

FIG. 33.

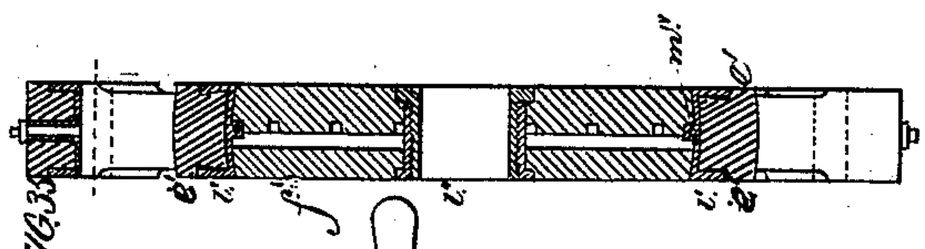


FIG. 3.

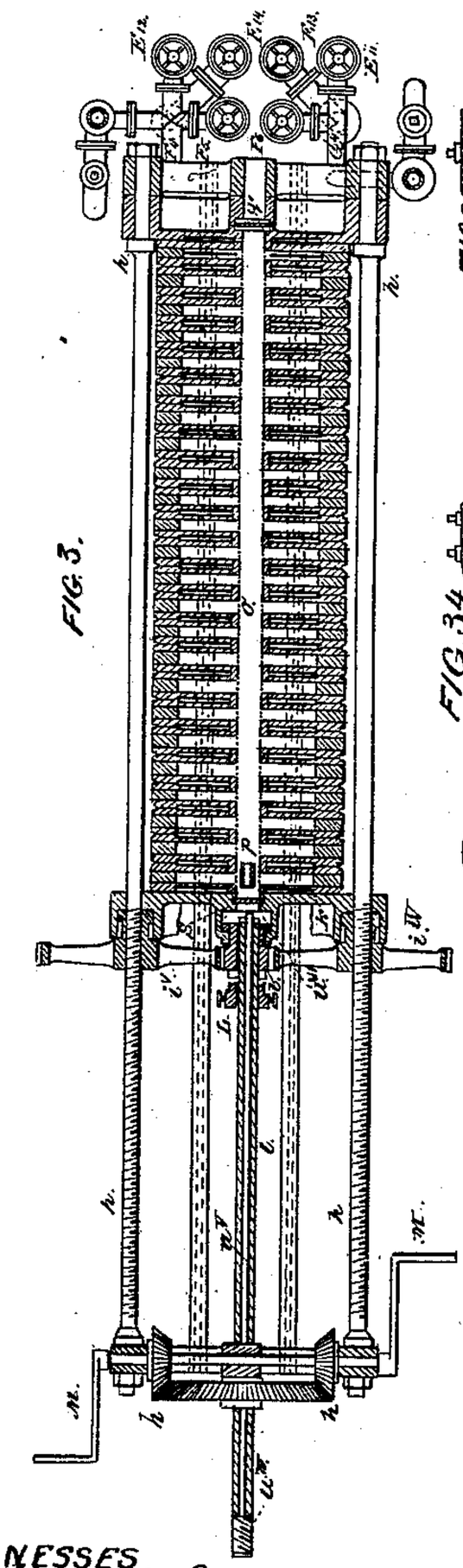


FIG. 34.

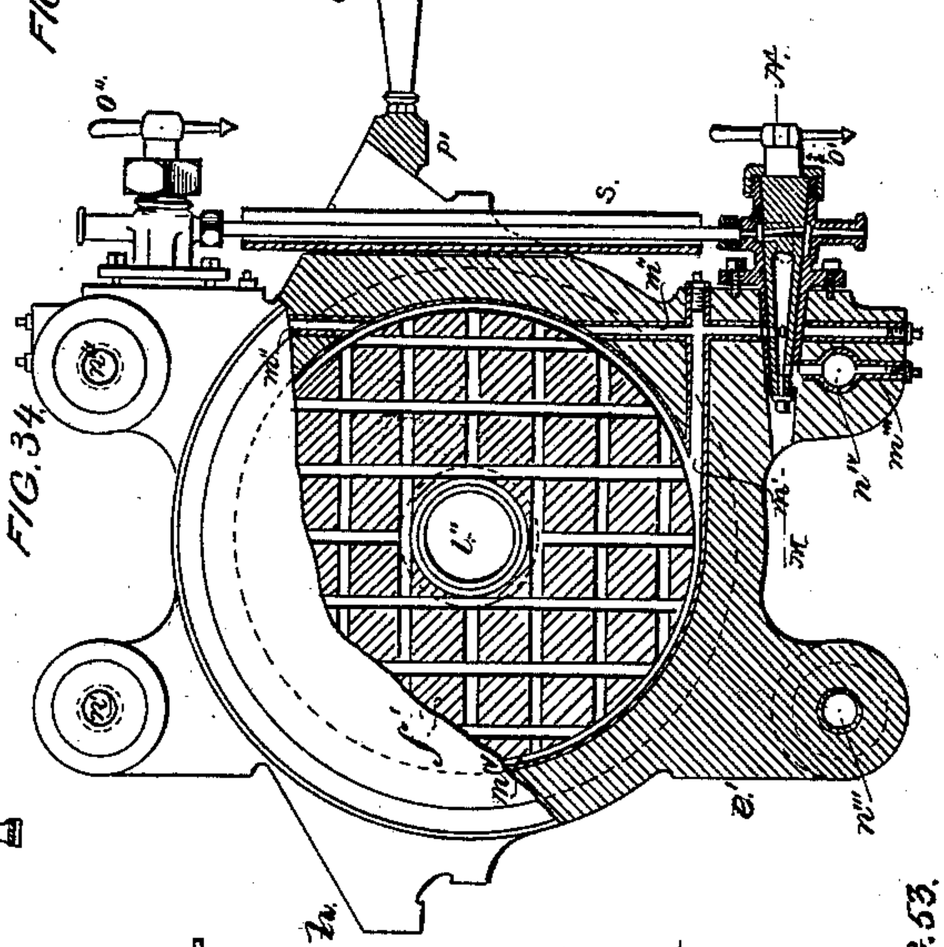


FIG. 36.

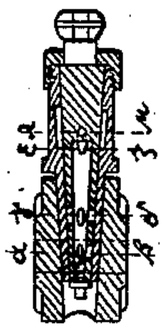


FIG. 2.

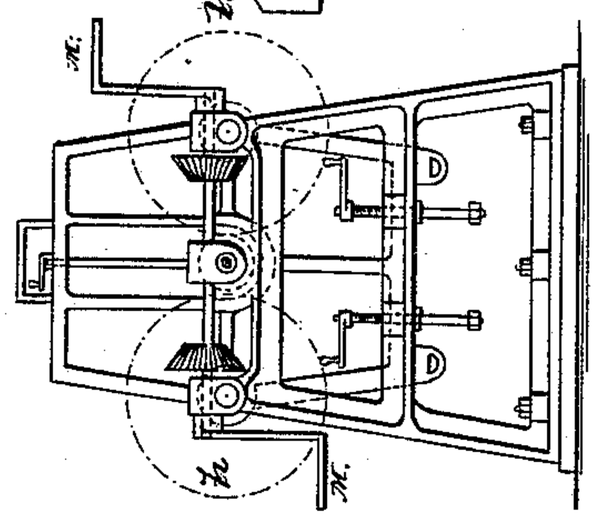
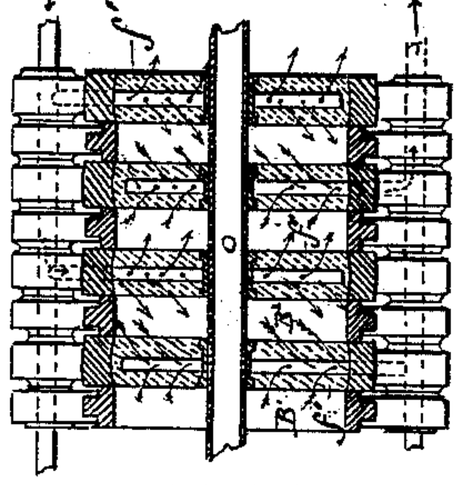


FIG. 53.



WITNESSES.

Aug. P. Jordan

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A. DREVERMANN.

Filter-Press.

No. 215,108. Patented May 6, 1879.

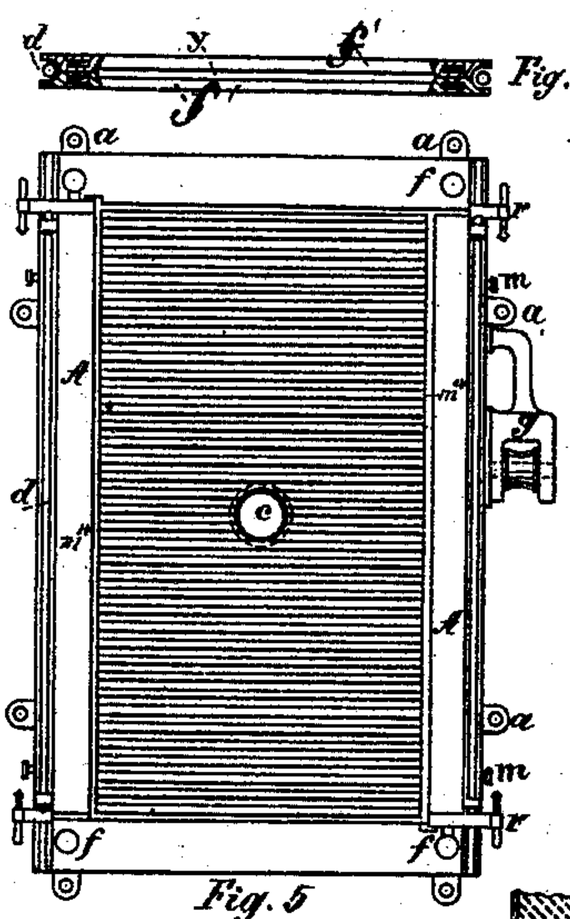
Fig. 5

Fig. 4


Fig. 6

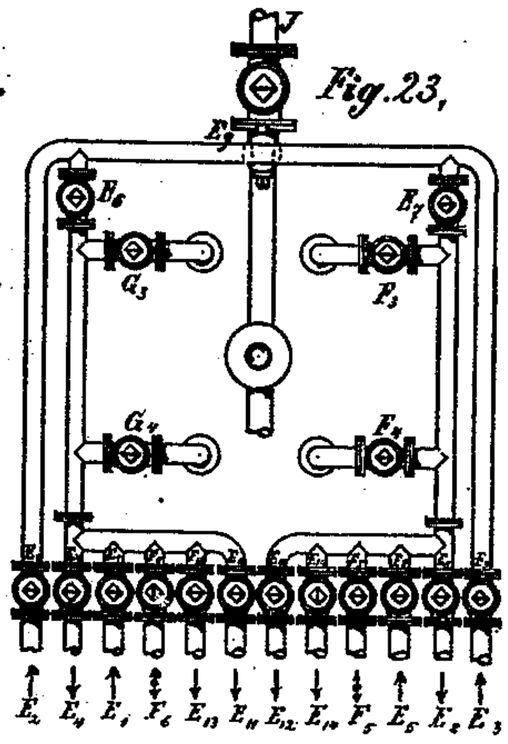
Fig. 23,

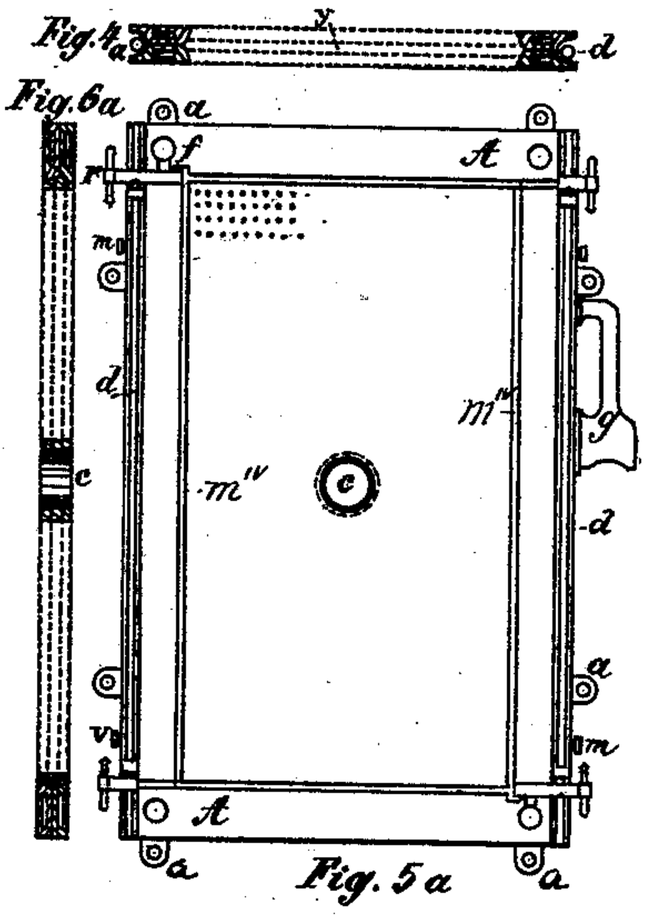
Fig. 5a

Fig. 4a

Fig. 6a

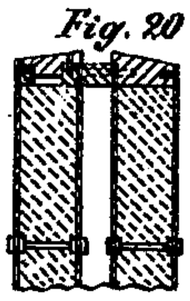
Fig. 20

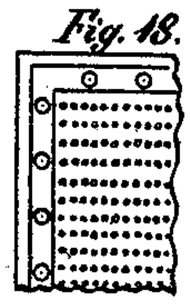
Fig. 18.

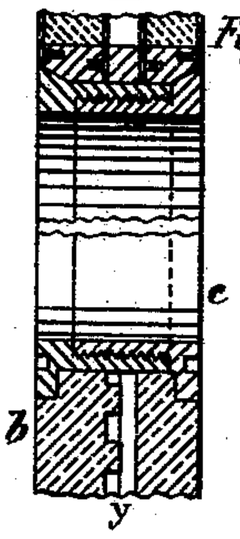
Fig. 21

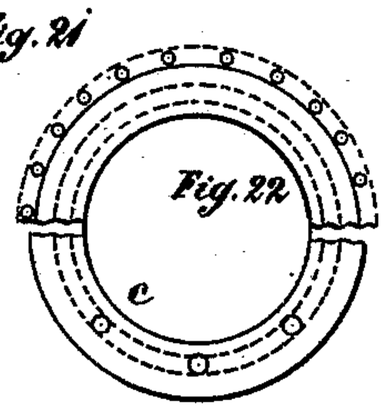
Fig. 22


Fig. 15


Fig. 14

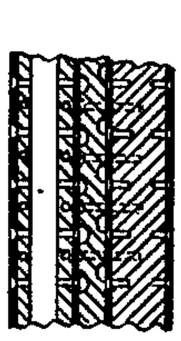
Fig. 19


Fig. 16


Fig. 17


Fig. 10

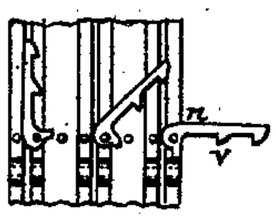
Fig. 11

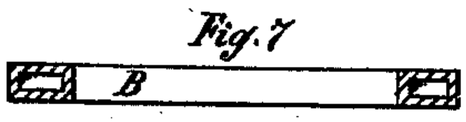
Fig. 7

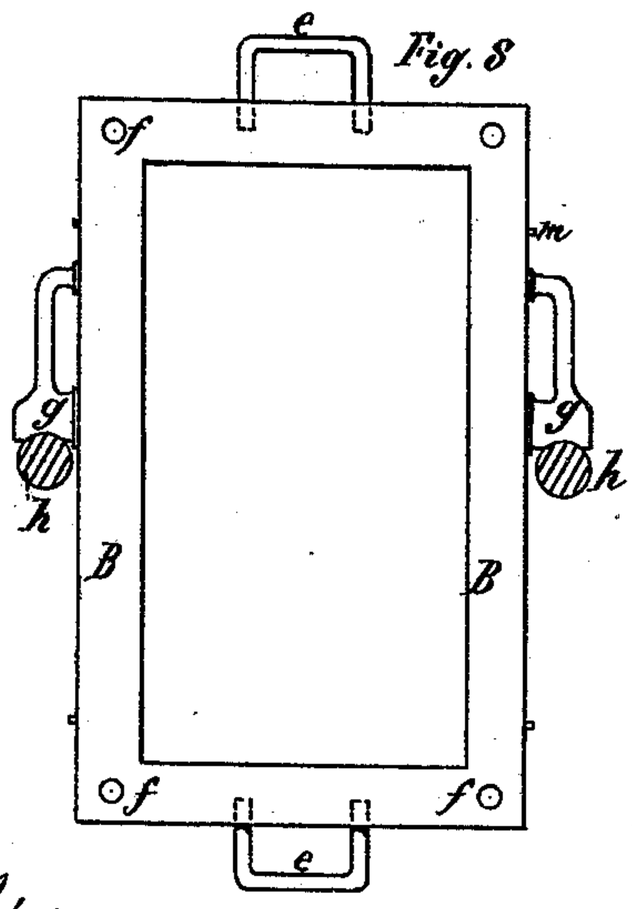
Fig. 8

Fig. 9

Fig. 12

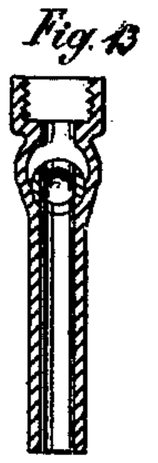
Fig. 13

Witnesses { W. C. Corlies, Jno. C. MacGregor.

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August Drevermann
By Edmund Thacher
Attorneys

6 Sheets—Sheet 4.

A. DREVERMANN.

Filter-Press.

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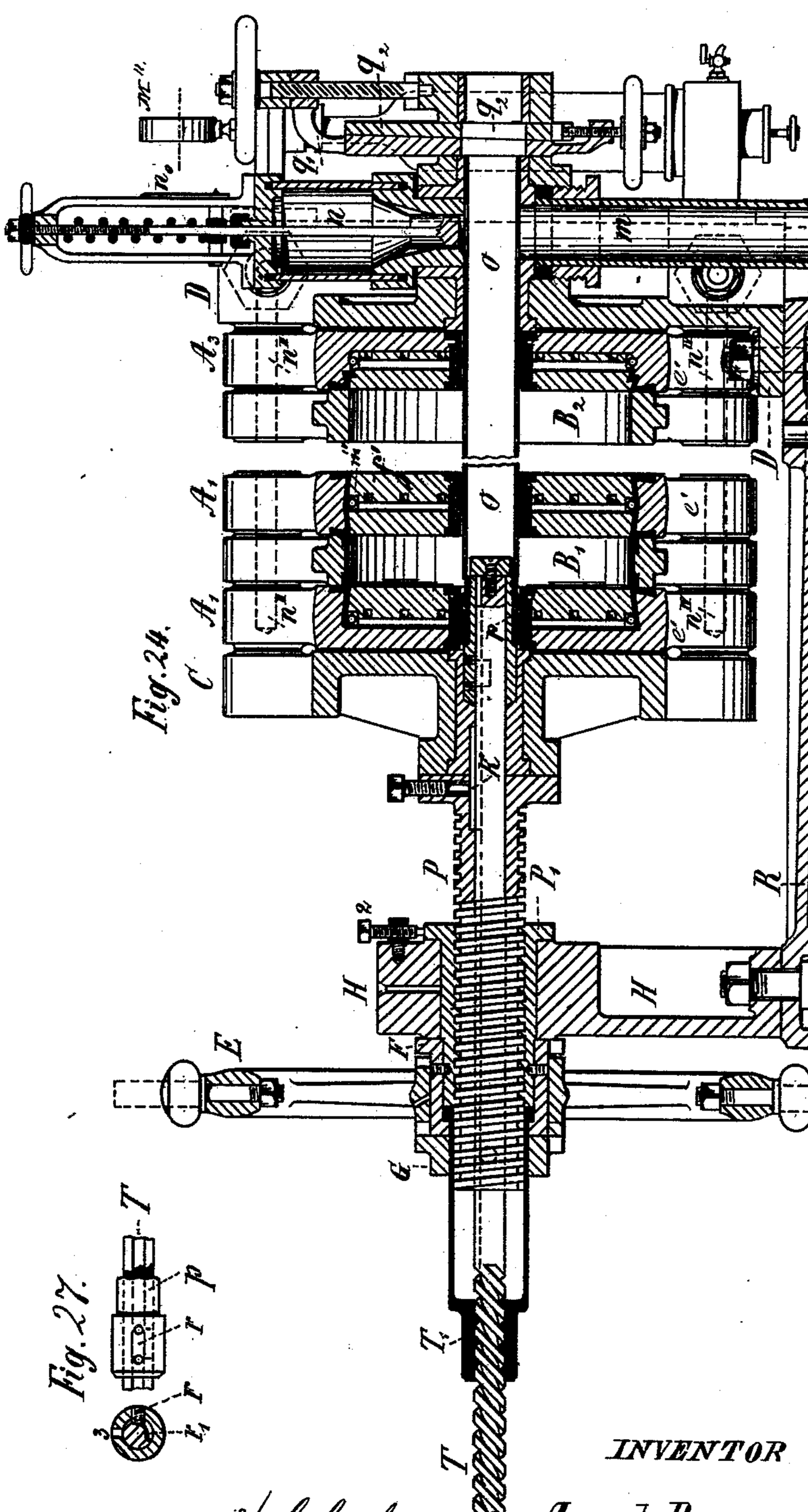

Fig. 24.

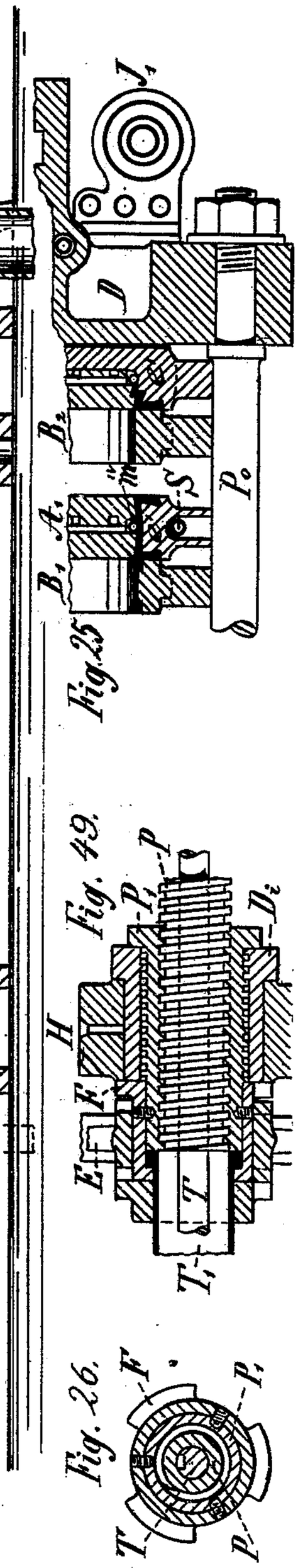

Fig. 25.

Fig. 27.

Fig. 49.

Fig. 26.

INVENTOR

August Drevermann

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By Johnson & Thacher Attorneys

6 Sheets—Sheet 5.

A. DREVERMANN.

Filter-Press.

No. 215,108. Patented May 6, 1879.

Fig. 48.

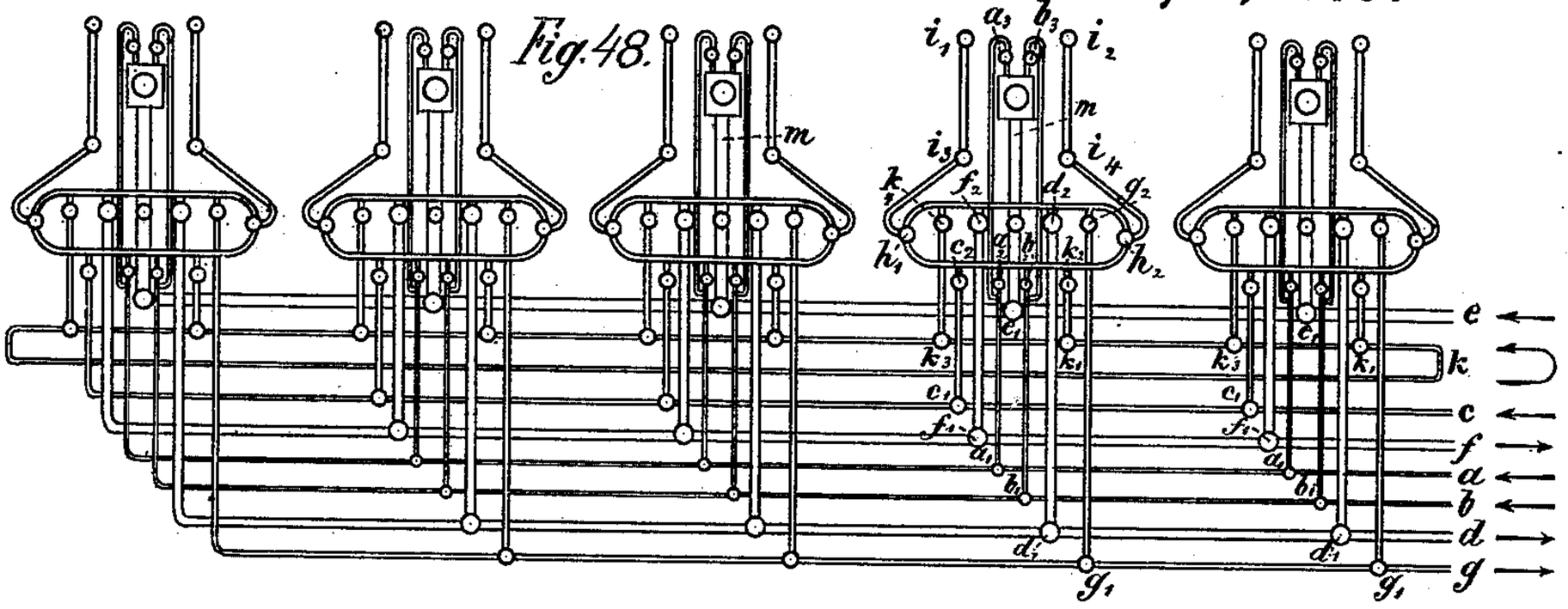


Fig. 28.

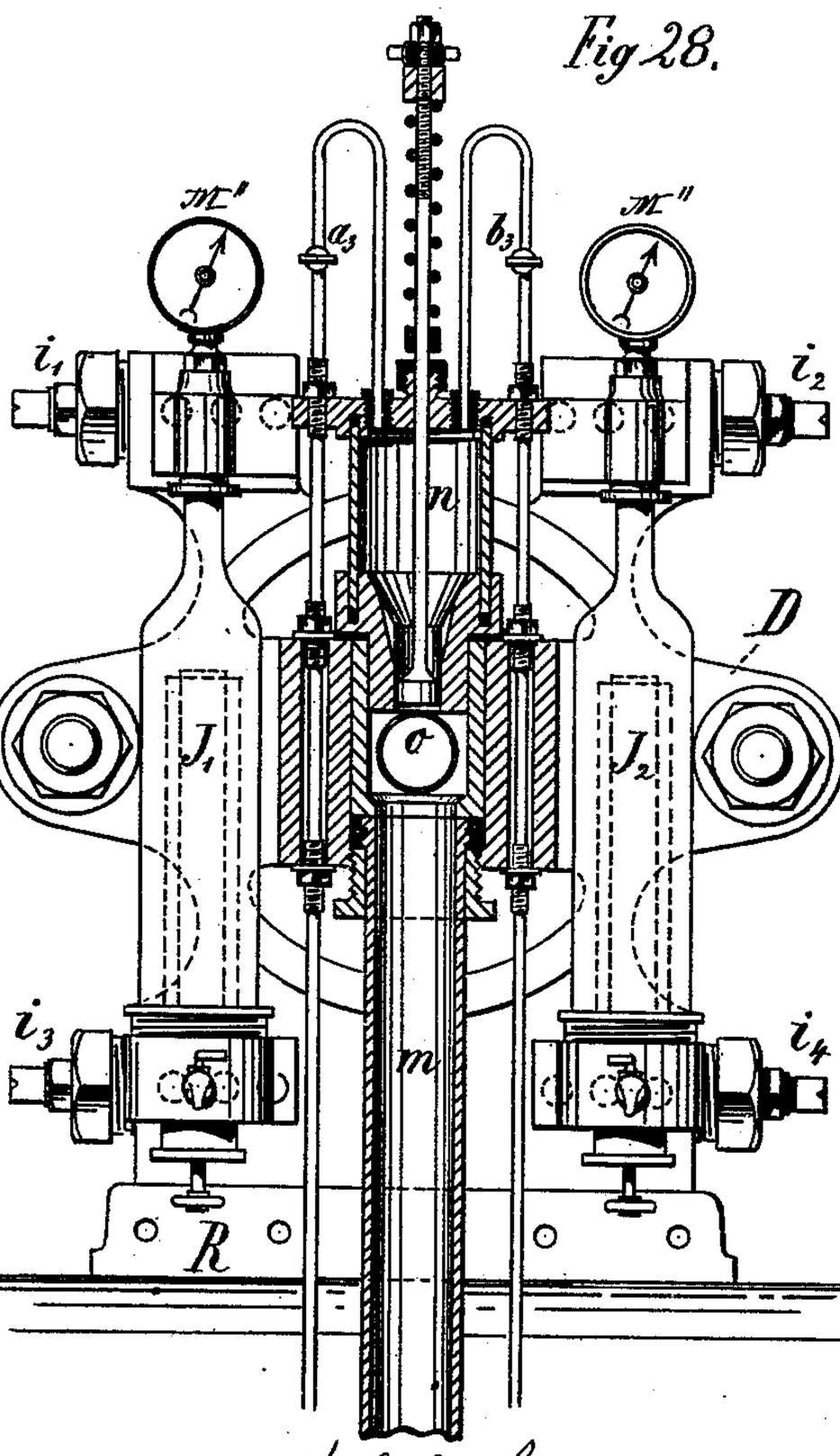


Fig. 29.

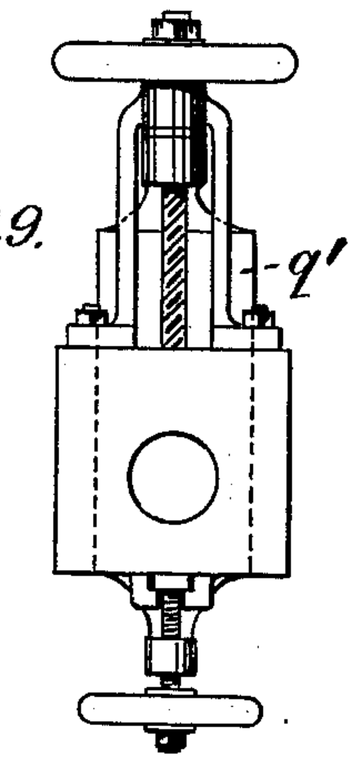
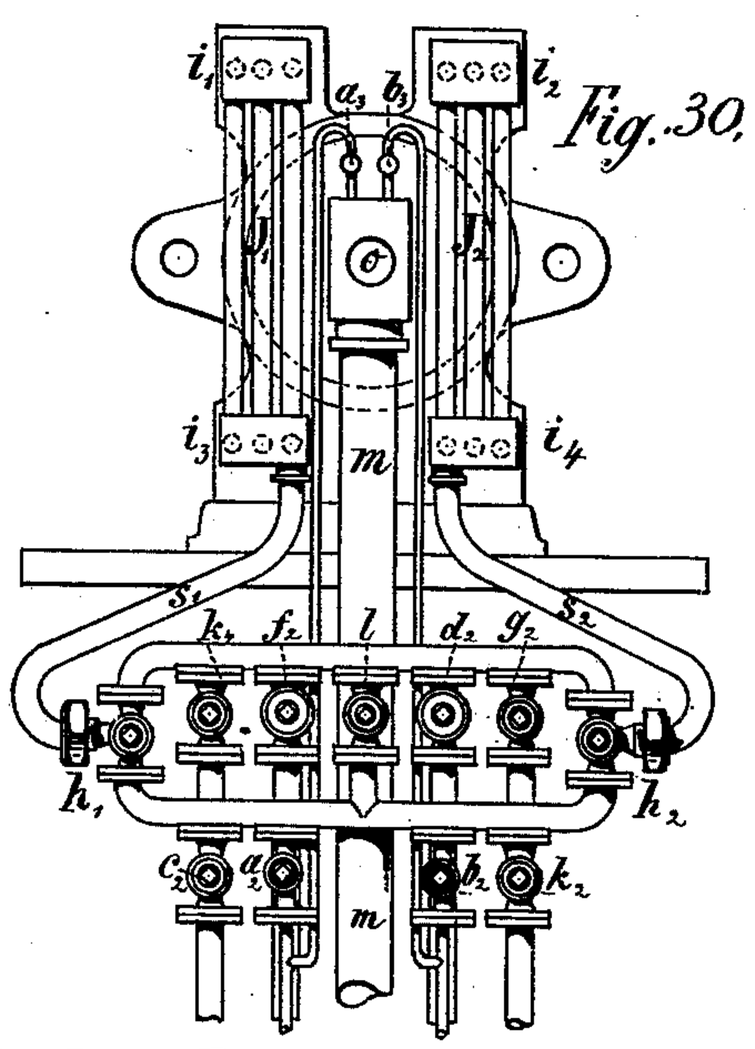


Fig. 30.



Witnesses { W. C. Coles, Jno. C. MacGregor }

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By Church & Church Attorneys

6 Sheets—Sheet 6.

A. DREVERMANN.

Filter-Press.

No. 215,108. Patented May 6, 1879.

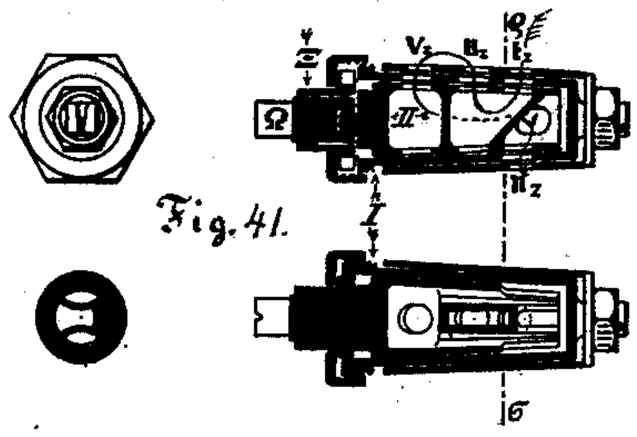

Fig. 41.

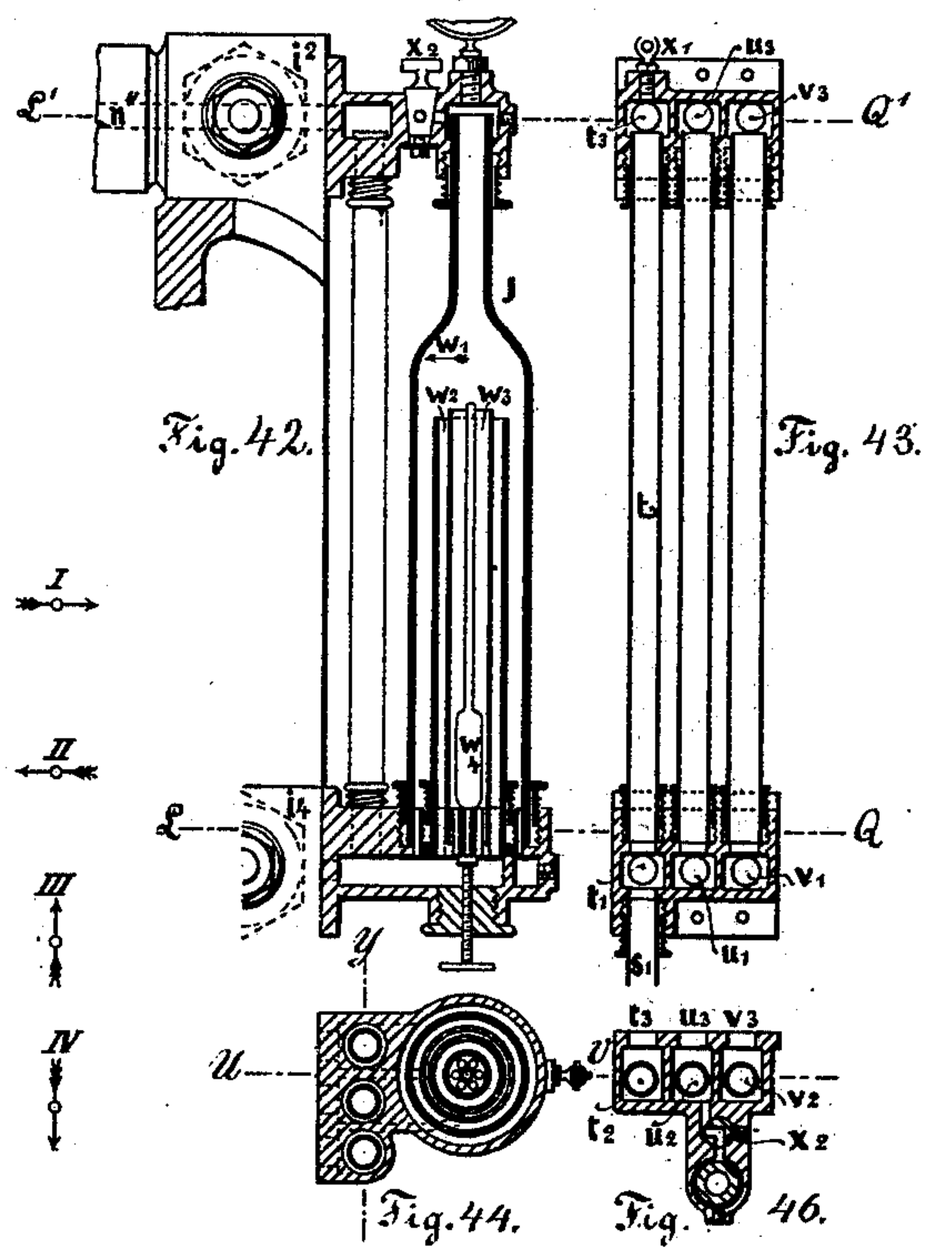

Fig. 42.

Fig. 43.

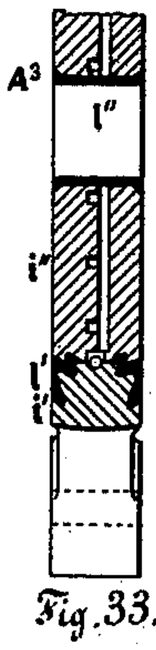

Fig. 33.

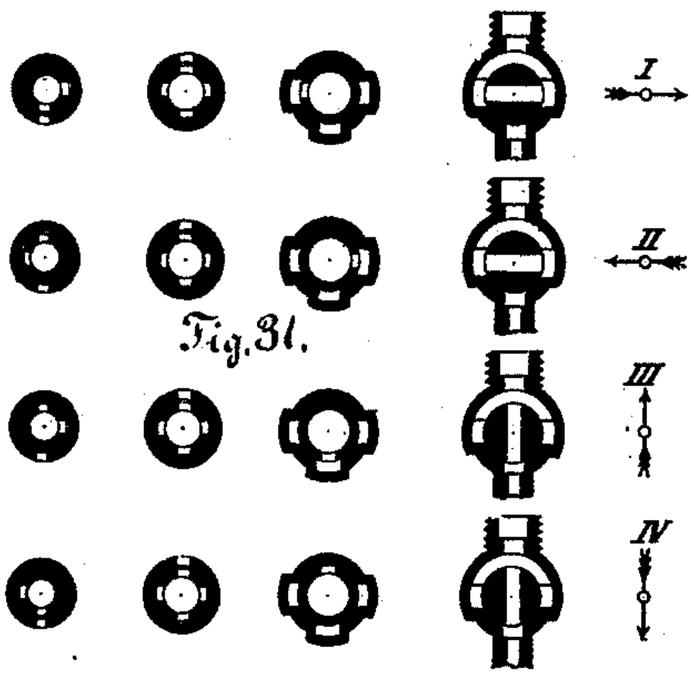

Fig. 31.

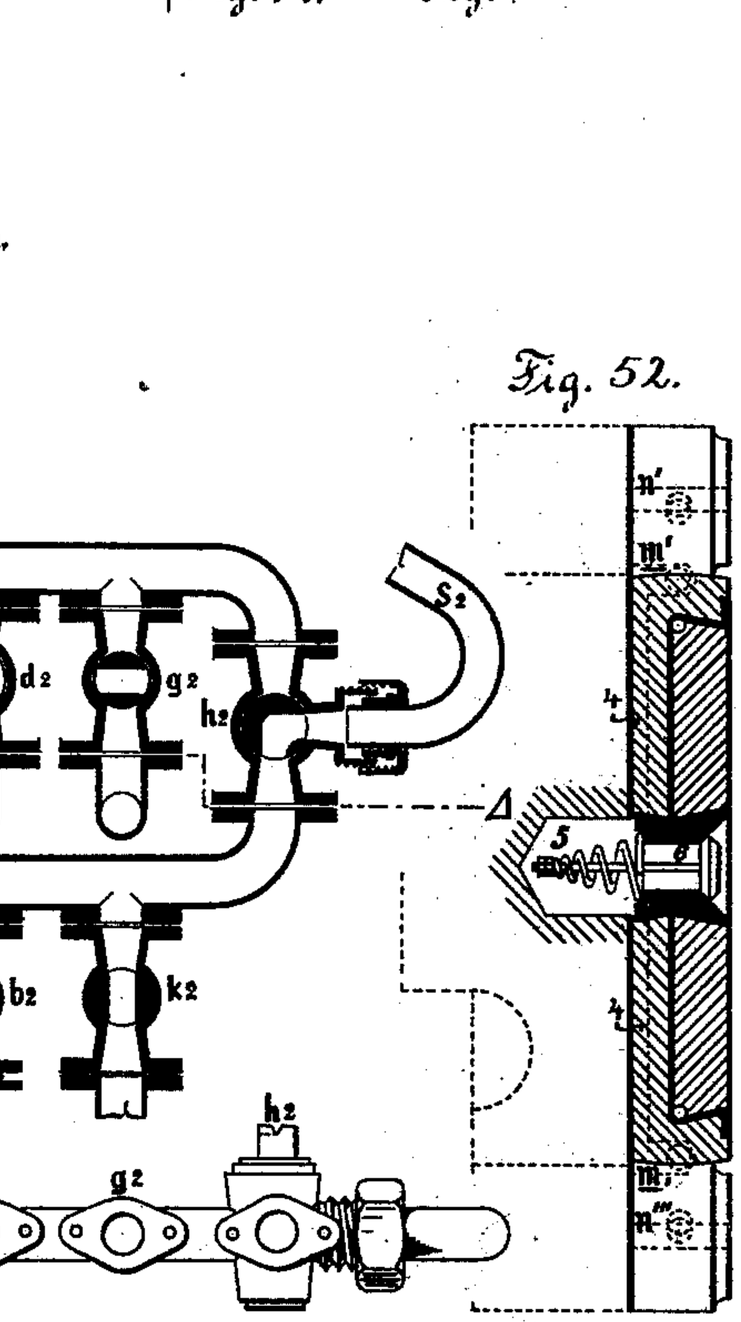

Fig. 44.

Fig. 46.

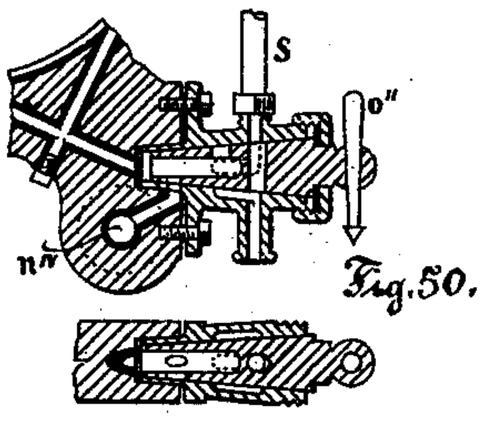

Fig. 50.

Fig. 51.

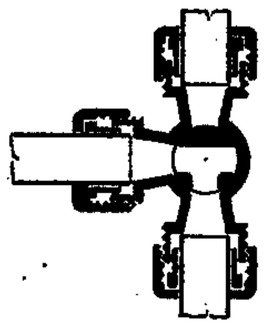

Fig. 32.

Fig. 52.

Fig. 47.

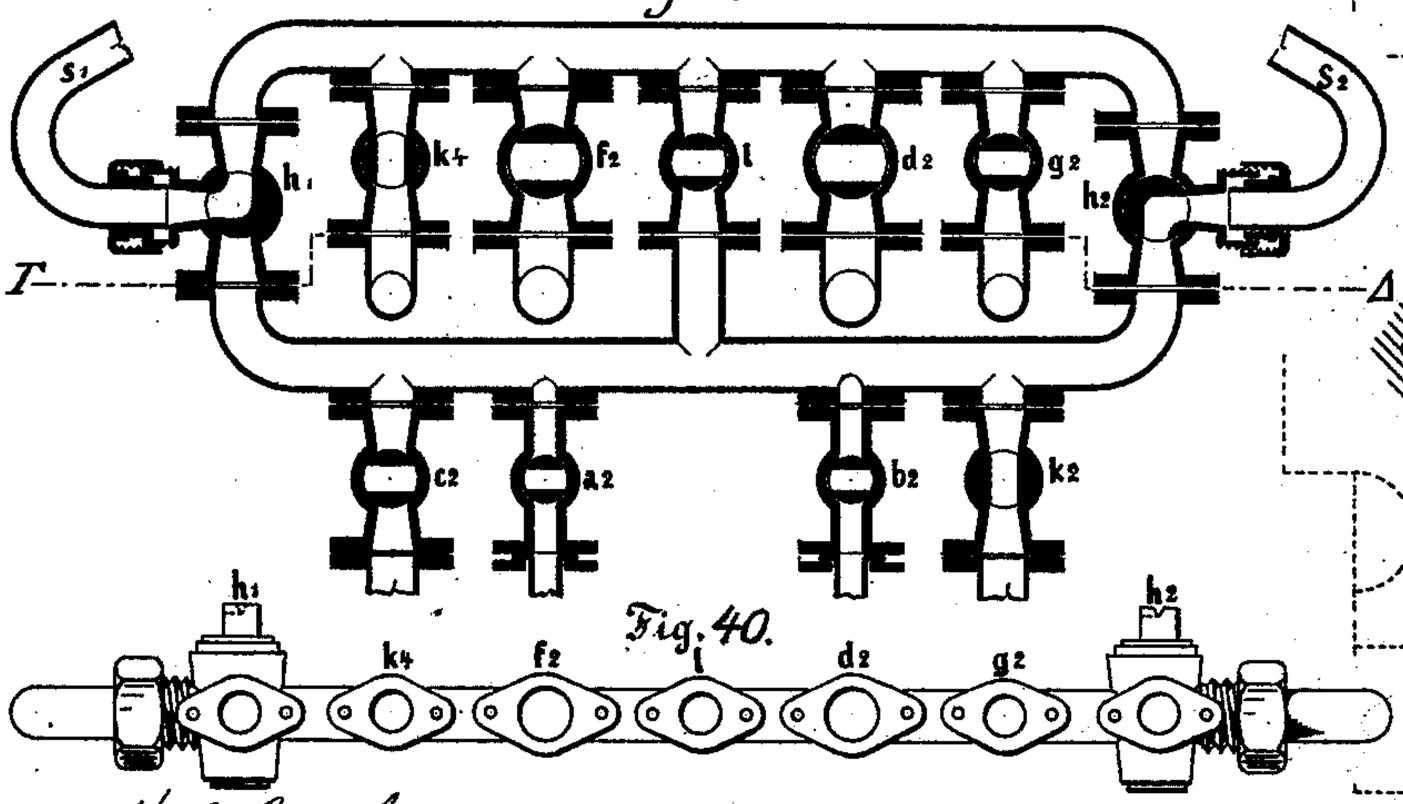

Fig. 40.

Witnesses { W. C. Corlies, Jno. Cullachregor. }

INVENTOR; August Drevermann.

By Coburn & Thacher Attorneys

UNITED STATES PATENT OFFICE.

AUGUST DREVERMANN, OF BERLIN, PRUSSIA.

IMPROVEMENT IN FILTER-PRESSES.

Specification forming part of Letters Patent No. **215,108**, dated May 6, 1879; application filed June 13, 1878; patented in England, March 2, 1877.

To all whom it may concern:

Be it known that I, AUGUST DREVERMANN, of Berlin, Prussia, have invented new and useful Improvements in Filter-Presses, of which the following is a true and exact description.

Filtration, one of the most frequent operations in chemical processes, has for its object, as is well known, the most perfect separation and clarification possible of liquids contained in masses of pulp, sediments, precipitates, &c., or, in other words, a separation of liquids from solids.

An important advance in filtering processes was made by the introduction, in 1828, of the so-called "compartment filter-press," first employed in porcelain manufacture, and afterward in that of beet-sugar, and chemical operations generally.

This invention is designed to obviate the imperfections still existing in these presses. The means by which these improvements have been attained consist, principally, first, in dispensing with the press-cloths and employing filtering-bottoms of a peculiar construction; second, in an equal and regulated admission of suitable steam, gases, or liquids, to act on the pulp or press-cake at any desirable temperature or pressure; third, in effecting an uninterrupted process of filtration by the suitable combination of several presses in a so-called "battery arrangement" in accordance with the principle of counter-pressure, for the purpose of effecting a systematic extraction of liquid from the pulp.

In the new press the filtration is effected in parallel filtering-frames, which rest on two supporters, on which they can slide or be pressed close together, and which contain a filtering material, either pulverized or compact, of a quadrilateral, circular, or any other form, as may be desired. In this press the pulp or other mass from which the liquid is to be extracted can be forced, under more or less pressure, into the interior of the press through a canal (pulp-feeder) in the frames, which is formed only when the frames are pressed together.

Those parts and processes in which this press differs from those heretofore in use, and by means of which it possesses material advantages over the latter, are given in the following summary: first, the filter-bottoms, their porous nature and various construction, instead of the press-cloths of older presses; second, the manner in which the filter-chambers are constructed, (*i. e.*, of the chambers in which the filtered liquid is first collected;) third, the manner in which the connection between the filter-chambers is made—(*a*) with the pipe for the escape of the filtered liquid; (*b*) with pipes which render possible the admission of new kinds of aeriform or liquid agents into the filter-chamber; (*c*) with the so-called "corner channels" or channels of a similar kind as that admitting the pulp, also running in the same direction as the latter, which are attached to the four corners of the frame or the four ear-like attachments thereof; (*d*) with the so-called "level-indicators," showing the height of the filtered liquor or juice, which is effected by means of peculiarly-constructed four-way cocks, or also by a combination of cocks and valves—fourth, an apparatus (thermo-aerometer) for the permanent control of the whole result of the process of filtration and washing; fifth, a peculiar arrangement connected with the press mechanism of the frame for the purpose of removing the firm mass of cake formed in the pulp-feeding canal, which serves at the same time as a so-called "stone-catcher;" sixth, the peculiar working of a combination of several presses in a so-called "lixiviating-battery" according to the system of counter-streams.

Reference is had to the accompanying drawings.

Figure 1 is a vertical longitudinal section of the compartment press, with a rectangular transverse section of the filtering-surfaces, and the filter-frames arranged in standing order lengthwise; Fig. 1[a], a front view of the combination of pipes and valves connected by the fixed hand-frame; Fig. 1[b], a skeleton plan for the combination of several presses for the same purpose; Fig. 2, a rear view of the press, showing also the mechanism for pressing the plates together; Fig. 3, a horizontal longitudinal section of the press; Figs. 4, 5, and 6, a rectangular filter-frame in transverse and longitudinal cross-section, with two porous plates; Figs. 4[a], 5[a], and 6[a], a similar filter-frame in plan and

longitudinal and cross section, the filtering materials of which, consisting of separate small parts, are held together by cases formed by two perforated plates; Figs. 7, 8, and 9, a rectangular pulp-frame in plan and longitudinal and cross section; Fig. 10, the position of the double hooks in an open (drawn asunder) press, and Fig. 11 the same in a closed press; Fig. 12, longitudinal section of one of the four-way cocks attached to the four-sided filter-frame; Fig. 13, transverse section of the cock from the line *y z*, Fig. 12; Fig. 14, transverse section of the cock from the line *w x*, Fig. 12; Fig. 15, transverse section of the cock from the line *u v*, Fig. 12; Figs. 16 and 17, longitudinal and transverse sections of the so-called "stone-catcher," with the piston belonging to it; Figs. 18, 19, and 20, detailed views of the filter-cases in Figs. 4[a], 6[a]; Figs. 21, 22, a hose-screw, for effecting a firm connection of the filter-plates in the middle or the formation of the inner pulp-canal; Fig. 23, a representation of the combination of the cocks which may be employed instead of the valves, Fig. 1[a]; Fig. 24, a compartment filter-press, in vertical longitudinal section, with transverse section of the filtering-surfaces and pulp-cakes; Fig. 25, a partial horizontal section of the same; Figs. 26, 27, details of the preceding figures; Fig. 28, a view of the front fixed head-plate, with a vertical section through the safety-valve; Fig. 29, a front view of the double sliding wedges for closing the feeding-canal, shown in section in Fig. 34; Fig. 30, same view as in Fig. 28, only completed by the pipes connected therewith, and cocks attached for the battery-like combination of several presses for the purpose of systematic lixiviation; Fig. 31, the four positions of the four-way cocks; Fig. 31, the construction of three-way cocks, marked in Fig. 30 k^4 f^2 g^2 or c^2 a^2 b^2 k^2; Fig. 32, a partial section through a filter-frame, analogous to Figs. 35 and 38; Figs. 34 and 36, representations of a circular filter-frame with a porous filter-plate in one piece, of which 36 gives a section of M N in 35; Figs. 37, 39, representations of a circular filter-frame with pulverized filtering material and the case containing the same in one piece. Fig. 40 is a vertical section of Fig. 47 upon the line *I J*; Fig. 41, one of the peculiar four-way cocks mentioned in Fig. 28—for example, in two longitudinal sections, one transverse section, corresponding to g^5, and a front view. Figs. 42[a] and 43[b] are two vertical longitudinal sections corresponding to the lines U V or Y Z, Fig. 44[c]. Fig. 44[c] is a horizontal section corresponding to L Q; Fig. 45, a similar section corresponding to L′ Q′. Fig. 47 is a plan or view of the system of draw-off cocks, more fully represented in Fig. 48. Fig. 48, a plan representing the mode of combination and the battery-like arrangement of several compartment presses for the purpose of effecting a systematic and uninterrupted working of these presses in a manner to satisfy all theoretical and practical requirements; Fig. 49, a differential-screw mechanism, with the mechanical arrangement for pressing together single filter-frames for the purpose of effecting a certain strong pressure at the end; Figs. 50 and 51, a modification of the four-way cock in Figs. 34 and 36; Fig. 52, a representation of the construction of the left-side end frame in the case of pressing out the mass from the interior feeding-canal. Fig. 53 is a longitudinal section, showing the direction of secondary filtering-currents.

The introduction of the mass to be filtered—either pulp, sediment, precipitates, or similar materials—is effected under pressure through the pipe *m*, Figs. 24, 28, 30. Of course, in this operation the press is closed—*i. e.*, all the filter-frames (constructed as the case may be, each like A B B^1 B^2 in Figs. 1, 3, 5, 8, 24, 34 or 35, 37, and 38) are firmly pressed together by the wheel E, Fig. 24, or by the lever placed in it, and by the screw P under a pressure of eight, ten, or more atmospheres. In this operation the front end of the pipe *o*, which passes through all the filter-frames, as shown in the drawings, must be imagined as closed by the double sliding wedges q^1 q^2.

The press is represented in Fig. 24 as divided in the middle. Through holes in the pipe *o* at the point of junction with the conducting-pipe *m* the pulp comes into the first-mentioned horizontal pipe, *o*, and through other holes in the same pipe at the points of junction with the pulp-frames B^1 B^2, &c., into the latter. From this the filtration is effected through the filter-plates f^1 of the two neighboring filter-frames into the chamber for gathering the filtered liquid situated in the interior. Suitably-combined canals m^I m^{II} m^{III} m^{IV}, Figs. 34, 37, conduct the filtered liquid which has been gathered in these chambers to the so-called "corner channels" n^I n^{II} n^{III} n^{IV}, and from these it is conducted, by suitable position of the cocks, through the peculiar cocks i^1 i^4, (shown in Fig. 41,) or, if desirable, through the control apparatus J^1 J^2, to the emptying-pipes S^1 S^2. (See Fig. 30, also 43[b] and 60.) The filtration will be, in fact, gradually stopped—that is, as soon as the pulp-frames are filled with a firm, equally-deposited cake formed from the residuum, and rendering a further introduction of the pulp impossible.

To extract the liquid still remaining in the residuum or cake is the object of the so-called "secondary filtration." To do this the introduction of the fluid (whether this be water, or steam, or compressed air, or carbonic acid, or any other acid, or alcohol, &c.,) for washing or removing the still remaining liquid to be filtered must be effected. This takes place by a proper opening of the cocks and valves. The introduction of this washing medium into the filter-chambers occurs at the two points situated on one side of the filter-frame. The exit of this fluid, which has passed through the half of two filter-plates and the press-cake, becoming thereby impregnated with the liquid to be filtered, must take place at the

two points as far distant as possible from the former—*i. e.*, at two points of the neighboring filter-chambers.

If we imagine all the filter-chambers so divided into two groups that to one belong the first, third, fifth, &c., and to the other the second, fourth, sixth, &c., filter-chambers, the introduction of the washing medium must be effected through the chambers designated by even numbers, and the exit of the same through those marked with odd numbers, or vice versa.

It must be mentioned, further, that the exit of the washing medium, more or less impregnated with the filter-liquid still held in the press-cake, does not take place in the open air, as heretofore, but first in the corner-channels opposite to those through which it was introduced, as has been shown, and from these into a common external pipe. This arrangement possesses several advantages: First, a complete exclusion of the external atmosphere from the filtered liquids is secured, thus preventing any evaporation in case they should be of a volatile nature, and also the injurious effects of the oxygen of the atmosphere is avoided; secondly, by a simple arrangement of the cocks i^1 i^2 i^4, the regulation of the filtration and washing in all the chambers of the press may be contemporaneously effected; thirdly, if a valve properly weighted be attached to the common external pipe before mentioned, a counter-pressure to any desirable extent may be produced, and the filtration and washing be completed under such pressure.

In this process of secondary filtration and washing all the conditions are fulfilled for causing an equal stream to pass through the cake in parallel planes, thus producing in this respect a perfect washing process.

After this secondary filtration or washing, if desired, is finished, the cake, more or less firm, according to the pressure employed, is to be removed from the pulp-feeding pipe *o*. This is effected by opening the double sliding wedge q^1 q^2, (see Figs. 24, 29,) and screwing in the rod T, Fig. 24, furnished with a plate in front, by means of the nut T^1 and hand-wheel E. In this manner after screwing back the rod T in a similar way the perforated pipe *o* is shoved out.

When this has been done, nothing prevents the opening of the press by the same hand-wheel E. Having by the help of the hand-wheel E drawn back the movable frame C toward the left, the single frames are successively shoved back on the supporters P *o*, also toward the left. The cake-frames, together with their contents, may be removed by the handle, as shown at p^1, Fig. 34, and the cake be knocked out of the frame by a slight blow on the flat side. It can then be replaced in the press—*i. e.*, on the supporters and conductors P *o*, Fig. 25.

The safety-valve *n*, Figs. 24 and 28, has for its object to show, by means of a scale-number, the pressure applied to the pulp conducted by *m*. It affords, further, the possibility of perceiving with certainty that when the valve is raised and the pulp enters into the glass vessel the filtering process is finished—that is, it shows that it is impossible to force any more pulp into the press with the given weight of the valve, and indicates the equal density of the press-cake in all the cake-frames.

The indicators S, (gages,) Figs. 25, 34, 37, are glass tubes that communicate, in general, with the interior of the filter-chambers, and have an object analogous to the water-gages in steam-boilers.

The control apparatus J^1 J^2, attached to the ends of the corner chamber n^1 n^{IV}, Figs. 25, 28, 30, and 42, are systems of glasses which at all times show the color and clearness of the expressed filtered liquid, or of the washing medium impregnated therewith, and, by means of a thermo-aerometer, w^4, Fig. 42, indicate the temperature and density of the same, while manometers m'', which stand over the apparatus, indicate the prevailing pressure during the operation of lixiviation. The difference in the pressure between the entrance and exit of the washing medium, as shown by the two manometers, affords an idea of the greatness of the friction to be overcome by the medium in passing through the press. Thus an opinion may be formed by inference as to the density of the cake, and, on the other hand, of the regularity of the principal filtering process.

Concerning the combination of several compartment presses, the particulars are more fully discussed below. It may here be simply remarked that such a combination must be considered as the only existing means, in the present state of science and results of experience, to effect a systematic extraction of filtered liquid from pulp, deposits, precipitates, &c., to the greatest perfection possible, and, furthermore, under the conditions of obtaining the highest possible concentration of the washing medium.

Having given in the above remarks some general and explanatory ideas, it is now necessary to add a more particular description not only of the construction, but also the peculiar functions, as well as the method of manufacturing, of those parts which may be considered as new and peculiar, and the nature of the new modes of procedure involved by them in the process of filtration.

As materials for ready-constructed filter-bottoms, there are used (in this respect differing from the filter-cloths, finely-perforated plates, or dense metallic sieves of the compartment filter-presses heretofore in use) porous substances of various kinds, such as plastic coal (of a mineral, vegetable, or animal origin) or natural or artificial sandstone, hardened clay, or of organic fibrous materials—for example, transverse plates of wood, or papier-maché, leather, felts, glass, or mineral wool, &c.; or they may consist of vegetable or animal fibers—for example, straw, tow, cotton, shoddy, wood, &c.

The sides of these cases may consist of one piece, or of two parts, capable of separation.

The filter-bottoms, of whatever material they are composed, form parts complete in themselves, which are firmly placed in the filter-frames, and can, when necessary, be removed from them.

The filter-plates mentioned are composed throughout of the same filtering material, whatever it may be, or to be considered as porous cases in which filtering substances are contained. The construction of these various bottoms and the manner of their insertion into the frame are seen in the Figs. 4 to 6, 4ª to 6ª, 18 to 20, 21 and 22, 33, 34, 36, 37, and 39.

Figs. 4 to 6 and the lower halves of Figs. 21 and 22 refer to a rectangular filter-frame with two coinciding porous filter-plates. (Referred to above.) The frame A A in itself consists of two parts, to receive the filter-plates f^1 f^1, which are beveled on the edges, and hold them firmly. The two parts are pressed together by screws through the adjoined pieces *a a*, Figs. 5 and 5ª. In the middle of their surfaces the plates are held together or stiffened by large hollow hose-screws *c*.

The tightening of the plates in the frames is effected by suitable cement or coating of india-rubber, or by casting in metal or solder.

Figs. 37, 39 represent a circular filter-frame, l', with a filter-plate composed of one piece, the tightening of which, as above described, is effected by plate l^{I}, rendered still tighter in the middle by means of a hose-screw, l^{II}, or by a metal casting. (See Fig. 33.)

In Figs. 4ª to 6ª, and 18 to 20, as well as the upper halves of Figs. 21 and 22, likewise 37ª, 39, are shown the filter-bottoms (filter-cases) formed of the materials mentioned. The latter consist of metallic cases with perforated sides. These cases, filled with pulverized substances, are firmly fixed, in a manner analogous to that above described, in frames consisting of one piece, rendered immovable by casting in metal, and hermetically sealed. (See Figs. 37, 39.)

In case the filter-bottoms (whether plates or cases) do not possess a sufficient resistance to the hydraulic pressure operating from the interior of these bottoms, it can be effected by means of any desirable number of suitable screws passing through both sides of the bottoms.

The various filter-bottoms, whether consisting of solid plates or cases filled with pulverized filtering materials, must be more or less porous, according to the nature of the pulp or deposits to be filtered.

The sides or surfaces of the filter-bottoms, against which the cake is pressed, instead of being smooth may be so formed as to produce any variety of figures in relief in the mass or cake resulting from the process of filtration.

If thin metal strips are fixed in the pulp-frames parallel to their broadsides and fastened together, crossing each other at right angles, they form the readiest means for cutting the cake into squares, so that it can easily be removed in pieces of a determined shape.

The introduction of rods likewise, so placed, however, that they can be drawn out lengthwise before the cakes are taken out, furnish an opportunity of forming hollow canals through the whole cakes or through the square pieces cut in the manner above described.

As is shown by the above examples, the construction of newly-formed filter-plates from whole cakes or from pieces made as above described may, without any especial trouble, be united with the process in the press itself.

Figs. 7 to 9 show the construction of a quadrilateral so-called "pulp-frame," B, and B′ B″, Figs. 24 and 25, show the same in a circular form. These are, therefore, frames placed between each pair of filter-frames.

Both filter-frames and pulp-frames are provided with arms on both sides, *g g* or p^1, by means of which they slide on the round supporters *h*. *e* in Fig. 8 are handles for lifting out the pulp-frames. The same is also effected by the handles p^1, Figs. 34, 37, made either of vulcanized rubber or wood.

The canals in the filter-frames or filter-bottoms are properly distinguished as such as collect the filtered liquid, and such as conduct the same; but these canals do not connect the product of the secondary filtration or the result of the after pressing and washing.

The filtration is effected through the two outer surfaces of the filter-bottoms or filter-cases toward the two inner surfaces. The whole space inclosed by these inner surfaces forms the so-called "filter-chamber."

The above-mentioned inner surfaces are grooved or fluted in the case where two filter-plates are placed together in halves. One of the filter-plates (Fig. 5 and the lower part of Fig. 21) is fluted parallel to the side forming the breadth, and the other parallel to that of the length. When they are formed of two halves in cases they are either kept apart and supported on the sides, Figs. 19, 20, or separated by a wire sieve placed between finely-perforated metal plates. (See Figs. 34 and 35.)

In case the filter-frame is composed of one piece, (Figs. 34 to 36 and Fig. 33,) the above-mentioned fluted surfaces are arranged into a system of grooves crossing each other at right angles.

Finally, in the example of filter-cases, Fig. 38, the filter-chamber is formed of whatever space there is between at least two thick metallic sieves which are placed between the two cases.

The filter-chambers of the new compartment filter-press formed in these various ways render possible an easy equal movement of the filtered liquid through the plates, and a regular distribution of the same through the whole interior space, as well as an easy conduction of the collected liquid out of the press.

The filter-chamber itself leads first into a canal running round the periphery of the press m^{IV}, Figs. 5 and 5ª, also m^{IV}, Fig. 34, out

of which run several other canals. Thus, in the rectangular filter-frames, Figs. 4 to 6, 4^a to 6^a, are those which lead into the four corner canals which contain the cocks *r* in the circular filter-frames. On the other hand, Figs. 34, 36, 37, 39, canals run partly horizontal, partly vertical, m^{II} and partly inclined, m^{I}, Fig. 37, the latter leading into the chamber furnished with cocks or vents, and from these, according to the position of the cock or vent *i*, Fig. 41, at the time, either to the four short corner canals n^{I} to n^{IV}, or the level or juice-gages S, or to the openings into the external filtering-channels.

In the first-mentioned rectangular frames there are also connections with the corner canals. (Here marked *f*.) These, however, are always at the two diagonal corners.

It must here be particularly noticed that in the press with a rectangular transverse section, Figs. 1 and 3, also Figs. 4 to 6, the direction of the diagonals to be established by these two modes of connection with the corner canals is to run by turns from the upper left hand to the lower right hand in the group designated by odd numbers, and from the upper right hand to the lower left hand in that designated by even numbers.

This changing diagonal connection of the corner canals with the filter-chambers serves to effect a regularly-conducted process of back filtration (washing)—*i. e.*, the fulfillment of the following conditions: the attainments of a pressure equally distributed through the filter-chambers, operating equally on the internal surfaces, and not modified by the frictional resistance of the communications, and also the securing of an equally long distance from all points for the penetration of the washing-liquid through the masses to be washed, with a corresponding conduction both to and from the frames.

Both of the above-mentioned conditions for an equal lixiviation are very well fulfilled by the diagonal communication of the corner canals and their filter-chamber. This kind of communication has, however, the disadvantage of requiring a level gage on both sides of the frame, with the necessary cocks, and of rendering the combination of valves or cocks which is necessary in a systematic lixiviation by connecting several presses together very complicated.

The latter disadvantage does not exist in the other possible mode of communication, viz: upper right hand with the lower right hand in one group; and, furthermore, it has been found on trial that, notwithstanding the distances through which the liquids have to pass are unequal, the perfection of the washing (lixiviating) is secured.

The second mode of communication between the corner canals and filter-chambers is so arranged in the press with circular frames that one group of frames bears the valve or cock system at the right hand, the other at the left.

On the other hand, to mention more particularly a new mode of incorporation of the plate consisting of one piece with the frame, as shown in Figs. 22, 34, 36, 37 to 39, also 24 and 25, this incorporation is effected by surrounding the plate with suitable metal or metallic composition, or, if necessary, by lining. Herein a distinction is to be made. The Figs. 34, 36, 37, 39, and partly also Figs. 24 and 25, (left side,) exhibit the complete surrounding of the filter-bottoms and the lining of all the canals in such a manner that the filtered liquid never comes in contact with the cast-iron frame. The filter-bottoms are shown here as completely isolated. Such an isolation is necessary when, for instance, the pulp or sediment to be filtered is strongly acid. In such a case a metallic composition capable of resisting the action of the acid would be most advantageously employed. It is otherwise in cases in which such isolation is not required; but only a fusion of the plates or cases with the frame seems advisable. The details in Fig. 33 and the right-hand-corner frame A^3, in Figs. 24 and 25, have reference to this. In the latter figures is seen also the construction of the pulp-frame B^2 belonging to it.

There are altogether four cases concerning the canal connections to be distinguished. These correspond to the four positions of the cock shown in Figs. 28, 30, 34, and 48.

First position.—The filter-chamber is connected with corner canals belonging to them, as shown, for example, in Figs. 34, 36, 37, 50, and 51, wherein N^4 is a corner canal, m m^{I} m^{II} m^{III} are the channels, and o' is the cock. This also makes connection with the level-indicator gage S, but is closed from the outside. (Compare the horizontal row I, Fig. 31.) This position or canal communication is necessary in the process of filtration, properly so-called. The filtered liquid from all the the frames is first collected at the same time in the intercommunicating corner canals, and can run through the discharge-pipes S^1 S^2 without atmospheric contact.

Second position.—The filter-chamber is connected with the level-indicator S, but is closed from the corner canals and from the outside. Compare the horizontal rows II, Fig. 31. This connection of the canals or position of the cocks is employed in an examination of the filtering capacity of the filter-bottoms, as well as in the combination of more than two filter-frames, for the purpose of effecting the so-called "reversed filtration" or lixiviation and treatment of the cake in the press.

Third position.—The filter-chamber is connected with the level-indicator, and a portion of the filtered liquid is permitted to run out. This result may be attained by permitting the contents of the gage S to be discharged, as in Fig. 34, or, by means of a separate cock, r^{I}, as in Fig. 37, to run out. (Compare horizontal row III, Fig. 31.) By this means it is possible to take a sample from each separate filter-

chamber, and also, if desirable, to conduct the contents of several or of all the chambers constantly to the outside by a channel.

Fourth position.—The filter-chamber is connected with the associated corner canals, and at the same time is closed from the level-indicator and from the outside. (Compare horizontal row IV of 31, also Figs. 34 and 36.) This position is of service in case of the removal of a broken glass, and secures an uninterrupted continuance of the process of filtration or lixiviation; hence, the condition mentioned above concerning the change in the situation of the cocks must be fulfilled.

In the group of filter-frames designated by even numbers, the glass gage and the cocks are placed on the side of the press opposite to that employed in the group with odd numbers. If this were applied to the square frames heretofore described, it would show that the diagonals through those two short canals connecting the filter-chamber with the corner canals of each frame would run, in the one group, from the upper right to the lower left hand, and in the other from the upper left to the lower right hand. The necessity for this change lies in the mode of treatment to be observed in the so-called "secondary filtration," the lixiviation.

Figs. 34, 36, 31 give details of the construction of the cocks. Another form of the four-way cock for the same purpose is shown in Figs. 50 and 51. It can be either partly or wholly removed from the frame. This allows a diminution in the thickness of the filter-frame, as a comparison of Fig. 36 with 51 will show, and also a shortening of the cock. It is more easily tightened and attached, and is, perhaps, more durable than the cock shown in Figs. 34, 36. The course of the canals is also rendered more simple.

Instead of the peculiar cocks O^1, valves may be employed, which may be made to serve the same purpose as the cocks, as above described—*i. e.*, to effect the four connections mentioned. This case has been provided for in Figs. 37, 39. Here a canal, m^1, leads to each valve, and a similar one to the corner canal n^1 or n^{IV}. The construction is rendered sufficiently plain in the drawings. It is only necessary to remark that the communication of the filter-chamber with the corner canal or shutting it off therefrom is regulated by the valve e^2 and its position; the communication with the level-indicator glass and the exit-cock r^1 by the valve e^{III}. (See Fig. 39.)

The secondary filtration or lixiviating process.—The lixiviation and treatment of the press-cake in the press with liquid or aeriform agents (steam, compressed air, carbonic-acid gas, water, acids, or alkalies, alcohol, ether, volatile oils, &c.,) for purposes mentioned in the proper place are commenced immediately after the first filtration is completed. To effect this the pulp-feeding canal *m* is to be closed, and the agent, whatever it may be, is conducted under pressure, and, making use of the position of the cock marked I, Fig. 41, through the corner canals of one group of the filter-frames. The agent enters, for example, through pipes k^2 and S^2, Figs. 30 and 47, and through the corner canals of the odd-numbered group in their filter-chambers, and spread by a perfectly equal pressure over the surfaces of these chambers. It penetrates the two filter-bottoms which form each chamber, proceeding in parallel strata, owing to their homogeneous nature, and reaches the cake which lies under strong pressure immovable in the pulp-frames. Through this, also, the agent must pass in parallel strata for want of any other opportunity, especially to escape laterally; and having done this it must, under the pressure constantly exercised, still penetrate through the halves of the contiguous filter-frames—for example, in the case in question, those of the even-numbered groups, as illustrated in Fig. 34. Thus the agent is impregnated with the liquid to be filtered, which still remains in the cake, reaches with equal flow the filter-chamber of the second group just mentioned, where it is collected, and further conducted out under an exclusion of the atmosphere by means of the corner canal of this filter-chamber, and discharged through pipe S^1.

The process thus indicated of the secondary filtration affords, as has been found on scientific trial and fully confirmed by practical results, very great advantages, such, indeed, as may justly be reckoned as the most important advantages of the new compartment press.

This process completely fulfills all those conditions which are necessary to insure an equal infiltration of the agent into the cake and its passage through it, thus effecting a complete lixiviation of the same.

The direction of the current through the press-cake in the secondary filtration is, as shown above, contrary to that in the process of the filtration proper. This fact suggests a simple means of cleaning the filter-bottoms of the new press. Experience has shown that the filtering power of the bottom is diminished solely by the filling up of the pores on their outer surfaces. The cleaning is, therefore, effected in the simplest mechanical manner by forcing a cleansing-fluid—steam or other gas—through the press in the same direction that the agent takes which is employed for lixiviation. This may be done either during the process of lixiviation or after first emptying the press and screwing it up again. In this process, in order, when necessary, to make it more effectual, chemical agents, acids, alkalies, &c., may be employed, or even superheated air, whenever the peculiar nature of the obstructing mass makes it desirable.

The four corner-canal systems $n^I\,n^{III}$ formed from the union of the corner canals of the separate filter-frames, have their exit through four cocks, $i^1\,i^2\,i^3\,i^4$, in the head-plate D, which is firmly connected with the frame R.

The construction of the cocks of a new and

peculiar kind is plainly to be seen in the details of Fig. 41. It corresponds to the work which the cocks have to do—viz: first, the effecting of a direct communication between the corner canals and the delivery or feeding pipes, as the case may be, S^1 and S^2, Figs. 30, 43; second, the effecting of the communication mentioned in connection with the control apparatus J^1 J^2; third, prevention of this communication—for example, closing the connection of the corner canals with the pipes S^1 and S^2.

The object of the pipes S^1 S^2 is, as shown in the drawings, either to conduct the filtered liquid in the filtering process properly, as well as the lixiviating liquids, &c., in the secondary filtration out of the press, or, in the secondary process, to conduct one of the above-mentioned agents into the press through two of the corner canals, and a simultaneous conduction of the lixiviating-liquid out of the press by the other two corner canals.

The cock above mentioned, Fig. 41, is composed of an exterior case, which may be regarded as a lining, to be placed in the fixed frame D on the right-hand side, and of two plugs, one within the other, the interior one of which, I, may be turned from without independently of the other by means of the square Ω; the second, I I, may be likewise turned by the hexagonal Ξ. The three openings t^z u^z v^z of the cock correspond respectively with those s^z u^z v^z of the control apparatus, Fig. 42; the opposite opening, n^z, with the respective corner canal.

In the position shown in the figure the cock permits the entrance of the agent coming through S^1, Fig. 43, through the openings t^z, exit through u^z re-entrance through v^z, and exit through 1 and u^z, as shown by the arrow in Fig. 41, from the corresponding corner canal. It is thus enabled to flow through the control apparatus J.

If the inner plug, I I, should be turned ninety degrees the control apparatus is shut off. The agent, coming through S^1 or t t^2 t^3, enters the cock through t^z, passes into the opposite hole 1, and enters directly into the press through n^z.

If the inner plug is turned ninety degrees farther, a position of the cock results which is necessary in case it is required to conduct the filtered liquid out of the press through the pipe S^1; hence the opposite of the preceding case. In this the control apparatus J is connected. If it is desired to disconnect it, the inner plug must be turned back ninety degrees.

Finally, in order to shut off the connection between the corner canals (control apparatus) and S^1, it is only necessary to turn the exterior plug I ninety degrees.

Besides serving to drive the liquid entering or leaving the press through the control apparatus at pleasure, whereby an examination of the whole process in all the frames is rendered possible, these four cocks, i^1 i^4, Figs. 28, 30, inserted in the corner canals, serve the important purpose of regulating the filtration and lixiviation by their position above, instead of using all the cocks of all the filter-chambers for that purpose.

There is but little to add concerning the construction and functions of the control apparatus, Figs. 30 and 43.

It is easily seen from the drawings that the glass tubes t^2 are in direct communication with the short canals t^1 and t^3, and, therefore, when the position of the cock permits, also with the pipe S^1 and the respective corner canals n^I and n^{III}—that is to say, the filtered liquid, or the agent impregnated with the filtered liquid, can flow directly from the press to the pipe S^2 through the glass tube t^2 without necessarily passing through the control apparatus. If the latter is connected, the filtered liquid enters also into the glass tubes u^2 and v^2, and can circulate, as is shown in the transverse section L Q, Fig. 44, between the glass tubes w^2 w^3 and the bottle w^1, thus coming in connection with the thermo-aerometer w^4. This instrument, as is also apparent from the drawings, can, if necessary, easily be removed.

Over the principal connecting tube t^2 there is a small cock, x^1, for the purpose of permitting the air to escape from all the filter-chambers at the commencement of the process of filtration or lixiviation. By means of another small cock, x^2, inserted between the space over the bottle w^1 and that over the tube u^2, a communication can be made, if necessary, with the atmosphere. Over the bottle there is a pressure-gage.

The object of the safety-valve n, placed over the pulp-feed pipe m, has been already explained. As is shown in Figs. 24 and 28, taken in connection with Fig. 30, the interior of the glass cylinder n communicates by small cocks a^3 and b^3 with small tubes, which, as seen in Fig. 48, can, at pleasure, be connected with steam or air feed pipes, and thus the pulp which has been introduced can be expelled.

The glass level or juice-gage d in Figs. 4, 5, 4^a 5^a, also S in Figs. 34, 37, which are attached to each filter-frame, and which may at pleasure be placed, as above specified, in communication with the filter-chamber and corner canals, serve the purpose of indicating externally the process of the filtration in the chambers. They are intended to show, for instance, whether in the filtration, and especially in the lixiviation, (second position of the cock,) the level rises equally in all the filter-chambers; whether all the filter-bottoms filter equally; whether all the atmosphere has escaped from all the filter-chambers; whether any one of the filter-chambers, from any accidental injury, delivers a turbid liquid. In the last case the filtered liquid of the defective chamber can, by using the third position of the cock, be kept separate from the clear liquid, and be conducted out of the press into the external canal.

The press contains a pipe, o, in the interior, whenever such appears desirable or necessary.

This passes through and is held by the formerly-mentioned hose-screw, and is perforated at the places of the pulp-frames B^1 B^2. Into this the pulp-feed pipe, in Figs. 24, 28, 30, opens, and through it the pulp enters the pulp-frames. Thus the pipe *o* serves to stop the passage of all coarse masses, stones, &c., and therefore it may be called the "stone-catcher."

The central pulp-feeding pipe of the press, whether furnished with the stone-catchers or not, is filled in the process of filtration with a cake (core) more or less solid. In case a subsequent lixiviation of the cake is intended, this core must possess the same consistency as the cake in the pulp-frames.

If the filtration is interrupted too soon, so that the core and the central portion of the pulp-cake are still in a soft, semi-fluid state, while that next the filter-bottoms has become more or less firm, the lixiviation, if commenced at this point, would be unsatisfactory. The lixiviation of the cake would by no means be equal.

The expulsion of this above-mentioned firm pulp-core, deposited in the pulp-canal *o*, is very necessary—first, because it necessarily is not subjected to the lixiviating process, and may also contain stones and coarse material; secondly, because it otherwise might cause unnecessary labor, and so many other inconveniences, in taking the filter and pulp frames apart after opening the press.

The mechanical arrangements for expelling the core and cleaning the stone-catching pipe, as well as for opening and closing the press, are different in the two constructions shown in the drawings.

The pipe *o* is closed at the front end by a slide, q^1, Figs. 1 and 3, and a cap-screw, and at the other end by a slide, *s*, against which rests a rod, *p*, capable of being moved through the whole pipe *o* (see also Figs. 16 and 17) when the process of filtration and lixiviation is terminated. *a*, the pulp-core, deposited in the pipe *o*, is first removed separately from the lixiviated pulp-cake in the pulp-frames; then the pipe *o* itself is drawn out; and then *c*, the press, is opened.

The slides q^1 *r s* are opened, the cap-screw *t* taken off, and the middle driving-wheel, *i*, Figs. 1 and 3, made to move freely on the tubular shaft *l* by disconnecting it from the coupling L. The hollow shaft contains inside a screw with long pitch, in which moves a short piston, u^{IV}, connected with a long square rod, n^v. If at *s* a cork, u^{VI}, is placed on this rod n^v, a revolving motion is prevented, but a movement forward along its longitudinal axis is permitted; and if the hollow shaft *l* is put in motion by means of the beveled cog-wheels *h h* and the cranks M M, a forward movement of the rod n^v of the piston *p* results, and hence an expulsion of the firm core deposited in the pipe *o*. The rod is drawn back again to its first position by reversing the action of the cranks M M, and, therefore, of the follow-shaft *l*. Having now placed a suitable wedge between the front end of the rod n^v and the back end of the pipe *o*, another movement of the rod n^v forward effects the withdrawal of the pipe *o*.

In order to draw the press apart it is only necessary to connect the middle driving-wheel, *i*, firmly with the bottom shaft by means of the coupling L and turn the crank M in the proper direction. The result is a corresponding movement of the wheels i^v and i^{v1}, in the naves of which box-screws are cut, and the backward movement of the head-plate *k* is effected.

Figs. 10 and 11 show the functions of the double hook, which is attached to each filter-frame, and has for its object to communicate the forward motion of the head-plate *k* successively to the single frames of the press, and, when the press is completely open, to hold them equidistant from each other. Fig. 11 shows the position of these double hooks when the press is closed; Fig. 10, their position when it is open or drawn apart.

The square rod n^v is here supplanted by a round rod, T, on the back end of which is cut a screw with long pitch, and carries a plate on the front end. It slides in a long pipe, P, attached to the head-plate *c*, and is provided with a long groove, which, in connection with an inserted tongue, *k*, prevents it from turning on its axis. The pipe P is formed as a flat-threaded screw, which fits into a corresponding box, P^1. The latter rests firmly on the standard H of the frame R. Connected with it by three screws is another box, F, (see also Fig. 26,) one end of which is provided with three segmental projections. The other end extends over the edge of the tubular prolongation of the box-screw T, and holds the latter at an unvarying distance from the standard H. On the box F the hand-wheel E sits loosely, the nave of which is provided with projections on both sides, corresponding on the one side with those of the above-mentioned box F, and on the other side with those of a ring, G. The latter is firmly attached to the box-screw T.

In order to expel the core from the pipe *o* it is only necessary, after having first opened the double wedge slide q^1 q^2, to turn the hand-wheel toward the left. In this manner a coupling of its nave to the ring G is effected. The hand-wheel E being now so turned that a forward movement of the rod T is produced, the expulsion of the core is a necessary consequence. This being done, the rod T is turned back to its former position.

To remove the pipes *o* from the press the piston *p* must first be turned a little by means of an iron pin placed in the hole 3 of the said piston, by which the small projection *r* of the piston *p* slides in a groove, *r'*, branching off from the principal groove, Fig. 27. On again turning the wheel E, which is thus coupled with the ring G of the screw T', in the same direction as before, the rod T, in its movement forward, takes the piston *p* with it by means of the small projection *r*, and, therefore, also

the pipe *o*, against which the piston *p* presses with its front beveled box-screw.

If the core in the interior pulp-canal has not attained a complete solidity, but is in a soft state, (a condition to be attained when a subsequent lixiviation is not intended by any earlier interruption of the filtration) it can be expelled by applying a counter-pressure of steam without employing the piston *p*. The steam is admitted at the back end of the inner pulp-canal into the space between the movable (now drawn back) piston *p* (or a double wedge slide attached in its stead) and the deposited core. For this purpose a steam-tubing is connected with the end filter-frame, Fig. 24, left side, or with those of its corner canals which do not stand in connection with a level-indicator. This steam-tubing must, of course, be closed by valves during the process of filtration.

Fig. 52 shows a transverse section of the construction of the end filter-frame in the above-mentioned case. This frame is provided with two more corner canals, with the usual four-way cocks belonging to them, on the side not connected with the filter-chamber, differing in this respect from the similar end frame. (Left side in Fig. 24.) Each of the canals m^{I} leading from these two corner canals does not, however, conduct, like the corresponding m^{I} in Figs. 34 and 37, to the filter-chamber, but through radiating canals 4 cut in the back side of the frame to a chamber, 5, in the head-plate. With the latter is connected a short canal, lying in the prolongation of the inner pulp-feeding canal, which is generally closed by a valve, 6. During the filtration the pressure in the press closes this valve still more firmly.

After the process of filtration is finished all the filter-frame cocks are shut off from the filter-chambers; but the two new cocks added, as above mentioned, to the end filter-frame, which thus far have been in the same position, are so turned that a communication of their corner canals n^{I} and n^{III} with the radiating canals 4 and with the chamber 5 is effected.

If, now, after opening the double wedge slides q^{1} q^{2}, Figs. 24, 29, steam of sufficiently high pressure is admitted, it will, on its passage through the canals 4, open the valve 6 and press out the pulp-cake. On shutting off the steam the valve 6 closes of itself.

The piston *p*, besides the purpose above mentioned, serves one still far more important. By placing the piston in a suitable position before commencing the filtration, and the insertion of a so-called "end filter-frame," it renders it possible to effect a filtration in any desirable number of filter-frames.

To open or draw apart the press, it is necessary at first only to set the projections of the wheel E into the corresponding spaces of the box F. The wheel E is then turned, which causes a movement of the box-screw P′, which has been previously loosened by unscrewing the screw 2, and consequently of the hollow screw-spindle P, as well as the head-plate C connected with it.

To resist the high internal pressure (upward of ten atmospheres) absolutely necessary, not only for the production of a firm condensed cake, but also in the combination of several presses into a battery for a systematic lixiviation, the press must be firmly and hermetically closed under strong final pressure. This is attained in that form of the press shown in plates I by the transmission of motion from the crank M M to the screw mechanism of the guides *h* of the filter-frames by means of the bevel-wheels *h* and the cog-wheels z z^{1} z^{2}.

In the spindle-press, Fig. 24, the above-mentioned strong final pressure is effected by the differential-screw mechanism shown in Fig. 49. Here it is necessary to turn the hand-wheel E in one direction and the box-screw D *i* in the other.

It is possible in all cases, where the soluble part of the pulp or deposit is sufficiently valuable, to continue the lixiviation until the soluble part is completely extracted from the cake. The process, however, necessary for this purpose must be regarded as one accompanied by no practical advantages for the more important part of the operation. The unavoidable result would be in most cases a filtered liquid which would have but little practical value on account of its great dilution.

By a systematic combination of several presses a process can be effected which, based on the same principles, has been employed with success in the soda industry and the manufacture of beet-sugar—viz., a battery combination of extracting-vessels in the former, and a similar arrangement of diffusion apparatus in the latter.

After the filtration proper has been completed in one press, the closing of the pulp-feeding canal is effected by shutting the respective valves or slide *q* in Figs. 1 and 3. At the same time the pulp still in the external part of the pulp-feeding pipe, as well as the filtered liquid remaining in the filtered chamber and corner canals, is forced into the respective holders by admitting steam under high pressure or compressed air.

The suitable lixiviating agent can now be conducted into the filter-frames of one group. (What is meant by "group" has been explained above.) The agent impregnated with the filtered liquid flows through the other group of the filter-frames. This agent is not permitted to run off, but is conducted into the next press, while into the first press another portion of the lixiviating agent is introduced. That which issues from the second press, already somewhat more concentrated that it was on leaving the first, is conducted into a third.

In the supposition that a combination of three presses will suffice for a systematic lixiviation, (in which case the scheme shown in Fig. 1^{b} and Fig. 48 is applicable,) as soon as this operation is commenced in the three com-

bined presses the process of filtration proper is begun in the fourth press. The first is completed, and the latter prepared for being connected with the battery. A fifth press is held meanwhile in reserve.

It may be here remarked again, simply to recall it to the memory, that the two schematic representations of the combination of several compartment filter-presses refer to the two detailed planes of the press. Fig. 1[b] refers to the press Fig. 1; Fig. 48 refers to press shown in Figs. 24 and 30. In the former, therefore, the lixiviating agent enters the press and leaves it through the diagonally-opposite corner canals; in the latter the entrance and exit take place through the corner canals at the top and bottom on one side.

The vertical longitudinal section, the front view, and plan of the respective valve and cock connections in Figs. 1, 1[a], and 3, also Fig. 23 as well, Figs. 30, 32, and 47, connected with 23, stand in close relation with the oft-mentioned schematic representation in Figs. 1[b] and 48. They indicate the grouping and local arrangement of those valves and cocks necessary for the respective distribution of the various agents that are introduced into the press or conducted out of it.

The purpose of these agents, so far as it has not been made clear in the above paragraphs, and the connection to be made in the canals and pipes, will be further explained with especial reference to the details, Figs. 1, 2, and 3.

It must be premised that the above-mentioned details refer to the case of a filtration and lixiviation of saturated pulps, and that five different agents, to be gradually introduced into the press by the connecting-pipes, may be used.

In the front view, Fig. 1[a], the pipes for these agents are shown as coming from above, and counting in succession from left to right.

The object of compressed air in the press is to cause a counter-pressure during certain stages of the process of filtration proper, as well as the expulsion of the filtered liquid still remaining in the filter-chambers, the filter-bottoms, and the press-cake before the lixiviation, when steam cannot be employed for this purpose.

Steam at high pressure is principally used in the mechanical cleansing of the filter-bottoms from each side, as well as for the purpose of heating the interior of the press before the process commences. It, however, serves many other purposes easily understood. For instance, it may be recommended, to facilitate the filtration of various precipitates, to apply heat on one side of the press-cake by admission of steam, and to let the liquid pass off from the other side.

The filtration of thick liquids with pulpy deposits—for example, the deposits formed in the melting-pan of sugar-refineries—is also greatly facilitated by an intermittent heating of the filter-bottoms on both sides. Heretofore in such cases the attempt has been made to produce the same effect by increased pressure, but without satisfactory results.

Water is employed for washing purposes and for cleansing the interior of the press.

Exhausted air serves to produce a negative pressure—*i. e.*, a suction effect—for the purpose of expelling all air-bubbles from the press-cake.

The lixiviating agent which issues from the first press in a battery (that is shown in Fig. 1[b], farthest left) descends through the pipe ξ into the third pipe, γ, and flows, under strong pressure, horizontally, to the nearest valve η, the position of which causes it to ascend through δ to the second press, where, in accordance with a proper arrangement of the cocks, it is forced to flow through one of the two groups of filter-frames—that is to say, to percolate equally through their press-cakes. There follows an analogous flowing off toward the same pipe, γ, a passage through the third press, and then its conduction through the second horizontal pipe, β, the so-called lixiviating-agent-delivery pipe, to the filter-basin.

The third and fourth pipes, γ and δ, are connected with each other. They permit a circulation of the liquid, which is necessary in connecting or disconnecting the presses at pleasure.

The fifth pipe, ϵ, is the pulp-delivery pipe; the first, α, the delivery-pipe for the filtered liquid.

The principles for conducting the single agents into and out of the press may be summed up as follows: For the press constructed as shown in Figs. 1 and 3, and the modification of the connecting system shown in Fig. 1[b], referring to Fig. 1[a], pipe 1′ is for the introduction of compressed air, and by means of the connecting-pipes and valves said compressed air may be introduced into the corner canals communicating with the filter-chambers designated by odd numbers, or with the corner canals communicating with the filter-chambers designated by even numbers, or with the filter-chambers of both odd and even numbers, simultaneously. Pipe 2′ is the steam-pipe, whereby steam may be introduced into the corner canals or filter-chambers, as above mentioned, or into the pulp-feed pipe, for the purpose of cleansing the same. Pipe 3′ is the pulp-feed pipe. Pipe 4′ is the water-pipe, which is a counterpart of the steam-pipe, and has the same connections. Pipe 5′ is the exhaust-pipe, communicating with the air-pump. It is the counterpart of pipe 1, and has the same connections.

With reference to the above, Fig. 1[b] represents pipe *a* communicating with the compressed-air pipe, pipe *b* with the steam-pipe, pipe *c* with the water-pipe, and *e* with the exhaust-pipe.

With reference to the modification of the system shown in Figs. 30 and 48, *e* is the pulp-feed pipe. K is the circulating-pipe. *c* is the

water-pipe. *f* is the delivery-pipe for filtered liquids. *a* is the compressed-air pipe; *b*, the high-pressure steam-pipe. *d* is the exhaust-pipe connecting with the air-pump, and *g* is the lixiviating-fluid-delivery pipe.

I claim as my invention—

1. The filter-bottoms molded in slabs having grooves, which constitute internal channels, substantially as described, of various geometrical forms, and fastened to the external filter-frames, substantially as set forth.

2. The artificial filter-bottoms constructed of powdered sandstone, coal, asbestus, mineral fiber, &c., molded in plates with internal channels, as set forth.

3. The filter plates or bottoms constructed with chambers in the interior, in which the filtered liquid is collected, equally distributed, and circulated, combined with external frames which have interior channels, to gather and conduct away the filtered liquid.

4. The filter bottoms or plates constructed with a series of internal chambers or canals crossing each other at right angles, substantially as set forth.

5. The filter-bottoms fastened to the filter-frames, and isolated therefrom by casting around them some metal or metallic composition not acted upon by the pulp or filtered liquid.

6. The filter-frames constructed with four corner canals, as described, connected together in pairs, either those which are situated diagonally opposite to each other or those on the same side of the frame, substantially as shown.

7. Combined with the filter-frames, as set forth, the cocks attached to each filter-frame, either internally or externally, and the corner canals, whereby the fluid from each filter may be discharged into or excluded from the common channel, as set forth.

8. The combination of the filter-chamber and the corner canal with the cocks having two or more ways and the level juice or liquid gage, whereby the filtered liquid may be observed from time to time as to quality or color, as set forth.

9. The compartment filter-press having inlet and outlet passages common to said compartments, combined with thermo-aerometers, whereby the temperature and specific gravity of the ingoing and escaping fluids may be compared, for the purposes described.

10. The single or double gearing arranged in combination with the separate frames of the press, for the purpose of securing a progressive pressure thereon.

11. In a compartment filter-press wherein the pulp is fed to the several compartments through a pipe common to all of them, a gate or valve to close one end of said pipe, and a mechanism to expel the solid or semi-solid core from said pipe when said gate is opened.

12. A compartment filter-press provided with corner canals and connecting-channels, provided with cocks or valves, whereby said compartments may individually be connected with said canals on either side, and a washing fluid may be thereby introduced to effect the secondary filtration, as set forth.

13. The filter-chamber provided with outlet-passages to the corner canals, to the open air, and to the gage, combined with a suitable valve or series of valves, whereby either of said outlet-passages may be opened or closed at will, as set forth.

14. The compartment filter-press combined with corner canals, either diagonally opposed in pairs or arranged on the same side of the filter-frames in pairs, as described.

15. The process of filtration with high or low temperature, with exhausted air under greater or less atmospheric pressure, or with steam or any kind of gas and pressure under exclusion of the atmosphere.

16. Two or more compartment-presses joined in battery in the manner indicated, and provided with systems of pipes common to all of them, whereby different liquids, steam, or gas may be separately or jointly admitted, and the expelled fluid collected and conducted away without exposure to or contact with the air, as and for the purpose set forth.

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

DR. AUGUST DREVERMANN.

Witnesses:

BERTHOLD ROI,

EDWARD P. MACLEAN.