Sheet 1, 4 Sheets.

H. Bessemer.

Mach. for Expressing Cane Juice.

No. 8,134. Patented Jun. 3, 1851.

Fig. 1.

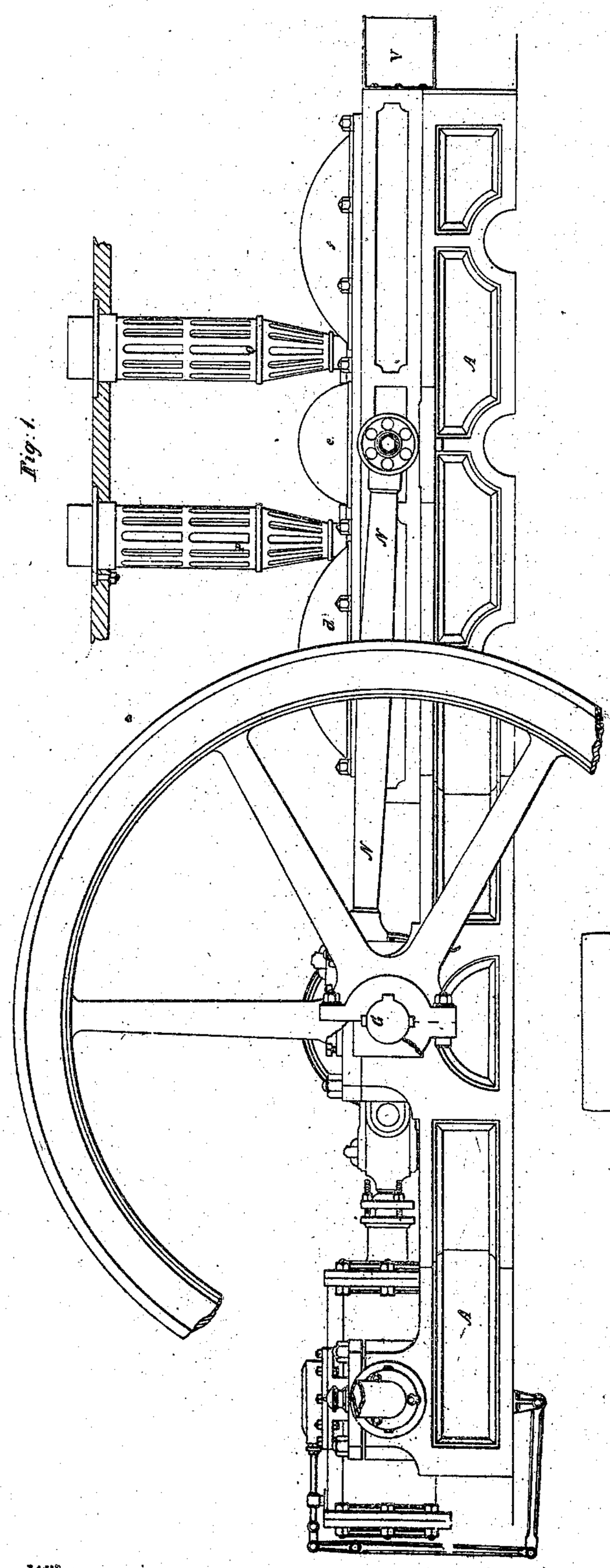
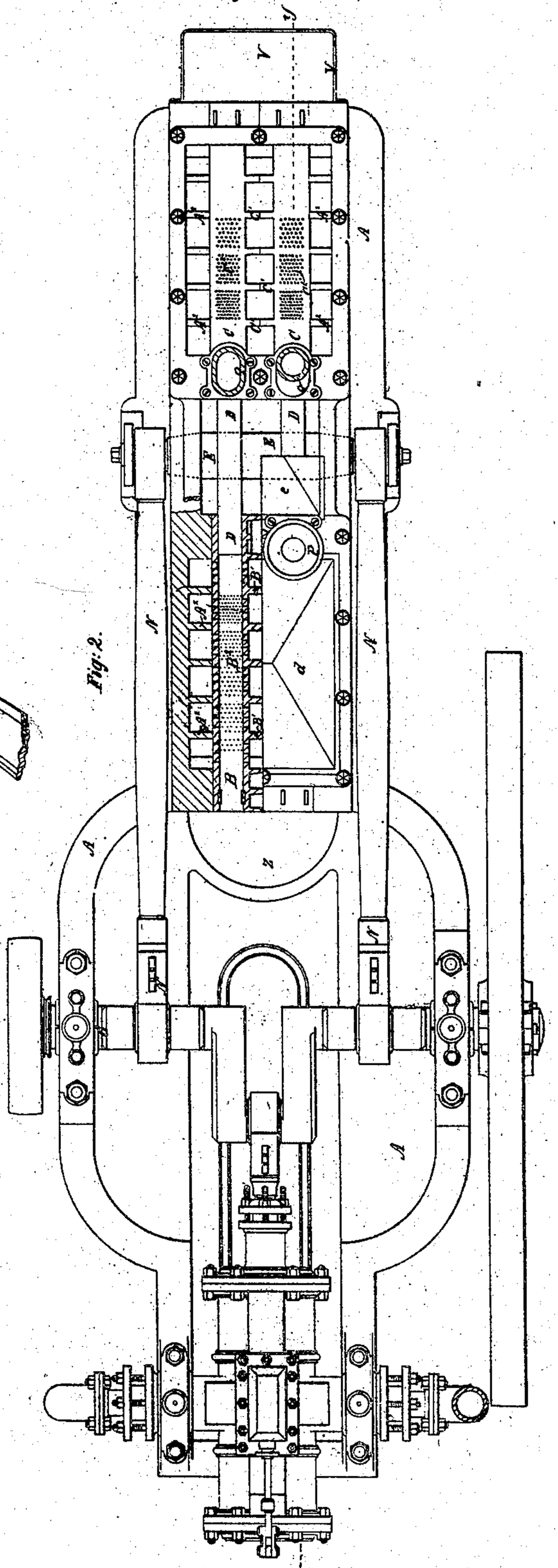


Fig. 2.



Witnesses:

Inventor:

Henry Bessemer

Sheet 2, 4 Sheets.

H. Bessemer.

Mach. for Expressing Cane Juice.

No. 8,137. Patented Jun. 3, 1851.

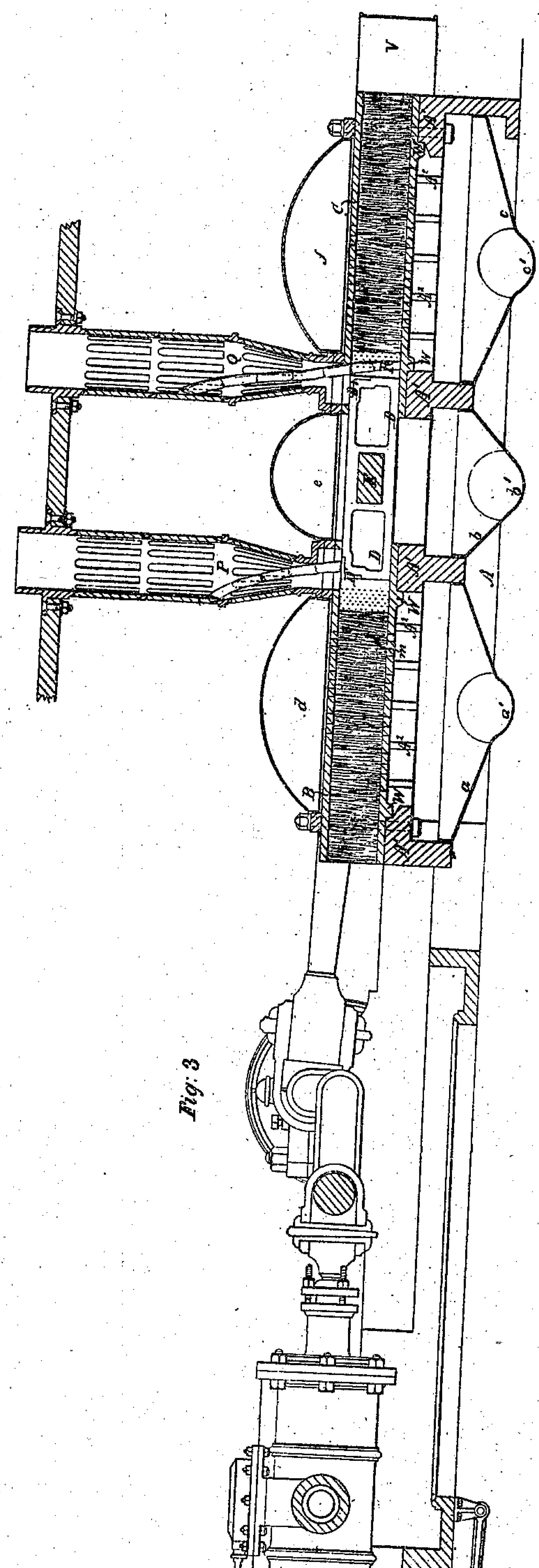


Fig: 3

Witnesses:

E H Bessemer 166 Fleet St London England

S B Milne 166 Fleet St London

Inventor.

Henry Bessemer

Sheet 3, 4 Sheets.

H. Bessemer.

Mach. for Expressing Cane Juice.

No. 8,137. Patented Jun. 3, 1851.

Fig. 4.

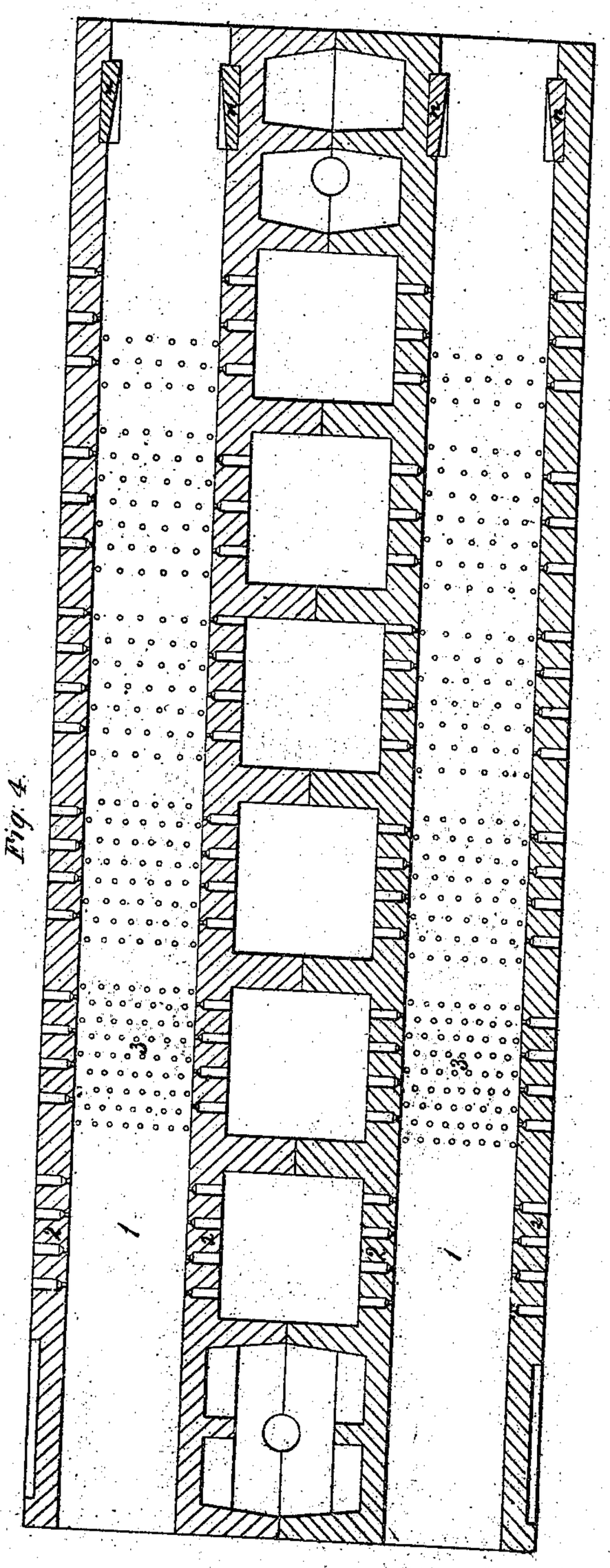
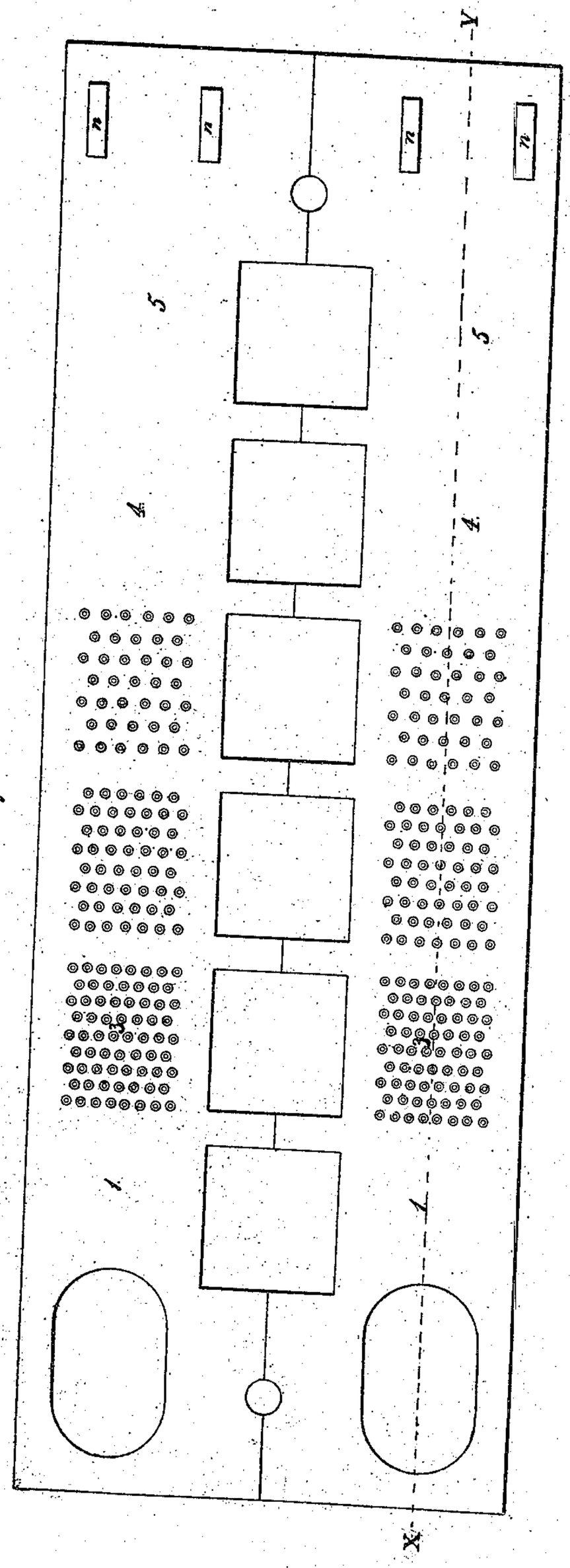


Fig. 5.



Witnesses:

R. Broomen 166 Fleet St London England
J. B. Hicks 166 Fleet St London

Inventor:

Henry Bessemer

Sheet 4, 4 Sheets.

H. Bessemer.

Mach. for Expressing Cane Juice.

No. 8,137. Patented Jun. 3, 1851.

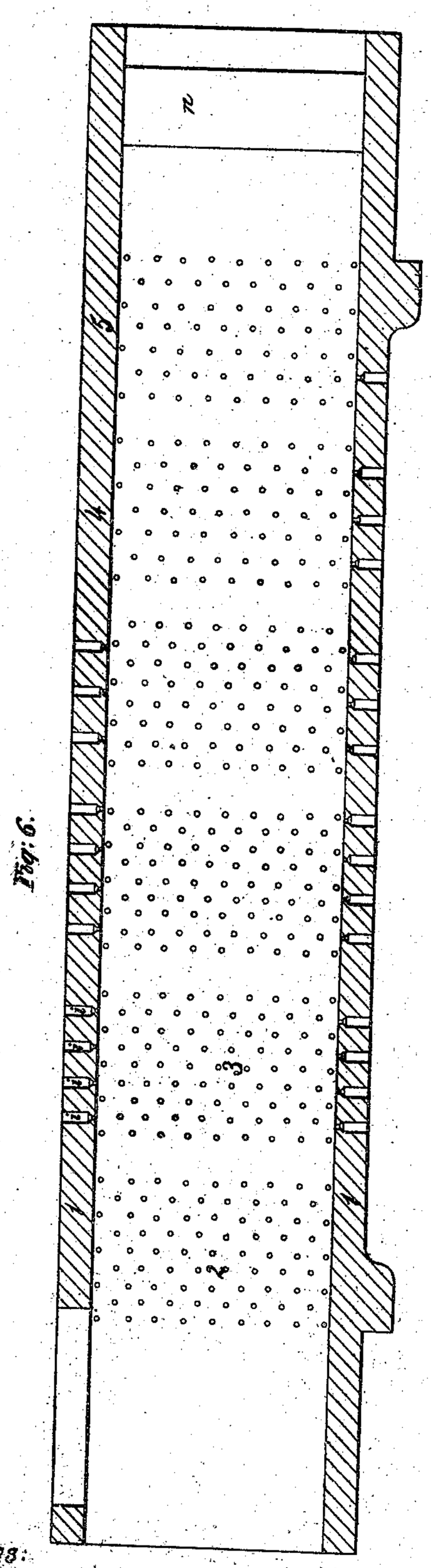


Fig: 6.

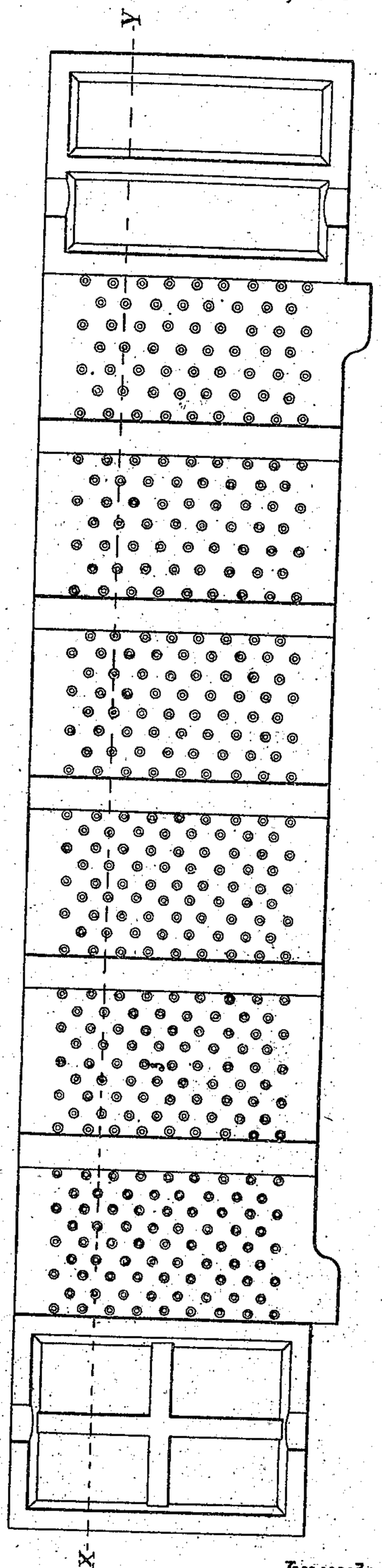


Fig: 7.

Witnesses:
R. H. Brooman 166 Fleet St. London England
G. F. Mathew 166 Fleet St. London

Inventor:
Henry Bessemer

UNITED STATES PATENT OFFICE.

HENRY BESSEMER, OF BAXTER HOUSE, OLD ST. PANCRAS ROAD, ENGLAND.

IMPROVEMENT IN MACHINES FOR EXPRESSING CANE-JUICE.

Specification forming part of Letters Patent No. 8,137, dated June 3, 1851.

To all whom it may concern:

Be it known that I, HENRY BESSEMER, of Baxter House, Old St. Pancras Road, in the county of Middlesex, England, engineer, a subject of the Queen of Great Britain, have invented or discovered new and useful improvements in the methods of extracting saccharine juices from the sugar-cane, as also in the machinery or apparatus employed therein; and I, the said HENRY BESSEMER, hereby declare that the nature of my invention and the manner in which the same is to be performed are fully described and ascertained in and by the present specification thereof, reference being had to the drawings hereunto annexed—that is to say:

The cane-mills now generally employed for extricating the saccharine juices from the sugar-cane consists of an arrangement of rollers, the number and position of which are varied, but most commonly three rollers are used, and arranged so that the canes are pressed a second time in passing through the spaces between them, which spaces are increased or diminished by regulating wedges or screws. The canes are fed endwise in between them by hand, several passing through at one time, crossing each other occasionally in all directions. The expressed juice runs into a receptacle below, and the refuse cane or bagasse passes out on the opposite side of the machine. Cane-mills of this description are subject to various defects, which I will here briefly point out, in order to show more clearly the nature of the present invention, which has for its object to lessen or entirely remove these defects. In order to extract the juice from a cane by means of a rolling-mill, it is obvious that the rollers must be set sufficiently close to give a very tight pinch; but the rollers must not be too close, inasmuch as too hard pressing of the cane extracts certain other matters therein contained which are found to be highly prejudicial to the saccharine juice. It is therefore clear that to produce the best effect the rollers should be set at a certain ascertained distance apart, which distance ought, of course, to depend on the thickness of the cane, for, suppose two rollers are placed so as to produce the best effect on a cane of one and a half inch in diameter, and that in the course of work two canes pass through together, one of which is an inch thick and the other two inches, it must follow that both will be done imperfectly, since their respective bulks are as four to one, the small one being only partially pressed, and a small portion of the saccharine juice extracted, while from the larger one a larger amount of saccharine juice will be expressed, but mixed with much of the foreign and injurious matters before referred to. Further, when a cane is passing between a pair of rollers the pressure at any one time does not extend to more than two or three inches of its length, and the extreme pinch is exerted on a mere line only where the rollers approach nearest together, the pressure gradually decreasing on each side of the center of pressure. Now, when rollers of two feet diameter are making ten revolutions per minute, the surfaces, and consequently anything passing between them, must be moving at a rate exceeding one foot per second; therefore, if we assume that the effective pressure upon a cane amounts to three lineal inches at one time, it is clear that one quarter of a second only is allowed for expressing the juice from each portion of the cane under operation, a period wholly inadequate to effect the thorough displacement of the fluid from the congeries of cells in which it is contained. Another serious defect of the roller-mill is the extraordinary facility it affords for the reabsorption of the juice after it has been once expressed. The cane, it is well-known, consists of an outer rind enveloping a spongy cellular mass, which contains the saccharine juice. The spongy mass possesses a considerable amount of elasticity when deprived of the juice, and as the cane emerges from its momentary pressure between the rollers this elasticity causes the cane to expand in the same way as sponge does when relieved from pressure, when it reabsorbs the juice which is flowing in contact with it among the rollers, and thereby not only wastes the juice but leaves the refuse cane so impregnated with it that it is found necessary to spread the cane trash in the mill-yard, to be dried by the sun before it can be burned. I have before stated that the pressure on a cane while passing between the rollers of a mill will always be in proportion to the relative thickness or di-

ameter of the cane and the amount of space between the rollers; but the amount of pressure exerted upon the different parts of the cane is far from equal, since the rind and knots are more hard and woody than the rest of the cane, and are therefore subjected to a much heavier pressure than the intermediate parts, which are composed, chiefly, of soft cellular matter and juice; and thus it is that so much green wax, chlorophyl, and other objectionable matters are expressed from the knots and rind, which should, if possible, have escaped pressure altogether. The superior hardness and solidity of these cause the roller to exert a far greater pressure upon them, by which the injurious matter before referred to are expressed, the juice greatly contaminated, and the power of the mill absorbed. This defect is common to all roller-mills however the rollers may be varied in number or position. Lastly, the action of the rollers upon the canes when great or repeated pressure is exerted tends to lacerate them to a considerable extent, causing thereby many of the larger fragments to fall into the juice, and forcing out and mixing with it innumerable small pieces of the delicate cellular tissues of which the structure of the cane is chiefly composed, the mixture of which with the juice greatly increases its tendency to fermentation, and impedes the process of defecation.

Having thus briefly pointed out the more prominent defects in the existing roller-mills, I will now proceed to describe the means by which I propose to remedy them.

In the drawings hereunto annexed, I have represented a cane-press intended to be worked by steam-power, the steam machinery being combined therewith in one framing and without any intermediate gearing.

Figure I represents a side elevation of the cane-press; Fig. II, a plan; Fig. III, a longitudinal section on the line X Y of Fig. II. Fig. IV is a longitudinal section of two tubes in the line X Y of Fig. VII. Fig. V is a plan of the same. Fig. VI is a vertical longitudinal section on the line X Y of Fig. V. Fig. VII is a side elevation of one of said tubes; and similar letters indicate similar parts throughout the figures.

A is a strong iron frame or bed-plate, cast in one piece. B B and C C are four gun-metal tubes or trunks placed above the cross-pieces A′, which also form part of the frame A. The ends of the tubes are firmly attached by bolts to the cross-pieces A′, and are further secured in their places by the projections W W, which are cast on the under side of the tubes, and abut against the cross-pieces A′. The tubes are rectangular in their cross-section, and are parallel throughout internally, and are of a width sufficient to receive a cane of the largest diameter. I prefer to make them of tough gun-metal, and they should be of such thickness as to be capable of withstanding a considerable amount of internal pressure. The tubes are also further strengthened by ribs B′ and C′, cast upon those sides of them which are nearest to the center. The opposite sides of the tubes come in contact with similar ribs, A^2, cast on the sides of the frame A, so that the vertical sides of tubes B and C are firmly supported at short distances apart, rendering it impossible to burst them with such force as the engine is capable of exerting. The tubes B and C have fitted into them two rams or pistons, D D, having a stout wrought-iron cross-head, E, passing through them. The pistons D D are worked by the engine by means of the connecting-rods, (seen at N N,) which couple the cross-head E with a pair of cranks attached to the main shaft G, these cranks being set at right angles to the crank of the engine. On the upper side of the tubes B B and C C are fixed the conical hoppers P P and Q Q. The tubes B B and C C are perforated all round with numerous small holes, B^2 and C^2. These holes may be about one-tenth of an inch in diameter on the interior of the tube, and a quarter of an inch on the exterior, the holes being made conical, in order to facilitate the escape of any matter that may be forced into them from the interior. In order that the place where these perforations should be made may be fully understood, I have shown at Fig. IV a horizontal section of two tubes on the line X Y of Fig. VII on an enlarged scale, and a plan of them at Fig. V; also, at Fig. VI a vertical longitudinal section on the line X Y of Fig. V, and a side elevation of one at Fig. VII, from which it will be seen that at the parts 1 1 on the upper and under side of the tubes there are no perforations, those being omitted because the rapid flow of juice from the cane, when the pressure first comes upon it, would cause a large quantity of the cellular tissues of the cane to be carried out with the juice from both ends of the cane; but at the parts 2 2 there are perforations for the escape of the juice. As, however, the cane has its fibers in a transverse direction, the cellular tissues and fibers are not driven out of these holes in the manner before referred to with reference to the parts 1 1. The parts 3 3 are perforated with numerous holes to facilitate as far as possible the escape of the juice. The cane, before it arrives at this part of the tube, is in a highly-compressed state, and its fibers so tightly held as to prevent their escape through these openings. From the parts 3 3 the perforations are less numerous in each compartment between the ribs as they approach the exit end of the tubes, and at the upper side, at the parts 4 and 5, the perforations cease altogether. This is done to prevent the reabsorption of any juice flowing over the upper part of the tubes. The form of the holes in the tube I prefer to make as shown at *i* in the section Fig. VI.

At *n*, Figs. IV, V, and VI, is seen a pair of wedges introduced into the discharge ends of the tubes, for the purpose of contracting the aperture in order to produce a back pressure upon the canes. These wedges are to be ad-

justed so as to jam the whole mass within the tubes sufficiently tight to express the juice to an extent considered desirable. The upper angles, D′, of the pistons D have a piece of hardened steel attached to them, and another piece of steel should be let into that part of the tubes B and C against which the cane is cut off; or the openings into the hopper might be lined with a ring of steel extending downward into the metal of the tube and flush with the inside of it. The two cutting-angles, being formed of steel, would last longer and act better than if of the metal forming the tubes and the pistons.

The operation is as follows: Motion having been given the pistons D D by the steam-engine or other motive force employed, canes are put into the hoppers P P and Q Q in a vertical position, and as the pistons D D move from under the hoppers the canes fall down into the tubes, as shown at R, Fig. III. In the drawings the machinery is represented as having been some time at work and the pistons in the middle of their stroke. On the return-stroke the pistons cut off from the canes, which have dropped from the hoppers P P into their respective tubes lengths equal to the height of the tubes, and the further progress of the piston forces the pieces so cut off against the compressed masses of cane *m* which have accumulated in the tubes B. While effecting this operation, the opposite ends of the pistons will have passed from under the openings into the hoppers Q Q, and allow a cane to drop from each of these hoppers down into them, as shown at R, so that on the next stroke of the pistons D they will also cut off from the canes last dropped lengths corresponding with the height of the tube, and compressed in the same manner as before. It has been found that canes so compressed in a tube require a considerable amount of force to be exerted upon them in order to move them forward in the tube, and the resistance thus opposed to the piston D is found sufficient to express the saccharine juice from the cane, which juice, passing through the perforations in the tubes, is received in the receptacles, whence it flows through the the spouts *a′ c′*, and may thence be conveyed into the defecating-vessel, as usual. The crank-throws which actuate the pistons D being placed at right angles to the throw, in connection with the steam-piston, it follows that as the steam-engine piston acquires its most powerful position the throws which act on the pistons D D will assume a position nearly horizontal, by which the force they exert will be immensely increased, and the masses of cane in the tubes yielding to the force thus exerted upon them, portions will be pushed out at the open ends of the tubes. The same advantageous position of the steam and other pistons with reference to each other takes place at each end of the stroke.

When the operation of pressing canes is first commenced with empty tubes, it will be found that the first two or three minutes' work will have been performed imperfectly, owing to the want of resistance in the tube. It will therefore be necessary to submit this small portion of "cane-trash" to a second operation, which will be effected by simply putting it again into the hoppers. When the pressure first comes upon a new portion of cane, the juice is given out so rapidly as to be projected through the perforations of the tubes with sufficient force to carry it beyond the receptacles *a* and *c*. To prevent this a cover formed of sheet-copper should be put over each set of tubes, as shown at *d* and *f*, and also a similar cover is placed at *e* over the pistons to prevent any splashing of juice from those. There is also a chute or receptacle, *b*, with a spout, *b′*, placed beneath the pistons, to prevent the waste of any juice that may escape past the pistons, which are fitted freely to the tubes and have no description of packing.

I have shown in Fig. II a semicircular guard or opening, Z, through which that portion of the cane-trash or bagasse falls which is expelled from the ends of the tubes nearest the cranks. There is also a rectangular gurd, V, at the opposite ends of the tubes, for the purpose of guiding the trash which falls at that end onto the endless web. The cane-press should be placed upon a slightly-elevated base, and a small arched opening should be left for the purpose of fixing the bagasse-carrier.

I have herein described how the friction against the parallel sides of the tubes forms a resistance to the movement of the canes along them. This resistance in a parallel tube must be in proportion to its length; but the resistance may be greatly increased by contracting the aperture, which may be either done quite at the end of the tube; or the tube may be made wedge-shaped throughout.

In order still further to regulate the pressure on the canes in a tube or other vessel, the ends at which the cane is intended to escape may be partially or entirely closed by a door or valve kept shut by a spring or weighted lever, so that the force required to overcome the counterpoise shall constitute, wholly or in part, the resistance required, and thus determine the force exerted upon the cane by the piston. This construction of the escape-aperture may be readily effected by forming a portion of the sides of the tube or other vessel into doors or flaps, which may be hinged to the side of the tubes, so as to unfold and form between them a parallel space equal to the size of the tube; but when inclined slightly inward toward each other (by the force of any weighted lever upon them) they would form a wedge-shaped aperture the size of which might be either regulated by a weighted lever or spring, as before described; or the doors or flaps might be acted upon by screws, so as to form a permanent contraction of the aperture to the required extent. I prefer, upon the whole, the parallel open-ended tubes, as represented in the drawings.

The advantages proposed to be realized under this head of my invention may be thus briefly summed up:

First. With regard to the equalization of pressure upon canes of different diameters in the cane-press, it deserves to be noticed that the pistons move an equal distance at every stroke; but that as the masses of canes, which form the resisting media, slide along the tubes whenever a certain amount of pressure is exerted upon them, and will so move any required distance without an additional intensity of pressure, it follows that as every cane, whatever may be its diameter, has to move the mass forward, an equal pressure is given to all of them, the only difference being that when a larger cane than ordinary is put on it causes, by the insertion of its increased bulk between the piston and the rest of the canes, a greater movement of the latter, and by the same rule, however small a cane is put in, the yielding mass does not give way until the requisite pressure is exerted upon it, when it will move forward a small distance only, which in every case must be in direct proportion to the bulk of solid matter contained in the newly-interposed portion of cane. The canes by this process are cut into convenient lengths for burning, and are not lacerated, as usual, the trash resembling flatly-collapsed tubes, having a smooth and glossy external appearance. The knots sink slightly into the soft portions of those pieces which come in contact with them, and consequently, although the pressure is sufficient to extract the saccharine juices from the soft cellular interior of the cane, it is not sufficiently rigid to cause the extraction of the green wax and other objectionable matters from the knots and rind.

Secondly. With regard to the time which is allowed in the common rolling-mill for the expression of the juice, I have before shown that in one quarter of a second after the pressure is applied it is again entirely removed; but in the cane-press herein described the pressure is continued on every portion of cane for a space of time equal to three minutes, for it is found that canes of an ordinary diameter occupy, when under pressure in the tube, each about one-sixth of an inch of its length. Therefore, if we assume that the piston makes sixty strokes a minute, and that the compressed cane occupies thirty inches of the length of the tube, it follows that each piece will require about three minutes before it arrives at and is expelled from the open end of the tube. It is this retention of pressure on the cane which causes so much of the juice to drain out of it with so little pressure, and that other matters more difficult to extract are retained in the rind and knots, whereby the purity of the saccharine juice is greatly enhanced.

Thirdly. With regard to reabsorption of the juice into the pores and cells of the cane as it emerges from the rollers of an ordinary mill, it will be seen from the operation of the cane-press just described that each piece of cane is propelled successively farther and farther along the tube. The first effort of the press brings out a large portion of juice; but as the piece of cane recedes from the piston it gets farther from contact with the principal flow of juice and continues to give out juice until it has progressed about eighteen inches along the tube and becomes exausted, or nearly so. Thus the piece of cane is deprived of its saccharine juice by a continued pressure, and ample time is afforded for the juice to percolate through the labyrinth of tissues in which it is contained, and the removal of the cane while under pressure from contact with the juice prevents the possibility of reabsorption.

I do not wish to limit myself to the precise forms of construction herein described, as many parts may be varied to suit the quantity of work to be performed or other contingencies; and I intend to make such changes, while I preserve substantially the general character I have set forth.

What I claim as of my own invention, and desire to secure by Letters Patent of the United States, is—

1. The extraction of the juice from cane by submitting the stalks of the same in perforated tubes, or other vessels constructed on the principle described herein, to a continuous pressure in the manner set forth, whereby time is afforded for the juice to flow from the cellular tissues, and reabsorption into the exhausted cane is avoided.

2. The perforated compressing-tubes having either a straight or a tapering bore.

3. The combination of the pistons with the perforated tubes and hoppers, whereby the operations of regulating the feed, cutting the canes into equal lengths, pressing, and discharging the same are effected, substantially as herein set forth.

HENRY BESSEMER.

Witnesses:

JOSEPH MARYATTE,

ALFRED LONGSDON.