No. 820,074. PATENTED MAY 8, 1906.

M. R. SPELMAN.

SUGAR CANE MILL.

APPLICATION FILED FEB. 4, 1905.

6 SHEETS--SHEET 1

Fig. 1.

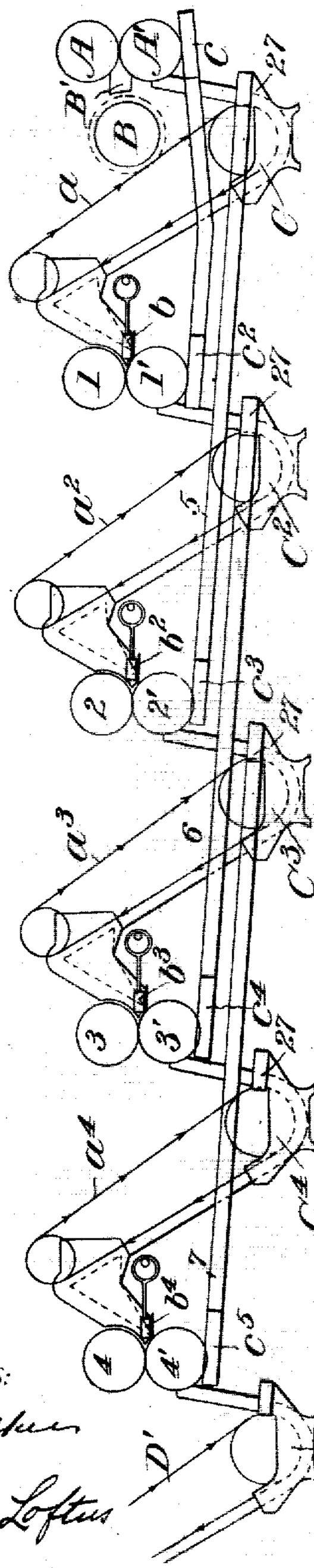
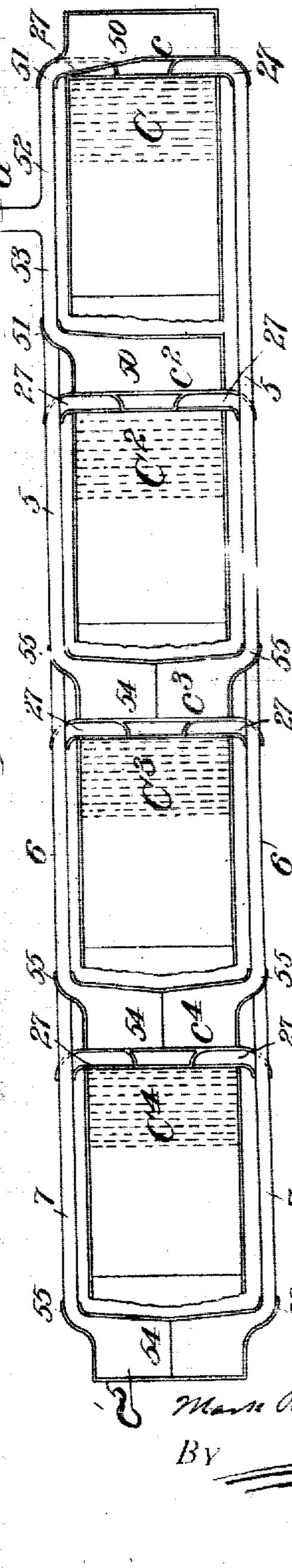


Fig. 2.



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6 SHEETS—SHEET 2.

FIG. 3.

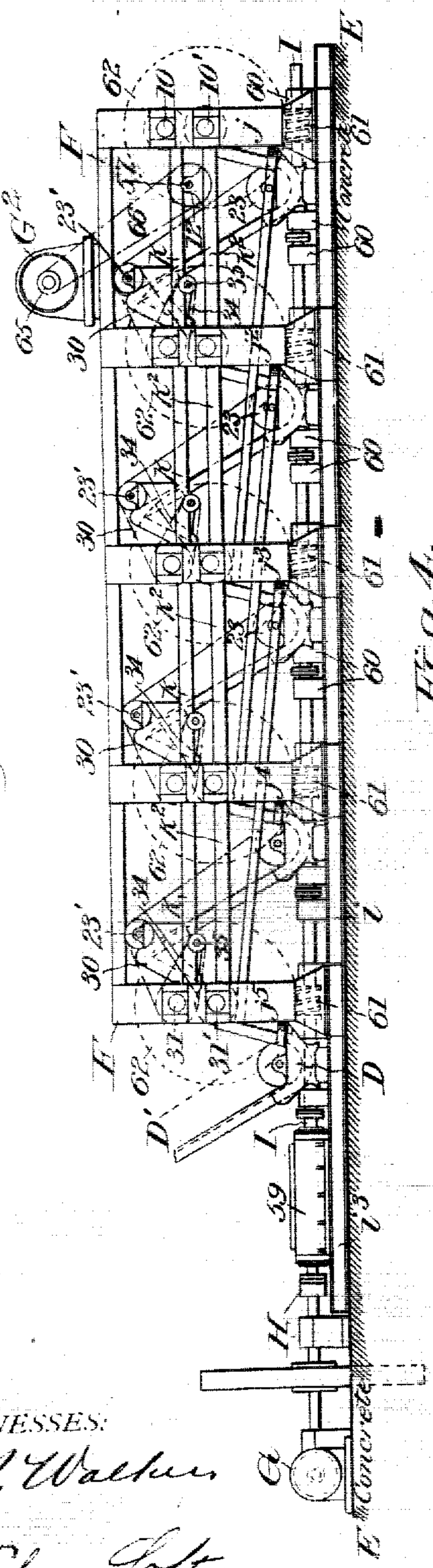
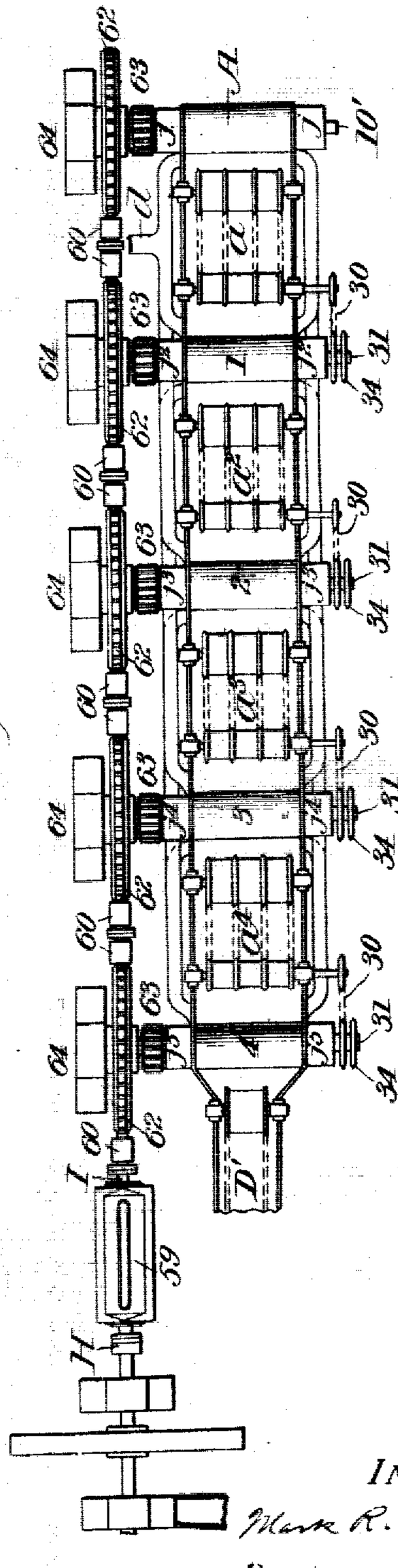


FIG. 4.



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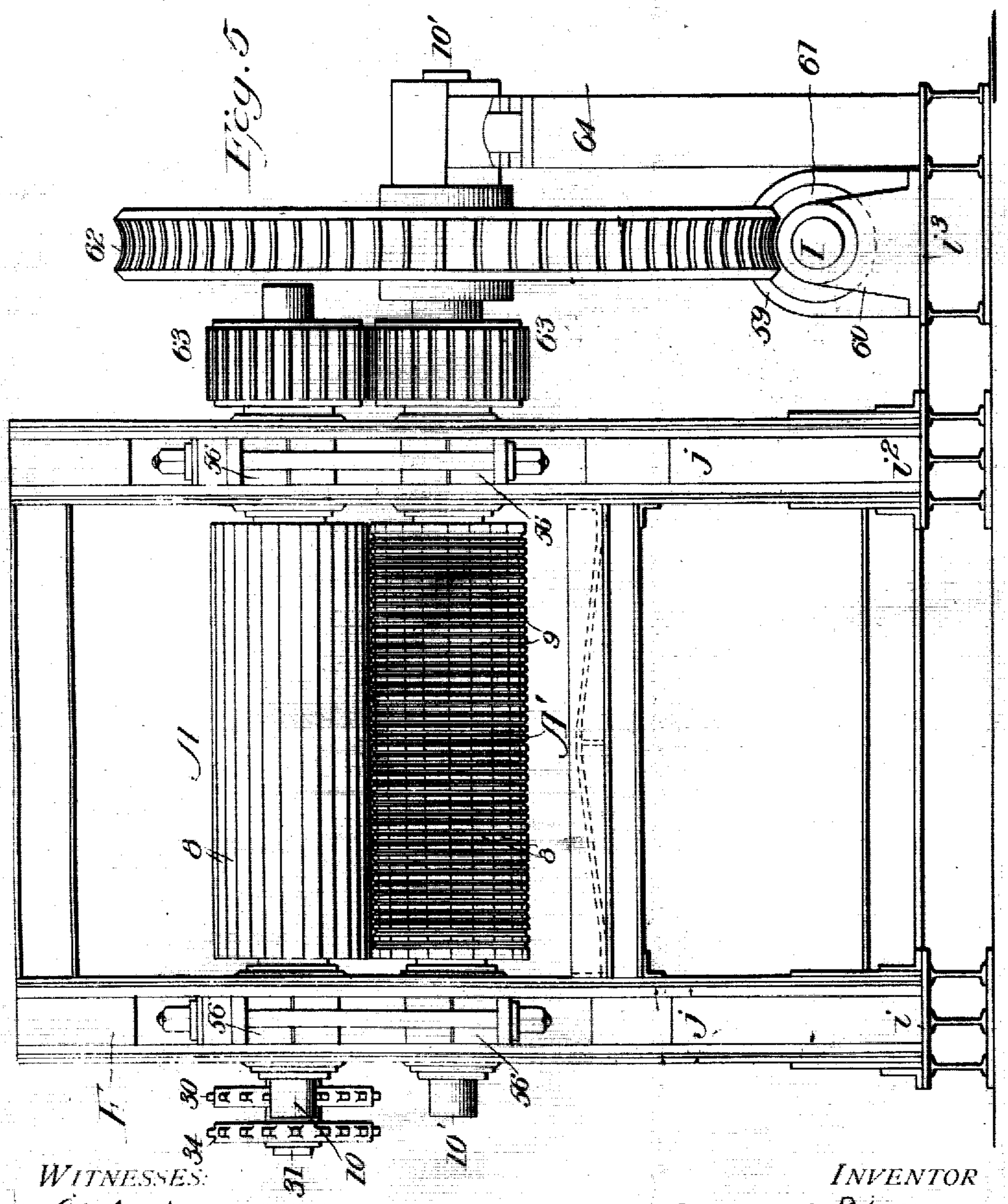
6 SHEETS—SHEET 3.

Fig. 5



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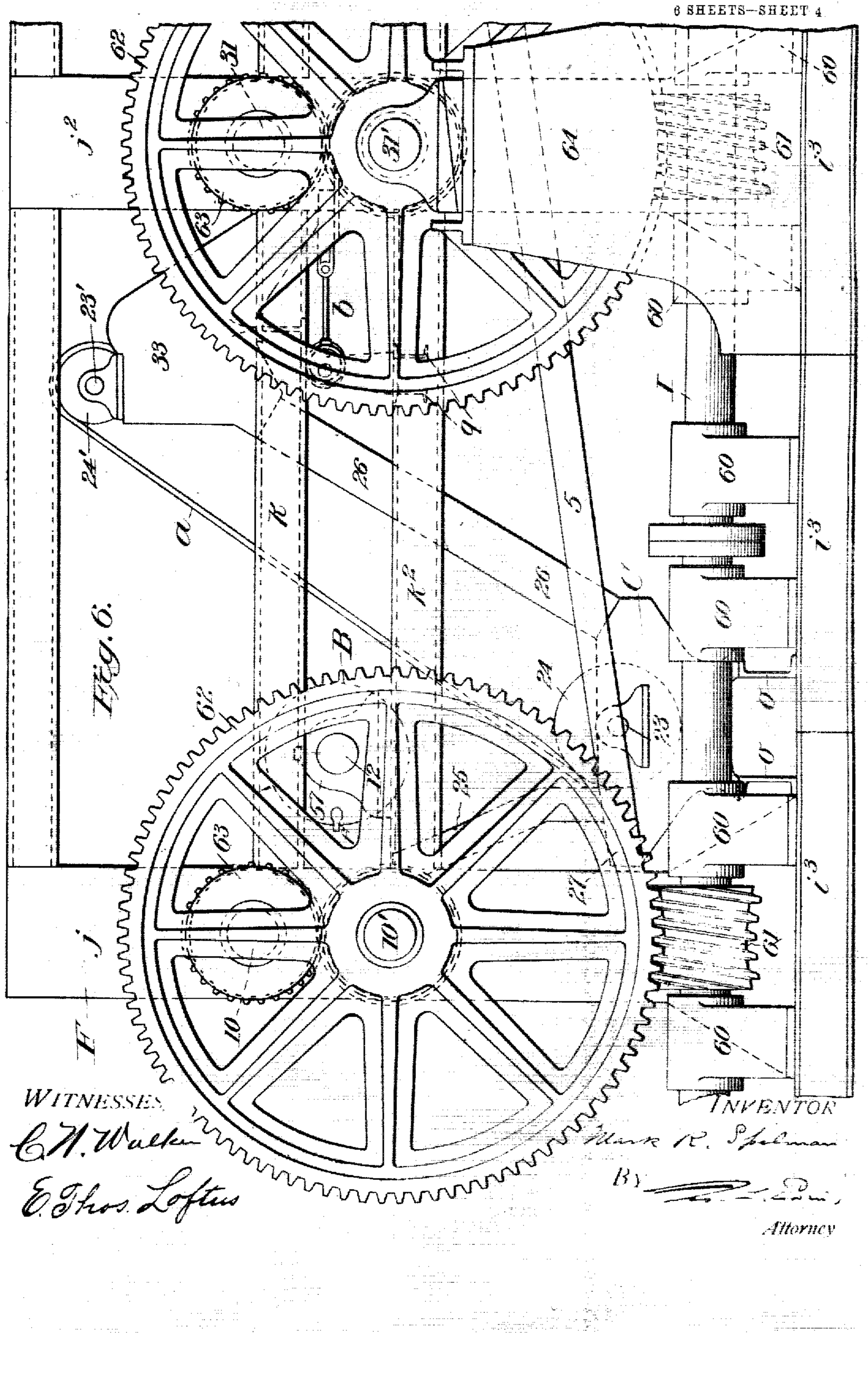
6 SHEETS—SHEET 4



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APPLICATION FILED FEB. 4, 1905.

6 SHEETS—SHEET 5.

Fig. 11.

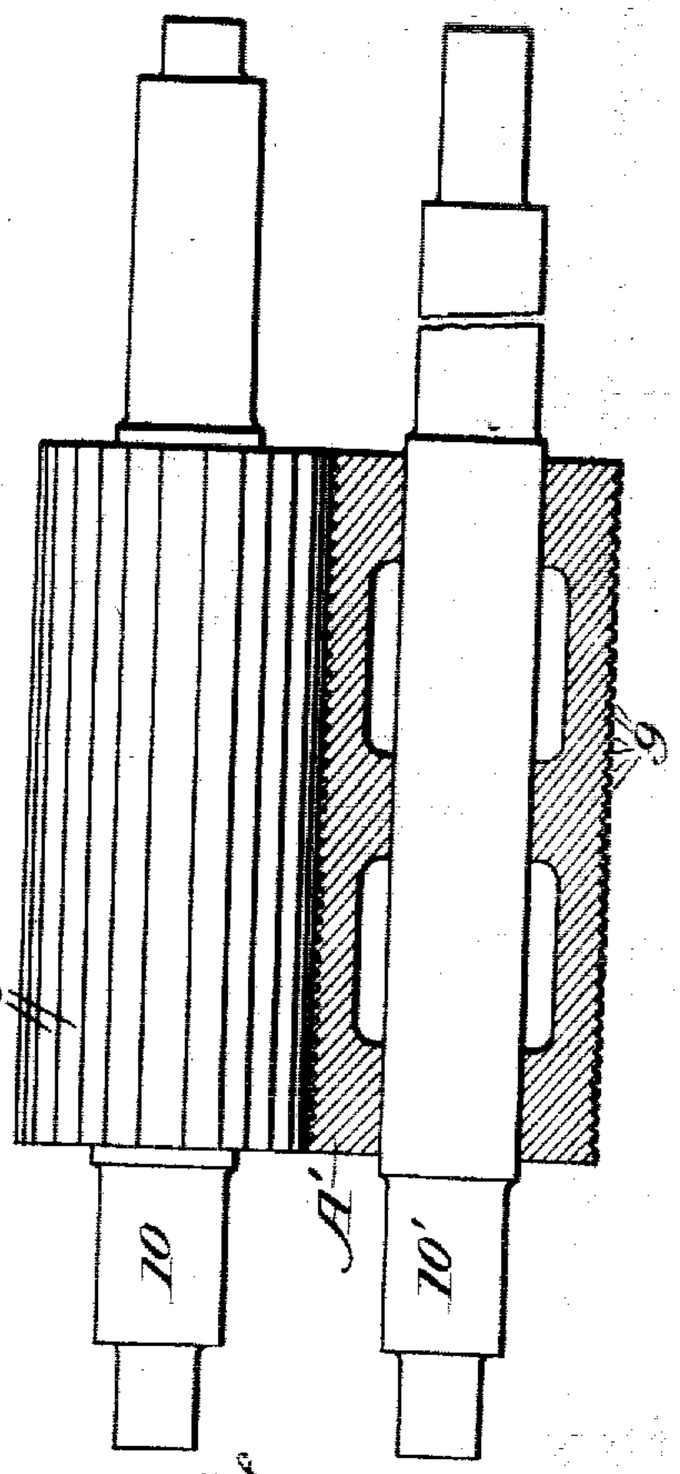

Fig. 12.

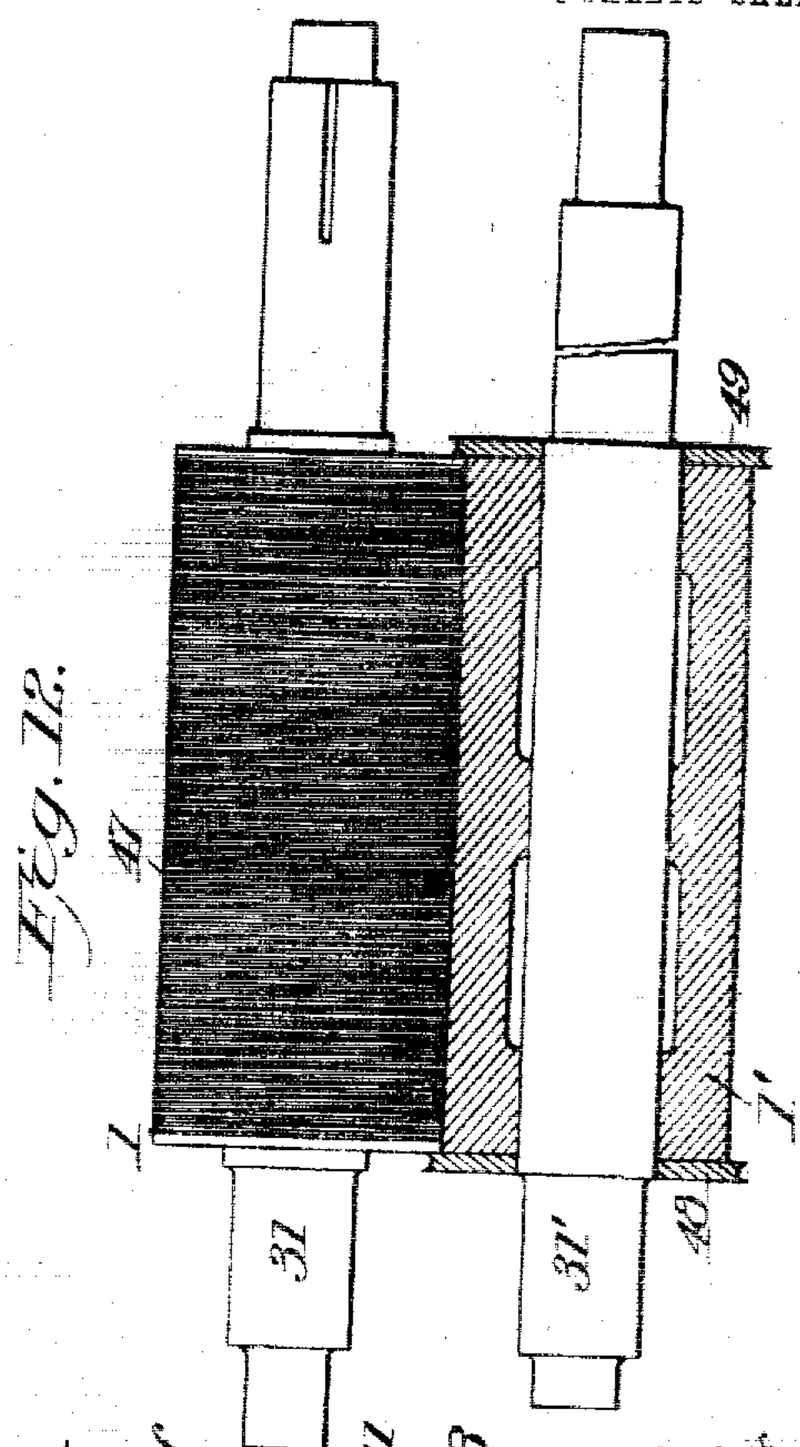

Fig. 7.

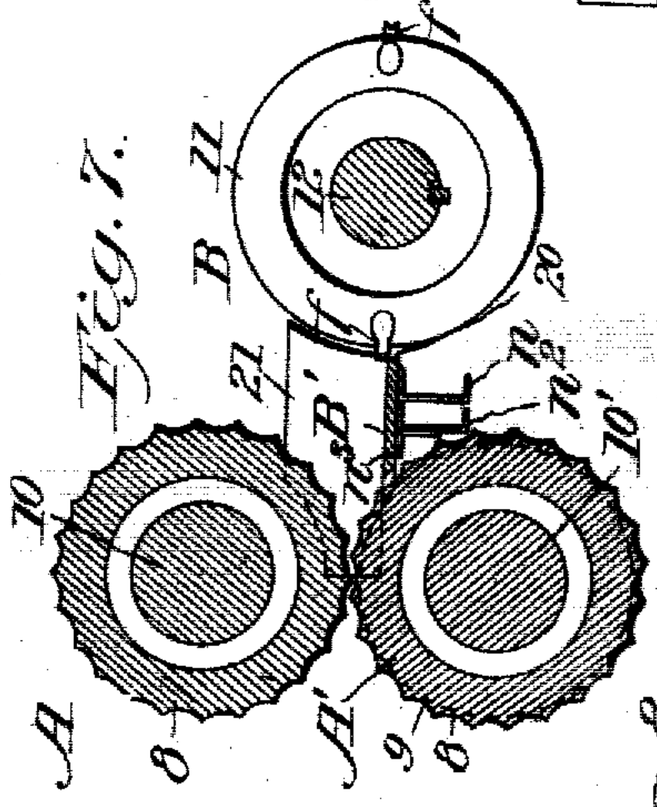

Fig. 8.

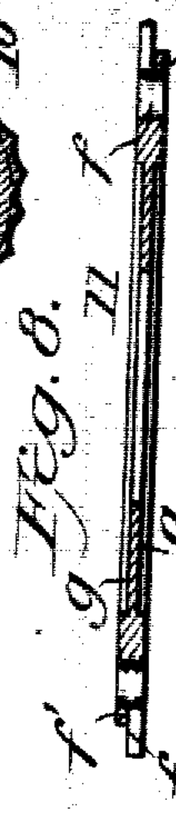

Fig. 9.

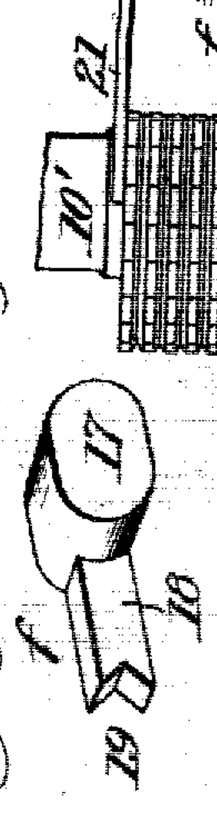

Fig. 10.

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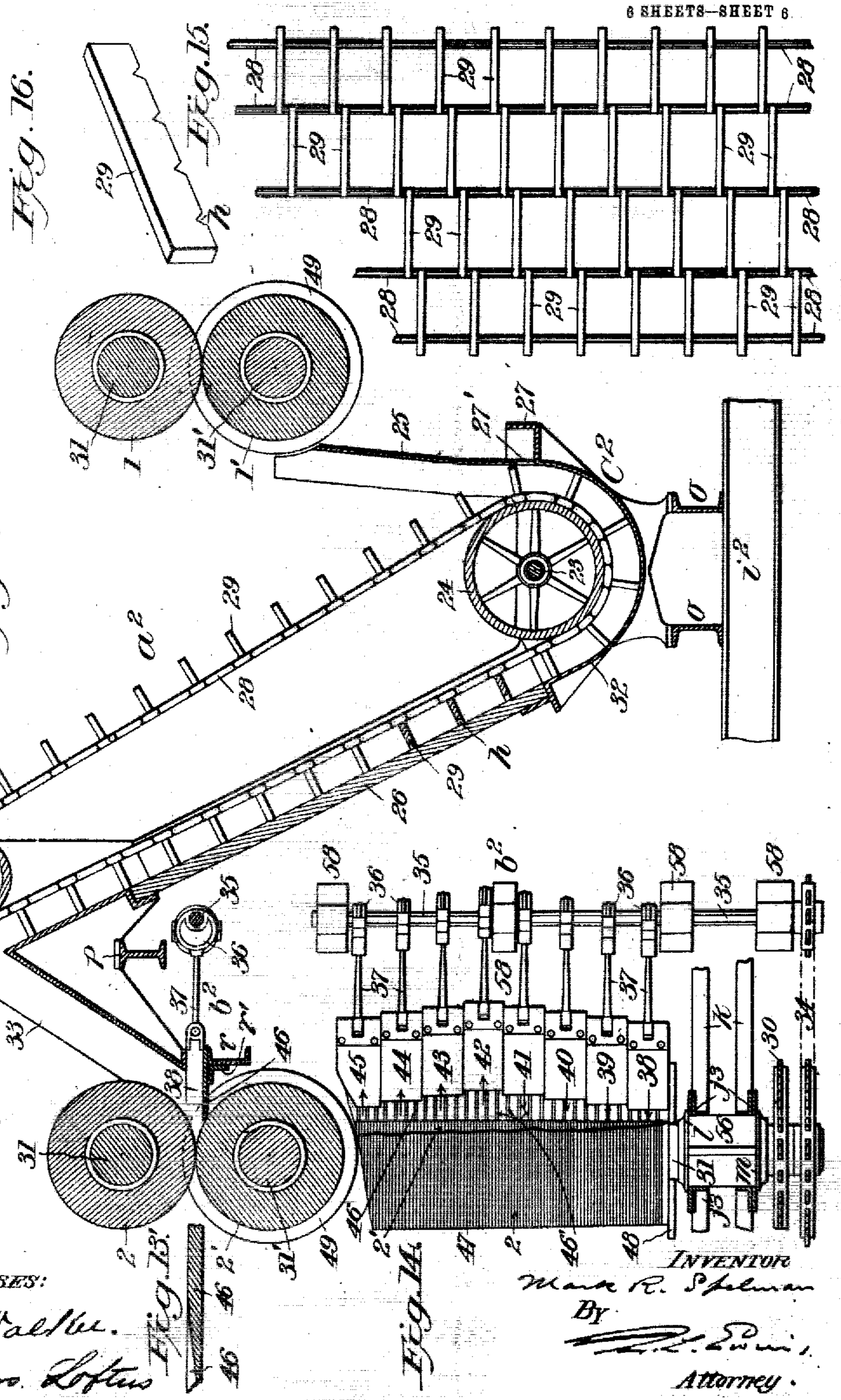
APPLICATION FILED FEB. 4, 1905.

6 SHEETS—SHEET 6.



UNITED STATES PATENT OFFICE.

MARK R. SPELMAN, OF NEW YORK, N. Y

SUGAR-CANE MILL.

No. 820,074. Specification of Letters Patent. Patented May 8, 1906.

Application filed February 4, 1905. Serial No. 244,200.

To all whom it may concern:

Be it known that I, MARK R. SPELMAN, a citizen of the United States of America, and a resident of the borough of Manhattan, New York city, in the State of New York, have invented a new and useful Improvement in Sugar-Cane Mills, of which the following is a specification.

This invention relates to apparatus for extracting saccharine matter from sugar-cane; and the invention consists in an improved sugar-cane mill hereinafter described and in certain novel combinations of parts embodied in the improved mill, as set forth in the claims hereto appended.

The objects of the present invention are to provide for extracting saccharine matter from sugar-cane by a continuous process of roller-pressing and diffusion combined by means of automatic machinery; to render the crushing-rolls more effective than those heretofore in use, with special reference to the ready escape of the juice from the lower roll; to provide for taking the cane as flattened by the crushing-rolls and cutting the same into chips with ends at right angles to the length of the cane, so as to fully expose the cellular tissue; to provide for positively immersing the chips in an effective manner by conveyers having flights which first carry the chips down into the diffusion-well and permit them there to expand and fill themselves with water and then elevate them for further treatment; to provide for feeding the chips in a positive manner between re-pressing rolls, to which they are carried by said conveyers; to collect the juice expressed by the crushing-rolls and by the several sets of re-pressing rolls and to finally discharge the same through a juice-trough common to all; to return the juice from succeeding re-pressing rolls to preceding diffusion-wells for concentration within the mill, and to provide for imparting motion to the several moving parts in the most effective and economical manner.

Six sheets of drawings accompany this specification as part thereof.

Figure 1 is a diagrammatic side view of the improved sugar-cane mill; and Fig. 2 is a diagrammatic plan view of its catch-basins, juice-troughs, and diffusion-wells, illustrating the operation of the mill in carrying into effect the aforesaid process. Figs. 3 and 4 are respectively a side elevation and a top view of the improved mill as a whole, Fig. 3 showing also the main and supplemental motors and Fig. 4 omitting these and other parts. Fig. 5 is an end elevation of the mill on a larger scale. Fig. 6 is an elevation of a portion of the gearing side of the mill with parts broken away. Fig. 7 is a fragmentary longitudinal section on the scale of Figs. 5 and 6, showing the crushing-rolls and cutting apparatus. Fig. 8 represents a section through one of the disks of the rotary cutter enlarged from Fig. 7. Fig. 9 is a perspective view of one of the knives detached. Fig. 10 is a fragmentary top view of the lower crushing-roll, cutter-table, and rotary cutter on the same scale as Figs. 5–7. Fig. 11 is a detail view of the crushing-rolls and their shafts, showing the upper roll and its shaft in elevation and the lower roll and its shaft in longitudinal section. Fig. 12 is a like detail view of one pair of the re-pressing rolls and their shafts. Fig. 13 is a fragmentary longitudinal section through one of the diffusion-wells and the succeeding intermediate conveyer and cane-chip feeder. Fig. 13′ represents a cross-section of the feed-table enlarged from Fig. 13. Fig. 14 is a fragmentary top view of the cane-chip feeder projected from Fig. 13. Fig. 15 is a detail view of a portion of one of the intermediate conveyers, and Fig. 16 is a perspective view of one of the conveyer-flights.

Like reference characters refer to like parts in all the figures.

In carrying into effect the aforesaid process by the improved mill as shown in Figs. 1 and 2, the sugar-cane, fed lengthwise to the mill by known or improved means, is acted on by a pair of crushing-rolls A and A′, by which the cane is flattened and reduced to from forty to fifty per cent. of its weight and volume by the expression of fifty to sixty per cent. of the "juice." The flattened cane is by the same means fed endwise upon a cutter-table B′ and is there reduced to "chips" in the form of short pieces, preferably from three-eights of an inch to an inch in length, by means of a rotary cutter B, cutting the cane at right angles to its length and exposing the cellular tissue of the cane at both ends of each chip. In this condition the cane falls into a diffusion-well C, in which it is immersed in a positive manner by the flights of a conveyer *a*, which permits the chips to expand and fill themselves with the "water" within the well and then transfers the soaked chips, with what water they have absorbed, to

the mechanical feeder *b* of the first pair of re-pressing rolls 1 and 1′, between which the chips are positively fed by said feeder, so as to preclude any interruption in the process. The re-pressed cane chips fall from the rolls last named, 1 and 1′, into a second diffusion-well C^2, where they are again immersed by the flights of a conveyer a^2, and after again absorbing water within said well are reëlevated to the feeder b^2 of a second pair of re-pressing rolls 2 and 2′. From this second pair of re-pressing rolls 2 and 2′ the chips fall into a third diffusion-well C^3, in which they are immersed by the flights of a third conveyer a^3, and after again absorbing water are reëlevated and delivered to another feeder b^3, by which they are fed between a third pair of re-pressing rolls 3 and 3′, from which the cane chips fall into a fourth diffusion-well C^4, in which they are immersed by the flights of a conveyer a^4 and thence reëlevated and delivered to the feeder b^4 of a fourth pair of re-pressing rolls 4 and 4′, from which they are dropped into the hopper D of a bagasse-conveyer D′, by which they are carried to a suitable drier preliminary to their transfer to furnaces for use as fuel.

The juice expressed by the crusher A A′ and by the respective pairs of re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′ is caught by catch-basins *c*, c^2, c^3, c^4, and c^5. (Compare Figs. 1 and 2.) The first and second catch-basins *c* and c^2 discharge direct, as shown in Fig. 2, into a main juice-trough *d*. The third catch-basin c^3 discharges, by way of a connecting-trough 5 at each side of the mill, into the first diffusion-well C, the connecting-troughs being so extended as to discharge into the front side of the well at points between its ends, so that the entering juice shall be effectively distributed and fall directly upon the descending chips. The fourth catch-basin c^4 discharges in like manner, by way of connecting-troughs 6, into the second diffusion-well C^2, and the fifth catch-basin c^5 discharges in like manner, by way of connecting-troughs 7, into the third diffusion-well C^3. The last diffusion-well C^4 is supplied with water (hot or cold) in measured quantities, and water may be introduced in like manner into one or more of the other diffusion-wells, if necessary, to supplement the supply of juice flowing into them, only so much water being introduced as may be necessary to complete the washing out of the saccharine matter in the series of diffusion-wells.

It is estimated, as the result of my experiments, that four re-pressing operations after the preliminary crushing operation and four immersions of the cane-chips in the diffusion-wells will be the most that will be required for the complete extraction of the saccharine matter. The number of operations may, however, be increased or diminished without departing from the invention.

It will be seen that the improved sugar-cane mill after crushing the cane and extracting from fifty to sixty per cent. of its juice by the crushing-rolls A and A′ exposes the cellular tissue of the flattened cane by the cutter and cutter-table B and B′, compels the absorbing of water in successive diffusion-wells C to C^4 by a positive immersion of the cane-chips therein by means of the conveyers *a* to a^4, and squeezes the juice out by succeeding sets of re-pressing rolls 1 and 1′ to 4 and 4′, so as to thoroughly wash out the sucrose or sweet juice from the cellular tissue of the cane in one and the same mill of limited extent.

The construction and operation of the respective parts of the apparatus above briefly referred to and their accessories will now be more particularly described, with reference to Figs. 3 to 16, inclusive, of the drawings.

The two crushing-rolls A and A′ are of steel and are mounted one above the other and designed and adapted to take the place of the three-roll crushers generally used. The rolls A and A′ in common are fluted longitudinally with oval or half-round concave flutes 8, as shown in Fig. 7, and the lower roll A′ is provided, in addition, with V-shaped grooves 9, Figs. 7, 10, and 11, at right angles to the fluting. The longitudinal flutes 8 serve in a highly-effective manner to crush and flatten the cane without shredding or disintegrating it and for feeding the cane endwise in a positive manner upon and over the feed-table to the cutter. The circumferential V-shaped grooves 9 permit the juice to escape from between the longitudinal flutes of the lower roll A′ in the most direct manner so as to flow downward into the subjacent catch-basin *c*. The rolls are preferably made hollow or internally recessed, as shown in Fig. 11, and are shrunk or keyed fast on shafts 10 and 10′, respectively, the shaft 10′ of the lower roll A′ being the driving-shaft.

The rotary cutter B is composed of a sufficient number of circular steel plates 11, Figs. 8 and 10, perforated at their centers for the cutter-shaft 12 and keyed fast thereto, the plates being held firmly together by a pair of heavy nuts 13 and 14 with right and left hand threads, respectively, screwed fast on threaded portions *e* and e^2 of the shaft 12, with end plates 15 and 16 as washers for the nuts, as shown in Fig. 10. Each of the cutter-plates 11, one of which is shown detached in section by Fig. 8, is recessed at its periphery to carry one or more insertible teeth or knives *f*, one of which is shown detached at Fig. 9. As shown in this figure and in Fig. 8, the inner ends 17 of the knives *f* are of the full thickness of the plate 11 and are connected by rectangular shanks 18 of half thickness with their protruding outer ends 19. There are preferably two knives *f* to each plate, with their shanks 18 flush with opposite sides, so that together the two knives make cuts as

wide as the plate is thick. The outer end 19 of each knife is indented, as shown in Fig. 9, so as to form two cutting edges that can be brought into use successively by transposing the knives of each plate. The knives *f* may be sharpened by deepening the indentations in their outer ends 19 and when shortened by wear may be set out by transferring liners from the outer extremities of the "inner ends" 17 to their inner extremities within the knife-holding recesses *f'* of the cutter-plates or in any other approved way. The recesses *f'*, Fig. 8, to hold the shanks 18 of the knives *f* being only one-half the thickness of the cutter-plates 11, the latter are unbroken at their perimeters and are not materially weakened by such recesses. The knives *f*, carried by successive cutter-plates, are staggered or arranged in spiral series, as indicated in Fig. 10, so as to render the cutting strain as nearly as practicable continuous. The speed of the cutter B is so regulated that the knives *f* will cut the cane into chips from three-eighths of an inch to one inch in length, with ends at right angles to the length of the cane passing lengthwise between the crushing-rolls A and A', so as to fully expose the sucrose-containing tissue at both ends of each chip. Recesses *g*, Fig. 8, concentric with the cutter-shaft 12, are also formed in the sides of the cutter-plates 11 to facilitate tightly clamping them and holding the knives *f* rigidly in place.

The cutter-table B' is composed of a straight-edge bar of steel extending the length of the crushing-rolls A and A', the front edge of the bar being set as near the lower crushing-roll A' as possible not to touch the fluting. Said front edge of the table B' has V-shaped projections 9', which loosely fit into the circumferential grooves 9 in the lower roll A', and said table B' itself is thus adapted to act as a scraper for said lower roll. The rear edge 20 of the table B' is in the form of a straight-edge, so located as to barely clear the extremities of the knives *f* of the rotary cutter B, as indicated in Fig. 7.

A pair of edge guards 21 and 22 at the lateral ends of the cutter-table B' prevent the escape of the cane therefrom except at its rear edge 20 and under the action of the knives *f* of the rotary cutter B.

The diffusion-wells C, C^2, C^3, and C^4 may be made of cast-iron, wood, or sheet metal, being in either case made water-tight and of sufficient strength. At the beginning of the operation each of them, or the first well C at least, is supplied with sufficient water in which to properly immerse and saturate the cane chips passing therethrough as they expand beneath the surface of the water.

Each diffusion-well forms or is provided with suitable bearings for the shaft 23 of the lower drum 24 of the intermediate conveyer *a*, a^2, a^3, or a^4, interacting therewith. Inclined chutes 25 and 26 lead to and from the front and rear sides of the well, respectively, and a pair of trough-terminals 27, leading to openings 27' in the front wall of the trough, as shown in Fig. 2 and Fig. 13, connect with a pair of the juice-troughs 5, 6, or 7, leading thereto, except in the case of the fourth diffusion-well C^4, in which the trough-terminals 27 are functionless, but are preferably included, so that all the wells may be made of one and the same pattern. The bagasse-hopper D is conveniently and preferably made of the same pattern, as shown. Each of the intermediate conveyers *a*, a^2, a^3, and a^4 is of the construction shown in Figs. 13, 15, and 16—that is to say, each is composed of five (more or less) parallel endless chains 28, with horizontal flights 29, preferably of hard wood, arranged in staggered sections, as shown in Fig. 15, and the conveyer is carried around one of said lower drums 24 and around a like drum 24', which may be, and preferably is, of less diameter, arranged at a sufficient height obliquely above the well, the shaft 23' of the upper drum 24' being connected by sprocket-chain gearing 30 with the upper shaft 31 of the succeeding set of re-pressing rolls 1 1', 2 2', 3 3', or 4 4'. (See Fig. 3.) The periphery of each of the lower conveyer-drums 24 is immersed to a considerable extent at least within the diffusion-well, and the bottom 32 of the well is concentric therewith, as shown in Fig. 13, so that the cane chips carried down into the well by the flights 29 are compelled to follow the periphery of the drum and pass beneath the same and are thus kept beneath the surface of the water long enough to expand and become fully saturated. In so submerging the cane chips the conveyers *a*, a^2, a^3, and a^4 also carry downward the juice from succeeding re-pressing operations received through said juice-troughs 5, 6, and 7 and said trough-terminals 27, so that the entering juice is thoroughly mixed with the liquid within the well and adapted to be reabsorbed. To provide for the return to the diffusion-well of the liquid carried up by the flights 29 and the cane chips and not absorbed by the latter, the outer edges of the flights 29 are provided with notches *h*, as shown in Fig. 13 and Fig. 16, so as to form passages for the liquid beneath the conveyer immediately above the floor of the delivery-chute 26. The upper end of said delivery-chute 26 is supported by a feeder-chute 33, which conveniently carries the bearings of the upper conveyer-shaft 23' and conducts the cane chips to the feeder *b*, b^2, b^3, or b^4 of the succeeding pair of re-pressing rolls, as shown in Fig. 13. Each of these feeders *b*, b^2, b^3, and b^4 is of the construction represented in Figs. 13 and 14 (which see)—that is to say, each feeder is driven by a chain and sprocket-wheel connection 34 with said upper shaft 31 of the adjacent pair of re-pressing rolls and comprises a horizontal

shaft 35, parallel with the rolls and octagonal in cross-section, a series of eight eccentrics 36, carried by said shaft and set on eighths, thrust connections 37, carried by the straps of said eccentrics, sliding feeder-sections 38, 39, 40, 41, 42, 43, 44, and 45, rectangular in cross-section and preferably of hard wood, and a horizontal feed-table 46, upon which said feeder-sections reciprocate side by side and which is fixedly supported immediately behind the lower re-pressing roll 1′, 2′, 3′, or 4′ and so as to project as close as practicable to its periphery and top. Owing to said arrangement of said eccentrics 36, four of the respective feeder-sections (38 to 41, for example) move forward in succession, while the other four (42 to 45, for example) are receding in like manner, as illustrated by the arrows thereon in Fig. 14. The feed is thus rendered as nearly as practicable continuous and is adapted to equalize and distribute the strain. The cane chips are at the same time fed between the re-pressing rolls in a positive manner, so as to preclude clogging.

The upper surface of the feed-table 46 is provided with grooves 46′, (represented in Fig. 13′ and Fig. 14,) extending in the direction of the feed to the delivery edge of the feed-table and increasing in width and depth, either or both, for increasing capacity toward that edge to discharge upon the lower re-pressing roll any juice that may escape from the cane chips under the pressure of the feeder-sections 38 to 45.

The re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′ are of the construction shown in Figs. 12 and 13. They are preferably made of a suitable mixture of cast-iron and are mounted on steel shafts 31 and 31′, parallel to each other and to the crushing-rolls A and A′. Like the latter, these re-pressing rolls are set one above the other and the lower shafts 31, are driving-shafts, as hereinafter set forth. Each of the rolls is provided with shallow or light circumferential grooves 47, six to the inch in practice, as reprersented in Fig. 12. A pair of disks 48 and 49 (represented in Fig. 12, Fig. 13, and Fig. 14,) attached to the ends of each lower roll 1′, 2′, 3′, or 4′, bridge the space between the rolls of each set at the ends, as shown in Fig. 13.

The catch-basins c, c^2, c^3, c^4, and c^5 may be of sheet metal or wood, as may be also the juice-troughs 5, 6, and 7 and the main juice-trough d common to all, and are securely supported within the frame of the mill, as sufficiently shown in Fig. 3. The first and second catch-basins c and c^2 have their bottoms 50 inclined so as to drain in one and the same direction toward the main juice-trough d and are directly connected therewith by laterally-projecting outlets 51 at that side of the mill, connected with said main juice-trough d by short lengths of trough 52 and 53, as shown in Fig. 2. The third, fourth, and fifth catch-basins c^3, c^4, and c^5 have bottoms 54 inclined downwardly in both directions from the middle, as indicated in Fig. 2, and the intermediate juice-troughs 5, 6, and 7 are coupled to a pair of laterally-projecting outlets 55 on each pan.

The conveyer D′ for discharging the bagasse-hopper D may be similar in construction to the intermediate conveyers a a^2 a^3, and a^4 or of any suitable form.

To support in a new and effective way all the parts of the improved sugar-cane mill without the aid of the enormously heavy castings which have heretofore distinguished such structures, a solid and level concrete foundation E (indicated in Fig. 3) is first constructed, and what is practically a single superposed frame F, of structural steel, is erected thereon. The construction of this frame is represented in Figs. 3, 5, and 6. It is composed of channel, I, and angle bars and plain plates, jointed, riveted, and connected longitudinally and transversely, so as to form one solidly-connected bearing for the superposed movable and immovable weights. Immediately above the foundation E there are three bed-plates i, i^2, and i^3 of such construction arranged longitudinally parallel with each other. On two of these bed-plates i and i^2 perpendicular columns j, j^2, j^3, j^4, and j^5, of structural steel, are erected and rigidly supported at each side of the frame F. These columns j, j^2, j^3, j^4, and j^5 are connected with each other in line and otherwise and properly braced. The longitudinal connections comprise two double lines of horizontal beams k and k^2 at each side of the mill. Said columns j to j^5 support the journal-bearings of the shafts 10 10′ and 31 31′ of the crushing-rolls A A′ and the re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′, substantially in line with said beams k and k^2, as illustrated in Fig. 14, where the journal-box 56 of one of the upper re-pressing rolls is shown in plan view. As shown in this figure, each of said journal-boxes 56 is held in place against displacement lengthwise of the mill by vertical angle-bars forming parts of said columns j to j^5, and displacement lengthwise of the rolls is prevented by flanges l and m on the ends of each journal-box. (See also Figs. 5 and 6.) The shaft 12 of the rotary cutter B is supported by a pair of pillow-blocks 57, mounted on the lowermost, k^2, of said longitudinal beams, as shown in Fig. 3 and Fig. 6, and the cutter-table B′ is supported beneath by a pair of transverse beams n n^2 and a supplemental angle-beam n^3, as shown in Fig. 7, the ends of said beams resting upon said lowermost longitudinal beams k^2 and forming part of an ample system of transverse beams tying the sides of the frame F together. The diffusion-wells C, C², C³, and C⁴ are supported in a lower plane by transverse channel-beams o, bridging said bed-plates i and i^2 beneath the frame F, as

shown in Fig. 13. The upper shafts 23′ of the intermediate conveycrs *a*, *a*¹, *a*², and *a*⁴ have their bearings on the feeder-chutes 33, as above described with reference to Fig. 13. These feeder-chutes 33 are supported beneath by transverse I-beams *p*, Fig. 13. Pillow-blocks 58, Fig. 13, for the feeder-shafts 35 are mounted on pairs of transverse channel-bars *q*, Fig. 6, between said lower longitudinal beams *k*², and the feed-tables 46 are supported beneath by channel-beams *r* and angle-bars *r*′, as shown in Fig. 13.

Motion is transmitted to the respective moving parts above named in the manner illustrated by Figs. 3, 4, 5, and 6, which see. A suitable main motor G, Fig. 3, is connected by a friction-clutch H to a longitudinal main driving-shaft I, made in sections coupled together endwise, as shown in Fig. 6. A thrust-box 59 and sufficiently-numerous supplemental housings 60 for the journals of said main driving-shaft I are mounted on the third, *i*³, of said bed-plates of structural steel, and the shaft I carries at fixed points five worms 61, running in oil. These worms 61 mesh, as shown in Fig. 6, with large worm-wheels 62, fast on the shaft 10′ of the lower roll of the crusher A A′ and on the shaft 31′ of the lower roll of each pair of re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′, and said lower shafts 10′ and 31′ are connected with the upper shafts 10 and 31 by shrouded spur-gearing 63 in customary manner. Pillow-blocks 64, Figs. 4, 5, and 6, of ample strength erected upon said third bed-plate *i*³ serve to support the outer ends of the roll-shafts 10′ and 31′, that carry said large worm-wheels 62. The requisite high speed for the rotary cutter B is obtained by a supplemental electric motor G², erected upon the top of the mill, as shown in Fig. 3. The shaft 65 of this motor is connected by belt-gearing 66 with the cutter-shaft 12, as shown in that figure. The upper shafts 23′ of the intermediate conveyers *a*, *a*², *a*³, and *a*⁴ are driven, as already mentioned, by sprocket-chain gearing 30 from the upper shafts 31 of the re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′. The shafts 35 of the several feeders *b*, *b*², *b*³, and *b*⁴ are driven in like manner by sprocket-chain gearing 34. (Compare Figs. 3 and 4 and Fig. 13.) The conveyer D′ for discharging the bagasse-hopper D may be driven by the main motor G or by any approved means.

A horizontal high-pressure steam-engine is preferred as the main motor G, the same to be run ordinarily at eighty revolutions per minute and the motion reduced to three revolutions per minute at the crushing-rolls A A′ and re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′. With rolls thirty-six inches in diameter this gives a peripheral travel of 28.27 feet per minute. The rate of travel is uniform at the crusher A A′ and re-pressing rolls 1 1′ to 4 4′ and is varied only as the engine is differently speeded. The proper relative speed of the intermediate conveyers *a*, *a*², *a*³, and *a*⁴ and cane-chip feeders *b*, *b*², *b*³, and *b*⁴ is determined by sprocket-wheels of appropriate sizes in the described sprocket-chain gearing 30 and 34. The independently-driven rotary cutter B has a relatively high speed that may be regulated as required by varying the speed of the supplemental electric motor G² without disturbing the speed regulation of the body of the mill.

The mechanical details of the various devices throughout the mill may be varied at will. The flutes 8 and grooves 9 of the crushing-rolls A and A′ may be increased or reduced in number and size. The number of cutter-plates 11 and the number of knives *f* in each plate of the cutter B may vary. The means for adjusting the knives *f* outward to take up wear may be of any approved kind. The cutter-table B′ may be in two or more parts, so as to render the scraper projections 9′ and the straight-edge 20 independently adjustable. The re-pressing rolls 1 1′, 2 2′, 3 3′, and 4 4′ may be of steel or other suitable metal, if preferred, and the size and number of their circumferential grooves 47 may vary. The bagasse-hopper D and its appurtenances may be of any known or improved construction. Structural iron may take the place of structural steel. The motion-transmitting mechanism admits of immaterial changes, and other like modifications will suggest themselves to those skilled in the art.

Having thus described said improvement, I claim as my invention and desire to patent under this specification—

1. A sugar-cane mill having, in combination, crushing-rolls adapted to crush and flatten the cane and to express a portion of its juice, a cutter-table arranged to receive upon it the flattened cane as discharged by said crushing-rolls, a cutter coacting with said cutter-table and adapted therewith to reduce the flattened cane to chips in the form of short pieces having ends at right angles to the length of the cane so as to expose the cellular tissue at both ends of each chip, a series of diffusion-wells supplied with liquid, a series of conveyers constructed and arranged to positively immerse the cane chips in flattened condition within the respective diffusion-wells and to elevate the saturated and expanded chips therefrom, mechanical feeders having feed-tables arranged to receive upon them the saturated cane chips as discharged by said conveyers, a series of sets of re-pressing rolls each of which is arranged to be fed by one of said feeders, and a bagasse-hopper arranged to receive the chips from the last set of re-pressing rolls.

2. A sugar-cane mill having, in combination, crushing-rolls adapted to crush and flatten the cane and to express a portion of its juice, a cutter-table arranged to receive upon

it the flattened cane as discharged by said crushing-rolls, a cutter coacting with said cutter-table and adapted therewith to reduce the flattened cane to chips, a series of diffusion-wells, a series of conveyers constructed and arranged to positively immerse such cane chips in flattened condition within the respective diffusion-wells and to elevate the saturated and expanded chips therefrom, mechanical feeders having feed-tables arranged to receive upon them the cane chips as discharged by said conveyers, a series of sets of re-pressing rolls, each of which is arranged to be fed by one of said feeders, catch-basins beneath each set of rolls, juice-troughs arranged to conduct the juice from all except the first two catch-basins into preceding diffusion-wells, a main juice-trough common to all, and juice-troughs directly connecting the first two catch-basins with said main juice-trough.

3. A sugar-cane mill having, in combination, a set of crushing-rolls adapted to crush and flatten the cane and to express a portion of its juice, means for reducing the flattened cane to chips in the form of short pieces having ends at right angles to the length of the cane, a series of diffusion-wells, a series of conveyers constructed and arranged to positively immerse such cane chips in flattened condition within the respective diffusion-wells and to elevate the saturated and expanded chips therefrom, mechanical feeders arranged to act upon such cane chips as discharged by said conveyers, four sets of re-pressing rolls parallel with said crushing-rolls and each set arranged to be fed by one of said feeders, catch-basins beneath the several sets of rolls, a main juice-trough common to all, juice-troughs directly connecting the catch-basins of said crushing-rolls and the first set of re-pressing rolls with said main juice-trough, juice-troughs connecting the respective ends of the third catch-basin with the first diffusion-well, juice-troughs connecting the respective ends of the fourth catch-basin with the second diffusion-well, and juice-troughs connecting the respective ends of the fifth catch-basin with the third diffusion-well.

4. In a sugar-cane mill, a crusher composed of two rolls placed one above the other, both of them fluted longitudinally, and the lower roll having V-shaped grooves cut circumferentially.

5. In a sugar-cane mill, the combination with a crusher composed of two crushing-rolls placed one above the other, and the lower roll provided with circumferential V-shaped grooves, of a cutter-table constructed with V-shaped projections arranged to project into said V-shaped grooves of the lower roll and to act as scrapers.

6. In a sugar-cane mill, the combination with crushing-rolls adapted to flatten the cane and express a portion of its juice, of a cutter-table arranged to receive the flattened cane from said rolls, a cutter interacting with said cutter-table and adapted to reduce the flattened cane to chips in the form of short pieces having ends at right angles to the length of the cane so as to expose the cellular tissue at both ends of each chip, re-pressing rolls parallel with said crushing-rolls, diffusion-wells supplied with liquid and arranged to receive the cane chips as they come from said cutter and the successive sets of said re-pressing rolls, and means for positively immersing such chips within the respective wells so as to permit them to expand beneath the surface of the liquid and thus become fully saturated preliminary to the succeeding re-pressing operation.

7. In a sugar-cane mill, the combination with a crusher adapted to flatten the cane and express a portion of its juice, and means for reducing the flattened cane to chips in the form of short pieces having ends at right angles to the length of the cane, of a diffusion-well supplied with liquid and arranged to receive such chips in flattened condition, and a conveyer comprising a horizontal drum immersed at bottom within said diffusion-well and sprocket-chains carrying flights of such dimensions as to fit the space between said drum and the bottom of the well, whereby the chips are positively immersed within said well and permitted to expand beneath the level of the liquid within the well.

8. In a sugar-cane mill, the combination with a crusher adapted to flatten the cane and express a portion of its juice, means for reducing the flattened cane to chips in the form of short pieces having ends at right angles to the length of the cane, and a diffusion-well arranged to receive the cane chips in flattened condition and provided with a partially-immersed horizontal drum, of a conveyer comprising sprocket-chains parallel with each other running around said drum, and provided with flights of proper dimensions arranged in staggered sections, whereby the cane chips are positively immersed within the well and are elevated therefrom, and a forwardly-extending chute interacting with said flights for elevating the cane chips.

9. In a sugar-cane mill, the combination with a crusher adapted to flatten the cane and express a portion of its juice, means for reducing the flattened cane to chips, and a diffusion-well arranged to receive the cane chips in flattened condition and provided with a partially-immersed horizontal drum, of a conveyer comprising sprocket-chains parallel with each other running around said drum and provided with flights of proper dimensions carried by said sprocket-chains and having notches in their outer edges, and an upwardly-extending chute interacting with said flights for the elevation of the cane

chips and the return of the non-absorbed liquid to the diffusion-well.

10. In a sugar-cane mill, the combination with means for crushing the cane and thereby flattening it and expressing a portion of its juice, means for reducing the flattened cane to chips, a series of diffusion-wells, means for positively immersing the cane chips within said wells to saturate them and for elevating the chips therefrom and a series of sets of re-pressing rolls to which the saturated cane chips are so elevated, of a cane-chip feeder composed of a series of sections of hard wood or other suitable material, a feed-table beneath the same, and means for successively advancing said feeder-sections so that the thrust of each feeder-section pushes the cane chips in contact with its inner end between the succeeding set of re-pressing rolls.

11. In a sugar-cane mill, the combination with means for crushing the cane and thereby flattening it and expressing a portion of its juice, means for reducing the flattened cane to chips, means for saturating the flattened chips, and re-pressing rolls for completing the expression of the juice, of a cane-chip feeder composed of a series of sections of hard wood or other suitable material, a table beneath the same, and means for successively advancing said feeder-sections including a series of eccentrics behind the respective sections.

12. In a sugar-cane mill, the combination with means for crushing the cane and thereby flattening the same and expressing a portion of its juice, means for reducing the flattened cane to chips, means for saturating the flattened chips, and re-pressing rolls for completing the expression of the juice, of a cane-chip feeder composed of a series of sections of hard wood or other suitable material, a table beneath the same, a series of eccentrics behind the respective feeder-sections, a shaft octagonal in cross-section common to said eccentrics, upon which the same are arranged on eighths, and means for transmitting motion from the respective eccentrics to the respective feeder-sections.

13. In a sugar-cane mill, the combination with means for crushing the cane and thereby flattening the same and expressing a portion of its juice, means for reducing the flattened cane to chips, means for saturating the flattened chips, and re-pressing rolls for completing the expression of the juice, of a cane-chip feeder for each set of re-pressing rolls composed of a series of feeder-sections, means for reciprocating said feeder-sections and a table beneath the feeder-sections having its delivery edge close to the periphery of the lower roll and constructed with juice-conducting grooves in its upper surface extending in the direction of the feed to said delivery edge.

14. In a sugar-cane mill, the combination with means for crushing the cane and thereby flattening the same and expressing a portion of its juice, means for reducing the flattened cane to chips, means for saturating the flattened chips and re-pressing rolls for completing the expression of the juice, of a cane-chip feeder for each set of re-pressing rolls composed of a series of feeder-sections, means for reciprocating said feeder-sections and a table beneath the feeder-sections having its delivery edge close to the periphery of the lower roll and constructed with juice-conducting grooves in its upper surface extending in the direction of the feed to said delivery edge, and of increasing capacity as they approach said edge.

15. In a sugar-cane mill, the combination of means for crushing the cane and thereby flattening the same and expressing a portion of its juice, means for reducing the flattened cane to chips, re-pressing rolls for completing the expression of the juice, and means for saturating the flattened chips in advance of each re-pressing operation, such saturating means comprising diffusion-wells constructed with trough-terminals leading to openings in the front walls of the wells and means for collecting the juice from said re-pressing rolls including troughs some of which communicate with such trough-terminals.

16. In a sugar-cane mill, the combination of means for crushing the cane and thereby flattening the same and expressing a portion of its juice, means for reducing the flattened cane to chips, re-pressing rolls for completing the expression of the juice, and means for saturating the flattened chips in advance of each re-pressing operation, such saturating means comprising diffusion-wells constructed with trough-terminals leading to openings in the front walls of the wells, means for collecting the juice from said re-pressing rolls including troughs some of which communicate with such trough-terminals, a partially-immersed horizontal drum within each diffusion-well, sprocket-chains parallel with each other running around said drum, and flights connecting pairs of said chains with each other and adapted to carry the cane chips beneath said drum and to mix with the liquid contents of the well the juice so introduced.

17. A sugar-cane mill having, in combination, a set of crushing-rolls and several sets of re-pressing rolls, each set being composed of two rolls fast on horizontal shafts one above the other and all the lower rolls having their bearings in one and the same horizontal plane, and means for driving said rolls in unison composed of an engine and a longitudinal shaft to which said engine is directly coupled, common to all, worms fast on said longitudinal shaft, worm-wheels meshed by said worms and fast on the shafts of said lower rolls, respectively, and spur-gearing connecting the shafts of each set of rolls.

18. A sugar-cane mill having, in combina-

tion, a set of crushing-rolls and several sets of re-pressing rolls, each set being composed of two rolls fast on horizontal shafts one above the other and all the lower rolls having their bearings in one and the same horizontal plane, means for driving said rolls in unison comprising an engine and a horizontal shaft common to all and worm-gearing transmitting motion from said longitudinal shaft to the several sets of rolls, a high-speed cutter arranged between said crushing-rolls and the first set of re-pressing rolls for reducing the flattened cane to chips, an independent high-speed motor, and means for transmitting motion from said independent motor to said cutter.

19. A sugar-cane mill having, in combination, a set of crushing-rolls and several sets of re-pressing rolls each set being composed of two rolls fast on horizontal shafts one above the other and all the lower rolls having their bearings in one and the same horizontal plane, means for driving said rolls in unison comprising an engine and a horizontal shaft common to all and worm-gearing transmitting motion from said horizontal shaft to the several sets of rolls, means for reducing to chips the flattened cane as discharged by said crushing-rolls, diffusion-wells in a lower plane between the successive sets of rolls, intermediate conveyers for immersing the cane chips in said wells and reëlevating the same therefrom, and sprocket-chain gearing transmitting motion to said conveyers from the shafts of the several upper re-pressing rolls.

20. A sugar-cane mill having, in combination, a set of crushing-rolls and several sets of re-pressing rolls each set being composed of two rolls fast on horizontal shafts one above the other and all the lower rolls having their bearings in one and the same horizontal plane, means for driving said rolls in unison comprising an engine and a horizontal shaft common to all and worm-gearing transmitting motion from said horizontal shaft to the several sets of rolls, means for reducing to chips the flattened cane as discharged by said crushing-rolls, means for saturating the cane chips between the successive sets of rolls, mechanical cane-chip feeders for the successive sets of re-pressing rolls, and mechanism transmitting motion to said feeders from the shafts of the several upper re-pressing rolls, substantially as hereinbefore specified.

MARK R. SPELMAN.

Witnesses:
H. B. LODOR,
MURRAY SAYER.