(No Model.)

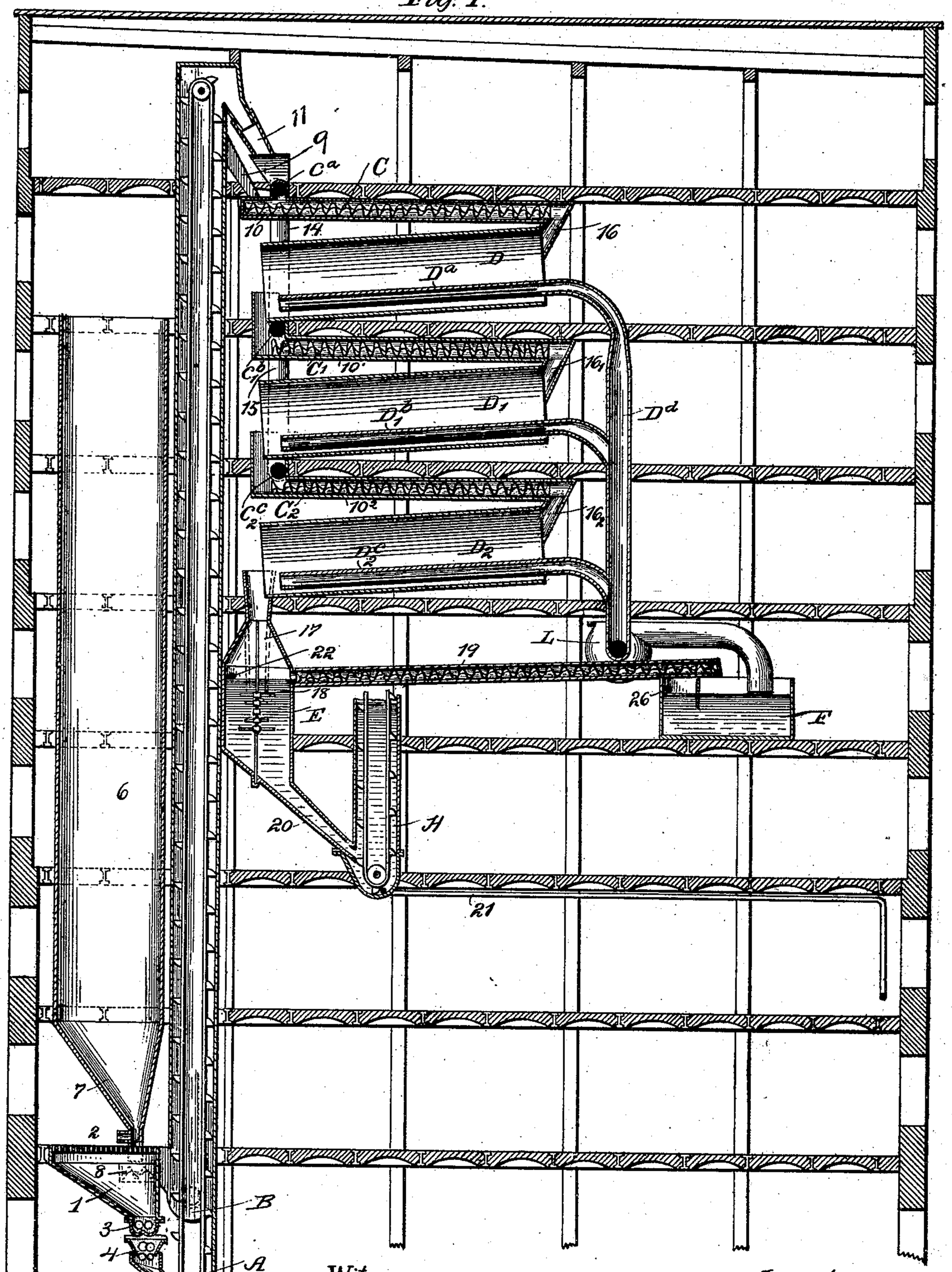
4 Sheets—Sheet 1.

G. ENGEL.

PROCESS OF REFINING SUGAR.

No. 501,878. Patented July 18, 1893.

Fig. 1.



Witnesses.
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Attorney.

(No Model.)

4 Sheets—Sheet 2.

G. ENGEL.

PROCESS OF REFINING SUGAR.

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Fig. 2.

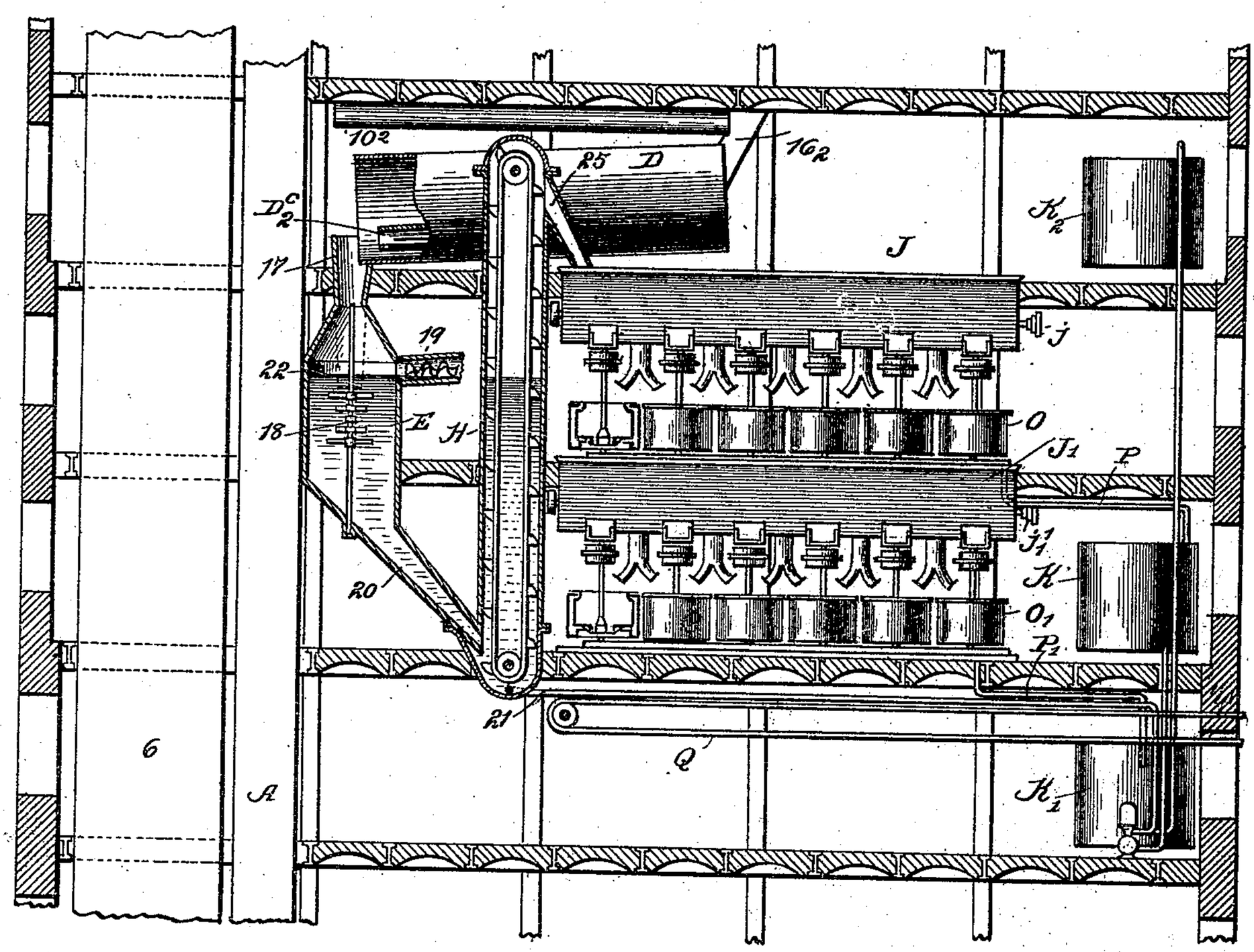
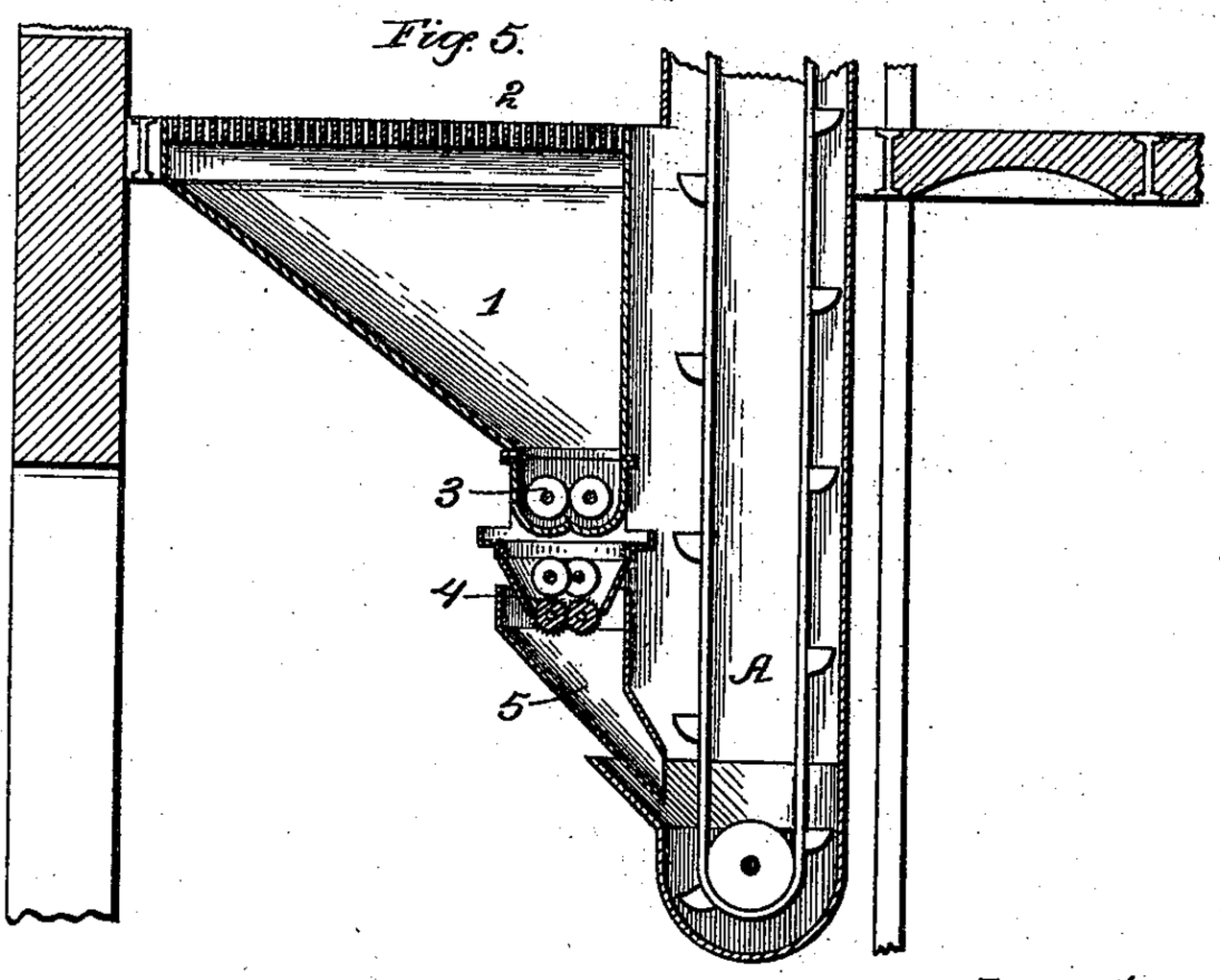


Fig. 5.



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4 Sheets—Sheet 3.

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Fig. 3.

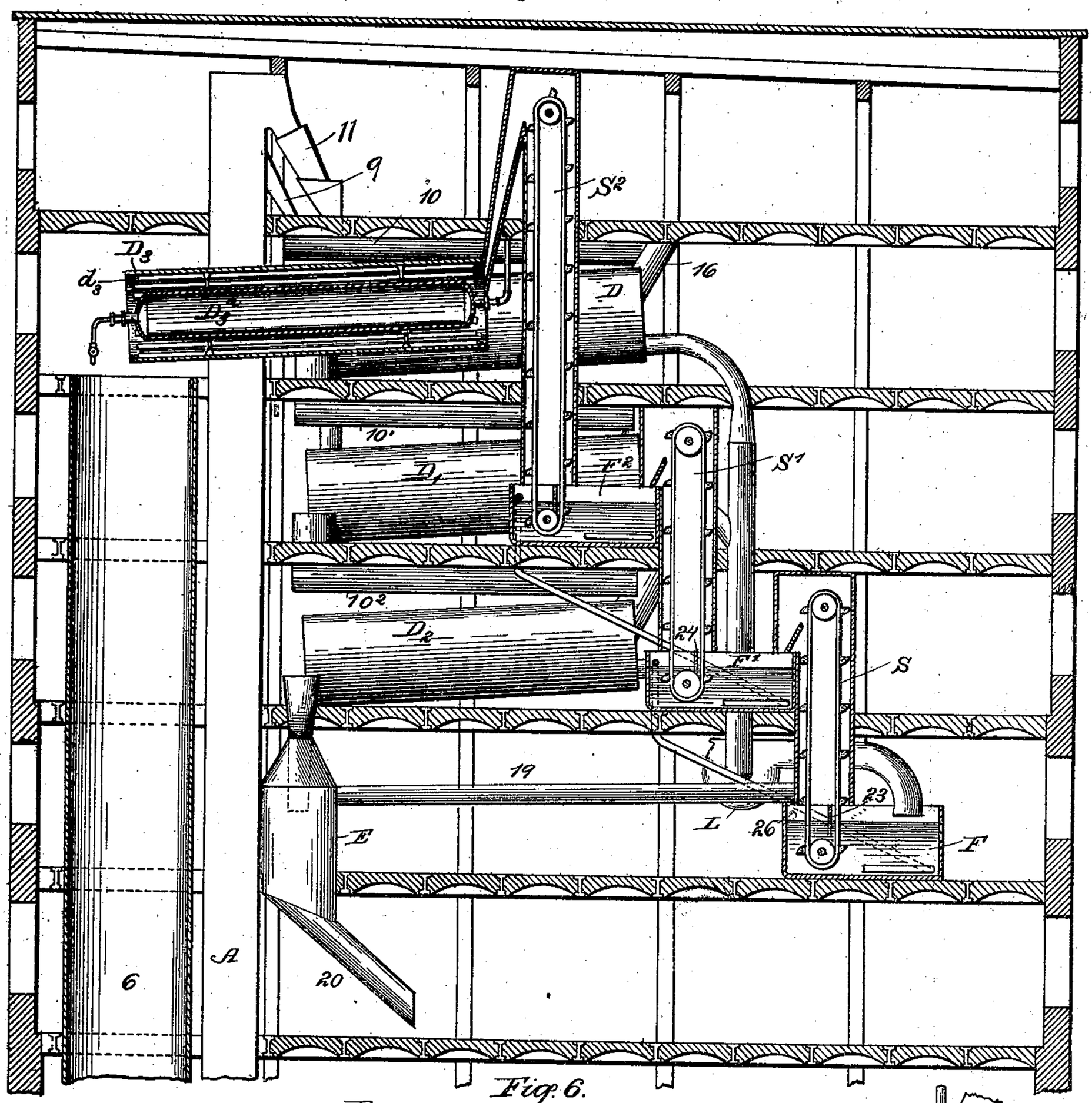
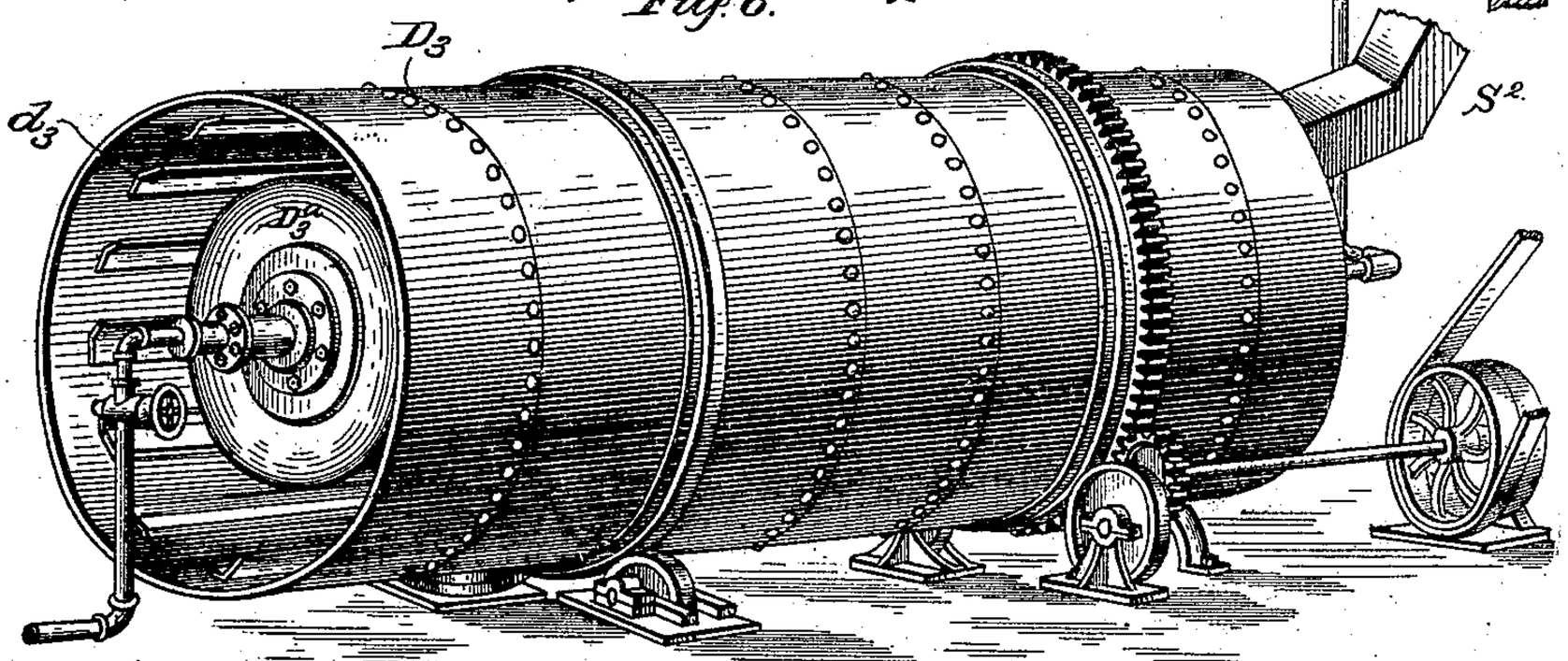


Fig. 6.



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4 Sheets—Sheet 4.

G. ENGEL.

PROCESS OF REFINING SUGAR.

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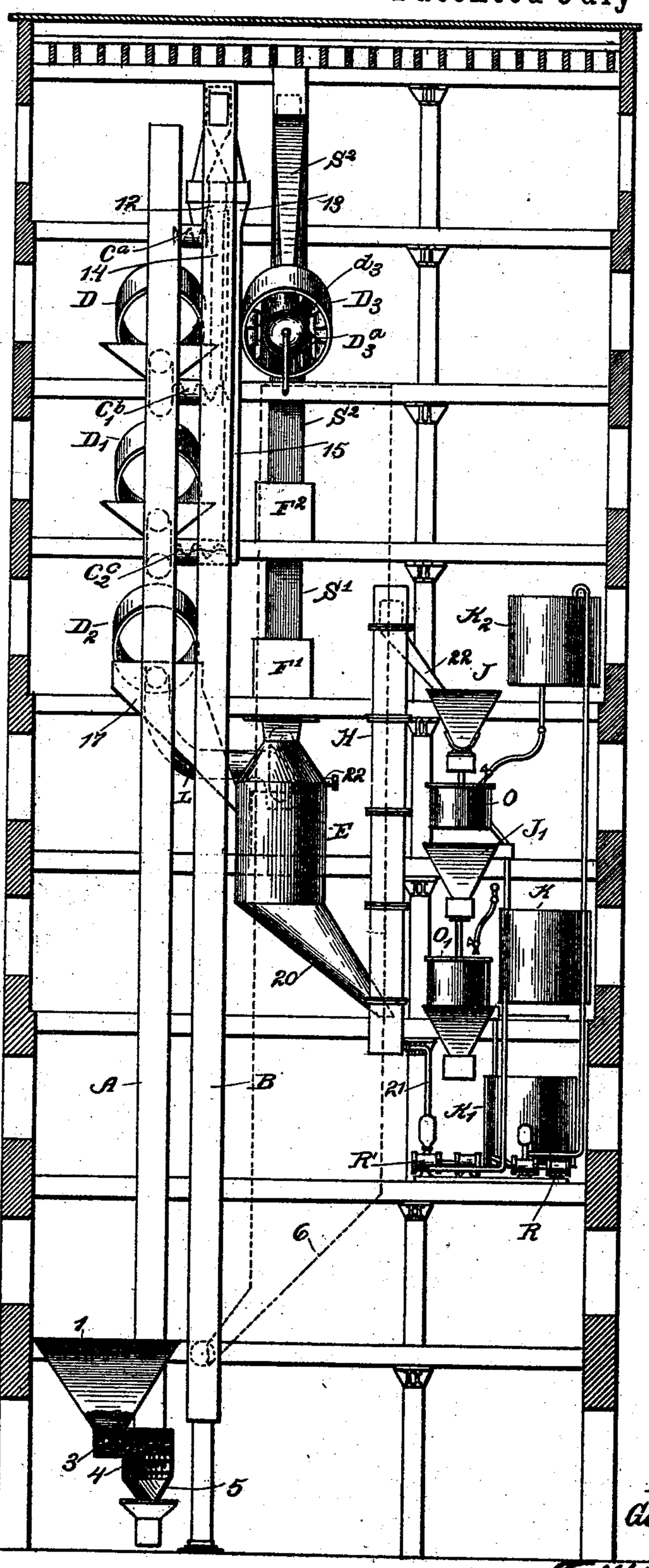
Fig. 4.



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UNITED STATES PATENT OFFICE.

GODFREY ENGEL, OF SOUTH BALTIMORE, MARYLAND.

PROCESS OF REFINING SUGAR.

SPECIFICATION forming part of Letters Patent No. 501,878, dated July 18, 1893.

Application filed November 17, 1892. Serial No. 452,302. (No specimens.)

To all whom it may concern:

Be it known that I, GODFREY ENGEL, a citizen of the United States, residing at South Baltimore, in the county of Anne Arundel and State of Maryland, have invented certain new and useful Improvements in Processes for Cleansing and Decolorizing Raw Sugar; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to the art of manufacturing sugar, and consists in an improved process for cleansing and decolorizing raw sugar, by intimately mixing with it in its natural condition a solid substance in either a finely or coarsely divided form, and subsequently separating the cleansing substance from the sugar, which will be more fully hereinafter described, and particularly pointed out in the claims.

Heretofore the cleansing and decolorization of sugar has usually been effected by treating the raw sugar as follows: First, giving the sugar a preparatory washing, whereby the gross impurities of the sugar are removed; second, dissolving the sugar in water, whereby the sugar is separated from its insoluble impurities; third, filtering the sugar solution through bone black filters, in order to decolorize the sugar; fourth, crystallizing the sugar from the sugar solution, accompanied by concentration of the solution; fifth, drying the sugar.

The complete process thus summarized is rendered very expensive by the large boiler plant required to furnish steam for heating the water used to dissolve the raw sugar, and for concentrating and crystallizing out the purified sugar, and also by the large amount of bone black used in the filtration process, and the expensive apparatus required therefor. Moreover, sugar is lost by inversion through the application of heat for the purpose of crystallization.

One object of my invention is to substitute for the present process of cleansing and decolorizing sugar, a process in which the expensive sub-processes of dissolving the raw sugar, cleansing it by filtration, and crystallization of the purified product are replaced by less expensive and more simple processes, which can be performed entirely by machinery of a less expensive character than that at present used, by the use of which the expert help at present required to supervise the crystallization of the sugar can be dispensed with, thus cheapening the cost of the final product.

Another object of my invention is to provide a process for cleansing and decolorizing sugar, the various steps of which are so arranged in relation to each other that the process can be carried on continuously, and without break or intermission, thereby enabling sugar to be produced much more rapidly than can be done by the present process.

Another object of my invention is to provide a process whereby the cleansing and decolorization of the raw sugar can be performed simultaneously, thereby effecting a further saving of time and labor in the production of the purified sugar. I accomplish these objects by the use of a process which consists of the following steps:

First. Cleansing the sugar crystals by intimately mixing them by mechanical means with a light, porous substance, which removes the sticky, molasses coating with which the sugar crystals are covered. This does away with the dissolving of the sugar.

Second. Bleaching the sugar crystals, in case they are colored internally, by saturating the cleansing substance with a bleaching reagent before it is mixed with the raw sugar, the thorough mixture which follows affording the bleaching reagent full time to act. This does away with the filtering process.

Third. Washing the sugar crystals, and at the same time separating out the substance used for cleansing, the liquid used for washing having no dissolving action on the sugar, and being of a specific gravity intermediate between that of the sugar and the cleansing substance, thus causing the sugar to sink to the bottom of the vessel in which the washing solution is contained, and the cleansing substance to rise to the surface of the solution. This does away with the crystallization process, and produces about the same kind of magma as that received from the crystallizing pans in the process now used.

Fourth. Drying the sugar crystals. This I perform by the use of centrifugal machines.

Fifth. Recovery and revivification of the

cleansing substance. This is performed by a series of washings, and a final drying, whereby the cleansing substance is completely revivified, and made ready to be used over again.

My process is especially designed for the treatment of the highest grade of raw sugar, which is called in the art "centrifugal" sugar, which as it comes to the sugar refineries is granulated in distinct granules a little larger than those found in granulated sugar, and which therefore can be reduced slightly in size by the removal of their outside coating of molasses and dirt without suffering any detriment, but it can also be used with lower grades of raw sugar, provided they have a distinct grain.

My process is practically a dry process with some moisture, as the sugar is first treated in its natural or dry state, is at no time dissolved in water, though it may be dampened according to circumstances, and is only introduced into a liquid to enable a complete separation between it and the cleansing substance to be effected. By the use of my process a fine grade of sugar, and a low molasses are obtained, and there is no waste, as the waste products are all recovered.

My process is carried out by the apparatus represented in the drawings accompanying and forming a part of this specification, in which the same reference numerals refer to the same or corresponding parts, and in which—

Figure 1 represents that portion of the apparatus by which the mixture of the cleansing substance with the sugar, the cleansing of the sugar, and the separation of the sugar from the cleansing substance is effected. Fig. 2 represents that portion of the apparatus wherein the sugar, separated from the cleansing substance, undergoes a final purifying treatment in the mixers and centrifugals, and is finally dried. Fig. 3 represents that portion of the apparatus wherein the recovery and revivification of the cleansing substance is effected, that portion of the apparatus represented in Fig. 1 being also shown in full lines. Fig. 4 is a section of a building in which my process is employed, showing the relative positions of the apparatus employed, and particularly showing the location of the tanks which contain the liquor with which the sugar is treated in the centrifugals. Fig. 5 is a detail view of the sugar dump, and the apparatus for feeding the sugar into the sugar elevator. Fig. 6 is a detail perspective view of the rotating drum used to dry the cleansing substance.

Referring to the drawings, 1 represents the receptacle into which the raw sugar is first dumped, it being provided with an inclined bottom, as shown, which directs the quantities of raw sugar, as they fall upon it through the perforated grating 2, with which the top surface of the sugar dump 1 is provided, and which is used to prevent the passage of large lumps into the interior of the sugar dump, which would otherwise speedily clog up the apparatus, to the conveying screw 3, which is located at the lower mouth of the sugar dump, and which conveys the sugar, in quantities regulated by the speed at which it is driven, to the crushing rollers 4, which break up any small lumps which may be present in the sugar, and deliver it, through the spout 5, into the boot of the sugar elevator A, in a finely divided or powdered condition, so that it may be readily mixed with the cleansing substance. The cleansing substance, which is in a finely or coarsely divided condition, is contained in the storage bin 6, which extends from the bottom nearly to the top of the building in which my process is to be employed, and which is provided at its lower end with a funnel-shaped opening 7, at the lower end of which works a conveying screw 8, which conveys the cleansing substance to the boot of the elevator B, placed parallel to the elevator A. For a reason which will hereinafter appear, the amount of cleansing substance carried up by the elevator B is treble the amount required for any one treatment of the sugar. This may be effected by using a larger size of conveying screw, or by making the conveying screw rotate at a higher rate of speed than does that used in connection with the elevator A, or by the use of both means. The cleansing substance used is preferably lighter than the raw sugar, so that it may be readily separated therefrom, may be used in all the grades of size from a coarsely divided to a finely divided or pulverized form, and should have an outer surface more or less rough, so that the particles of dirt carried by the sugar, and the molasses coating of the same, may find ready lodgment on its surface. When the raw sugar is to be decolorized, as well as cleansed, the cleansing substance is saturated with some bleaching reagent before removal from the storage bin, or as the sugar and cleansing substance intermingle with each other in the mixing screw, to be described later. For such bleaching reagent I preferably use phosphoric acid, although I may use other reagents, such, for instance, as binoxide of hydrogen in a liquid form; or I may perform the bleaching action by drawing a bleaching gas, such as chlorine, ozone, &c., through the revolving drums, wherein the sugar is separated from the cleansing substance by means of the exhaust draft provided for the removal of such cleansing substance, in this latter case the bleaching gas being allowed to enter the said revolving drums instead of the atmosphere.

As examples of cleansing substances which I intend to use, I mention sawdust, cork, brown coal, &c., though I do not limit or confine myself to the use of these substances, as other substances may be used.

The elevator A discharges the sugar through its funnel 9 into the trough 10, in which is continually working a conveyer screw C, which is, as shown, of considerable length. Elevator

B discharges through its funnel 11 into the short conveying screw C^a, which runs at right angles to the conveying screw C and discharges its contents into the same, a sufficient quantity of the cleansing substance for one treatment of the sugar, distributing the remainder of the cleansing substance which it carries between the funnels 12 and 13 of the tubes 14 and 15, whose function will hereinafter appear. An even distribution of the cleansing substance between the upper cross-conveying screw C^a, and the funnels 12 and 13 is secured by giving a pendulum motion to the funnel 11 of the elevator B. The raw sugar and the cleansing substance, thus discharged into the trough 10, are thoroughly and intimately intermixed as they are carried along by the conveying screw C, the rolling action between the sugar and the cleansing substance resulting in the latter becoming covered with the sticky, molasses coating of the sugar, and the former being partially bleached by the action of the bleaching reagent with which the cleansing substance is saturated. Both the sugar and the cleansing substance fall from the conveyer screw C into the inclined spout 16, which discharges into the revolving drum D, which is open at both ends, and caused to revolve by means of gearing, such as that represented in Fig. 6. This drum is slightly inclined forward, and has extending through it, considerably below its axis of rotation, a pipe D^a, provided on its lower surface with a number of longitudinal slots extending its whole length, which is connected to the main exhaust pipe D^d, in which an outward draft is maintained by the blower L. As the sugar and the cleansing substance fall from the inclined spout 16 into the rotating drum D, a natural separation of the two takes place on account of their differing specific gravities, the sugar falling farther into, and rolling down the inclined bottom of the rotating drum faster than the cleansing substance. The separation, however, is made thorough, and the cleansing substance removed, by the outward draft maintained in the slotted exhaust pipe D^a, which sucks up and carries away the cleansing substance, but does not have any effect on the sugar, on account of the greater weight of the same. The cleansing substance is finally deposited in the tank F, where it undergoes a treatment which will be hereinafter described. The sugar, partially cleansed and separated from the cleansing substance with which it has been treated, falls from the drum D into the trough 10′, where there is a second conveyer screw C′. Here it is met with a fresh quantity of cleansing substance, delivered from the tube 14 by the short conveyer screw C'^b, and is again thoroughly and intimately mixed with the cleansing substance, a further portion of the molasses coating of the sugar being removed, and the bleaching action of the bleaching reagent continuing. It is discharged by conveyer screw C′ into the funnel 16′, and is by that discharged into the rotating drum D′. Here again the separation of the cleansing substance, which has become covered with molasses and hence is incapable of exerting a further cleansing action, from the sugar is repeated by means of the slotted pipe D'^b, which discharges the cleansing substance it carries away into the same tank F into which the previous quantity of cleansing substance was delivered. The cleansing operation is again repeated in a manner similar to that above described by the conveying screw C^2, working in trough 10^2, into which the sugar falls from drum D′, (a fresh quantity of cleansing substance being supplied by pipe 15 and cross-conveying screw C^{2c},) the inclined funnel 16^2, the rotating drum D^2, and the slotted exhaust pipe D^{2c}, the sugar, which has been thoroughly cleansed and is bleached to the proper color, being finally delivered through the pipe 17, slotted at its lower end, into the water tight reservoir E, which is filled with a liquid incapable of exerting a dissolving action on the sugar, and of a specific gravity intermediate between that of the cleansing substance and the sugar. The liquid preferably used, and that to which I shall hereinafter refer, is a saturated solution of sugar in water, or sugar liquor. In reservoir E is revolving an agitator 18, which extends lengthwise of the cylinder. A final separation between the sugar, and whatever cleansing substance may remain mixed with it, is effected in this reservoir, as the sugar, being heavier than the sugar liquor, will fall to the bottom of the reservoir, while the cleansing substance, being lighter than the sugar liquor, will remain on the top of said liquor until it is carried away by the conveying screw 19, and discharged into the tank F, the common receptacle of the quantities of cleansing substance used in the previous cleansing process. The agitator 18 keeps the sugar liquor stirred up, and thus facilitates the carrying away of the cork.

The separation of the cleansing substance from the sugar crystals effected in the manner and by the steps hereinbefore described is mechanical in that it is brought about by the positive action of physical agencies, but no limitation is meant to be made to any particular apparatus for performing the separation. Any equivalent which separates the cleansing substance mechanically from the sugar which acts in a positive manner, and by means of the action of physical laws can be used in place of that herein described. The sugar, which has fallen to the bottom of the reservoir E, falls farther down the inclined spout 20, being continually subjected to the scouring action of a stream of sugar liquor delivered through the pipe 21, into the boot of the elevator H. The joint between the inclined spout 20, and the casing of the elevator H is water-tight, so that no liquor can escape. The elevator H has perforated buckets, and thus the sugar which it carries is al-

lowed to drain. The sugar is deposited from the elevator H through the spout 25 into the mixer J, in which an agitator *j* is constantly rotating, and is from that discharged into the centrifugals O. I use a series of centrifugals, only a portion of which are at any time employed, because any one pair or section of the centrifugals must at times be stopped to discharge its contents, and I wish to keep the cleansing apparatus, conveying screws, rotating drums, &c., constantly in motion. By so choosing the size of the centrifugals that they operate sufficiently rapid to carry off the sugar deposited into the mixer J when used in sections of two or more, I am enabled to accomplish my object. The sugar, which has been deposited into one or other of the sections of the centrifugals O, is washed by a liquor brought from the tank K^2, and the liquor is then expressed by the rapid rotation of the centrifugals, the expressed liquor falling into gutters in the bottoms of the outer casings of the centrifugals, and from thence into a common gutter P, which carries it to the tank K. After the sugar has become sufficiently dry, it is deposited into a second mixer J', provided with an agitator *j'*, from whence it is apportioned between the sections of the centrifugals O', washed with sugar liquor, which this time is perfectly fresh, the liquid expressed and carried into the tank K' by the gutter P', and the sugar, perfectly dry, and having undergone its final purification, is deposited upon the surface of the endless belt Q, by which it is carried away to be loaded into barrels. If desired, the liquor used to wash the sugar in the centrifugals, may have a slight bleaching action, so as to give a perfect tone to the sugar as it is finally delivered from the second centrifugals, or the entire bleaching action may be performed by this liquor, in which case the cleansing substance would not be saturated with a bleaching reagent.

I have said that the liquor which is used to cleanse the sugar in the second centrifugal is fresh, and perfectly pure, and this is necessary, because the sugar which it treats is to undergo its final purification, but the liquor expressed from the centrifugals O', and contained in the tank K', is not so dirty as to render it unadvisable to use it again, and hence it is pumped by the pump R into the tank K^2, from whence it is drawn to wash the sugar which is delivered into the centrifugals O. This liquor, again, which after being expressed is carried into the tank K, is still in condition to be reused, and hence is pumped by the pump R', into the boot of the elevator H, where it exerts a scouring influence, as has before been stated, on the sugar which has just been separated from the cleansing substance, and is about to undergo its final purification in the centrifugals and mixers. The overflow pipe 22 carries away the overflow of the sugar liquor in the reservoir E. It will thus be seen that an inverse order of selection of the grades of purity of the sugar, and the sugar solution with which it is to be treated, is maintained, the purest sugar being treated by the purest sugar liquor, the second grade of sugar with regard to purity being treated with sugar liquor which has been used once, and so on. By thus subjecting the sugar in its final stages of purification to the cleansing action of a liquor which is in a state of purity corresponding to that of the sugar it is used to cleanse, I obviate the excessive use of sugar liquor. The liquor which overflows from the reservoir E is carried to the refining vats, to undergo the process of refining used at present.

I have thus described how the sugar is purified. It remains to be stated how the cleansing substance, which has become dirty through contact with the raw sugar, is recovered and revivified.

In the tank F, in which all of the cleansing substance used has been collected, a current is maintained in a certain direction, which in Fig. 3 is represented as being from right to left. The cleansing substance, being lighter than the water, floats on its surface, and is carried toward the buckets of the elevator S, which works with its boot in the tank F, and is by said elevator carried up and discharged into the tank F'. The passage of the cleansing substance beyond the buckets of the elevator S is prevented by the partition 23, which extends across tank F in the position shown in Fig. 3. An overflow pipe 26 is provided for tank F. The tank F' is in all respects like tank F, having a current of water flowing in it from right to left, being formed with a partition 24, and having an elevator S' working with its boot in it, so that the cleansing substance is here again cleansed, and is discharged by the buckets of the elevator S' into the tank F^2. Since the cleansing substance is to be cleansed for the last time in the tank F^2, the water which is supplied is perfectly clean, and is preferably hot. The cork, taken from the tank F^2 by the elevator S^2, is discharged into the rotating drum D^3, (shown in detail in Fig. 6,) which is slightly inclined forward, and whose sides are provided with curved blades d^3. Through this drum extends the steam drum D^{3a}. Thus the cleansing substance, passing through the drum D^3, is dried, restored to its natural condition, and finally deposited in a condition to be used over again in the storage bin 6.

It should be stated that the buckets of elevators S, S', and S^2 are perforated, to allow for the drainage of the cleansing substance.

The overflow from tank F^2 is used to purify the cleansing substance in tank F', and the overflow from tank F' is used over again in tank F, the overflow from tank F passing to the refining vats, to be refined. It will thus be seen that the inverse order of selection of the cleansing substance and the water is maintained in this case, as it was in conducting the sugar through its final stages of purification.

In case phosphoric acid is used as a bleaching reagent, such of it as is washed from the cork by the process of cleansing used for the same may be removed by treating in separate tanks the contents of the tank F with lime, when the phosphoric acid will be precipitated as phosphate of lime. The contents of tank E may also be treated from time to time with lime, to remove any phosphoric acid which has been washed from the sugar.

I do not limit myself to the precise number of steps which I have herein described; but

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

1. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance such as cork, wood, or brown coal, to which the impurities of the sugar will adhere, and then mechanically separating the cleansing substance with the impurities adhering thereto from the sugar, substantially as described.

2. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance such as cork, wood, or brown coal lighter than the raw sugar and to which the impurities of the sugar will adhere, and then mechanically separating the cleansing substance with the impurities adhering thereto from the sugar by reason of their differing specific gravities, substantially as described.

3. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance lighter than the sugar, and to which the impurities of the sugar will adhere, separating the cleansing substance with the impurities adhering thereto from the sugar, effecting a final separation between the sugar and the cleansing substance by discharging the sugar into a vessel containing a liquor incapable of dissolving the sugar, and of a specific gravity intermediate between that of the sugar and the cleansing substance, and drying the sugar, substantially as described.

4. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance lighter than the sugar and to which the impurities of the sugar will adhere, separating the cleansing substance and the impurities adhering thereto from the sugar, effecting a final separation between the sugar and the cleansing substance by discharging the sugar into a vessel containing a liquor incapable of dissolving the sugar, and of a specific gravity intermediate between that of sugar and the cleansing substance, and repeatedly washing the sugar with a liquor of a grade of purity corresponding to that of the sugar it is to treat, after each washing expressing the liquor, substantially as described.

5. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance such as cork, wood, or brown coal, to which the impurities of the sugar will adhere, mechanically separating the cleansing substance with the impurities adhering thereto from the sugar, and recovering and revivifying the cleansing substance, substantially as described.

6. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, separating the cleansing substance with the impurities adhering thereto from the sugar, effecting a final separation between the sugar and the cleansing substance by discharging the sugar into a vessel containing a liquor having no dissolving action on the sugar and intermediate in specific gravity between the sugar and the cleansing substance, the different quantities of cleansing substance separated being all conveyed to a common receptacle, drying the sugar, and recovering and revivifying the cleansing substance, substantially as described.

7. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance such as cork, wood, or brown coal, to which the impurities of the sugar will adhere, mechanically separating the cleansing substance with the impurities adhering thereto from the sugar, and recovering and revivifying the cleansing substance by a series of washings and a final drying, substantially as described.

8. The herein described process of cleansing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, and which is of a less specific gravity than water, separating the cleansing substance with the impurities adhering thereto from the sugar, and recovering and revivifying the cleansing substance by a series of washings and a final drying, the purity of the water used for purifying the cleansing substance being of a grade corresponding to that of the substance it is to purify, substantially as described.

9. The herein described process of cleansing and decolorizing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, during such mixing subjecting the sugar to the action of a bleaching reagent, and then withdrawing the cleansing substance with the impurities adhering thereto, substantially as described.

10. The herein described process of cleansing and decolorizing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, and which is saturated with a bleaching reagent, and then withdrawing the cleansing substance with the impurities adhering thereto, substantially as described.

11. The herein described process of cleansing and decolorizing sugar, which consists in

mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, and which is saturated with a bleaching reagent, separating the cleansing substance with the impurities adhering thereto from the sugar, and recovering and revivifying the cleansing substance, substantially as described.

12. The herein described process of cleansing and decolorizing raw sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, which is saturated with a bleaching reagent and is lighter than the sugar, separating the cleansing substance with the impurities adhering thereto from the sugar, and recovering and revivifying the cleansing substance, substantially as described.

13. The herein described process of cleansing and decolorizing sugar, which consists in mixing with the raw sugar a finely or coarsely divided substance to which the impurities of the sugar will adhere, and which is saturated with a bleaching reagent, separating the cleansing substance with the impurities attached thereto from the sugar, effecting a final separation between the sugar and the cleansing substance by discharging the sugar into a vessel containing a liquid incapable of dissolving the sugar and of a specific gravity intermediate between that of the sugar and the cleansing substance, drying the sugar, and recovering and revifying the cleansing substance.

14. The herein described process of cleansing and decolorizing sugar, which consists in mixing with the raw sugar a finely or coarsely divided subtance to which the impurities of the sugar will adhere, which is saturated with a bleaching reagent, and is of a less specific gravity than water, separating the cleansing substance with the impurities attached thereto from the sugar, effecting a final separation between the sugar and the cleansing substance by discharging the sugar into a vessel containing a liquid incapable of dissolving the sugar and of a specific gravity intemediate between that of the sugar and the cleansing substance, the different quantities of cleansing substance separated being all conducted to a common receptacle, repeatedly washing the sugar with a liquor such as that above described and of a grade of purity corresponding to that of the sugar it is to cleanse, after each washing expressing the liquor, and recovering and revivifying the cleansing substance by repeatedly washing it with water of a grade of purity corresponding to that of the cleansing substance it is to purify, and finally drying the cleansing substance, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

GODFREY ENGEL.

Witnesses:
W. N. WAMSLEY,
WM. H. JONES.