(No Model.) 4 Sheets—Sheet 1.

F. D. CUMMER.

MECHANICAL DRIER.

No. 545,058. Patented Aug. 27, 1895.

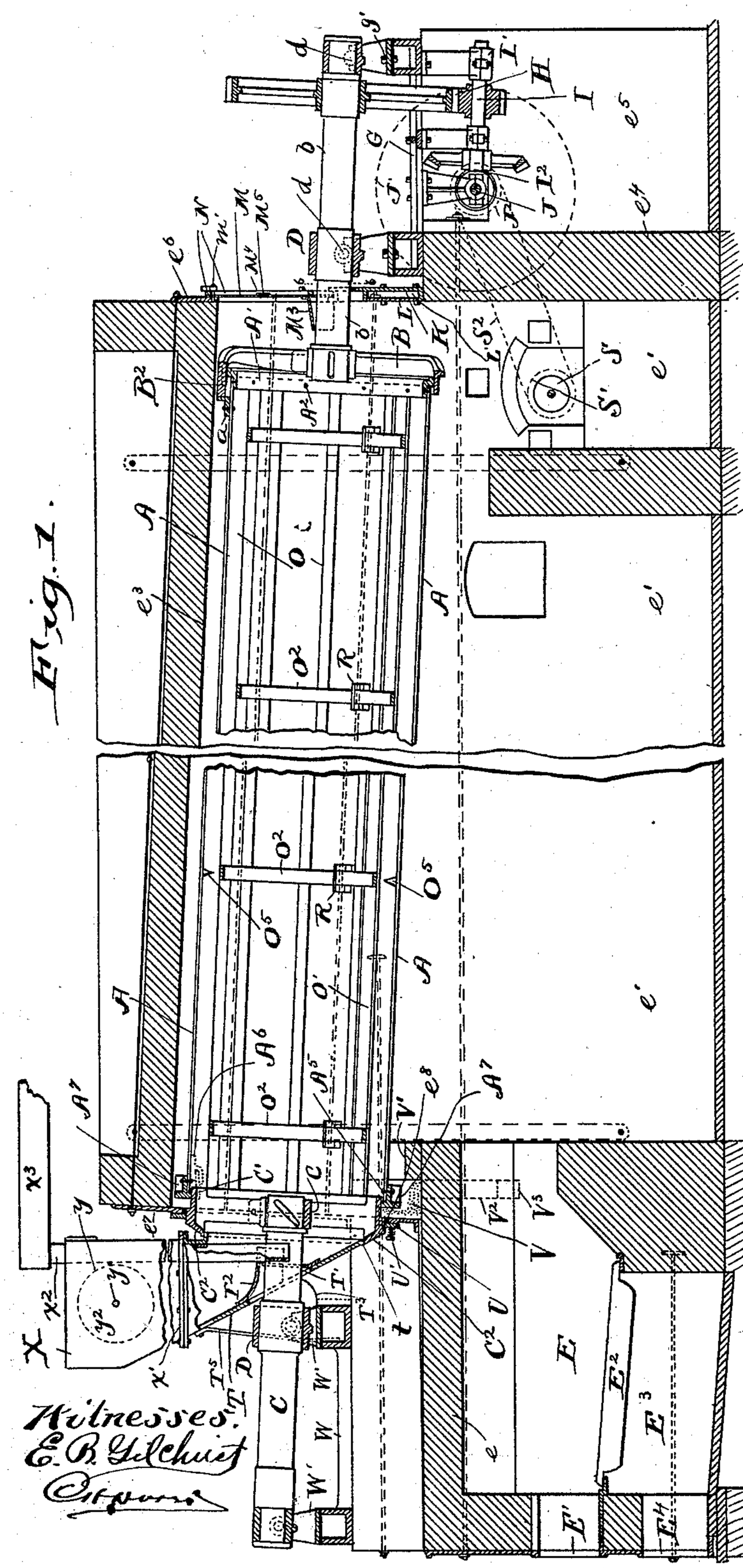

Fig. 1.

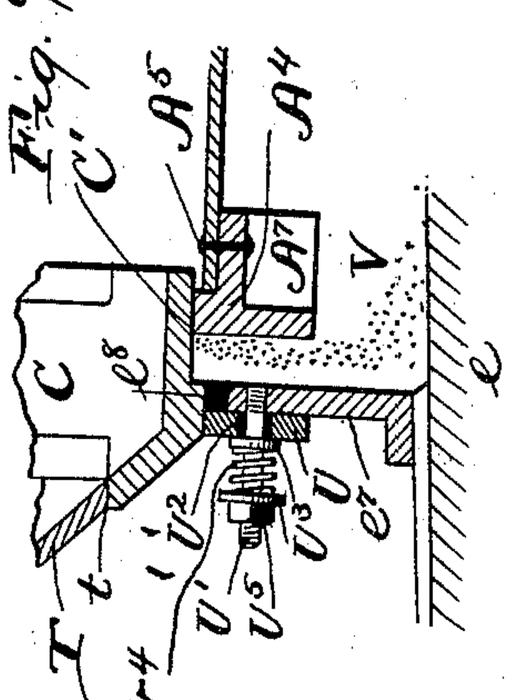

Fig. 9.

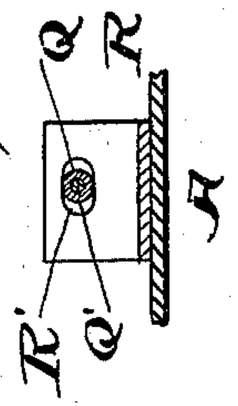

Fig. 8.

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(No Model.) 4 Sheets—Sheet 2.

F. D. CUMMER.

MECHANICAL DRIER.

No. 545,058. Patented Aug. 27, 1895.

Fig. 2.

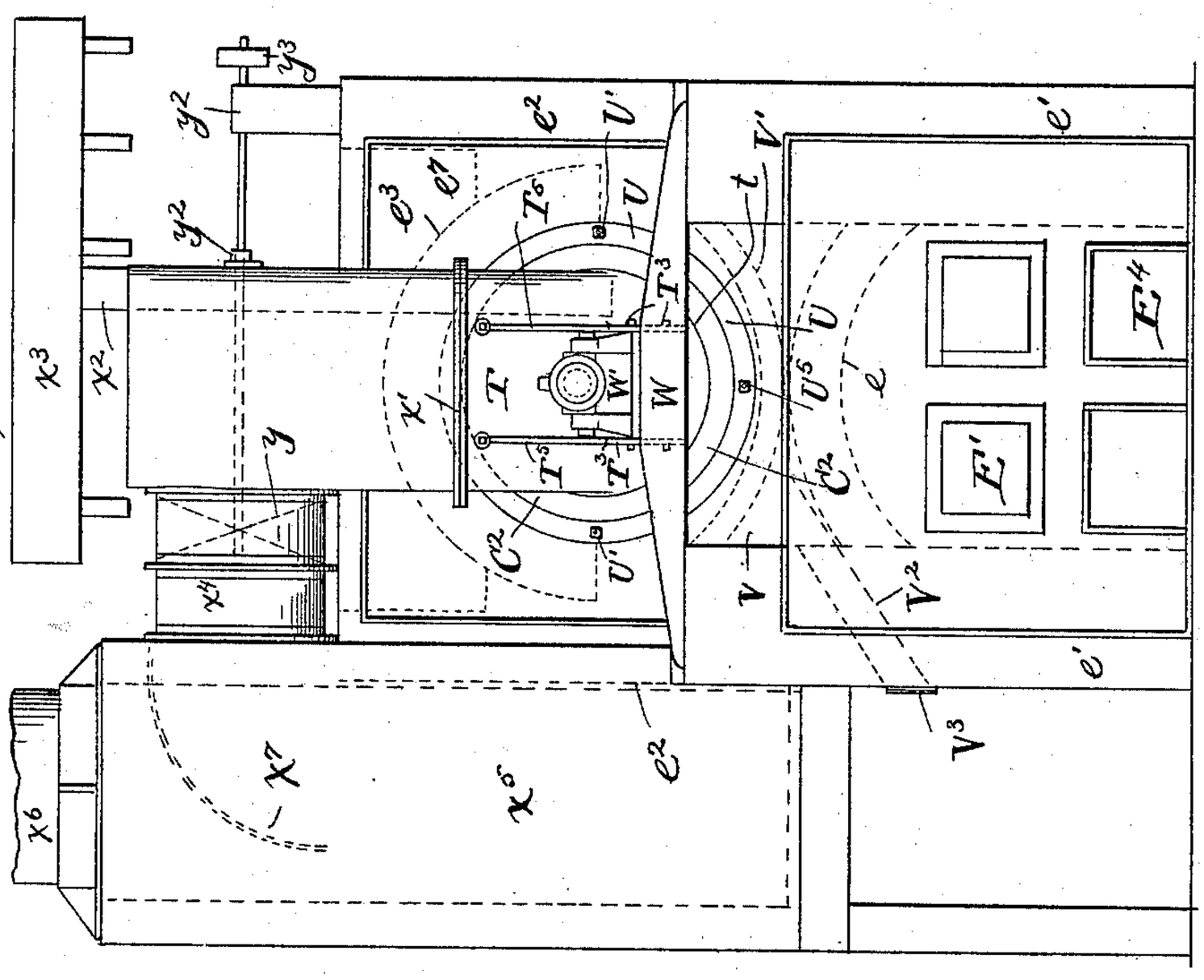
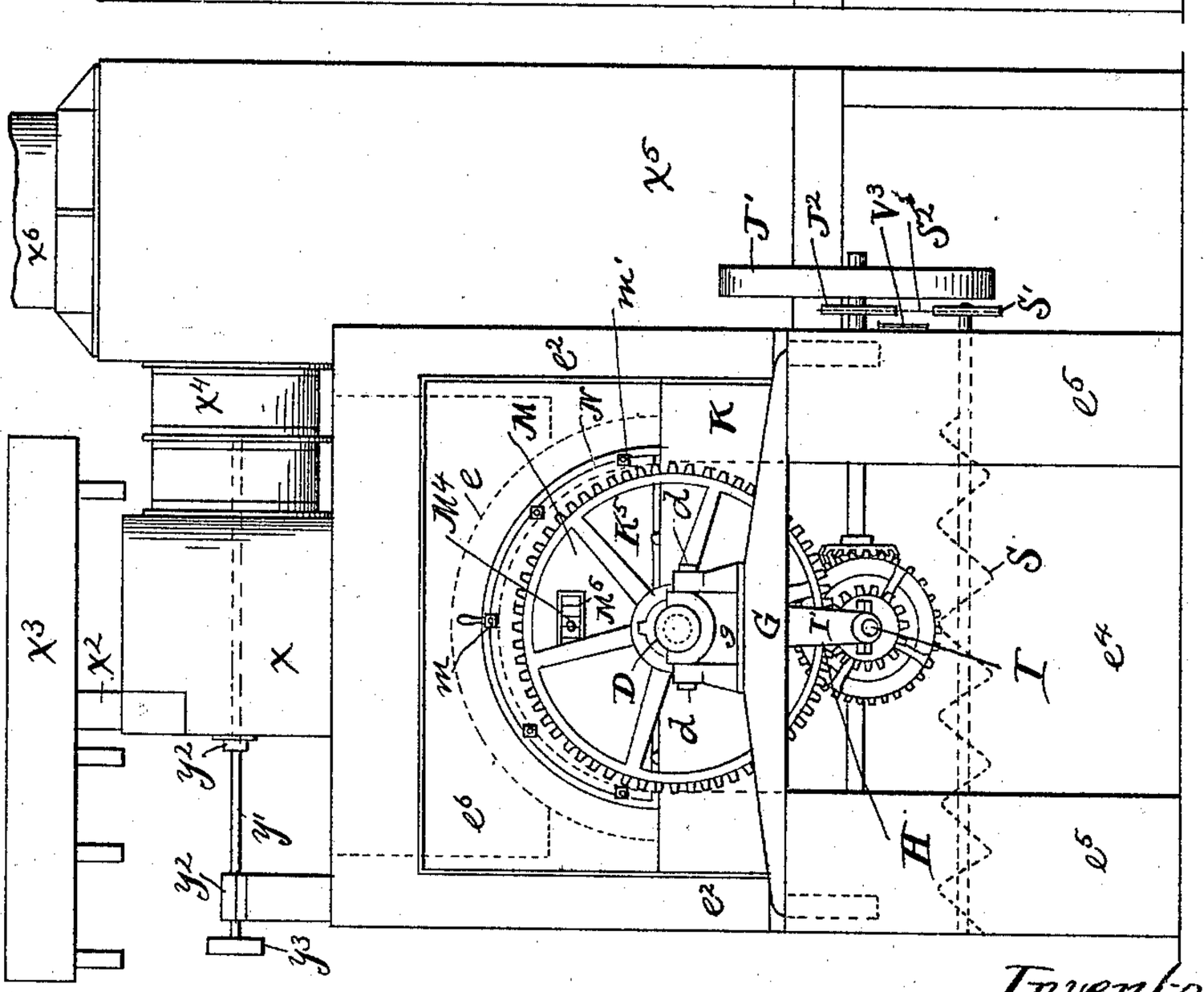


Fig. 3.



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(No Model.) 4 Sheets—Sheet 3.

F. D. CUMMER.

MECHANICAL DRIER.

No. 545,058. Patented Aug. 27, 1895.

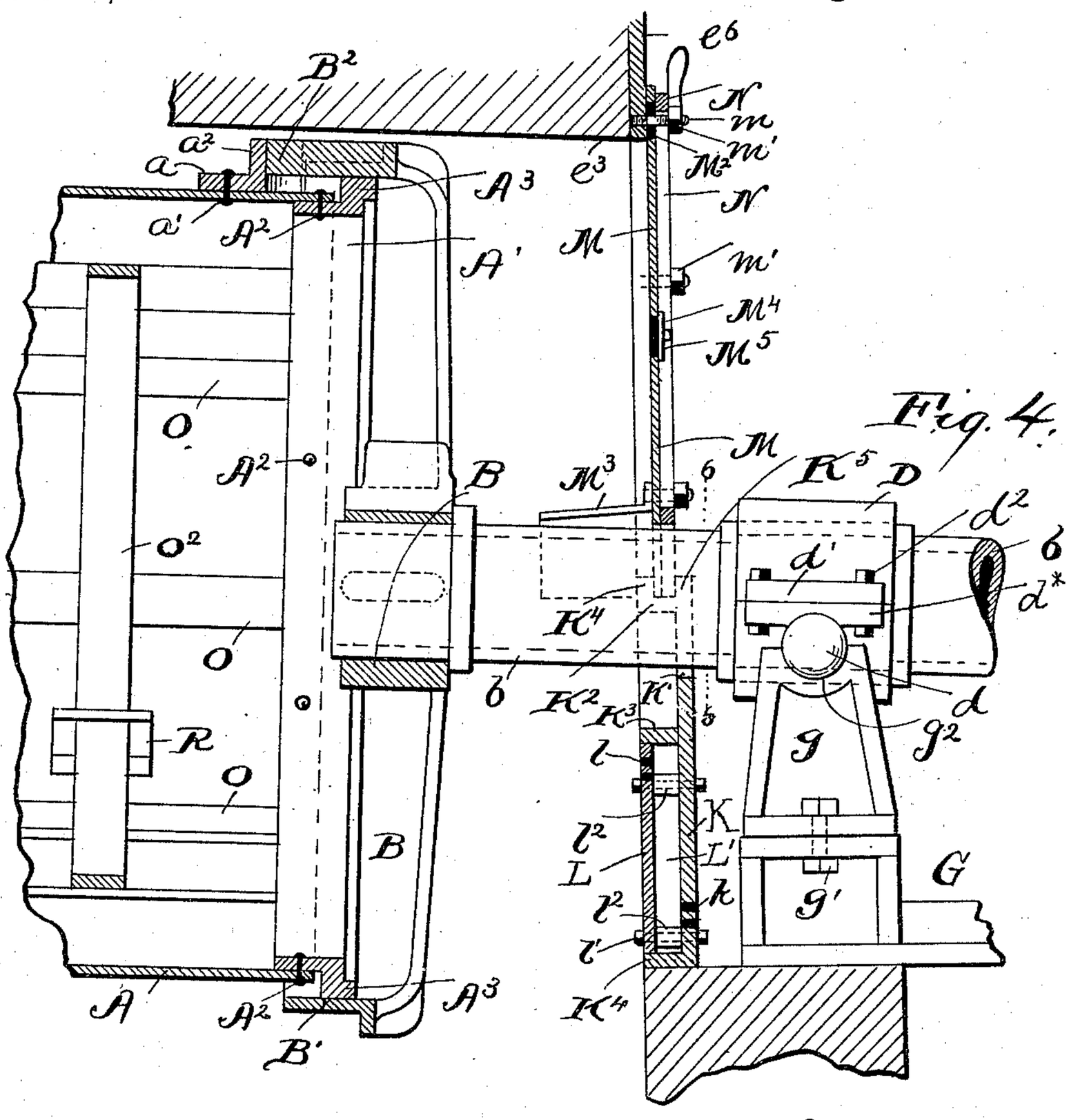

Fig. 4.

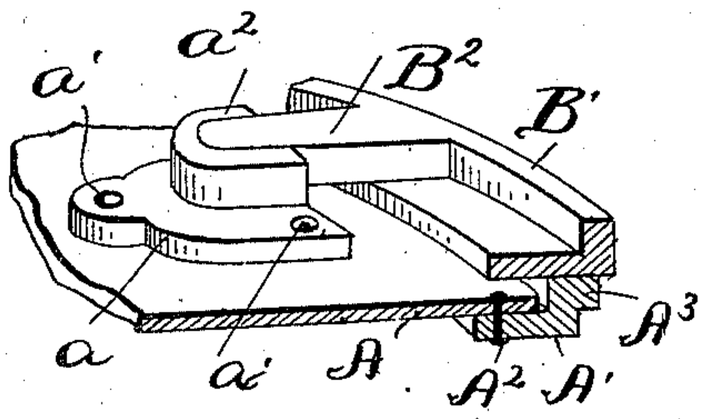

Fig. 5.

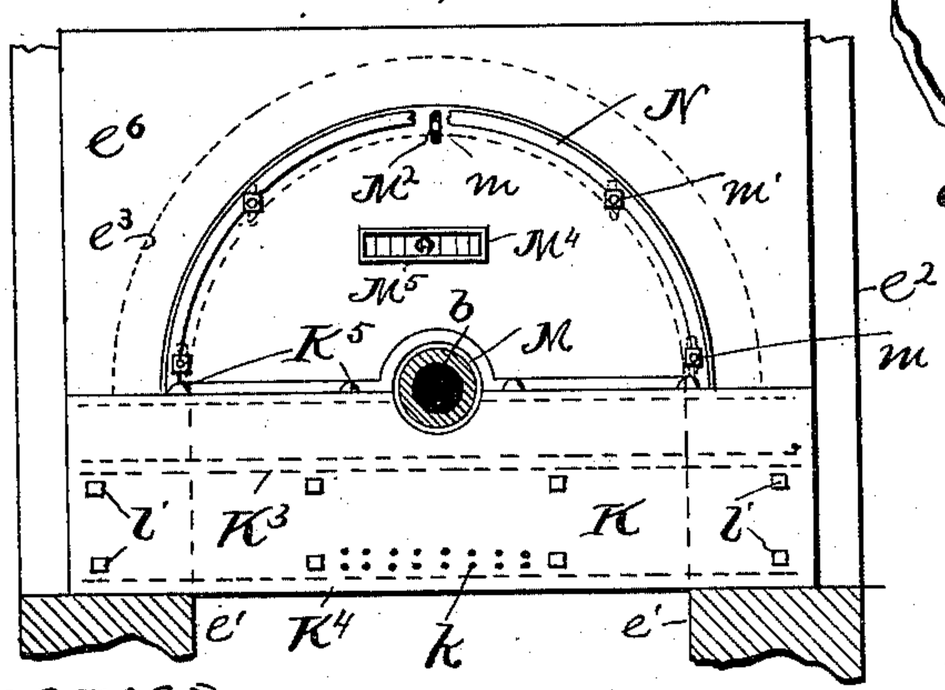

Fig. 6.

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(No Model.)

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F. D. CUMMER.

MECHANICAL DRIER.

No. 545,058. Patented Aug. 27, 1895.

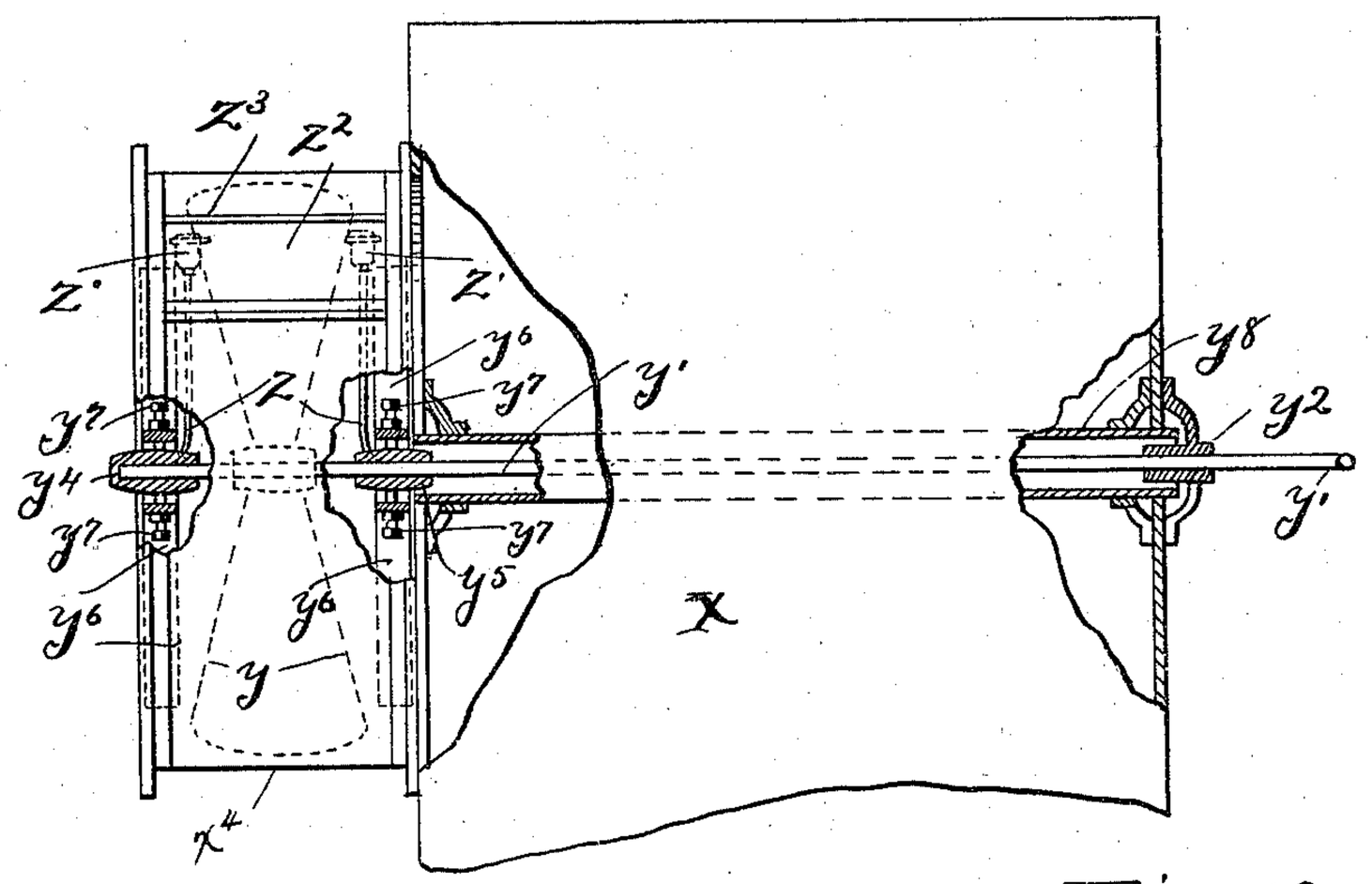


Fig. 10.

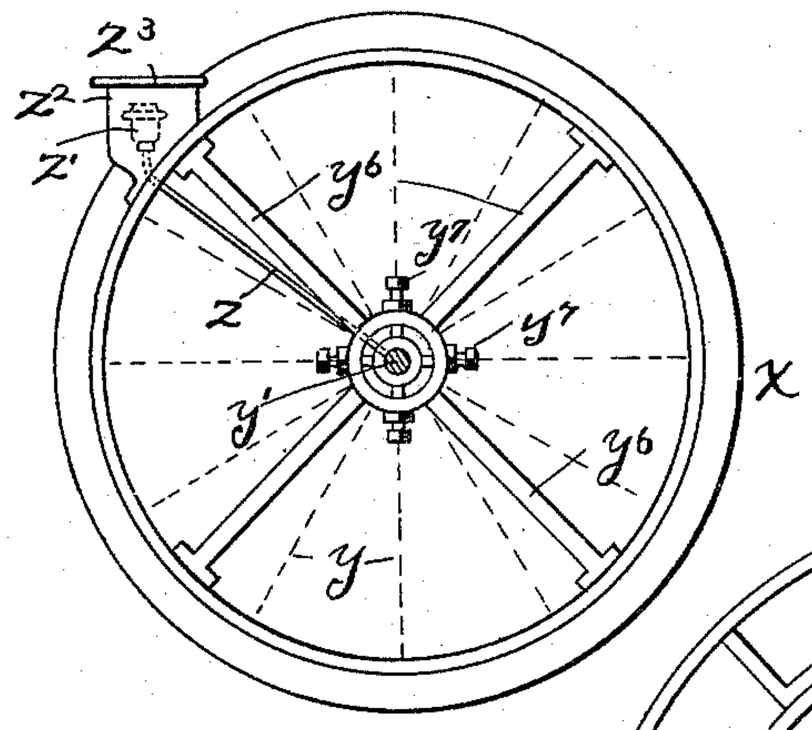
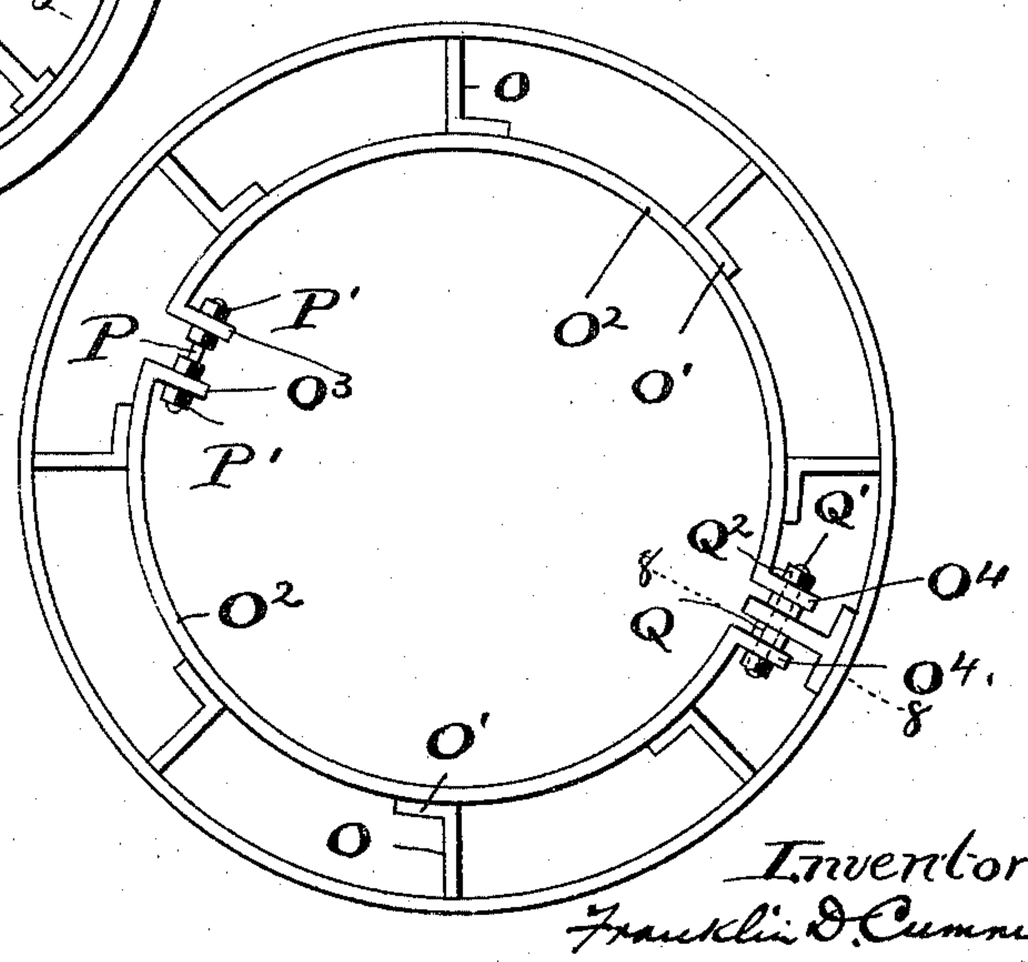


Fig. 11.

Fig. 7.



Witnesses,
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C. Brown

Inventor:
Franklin D. Cummer

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UNITED STATES PATENT OFFICE.

FRANKLIN D. CUMMER, OF CLEVELAND, OHIO, ASSIGNOR TO ELIZA E. CUMMER, OF SAME PLACE.

MECHANICAL DRIER.

SPECIFICATION forming part of Letters Patent No. 545,058, dated August 27, 1895.

Application filed April 9, 1894. Serial No. 506,856. (No model.) Patented in England November 30, 1893, No. 23,045; in Canada August 2, 1894, No. 46,714; in France October 20, 1894, No. 229,228, and in Belgium October 20, 1894, No. 85,777.

To all whom it may concern:

Be it known that I, FRANKLIN D. CUMMER, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Mechanical Driers and Processes of Drying and Disintegrating Materials, (for which I have obtained Letters Patent in the following countries: England, dated November 30, 1893, No. 23,045; Canada, dated August 2, 1894, No. 46,714; France, dated October 20, 1894, No. 229,228; Belgium, dated October 20, 1894, No. 85,777, and have applications pending in Germany, Victoria, New Zealand, and New South Wales;) 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 improvements in mechanical driers and to a novel process of drying and disintegrating materials; and the invention consists, in addition to the process hereinafter described, in certain features of construction and combinations of parts hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation, mostly in central vertical section, of a drying apparatus embodying my invention, portions being shown merely in elevation and portions being broken away to more clearly show the construction and to reduce the size of the figure. Figs. 2 and 3 show, respectively, a front end elevation and a rear end elevation of the drying apparatus. Fig. 4 is an enlarged side elevation, partly in central vertical section, of a portion of the apparatus. Fig. 5 is an enlarged view, in perspective, exhibiting the means employed for driving the rotating rearwardly-declining cylinder A and for sustaining the end-thrust of the cylinder. Fig. 6 is a rear end elevation in section on line 6 6, Figs. 1 and 4, the figure, of course, showing the parts reduced in size as compared with the size shown in Fig. 4. Fig. 7 is an end elevation showing the shell of the rotating cylinder and the devices employed for stirring the material to be treated in its passage through the cylinder. Fig. 8 is a section on line 8 8, Fig. 7. Fig. 9 is an enlarged elevation, in section, exhibiting the details hereinafter described, said figure being placed on the same sheet that contains Fig. 1. Fig. 10 is an enlarged side elevation of a portion of the drying apparatus, portions being broken away and in section to more clearly show the construction. Fig. 11 is an end elevation of the casing that contains the fan Y, the same being a right-hand-end elevation relative to the illustration of the same matter in Fig. 10, the fan being shown in dotted lines.

A represents a metallic cylinder, usually constructed of boiler-plate, and supported loosely by rimmed spiders B and C. Said spiders have long trunnions *b c*, respectively, each trunnion being supported by two journal-boxes D D, as shown in Figs. 1, 2, and 3, the boxes of a trunnion being separated some little distance, so that either trunnion and its rimmed spider are self-sustaining in case the cylinder be removed. The cylinder fits preferably outside of the rim C′ of the forward spider, and fits preferably inside of the rim B′ of the rear or driving spider, thereby avoiding obstructing-shoulders in the path of the material through the cylinder. The cylinder and axes of the trunnions decline downwardly and rearwardly, and hence the cylinder will gravitate rearwardly as far as permitted.

The cylinder at its rear end is reinforced by a metallic ring A′, (see Fig. 4,) that fits the cylinder internally, and is riveted or bolted to the cylinder, as at A^2. Said reinforcing-ring extends rearwardly of the cylinder, and its outer end is flanged laterally and outwardly, as at A^3, said laterally-projecting flange being nicely turned or ground on its external periphery, and nicely fitting the internal periphery of the rim of the rear or driving spider.

I would here remark that the rear trunnion is rotated, as will hereinafter appear, and that the rear spider is operatively mounted upon said trunnion in any suitable manner, and that the cylinder is operatively connected with said spider, so as to rotate therewith. The means for establishing operative connection between the cylinder and driving-spider consists preferably of one or more dogs or inwardly-projecting arms B^2, (see Fig. 5,) three

of which, located at suitable intervals, are usually employed, rigid or integral with the rim of the driving-spider, and engaging, respectively, a socket, jaw, or projecting member *a*, rigidly secured to the outer side of the adjacent portion of the cylinder, said projecting member or members on the cylinder consisting preferably of a plate riveted or bolted to the cylinder, as at *a'*, and having a laterally and upwardly U-shaped flange a^2, that is arranged in line with the cylinder and embraces a dog or projecting arm B^2 on the driving-spider. By this construction it will be observed that the cylinder is positively driven; also, by means of the employment and nice fit of the reinforcing-ring at the rear end of the cylinder with the internal periphery of the rim of the rear spider, as hereinbefore described, there is no liability of grit obtaining ingress to the aforesaid jaws or projecting-members on the cylinder; also, the rearward end-thrust of the cylinder is received by said dogs or projecting members of the spider, so that there is no liability of the cylinder working rearwardly into frictional contact with the arms of the spider, where there is always more or less grit, and by which contact the parts would soon become worn.

The cylinder at its forward end is reinforced externally by means of a metallic ring A^4, that is riveted or bolted to the cylinder, as at A^5, and extends somewhat forwardly of the cylinder, said forwardly-extending portion of the reinforcing-ring suitably embracing and resting upon the rim of the forward spider, so that the friction resulting from the weight of the forward end of the cylinder on the front spider shall for ordinary and light work be sufficient to drive the front spider; and I would here remark that it does not require much power to drive said spider and its trunnion, since the trunnions of the spiders are carried in lubricated journal-boxes. I would here remark that for very heavy work one or more dogs or projecting members A^6 (shown in dotted lines, Fig. 1) are preferably employed at and secured to the front end of the cylinder, said dogs or projecting members engaging inwardly-projecting dogs or members *c'* (shown in dotted lines in Fig. 1) on the front spider; but for ordinary or light work the friction had between the internal surface of the reinforcing-ring at the front end of the cylinder and the external rim of the front spider will be found sufficient to drive said spider. I would also remark that the cylinder should have sufficient end play to prevent any crowding of the spiders in case the cylinder is expanded by the heat to which it is subjected.

The arms of the forward spider are set obliquely to the axis of the spider, somewhat like the blades of the propeller-wheel, so as to properly feed the material it receives into the cylinder, the material passing through the cylinder and out between the arms of the driving-spider.

The fire-chamber E is located at the forward end of and below the cylinder, preferably entirely or almost entirely forward of the cylinder. E' designates the doors leading to the fire-chamber; E^2, the furnace-grate; E^3, the ash-pit, and E^4 the doors leading to the ash-pit.

The fire or fuel chamber is suitably arched over on the top, as at *e*, and the side walls *e'* of the furnace extend rearwardly the entire length of and beyond the cylinder, as shown in Fig. 1, and extend upwardly on opposite sides of the cylinder, respectively, as at e^2, and arched over the cylinder, as at e^3. (See Figs. 1, 2, and 3.) The cylinder is thus inclosed at the top and sides. Below the rear portion of the cylinder is located a bridge-wall F, that extends from one side wall to the other side wall of the setting and to within a suitable distance of the lower side of the cylinder.

The portions e^2 of the side walls of the setting extend a suitable distance rearwardly of the rear spider of the cylinder, and the space between said side walls at the rear end of the cylinder is partially closed by a transverse wall e^4, that constitutes the rear wall of the setting, and is located below and extends to within a suitable distance of the lower side of the trunnion of the rear spider. The side walls of the setting extend rearwardly of said rear wall, as at e^5. Said rearwardly-extended portions of the side walls have the same height as the rear wall, and together with the rear wall support the metallic frame G, to which the standards *g*, that carry the journal-boxes of the trunnion of the rear spider, are secured. Said frame is of any suitable construction, and the journal-box-supporting standards are preferably bolted to the frame, as at *g'*. A pair of standards is preferably provided for each journal-box, as shown in Fig. 3, said standards being preferably integral or rigid with each other. The standards at their upper end are provided, respectively, with semi-cylindrical depressions g^2, (see Fig. 4,) in which rest the laterally-projecting lugs *d* of the lower half of the respective journal-box, the upper half of the journal-box being provided with laterally-extending flanges at its lower end, as at *d'*, said flanges bolted to the flanges *d** of the lower half of the box, as at d^2. The trunnion of the rear spider is intergeared, as at H, with a shaft I, located below and supported by means of arms, brackets, or hangers I' rigid with frame G, shaft I being, of course, arranged parallel with the trunnion and suitably intergeared, as at I^2, with the driving-shaft J, that is arranged at right angles to shaft I, and suitably supported from frame G and provided with a driving-pulley J'. (See Figs. 1 and 3.) Frame G is of course suitably constructed to accommodate the location and operation of the gearing employed in establishing operative connection between the driving-shaft and the trunnion of the driving-spider.

The space between the side walls of the setting at the rear of the drying-cylinder is preferably closed as follows: Referring, first, to the portion of said space below the axle of the trunnion of the rear spider, it will be observed, upon reference to Figs. 1, 3, 4, and 6, that said portion of the space in question is closed by a metallic plate K, that is suitably cut away at the top and centrally, as at K′, to accommodate the location and operation of the trunnion of the driving-spider, has an inwardly and laterally projecting flange K^2 at its upper edge, (see Fig. 4,) and is also flanged laterally and inwardly a suitable distance below the trunnion, as at K^3, and also at its lower end, as at K^4, the lowermost flange resting upon the rear wall of the setting. Between and at the inner ends of flanges K^3 and K^4 of plate K is fitted a plate L, thereby forming an air-chamber L′ between the two plates K and L below the trunnion of the driving-spider, and the plates are perforated, as at *k* and *l*, respectively, (plate L being perforated near the top and plate K near the bottom,) to permit the passage of air from the outside and prevent said plates and adjacent journal-box of the trunnion of the rear spider from becoming overheated and to take up the heat that would otherwise be wasted and return the same to the drier. Plates K and L are suitably secured together, preferably by bolts and nuts, as at *l*′, and are braced apart by means of sleeves or tubes l^2, mounted upon the shanks of the bolts between the two plates. Flange K^3 of plate K should, however, be located so far below the trunnion of the driving-spider as to avoid material piling upon said flange to such an extent as to escape at the bottom of the trunnion, where said trunnion extends through plate K and to prevent radiation of heat. The portion of the space between the side walls of the setting above the axis of the trunnion of the rear spider is closed by a removable plate M, that rests upon the uppermost flange K^2 of plate K, and is cut away, as at M′, to accommodate the location and operation of the trunnion of the driving-spider. Plate M rests upon flange K^2 of plate K between two series of lugs K^5, respectively, on plate K. The inner series of lugs K^6 act to hold plate M against displacement from its position upon plate K. Plate M is suitably mounted upon studs *m*, that are suitably secured to the setting at suitable intervals along the outer edge of plate M.

Plate M is held in position upon studs against the setting or against a metallic plate e^6, suitably secured to the setting by means of a half-ring N, that engages plate M at or near its outer edge, and is mounted upon the aforesaid studs and rests upon the uppermost flange K^2 of plate K between the plate M and the outer series of lugs K^5 on plate K, and is held against upper plate M by means of nuts *m*′, that are mounted upon the outer ends of studs *m*, the nuts being tightened to bring half-ring N into tight engagement with plate M, and thereby secure the latter in position. The holes M^2 in plate M through which studs *m* extend are elongated vertically to permit said plate, when the nuts are loosened or removed, to be removed with half-ring N, as required for entering the rear end of the drying-cylinder for repairs, observations, or other purposes.

The fuel or fire chamber being, as already indicated, located under the forward and upper end of the drying-cylinder, the products of combustion pass thence rearwardly under the cylinder to the rear side of the rear spider, and thence return through said spider and through the cylinder, thereby coming in contact with the material in the cylinder, such material, by means of suitable lifting blades or devices with which the cylinder is internally provided, together with the rotation of the cylinder, being carried up by the ascending side of the cylinder and sprayed or scattered down about equally across the diameter of the cylinder. The cylinder directly adjacent to the fire-chamber will be burned out soonest, and when this section of the cylinder begins to show signs of giving out the cylinder is changed end for end, thereby prolonging the life of the cylinder about one-half, and when the cylinder requires renewing the worn-out cylinder can readily be removed without in any wise mutilating or injuring any other parts of the apparatus, but leaving them in perfect condition for use in the new cylinder. It will of course be understood that one of the spiders and other parts of the apparatus would be removed in order to turn the cylinder end for end in order to remove the cylinder.

The devices employed within the cylinder for carrying up the material on the ascending side of the cylinder during the rotation or operation of the latter comprise, preferably, lifting-blades O, (see Figs. 1 and 7,) set preferably at equal distances and extending lengthwise of the cylinder, said lifting-blades being arranged radially, as shown, and provided with inwardly-presenting heads O′, as shown in Fig. 7.

The drying-cylinder illustrated is shown provided with eight of said lifting-blades, four adjacent lifters being connected into a group by segmental straps O^2, said straps being secured in any suitable manner to the heads of the lifting-blades and provided at suitable intervals lengthwise of the cylinder. Each of the straps that connects one group of lifters is located immediately adjacent a strap that connects the other group of lifters, and said adjacent straps of the two groups of lifters are connected with each other by means of a screw-threaded rod P, that extends through laterally and inwardly bent members or extremities O^3 of said straps, and has nuts P′ mounted thereon at opposite sides of said inwardly-projecting members of the straps, by manipulating which nuts the straps can be adjusted as required to bring them into proper

engagement with the heads of the lifting-blades or lifters and properly hold the latter against the inner side of the cylinder. The adjacent straps of the two groups of lifters are also bent laterally and outwardly at their opposite ends, as at O^4, said laterally-bent portions of the straps engaging opposite ends of a short pipe-section or tube Q, respectively, and being perforated for the passage of a bolt Q′, that extends through the pipe or tube, the head of the bolt abutting the outer side of the laterally-bent member of the one strap and nut Q^2 mounted on the shank of the bolt and engaging the outer side of the laterally-bent member of the other strap, as shown in Fig. 7, the pipe-section or tube extending also through the central member of a T-iron R, that is suitably secured to the drying-cylinder. By the construction just described the lifting-blades and segmental straps, to which said blades are suitably secured, are adequately held in place; but the holes R′ in the T-irons, through which bolts Q′ extend, are elongated in the direction of the length of the cylinder to accommodate the movement of the T-irons in the expansion and contraction of the cylinder. The bodies of the lifting-blades by contact with the cylinder become hotter and expand more than the heads of the blades, and to prevent said blades, when the latter are heavy and deep, from buckling under such conditions, and more especially when high temperatures outside and moderate temperatures inside the cylinder are desirable, I notch or gore the body of the blades at suitable intervals, as at O^5. By such construction the lifting-blades and cylinders do not damage each other by unequal expansion. I would remark that the shell of the cylinder expands from two to three times as much as the lifting-blades, and that the difference of expansion is accommodated by the slots in the T-irons aforesaid. The lifting-blades being fastened together in groups, each group can, without much difficulty, be inserted in or removed from the cylinder—for instance, when a new cylinder is required—but in case the cylinder is turned end for end the lifting-blades need not necessarily be thus turned, from the fact that said blades will operate with equal facility in elevating the material, regardless of the direction in which the cylinder is rotated. The material to be dried passes through the cylinder and through the rear spider into the space at the rear of said spider, whence it is delivered to a conveyer S, (see Figs. 1 and 3,) that may be of the screw or spiral variety shown, or of any other suitable construction, and is arranged to convey the material where desired, said conveyer being shown operatively connected with the driving-shaft by means of a sprocket-wheel S′, operatively connected with the conveyer, and a chain S^2, operatively connecting said sprocket-wheel with a sprocket-wheel J^2 on the driving-shaft. The conveyer is located between the rear wall of the setting and bridge-wall F, a suitable distance below the top of said bridge-wall. In this location, it will be observed, the conveyer is protected from the heat of the products of combustion passing to the rear end of the cylinder.

The rim of the front spider at its outer end is lipped or flanged inwardly, as at C^2, (see Fig. 1,) and the breeching T, through which the products of combustion escape upon leaving the front end of the cylinder, and that is preferably supported, as hereinafter described, is fitted into said lip or flange of the front spider, as shown at *t*. A metallic plate e^7 is suitably secured to the front of the setting around the front spider, but so as to leave a space e^8, however, between the rim of the spider and said plate to facilitate the assemblage of the parts and to accommodate the expansion or subsequent settling of the parts, said space being closed by a metallic ring U, that nicely but easily embraces the front spider at the outer side of plate e^7, said ring being secured to the front plate, preferably by means of studs U′ in the following manner: The ring has enlarged holes U^2, (see also Fig. 9, that is placed on sheet of drawings containing Fig. 1,) through which the securing-bolts pass, and these bolts outside the ring are provided with washers U^3, spiral springs U^4, (see Fig. 9,) coiled upon the studs, and nuts U^5. By tightening these nuts, the springs are compressed and give such tension that they hold the weight of the ring. That is to say, the ring, by means of the springs, is pressed against the front plate e^7 with such force that the ring is held by friction, and at the same time the ring may move in any direction up or down or laterally by means of the bolts passing through the enlarged holes, so that in case, for instance, the foundation should settle, the ring can accommodate itself to the change and thereby maintain a tight joint without undue friction or wear of the parts.

By the construction hereinbefore described there is little liability of material working its way outside of the cylinder between the front reinforcing-ring and the external periphery of the rim of the front spider. In treating some substances, some finer dust-like material will, however, find its way out between the lower side of the spider and reinforcing-ring. To prevent the material thus escaping from the cylinder from being lost or through accumulation interfering with the operation of the machine, I provide a pocket V (see Figs. 1 and 2) at the point indicated to catch the material, said pocket being formed preferably by the wall that arches over the fire-chamber in conjunction with front plate e^7 and a reversed arch V′, placed upon the rear end of and strengthening the arch over the fire-chamber. A drain pipe or spout V^2 leads from said pocket to one side of the drier, as shown more clearly in Fig. 2, said pipe or spout declining, as shown, and being preferably provided with a gate or valve V^3, hinged at the top and

adapted to open outwardly. The front reinforcing-ring of the cylinder is preferably provided at suitable intervals with outwardly-projecting blades A^7, adapted to scoop the material accumulated in pocket V into the aforesaid drain pipe or spout. I would here remark that with some materials or substances the dirt-like or finer product is the most valuable, and hence the importance of avoiding any loss of the material.

The side walls of the fuel-chamber of the furnace extend somewhat above the top wall of said chamber and support the metallic frame W, to which are suitably secured uprights or standards W′, that support the journal-boxes of the trunnion of the front spider, the construction being substantially the same as that of the frame, standards, and journal-boxes employed for carrying the trunnion of the driving-spider at the rear end of the cylinder, a pair of uprights or standards W′ being provided for each box of the front trunnion and having a semicylindrical depression in their upper ends in which rest the laterally-projecting lugs on the lower halves of the boxes, the upper halves of the boxes being secured to the lower halves in any suitable manner.

The breeching at the front end of the cylinder is shaped like a hopper, the front wall or side thereof being slotted, as at T′, to accommodate the location and operation of the front trunnion. To prevent the escape of any material at the side of said trunnion where the same extends through the breeching, I provide a hood T^2, surrounding the upper half of the trunnion and suitably secured to the front side of the breeching. A similar hood M^3 is also provided for preventing the escape of material at the sides of the trunnion of the rear spider, where said trunnion extends through the wall that closes the space at the rear of the rear spider, said hood being suitably secured to removable plate M and the top of the hood declining toward its free end to facilitate the dislodgment of any material falling thereon.

The breeching at the front end of the drying-cylinder is suitably supported from the frame that supports the uprights or standards that bear the journal-boxes of the front trunnion, a preferable construction being illustrated in Figs. 1 and 2, wherein the breeching at the bottom has two forwardly-projecting flanges T^3, located at opposite sides of the trunnion, respectively, and secured to frame W, and two braces T^5, located at opposite sides of the trunnion, respectively, are suitably secured to and connect the upper end of the breeching with said frame.

The breeching x is shown as forming a chamber with a lateral duct or passage x^4 at its top, in which is the rotary suction-fan y. This construction affords a settling-chamber before the fan is reached, and such chamber is indispensable on many accounts and especially when sandy, gritty, or flinty material is being dried. Otherwise the flying particles drawn off by the suction would very quickly cut away the fan. Then, again, the settling-chamber formed by the breeching x intercepts and deposits much of the light or dusty material that otherwise would be carried away.

Breeching T supports another and preferably larger breeching X, that is preferably quadrangular in plan and flanged laterally at its lower end, as at x', with the flanges resting upon and bolted to laterally-projecting flanges at the upper end of the lower breeching. A feed-pipe x^2, that is suitably secured to the upper breeching, is located in one of the inner corners of said breeching and extends downwardly through the breeching into and to near the lower portion of the lower breeching, into which the pipe discharges. Said pipe at its upper end opens into the bottom of a tank or vat x^3, that receives the material to be treated, the material being fed down pipe x^2 into the lower portion of the lower breeching, and thence passing to the front spider, that delivers it, as already indicated, to the cylinder, the vapors arising from the material that is fed into the cylinder and the products of combustion passing off through the breechings.

A short duct x^4 connects and establishes open relation between the upper breeching and a settling-chamber x^5, that is provided with a stack x^6, of any suitable height, the products of combustion and any vapors arising from the material being treated passing from the upper breeching, *via* duct x^4, into chamber x^5, and thence into the stack.

A rotary fan or blower Y (see also Fig. 10) is preferably located in duct x^4, immediately adjacent the upper breeching, the fan or blower shaft Y′ extending outside of the breeching and being journaled in suitable boxes Y^2 Y^2, the one box being rigid with the upper breeching and the other box being suitably supported from the setting of the drying apparatus, Y^3 designating the driving-pulley with which the fan or blower shaft is provided. The fan or blower is adapted to maintain within the upper breeching a constant partial vacuum or suction in excess of the suction produced by a natural draft.

Nearly all of the dust that is carried out by the vapors is saved by discharging them (the dust-laden vapors) into settling-chamber x^5. Some of the dust-laden vapors will, however, pass into stack x^6, and after a time a large amount of fine material, owing to the condensation of the vapors passing into the stack, will have accumulated upon the inner side of the stack, and the dust or fine material thus accumulated on the inner side of the stack can be readily precipitated into the settling-chamber x^5 below by rapping the stack more or less vigorously on the outside. I would here remark that the fine or dust-like material is in some cases of the greatest value, and it is therefore important to save

it all, if possible. I therefore also preferably provide a hood x^7 at the discharging end of duct x^4, said hood projecting into dust and settling chamber x^5 and being adapted to precipitate into the bottom of chamber x^5 material carried out with the vapors and products of combustion.

By my improved drying apparatus and process the waste of material is reduced to a minimum. I can dry material, all of which when dried is impalpable flating powder, and save all except one or two per cent. By my improved process and construction of drier the capacity of the drier is not only increased, as already indicated, but the drying apparatus is enabled to do from three to four times as much drying with a given amount of fuel than has heretofore been possible. The even draft gives a more uniform and more rapid combustion, and this added to the ability of utilizing the heat down to about 140° Fahrenheit, instead of discharging it up the stack at 450° to 600° Fahrenheit, renders my improved apparatus and process exceedingly economical. The even and reliable draft enables a safe and reliable drying of many materials that would be injured if dried with the varying and unreliable natural draft.

The fan-carrying shaft is journaled also in boxes Y^4 Y^5 at opposite ends of the hub of the fan, respectively, and suitably supported from stationary spiders Y^6 (see Figs. 10 and 11) rigid with the casing of duct X^4, the hubs of the spiders encircling boxes Y^4 Y^5, and set-screws Y^7 that extend through the hubs and engage and hold the boxes in the desired adjustment relative to the fan-shaft. It is important, however, to prevent the portion of the fan-shaft that extends through the upper breeching and box Y^5, that is located next adjacent to said breeching, from becoming overheated, and I therefore, inclose or jacket said portion of the shaft by means of a pipe Y^8 suitably supported from breeching X, said pipe being adapted to permit the passage of air from the outside between the same and the fan-shaft, and around box Y^5, thereby keeping said shaft and box in a comparatively cool condition. Pipes Z are provided for conducting oil or lubricant to boxes Y^4 Y^5 from oil-cups Z′, suitably supported at the outer side of the casing in which the fan is located. (See Figs. 10 and 11.)

To prevent the oil or lubricant from being affected by the cold, in case the drying apparatus is used in regions subject to a colder climate or to freezing temperature, I provide a hot-air chamber Z^2 for the oil or lubricant receptacles, said chamber being formed preferably by a box or casing suitably secured to the casing in which the fan is located, and being provided with a lid or cover Z^3 for access to the lubricant-receptacles within the chamber. The heat radiating into said chamber from the casing in which the fan operates, keeps the lubricant-receptacles in a warm condition and prevents the oil or lubricant in said receptacles from being affected by any cold or freezing temperatures existing outside.

Plate M that closes the upper portion of the space at the rear end of the cylinder of the drier is preferably provided with holes M^4, adapted to be closed by one or more dampers or doors M^5, so that besides the supply of air required for perfect combustion, an additional supply of air by opening dampers or doors M^5 will be admitted at openings M^4, for the purpose of separating the finer product of the material passing through the drier in some cases, and for the purpose of carrying off moisture and for other purposes in other cases.

What I claim is—

1. In a drying apparatus a furnace chamber, a drying cylinder in said chamber and having trunnions with bearings outside said chamber, a breeching connected with one end of said cylinder, a settling chamber above said breeching and a suction fan in the draft passage from said settling chamber, substantially as set forth.

2. In a drying apparatus, a furnace, a heating chamber into which the furnace discharges, a drying cylinder in said chamber, its rear end exposed across its entire area for the admission of products of combustion from the furnace and having a spider and trunnion supporting each end of said cylinder, bearings for said trunnions outside of the said heating chamber, and a blower at the front end of said cylinder in the discharge flue or passage therefrom above the axis of the cylinder, substantially as set forth.

3. The combined furnace and heating chamber, the drying cylinder located in said chamber and having spiders and trunnions to support its ends, a breeching at the induction end of the cylinder through which the products of combustion escape and the material is fed to the cylinder having its lower wall inclined and arranged to project within the cylinder, and a suction fan in the draft passage from said breeching above said inclined portion, substantially as set forth.

4. The furnace and the heating chamber connected therewith, in combination with a drying cylinder in said chamber exposed at its rear end over its entire area to the inside of the chamber, and spiders and trunnions supporting the ends of the cylinder, a breeching at the front end of the cylinder through which the products of combustion are discharged and the material to be dried enters the cylinder and engaging the end of the cylinder at its periphery all around, and a suction fan in the draft passage from said breeching above the point where the raw material is fed to the machine, substantially as set forth.

5. The furnace and the heating chamber at the rear thereof extending above the throat or outlet from said furnace, and a revolving drying cylinder located in said chamber exposed over the whole of its rear end to the

inside of said chamber, and having its front end raised some distance above the said throat or outlet, and projecting through the front wall of the heating chamber, whereby the drying cylinder is protected from the direct heat of the furnace at its front and the front end of the cylinder is kept cool, a breeching over the front end of the cylinder encircling the front end thereof, and a suction fan in the draft passage from said breeching, substantially as set forth.

6. The furnace, the heating chamber at the rear thereof and extending above the plane of the discharge of the furnace, a rotatable drying cylinder having its front end extending through the wall of said chamber and raised to be above the direct reach of the flame of the furnace, and the rear end of said cylinder exposed across its entire width to the inside of said chamber and arranged to discharge the dry material within the heating chamber, a device to remove said dried material from said chamber, a breeching at the front of the cylinder forming a discharge flue for the products of combustion, and a suction fan in the draft passage from said breeching on a plane above the axial center of the cylinder, substantially as set forth.

7. The furnace and drying chamber into which the furnace discharges, in combination with a rotatable drying cylinder in said chamber having its front end exposed outside the wall of said chamber, a breeching through which the material is fed to the cylinder and the products of combustion pass from the cylinder, said breeching extending within the end of the cylinder all around and fitting closely therein, and a suction fan in the line of draft from said breeching, substantially as set forth.

8. The heating chamber, the drying cylinder, the breeching at the front of said cylinder having an inclined front portion running down to the bottom of the cylinder, a settling chamber above said inclined portion, and a suction fan in the draft passage from said settling chamber, substantially as set forth.

9. In a drying apparatus, the furnace and the heating chamber, in combination with the drying cylinder in said chamber, a plurality of settling chambers in the line of draft from said cylinder, and a suction blower in the line of draft between said settling chambers, substantially as described.

10. In a mechanical drier, the rotating cylinder, two rimmed and trunnioned spiders carrying opposite ends of the spiders, respectively, the trunnions being supported, the cylinder being reinforced at each end by a metallic ring, the rear reinforcing ring being flanged outwardly at its outer end and the rear spider being mounted upon said flange, the front reinforcing ring being flanged inwardly at its outward end with the flange resting upon and embracing the front spider, one of said spiders being operatively connected with the cylinder, and suitable means or mechanism operatively connected with the trunnion of said driving-spider for operating the latter, substantially as set forth.

11. In a mechanical drier, a rotating cylinder suitably supported at one end, a rimmed and trunnioned spider supporting the free end of the cylinder, suitable means operatively connected with the trunnion of said spider for driving the latter, one or more metallic plates a secured to the cylinder adjacent to said spider, said plate or plates having a laterally and outwardly U-shaped flange a^2 the inner side whereof is engaged by an inwardly-projecting arm on the spider, said flanged-plate or plates on the cylinder and projecting arm or arms of the spider establishing operative connection between the spider and cylinder and limiting the movement of the cylinder in the direction of the spider, substantially as set forth.

12. In a mechanical drier, a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the cylinder being suitably inclosed and a suitably inclosed space being provided at the rear end of the cylinder, which space is in open relation with the cylinder and through which space the material is discharged from the cylinder, an air-chamber forming the lower portion of the rear wall of said space, the front and rear walls of said chamber being perforated, substantially as shown, for the purpose specified.

13. In a mechanical drier, the rotating cylinder through which the material to be treated and products of combustion or heating-agent pass in opposite directions, respectively, the cylinder being provided internally with suitable devices for stirring the material in its passage through the cylinder, the cylinder being suitably supported from trunnions, a space at the rear of the cylinder through which space the material is discharged from the cylinder, a suitably constructed wall closing said space at the rear, and the rear supporting trunnion extending through said wall, that portion of the wall below the trunnion being partially formed by an air-chamber whose front and rear walls are perforated, substantially as indicated, a shelf at the top of said air-chamber upon which shelf a portion of the material discharged from the cylinder may lodge and form an insulation to prevent the escape of heat between the rear trunnion and said chamber, said shelf being located a sufficient distance below that trunnion to prevent material from piling upon said shelf to such an extent as to come in contact with the under side of the trunnion, substantially as set forth.

14. In a mechanical drier, the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the cylinder being provided internally with suitable devices for stirring the material in its passage through the cylinder, and being suitably inclosed and supported, a

space at the rear of the cylinder through which space the material is discharged from the cylinder, a suitably constructed wall closing said space at the rear, said wall being partially composed of a plate M removable for repairs, observations or other purposes, substantially as set forth.

15. In a mechanical drier, a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the cylinder being provided internally with suitable devices for stirring the material in its passage through the cylinder and being suitably inclosed, a space at the rear of the cylinder through which space the material is discharged from the cylinder, a suitably constructed wall closing said space at the rear, the lower portion of said wall being formed by plates K and L, plate K having flanges K^2, K^3, K^4, and plate L fitting between flanges K^3 and K^4, said plates being perforated, as at *k* and *l*, respectively, and the upper portion of the aforesaid wall being formed by a metallic plate M resting upon flange K^2, said plate being mounted upon studs *m* rigid with the inclosure of the cylinder, the holes in plate M through which said holes extend being elongated vertically, a half-ring M mounted upon studs *m* against plate M and resting upon flange K^2 of plate K, and nuts *m'* mounted upon the aforesaid studs against the outer side of half-ring N, all substantially as shown, for the purpose specified.

16. In a mechanical drier, a rotating cylinder supported by rimmed spiders, the trunnions of the respective spiders having journal-bearings so far separated as to support the spiders independently of the cylinder, substantially as and for the purpose set forth.

17. In a mechanical drier, a rotating cylinder containing a series of metallic lifting-blades arranged lengthwise thereof, adjacent lifting-blades being connected in groups by means of segmental straps, and suitable means for holding said blades out against the interior surface of the cylinder, substantially as and for the purpose set forth.

18. In a mechanical drier, the combination with the rotating cylinder, of lifting-blades arranged lengthwise of and adapted to engage the cylinder internally, and having one or more notches or gores, substantially as and for the purpose set forth.

19. In a mechanical drier, the combination with a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, of lifting-blades, O, arranged lengthwise of and adapted to engage the internal surface of the cylinder, said lifting-blades having inwardly-presenting heads, O', the lifting-blades being divided into groups and the blades of each group being connected by segmental straps provided at suitable intervals lengthwise of the cylinder, and suitable means for retaining said straps in position holding the lifting-blades out against the interior surface of the cylinder, substantially as set forth.

20. In a mechanical drier, the combination with the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, of lifting-blades, O, arranged lengthwise of and adapted to engage the internal side of the cylinder, said lifting-blades having inwardly-presenting heads, O', the lifting-blades being divided into groups and the blades of each group being connected by segmental straps provided at suitable intervals lengthwise of the cylinder, the segmental straps of one group of lifters being arranged immediately adjacent the segmental straps of the other group of lifters, the adjacent pair of straps of the two groups of lifters, respectively, being bent inwardly at one end, a screw-threaded rod extending through said inwardly-bent members of the straps and nuts mounted upon said rod at opposite ends of said members of the straps, respectively, and the other ends of said straps being suitably connected with the cylinder, substantially as set forth.

21. In a mechanical drier, the combination with a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, of lifting-blades, O, arranged lengthwise of and adapted to engage the interior surface of the cylinder, said lifting-blades having inwardly-presenting-heads, O', the lifting-blades being divided into groups and the blades of the group being connected by segmental straps provided at suitable intervals lengthwise of the cylinder, the lifting-blades of each group of lifters being connected by segmental straps and the segmental straps of one group of lifters being located immediately adjacent the segmental straps of the other group of lifters adjacent straps of the two series of straps, respectively, being suitably connected with each other at one end and the other ends of said straps being bent outwardly, a pipe-section or tube extending through said outwardly-bent members of the straps and a bolt extending through said pipe-section or tube, the head of the bolt engaging the one end of the pipe or tube, the latter extending also through a T-iron or member rigid with and projecting inwardly from the shell of the cylinder, the hole in said T-iron or inwardly-projecting member of the cylinder being elongated in the direction of the length of the cylinder, substantially as and for the purpose set forth.

22. In a mechanical drier, the combination with the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, of metallic lifting-blades arranged at suitable intervals lengthwise of the inner side of the cylinder, suitable means for holding said blades in position within the cylinder, and the blades

being notched or gored at suitable intervals lengthwise thereof, substantially as and for the purpose set forth.

23. In a mechanical drier, the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the rear end of the cylinder being suitably supported and the front end of the cylinder being supported by a rimmed and trunnioned spider that is lipped or flanged inwardly, as at C^2, a breeching T fitted into said lip, as at *t*, a feed-pipe discharging into said breeching, and the latter being adapted to deliver the material to the aforesaid rimmed spider that has its arms arranged obliquely somewhat like the blades of a propeller-wheel to properly feed the material into the cylinder, the cylinder being suitably inclosed at the top and sides, a metallic plate e^7 secured to the front end of said inclosure and around the aforesaid spider, the arrangement of parts being such that a space e^8 is had between said plate and spider, a metallic ring U inclosing said space, the latter being held yieldingly in place by friction, substantially as set forth.

24. In a mechanical drier, the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the cylinder being suitably supported at its rear end and supported by a rimmed and trunnioned spider at its forward end, the cylinder resting upon and embracing said spider, a pocket V for catching any material that may escape from the cylinder between the lower side of the aforesaid spider and the shell of the cylinder, and a discharge or drain-pipe V^2 leading from said pockets to one side of the drying apparatus, substantially as set forth.

25. In a mechanical drier, a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the cylinder being suitably supported at its rear end and supported by a rimmed and trunnioned spider at its forward end, the cylinder resting upon and embracing said spider, a pocket V for catching any material that may escape from the cylinder between the lower side of the aforesaid spider and the shell of the cylinder, and a discharge or drain-pipe V^2 leading from said pocket to one side of the drying apparatus, and blade A^7 rigid with the cylinder and adapted to scoop the material from said pocket into the drain-pipe, substantially as set forth.

26. In a mechanical drier, a rotating cylinder through which the material and heating-agent pass in opposite directions, respectively, the rear or discharging end of the cylinder being suitably supported, and the forward or feeding end of the cylinder being supported by a rimmed and trunnioned spider lipped or flanged inwardly, as at C^2, a breeching T, fitted into said lip or flange, a pipe or passage-way for discharging the material into said breeching, the latter being adapted to deliver the material to the aforesaid spider whose arms are arranged obliquely somewhat like the blades of a propeller-wheel, the forward side of said breeching having an opening to accommodate the location and operation of the trunnion of said spider, and a hood T^2 secured to said wall of the breeching over the trunnion, substantially as and for the purpose set forth.

27. In a mechanical drier, the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the rear end of the cylinder being suitably supported and the front end of the cylinder being supported by a rimmed and trunnioned spider, a breeching at the front end of the cylinder and a feed-pipe discharging into said breeching, the breeching being adapted to deliver the material to the spider whose arms are arranged obliquely not unlike the blades of a propeller-wheel, the trunnion of said spider extending through the breeching having bearing in suitable boxes that are supported by a single metallic frame, substantially as and for the purpose set forth.

28. In a mechanical drier, the combination with a rotating cylinder through which the material to be treated and products of combustion pass in opposite directions, respectively, of a lower breeching suitably supported at the front end of the cylinder and in open relation with the cylinder, an upper breeching X secured to the lower breeching, a feed-pipe or passage-way extending downwardly at the inner side of said breechings and discharging into the lower breeching, substantially as set forth.

29. In a mechanical drier, the combination with a rotating cylinder through which the material to be treated and products of combustion pass in opposite directions, respectively, of a lower breeching suitably supported at the front end of the cylinder and in open relation with the cylinder, an upper breeching X secured to the lower breeching, and a feed-pipe or passage-way extending downwardly at the inner side of said breechings and discharging into the lower breeching, the portion of said pipe that extends into the lower breeching being open at its inner side, substantially as set forth.

30. In a mechanical drier, the combination with a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, the lower breeching T located at the forward end of and in open relation with the cylinder, an upper breeching supported by said lower breeching, a feed-pipe or passage-way extending from said upper breeching into the lower breeching, a dust-collecting and settling-chamber x^5 and a short duct x^4 establishing open relation between said chamber and the upper breeching, a stack x^6 for said chamber, and a fan or suitable device for establishing a forced draft

through and from the cylinder through the breechings to the aforesaid stack, substantially as set forth.

31. In a mechanical drier, the combination with a rotating-cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, of a lower breeching T located at the forward end of and in open relation with the cylinder, an upper breeching supported by said lower breeching, a feed-pipe or passage-way extending from said upper breeching into the lower breeching, a dust-collecting and settling-chamber x^5, a short duct x^4 establishing open relation between said chamber and the upper breeching, a stack x^6 for said chamber, and a fan or suitable device for establishing a forced draft through and from the cylinder, through the breechings to the aforesaid stack, and a hood for precipitating more or less dust or fine material from the dust-laden vapors in the passage to the aforesaid stack, substantially as set forth.

32. In a mechanical drier, the combination with the rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, a lower-breeching T located at the forward end of and in open relation with the cylinder, an upper breeching supported by said lower breeching, a feed-pipe or passage-way extending from said upper breeching into the lower breeching, a dust collecting and settling-chamber x^5, a short duct x^4 establishing open relation between said chamber and the upper breeching, and a stack x^6 for said chamber, of a fan or suitable device for establishing a forced draft through and from the cylinder, through the breechings to the aforesaid stack, said fan or draft-creating-device being located at the inner end of the aforesaid duct and operatively mounted upon a shaft that extends through the upper breeching, the portion of said shaft extending through the breeching being suitably jacketed, substantially as and for the purpose set forth.

33. In a mechanical drier, the combination with a rotating-cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, a lower breeching T located at the forward end of and in open relation with the cylinder, an upper breeching opening into the lower breeching, a feed-pipe or passage-way extending from the upper breeching into the lower breeching, a dust-collecting and settling-chamber x^5, a short duct x^4 establishing open relation between said chamber and the upper breeching, and a stack x^6 for said chamber, of a fan or suitable device for establishing a forced draft through and from the cylinder, through breechings to the aforesaid stack, the fan or draft-creating-device being located at the inner end of the aforesaid duct and operatively mounted upon a shaft that extends through the upper breeching, the portion of said shaft extending through the breeching being suitably jacketed, the jacket being open from end to end and opening into the atmosphere outside, substantially as and for the purpose set forth.

34. In a mechanical drier, the combination with a rotating cylinder through which the material to be treated and heating-agent pass in opposite directions, respectively, a lower breeching T located at the forward end of and in open relation with the cylinder, an upper breeching X, in open relation with the lower breeching, a feed-pipe or passage-way extending from the upper breeching into the lower breeching, and a short duct x^4 leading from the upper breeching, of a fan for establishing a forced draft through and from the cylinder, through the breechings, and aforesaid duct, the fan being located at the receiving-end of the aforesaid duct and operatively mounted upon a shaft that extends through the upper breeching and has bearing at opposite ends of the hub of the fan, one or more oil-cups Z′ suitably supported at the outer side of the casing in which the fan is located, said oil-cup or cups being located within a hot-air-chamber Z^2 formed substantially as indicated, and passage-ways leading from said cups to the aforesaid bearings, substantially as set forth.

In testimony whereof I sign this specification, in the presence of two witnesses, this 7th day of November, 1893.

FRANKLIN D. CUMMER.

Witnesses:
C. HOOVER,
WARD HOOVER.