(No Model.) 4 Sheets—Sheet 1

A. G. MATHER & H. E. COLLINS.

DRYING APPARATUS.

No. 544,679. Patented Aug. 20, 1895.

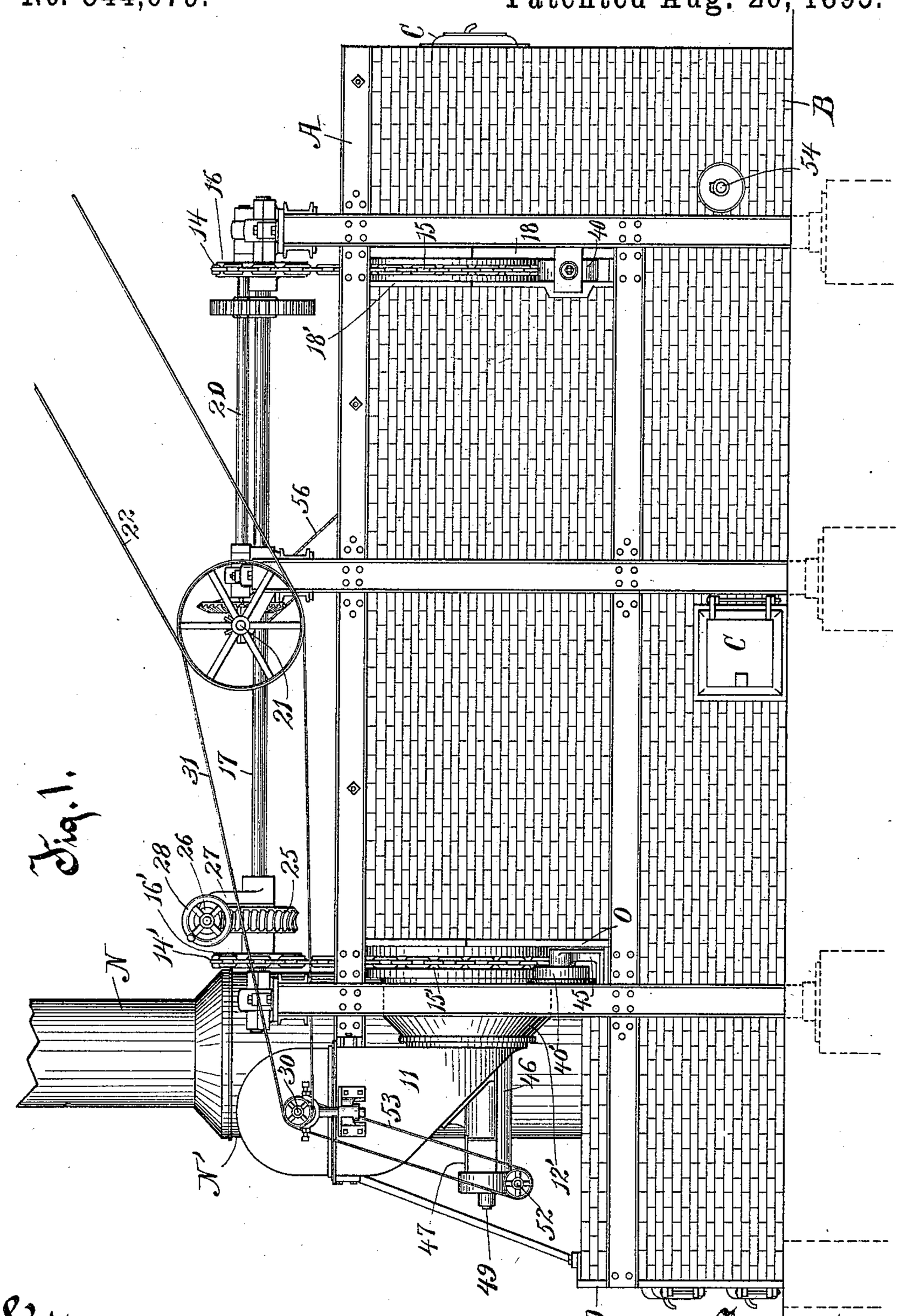

Fig. 1.

Witnesses.
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Fred S. Hunt

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(No Model.) 4 Sheets—Sheet 2.

A. G. MATHER & H. E. COLLINS.

DRYING APPARATUS.

No. 544,679. Patented Aug. 20, 1895.

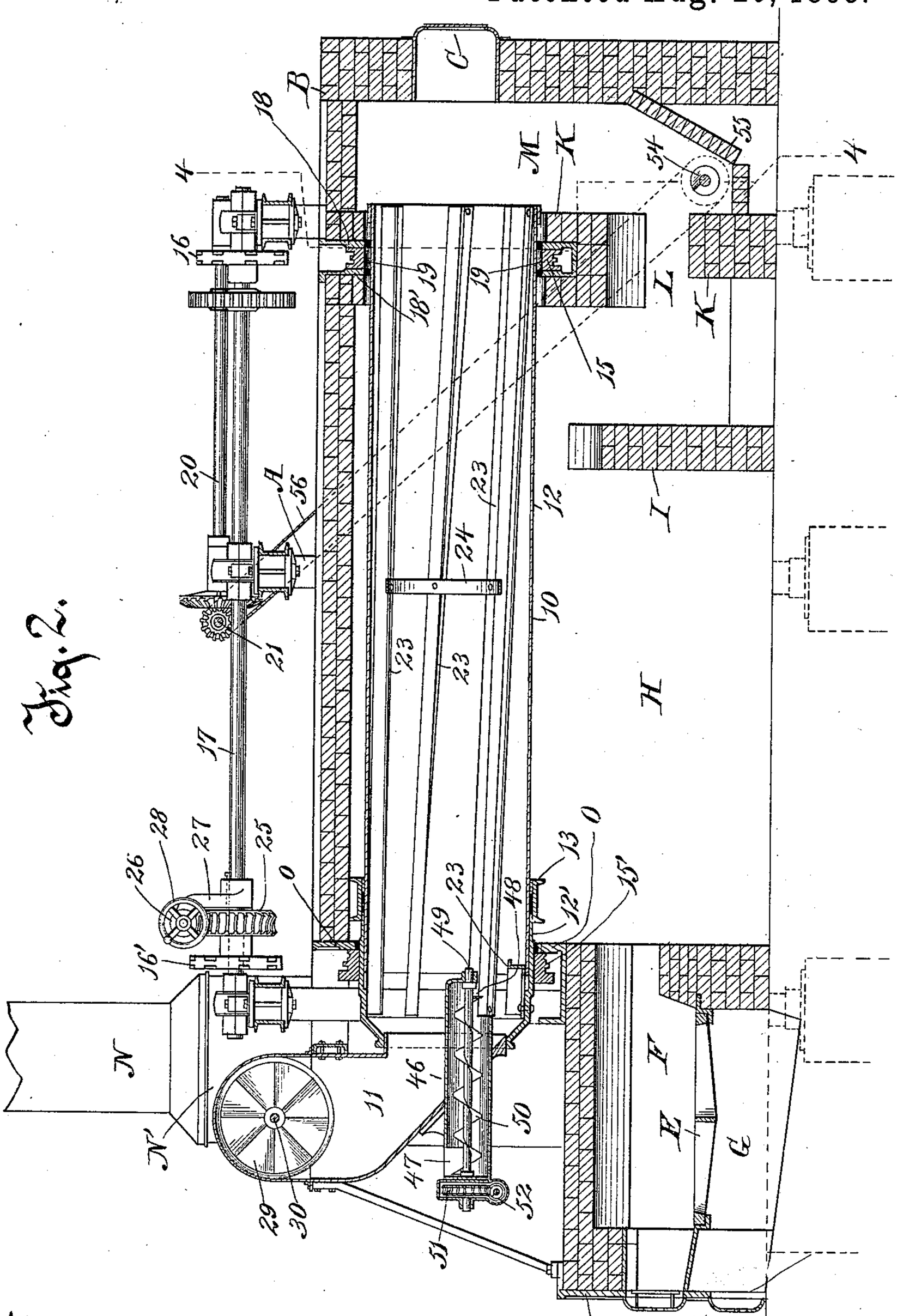

Fig. 2.

Witnesses.
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(No Model.) 4 Sheets—Sheet 3.

A. G. MATHER & H. E. COLLINS.

DRYING APPARATUS.

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Fig. 3.

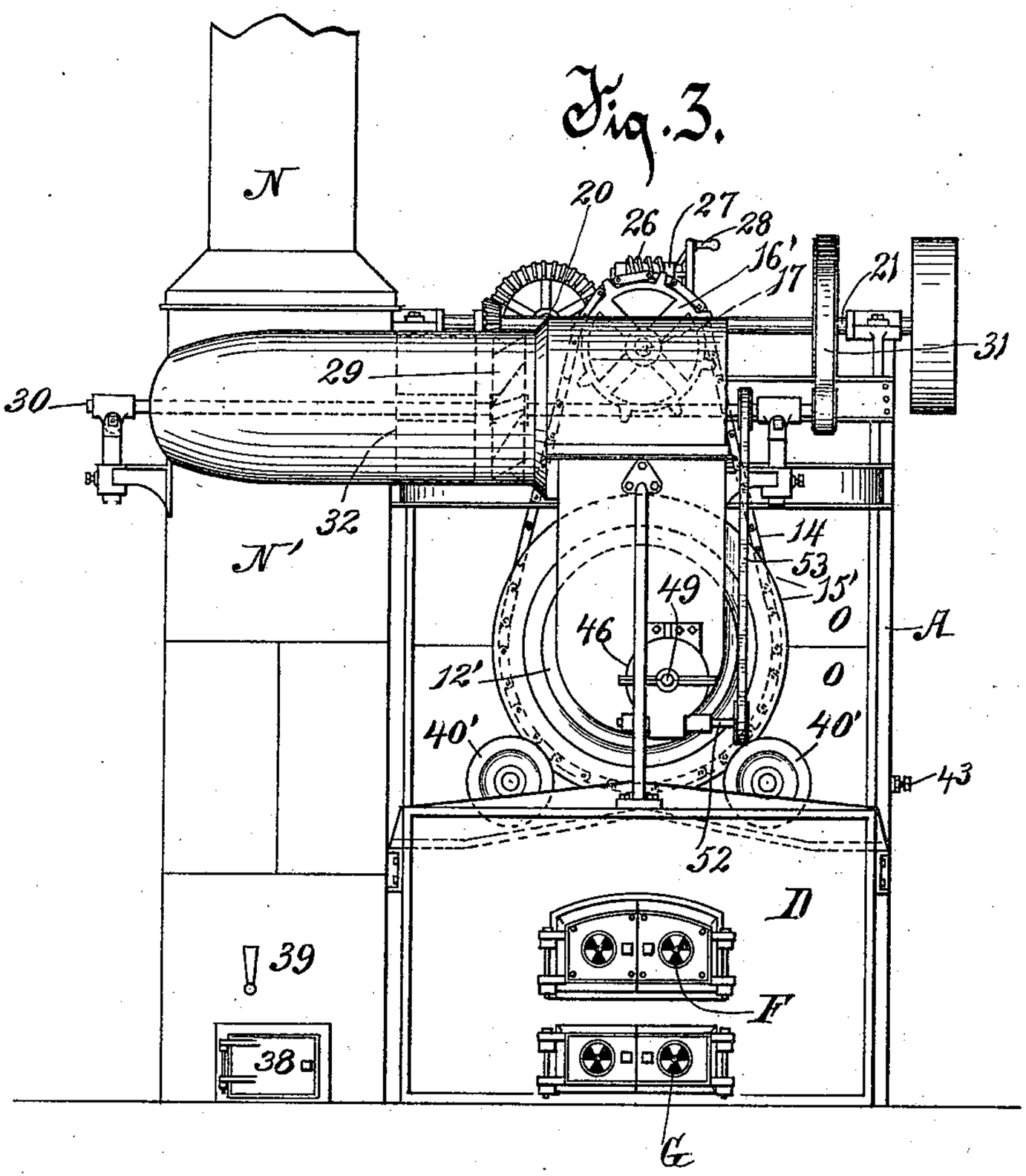


Fig. 7.

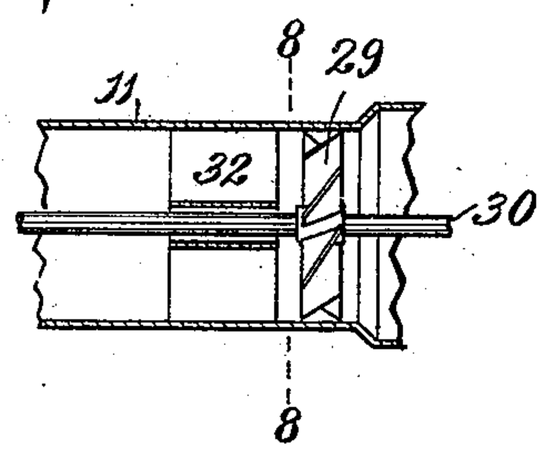
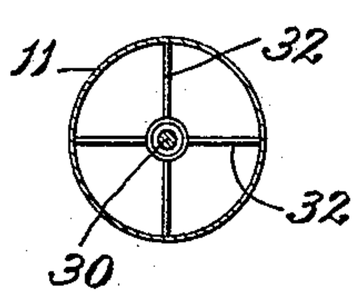


Fig. 8.



Witnesses.
C. N. Kelsey.
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(No Model.) 4 Sheets—Sheet 4.

A. G. MATHER & H. E. COLLINS.

DRYING APPARATUS.

No. 544,679. Patented Aug. 20, 1895.

Fig. 4.

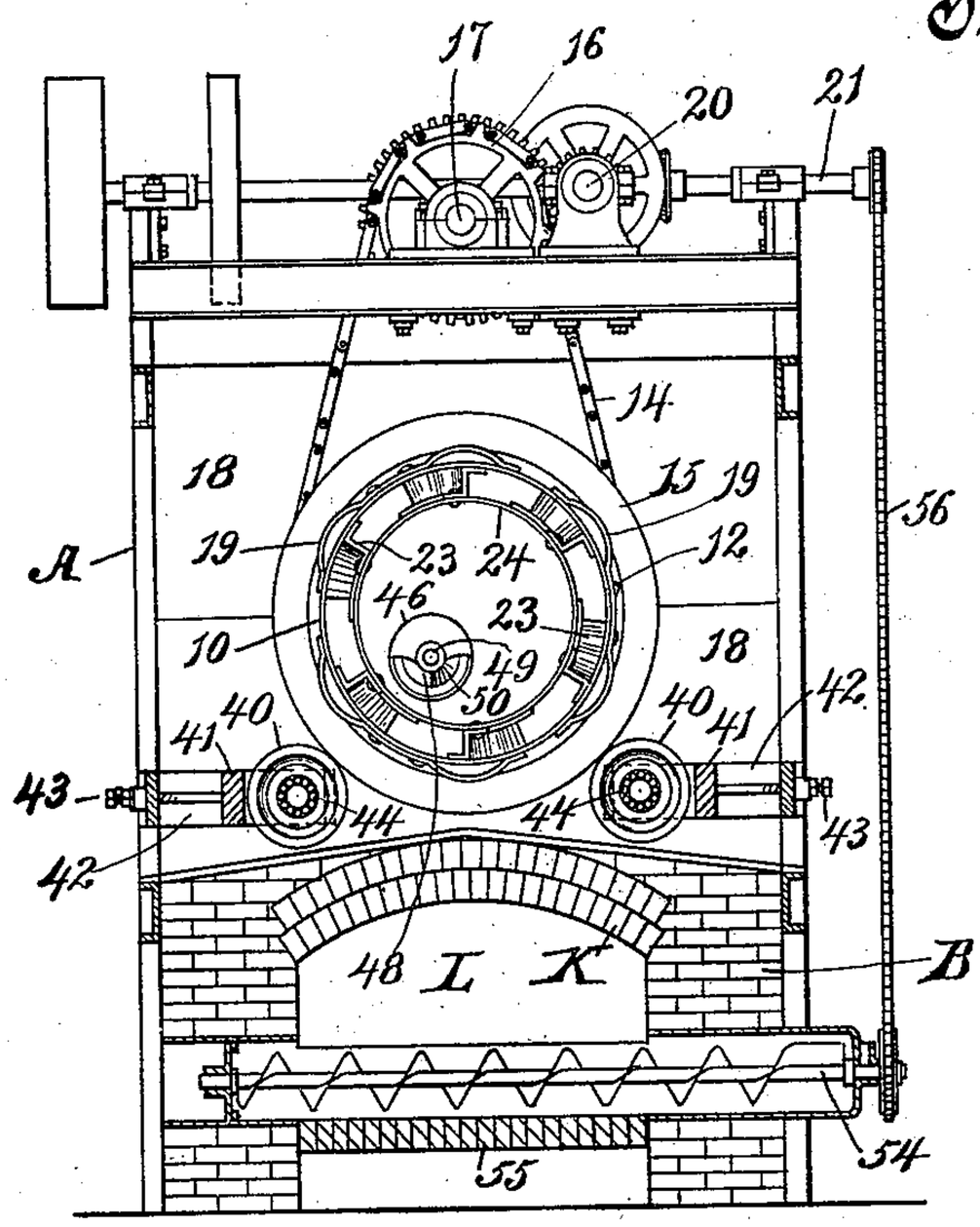


Fig. 5.

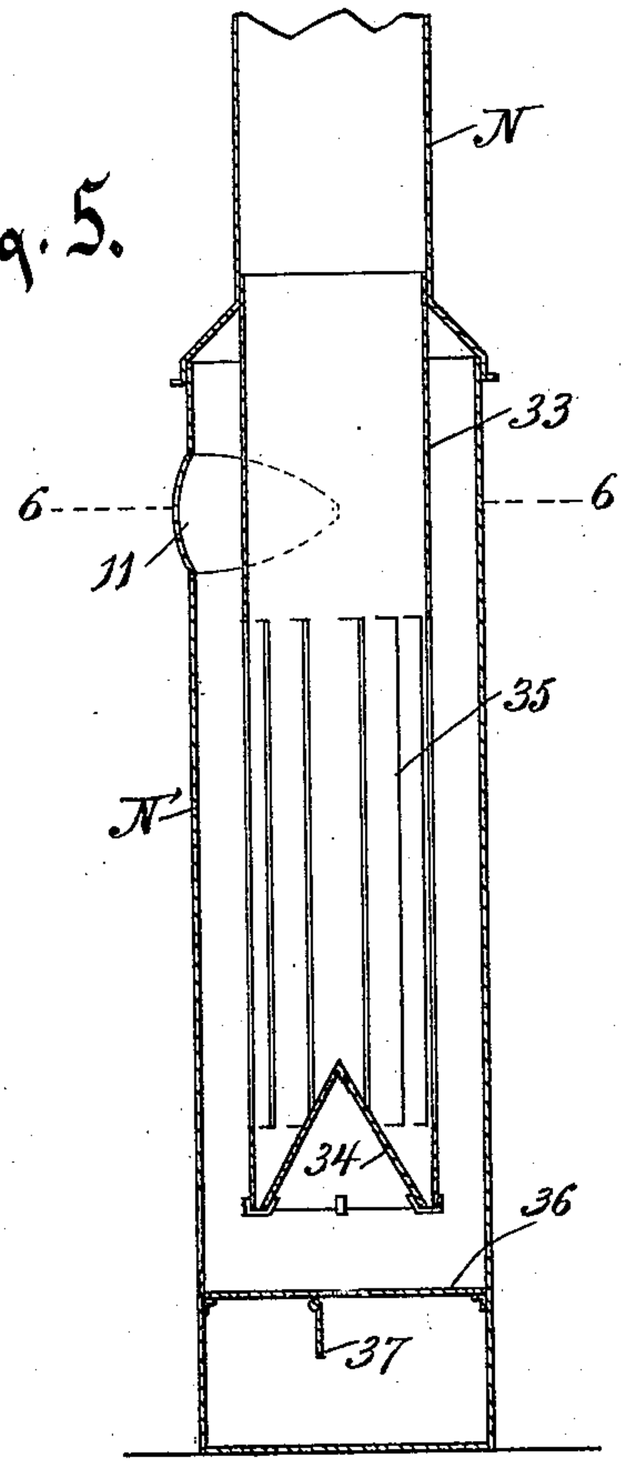
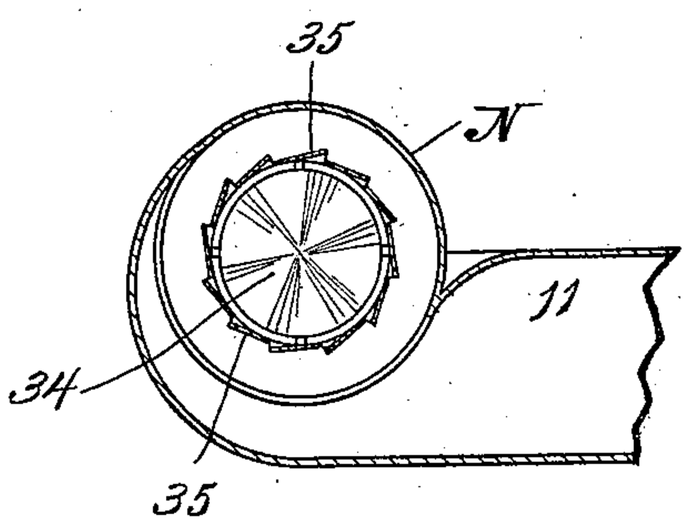


Fig. 6.



Witnesses.
C. F. Kenney.
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UNITED STATES PATENT OFFICE.

ALLAN G. MATHER AND HENRY E. COLLINS, OF MILWAUKEE, WISCONSIN.

DRYING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 544,679, dated August 20, 1895.

Application filed November 24, 1894. Serial No. 529,840. (No model.)

To all whom it may concern:

Be it known that we, ALLAN G. MATHER, a citizen of the Dominion of Canada, and HENRY E. COLLINS, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Drying, Desiccating, and Roasting Apparatus, of which the following is a description, reference being had to the accompanying drawings, which are a part of this specification.

Our invention relates to improvements in drying, desiccating, and roasting apparatus in which a hot-air blast is brought into contact with the material being operated on while in a drum or cylinder in which the material is elevated and allowed to fall through the air-blast for drying it. The apparatus is adapted for operating on phosphate, infusorial earths, sand, clay, &c.

The principal object of the invention is to provide mechanism by which the length of time in which the material being operated on in passing through the cylinder is increased or diminished, and in the devices in and by which said elevating mechanism can be shifted or adjusted so as to work rapidly or slowly, as desired, and also in devices and mechanism in and by which the efficiency and construction of the apparatus are usefully improved.

The invention consists of the apparatus, its parts and combinations, as hereinafter described and claimed, or their equivalents.

In the drawings, Figure 1 is a side elevation of the complete apparatus. Fig. 2 is a vertical longitudinal section of the apparatus. Fig. 3 is a front end elevation of the improved apparatus. Fig. 4 is a vertical section of the apparatus on line 4 4 of Fig. 2, looking toward the left. Fig. 5 is a vertical section of the lower portion of the smoke-stack, showing the construction of a dust separator and pit therein. Fig. 6 is a horizontal section of the smoke-stack and of a fragment of the blast-flue at the point of junction of the flue with the smoke-stack. Figs. 7 and 8 are respectively a longitudinal and a transverse section of the blast-flue at the rear of the suction-fan.

In the drawings, A is a metal frame constructed principally of steel channel-irons of such form and strength as are required to support the operative parts of the mechanism of the apparatus, and in connection with which, but independently thereof, the brickwork B is constructed, which brickwork consists chiefly of the shell that incloses the fire-box and combustion-chamber of the apparatus. The brickwork of the furnace is provided with door-closed manholes C. The front steel-metal door-plate D, which forms a part of the frame of the apparatus, is provided with suitable furnace-doors, and there is a grate E at the bottom of the fire-box F above the ash-pit G. In the combustion-chamber H there is a transverse breast-wall I, adapted to compel the hot air and gases of the chamber to rise above it, near to the drying drum or cylinder, in passing over it to the rear, and there is also a transverse partition-wall K at the rear end of the combustion-chamber, provided with a passage L near the floor, through which the hot blast passes from the combustion-chamber into the hot-blast chamber M in the rear part of the furnace-shell. The frame A is footed on piers (indicated in Figs. 1 and 2) which are independent of the brickwork B. A smoke-stack N stands alongside the furnace at its front.

The drying-drum or hollow cylinder 10, in which the drying, desiccating, or roasting of the material operated on chiefly takes place, is located in the upper part of the combustion-chamber H and is horizontally disposed, its rear end being inserted independently thereof and revoluble therein through the partition-wall K, and the front end of the cylinder is similarly inserted through the front wall of the combustion-chamber. This construction compels the air and products of combustion passing from the chamber H into the chamber M to escape therefrom forwardly through the drum into the blast-flue 11. The drum is advisably constructed of sheet metal, and consists of a principal or body part 12, extending from the rear wall K to and through the front wall of the combustion-chamber, and of a sleeve or neck portion 12′, which sleeve fits movably about the front extremity of the part 12, extending through the front wall of the combustion-chamber, and is contracted to a circular mouth fitting revolubly about the thereto-joining end of the blast-flue 11. Preferably an annular band 13, secured

to the member 12 so as to form an annular recess at the front end thereof between it and the drum, serves as a cap or bearing for the rear end of the member 12′, within which it is revoluble by a comparatively tight joint. This construction also provides for the longitudinal expansion of the member 12 of the drum without detriment to it or to the furnace-walls in which it is mounted. This drum is rotated by the sprocket-chains 14 14′. Sprocket-rings 15 15′ are secured to the drum, the ring 15 being about and secured to the member 12 in a space therefor in the partition-wall K, and the ring 15′ being about and secured rigidly to the member 12′ immediately in front of the metal plates O O, that form the front wall of the furnace at this locality. The sprocket-chains 14 14′ run and are supported, respectively, on the sprocket-wheels 16 16′, the wheel 16 being fixed on the shaft 17 and the wheel 16′ being adjustable revolubly on said shaft 17. The chains 14 14′ are carried about the drum 10 and run on the rings 15 15′, whereby the drum is rotated from the shaft 17. Metal plates 18 18′, each plate being conveniently made in an upper and lower section, one plate bearing against the rear and the other against the front of the ring 15, are fitted in the partition-wall K and loosely about the member 12 of the drum. The member 12 of the drum is subjected to great heat, and to provide for expansion thereof the annular ring 15 has its interior aperture somewhat larger than the periphery of the drum, providing a space between them in which the drum may expand.

To secure the ring to the drum, so as to compel rotation of the drum with the ring and at the same time provide for the expansion of the drum, semielliptical or bent springs 19 are interposed between the drum and the ring. These springs are severally secured at one end to the drum, the other end being free and bearing against the drum, while the central projecting part of the spring enters a recess therefor in the inner surface of the ring. These springs are of such stiffness that, entering the recesses therefor in the ring, they carry the drum around revolubly with the ring, while sufficiently yielding to permit of the expansion of the drum. The plates O O at the front of the furnace fit loosely about the member 12′ of the drum, and the ring 15′ abuts against these plates, making a comparatively-tight joint through the wall of the furnace at this locality, providing for expansion and contraction of the drum.

Motion is communicated to the shaft 17 from the counter-shaft 20, geared thereto, the counter-shaft 20 being driven from the transverse shaft 21, which is driven by the belt 22, running from the source of power. The shaft 17, the counter-shaft 20, and the transverse shaft 21 are mounted on the frame A. As the drum 12, with its load, is liable to be very heavy, it must be supported entirely or principally by other means than suspending it in the chains 14 14′. For this purpose idle supporting-wheels 40 40 are provided at the rear end of the drum, and other idle-wheels 40′ 40′ are provided at the front end of the drum. The wheels 40 are located one at each side of and below the drum and are respectively mounted in a block 41, adjustable horizontally toward and from the drum on ways 42 in the plates 18 18′, which are a part of the frame. A bolt 43, turning by a screw-thread through the frame, bears against the sliding block 41 and is adapted to force the wheel 40 farther underneath the drum, the weight of the drum being sufficient to force the wheels and the blocks outwardly when the bolts 43 are withdrawn. Bearing-rollers 44 are inserted about the axles of the wheels 40 to reduce the friction. These wheels 40 receive thereon and carry the sprocket-ring 15, the ring having annular flanges therefor at the sides of the groove in which the sprocket-chain runs, which flanges bear against and run on the wheels 40. The sprocket-ring 15′ is provided with an annular flange at its outer end, which bears against and travels on the wheels 40′, which are mounted revolubly on brackets 45, fixed on the frame. These wheels 40′ are located below and at the sides of the drum and are provided with radial flanges at their outer edges that bear against the outer end of the sprocket-ring 15′ and prevent the movement of the ring and the member 12′ endwise in that direction.

For the purpose of elevating and advancing the material being operated on through the drum, spiral buckets or flights are used therein. These buckets consist of a series of longitudinally-disposed angle-irons 23, preferably of reversely-flanged double **Z** form in cross-section. These irons are substantially as long as the drum, and at their rear ends are pivoted at little distances apart on the interior of the member 12 of the drum. At their front extremities these buckets are pivoted at corresponding distances apart to the member 12′ of the drum. Medially, for the purpose of stiffening the buckets and holding them in position against or near to the wall of the drum, a ring 24 is pivoted to the interior edge or flange of each bucket. When the parts are thus connected together, it is only necessary to rotate the member 12′ on the member 12 to increase or diminish the inclination revolubly or the pitch of the buckets 23 spirally. This it is frequently desirable to do, even while the apparatus is in operation, so that a quantity of material having a superabundance of moisture can be advanced through the drum slowly, which is done by diminishing the pitch of the buckets, or another quantity or portion of the material having less moisture therein can be advanced more rapidly through the drum, while revolving at the same rate of speed as before, by increasing the pitch or inclination of the buckets. To accomplish conveniently, and even while the apparatus is in operation, the change in the

pitch or inclination of the buckets, the sprocket-wheel 16′, which is loose on the shaft 17, is provided with a worm-wheel 25, rigid on its hub, and a worm 26, gearing therewith, is mounted revolubly only in a bracket 27, keyed or fixed on the shaft 17. The worm 26 is provided with a hand-wheel 28, by which it is rotated. By turning the worm 26 the sprocket-wheel 16′ is rotated on the shaft 17, and the member 12′ is correspondingly rotated on the member 12, whereby the shifting of the pitch of the buckets 23 is readily accomplished. As the shaft 17 ordinarily rotates at a comparatively slow speed, the worm 26 can be quickly rotated by hand without stopping the mechanism, if desired.

For producing a strong blast of hot air from the combustion-chamber through the drum 10, a rotary suction-fan 29 is arranged in the blast-flue 11, which leads from the drum 12 into the smoke-stack N. This fan is fixed on a shaft 30, which is driven by a belt 31, running from the transverse shaft 21. To prevent or break up the gyratory movement of the air and dust produced by the fan 29, a series of longitudinal ledges or blades 32 are fixed in the flue 11 at the rear of the fan. This construction directs the air-blast and dust particles therein directly into an exterior chamber of the smoke-stack, into which it enters in a tangential direction, the smoke-stack having preferably a circular form at this locality, whereby the air and dust are given a circulatory motion therein around the cylindrical wall 33 of an interior chamber of the smoke-stack, which interior chamber is continuous with the flue in the upper part of the smoke-stack. The exterior chamber of the smoke-stack at this point and below is formed by the exterior wall N′, of greater diameter than the remainder of the smoke-stack, this exterior wall extending from the bottom of the stack upwardly to a point somewhat above that at which the flue 11 leads into the stack, at which upper extremity of the wall N′ it is joined to the wall of the smoke-stack N, whereby the exterior chamber is closed upwardly. The interior cylindrical wall 33 extends downwardly nearly to the bottom of the smoke-stack, and is there partially closed by the diametrically smaller cone-shaped bottom 34. This bottom 34 is secured to the wall 33 by straps, leaving a slight space between its lower edge and the end of the cylindrical wall, through which dust may escape. Sections forming elongated deflecting-doors 35 are cut in the sheet-metal wall 33, and at their free edges are bent outwardly, slightly forming passages through which the hot air circulating in the exterior chamber may escape into the smoke-stack. This construction, which compels the air entering the exterior chamber of the smoke-stack to flow downwardly and around the cylindrical wall 33 before it escapes into the inner chamber of the smoke-stack, is adapted to cause dust or foreign matter in the air-blast to settle to and pass through the false bottom 36 in the smoke-stack before the air enters the interior chamber of the smoke-stack, and even after it has entered the interior chamber past the doors 35 other dust or foreign matter still remaining in the air-blast will drop on the cone bottom 34 and slide down it and be discharged to the false bottom 36. A trap-door 37, closing an aperture across this false bottom provides for the escape of the dust and foreign matter from the chamber above the floor 36, which can be removed from the dust-pit at the bottom of the smoke-stack through the door 38 therein. As the air laden with dust and foreign matter to some extent gyrates around in the chamber above the floor 36, the dust and foreign matter fall down on the floor and are moved around thereon until they fall through this elongated transverse aperture therein. A crank-handle 39, attached to the door 37, is adapted for opening and closing the door.

For feeding material, especially such as is wet, sticky, and heavy, into the drum 12 a spiral conveyer is provided, consisting of a cylindrical tube 46, located in front of the drum and disposed horizontally, which tube passes through the wall of the flue 11 and projects into the mouth or front end of the drum 12. It is provided with an aperture 47 in its upper side near the front end for receiving the material and with an aperture 48 in its lower side at the interior end for discharging the material in the drum 12. A shaft 49 is journaled in the tube longitudinally and centrally thereof, which shaft is provided with a spiral flight 50, adapted by the rotation thereof to move the material forward through the tube. The shaft 49 is provided with a worm-wheel 51, which meshes with a worm 52, the worm being driven by a belt 53 from the shaft 30. A spiral conveyer 54 is provided for discharging the material from the furnace after it has been operated on. This conveyer is located at the bottom of the chamber M, near the front side thereof, in a trough formed by the partition-wall K and a suitably-constructed false bottom 55, arranged at the rear side to dump the material into the bottom of the trough occupied by the spiral conveyer. The conveyer-shaft is journaled and supported in a metal case or bearings therefor fixed in the wall B. An aperture through the wall at the discharging extremity of the conveyer provides for the discharge of the material through the wall out of the furnace. A belt 56, running on the conveyer-shaft and on the shaft 21, drives the conveyer.

The operation of the apparatus is substantially as follows: There being a fire in the fire-box F, producing fierce combustion and great heat in the combustion-chamber H, which surrounds the drum 12, a hot blast from which is drawn through the passage L, the chamber M, the drum 12, and the flue 11, and discharged into the smoke-stack by the suction of the fan 29, material is introduced into the

conveyer 46, which is discharged therefrom into the drum 12, and is by the revolution of the drum elevated by the buckets 23, and falling therefrom near the top passes through the air-blast flowing through the drum, and is by the action of the spiral buckets 23, serving as a conveyer, advanced through the drum and is discharged therefrom, falling in the chamber M on the false bottom 55 and into the trough formed thereby, from which it is moved and discharged through the wall of the furnace by the conveyer 54. The dust and soot (if any) that are drawn through the fan 29 and discharged into the smoke-stack ultimately mostly fall to the bottom of the smoke-stack, either outside or inside of the cylindrical wall 33, and are moved to and deposited through the aperture transversely of the false bottom 36 into the pit at the bottom of the smoke-stack. The fan is revolved directly from the drum-revolving mechanism, so that if the drum, for any cause, ceases to rotate, the fan will also stop, thereby stopping the air-blast and great heat, which, if continued about and through the drum when its wet load was not being shifted from side to side of the drum, would quickly destroy it.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. In a drying apparatus a cylindrical drum open at both extremities formed in two parts adjustable revolubly and telescopic longitudinally on each other, the enveloping part being contracted beyond the extremity of the included part to a diameter less than the diameter of the included part, substantially as described.

2. In a drying apparatus, a cylindrical drum open at its extremities and adapted to serve as a passage for material and a hot blast therethrough, said drum being in two parts, the principal part being substantially as long as the drum itself, and being provided with an encircling ring secured thereto at one extremity by which this extremity of the drum is supported and revolved, the lesser part of the drum being a sleeve in which the other extremity of the principal part of the drum is fitted revolubly, which lesser part is provided with an encircling ring secured thereto by which this extremity of the drum is supported and revolved, substantially as described.

3. In a drying apparatus, a cylindrical drum formed in two parts adjustable revolubly and telescopic longitudinally on each other, a circumferential band secured to one part in such manner as to form an annular recess between it and the part to which it is secured in which recess the extremity of the other part is received and is movable revolubly and longitudinally, substantially as described.

4. In a drying apparatus, a cylindrical drum in two parts revoluble on each other, a ring about and secured to each part, and wheels mounted on the frame on which wheels the rings and the drum therein are mounted and rotate, combined substantially as described.

5. In a drying apparatus, a cylindrical drum in two parts revoluble on each other, a ring with sprocket teeth about and secured to each part, wheels mounted on the frame on which wheels the rings are mounted and rotate, sprocket chains running on the rings and on wheels on a driven shaft whereby the rings and the drum therein are rotated, substantially as described.

6. In a drying apparatus, a cylindrical drum in two parts revoluble on each other, a ring with sprocket teeth about and secured to each part, a chain running on one of said rings and on a wheel fixed on a driven shaft, another chain running on the other of said rings and on a wheel loose on said shaft, and a means substantially as described for adjusting said loose sprocket wheel revolubly on and clutching it to said shaft.

7. In a drying apparatus, a cylindrical drum in two parts adjustable revolubly on each other, and a bucket or buckets in the drum longitudinally thereof the ends of which are secured to the two parts of the drum respectively, whereby by the adjustment of the parts of the drum revolubly on each other, the buckets are put into spiral form with more or less pitch as desired, substantially as described.

8. In a drying apparatus, the combination with a metal cylindrical drum liable to be subjected to great heat, of a revoluble metal ring of somewhat larger size than the drum, about the drum, springs interposed between the drum and the ring whereby the drum is supported and held to revolution with the ring while expansion of the drum in the ring is provided for, substantially as described.

9. In a drying apparatus, the combination with a metal cylindrical drum in two parts telescopic on each other, and rings one about each part of the drum in and with which the drum is supported and revolved, of supporting wheels located below and at opposite sides of the drum bearing against and holding the rings to registry movably therewith, and adjustable blocks in which the wheels are mounted, substantially as described.

10. In a drying apparatus, the combination with a cylindrical drum in two parts adjustably revoluble on each other, of sprocket rings about the drum one ring being secured to each part, a driven shaft parallel with the drum, sprocket wheels on the shaft one being fixed thereto and the other being loose thereon, sprocket chains running on the rings and on the corresponding wheels on the shaft, a worm revoluble in a bracket fixed on the shaft, and a worm wheel rigid to the sprocket wheel loose on the shaft, substantially as described.

11. In a drying apparatus, the combination with a revoluble horizontally-disposed cylindrical drum, and a furnace having a chamber at one end continuous with and a part of the

combustion chamber and hot blast flue into which chamber solid material is discharged and through which it falls from the drum, said chamber being so constructed as to form a trough therein at its bottom, of a spiral conveyer revoluble in the trough and adapted to convey the material discharged therein from the drum, out of the furnace, substantially as described.

12. In a smoke-stack, of a drying apparatus, an exterior wall inclosing an exterior chamber closed at the top, an interior cylindrical wall at a distance from the exterior wall forming an interior chamber continuous with the flue of the smoke-stack upwardly, deflecting doors in this interior wall at a tangent to the wall, and a blast flue leading into the exterior chamber at a tangent to its walls above the doors into the interior chamber, substantially as described.

13. In a smoke-stack of a drying apparatus, an exterior wall inclosing an exterior chamber closed at the top, an interior cylindrical wall at a distance from the exterior wall forming an interior chamber continuous with the flue of the smoke-stack upwardly, deflecting doors in this interior wall at a tangent to the wall, a blast flue leading into the exterior chamber above the doors into the interior chamber, a conical bottom to the interior chamber having an opening or openings about its lower peripheral edge adapted to discharge dust therethrough, and a false bottom in the smoke-stack below the interior chamber, said false bottom being provided with a transverse aperture adapted to permit of the passage of dust therethrough, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

ALLAN G. MATHER.
HENRY E. COLLINS.

Witnesses to the signature of Allan G. Mather:

ARTHUR L. MORSELL,
ANNA V. FAUST.

Witnesses to the signature of Henry E. Collins:

C. H. KEENEY,
FRED S. HURST.