No. 708,603. Patented Sept. 9, 1902.

A. T. WELCH.

DRIER.

(Application filed Feb. 16, 1899. Renewed July 31, 1902.)

(No Model.) 4 Sheets—Sheet 1.

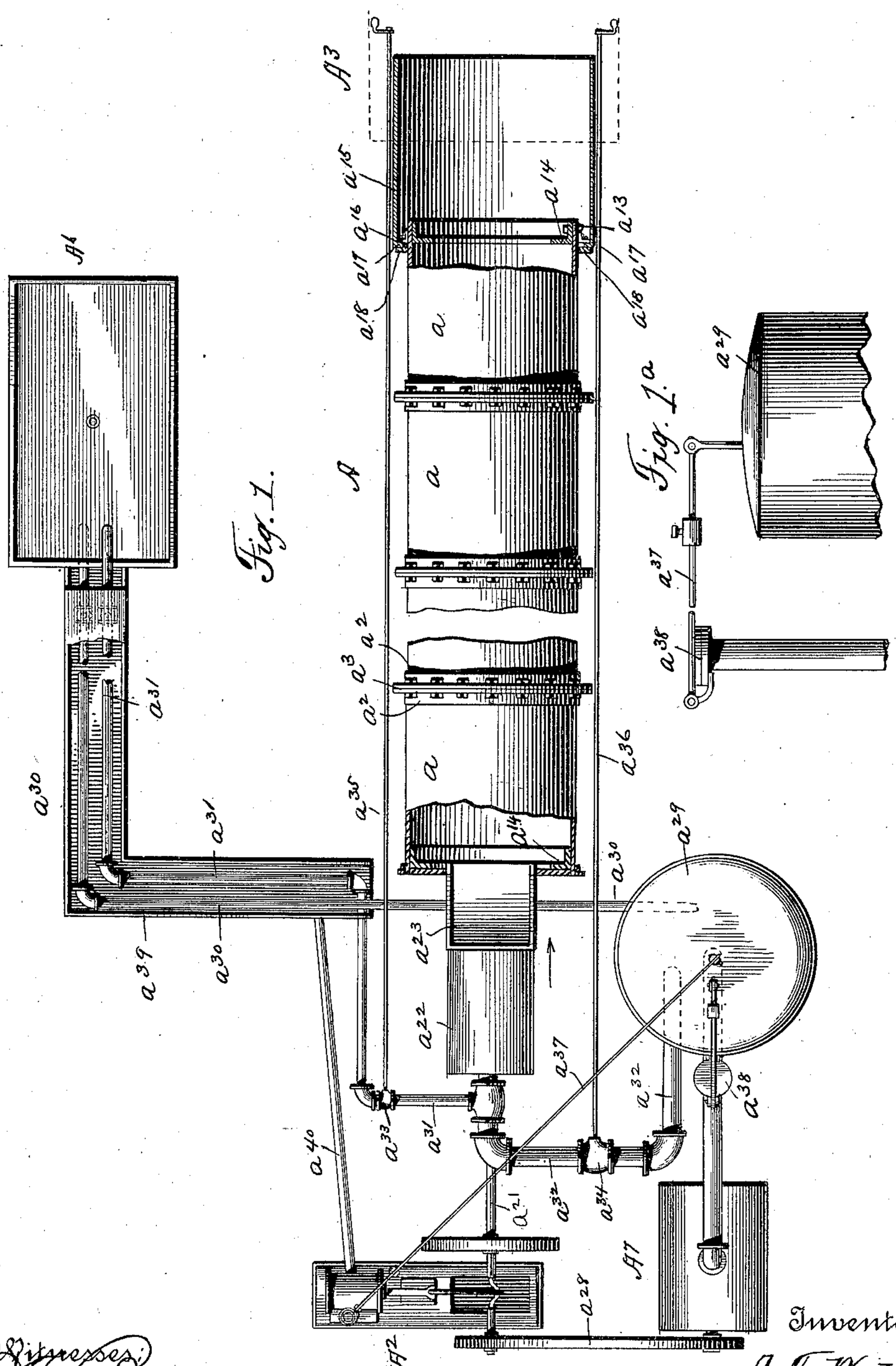

Fig. 1.

Fig. 1a

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(No Model.) 4 Sheets—Sheet 2.

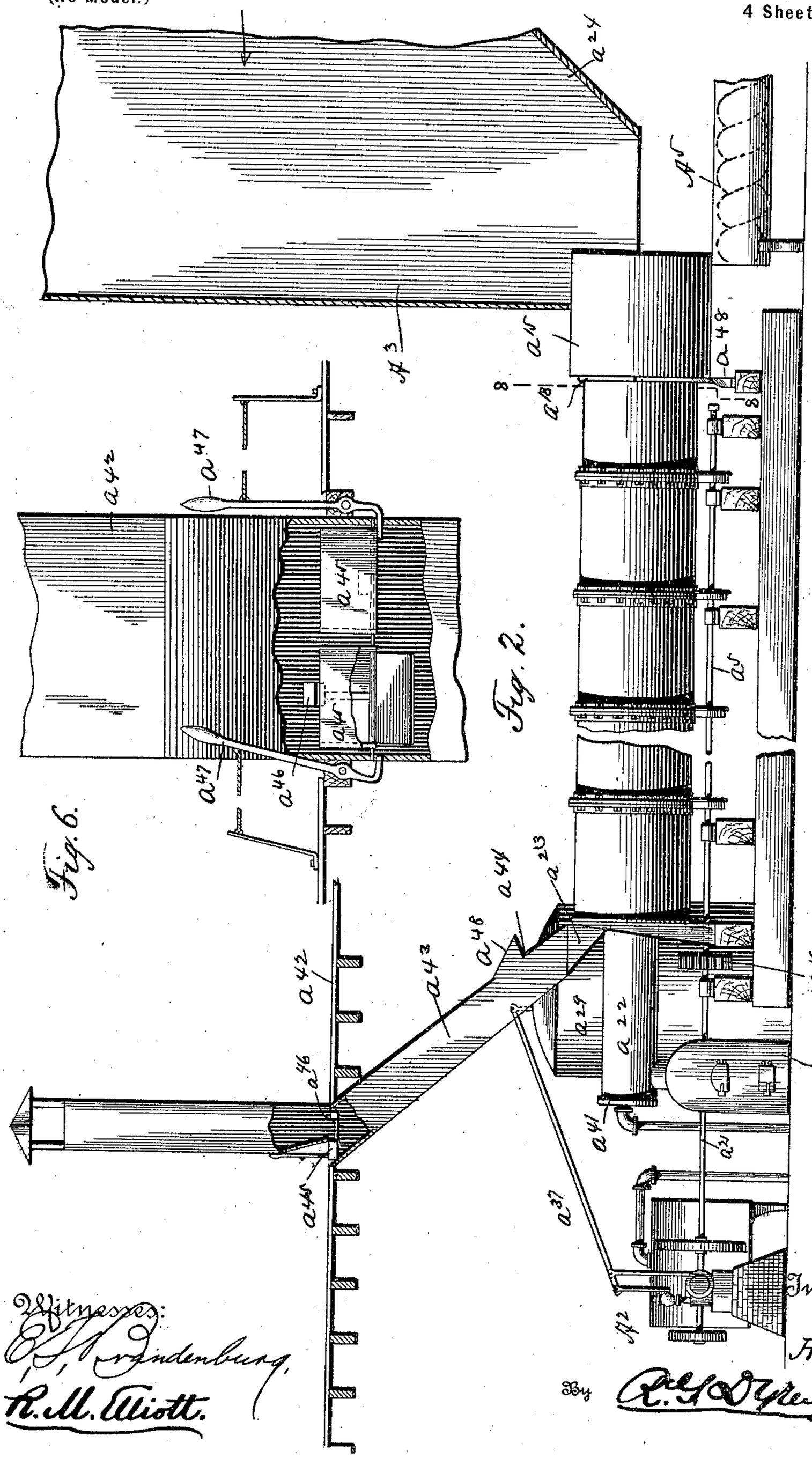

Fig. 2.

Fig. 6.

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(No Model.) 4 Sheets—Sheet 3.

Fig. 4.

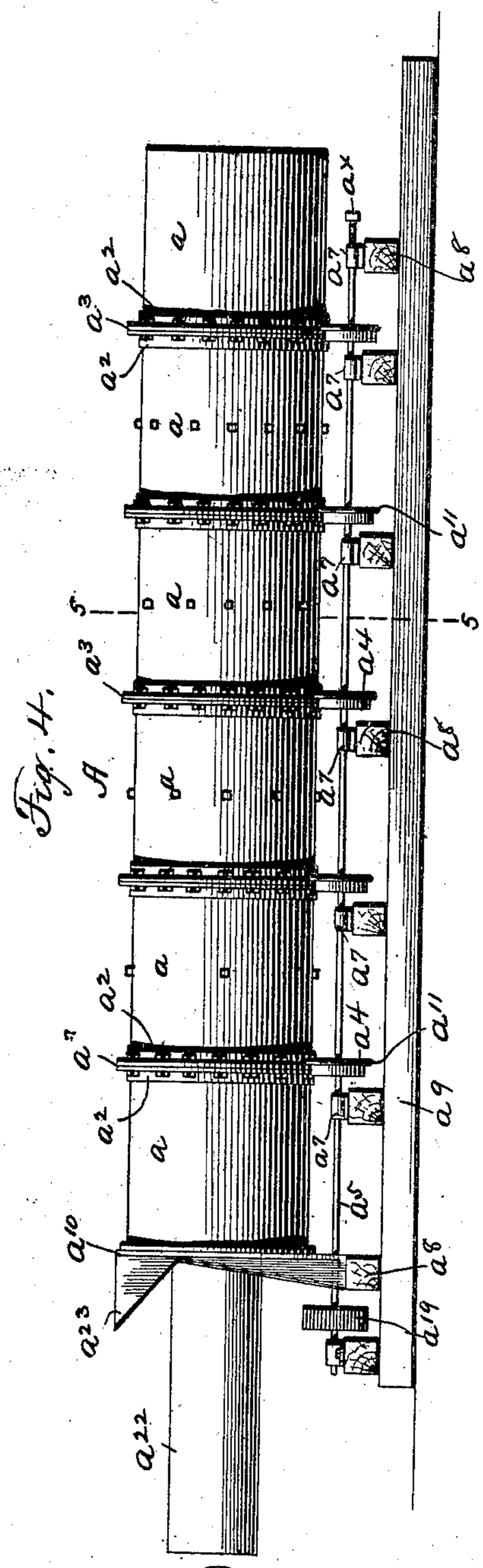

Fig. 3.

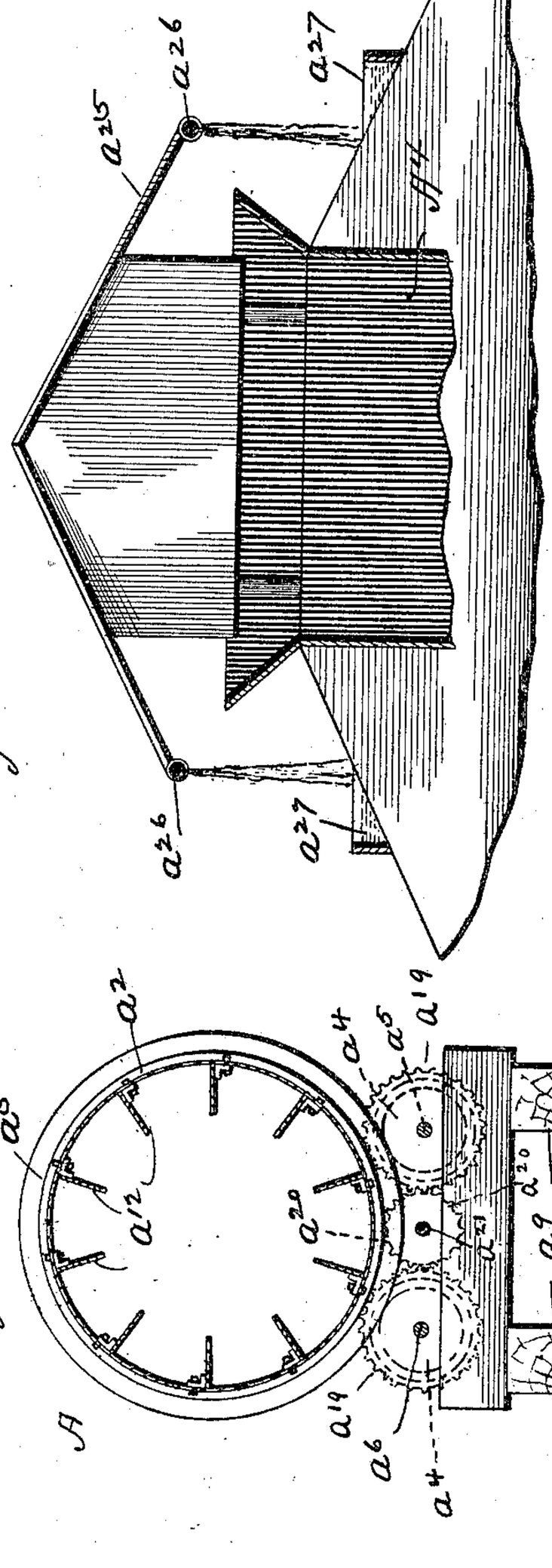

Fig. 5.

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(Application filed Feb. 16, 1899. Renewed July 31, 1902.)

(No Model.) 4 Sheets—Sheet 4.

Fig. 7.

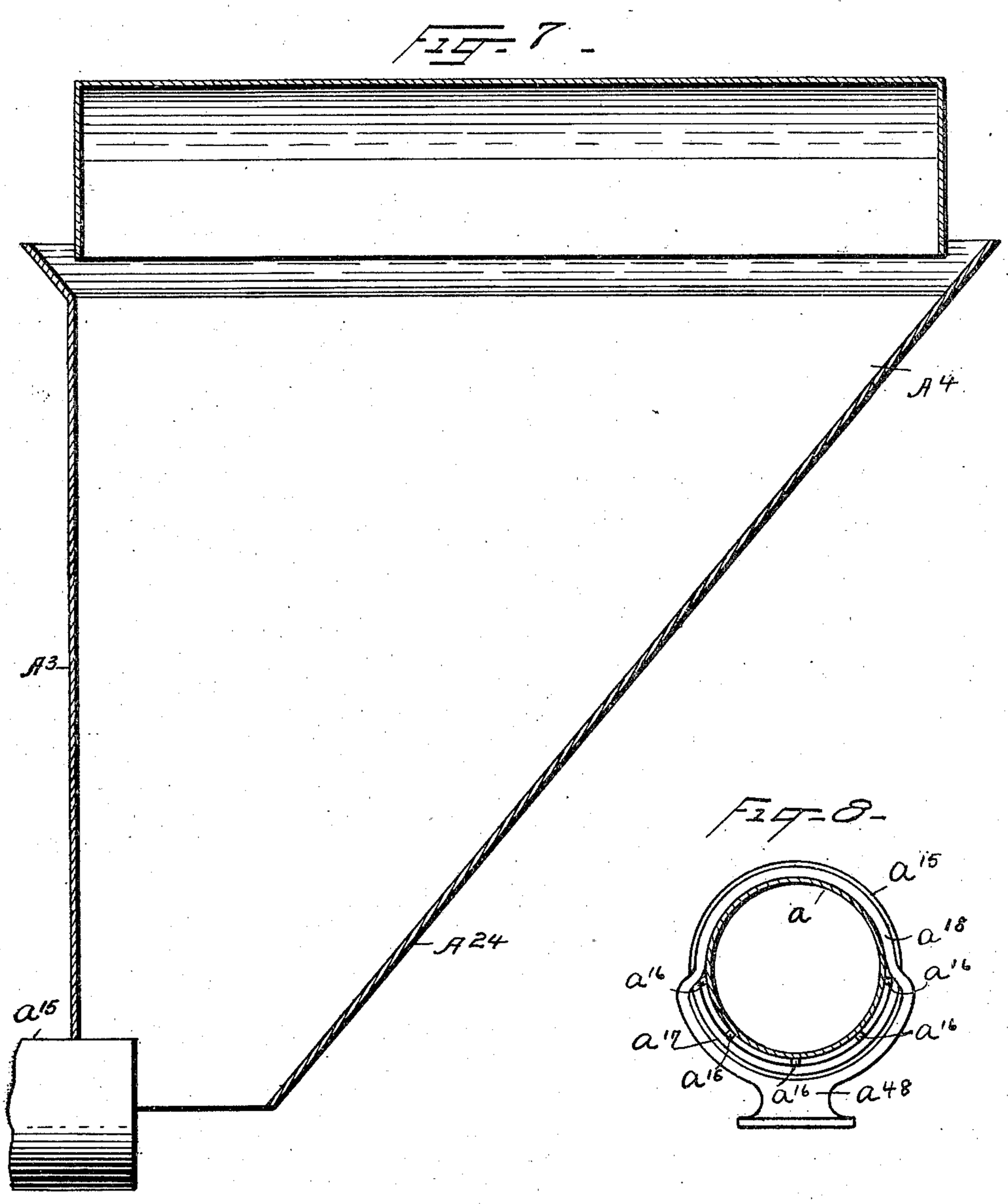

Fig. 8.

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UNITED STATES PATENT OFFICE.

ABRAHAM T. WELCH, OF BALTIMORE, MARYLAND.

DRIER.

SPECIFICATION forming part of Letters Patent No. 708,603, dated September 9, 1902.

Application filed February 16, 1899. Renewed July 31, 1902. Serial No. 117,820. (No model.)

To all whom it may concern:

Be it known that I, ABRAHAM T. WELCH, a citizen of the United States, residing at Baltimore city, State of Maryland, have invented certain new and useful Improvements in Driers; 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.

This invention relates to an apparatus adapted to operate as a cooker, processer, drier, and evaporator, or a combination of any or all.

The objects of the invention are generally to improve the construction of the drying cylinder or drum in such manner as to secure automatic alinement, and thus accuracy of rotation in use, facility in setting up and in transportation, readiness of repair when necessary, and ease of adjustment in length to adapt the drum for drying different kinds of materials; furthermore, to effect conservation and utilization of any dust that may escape from the drier, whereby practically all of the goods dried will be saved and at the same time exclusion of steam or moisture and separation of dust from the steam and hot air will be effected; furthermore, to effect thorough disintegration and partial cooling of the goods being dried prior to discharge from the cylinder, whereby balling of the goods and loss of valuable ammonia are obviated; furthermore, to effect drying of the goods by employing as a heating medium the products of combustion derived from gas, hydrocarbon oil, or coal—either anthracite or bituminous—or a combination of gas and coal heat, as may be preferred; furthermore, by visual means to enable a workman to determine how the device is operating—that is to say, whether the goods are being properly or improperly subjected to the highest heat at the feed end of the cylinder, thus effectively preventing loss by burning, as where the amount of goods fed to the cylinder is too small in proportion to the volume of heat, or insufficient drying, as where the amount of goods fed to the cylinder is too great in proportion to the volume of heat; furthermore, to effect accurate and ready feeding of goods to a cylinder in predetermined quantities, whereby overfeeding will be obviated; furthermore, automatically to control the amount of heat and air fed to the cylinder, whereby uniformity of operation in drying various kinds of goods or the same kinds of goods containing different amounts of moisture will be effected; furthermore, to utilize the exhaust-heat from the engine to heat the air passing to and gas coming from the carbureter when the latter is employed, whereby to render it possible to vaporize and employ cheaper grades of naphtha with heavy by-products, thereby reducing the cost of operating the drier, and, finally, to utilize air-pressure automatically to effect discharge of the goods from the cylinder when properly dried, whereby the employment of a cylinder mounted and operating on a level plane will be rendered possible.

With these objects in view the invention consists in the novel construction and combination of parts of a drier, as will be hereinafter fully described and claimed.

In the accompanying drawings, forming a part of this specification and in which like letters of reference indicate corresponding parts, I have illustrated a form of embodiment of my invention, with a modification thereof, it being understood that other forms of embodiment may be employed without departing from the spirit of the same; and in the drawings—

Figure 1 is a view in plan, partly in section, in the nature of a diagram, displaying a drying-plant embodying the essential features of my invention and in which a carbureter is employed for furnishing the fuel for combustion. Fig. 1ª is a detail view of the airometer. Fig. 2 is a view in side elevation, partly in section, exhibiting the building in which the device is located, and also, as a modification, a coal-burning furnace in connection with the drying-cylinder in lieu of the gas-burner shown in Fig. 1. Fig. 3 is a view in rear elevation looking in the direction of the arrow in Fig. 2. Fig. 4 is a view in elevation of the drying-cylinder, showing more clearly the manner in which it is constructed and supported and the mechanism, in this instance positively-driven friction-rollers, by which it is revolved. Fig. 5 is a section view, taken on line 5 5 of Fig. 4, showing the shelves on the inside of one of the drum-

sections. Fig. 6 is a rear view, on an enlarged scale, of the feed-doors of the chute and means for controlling them. Fig. 7 is a sectional view of the dust-collector; and Fig. 8 is a section taken on lines 8 8, Fig. 2.

Referring to the drawings, A designates the drying cylinder or drum, the same being constructed of a plurality of sections *a*, connected to form a continuous and in operation dust-proof structure. The means employed for securing the sections together in this instance consist of flanged bands a^2, cast or otherwise secured at each end of each section and lying flush with the edges thereof, bolts passing through the flanges a^3 of the opposing bands of the successive sections serving to hold the sections firmly assembled. By this manner of constructing the cylinder provision is made for readily setting it up, taking it down, and for transporting it in sections from place to place. The main advantage gained, however, by this arrangement is that while a cylinder so constructed possesses the strength and rigidity requisite for accomplishing the work intended, yet in reality it will, by reason of the plurality of joints presented, be slightly yielding in character throughout its length, so that perfect and automatic alinement on its supports will at all times be afforded, thus saving wear and tear resulting from strain due either to the imperfect manner of setting up the cylinder or to lack of uniformity in the structure and as a result reducing the power necessary to operate the same. The flanges a^3 constitute bearings to run on flanged rollers a^4, carried by two positively-driven axially-alined shafts a^5 a^6, working in bearings a^7, mounted on transverse bed-blocks a^8, the blocks being supported by base-beams a^9, the latter in this instance to rest upon the floor of the structure inclosing the drying apparatus. The cylinder is set level, and any tendency to retrograde movement that would operate to separate the cylinder from the head-plate a^{10} will be prevented by the flanges a^{11} of the rollers a^4 coacting with those of the bands a^2, so that escape and consequent waste of heat and leakage of material will be obviated. Any wear of the head-plate or of the feed end of the cylinder can be taken up by the thrust-screws $a^\times$ in the end bearings, which screws operate to move the drive-shafts forward, and the flanges on the rollers a^4 by contact with the flanges a^3 of the bands a^2 will force the cylinder forward, and thus keep the same in close and effective contact with the head-plate. Secured to the inner surfaces of the sections are shelves or knives a^{12}, which operate to take up and drop the goods through the stream of heat entering the head of the cylinder and also to comminute and divide the goods, whereby to facilitate thorough and even drying of the same. The shelves are increased in number in the successive sections, starting from the head of the cylinder, and in order that as the goods are progressively dried they will be more finely broken up in each succeeding section, so that by the time the last section, or that at the discharge end of the cylinder, is reached the goods will be in a finely-divided and thoroughly-dried condition. In arranging the knives within the sections of the cylinder, beginning at the feed end thereof, the first section may be of the same length as the others of the series or be only one-half of the length of the same and may or may not be provided with knives. The latter arrangement—that is to say, the omission of the knives—is in some instances preferred, as when the knives are omitted the freshly-admitted, and thus the wettest, goods are permitted to roll around and around the cylinder, and at each revolution a certain portion of the goods when subjected to sufficient heat is by air-pressure and high heat separated from the mass and is blown along in the cylinder, the speed of travel, and thus the discharge, being progressively increased as the goods become lighter and finer upon loss of moisture and consequent decrease in weight, thus leaving in the cylinder that portion of the goods which has not been properly dried, to be subjected to further rolling and drying action. The great advantage accruing from the employment of a level drum or cylinder as opposed to one set upon an incline is that the discharge of the goods is effected by air-pressure, and as a consequence of this pressure only that portion of the goods properly dried will be discharged from the cylinder, the wetter, and thus denser, goods remaining near the feed end of the cylinder until the contained moisture is removed and the goods become light and divided by loss of moisture. It is to be understood, of course, that too rapid feeding of wet goods will cause the same to bank up at the feed end of the cylinder and be discharged rapidly by reason of the tendency of the goods to level themselves lengthwise of the cylinder; but by feeding the wettest goods slowly in a level cylinder they will move very slowly at first toward the discharge end of the cylinder and progressively faster as they lose moisture. This feature insures automatic regulations of heat to prevent burning and effective discharge of dried goods. The number of knives in the sections succeeding the first section is purely arbitrary, and, as one example, there may be employed in the five sections succeeding the first the following number of knives: in the first, four knives; in the second, eight; in the third, ten; in the fourth, sixteen; in the fifth, twenty, and so on; but the number of these knives may be varied to suit the requirements of different cases, and a greater or less number of sections may be employed in constructing the cylinder. In the last section of the cylinder, as in the first, the knives may be omitted, and the length of this section may be one-half that of the other sections. In each of the sections the knives are preferably to be made detachable, so as to be removed or replaced

at will, and are for this purpose preferably secured by bolts. With very light goods, such as brewers' grains, the shelves or knives instead of being dispensed with may be reduced in number throughout the cylinder; but where heavy goods—that is, goods containing a high per cent. of moisture, such as fish, garbage, and the like—are to be dried a greater number of knives will be required at the front end of the cylinder and a progressive increase in number in the successive sections toward the rear of the cylinder. In other words, the heavier the goods to be treated the greater will be the number of shelves or knives required, and the lighter the goods to be treated the fewer will be the number of knives or shelves required. Inversely, the drier the goods are the lighter will they be in weight and the faster they will be blown through the drier, and the finer the goods are the lighter they will be in weight, and thus the quicker will they dry and travel through the cylinder.

At both the feed and discharge ends of the cylinder and on the inside thereof there is arranged a band a^{13}, Fig. 1, having an in-turned flange a^{14}, constituting what is termed from its function a "retainer." This band is to be detachably secured to the cylinder, preferably by means of bolts, and operates to prevent escape of liquid therefrom, so that in operation any liquid to be reduced, such as brine, to obtain the salt by precipitation, or grease or oil from water pressed from animal, vegetable, or other matter by skimming, the amount of liquid contained in the cylinder will be sufficient to avoid loss of heat by having the hot air escape without carrying off its fullest quota of moisture. It is also to be understood that the retainer is not always employed, as in drying some kinds of goods there will be no objectionable accumulation of liquid at the discharge end of the cylinder, and that it is to be employed when liquids alone are to be reduced. Inclosing the discharge end of the cylinder and revolving therewith is a section a^{15}, of greater diameter than the cylinder and without the shelves or knives constituting what is termed a "cooler." This cooler is held in place on the cylinder in any suitable manner, in this instance by straps a^{16}, and the inner end of the cooler is flanged or turned inward, as at a^{17}, to prevent escape of goods between the cylinder and the cooler. The connection of the cooler and the cylinder is such that a space is left between the two, and this space is closed, preferably for one-half of its circumference, by a band a^{18}, said band being supported by a suitable bracket a^{48}, suitably secured to the base, leaving an air-space between the cooler and the cylinder at the lower portion of the latter for the passage of air through the cooler and over the goods, thus to carry off remaining moisture and to cool and dry the goods. The air is introduced into the cooler by an induced draft generated by the passage of air and steam through the cylinder.

Each of the shafts a^5 and a^6 carries a gear-wheel a^{19}, and these two gears mesh with a pinion a^{20}, carried by the shaft a^{21}, driven from an engine A^2—in this instance a steam-engine—although it is to be understood that any other form of engine, as a gasolene or gas engine or an electric motor, may be employed for the purpose. The rollers a^4 are thus positively driven and revolve the cylinder by frictional contact with the flanges a^3, by which arrangement the employment of cogged bands on the cylinder is dispensed with and the power necessary to revolve the cylinder is reduced to a minimum. The liability, also, of breakage and stoppage of the cylinder arising from the stripping of teeth or breaking of the bands is obviated. The head-plate a^{10} is suitably held in position against the end of the cylinder and carries a combustion-chamber a^{22} and a feed-hopper a^{23}, these parts being by preference connected together to present a single structure. The rear portion of the cylinder, including the cooler when one is used, projects into a dust-collector A^3, the same having vertical front and side walls and an upward and outward inclined rear wall a^{24}, the upper open end of this collector terminating in a dust-room A^4, arranged toward the roof of the building and covered by a peaked roof a^{25}, a space being left between the upper edges of the dust-collector and the roof, around the whole structure, to permit escape of steam, and arranged on the outer edge of this roof is a perforated pipe a^{26}, through which water is sprayed through the steam to condense the same and to catch any escaping dust, the water of condensation being caught in a trough a^{27}, surrounding the upper portion of the main building, and thence led by a pipe to the ground. In the operation of the drier the hot air, dust, and moisture from the cylinder are discharged into the dust-collector, which from its construction presents a constantly-enlarging space, so that most of the dust will be chilled and will be precipitated before reaching the top of the collector and will drop back upon the floor in front of the discharge end of the cylinder, and the cooled moisture will be forced through an opening near the top of the system by the lifting-power of the hot air through the neck of the dust-collector near its bottom, and at the same time sufficient cold air will be drawn in through the said neck to chill the hot air and moisture. The cylinder may discharge directly upon the floor, or an endless conveyer A^5 may be employed for the purpose of carrying off the goods as fast as discharged.

Where gas is used as a fuel, the same is supplied from a carbureter A^6, located some distance from the building in which the apparatus is housed, and the engine which drives the shafts a^5 a^6 also operates a positive blower A^7 through the medium of a belt a^{28}.

From the blower the air enters an airometer a^{29}, and passes thence through a pipe a^{30} to the carbureter. The gas from the carbureter is supplied to the combustion-chamber a^{22} through a pipe a^{31} and air from the airometer to the combustion-chamber through a pipe a^{32}. On both the pipes a^{31} a^{32} there is arranged a valve a^{33} and a^{34}, respectively, and connected with the valve-stem of each of these valves is a rod a^{35} a^{36}, respectively, which leads back and into the dust-collector, so that an operator stationed at the discharge-mouth of the apparatus and watching the front of the cylinder and feeling of the dry material at its discharge end can determine by the color of the vapor or smoke from the feed-hopper whether the drier is operating properly at its front end, as well as at its back, and may regulate any defect in this particular either by turning the rods a^{35} a^{36} to change either the supply of air or gas to the combustion-chamber or by feeding the goods into the hopper faster or slower.

As a means for regulating the speed of the engine, so as to cause the drier to work regularly at all times and slowly when the goods in the drier are not being properly dried, I employ a lever a^{37}, suitably fulcrumed upon the engine-frame and connected at one end to the governor-valve of the engine and at the other end resting on the top of the airometer. Thus when the drier is working properly and the airometer is at its lowest working point the engine will run at its highest or regular speed; but should an overcharge of goods enter the drier and the workman turn the rod a^{35} to cut off the supply of air to the combustion-chamber the regulator will rise and the engine slow down, and the goods will not be blown through the cylinder so fast and will be given time to become dry in the cylinder. A blow-off valve a^{38} will allow the air to escape from the main pipe connecting the blower and the airometer upon sudden changes from fast to slow. Upon opening the air-valve of the combustion-chamber the airometer will lower somewhat, and the engine will again start at full speed. It will be noted by Fig. 1 that the air and gas pipes leading to the carbureter are inclosed in a boxing a^{39}, and into this boxing exhaust-steam is fed through a pipe a^{40}, so that the said pipes are kept heated, and by this arrangement a lower grade of oil can be employed for making the gas than if the pipes were exposed to the air.

Where the heat for the drier is to be generated from coal, a furnace A^8 is employed, as shown in Fig. 2, and the furnace is tapped into the combustion-chamber, the outer end of the combustion-chamber being closed for this purpose by a cap a^{41}, through which projects the air-supply pipe, which acts as an ejector of the heat from the furnace and as an injector of heat to the cylinder and a supply of fresh air to increase combustion and consume smoke and gases from the furnace. Suitable above and below grate-doors may be employed to control the heat, the volume of heat being controlled by the upper door and the intensity of heat by the lower door to the combustion-chamber. It is to be understood that, if desired, I may employ both gas and coal heat together for heating the combustion-chamber by partially removing or entirely removing the cap a^{41}. The cap a^{41} encircles the pipe a^{32}, and may be moved back and forth on the same to open or close the rear end of the combustion-chamber. If desired, this cap may be entirely removed, as shown in Fig. 1. The goods are fed to the cylinder from a platform a^{42}, located above the cylinder, and down a combined stack and chute a^{43} into the feed-hopper a^{23} on the head-plate, and adjacent to this hopper the chute is provided at its front with an opening to provide a vapor-sight a^{44}, through which the vapor or smoke from the hopper will be seen. This vapor-sight consists simply of an opening in the front of the chute a^{43}. The pull of the stack will maintain an inward draft through the vapor-sight and prevent the escape of gases; but to insure this I place over the opening a hood a^{48}. The vapor-sight also acts as a damper to the stack a^{43} by admitting cold air and checking the draft, so that it will not exert too much pull on the contents of the cylinder. Should the goods be banked up at the front end of the cylinder, as from overfeeding, the color and amount of vapor and smoke escaping up through the chute indicating how the heat is effecting the goods at the front of the cylinder. The feeding is effected by two measuring-boxes a^{45}, Fig. 6, which are tripped by an operator standing on the platform, one of these boxes to be dumped while the other is being filled. To the bottom of each box is connected a weighted lever a^{46}, arranged inside the chute or stack, the weight being sufficient automatically to keep the box-bottoms closed; but when the weight of the material put into the box counterbalances the weight of the lever and the bottom is released by the operator who actuates the trip-lever a^{47} it will tilt and discharge the goods down into the feed-hopper, and the weight will automatically again operate to close the bottom. One box or measure of goods is dumped at a given number of revolutions of the cylinder, more or less, according to the amount of moisture in the goods. The revolutions of the cylinder are counted by the operator, or a mechanical counter may be employed for the purpose which can be set or changed by the operator. At a given number of revolutions the operator gives a signal, as by a bell or whistle, to the feeder on the platform to dump one box of material. This method of measuring the wet material according to its moisture insures a uniformly-dried material.

In determining how the device is operating the color of the vapor can readily be seen

by day or night at the vapor-sight by the light of the white-hot flame which extends into the feed end of the cylinder.

In operation the heat is always kept at the highest point possible to be maintained whether drying feathers, rocks, fish, garbage, or any other material, the feed of material being varied according to the amount of moisture it contains.

By the principle I employ of using the highest possible maintainable heat when drying material of any kind and by regulating the drying capacity of the device merely by the feed of the material I am enabled when drying materials containing a large amount of moisture to save the most volatile, and thus the most valuable portion of the ammonia, as when the goods first enter the cylinder I can in some instances singe them, thus to prevent the loss of ammonia, and thereafter by the progressive drying toward the discharge end of the cylinder save the more volatile portions, and thus increase the fertilizing quality of the product as completed.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a drier the combination of a level-drum closed by a vertical wall at one end and open at the other with means for supplying material to be dried to the drum at the closed end, and delivering the same against the vertical wall, so that the material lies in a pile the depth of which decreases from the vertical wall toward the open end of the drum, means for projecting a flame into the drum from its closed end such a distance from the bottom of said drum that the flame upon entering will not impinge upon the goods piled on the bottom, means for rotating the drum and means whereby by the rotation of the drum the material is dropped through the flame and fed through the drum toward the open end thereof.

2. In a drier the combination of a level-drum closed by a vertical wall at one end and open at the other, of means for supplying material to be dried to the drum at the closed end and delivering the same against the vertical wall so that the material lies in a pile the depth of which decreases from the vertical wall toward the open end of the drum, means for projecting a flame through the vertical wall into the drum such a distance from the bottom of said drum that the flame upon entering will not impinge upon the goods piled on the bottom, and means for rotating the drum whereby by the rotation of the drum the material is dropped through the flame and progressed through the drum toward the open end thereof.

3. In a drier the combination of a drum closed at one end by a head substantially at right angles to the axis of the drum, and open at the other, the level of the discharge being the same as that of the base at feed end, means for supplying to the drum at the closed end material to be dried, means for revolving the drum, and means for projecting into the drum at its closed end a flame at or about the center of the head substantially as described.

4. In a drier the combination of a receiver, the discharge end of which is at substantially the same level as the goods-receiving surface at the feed end, and having at its rear end an abrupt wall high enough to permit in the receiver an incline of goods of such an inclination that goods of any given moisture, while traveling down the incline from the feed to the discharge end of the receiver, will lose the desired quantity of moisture, means for agitating the material to be dried, means for feeding to the receiver measured quantities of material to be dried, means for projecting a flame through said wall such a distance from the bottom of said drum that the flame upon entering will not impinge upon the goods piled on the bottom.

5. In a drier the combination of a rotating drum open at one end, and closed at the other by a stationary vertical wall, means for projecting a flame through said wall into said drum at a substantial distance above the base of said drum, means for feeding material to be dried into said drum through said wall and means for rotating said drum.

6. In a drier the combination of a rotating drum open at one end and closed at the other by a stationary vertical wall, means for projecting a flame through said wall into said drum, means for feeding material to be dried into said drum through said wall, means for rotating said drum, and means whereby by the rotation of the drum the material is fed through the same and dropped through successive parts of the blast.

7. In a drier the combination of a rotating drum closed at one end by a stationary vertical plate, means for rotating said drum and means for adjusting said drum longitudinally, so that it will always bear tightly against said plate.

8. In a drier the combination of a drum composed of sections suitably secured together, flanges on the drum, of flanged friction-rollers for rotating the drum, a combined head-plate, feed-chute and combustion-chamber closing the feed end of the drum and means for shifting the shafts carrying the friction-rollers whereby to cause the drum to bear tightly against the head-plate.

9. The combination with the drying-receptacle provided with means for supplying heat at the feed end and having a cooler arranged at the discharge end, and a dust-collector inclosing the cooler.

10. The combination with the drying-cylinder provided with means for supplying heated products of combustion at the feed end and having a cooler arranged at the discharge end, of a dust-collector inclosing the cooler, substantially as described.

11. The combination with the drying-cyl-

inder provided with means for supplying heated products of combustion at the feed end and having a cooler arranged at the discharge end, a dust-collector inclosing the cooler, said collector being provided with a spray to carry down the dust, substantially as described.

12. The combination with a drying-chamber, of a dust-collector located at the discharge end thereof in position to receive gases and floating particles therefrom but not the bulk of the dry material, consisting of a chamber open at the bottom and nearly closed at the top, the cubical contents of which progressively increases from the bottom toward the top, whereby the dust and floating particles are precipitated, the bulk of material being discharged without passing into the dust-collector.

13. The combination with a drying-chamber, of a dust-collector located at the discharge end thereof in position to receive gases and floating particles therefrom but not the bulk of the dry material, consisting of a chamber open at the bottom for the admission of cool air, the cubical contents of which progressively increase from the bottom to the top whereby the dust and floating particles are precipitated, the bulk of material being discharged without passing into the dust-collector.

14. The combination with a drying-chamber, of a dust-collector located at the discharge end thereof in position to receive gases and floating particles therefrom but not the bulk of the dry material, consisting of a chamber open at the bottom for the admission of cool air and nearly closed at the top, the cubical contents of which progressively increase from the bottom to the top, whereby the dust and floating particles are precipitated, the bulk of material being discharged without passing into the dust-collector.

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

ABRAHAM T. WELCH.

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JOHN J. CARROLL,

THOS. C. BAILEY.