Nov. 18, 1924. 1,515,596

G. D. HARRIS

DRYING MACHINE

Filed June 14 1921 4 Sheets-Sheet 1

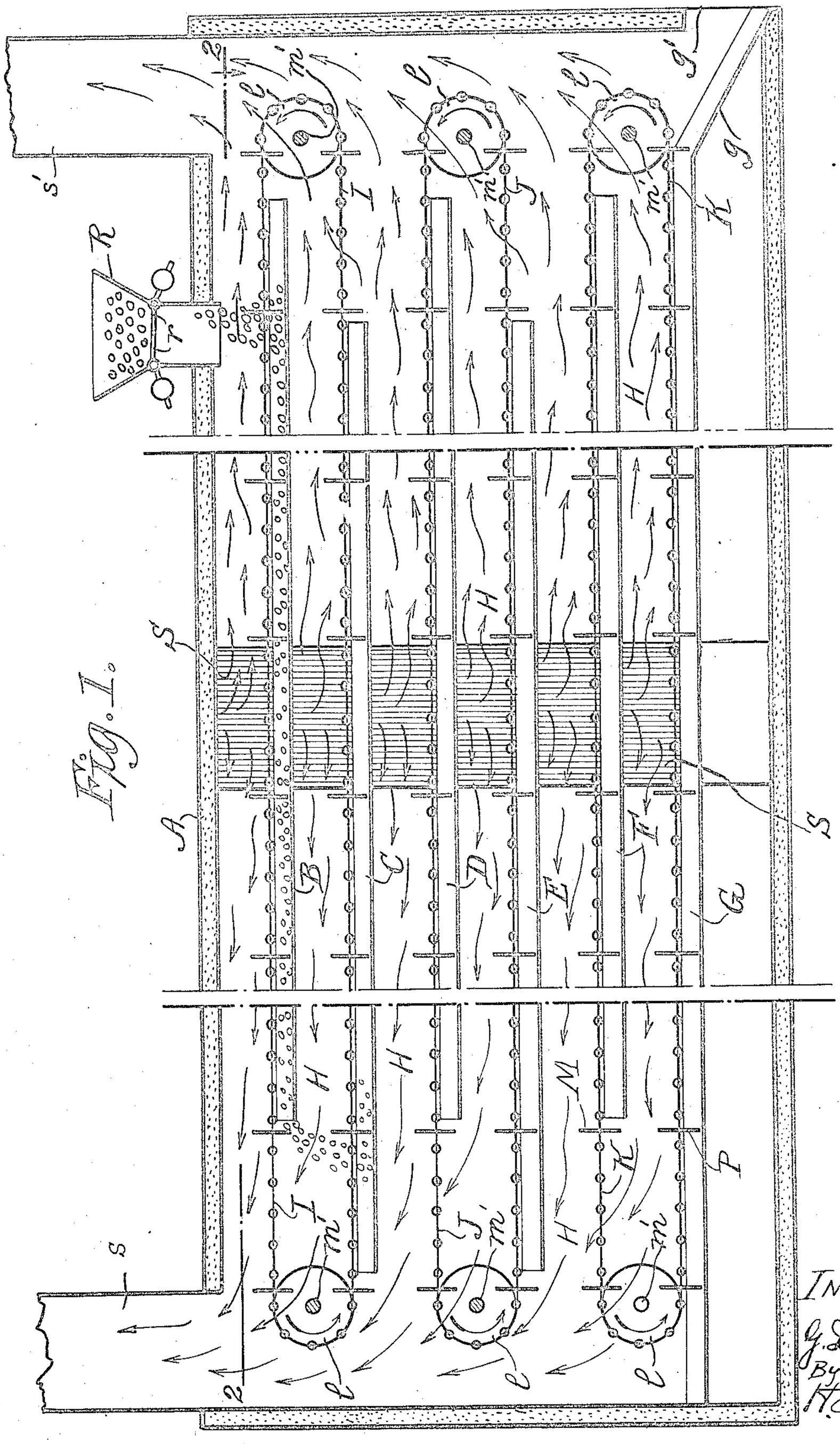


FIG. 1.

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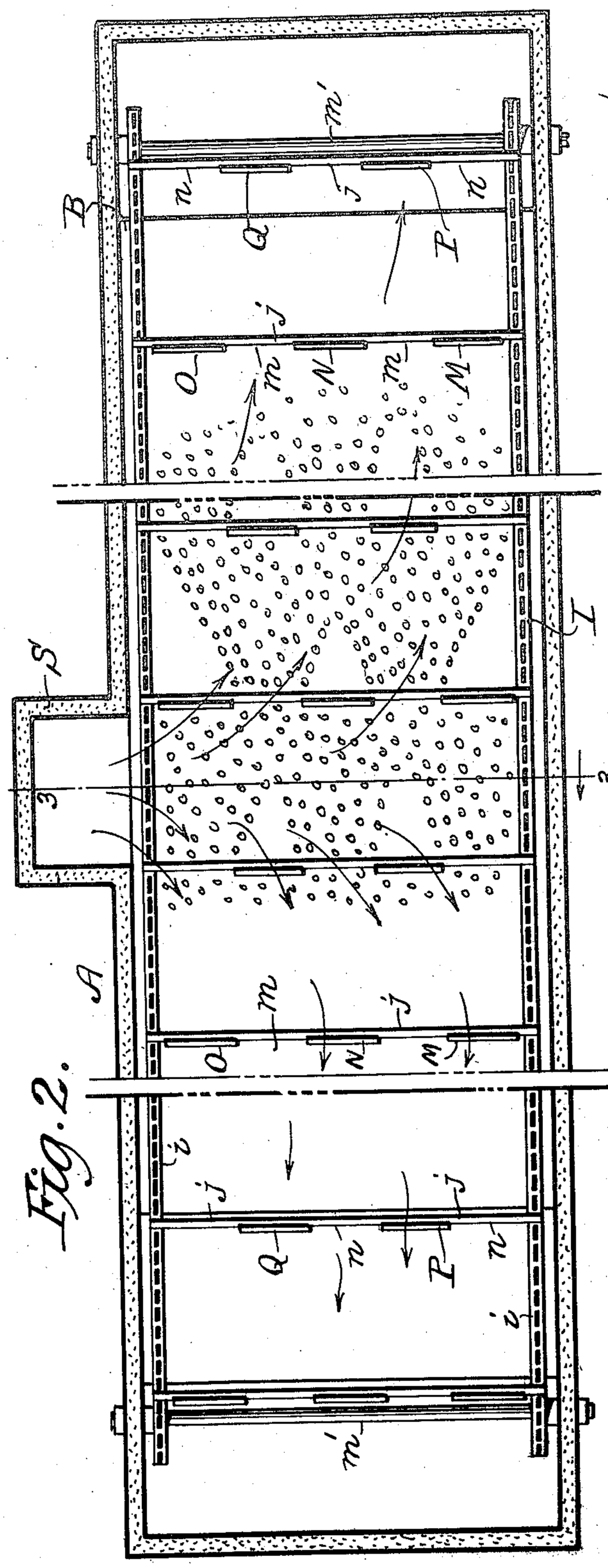


Fig. 2.

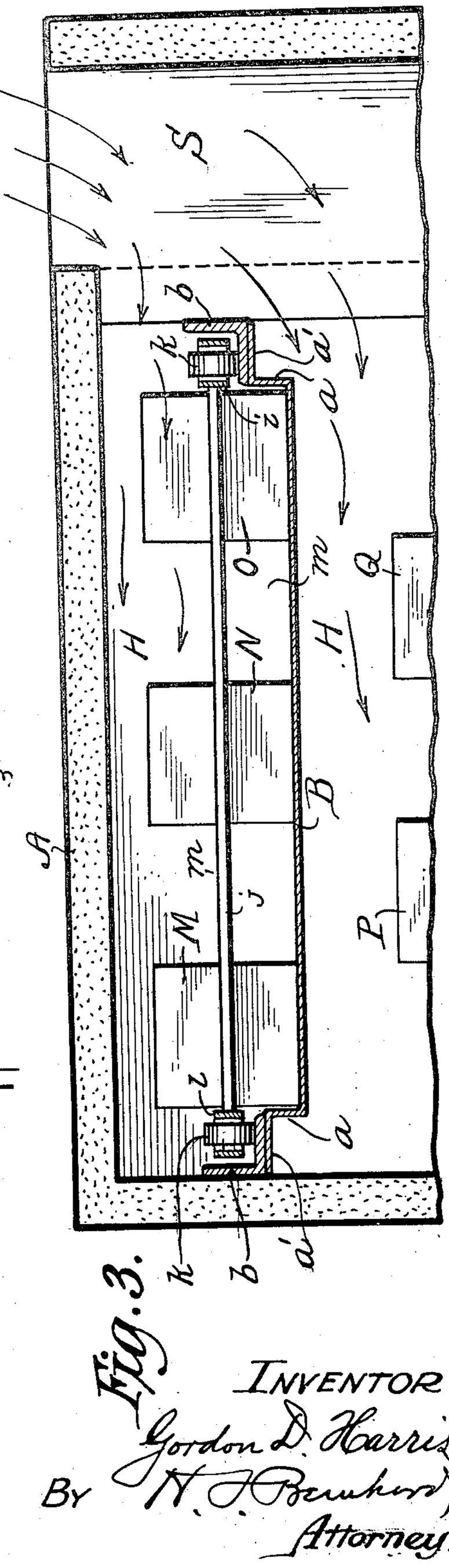


Fig. 3.

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DRYING MACHINE

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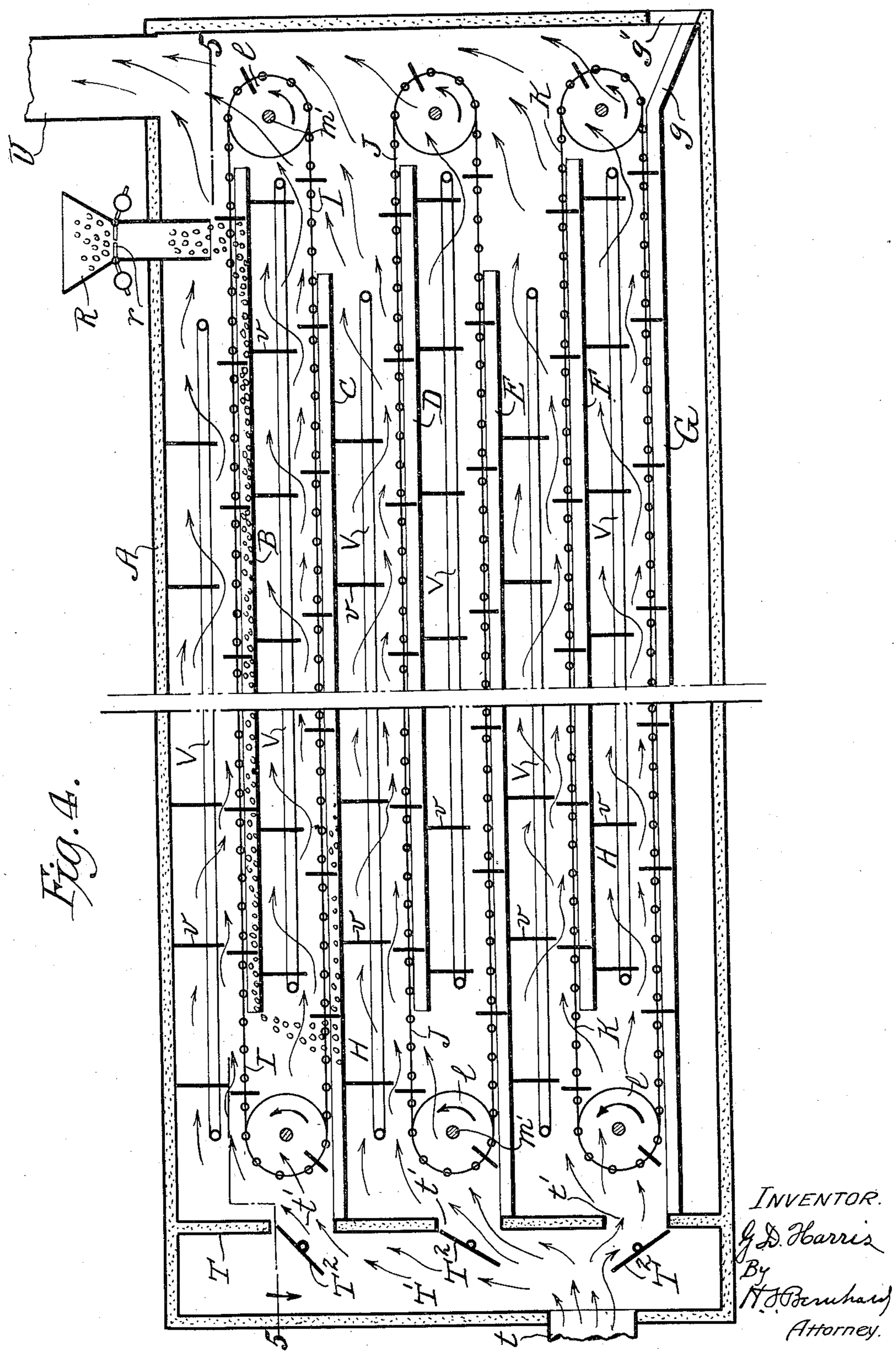

Fig. 4.

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DRYING MACHINE

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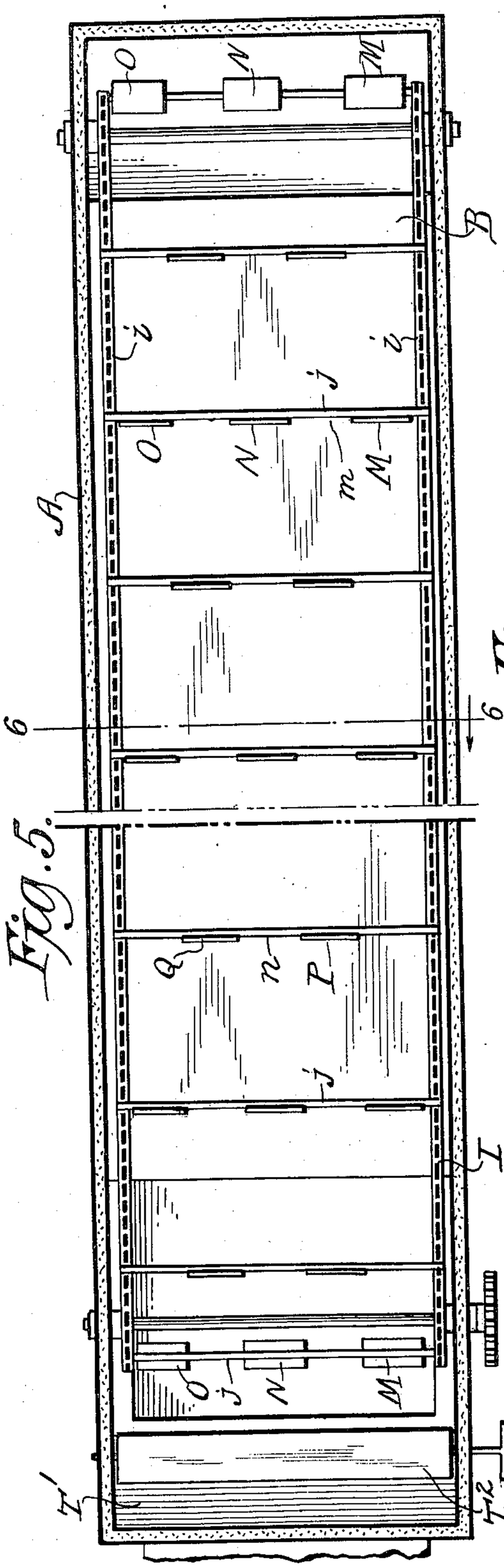


Fig. 5.

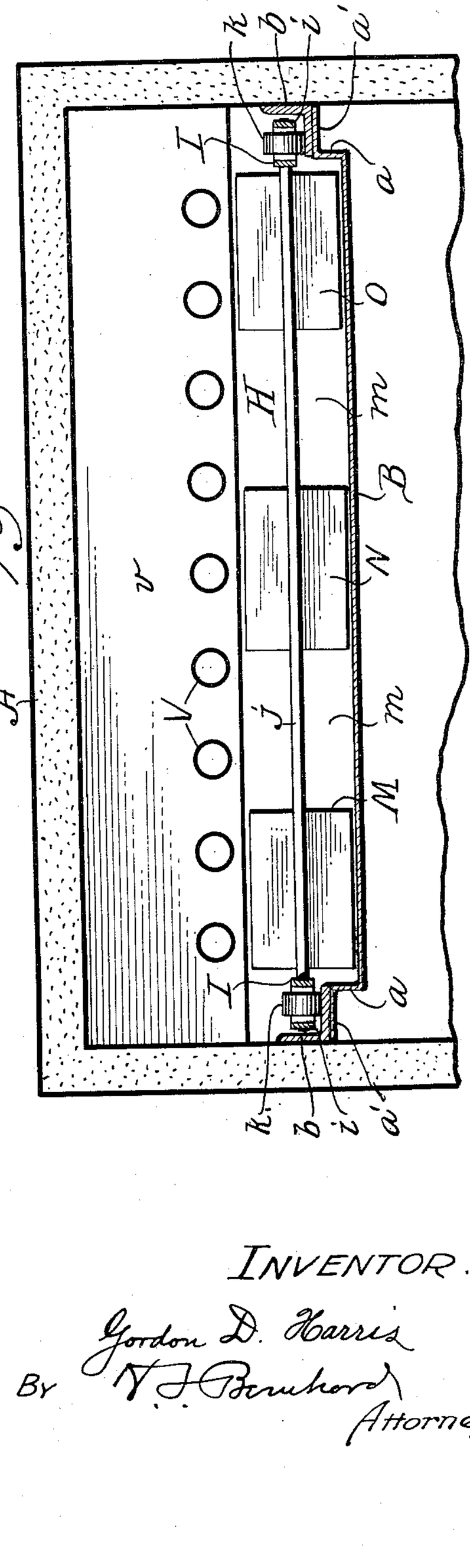


Fig. 6.

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Patented Nov. 18, 1924. 1,515,596

# UNITED STATES PATENT OFFICE.

GORDON DON HARRIS, OF ISLIP, NEW YORK, ASSIGNOR TO INDUSTRIAL DRYER CORPORATION, OF NEWARK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

## DRYING MACHINE.

Application filed June 14, 1921. Serial No. 477,388.

*To all whom it may concern:*

Be it known that I, GORDON DON HARRIS, a citizen of the United States, residing at Islip, county of Nassau, and State of New York, have invented a certain new and useful Drying Machine, of which the following is a specification.

This invention is a drying machine adapted, more particularly, for the economical handling of material in bulk condition, such as grain, phosphates, and other substances from which it is necessary or desirable to evaporate moisture.

The material is fed to the interior of the housing, distributed in relatively thin layers therein, advanced or carried while in such distributed condition within the flow channels, and discharged from said housing, all of such operations being performed mechanically and without the intervention of manual labor.

Concurrently with the performance of the aforesaid operations, the material is exposed to the effect of a drying atmosphere circulated within the flow channels in a manner to exchange heat for moisture while the material is in such relatively thin layers or masses.

One of the characteristic features of my invention consists in means acting to perform the double function of agitating the material by tumbling or turning it over while in the distributed layer condition and of feeding such material successively from one pan or tray to another of a series of such pans or trays, as a result of which tumbling and feeding actions the material is kept in a state or condition of agitation and concurrently therewith said material and all parts thereof are subjected to evaporation by the flow of the drying atmosphere.

Another characteristic of my invention consists in a mutual adaptation of material pans and scraper carriers whereby the two leads or runs of each carrier are utilized for the operation of scrapers moving within two adjacent pans or trays, as a result of which the material under treatment is carried back and forth within the successive pans and there are no idle runs of leads of the carriers, whereby the capacity of the apparatus as a whole is increased and the area or floor space occupied by the machine is decreased.

According to a practical embodiment of the invention the material pans are positioned one above the other and within a housing so as to establish a succession of flow channels for the circulation back and forth of a drying atmosphere, the delivery end of each pan being over the loading end of the pan next below it, whereby the material is fed to one end of each pan, carried along the pan, and delivered from the other end to the pan next below it, this action being repeated upon each pan of the series. Co-operating with said pans are endless carriers or conveyers each provided with scrapers positioned in a novel relation, to be hereinafter referred to, but it is to be noted that each carrier or conveyer is so related to two adjacent pans for the scrapers on one lead to co-operate with one pan so as to feed and tumble the material resting thereon, whereas the lower lead of the same carrier or conveyer is related to the next pan for the scrapers thereon to feed and tumble the material on said pan, the two leads of runs of each carrier or conveyer being active relatively to two adjacent pans so that there are no idle or inactive runs on the conveyers or carriers, and each of the same.

Each carrier comprises endless chains and cross rods, and on the cross rods are provided scrapers, the scrapers on each rod being spaced and the scrapers of adjacent rods being positioned in staggered or alternate order, whereby the scrapers act on the material to feed the same within the pans in a manner for some of the material to pass through the spaces between the scrapers of one rod and for the escaping material to be caught by the scrapers of the following rods, as a result of which the material, or some of it, is swept transversely within the pans and thereby agitated and tumbled in order to thoroughly expose said material to the action of the drying atmosphere.

The treatment of certain materials, such as have a high moisture content and give off or part with moisture freely during evaporation, results in a comparatively rapid drop in temperature of the drying atmosphere. To maintain such atmosphere in an efficient condition for the exchange of heat for moisture, provision is made for boosting or reheating the atmosphere during the periods of its flow within the flow channels and into contact with the moist material concurrently with the feeding and tumbling action imparted thereto by the conveying mechanism.

To these ends it is preferred to position heating coils within the flow channels, substantially parallel to the material pans, and to employ baffles or deflectors arranged crosswise of the heating coils and in the path of the drying atmosphere with a view to baffling the flow of the atmosphere circulated within the channels whereby the heat units lost in exchanging heat for moisture are restored by contact with the heating coils.

Other functions and advantages of the invention will appear from the following description taken in connection with the drawings, wherein—

Figure 1 is a vertical sectional elevation taken longitudinally through a drying machine embodying this invention.

Figure 2 is a sectional plan view thereof taken in a plane above one of the pans and the scraper carrier co-operating therewith.

Figure 3 is a vertical cross section on the line 3—3 of Figure 2 through one of the pans illustrating the details of the carrier and the scrapers of one series carried thereby.

Figure 4 is a vertical longitudinal section through a form of drying machine embodying boosters or reheaters in conjunction with the trays or pans and a series of scraper conveyers.

Figure 5 is a sectional plan view through the apparatus of Figure 4, and

Figure 6 is a vertical cross section on the line 6—6 of Figure 5.

Within a housing A is positioned the desired number of pans or trays indicated at B C D E F G, six being shown, although the number is not essential. Each pan or tray is provided with longitudinal flanges *a* at the respective sides thereof, see Figure 3, said flanges being outturned as at *a'* and attached in a suitable way to the side walls of the housing as, for example, by means of angle irons *b*, see Figure 3. The angle irons for each pan or tray are secured to the sides of the housing for supporting the pan or tray in a fixed position, each angle iron having an offstanding member serving as a trackway for supporting the weight of the roller chains and scrapers. The pans or trays are parallel to each other and separated a suitable distance to produce a series of horizontal flow channels H. The pans or trays are arranged in staggered order, as shown in Figure 1, so that the discharge end of one pan or tray is in overhanging relation to the loading end of the pan or tray next below it, and thus the material from the upper pan or tray is delivered upon the protruding end of the pan or tray next below it.

Co-operating with the pans or trays are endless scraper carriers I J K, each arranged for the upper and lower runs or leads to co-operate with two adjacent pans. In the embodiment shown in Figure 1 there are six pans and three endless scraper carriers, one scraper carrier being in active relation to two pans, thereby simplifying the construction without loss of function. Each scraper carrier is shown as consisting of parallel chains *i i*, cross rods *j*, rollers *k*, and supporting sprocket wheels *l* mounted on appropriate shafts *m* journaled in bearings at the sides of the housing. The endless scraper chains travel over the angle irons *b*, so that the rollers *k* ride upon the offstanding flanges of said angle irons. The rollers *k* are loosely mounted on the end portion of rods *j*, said rods extending crosswise of the pans and attached suitably to the side chains of the scraper carrier, whereby the cross rods *j* operatively connect the two said chains of each carrier and afford means for mounting the rollers in the links of the carrier, although the ordinary roller chains may be used wherein the rollers are mounted in links of the chain independently of the connecting rods.

By reference to Figure 1 it will be seen that the upper run of carrier I is in co-operative relation to the first pan B, whereas the lower run of said carrier I is in like relation to the pan C, whereby the scrapers on the upper run of the carrier are adapted to travel within the pan B for sweeping the material in one direction lengthwise of said pan B, whereas the scrapers on the lower run of the carrier travel within pan C for sweeping the material therein in an opposite direction to the path of the material on pan B. Scraper carrier J is in similar relation to the pans D and E, and the scraper carrier K co-operates with the next two pans, F G.

The cross rods *j* of each carrier support gangs of scraper blades, the arrangement of which is indicated more particularly in Figures 2 and 3. One gang consists of scraper blades M N O which are separated relatively one to the other so as to leave intervening spaces *m*, but the adjacent rods *j* carry gangs of blades indicated at P Q, the same being spaced to leave intervals at *n*, whereby the scrapers P Q of one gang are in alternate or staggered relation to the scrapers M N O of the adjacent gang.

The scrapers consist of suitable blades attached to the cross rods so as to occupy vertical relation thereto, the blades extending from the rods into the pans for the purpose of sweeping close to or on the bottom of each pan.

The gangs of scrapers on the endless carrier feed the material lengthwise of the pan and impart a tumbling action to the material with a view to agitating said material in order to expose it to the action of the drying atmosphere. It will be understood that the scrapers of one gang sweep the material along the pan in a definite path, but during this movement the material piling up in front of the scrapers has a tendency to flow

toward the spaces *m* so that the material accumulates in the path of the scrapers of the next gang, as a result of which the scrapers sweep the material both lengthwise and crosswise of the pan so as to impart a tumbling action or agitation to said material.

The material is supplied in bulk to a hopper R having suitable gates *r* for controlling the feed of the material to the uppermost pan B of the series, said hopper being positioned on the housing and adjacent the loading end of pan B. The lowest pan G of the series is provided with an inclined delivery chute *g* for feeding the material to the delivery opening *g'* of the housing. The material is supplied automatically to the upper pan B, and it is swept along said pan by the scrapers of the upper run of carrier I, whereby the material is discharged from the delivery end of pan B upon the loading end of pan C. The scrapers on the lower run of carrier I move the material along the pan C in order to discharge the material from pan C upon the loading end of pan D, and these operations are repeated by the carriers J K co-operating with pans D E F G until the material is delivered by chute *g* from the delivery opening *g'*.

Means are provided for feeding and circulating a drying atmosphere, usually hot air, within the flow channels H intermediate the series of pans. In the embodiment in Figure 1, the drying atmosphere is supplied centrally to the flow channels and is free to flow in two directions within each channel; i. e. from the central part of the channel toward the respective ends thereof. As shown, the heating flue or duct S extends along one wall of the housing substantially centrally thereof, said duct S being in communication with flow channels H. The housing is provided at its ends with upstanding flues or uptakes *s s'* which are in free communication with the flow channels H, and thus the drying atmosphere supplied by flue S to the flow channels H is free to circulate within said channels toward the uptakes *s s'*. The agitation of the material on the pans takes place at the same time that the drying atmosphere is circulated within the flow channels, and thus the material in a state of agitation is exposed to the evaporation of the drying atmosphere so as to eliminate the moisture rapidly and thoroughly from the material undergoing treatment within the machine.

The construction of the drying machine in Figures 4 to 6, inclusive, is similar to that heretofore described in connection with Figures 1 to 3, inclusive; but the means for circulating drying atmosphere is modified so as to establish a flow of the drying atmosphere from one end of the housing to the other end thereof, and in addition to this change in structure means are provided for boosting or reheating the drying atmosphere as it flows within the flow channels and into contact with the material on the pans.

Within the housing is a series of pans B C D E F G spaced to establish the flow channels H, and with said pans co-operate the scraper carriers I J K, each having gangs of scraper blades, as heretofore described. At one end of the housing is a partition T forming a flue T' with which connects the feed duct *t*, and in partition T is a series of ports *t'* for feeding drying atmosphere to the flow channels H, said ports *t'* being controlled by dampers $T^2$, whereby the volume of the drying atmosphere may be regulated to the several flow chanels H. At the opposite end of the housing is an eduction flue or uptake U in communication with the flow channels H. In order to accommodate the boosters or reheaters V the pans are spaced at a desired interval for increasing the depth of each flow channel between two adjacent pans. This arrangement makes provision for the employment of reheaters or boosters V within the flow channels H, and intermediate the bottom of one pan and the path of the carrier associated with the next pan below it. Each reheater V is shown as pipes extending lengthwise of the flow channel and substantially parallel to adjacent pans, provision being made for feeding the heating medium, usually steam, to said pipes constituting the reheater.

Extending crosswise each reheater is a series of baffles *v*, said baffles being within the flow channel and above the path of the carrier. Each baffle is a flat vertical plate intersecting with the coil of the heater, said plate being positioned substantially in contact with the bottom of the pan above the reheater coil, whereas the lower edge of the plate is above the path of the scrapers on the carrier of the pan positioned below the reheater coil.

The material is fed from the hopper R to the upper pan B; air heated to a desired temperature is supplied by duct *t* to flue T' and thence flows through the ports *t'* into the channels H, and the carriers having been set in motion, the scrapers thereon travel within the pans for agitating the material resting upon the pans and for feeding said material successively from one pan to another throughout the series until the material is discharged by the chute *g* through the opening *g'* of the housing. The flow of the drying atmosphere into contact with the material on the pans exchanges heat for moisture thus resulting in a drop in temperature of the drying atmosphere, but the heat units given off to the material by the flow of the drying atmosphere are restored to said atmosphere by the contact of the atmosphere with the coils of the reheaters

V, as a result of which the drying atmosphere is conditioned for the efficient evaporation of moisture from the material on the pans.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. A drier embodying a plurality of pans or trays positioned one above the other and producing a flow channel therebetween for a drying atmosphere, and a conveyor or carrier the leads or runs of which are in active relation to adjacent pans, each carrier being provided on the runs thereof with gangs of flat plate scrapers disposed in endwise relation to each other transversely to the line of travel of the carrier.

2. A drier embodying a plurality of pans or trays positioned one above the other and producing a flow channel therebetween for a drying atmosphere, and a conveyor or carrier the leads or runs of which are in active relation to adjacent pans, each carrier being provided on the runs thereof with gangs of flat plate scrapers disposed in endwise relation to each other transversely to the line of travel of the carrier, all the scrapers of adjacent gangs being positioned in staggered order lengthwise of the pans.

3. A drier embodying a plurality of pans or trays positioned one above the other and producing a flow channel therebetween for a drying atmosphere, and a conveyor or carrier the leads or runs of which are in active relation to adjacent pans, each carrier being provided on the runs thereof with gangs of flat plate scrapers disposed in endwise relation to each other transversely to the line of travel of the carrier and all the plates of said gangs lying in the same plane crosswise of the path of travel of the scraping mechanism and serving to turn the material.

4. A drier embodying a plurality of pans, fixed rails adjacent said pans at the sides thereof, endless carriers positioned for the upper and lower runs of each carrier to cooperate with two of said pans, each carrier being provided with rods and said rods having rollers adapted to ride upon said rails, and gangs of scrapers to sweep adjacent said pans, the scrapers of each gang being spaced relatively to each other and carried by said one of said rods, and the scrapers of one gang being in alternate order to the scrapers of adjacent gangs.

5. In a drier, the combination with a plurality of pans, of scraping mechanism including scrapers in gangs positioned for the scrapers of one gang to occupy a staggered order with respect to the scrapers of adjacent gangs, each gang of scrapers comprising a plurality of flat plates spaced relatively to each other, with the plates of each gang in endwise relation one to the other and all the plates of said gang lying in the same plane crosswise of the path of movement of the scraping mechanism.

6. In a drier, the combination with a plurality of pans, a plurality of endless carriers positioned for the leads or runs of each carrier to occupy a co-operative relation to two adjacent pans, and gangs of scrapers carried by said endless carriers to occupy an active relation to said pans, the scrapers of each gang being spaced relatively to each other and said scrapers of adjacent gangs being positioned in staggered order lengthwise of the pans.

7. In a drier, the combination with a plurality of pans, a plurality of endless carriers positioned for the leads or runs of each carrier to occupy a co-operative relation to two adjacent pans, and gangs of scrapers mounted on said carriers for the scrapers of one gang to occupy a staggered relation to the scrapers of adjacent gangs, said scrapers of each gang consisting of a plurality of flat plates spaced relatively to each other and positioned in endwise relation to each other and with all the plates of each gang in the same plane transversely of the line of movement of the endless carrier.

8. In a drier, the combination of a plurality of pans positioned for the delivery end of one pan to discharge material to the loading end of an adjacent pan, and scraping mechanism including gangs of scrapers positioned in staggered order relative to each other and arranged in active relation to said pans for feeding and tumbling the material thereon.

9. In a drier, the combination of a succession of pans positioned for discharging material from one to the other pan of the series, means for feeding material to the first pan, means for discharging material from the last pan of the series, gangs of flat plate scrapers positioned in staggered order with respect to each other and operable within said pans for moving and tumbling material within said pans, and means for circulating a drying atmosphere between said pans during the agitation imparted to said material by the feeding and tumbling motion given thereto by said scraping means.

10. A drier embodying a plurality of pans spaced relatively to each other for producing a flow channel, scraping means movable relatively to the pans for feeding and agitating the material thereon, means for circulating a drying atmosphere within said flow channels, baffles within the flow channels and out of the path of the scraping means, and reheaters within the flow channels and in co-operative relation to the baffles for boosting the drying atmosphere as it circulates within said channels.

In testimony whereof I have hereto signed my name this 11th day of May, 1921.

GORDON DON HARRIS.