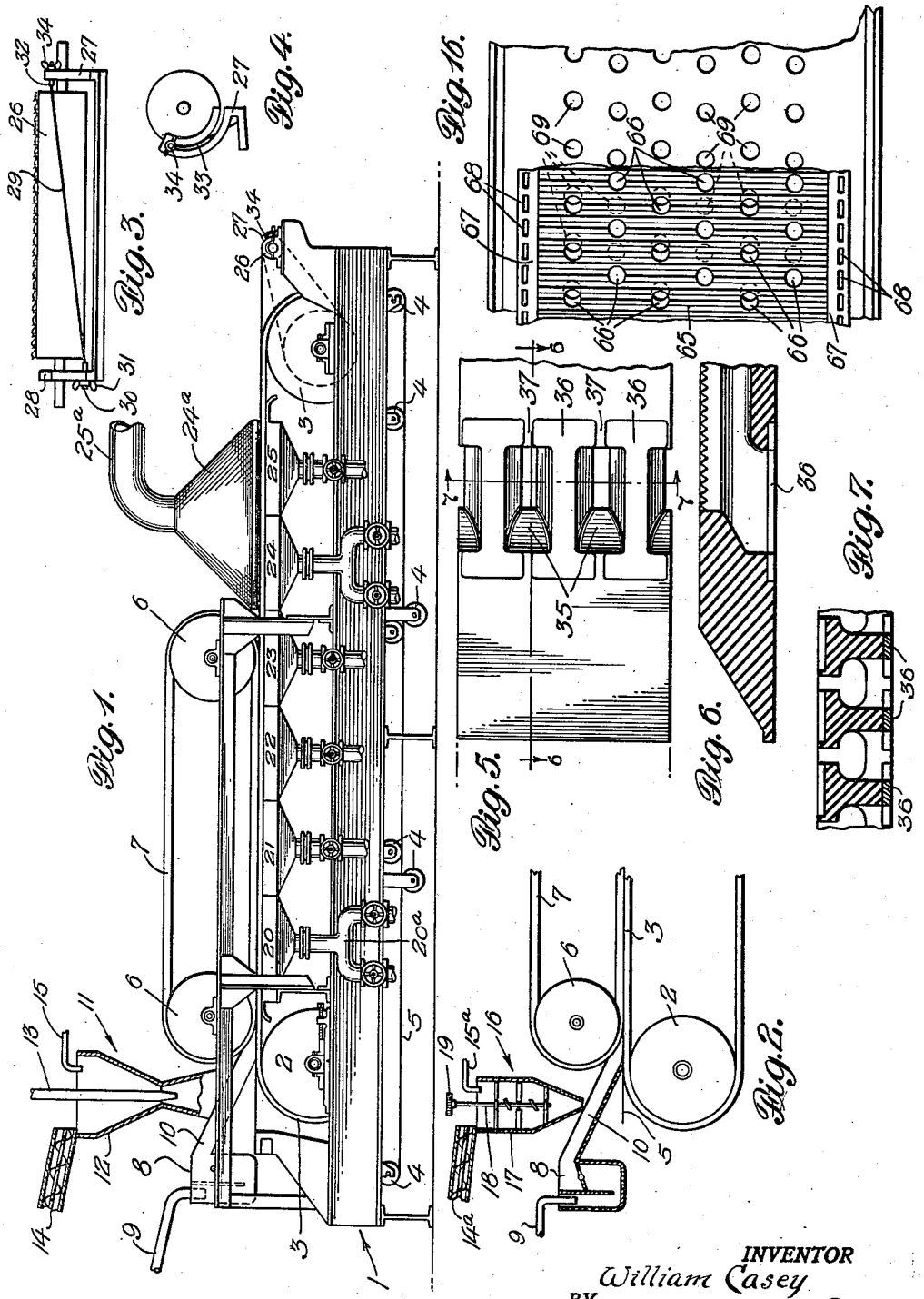
Dec. 7, 1937. W. CASEY 2,101,042

METHOD OF AND APPARATUS FOR TREATING MATERIALS

Filed Jan. 23, 1935 2 Sheets-Sheet 1



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Dec. 7, 1937. W. CASEY 2,101,042

METHOD OF AND APPARATUS FOR TREATING MATERIALS

Filed Jan. 23, 1935 2 Sheets-Sheet 2

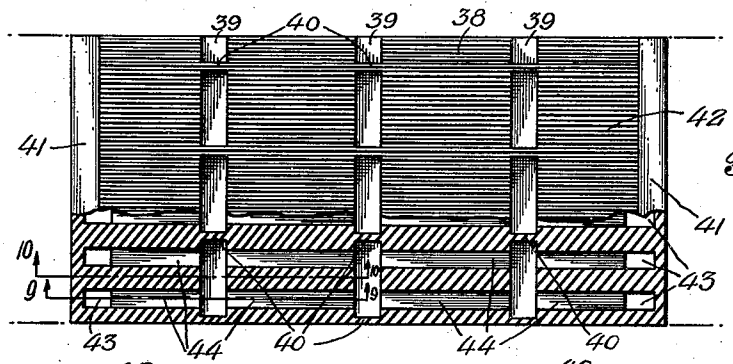


Fig. 8.

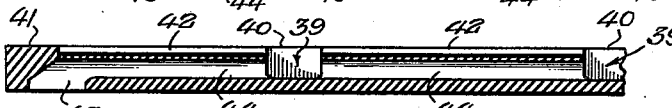


Fig. 9.



Fig. 10.

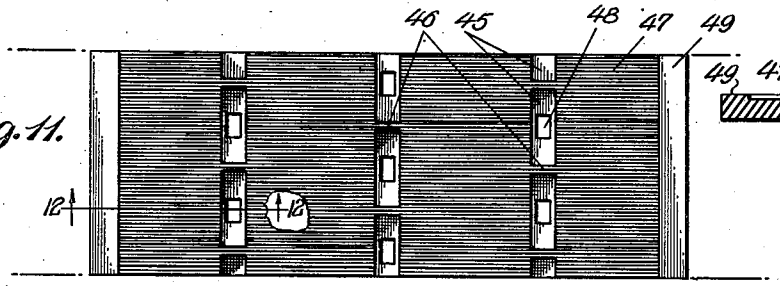


Fig. 11.

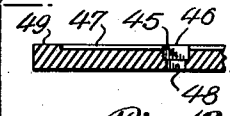


Fig. 12.

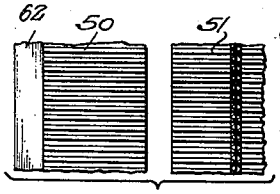


Fig. 14.

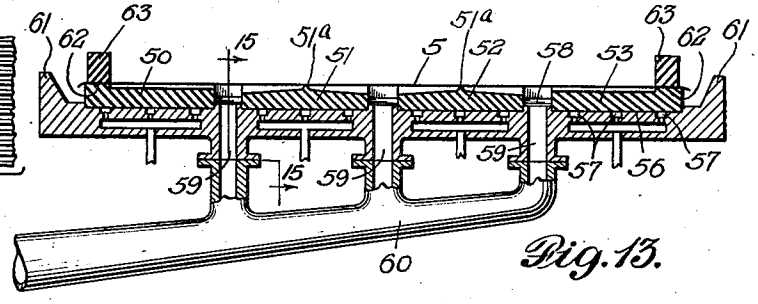


Fig. 13.

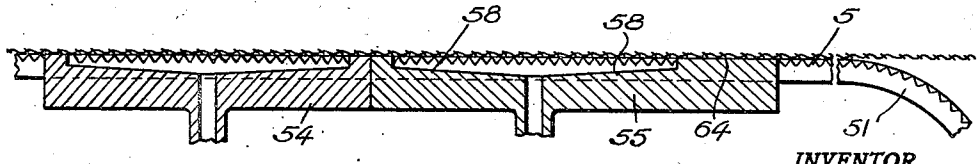


Fig. 15.

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2,101,042

METHOD OF AND APPARATUS FOR TREATING MATERIALS

William Casey, Kingston, Ontario, Canada, assignor to Canadian Locomotive Company, Limited, Kingston, Ontario, Canada, a corporation of Canada

Application January 23, 1935, Serial No. 2,978

7 Claims. (Cl. 210—197)

This invention relates as indicated to material treating apparatus and more particularly to the general type of apparatus such as is disclosed in the copending application of William R. Thomson, Serial No. 2,977, and filed January 23, 1935 and which is particularly applicable for use in separating the solid and liquid components of material, such as sludges, slurrys, etc.

More particularly this invention relates to a method of and apparatus for treating materials of the character described, characterized by simplicity of construction and low cost of operation of the apparatus as well as improved results achieved by practicing the method comprising this invention.

It is a principal object of my invention to provide an apparatus of the character described in which novel means are provided for supporting the material to be treated during the carrying on of the process which means make possible variations in said process not possible by any means provided in the prior art.

It is a further object of my invention to provide an apparatus of the character described in which improved results may be obtained by an expenditure of minimum power.

It is a further object of my invention to provide a method of the character described which results in the building up, on the filter medium in the apparatus, of a filter cake of such character that further dehydration thereof may be accomplished most efficiently.

It is a further object of my invention to provide a method of the character described in which additional materials are added to the filter cake during the process of dehydration in order to vary or improve for certain purposes the characteristics of such cake as it is discharged from the apparatus.

Other objects of my invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends this invention therefore comprises the hereinafter described means and mode of operation, such disclosed means and mode being, however, only illustrative of my invention as defined by the appended claims.

In the annexed drawings, Figure 1 is a side elevational view of one form of apparatus constructed in accordance with the principle of my invention and disclosing one means for carrying out the process comprising my invention.

Figure 2 is a side elevational view of a part of a machine similar to that illustrated in Figure 1, but disclosing a modified form of supplemental feed.

Figures 3 and 4 are likewise respectively plan and side elevational views drawn to an enlarged scale of a portion of the apparatus illustrated in Figure 1.

Figure 5 is a plan view of one form of suction belt or mat which may be utilized in apparatus such as is disclosed in Figure 1.

Figure 6 is a transverse sectional view of the belt or mat shown in Figure 5 taken on a plane substantially indicated by the line 6—6.

Figure 7 is a sectional view of the belt or mat illustrated in Figure 5 and taken on a plane substantially indicated by the line 7—7.

Figure 8 is a plan view of another form of belt or mat which may be employed in apparatus such as is illustrated in Figure 1.

Figure 9 is a transverse sectional view of the mat or belt illustrated in Figure 8 taken on a plane substantially indicated by the line 9—9.

Figure 10 is a sectional view of the mat illustrated in Figure 8 taken on a plane substantially indicated by the line 10—10.

Figure 11 is a plan view of yet another form of mat or belt capable of use in apparatus of the character disclosed in Figure 1.

Figure 12 is a fragmentary sectional view of the mat or belt shown in Figure 11 and taken on a plane substantially indicated by the line 12—12.

Figure 13 is a fragmentary sectional view of a portion of an apparatus similar to that disclosed in Figure 1 showing in conjunction therewith another form of suction mat or belt.

Figure 14 is a fragmentary plan view of the assembly shown in Figure 13.

Figure 15 is a sectional view of the apparatus illustrated in Figure 13 taken on a plane substantially indicated by the line 15—15, and

Figure 16 is a plan view of yet another form of suction mat or belt capable of use in apparatus of the character to which this invention pertains.

Referring now more specifically to the drawings and more especially to Figure 1 the apparatus herein disclosed consists generally of a frame work indicated at 1 which may be conveniently fabricated from conventional structural steel shapes. Rotatably supported in the frame 1 adjacent opposite ends thereof and driven by any suitable power means not shown are drums or pulleys 2 and 3. About the drums 2 and 3 there is trained an endless flexible suction belt or mat 3 of the character hereinafter more fully described. The frame 1 also carries a plurality of idler rolls such as 4 which cooperate

to support the filter web generally indicated at 5 and which in its upper run overlies the upper run of the suction belt or mat 3, moves at a uniform rate of speed therewith and supports thereon the material being treated.

Rotatably supported on the upper portion of the frame 1 are spaced pulleys 6 about which are trained conventional deckle straps 7 which in their lower run rest upon the filter web 5 and laterally define the filter cake built upon the upper surface of such filter web.

Mounted on the frame 1 adjacent the feeding or receiving end of the machine is a transversely extending trough 8. The material to be treated may be fed to the trough 8 by any suitable means such as a conduit 9. An apron 10 extends from the trough 8 downwardly to the filter web 5 to convey thereonto the material to be treated from the feed trough 8.

Mounted above the feeding or receiving end of the machine is an auxiliary feeding device generally indicated at 11 and comprising a Venturi shaped hopper 12 into the throat of which there extends an airpipe 13. The material to be fed by such auxiliary feeding means 11 is introduced to the hopper 12 either by means of the screw conveyor 14 and/or the conduit 15. At this point it should be noted that the lower or discharge end of the hopper 12 is flared transversely of the machine so that the material passing downwardly therethrough is deposited substantially uniformly transversely of either the material flowing downwardly over the apron 10 or such material after the same has been deposited on the filter web 5.

A modified form of supplemental feeding means is illustrated at 16 in Figure 2 and comprises a hopper 17 having its lower open end positioned above either the apron 10 or the upper active surface of the filter web 5. Within the hopper 17 there may be rotatably mounted an agitator or impeller generally indicated at 18 which may be provided with any suitable driving means such as a pulley 19 about which a driven belt may be trained. Here again the lower end of the hopper 17 will be so formed that it will deposit a substantially uniform layer of material transversely of either the apron 10 or the web 5.

Positioned either on opposite sides of the machine or in a single or plurality of rows intermediate the opposite sides of the machine are a plurality of suction boxes generally indicated at 20, 21, 22, 23, 24 and 25. When a suction web or mat such as is illustrated in Figures 5 to 7 is employed the suction boxes 20 to 25 will be positioned along opposite sides of the machine. If suction belts or mats such as are disclosed in Figures 8 to 15 are employed the suction boxes will be arranged either in a single or a plurality of rows longitudinally of the machine and intermediately of the side edges of the suction belt or mat. When a suction belt or mat similar to that illustrated in Figure 16 is employed the suction boxes 20 to 25 may extend transversely of the entire width of the suction belt and for certain purposes it may be possible to employ a single suction box covering the entire lower surface of the upper run of a suction belt of the character disclosed in Figure 16. The employment of a plurality of suction boxes will, however, provide a sufficiently flexible construction so that the mode of operation of the apparatus may be varied in a manner not possible when only one suction box is employed.

Adjacent the discharge or right hand end of the machine as viewed in Figure 1 there is mounted a discharge roller about which the filter web 5 is trained and the construction of which is most clearly illustrated in Figures 3 and 4. The discharge roller 26 is rotatably supported between fixed spaced brackets 27 and 28 on opposite sides of the machine. A cut-off wire 29 is stretched between the standards 27 and 28 and the wire is so positioned as to be in engagement with the filter web 5 passing under such wire and over roll 26. One end 30 of the wire 29 passes through an opening provided therefor in the standard 28 and a wing nut 31 threaded on the end of such wire may be employed for the purpose of regulating the tension thereon. At its opposite end 32 the wire 29 passes through an arcuate groove 33 formed in an extension of the bracket 27 and any suitable means such as a wing nut 34 may be employed for the purpose of securing the end of the wire 29 at any selected position within the groove 33. This mode of supporting the cut-off wire 29 causes such wire to pass in a substantially helical manner from one end of the roll 26 to the other and by the provision of the adjusting means above described the extent of angular displacements of the two ends of the wire on the roll 26 may be conveniently varied to suit particular operating conditions and types of material.

While a wire 29 has been shown as the means for cutting off the filter cake from the filter web, it should be noted that it is within the contemplation of my invention to employ any other suitable means for such purpose such as a flat metallic band having a sharp edge, which band may be pressed against the roll 26 either helically in the manner above defined, or truly axially of the roller, depending upon the particular operating conditions of the apparatus and the types of material being operated upon.

The suction belt or mat illustrated in Figures 5, 6 and 7 is characterized by the provision of a plurality of suction ports generally indicated at 35 on the inner face of the belt. The main body of the belt and more particularly the arrangement therein of the suction passages, openings, etc. of the belt as illustrated in Figures 5 to 7 may be any arrangement such as is illustrated in the above identified co-pending application of William R. Thomson, as well as the expedients disclosed in this application in Figures 8 to 16.

The particular feature of novelty possessed by the belt illustrated in Figures 5 to 7 is the provision of a plurality of metallic inserts generally indicated at 36 between the suction ports and preferably extending to the edges of such ports. These metallic inserts provide means wherewith sprocket teeth on either or both of the drums 2 and 3 may engage in order to insure positive driving communications between such drum or drums and the belt. The metallic inserts 36 are preferably slightly spaced as at 37 so as to provide areas therebetween in which the belt may freely flex as it passes around the drums 2 and 3. It will be evident, of course, that while inserts of substantially I-shape are admirably suited for use in conjunction with substantially rectangular suction ports such as 35, nevertheless, the contour or such inserts may be varied from the form illustrated either to accommodate particularly formed sprocket teeth on the drums 2 and 3 or to conform to differently shaped suction ports.

In place of the metallic inserts molded in the mat between these suction ports I may utilize a

conventional type of sprocket chain which is molded in the mat for the same purpose and when the suction ports in the mat are arranged intermediately of its edges the opening between the links of such sprocket chain in the mat need not necessarily be suction ports but merely of such depth as to accommodate the sprocket teeth 4 carried by the drums about which the belt or mat is trained.

The suction belt or mat illustrated in Figures 8 to 10 will preferably be endless in form so as to be trained about drums such as 2 and 3 similarly to the manner in which the belt 3 is shown trained about such drums in Figure 1. The belt or mat generally indicated at 38 in Figure 8 is characterized by the provision on its outer or active face of substantially longitudinally extending drainage passages or grooves 39 which grooves are bridged at spaced points by partitions such as 40. While the bridges 40 have been shown as arranged in substantial alignment transversely of the belt or mat it may be desirable to stagger such bridges transversely of the belt.

The upper surface of the belt 38 is along opposite edges provided with substantially smooth areas 41 on which the deckle straps will be supported. Intermediately of these flat marginal areas the belt will be provided with a plurality of relatively shallow closely spaced serrations providing ridges 42 therebetween so as to support the web such as 5 in a substantially continuous plane at a slight distance above the solid body of the belt. These ridges 42 may either be straight as shown or if preferred they may be of curved or zigzag contour. The only requirement being that the space between adjacent ridges drain into at least one of the drainage grooves 39. The vertical extent from the solid body of the belt of the ridges 42 and the distance between adjacent ridges will depend upon the character of the web 5 to be supported thereby. If a relatively thin web such as a fine silk is employed the ridges 42 should be relatively shallow and rather closely spaced in the nature of about ⅛ to ½ inch. If a heavier material such as canvas is employed as the filter web 5 the spacing between the ridges 42 and the depth of the grooves between such ridges may be appreciably greater than when a web of silk for example is employed.

The inner face of the belt 38 is provided with a plurality of spaced suction ports 43 which communicate with the drainage grooves 39 through passages 44. In Figures 8 and 9 the suction ports 43 have been shown as arranged adjacent the lateral edges of the belt 38. It is within the contemplation of my invention, however, to arrange such ports either as a single row or a plurality of rows intermediately of the edges of the belt in which event the outer ends if no suction ports are provided at the edges of the belt will be closed and drainage effected through the centrally located ports. When the belt 38 is relatively narrow only one row of centrally located suction ports may be necessary and in case the belt 38 is of appreciable width two or more symmetrically arranged rows of suction ports may be provided intermediately of the edges of the belt and used either with or without rows of suction ports arranged at the extremities of the passages 44 i. e. adjacent the edges of the belt. The particular arrangement of the rows of suction ports in any of the above defined manners will of course determine the type of suction boxes to be employed in conjunction therewith.

With the suction ports arranged as illustrated in Figure 8, i. e., along opposite edges of the belt, two series of suction boxes such as 20 to 25 positioned along opposite sides of the machine will be employed. If only a single row of suction ports 43 is provided such as may be arranged at the middle of the belt only one series of suction boxes such as 20 to 25 arranged centrally of the machine will be required.

The suction belt or mat illustrated in Figures 11 and 12 is generally similar to that shown in Figures 8 to 10 i. e. the suction belt or web extends continuously across the machine beneath the filter web 5 and is provided with a plurality of drainage grooves 45 in its upper face. The drainage grooves are provided with bridges 46 at spaced points and such bridges are preferably staggered transversely of the belt. The drainage grooves 45 in the belt 47 shown in Figure 11 are illustrated for purposes of convenience as extending substantially longitudinally of the belt, however, if desired such drainage grooves may be arranged transversely of the belt without departing from the principles of my invention.

The space in each drainage groove intermediately of the bridge walls 46 are provided with openings 48 extending downwardly through the body of the belt and terminating in spaced suction ports on the inner periphery of the belt. The marginal areas 49 on the outer surface of the belt will be left flat similarly to the marginal portions 41 of the belt illustrated in Figure 9 for the purpose of providing a supporting surface for the deckle straps. The area between the marginal portions 49 of the belt 47 will be serrated in any of the manners and for the purposes defined in connection with the serrations of the upper surface of the belt illustrated in Figure 8.

The supporting means for the filter web 5 illustrated in Figures 13 to 15 is different from the belts hereinbefore described in that in Figures 13 to 15 a plurality of separate laterally spaced belts 50, 51, 52 and 53 are employed instead of the single belts such as 38 and 47 respectively illustrated in Figures 8 and 10. When belts such as 50 to 53 are employed in combination a slightly different form of supporting means therefor is likewise necessary. In Figures 13 and 15 the supporting means for the belts 50 to 53 has been illustrated as comprising a plurality of suction boxes such as 54 and 55. Each of which may extend transversely of the entire machine and be in abutting relation to a longitudinally contiguous similar suction box. The construction illustrated in Figures 13 and 15 has been shown for purposes of convenience only, it being within the contemplation of my invention to separate the suction boxes in the opposite direction.

The suction boxes illustrated in Figures 13 and 15 are provided with a supporting surface generally indicated at 56 which is provided with grooves 57 and ridges 58. The grooves 57 are for the purpose of providing lubrication and a seal for the lower face of the belts. The grooves 57 will preferably extend in a crisscross fashion on the upper face 56 of the suction boxes and one or more of such grooves may open at the inner edge of the belt supported thereover so that water flowing downwardly over the edge of such belt may flow into the groove and thus maintain the same filled.

The suction boxes are provided with spaced manifold connections 59 to which an outfall manifold 60 may be conveniently connected. The

passages extending upwardly through the suction boxes at 59 terminate on the upper face of such boxes between convergent ridges 58. These ridges 58 tend to maintain the belts in spaced relation and furthermore carry the water downwardly to the discharge ports. The edges 61 of the suction boxes are flared upwardly so as to provide seepage collection troughs along opposite sides of the machine. Each of such seepage collection troughs may be provided with a conveniently located drainage opening not shown.

The upper face 56 of the suction boxes is provided with longitudinally extending depressions of substantially the same width as the belts 50 to 53 for the purpose of insuring proper alignment of such belts on the machine.

In Fig. 13, as above indicated, the upper surfaces 56 of the suction boxes are provided with a plurality of ridges positioned intermediately of the belts 50 to 53 for the purpose of maintaining such belts in proper alignment. It should be noted, however, at this point that it is within the contemplation of this invention to provide a smooth upper surface on the suction boxes or the means supporting the belts and to provide means associated with the respective belts such as laterally extending projections which maintain the belts in proper spaced relation and alignment. It is also within the contemplation of my invention to provide narrow spacing belts between the main belts of a width equivalent to the width of the ridges 58, but which belts instead of being as high as the belts 50 to 53 will be of the general form of the ridges 58, i. e., to a continuous base there will be applied projections and sloping faces similar to the projections 58 lying between adjacent belts.

The lateral outer belts 50 and 53 i. e. those along opposite sides of the machine are at their outer edges preferably provided with flat areas 62 upon which the deckle straps 63 rest. The remaining upper surface of the belts 50 and 53 as well as the entire upper surface of belts 51 and 52 will be serrated in the manner and for the purposes in which the upper surfaces of previously described belts 38 and 47 have been serrated.

The belts 50 to 53 shown in Figure 13, it will be noted, need not be provided with ports therethrough of any kind. The water which passes downwardly through the web 5 merely flows to the edges of the belts where it spills over into the space between such belts where it is drawn off through the passages at 59 and the manifold 60. When such construction is employed it will be evident that the belts 50 to 53 need not be truly continuous endless belts, inasmuch as the belts are not interposed in the vacuum circuit they may be formed by lacing or similar securing together the ends of a flat band.

It will be noted that ridges 51*a* are provided on certain of the belts such as 51 and 52 for the purpose of laterally dividing the area of the filter web into sections which are respectively served by the different drainage ports 59. The ridges 51*a* not only have a tendency to direct the downwardly flowing water into the discharge openings in the suction boxes, but also may be conveniently utilized to separate the table into longitudinally extending laterally adjacent areas which, when separate outfall conduits are respectively attached to the suction ports 59, may be operated at a different degree of suction or air pressure.

When a construction such as is illustrated in Figures 13 to 15 is employed some means must be provided to seal the supporting table longitudinally between the belts at the ends of the machine. This may be conveniently accomplished as shown in the suction box 55 in Figure 15 by carrying the last ridge 58 between the belts upwardly into sliding engagement with the mat 5 as at 64. It is within the contemplation of my invention to provide a spring supported insert on the face 64 to resiliently engage the under surface of the mat 5 to further insure that a perfect seal will be secured in such area.

The belt shown in Figure 16 is different from any previously described form of construction in that such belt generally indicated at 65 extends laterally throughout the entire width of the filter web 5 and is provided with a plurality of particularly arranged openings generally indicated at 66 which pass directly downwardly through the belt 65. The marginal edges 67 of the belt 65 are formed similar to the marginal edges 41 of the belt 38 for the support of the deckle straps. In addition the marginal edges 67 may be provided with spaced openings generally indicated at 68 for the reception of sprocket teeth formed on the drums such as 2 and 3 about which the belt will be trained. If desired metallic inserts such as 36 shown in Figures 5 and 6 may be employed around the openings 68 to reinforce the belt in the areas in which the same is engaged by the sprocket teeth.

The suction boxes which will be employed in connection with a belt such as 65 shown in Figure 16, will as previously indicated cover substantially the entire lower area of the upper run of such belt. The suction boxes upon which the belt 65 operates may be either a single suction box covering the entire upper run of the belt or such area may be sub-divided and thus covered by a plurality of adjacent suction boxes related to each other and to the belt area in any desired manner.

The surfaces of the suction box or boxes over which the belt 65 moves will be provided with a plurality of spaced suction ports generally indicated at 69 which are so spaced relatively to each other and to the ports or openings 66 in the belt that as the belt moves over the suction boxes at no time will all of the holes respectively formed in the suction boxes and the belt be in complete register. In the filtration of certain materials the actions set up by the intermittency of application of vacuum pressure on the material to be filtered gives a most desirable effect and a better extraction is obtained by such intermittent application and release of pressure. Furthermore, by the arrangement of the openings as illustrated in Figure 16 substantially the entire area of the belt may at one time or another be subjected to the action of the vacuum, but due to the fact that only a portion of the belt is at any one time being operated upon a minimum amount of suction is required.

The operation of the previously described apparatus is briefly as follows:—

The material from which a portion of the liquid component is to be removed is fed to the machine by being passed downwardly over the apron 10. The material is thus flowed onto the left hand portion of the upper run of the filter web 5. I have discovered that certain materials can best be thus dehydrated if the material, after being thus deposited on the filter web 5, is permitted a predetermined time interval within which to naturally stratify, i. e., within which the water content may be permitted to flow therefrom under the influence of gravity alone or only a very

slight amount of additional suction. To this end the filter box **20** is provided with a branched manifold **20***a*, each branch being provided with valves, and such branches respectively leading to a free discharge and a suction conduit. By closing the valve from the suction conduit and opening the valve to the gravity discharge the material to be dehydrated will not be under the influence of suction while it passes over the first suction box **20**. This natural stratification of the material permits the larger particles to form the lower stratum immediately on top of the filter web **5**, thus retaining an open surface on the web which would otherwise become clogged if the material were at once subject to suction and the finer constituents thereof were sucked into sealing engagement with the pores on the surface of the filter web. Certain materials, if sufficiently coarse, so that this difficulty is not encountered, may of course, be subjected to an immediate suction in passing over the suction box **20** in which the valve to the gravity discharge would be closed and the valve to the suction discharge open.

It should also be noted that permitting the material such as the sludge or slurry to drain by gravity in the first stage or stages of the machine has the following and more particular advantage so far as the efficiency of operation of the machine as a whole is concerned. As the clean and previously prepared filter medium is brought into the receiving area of the machine, its physical structure includes a large number of minute pores or passages which extend therethrough and which serve as a means for conducting the liquid through the belt, i. e., from one side thereof to the other. The rate at which the water may be filtered through the filtering medium depends upon the extent to which such pores or passages remain unblocked. If suction of any considerable degree or pressure is placed upon this cellular structure, such pressure has a tendency to compact or compress such open structure and thus constrict or close off the capillary passages therethrough and through which the water must pass. If no suction is employed in the opening stages of the operation, these capillary passages are not squeezed shut and the rate of passage of the water through the belt will be considerably more rapid under the influence of gravity than if suction were applied. However, after the major portion of the water has passed through the belt and after the above defined pores or passages become partially clogged or so water-logged that the flow of liquid therethrough is no longer free, the application of suction for the purpose of facilitating such flow will increase the rate at which the water will pass downwardly through the filtering medium.

Most materials are so constituted that as the filter cake progresses towards the discharge end of the machine, the most efficient extraction of liquid from the filter cake will be accomplished by progressively increasing the degree of suction to which the filtering medium is subjected as it approaches the discharge end of the machine. There may be certain materials, however, which due to their particular nature or due to physical changes which occur in the filter cake during the drying cycle may be dried best if the degree of suction is varied somewhat differently from the manner above defined.

After the material has progressed to a position adjacent the discharge end of the machine, or for that matter at any stage of its travel over the suction boxes after the material has achieved a proper condition, it may be advantageously subjected to flow of air or gases at an elevated temperature. This may be conveniently accomplished by positioning a hood generally indicated at **24***a* over a portion of the filter cake, which hood is provided with a conduit **25***a* through which the gases at an elevated temperature are supplied. When operating on materials such as sewage sludges and the like in which the filter cake is incinerated after being discharged from the filter machine, it is within the contemplation of my invention to dispose such incinerator immediately adjacent the discharge end of the filter and to utilize the waste heat from the incinerator to provide the air or gases at an elevated temperature for the hood **24**. It will be understood, of course, that the treating medium to which the filter cake may be subjected under the hood **24***a* is not limited to heated gases resulting from incineration of the discharged filter cake. It is within the contemplation of my invention to employ heated air for the purpose defined, regardless of the manner in which the same is heated, and for certain types of material it may be found advantageous to employ chemical gases which will react with the filter cake or certain constituents thereof.

The use of heated air or the various fluids as above defined for the purpose of treating the material being operated upon is not limited to the supplying of such treating medium to the filter cake by means of the hood **24**, but such heated air or the like may be introduced to the material being treated through one of the suction or blower boxes such as **24**.

The auxiliary feeding devices **11** and **16** are principally provided for the purpose of supplying to the material being treated a constituent normally in place therein and which imparts a desirable characteristic to the filter cake which would otherwise not be possessed thereby. For instance, when treating materials in which the filter cake is finally disposed of by incineration, and if such filter cake does not burn readily, it is within the contemplation of my invention to add a combustible material such as wood, coal, coke, etc., in partially, or finely, divided form to the filter material by means of the auxiliary feeding devices **11** and **16**.

The type of material which may be added to the material being treated by means of the feeding devices such as **11** and **16** is not limited to the above defined, but may be any suitable material which will produce a desired modification in the filter cake either from the standpoint of its physical or chemical composition or both. It will be noted that when certain finely divided materials are being operated upon, it will be advantageous to employ an additional material of the character above defined which will not only primarily impart to the filter cake a different characteristic than that which would normally be possessed thereby, but which will have the additional function of acting as a filter aid, i. e., it is within the contemplation of my invention to introduce to the material being filtered a substance of such nature that when co-mingled with the solid constituents of the material will render the resultant filter cake of such cellular nature that dehydration thereof may be carried on more efficiently.

When a finely divided additional material is employed for any of the above purposes it may become necessary to either forcibly propel the same into the wet material flowing down the apron **10** in order to prevent such fine material

from floating on top of the filter cake and thus be unevenly distributed therethrough. By utilizing the auxiliary feeder 16 such fine material may be mixed with a suitable liquid medium introduced through the conduit 15a to form a slurry which will readily mix with the wet material flowing downwardly over the apron 10 and therefore be uniformly co-mingled therewith.

It has been found that when operating upon materials having a very high liquid content improved results may be achieved by inclining the operative surface, i. e., the upper run of the web 5 or a part thereof to the horizontal so that the wet material when flowed onto the web will not flow backwardly over the feeding end of the web 5 but instead flow forwardly into the gravity area previously referred to, and/or one or more of the initial suction stages. This inclination, as previously indicated, may extend throughout the entire upper run of the belt or mat and may be effected by tilting the entire machine; by a difference in elevation of the axes of the drums 2 and 3 or by a change in the diameter of either or both of such drums, or the inclined portion may extend for only a part of the upper run of the filter web, depending upon the particular material being operated upon as well as the condition of service.

When operating upon a material in which there is an appreciable solid content it may be advantageous to incline the filtering run of the web 5 in the opposite direction, i. e., toward the receiving rather than the discharge end of the machine. This may be accomplished in any of the previously defined modes and the extent of such inclination as well as the degree of inclination will depend upon the characteristic of the material being treated.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In apparatus of the character described, the combination with an endless filter web of means for supporting such web and causing a flow of air therethrough and the material supported thereon, said means comprising a stationary support provided with suction ports and a movable mat overlying said support and carrying said web, said mat provided with drainage grooves extending longitudinally of the mat and communicating with said suction ports.

2. In apparatus of the character described, the combination with an endless filter web of means for supporting such web and causing a flow of air therethrough and the material supported thereon, comprising a stationary support provided with suction ports and a movable mat overlying said support and carrying said web, said mat provided with drainage grooves extending longitudinally of the mat and communicating with said suction ports and means maintaining said web in slightly spaced relation to the body of said mat.

3. In apparatus of the character described, the combination with an endless filter web of means for supporting such web and causing a flow of air therethrough and the material supported thereon, comprising a stationary support provided with suction ports and a movable mat overlying said support and carrying said web, said mat provided with drainage grooves extending in the direction of movement of said belt, communicating with said suction ports and bridge walls extending transversely of said drainage areas and into substantial engagement with said mat.

4. In apparatus of the character described, the combination of a table provided with a plurality of spaced suction ports, a suction chamber in communication with said ports, a plurality of endless belts disposed laterally adjacent each other, supported externally of said suction chamber and having their upper runs supported on said table between said suction ports, and a filter web overlying said belts and supported thereby on said table.

5. In apparatus of the character described, the combination of a table provided with a plurality of spaced suction ports, a suction chamber in communication with said ports, a plurality of endless belts disposed laterally adjacent each other, supported externally of said suction chamber and having their upper runs supported on said table between said suction ports, and a filter web overlying said belts and supported thereby on said table.

6. In apparatus of the character described, the combination of an endless flexible suction mat provided with a plurality of spaced suction ports on its inner periphery, reinforcing inserts in said belt around said openings, spaced drums about which said belt is trained and said drums provided with projections arranged to extend into said suction ports to provide positive driving communication between said mat and said drums.

7. In apparatus of the character described, the combination of spaced drums, an endless suction web trained about said drums, and means for separating the material being treated from said web as the latter passes around one of said drums, said means comprising a single wire under tension extending helically across the entire face of said web as the latter passes around its supporting drum at the discharge end of the machine.

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