

Nov. 3, 1936.

H. J. BROWNLEE

2,059,435

FEEDING DEVICE AND A PROCESS OF USING THE SAME

Filed June 16, 1930

3 Sheets-Sheet 1

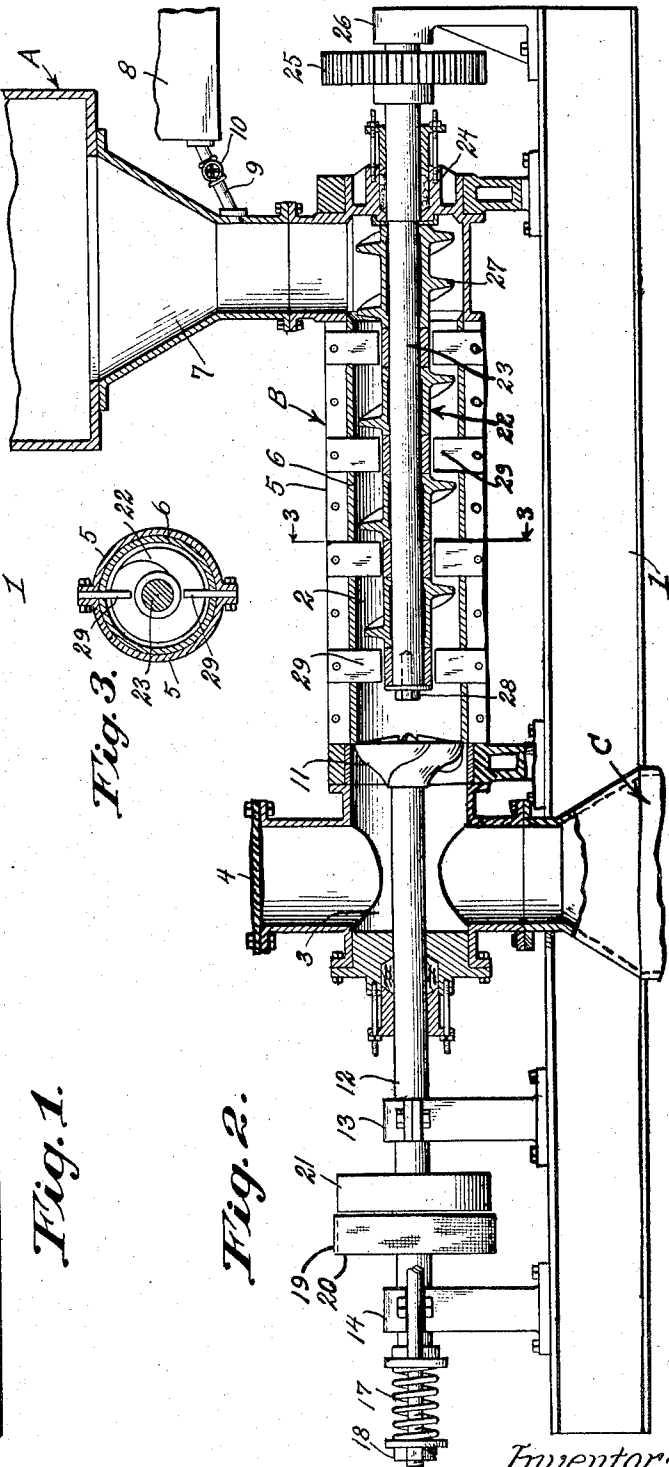
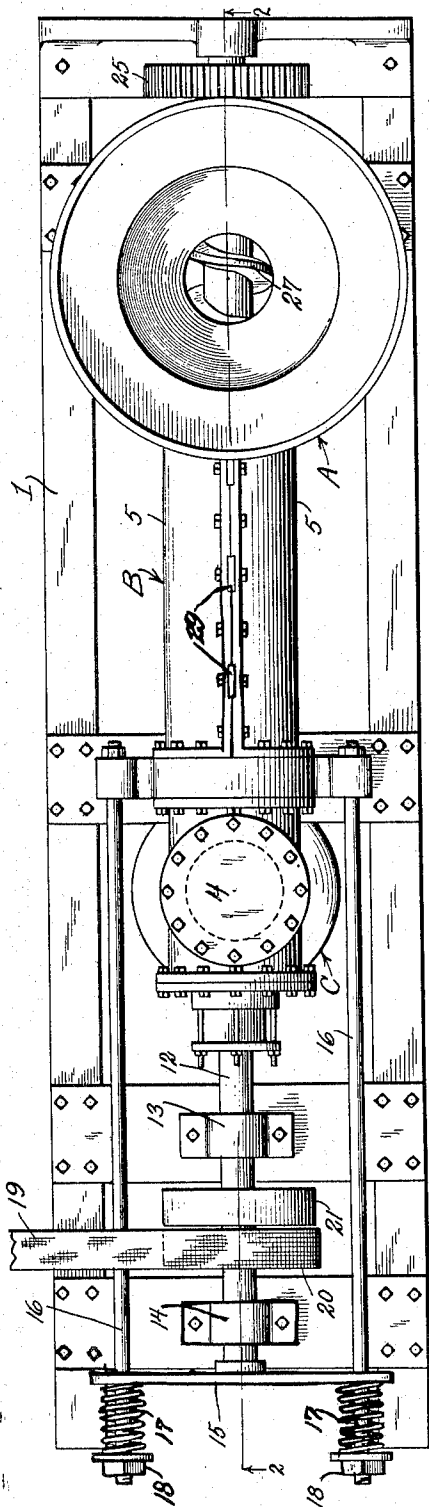


Fig. 1.

Fig. 2.

Fig. 3.

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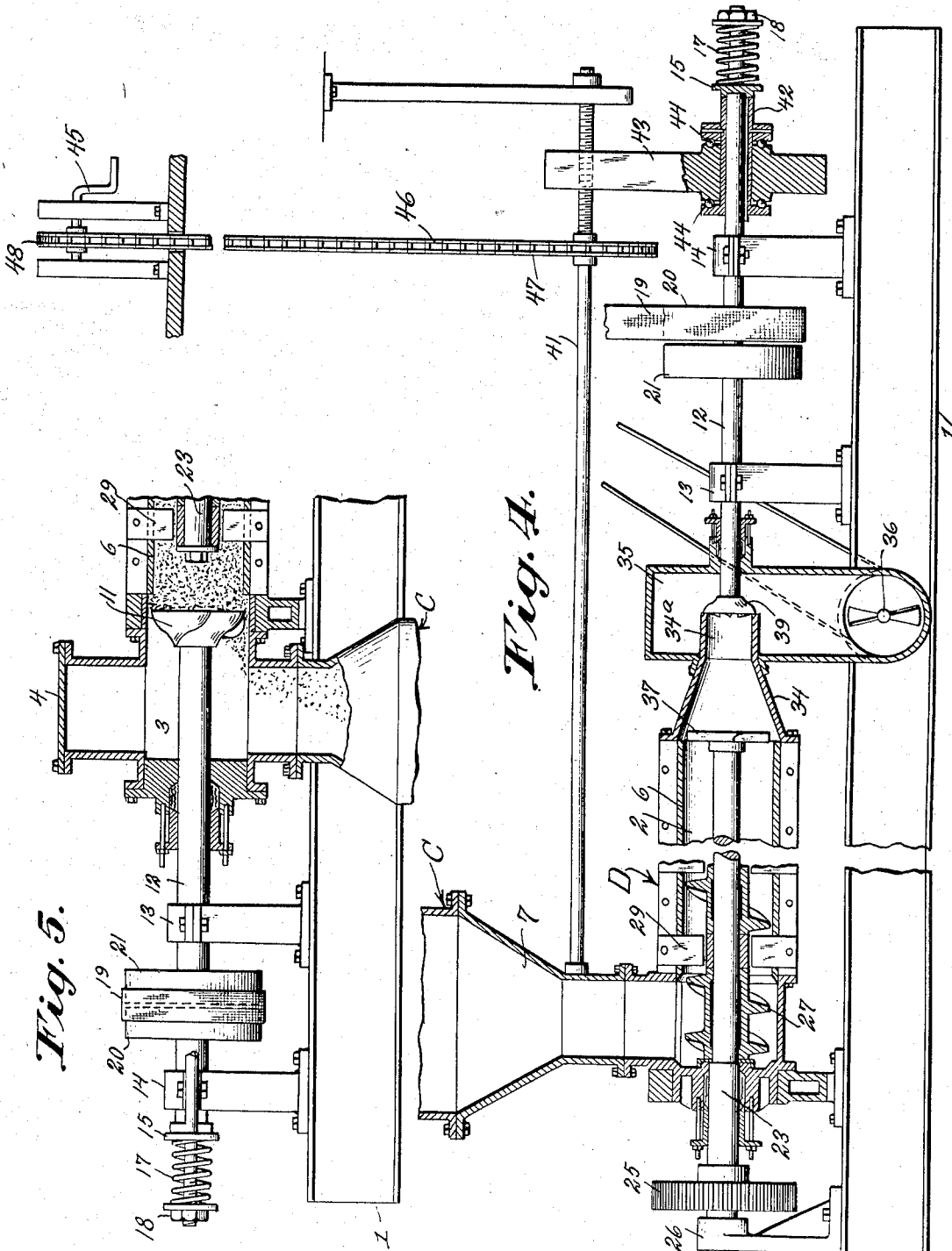
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FEEDING DEVICE AND A PROCESS OF USING THE SAME

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3 Sheets-Sheet 2



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FEEDING DEVICE AND A PROCESS OF USING THE SAME

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3 Sheets-Sheet 3

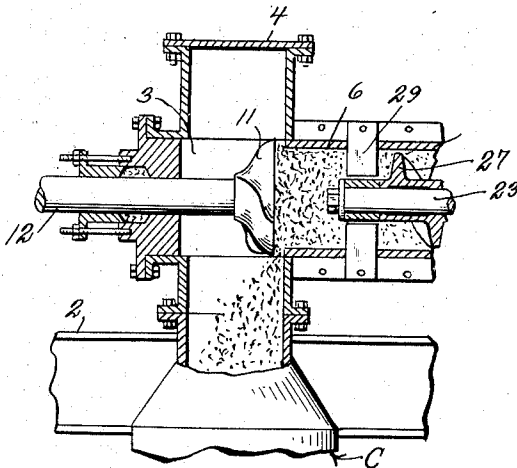


Fig. 10.

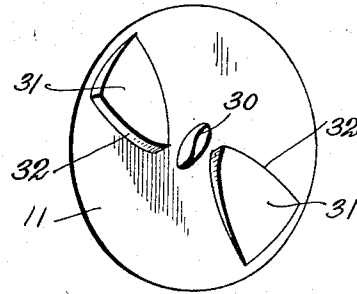


Fig. 9.

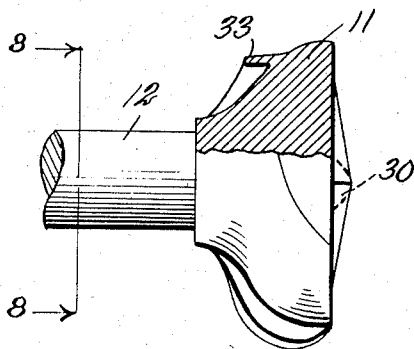


Fig. 7.

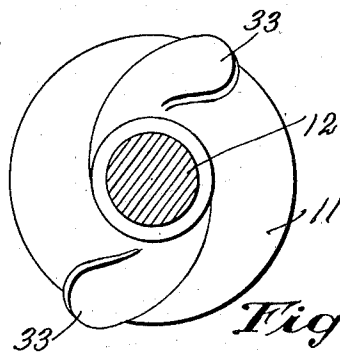


Fig. 8.

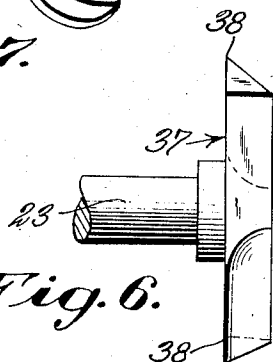


Fig. 6.

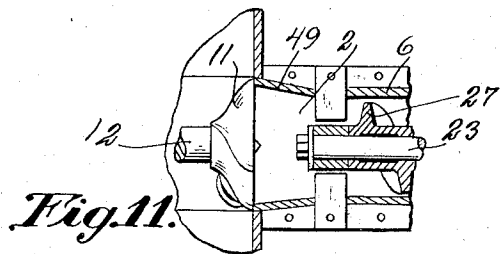


Fig. 11.

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UNITED STATES PATENT OFFICE

2,059,435

FEEDING DEVICE AND A PROCESS OF
USING THE SAMEHarold J. Brownlee, Cedar Rapids, Iowa, assignor
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poration of New Jersey

Application June 16, 1930, Serial No. 461,293

20 Claims. (Cl. 260—54)

My invention relates to improvements in feed-
ing devices, with special reference to devices for
continuously feeding various materials, such as
oat hulls, rice hulls, cotton seed hulls or other
pulverulent compressible material of a similar
nature, into and out of a chamber in which a
comparatively high pressure is continuously
maintained.

More particularly my present invention per-
tains to a device for continuously feeding pento-
san-bearing material, such as oat hulls, into an
autoclave or digesting chamber wherein furfural
is manufactured under suitable conditions of
steam pressure and temperature, and for re-
moving the residue therefrom after the digesting
process has been completed.

While my invention may be used for feeding
material continuously into and out of any suit-
able pressure chamber, it is especially adapted
for use in connection with a digester similar to
that disclosed in my copending application, Ser-
ial No. 246,976, in which digester a suitable
steam pressure is maintained continuously, and
furfural and other volatile substances are con-
tinuously formed and continuously removed from
the pentosan-bearing or furfural-yielding ma-
terial, which latter is continuously supplied to,
and after being processed is continuously re-
moved from, the digester or reaction chamber.

It is an object of my invention to provide
means for continuously feeding the above-men-
tioned materials, or others of a similar nature,
into and from the digester or autoclave, and at
the same time provide a gas-proof seal to prevent
the release of the pressure therein.

My invention also contemplates the method of
using the material handled as an efficient gas-
proof seal during the operation of the device, and
the provision of an automatic gas-proof means
for retaining the pressure when there is no ma-
terial passing through the device.

In the manufacture of furfural and similar
volatile substances, it is desirable that a suit-
able acid liquid be thoroughly intermixed with
the pentosan-bearing material to be fed into the
digester, and my invention also contemplates the
method of thoroughly intermixing the material
with a suitable moistening fluid and continuously
feeding the dampened or wet mixture into the
digester against the comparatively high pressure
maintained therein, and removing the residue
therefrom without materially reducing the pres-
sure.

For a better understanding of the nature,
scope and characteristic features of my present

invention, including the method mentioned, ref-
erence may now be had to the following descrip-
tion and accompanying drawings, in which:

Figure 1 is a top plan view of an apparatus em-
bodying one form of my invention, and by means
of which my present process may be practised;

Fig. 2 is a longitudinal sectional view taken
on a line corresponding to line 2—2 of Fig. 1;

Fig. 3 is a transverse, sectional view through
the feeding chamber and taken substantially on
line 3—3 of Fig. 2;

Fig. 4 is a longitudinal sectional view of the
feeding device used for removing the residue
from the pressure chamber;

Fig. 5 is a detail view partially in longitudinal
section of the valve and valve operating means,
the valve being shown in open operative position;

Fig. 6 is a perspective view of the cutting and
loosening knife illustrated in Fig. 4;

Fig. 7 is a side elevation of the valve member,
a portion being broken away better to illustrate
the fin contour;

Fig. 8 is a rear view of the valve member taken
on line 8—8 of Fig. 7, the valve stem being shown
in section;

Fig. 9 is a front end view of the valve member;

Fig. 10 is a vertical, longitudinal section illus-
trating the use of my invention in connection
with a somewhat different form of chamber inlet
construction; and

Fig. 11 illustrates a form of feeding device in
which the feeding chamber tapers outwardly to-
ward the valve.

Referring to the drawings in detail, in the em-
bodiment illustrated a horizontally disposed com-
pressing section B is supported on a suitable base
1 and provided with a cylindrical impregnating
and compressing chamber 2 therein. The com-
pressing chamber communicates with an auto-
clave or digester C of any suitable construction
through a passage 3 in an ingress section 4.

The compressing section B includes a casing
comprising a plurality of longitudinal sections
secured together and provided with a tubular lin-
ing 6. The section is adjacent the mixing tank
or oat hull bin A and is arranged to receive oat
hulls or similar material therefrom through an
ingress passage 7. In order that the material
and the acid liquid may be mixed in the com-
pressing section, if desired, instead of being
previously mixed in the tank A, a supplemental
acid tank 8 feeds into the ingress passage 7
through a pipe 9, which latter is provided with
a control valve 10. This allows the flow of liquid
to be controlled and fed into the mixing cham-

ber, simultaneously with the material from the bin A, where it will be thoroughly mixed by a means which will be later described.

The passage 3 in the digester ingress section 4 is normally closed by means of a valve head 11 resting against the end of the mixing chamber lining 6, which latter forms a valve seat therefor. The valve head 11 is secured to a valve stem 12, which latter is rotatably and slidably mounted in the bearings 13 and 14 on the base 1. A cross-head 15 is slidably mounted on longitudinally disposed rods 16 and forms a thrust bearing for the end of the valve stem 12. The valve is normally held closed by compression springs 17 on the rods 16 and bearing against the cross-head 15. The valve is normally held closed and the compression of the springs 17 and the consequent pressure of the valve head 11 against the valve seat may be adjusted by means of nuts 18 on the rods 16. During the operation of the machine the valve head 11 is rotated at a suitable speed, from any suitable power source, the operation being controlled by a belt 19 and tight and loose pulleys 21 and 20, respectively, on the valve stem 12. It will be noted that when the valve 11 is seated, it will be stationary as the belt is then on the loose pulley 20, and when the valve is opened by the pressure of incoming material, it will be rotated by the engagement of the belt 19 with the tight pulley 21.

The compressing section B is provided with an interrupted screw conveyor 22 therein, comprising a shaft 23 mounted in a bearing 24 and extending into the impregnating and compressing chamber in axial alignment therewith. A gear 25 is secured to the shaft 23 by which it may be driven from any suitable source of power. A thrust bearing 26 prevents longitudinal movement. Spiral ejector flights 27 are removably mounted on the shaft 23 and rigidly clamped thereon by means of a screw 28. When the moistened material is fed through the inlet passage 7 to the compressing chamber, it will be forced toward the valve 11 by the conveyor flights 27. Inwardly extending baffle plates 29 are supported by the casing sections 5 as illustrated in Figs. 2 and 3, and extend inwardly and adjacent the shaft 23. These baffle plates prevent the material from rotating with the conveyor. The conveyor blades 27 force the material in the compressing chamber 2 toward the valve 11 and cause, in conjunction with the baffle plates 29, the material to be progressively compressed to form a moving gas-tight plug adjacent the valve. This compressed plug of material will be pressed against the rotating valve head 11 until the constantly increasing pressure overcomes the compression springs 17 and the valve head 11 will be moved away from the valve seat, as illustrated in Fig. 5, to allow the material to be forced into the digester inlet passage 3. The valve will then be automatically rotated by the engagement of the belt 19 with the pulley 21 as previously mentioned. The material in the chamber adjacent the valve head is very snugly compressed and forms a moving gas-tight plug which effectively overcomes the pressure maintained in the digester or autoclave C.

In order to break up the material of the plug so that it will pass around the rotating valve head and into the passage 3, the valve head is provided with a spiral center bit point 30, and outwardly extending lugs 31 having spirally disposed cutting edges 32. The axially disposed spiral bit point 30 and the cutting lugs 31 effec-

tively break up the end of the compressed plug of material, and this loosened material is forced around the valve head 11 and into the passage 3 by the pressure of the material following. The valve head 11 is also provided with spirally disposed fins 33 arranged to push the loosened material through the passage 3 to a position where it will drop by gravity into the digester C. If the feeding of the material to the mixing chamber is interrupted, the resultant reduced pressure against the valve head 11 will allow it to reseal and retain the pressure in the digester chamber.

In the form shown in Fig. 10 the ingress passage to the digester is directly in alignment with the face of the valve head 12, so that loosened material drops directly into the digester.

In Fig. 4 is illustrated the output means for removing the residue from the digester. This output feeder D is similar in construction to the input device B just described and, in fact, they may be used interchangeably if desired. However, a restricted outlet opening is desirable, and a funnel-shaped portion 34 is secured to the feeder, and having a restricted outlet passage 34a through which the residue is discharged into a chamber 35, where it drops by gravity to a conveyor 36, by which it is carried away.

In using the feeder as an output device, the ingress passage 7 is arranged to receive the spent hulls or residue from the digester and from which they will fall by gravity into the conveying and compressing chamber 2, where they are compressed to form a moving plug to prevent the direct escape of live steam or other pressure. A propeller-shaped cutting knife 37 in the form of a propeller is secured to the end of the shaft 23 and provided with cutting edges 38 (see Fig. 6).

The purpose of the cutting knife in the outlet feeder is to break up the outer end of the moving plug in the chamber 2 so that the material may enter the funnel-shaped member 34 and pass through the restricted passage 34a.

In the output device, the chamber 2 is at cooking pressure, while the chamber 35 is at atmospheric pressure. A large inlet passage 7 is necessary to prevent bridging of the material at the entrance, and the restricted outlet passage 34a is provided, as the velocity of the material at the point of contact with atmospheric pressure is very high. Since the velocity of the material is so great, large quantities can be discharged through a small opening. If the same size opening extended through to the input end of this feeder, the difficulty of bridging might result. The spent hulls are discharged around a valve 39, which is similar to the inlet feeder valve 11 and is secured to the stem 12.

The spent hulls as discharged give up the heat therein contained, in the form of steam. This steam is given up so quickly that the hulls have the appearance of being blown through the valve, but measurements of the steam given off show that the spent material on discharge yields approximately the theoretical amount of steam.

In feeding the material, it is desirable to control the rate of discharge, since too rapid a discharge will very quickly remove the material from the compressing chamber and insufficient material will be left therein to form a gas-tight plug. It will be apparent that a rate of discharge should be maintained corresponding to the pressure and the rate at which it is desired to feed the material through the digester. In order to

control the rate of discharge, an adjustable means is provided to allow the ejected plug of material to extend a short distance beyond the valve seat before coming in contact with the face of the valve head, and comprising a threaded shaft 41 rotatably mounted in longitudinal relation to the valve stem 12. A sleeve 42 is splined for sliding adjustment on the valve stem and arranged to be moved into or out of engagement with the cross-head 15. An arm 43 is loosely mounted on the sleeve 42 by means of the ball bearings 44 and is tapped for engagement with the threaded shaft 41. The shaft 41 may be manually rotated by any suitable means, such as the crank 45 for moving the chain 46 on the sprockets 47 and 48.

It is evident that, through the mechanism just described, the sleeve 42 may be adjusted to cause the compression springs 17 to be effective only when the valve head 39 moves the desired distance from the valve seat. The rate of discharge will therefore be relative to the adjusted position of the valve head.

The relative horse power developed by a motor used for operating the feeding device will indicate when the plug has been formed. Another method is to insert a stirring device in the feeding chamber and the material is allowed to build up until the stirring device does not turn freely.

The difference in the appearance of the discharge will indicate whether or not a suitable plug is maintained, or a drop in pressure may be noted on a suitable pressure recording instrument.

The above noted considerations indicate the desirability of a suitable discharge control means.

In the embodiment shown in Fig. 4, the plug of material may be allowed to extend to any desired distance beyond the valve seat before the pressure of the springs 17 becomes effective, and the material broken up and removed by the valve head will drop directly to the conveyor 36.

It will be understood from the above description that the feeding device may be used either as an input or output feeder and in either case the restricted passage may or may not be used. However, it is desirable in practice to use the restricted passage for the output.

In operation, the material falls by gravity from the tank or bin A into the input feeder B where it is mixed, impregnated and compressed into a moving gas-tight plug and passed into the digester or autoclave C by being broken up by the rotating valve and dropping therein by gravity. The furfural is there removed under suitable conditions of steam pressure and temperature maintained therein, and the residue falls by gravity into the output feeder D, in which it is again compressed to a moving gas-tight seal and broken up and discharged through the restricted passage 34a and around the valve 39 into atmospheric pressure, where it drops by gravity to the conveyor 36 to be disposed of as desired. In the modified form shown in Fig. 11, the chamber 2 of the feeder tapers outwardly slightly at 49 to allow the end of the plug to expand and loosen the material somewhat.

While I have described one embodiment of my invention, it is to be understood that many modifications may be made without departing from the spirit and scope of the appended claims.

I claim:

1. The method of continuously feeding solid, pulverulent, furfural-yielding material into a di-

gester against substantial superatmospheric pressure maintained therein, which comprises impregnating the material with a dilute acid and continuously feeding said material to the digester in the form of a continuously renewed highly compressed gas-proof plug formed at the ingress of said digester to constitute thereat a seal against the escape of the pressure from the digester, and continuously breaking up the inner end of the plug to allow the material to enter the digester.

2. The method of continuously feeding solid, pulverulent, furfural-yielding material into a digester against substantial superatmospheric pressure maintained therein, which comprises moistening said material, then compressing the material into a highly compressed gas-proof plug at the ingress of the digester and then forcing said plug into the digester through said ingress whereat said plug constitutes a gas-proof seal in the form of a continuously renewed and continuously moving plug, and continuously breaking up the inner end of said plug.

3. In combination with a digester for pulverulent material wherein a superatmospheric pressure is continuously maintained, said digester having a gas-tight ingress passageway, of a mechanism for continuously feeding said pulverulent material into the digester through the said passageway which comprises a housing that communicates at its inner end with said passageway, means in said housing for continuously forming said material into a compacted solid plug to provide continuously within said housing adjacent to the said ingress passageway of the digester a gas-proof seal that precludes the release pressure from the digester and for continuously replenishing the plug at its outer end with fresh material that likewise is densely compacted into the plug, and means for continuously removing some of said material from the compacted plug and delivering the same to the digester while keeping the major portion of said plug intact as a gas-proof seal.

4. A feeding device for continuously feeding solid pulverulent material into a digester against substantial superatmospheric pressure continuously maintained therein, comprising means for continuously forming said material into a compacted solid plug at the ingress to said digester to constitute a gas-proof seal thereat and for constantly renewing said gas-proof seal with additions thereto of said material, means for removing continuously some of said material from said seal for use in said digester while keeping said plug intact at said ingress as a gas-proof seal, said removing means forming automatically a gas-proof mechanical valve for said ingress when the said plug is not effective to seal the pressure within the digester.

5. A feeding device for continuously feeding solid pulverulent material into a digester against substantial superatmospheric pressure continuously maintained therein, comprising means for continuously forming said material into a compacted solid plug at the ingress to said digester to constitute a gas-proof seal thereat and for constantly renewing said gas-proof sealing plug with additions thereto of said material, a gas-proof mechanical valve normally closing said ingress to preclude escape of pressure from said digester, the pressure of said plug after being formed operating to automatically open said valve, and means for breaking material from said plug for entrance into said digester, said

forming and renewing means maintaining said gas-proof sealing plug intact to seal the pressure within the digester.

6. In combination with a digester for pulverulent material wherein a superatmospheric pressure is continuously maintained, said digester having at least one gas-tight passageway, a movable gas-proof valve normally closing said passageway, of a mechanism for continuously handling said pulverulent material comprising a housing adjacent to and communicating with said passageway, means in said housing for continuously compressing said pulverulent material into a highly compacted gas-proof plug against said valve to open it and to project said plug into said passageway to seal continuously the latter against the release of pressure within the digester and for continuously replenishing said plug with fresh pulverulent material, said valve continuously breaking up said plug at its end that has advanced through said passageway.

7. The method of continuously feeding solid, pulverulent, furfural-yielding material through a chamber having a substantial superatmospheric pressure, which comprises impregnating the material with a dilute acid and continuously feeding the material to the pressure chamber in the form of a continuously renewed highly compressed gas-proof plug that is held against rotation to seal the chamber at the ingress passageway against release of pressure, and continuously breaking up the plug under the chamber pressure, then feeding the residue from the chamber in the form of a highly compressed gas-proof plug that is held against rotation to seal the chamber at the egress passageway against release of pressure and continuously breaking up the last named plug under atmospheric pressure.

8. The method of continuously feeding solid, pulverulent, furfural-yielding material through a digester wherein a substantial superatmospheric pressure is maintained which comprises moistening the material and compressing it under atmospheric pressure into the form of a continuously renewed highly compressed gas-proof plug that is held against rotation to seal the digester at the ingress passageway against release of pressure, feeding the plug continuously into the digester, and continuously breaking it up under the digester pressure, then compressing the residue under the digester pressure into the form of a continuously renewed, highly compressed gas-proof plug that is held against rotation to seal the digester at the egress passageway against release of pressure, feeding the last named plug continuously out of the digester, and breaking it up under atmospheric pressure.

9. The method of continuously feeding compressible, pulverulent, furfural-yielding material into a digester against a relatively high pressure maintained therein which comprises impregnating the material with an acid liquid, then continuously and progressively compressing said material into a dense, highly compacted, gas-tight plug at the ingress to said digester to form a pressure seal at said ingress, continuously forcing the inner end of said plug into said digester while continuously replenishing the plug at its outer end with fresh material that is likewise compacted, and continuously breaking up the plug at its inner end so that said material is delivered to the digester in uncompacted form.

10. The method of continuously feeding pulverulent solid material into a digester against a relatively high pressure continuously maintained

therein which comprises dampening the material, then continuously and progressively compressing said dampened material into a dense, highly compacted, gas-tight plug at the ingress to said digester to form a pressure seal thereat, maintaining said plug against rotation while continuously forcing the inner end thereof into the digester wherein it is dissociated, and continuously replenishing said plug at its outer end with fresh dampened material that is likewise densely compacted to keep an intact plug continuously at the ingress of said digester.

11. The method of continuously feeding pulverulent solid material into a digester against a relatively high pressure continuously maintained therein which comprises dampening the material, then continuously and progressively compressing said dampened material into a dense, highly compacted, gas-tight plug at the ingress to said digester to form a pressure seal thereat, maintaining said plug against rotation while continuously forcing the inner end thereof into the digester, continuously replenishing said plug at its outer end with fresh dampened material that likewise is densely compacted to keep an intact plug of said material continuously at the ingress of said digester, and continuously breaking up the plug at its inner end so that said material is delivered to the digester in uncompacted form.

12. The method of continuously feeding compressible, pulverulent, solid material into a container wherein a relatively high pressure is continuously maintained which comprises compressing said material into the form of a dense, highly compacted, gas-tight plug which continuously seals said container at its ingress against the release of the pressure therein, continuously forcing the inner end of said plug into said container while continuously replenishing the plug at its outer end with fresh material that likewise is densely compacted to keep an intact plug of said material continuously at the ingress of said digester, and continuously breaking up the inner end so that said material on delivery into said digester resumes substantially its initial loosened state.

13. The method of continuously feeding compressible, pulverulent, solid material into a container wherein a relatively high pressure is continuously maintained which comprises compressing said material adjacent the ingress of the container into the form of a dense, highly compacted, gas-tight plug, maintaining said plug against rotation thereby effectively sealing said container at its ingress against the release of a pressure therein, and continuously forcing the inner end of the plug into said digester wherein it is dissociated while continuously replenishing the plug at its outer end with fresh material that likewise is densely compacted, thus keeping an intact gas-tight plug at all times at the ingress to said container.

14. The method of continuously feeding compressible, pulverulent, solid material into a digester wherein a relatively high pressure is continuously maintained which comprises impregnating said material with a liquid, then compressing said material adjacent the ingress of the digester into a dense, highly compacted plug that is held against rotation thereby effectively sealing said digester at its ingress against the release of the pressure therein, continuously forcing the inner end of said plug into said digester while continuously replenishing the plug at its outer end with impregnated fresh material that is likewise

densely compacted whereby a gas-tight seal is continually maintained at said ingress while the material is being fed into the digester, and then continuously breaking up the plug at its inner end so that said material is delivered to the digester in an uncompacted state.

15. The method of processing pulverulent, solid, furfural-yielding material which comprises impregnating said material with an acid liquid, continuously feeding such material into a digester wherein a substantially superatmospheric pressure is continuously maintained, said feeding operation comprising continuously and progressively compressing said dampened material into a dense, highly compacted, gas-tight plug at the ingress to said digester to form a pressure seal thereat, maintaining said plug against rotation while continuously forcing the inner end thereof into the digester wherein it is dissociated, and continuously replenishing said plug at its outer end with fresh dampened material that is likewise densely compacted to keep an intact plug continuously at the ingress of said digester, then processing said material within said digester, and continuously withdrawing the spent material from the digester through its egress, the withdrawing operation comprising continuously and progressively compressing such spent material into a dense, highly compacted, gas-tight plug at the egress of said digester to form a pressure seal thereat, maintaining said plug against rotation while continuously forcing the outer end thereof from the digester, and continuously replenishing said plug at its inner end with spent material that is likewise densely compacted to keep an intact plug continuously at the egress of said digester.

16. An apparatus for continuously processing loose solid material which comprises a digester wherein superatmospheric pressure is continuously maintained, means for continuously feeding said loose material into said digester through an ingress thereof, said means continuously forming said material at said ingress into a compacted gas-proof plug that seals said ingress against the release of pressure and continuously replenishing said plug with fresh material as said plug is advanced into said digester, a mechanical valve that normally seals said ingress against the release of pressure from said digester, said valve being automatically unseated from said ingress by the pressure of the said plug as it advances through said ingress, and means to dissociate the inner end of said plug to deliver the material in uncompacted form to the digester.

17. An apparatus for continuously processing loose solid material which comprises a digester wherein superatmospheric pressure is continuously maintained, means for continuously feeding said loose material into said digester through an ingress thereof, said means continuously forming said material at said ingress into a compacted gas-proof plug that seals said ingress against the release of pressure and continuously replenishing said plug with fresh material as said plug is advanced into said digester, means for holding said plug against rotation as the same is advanced into the digester, a mechanical

valve that normally seals said ingress against the release of pressure from said digester, said valve being automatically unseated from said ingress by the pressure of the said plug as it advances through said ingress, and means to dissociate the inner end of said plug to deliver the material in uncompacted form to the digester.

18. An apparatus for continuously processing loose solid material which comprises a digester wherein superatmospheric pressure is continuously maintained, means for impregnating said loose material with a liquid and for continuously feeding said loose material into said digester through an ingress, said means comprising an interrupted screw conveyor and spaced baffles interposed between threads of said conveyor for continuously forming said material at said ingress into a compacted, non-rotatable, gas-proof plug that seals said ingress against the release of pressure and for continuously replenishing said plug with fresh impregnated material as said plug is advanced into said digester, a mechanical spring-pressed valve that normally seals said ingress against the release of pressure from said digester but which is automatically unseated from said ingress by the pressure of said plug as it advances through said ingress, and means to dissociate the inner end of said plug to deliver the material in uncompacted form to the digester.

19. An apparatus for continuously processing loose solid material which comprises a digester wherein superatmospheric pressure is continuously maintained, means for impregnating said material with a liquid, means for continuously feeding said loose impregnated material into said digester through an ingress, said feeding means comprising an interrupted screw conveyor and spaced baffles for continuously forming said material at said ingress into a compacted gas-proof plug that seals said ingress against the release of pressure and for continuously replenishing said plug with fresh material as the said plug is advanced into said digester, an independently operated spring-pressed valve that normally seals said ingress against the release of pressure from said digester, said valve being automatically unseated from said ingress by the pressure of the said plug as it advances through said ingress, and means mounted on said valve to dissociate the inner end of said plug to deliver the material in uncompacted form to the digester.

20. An apparatus for continuously feeding solid pulverulent material into a digester against a substantially superatmospheric pressure continuously maintained therein which comprises means for continuously forming at the ingress passageway to said digester a gas-proof seal of said material in the form of a highly compacted non-rotatable plug, and means for continuously removing portions of the said material constituting said plug and feeding the material to the digester, said first means continuously replenishing the plug by delivering thereto in highly compacted form fresh pulverulent material on one side thereof as the plug is being constantly depleted on the other side thereof when the material is fed to the digester.

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