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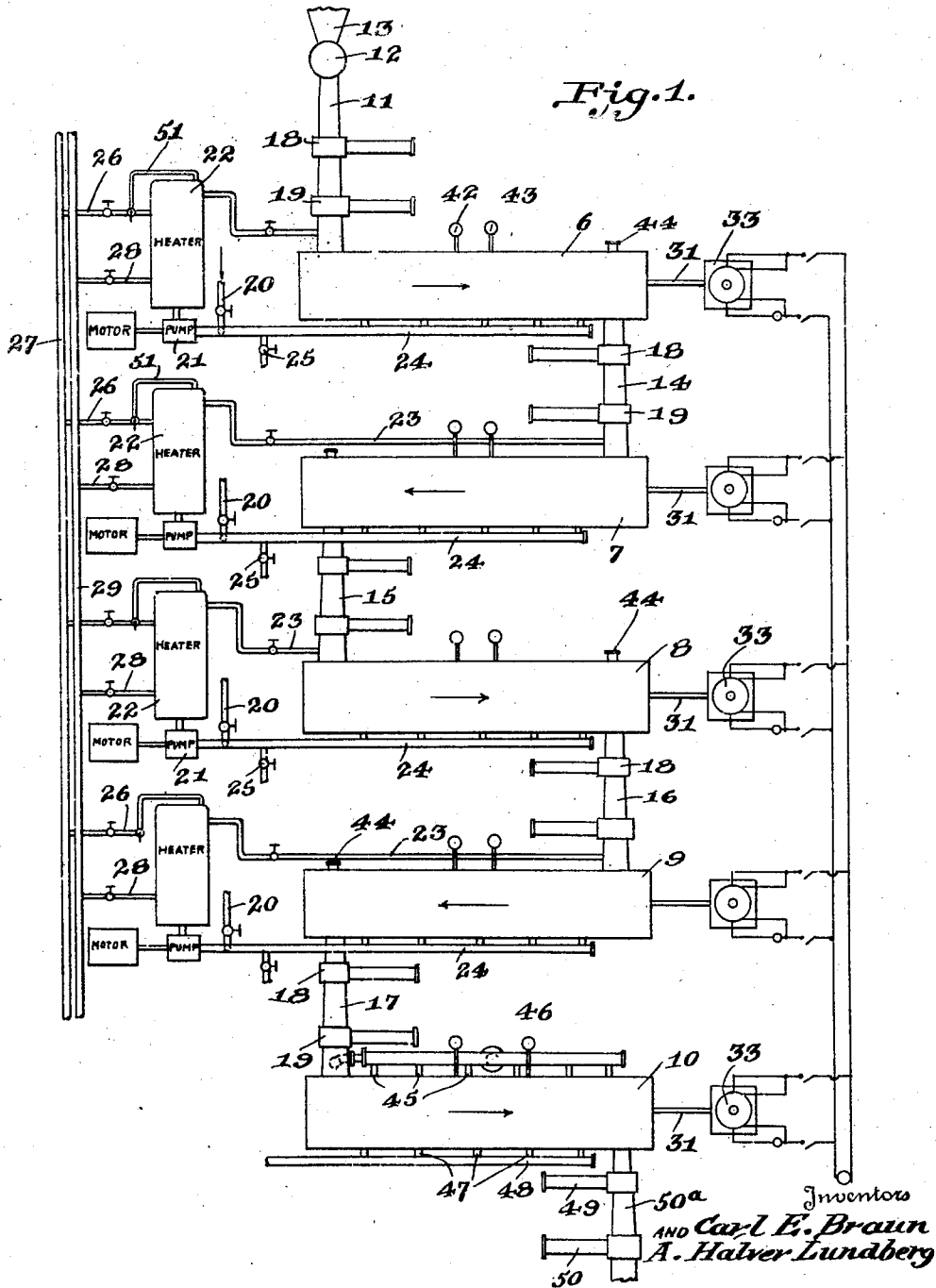
C. E. BRAUN ET AL

1,938,802

CONTINUOUS PROCESS AND APPARATUS FOR PULPING FIBROUS MATERIALS

Filed April 19, 1932

4 Sheets-Sheet 1



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Dec. 12, 1933.

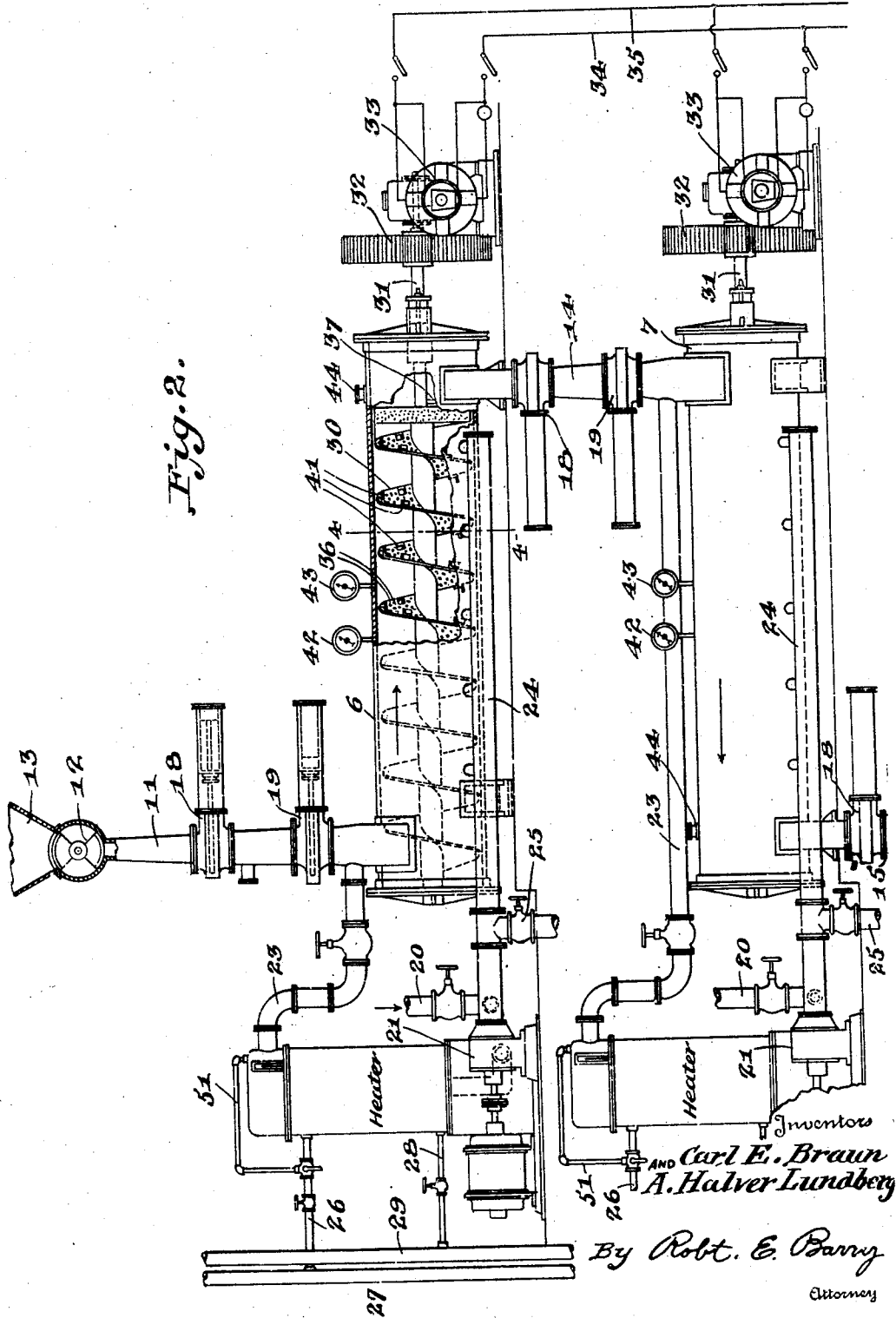
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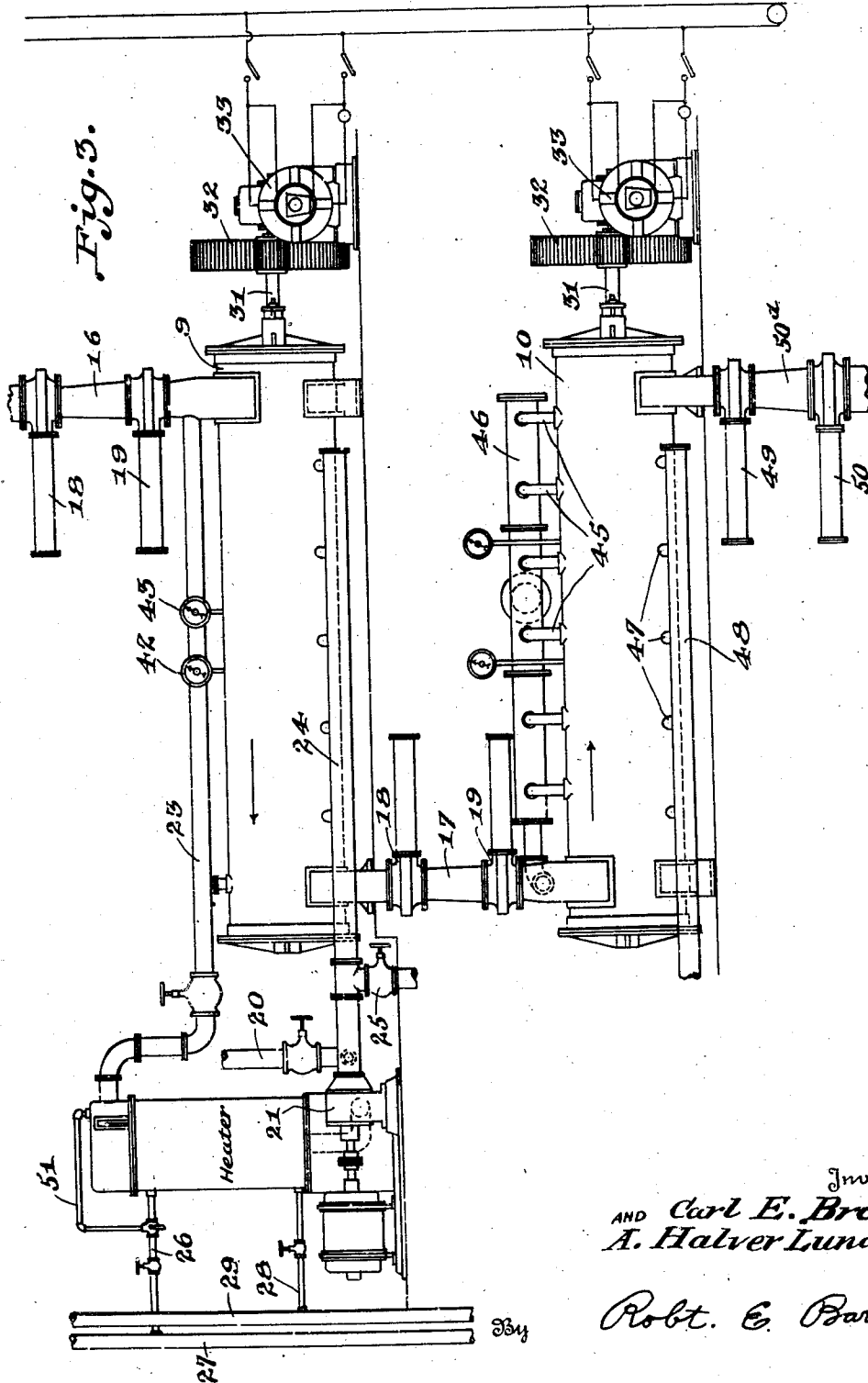
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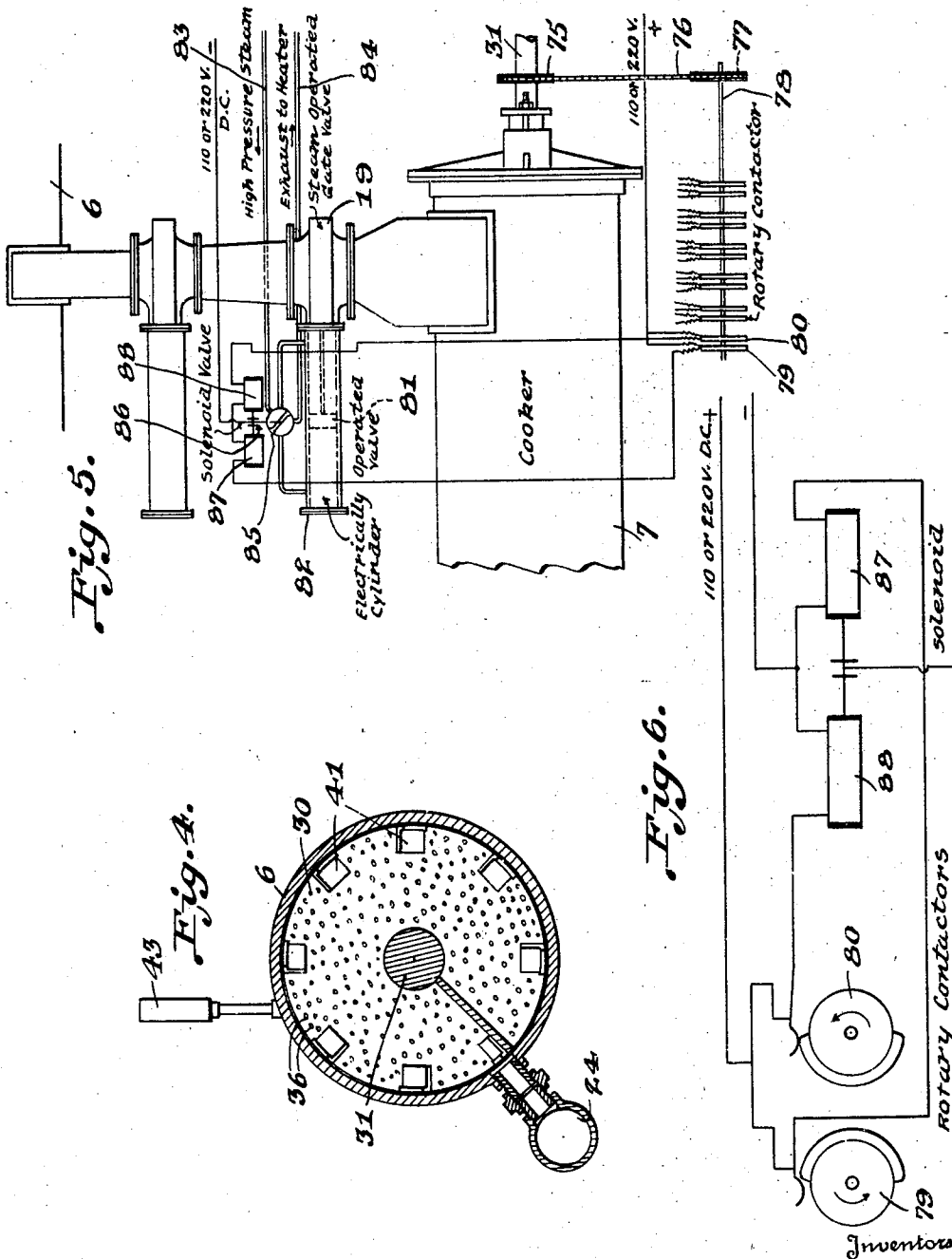
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CONTINUOUS PROCESS AND APPARATUS FOR PULPING FIBROUS MATERIALS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

1,938,802

CONTINUOUS PROCESS AND APPARATUS
FOR PULPING FIBROUS MATERIALS

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Application April 19, 1932. Serial No. 606,255

38 Claims. (Cl. 92-7)

This invention relates to improvements in processes and apparatus for digesting fibrous material such as wood chips, and for the bleaching and washing of wood pulp.

One of the objects of the invention is to provide a continuous cooking and washing, or cooking, bleaching and washing system for use in the production or treatment of all chemical pulps.

Another object is to provide a suitable apparatus by which fibrous material may be digested with different kinds of chemical liquors in different units of the apparatus, and by which the fibrous material may be washed in one unit after it has been digested in a previous unit with one kind of chemical liquor, and before it is digested in a following unit with another kind of chemical liquor.

With the foregoing objects outlined and with other objects in view which will appear as the description proceeds, the invention consists in the novel features hereinafter described in detail, illustrated in the accompanying drawings, and more particularly pointed out in the appended claims.

In the drawings,

Fig. 1 is a diagrammatic view of the complete apparatus.

Fig. 2 is a side elevation partly in section, of the first two units of the apparatus and their associated equipment.

Fig. 3 is an elevation of the last two units of the system and their associated equipment.

Fig. 4 is a vertical sectional view on the line 4-4 of Fig. 2.

Fig. 5 is a diagrammatic view of an electric device for controlling the apparatus.

Fig. 6 is a similar view of the wiring arrangement of such apparatus.

Referring first to Fig. 1, it will be noted that the apparatus consists of a number of units or closed drums 6, 7, 8, 9 and 10, arranged in series.

The first unit has a chip inlet conduit 11 provided at its admission end with a measuring valve 12 which receives the chips or other fibrous material from a hopper 13. Other conduits 14, 15, 16 and 17 connect the units in series whereby after the fibrous material has been treated in one drum or tank, it can be introduced into a succeeding one. Each of the conduits 11, 14, 15, 16 and 17 flares downwardly to prevent hanging up of chips and cooked pulp, and is provided with a pair of valves 18 and 19 to permit feeding of material through the system without

affecting the temperature or pressure conditions existing in any one of the units.

The fresh treating liquor is introduced into the units by way of valved pipes 20, and of course, if the same kind of cooking liquor is to be used in two or more of the units, the pipes 20 may be connected to a common header through which the liquor flows.

The liquor introduced at 20 into each unit 6, 7, 8 and 9, is forced by a pump 21 through an indirect heater 22, and after it is heated, it passes by way of a valved pipe 23 into the upper portion of the unit. Liquor is drained from each unit into a recirculating pipe 24 which may return some or all of it to the pump of that unit. We prefer, however, to provide each pipe 24 with a valved outlet 25 to allow discharge of some or all of the treating liquor when desired.

All of the heaters 22 are connected by valved branch pipes 26 to a steam header 27, and the lower ends of the heaters are connected by valved branches 28 to a condensate header 29 that may be used for returning the hot condensate back to the steam generating boiler (not shown).

As indicated in Fig. 2, each of the units or drums is provided with a rotatable worm or feeding screw 30, and these worms are positioned on rotatable shafts 31, and driven through the instrumentality of reduction gearing 32 by an electric motor 33. All of these motors may receive current from lead wires 34 and 35.

Each worm, as indicated in Fig. 2, is perforated as at 36 to permit circulation of the treating liquor through the drum, and each drum is provided near its outlet end with a weir 37 over which the fibrous material is forced by the worm.

The valves 18 and 19 may be controlled by any suitable means, for example, by the device illustrated in Figs. 5 and 6. In this arrangement, the shaft 31 of the second cooker is provided with a sprocket wheel 75 that drives a sprocket chain 76. This chain in turn drives a sprocket wheel 77, fixed to a shaft 78. This shaft carries pairs of contact disks or wheels 79 and 80, and the number of pairs corresponds to the numbers of the valves 18 and 19. Each of these valves is provided with a piston 81, operating in a steam cylinder 82. Steam is fed to the cylinder through a pipe 83, and the exhaust steam returns to the heater (not shown), by means of a pipe 84. A rocking valve 85 controls the feed and discharge of steam, and the lever 86 of this valve may be moved in opposite directions by solenoids 87 and 88 interposed in electric circuits which are opened

and closed by the contactor wheels 79 and 80. It will be understood that when the contactor wheel 79 closes the circuit through the solenoid 87, the valve 85 will be moved in one direction, and when the contactor wheel 80 closes the circuit through the solenoid 88, the valve will be moved in the opposite direction.

By the use of such a control mechanism, it will be evident that all of the valves 18 and 19 throughout the system, may be operated in proper sequence.

Referring to the operation of such apparatus, it will be noted that the valve 12 is of the rotatable type, and it may be constantly or intermittently rotated for automatically feeding the chips or the like into the pipe 11. As this automatic chip feeder is divided into quarters, two sides are open and two sides are closed. As the valve revolves, one of its chambers fills with a determined amount of the fibrous material to be cooked, and as the valve revolves, this amount is discharged into the pipe 11 and on top of the sliding valve 18. This valve then opens while the second valve 19 remains closed to hold the pressure in the first chamber or unit 6. After the first valve has discharged its burden, it closes, and then the second valve opens and discharges the chips into the first unit 6.

At this point it will be noted that the measuring valve 12 and the first and second valves 18 and 19 of each of the conduits are operated in a definite sequence, either by hand or by an automatic control shown in Figs. 5 and 6.

After the valve 19 dumps its burden into the unit 6, this valve closes.

A determined amount of fresh hot cooking liquor is added by way of pipe 20 during each opening of the second valve 19. This liquor enters just back of the circulating pump 21 which draws the liquor out of the side or bottom of the unit. The pump discharges to the high velocity heater 22, and the hot liquor leaves this heater and is admitted to the head of the unit 6 just below the valve 19.

The chips or other fibrous material in the continuous cooker 6 are slowly moved from the entering end of the cooker to the discharge end, and this is accomplished by the worm or slowly revolving screw 30. The worm may have in addition to the perforations, blades 41 to agitate the material undergoing cooking.

Such worm conveyor is driven at a relatively slow speed by the direct current motor 33 through the reduction gear set 32. It has been found best to use a direct current motor as it permits better speed regulation and a wider range of speeds. We recommend the use of a standard paper machine electric drive, as this gives better regulation between the cookers, and also group speed range.

Each unit has on its shell, outlets conveniently arranged for the attachment of temperature and pressure gauges 42 and 43. Provision is also made at the outlet end of each unit, as indicated at 44, with the exception of the last one, for the connection of a gas relief line. The passage of gases through such lines may be regulated by suitable control means responsive to the pressure existing in the units.

During operation, the chips or other fibrous materials are moved forward until they reach the outlet end of the cooker, and then they are forced over the top of the bulkhead 37 with a certain amount of liquor and dropped on top of the valve 18 in the conduit 14. At this time, both

valves 18 and 19 in the conduit 14 are closed. When a determined amount of the partly cooked contents and liquor are deposited on the valve 18, it is opened and this amount is dropped on to the valve 19, after which the valve 18 of this conduit is closed. Then, when the valve 19 of such conduit is opened, this partly cooked material and such liquor are dropped into the unit 7, which can be actuated at a higher or lower pressure than exists in the unit 6.

The operation from here on is exactly the same for each cooker, regardless of how many cookers are used, and also regardless of the pressure existing in the various cookers.

The last unit 10 which may be called the discharge drum, is the same internally as the previous ones, but it has a row of inlets 45 at its top to admit water from a manifold 46 for the purpose of condensing steam, gases, etc. The bottom has a row of outlets 47 joined to a discharge manifold 48 which can be used to drain the liquor for reclaiming if necessary. By arranging suitable valves 49 and 50 in the discharge conduit 50a, the unit 10 can be kept under pressure if desired.

From the pipe 50a, the stock is dumped continuously into a chest or over a washer, and thence to a knotter and the conventional riffles, flat screens, etc.

In operating the apparatus, we prefer to drive the worm conveyor of the unit 6 faster than the worm of the unit 7, and so on. The reason for this is that as the chips cook down, we want to keep each cooker as full as possible for best results.

This system, regardless of size, can be controlled by a single operator from the chip bin to the screens. In commercial operation, an operator can be stationed at the last cooker, and before him will be a control board showing the cooking procedure in the various units by temperature and pressure gauges. The operator can have an electrical master control on this board, whereby he can control the speed of the conveyor worms of all the units at his will. For his observation, a certain portion of the cooking liquor from each of the cookers can be circulated down to this control board and be passed through a visible glass on the board before it is returned to the cooker. A drain cock may also be placed below each such indicator for sampling and testing. A cock may also be used for testing the fresh cooking liquor. It is also advisable to have the shift pulp tester located at such control board, so as the pulp comes out of the last unit, the observer can immediately give his results to the man in charge of the cookers.

In actual practice, we intend to pass the relief fluids from the connections 44 to an accumulator containing acid liquor for the purpose of preheating and preconditioning such liquor. Such accumulator will have a heater attached so that the liquor drawn off for the cookers will always be of the same temperature. Consequently, the heater 22 of any particular unit, will heat the preheated liquor up to the desired temperature. The temperature of each liquor heater is kept constant by the use of proper temperature controls and thermometers controlling the amount of steam entering the heater through the pipe 26. Such a control is indicated diagrammatically at 51.

With this system, it is possible to maintain positive pressures and temperatures in each cooker regardless of the temperature and pres-

sure existing in any other cooker, and to still be able to admit the material undergoing cooking from one chamber to the next without disturbing the individual pressures and temperatures. Furthermore, this system has the advantage of making any class of pulp possible, simply by changing the cooking time and the strength of the cooking liquor. This it is possible to do instantaneously.

10 In addition, this system will make a far superior grade of Mitscherlich pulp. The pulp will always be uniform, and a greater yield of pulp per ton of raw material can be obtained.

15 It is also possible with our apparatus to reclaim the liquor for further refining and reuse. Due to the indirect method of heating which we employ, the cooking liquor will not be diluted with condensed steam, and consequently, the cooking time can be shortened. By using external heaters, the steam consumption is lowered, as the condensate from the heaters can be returned to the steam plant for direct admission to the boilers.

25 There would be no objection to having our system located in the immediate vicinity of any town, as there are no gases to liberate to the atmosphere, as they are condensed in the last unit 10, and such condensation may be carried out continuously.

30 The metal of each cooker can be made of the proper material to withstand the corrosive action of the cooking liquor. Chromium nickel steels that are now available are highly resistant to the acids and alkalis used in producing chemical pulp. Therefore, our method is feasible from the point of materials available for the construction of the apparatus, and further, the complete cost of a large daily tonnage plant will be very much smaller than plants in use today, particularly as the sulphite process, when practiced with our system, will not require the use of any acid-proof lining, and the system for this purpose can be built in such small units that it is easily constructed of available materials. It would be impossible to build a sulphite digester of the sizes now commonly used of chrome nickel steel, as it would be impossible to heat treat such chrome nickel steel after the digester was erected. Therefore, all prior digesters are constructed of flange steel plates riveted together and lined with an acid-proof lining. Drums, in accordance with our invention, do not require any acid-proof lining, and as the system has large capacity, even with the use of small units, the apparatus is very economical and uses up less space.

50 If desired, the same cooking drums can be applied to bleaching, as our construction makes it possible to use the most injurious chemicals with no drastic effects to the operators.

55 It will also be observed that we effect a saving in initial cost, as it is unnecessary to have more than one chip bin, and this need only hold an amount equal to about half the capacity of one of the units at any one time.

60 There are no blow pits to take care of in our system with a loss of good stock through the drainer bottoms. This system will be of considerable advantage in the new two liquor process which has promises of cooking Douglas fir, using the sulphate or soda liquor first, then washing in one of the chambers, and continuing the cooking by the sulphite process in one or more of the following units. In such operation, some of the units are used as sulphate cookers, and the sulphate liquor is drawn off from those units for

reclaiming. Then the stock is washed in a succeeding unit and after that it is put through the sulphite process in a later unit or units. There is no limit to the possibilities this system has in any liquor combination.

This method of cooking and our apparatus also can be used in cooking either sulphite, soda, sulphate, or kraft pulp. In fact, it can be used for any chemical method of pulping material containing cellulose.

While we have described our process and apparatus in such manner that they may be readily understood by those skilled in the art, we are aware that changes may be made in the details disclosed, without departing from the spirit of the invention, as expressed in the claims.

What we claim and desire to secure by Letters Patent is:

1. A continuous process for the chemical pulping of fibrous materials, comprising feeding the material through a plurality of superposed digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a determined pressure independently of the pressure existing in the other chamber, and dropping the material from the upper to the lower chamber.

2. A continuous process for the chemical pulping of fibrous materials, comprising feeding the material through a plurality of superposed digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a determined pressure independently of the pressure existing in the other chamber, dropping the material from the upper to the lower chamber and circulating the chemical liquor through the fibrous material in each chamber.

3. A continuous process for the chemical pulping of fibrous materials, comprising feeding the material through a plurality of digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a determined pressure independently of the pressure existing in the other chamber, and circulating the chemical liquor in an endless path and through the fibrous material in each chamber.

4. A continuous process for the chemical pulping of fibrous materials, comprising feeding the material through a plurality of digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a predetermined pressure independently of the pressure existing in the other chamber, circulating the chemical liquor in an endless path and through the material in each chamber, and heating the liquor in its travel along said endless path.

5. A continuous process for the chemical pulping of fibrous materials, comprising feeding the material through a plurality of digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a determined pressure independently of the pressure existing in the other chamber, circulating the chemical liquor in an endless path and through the fibrous material in each chamber, and heating the liquor in its travel along said endless path, but outside of the chamber.

6. A continuous process for the chemical pulp-

ing of fibrous materials, comprising feeding the material through a plurality of digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a determined pressure independently of the pressure existing in the other chamber, and indirectly heating the chemical liquor exteriorly of the chamber before introducing the liquor into the chamber.

7. A continuous process for the chemical pulping of fibrous materials, comprising feeding the material through a plurality of digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a predetermined pressure and temperature independently of the pressure and temperature existing in the other chamber, and circulating the chemical liquor through the fibrous material in each chamber while the fibrous material is moving through the chamber.

8. A continuous process for the chemical pulping of fibrous material, comprising feeding the material through a plurality of digesting chambers, subjecting the material in each chamber to contact with a heated chemical liquor, maintaining the material in each chamber at a determined pressure independently of the pressure existing in the other chamber, circulating the chemical liquor in an endless path and through the material in each chamber while the fibrous material is moving through the chamber, and heating the liquor exteriorly of the chamber while the liquor is circulating in said endless path.

9. A continuous method of chemically pulping fibrous material, comprising positively moving such material through a digesting chamber maintained under super-atmospheric pressure, adding raw fibrous material substantially continuously to the inlet end of said chamber, discharging material which is at least partially cooked substantially continuously from the outlet end of the chamber, circulating hot chemical liquor at a predetermined temperature in an endless path and through the chamber while the fibrous material is being moved through the chamber, and heating the liquor exteriorly of the chamber.

10. A continuous method of chemically pulping fibrous material, comprising positively moving such material through a digesting chamber maintained under super-atmospheric pressure, adding raw fibrous material substantially continuously to the inlet end of said chamber, discharging material which is at least partially cooked substantially continuously from the outlet end of the chamber, circulating hot chemical liquor in an endless path and through the chamber while the fibrous material is being moved through the chamber, and continuously heating the chemical liquor exteriorly of the chamber as it travels in said endless path.

11. A continuous method of chemically pulping fibrous material, comprising positively moving such material through a digesting chamber maintained under super-atmospheric pressure, adding raw fibrous material substantially continuously to the inlet end of said chamber, discharging material which is at least partially cooked substantially continuously from the outlet end of the chamber, circulating hot chemical liquor in an endless path and through the chamber while the fibrous material is being moved through the chamber, and continuously heating the chemical liquor indirectly and exteriorly of the chamber

while the liquor circulates in said endless path.

12. A continuous method of chemically pulping fibrous material, comprising positively moving such material through a digesting chamber maintained under super-atmospheric pressure, adding raw fibrous material substantially continuously to the inlet end of said chamber, discharging material which is at least partially cooked substantially continuously from the outlet end of the chamber, circulating hot chemical liquor in an endless path and through the chamber while the fibrous material is being moved through the chamber, and indirectly heating the chemical liquor exteriorly of the chamber while the liquor circulates in said endless path.

13. A continuous method of chemically pulping fibrous material, comprising positively moving such material through a digesting chamber maintained under super-atmospheric pressure, adding raw fibrous material substantially continuously to the inlet end of said chamber, discharging material which is at least partially cooked substantially continuously from the outlet end of the chamber, circulating hot chemical liquor in an endless path and through the chamber while the fibrous material is being moved through the chamber, and adding fresh chemical liquor to the circulating liquor.

14. A process for chemically pulping fibrous material, comprising introducing cooked fibrous material and cooking liquor in hot condition into a chamber, and introducing a combined washing and cooling fluid into the chamber for cooling the fibrous material to a predetermined temperature and condensing any gases or vapors tending to separate from the hot liquor.

15. A process for chemically pulping fibrous material, comprising introducing cooked fibrous material and cooking liquor in hot condition into a chamber, introducing a combined washing and cooling fluid into the chamber for cooling the fibrous material to a predetermined temperature and condensing any gases or vapors tending to separate from the hot liquor, and continuously moving the fibrous material through said chamber while it is subjected to the cooling and washing fluid.

16. In a process of the character described, positively and substantially continuously moving a stream of fibrous material through a chamber, simultaneously circulating a chemical treating liquor in an endless path through the material in said chamber, and heating said liquor exteriorly of the chamber without mixing steam with the liquor.

17. In a process of the character described, positively and substantially continuously moving a stream of fibrous material through a chamber, simultaneously circulating a chemical treating liquor in an endless path through the material in said chamber while maintaining the chamber under superatmospheric pressure, and heating said liquor exteriorly of the chamber without mixing steam with the liquor.

18. In the chemical pulping of fibrous material, feeding said fibrous material through a series of superposed chambers, cooking said material in the first chamber with a hot chemical cooking liquor, then dropping the material into a lower one of the chambers and cooking said material subsequently in the last mentioned one of the chambers with a different kind of chemical cooking liquor.

19. In the chemical pulping of fibrous material, feeding such material through a series of cham-

bers, cooking the material in the first one of the chambers with a chemical cooking liquor, afterwards washing the material in a succeeding one of the chambers with a washing liquid, and afterwards again cooking the fibrous material in a further one of the chambers with a different kind of chemical cooking liquor than that used in the first chamber.

20. In the chemical pulping of fibrous material, continuously feeding such material through a series of connected chambers, circulating a hot chemical cooking liquor through the first chamber while the material is passing through the same for initially cooking the material, washing the material with a washing liquid while the material is passing through a second chamber of the series, and cooking the material in a third chamber of the series by circulating a hot different kind of chemical liquor through said third chamber while the fibrous material is passing through the third chamber.

21. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber.

22. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, each conveyor being provided with means to permit the passage of liquor through the same.

23. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, each conveyor being in the form of a rotatable worm.

24. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, each conveyor being in the form of a rotatable worm, and means for driving the conveyor of each chamber at a different speed from that of a conveyor of another one of the chambers.

25. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the out-

lets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, and a weir in each chamber near the outlet end of the same.

26. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, the last mentioned means including a pump for circulating the liquor.

27. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, the last mentioned means including a circulating pump and a heater for the liquor.

28. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, and means for venting gases and vapors from certain of the chambers.

29. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, the valves being arranged in pairs in each of the conduits.

30. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber, a pipe for introducing fibrous material into the inlet of the first chamber of the series, valves in tandem arrangement interposed in said pipe, and means

for introducing fibrous material into said pipe.

31. An apparatus of the class described, comprising a stationary closed chamber having an inlet at one end and an outlet at its opposite end, a movable conveyor in the chamber for feeding fibrous material through the chamber from the inlet to the outlet, a heater, a pipe placing the heater in communication with the chamber, a second pipe for withdrawing cooking liquor from the chamber, and means for forcing liquor from the last mentioned pipe through the heater and into the first mentioned pipe.

32. An apparatus of the class described, comprising a stationary closed chamber having an inlet at one end and an outlet at its opposite end, a movable conveyor in the chamber for feeding fibrous material through the chamber from the inlet to the outlet, a heater, a pipe placing the heater in communication with the chamber, a second pipe for withdrawing cooking liquor from the chamber, means for forcing liquor from the last mentioned pipe through the heater and into the first mentioned pipe, an inlet conduit connected to the inlet of the chamber, an outlet conduit connected to the outlet of the chamber, and a pair of valves in tandem arrangement interposed in each of said conduits.

33. An apparatus of the class described, comprising a stationary closed chamber having an inlet at one end and an outlet at its opposite end, a movable conveyor in the chamber for feeding fibrous material through the chamber from the inlet to the outlet, a heater, a pipe placing the heater in communication with the chamber, a second pipe for withdrawing cooking liquor from the chamber, means for forcing liquor from the last mentioned pipe through the heater and into the first mentioned pipe, and means for rotating said conveyor.

34. An apparatus of the character described, including a closed chamber having an inlet at one end and an outlet at its opposite end, a movable conveyor in the chamber for moving fibrous material through the chamber from its inlet to its outlet, a manifold having branch pipes connected to the top of the chamber at spaced points along the length of the chamber, and a liquor discharge pipe having branches connected to the bottom of the chamber at spaced points along the length of the chamber.

35. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, and means for alternately operating the valves in each of said conduits.

36. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, and means for alternately operating the valves in each of said conduits, the last mentioned means comprising a pressure fluid operated piston.

37. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, and means for alternately operating the valves in each of said conduits, the last mentioned means including an electric circuit, a solenoid interposed in said circuit, a valve actuated by the solenoid, and a movable contact element for opening and closing said circuit.

38. An apparatus for digesting fibrous material, comprising a series of chambers, each having an inlet and an outlet, downwardly flared conduits connecting the outlets of certain of the chambers to the inlets of certain of the other chambers, valves in said conduits for maintaining the pressure in each chamber independently of the pressure existing in any other one of the chambers, a conveyor in each chamber, and means for introducing a treating liquor into each chamber and for discharging said liquor from the chamber.

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ALRIK H. LUNDBERG.

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