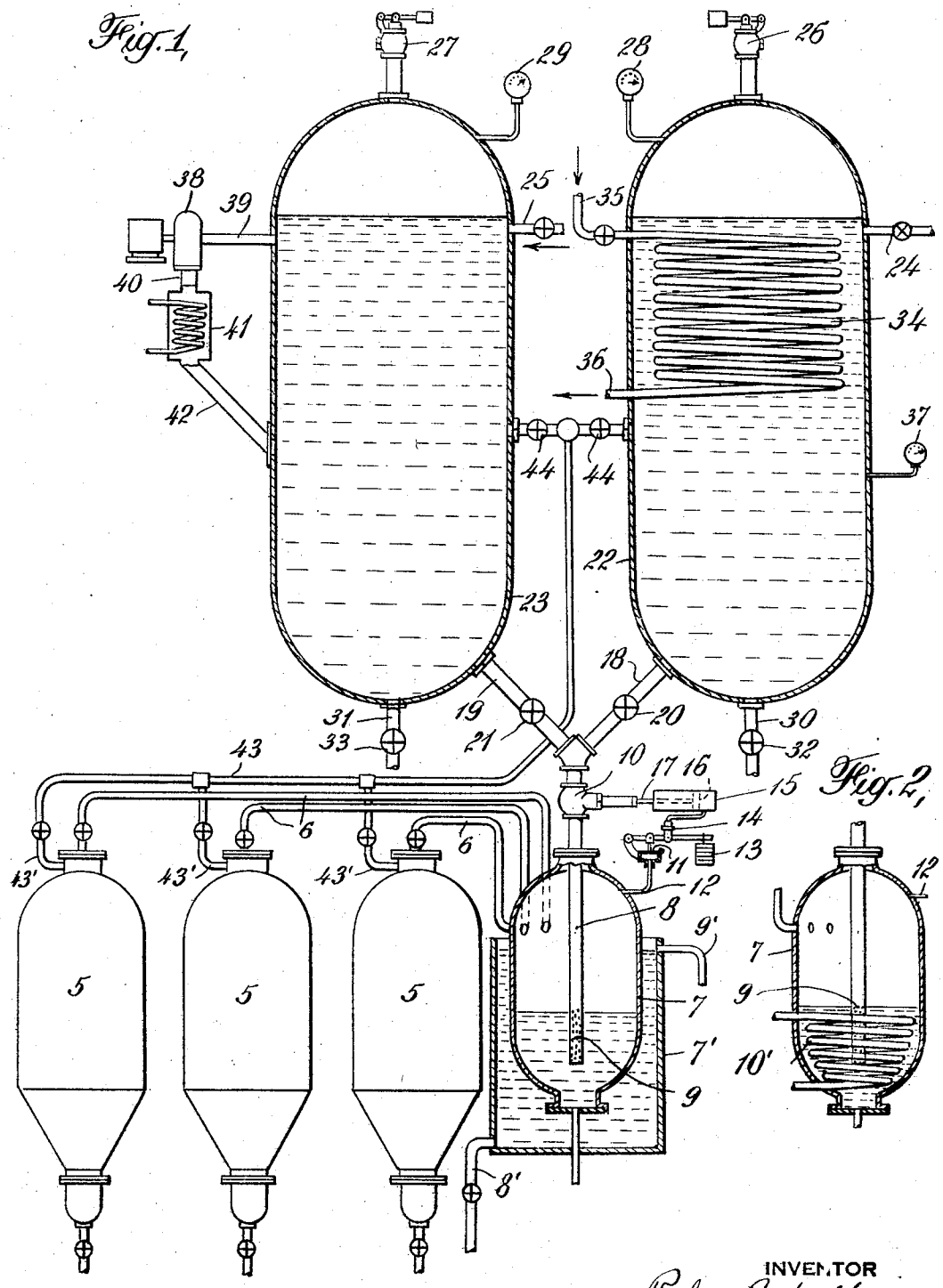
Nov. 4, 1930. R. B. WOLF 1,780,638

PRODUCTION OF PAPER PULP

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Fig. 1.



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PRODUCTION OF PAPER PULP

Application filed December 23, 1929. Serial No. 416,014.

This invention relates to the production of paper pulp and particularly to improvements in the sulphite process and in the recovery of the acid employed therein.

To secure a proper understanding of the invention it is necessary to review briefly the development of the sulphite process for treating paper pulp which was described originally in the patent to Tilghman No. 70,485, November 5, 1867. In the process as originally applied, it was impossible to recover practically the blow-off or relief gases. These gases, consisting principally of sulphur dioxide, were discharged to the atmosphere and constituted a serious loss. The first attempt to recover the gases involved the absorption thereof in the cooking liquor, as described in the Drewsen Patent No. 492,196 dated February 21, 1893. This constituted a material advance, but the method was subject to certain disadvantages, particularly the impossibility of retaining the sulphur dioxide gas in the acid at the high temperature resulting from the introduction of the hot gas thereto.

The advantage of using strong acid was pointed out in the Wolf Patent No. 1,699,556 dated June 22, 1929. That patent also called attention to the fact that strong acid has not been used because the excess of sulphur dioxide gas remaining in the digester at the end of the cook ordinarily could not be forced over into the recovery tanks without advancing the temperatures in the cooking operation and thereby losing most of the benefit resulting from the use of strong acid. A method of recovering strong acid is described in the Wolf Patent No. 1,097,781 dated May 26, 1914, and a simpler and more effective method is described in the Wolf Patent No. 1,499,898 dated July 1, 1924.

To get the best results, strong acid should be used at low temperatures. This principle is recognized in the patent to Moore and Wolf No. 1,110,454 dated September 15, 1914, which relates to a method of blowing the digesters into a blow pit and collecting the vomit stack gases and passing them through a surface condenser to condense out the water vapor, the acid being prepared from the recovered gases. A simpler method of accomplishing the same result is described in the Wolf Patent No. 1,699,556.

Another step in the industry was in the direction of making it possible to get the effect of stronger "free" acid by another method, namely, the method of relieving the digesters into an accumulator without cooling the relief gases and liquids. The first description of this method appears in the Clemm Patent No. 1,429,128 dated September 12, 1922 which is followed by the hot acid recovery system of Richter described in Patent No. 1,653,416 dated December 20, 1927 and in other and later patents.

In the hot acid recovery system the emphasis is upon the recovery of heat from the relief gases. These gases are conducted, therefore, without cooling to a hot acid accumulator. In the ordinary mill, a number of digesters are connected to a common relief line which carries the gases from the digesters to the acid accumulator. This induces serious difficulties including a wide variation in the acid strength and in the temperature of the acid which is introduced from the accumulators to the digesters, but more particularly in the constant variation of the pressure in the relief line which seriously affects the cooking operation, being equivalent to constant manipulation of the relief valves of the respective digesters. It is a matter of common knowledge in the operation of digesters that the pressure therein must remain substantially constant. The operator usually sets the relief valve at the desired opening to maintain a constant pressure, but this control becomes wholly ineffective under the system described in which the hot relief gases are conducted through a common relief line to the hot acid accumulators.

To appreciate this difficulty more fully, it is desirable to consider the normal operation of a digester. The digester is first filled with chips and with acid, the acid being, as nearly as possible, of uniform temperature and uniform chemical composition. The cover of the digester is secured in place, and steam is admitted into the bottom of the digester. The pressure is brought up to approximately

75 pounds per square inch at the bottom of the digester in a period ranging from two to three hours. After the pressure has reached 75 pounds, which is the usual working pressure, no more steam can be admitted unless gas is relieved from the digester. This is accomplished by means of a relief valve on the cover. The speed with which the temperature in the digester is raised depends upon the amount of opening of the relief valve, a wide opening, permitting the escape of a large amount of gas, lets in a large amount of steam and therefore there will be a rapid advance in temperature. The reverse is true if the relief valve is only slightly open, namely; the temperature will advance slowly. It is possible to control the speed of cooking, so that the variation in practice is between seven hours and twenty hours, the purpose of the longer cooking time being to complete the disintegration of the wood chips into fibres at as low temperatures as is possible. If the pressure in the relief line varies constantly, the control of the cooking time is lost substantially and the temperature of the digester will fluctuate widely because of the variations in the amount of steam introduced thereto.

The rate of acceleration of temperature in the cooking operation is very important. In other words, it makes quite a difference in the character of the pulp whether the temperature is advanced rapidly during the first part of the cook and slowly during the latter part, or advanced slowly during the first part and rapidly during the latter part of the cook. The rate of advance of temperature is entirely a matter of control of the relief valve on the cover of the digester: hence it is very important for the pressure in the relief lines to be absolutely constant so that when the cook sets his valve in a certain position he knows he will get a constant amount of relief.

It is the object of the present invention to provide a method and apparatus whereby the difficulties experienced heretofore in the operation of digesters and the recovery of acid therefrom are avoided and whereby stronger acid can be recovered and utilized more effectively and without losses heretofore incident to the operation of the sulphite process.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and the accompanying drawing, in which

Figure 1 illustrates diagrammatically the preferred form of the invention; and

Fig. 2 shows a slightly modified cooling arrangement.

In carrying out the invention, I employ two or more recovery tanks and a small relief accumulator, the latter being connected preferably by separate relief lines to each individual digester of a group constituting the system. The relief accumulator is a small vessel adapted to receive the gases and liquids from the individual digesters as they escape through the relief valves thereof. The gases and liquids are permitted to escape from the accumulator through a pressure regulating valve, preferably of the type known as the "Locke regulator" which is used in sulphite pulp mills to maintain uniform pressures in the digesters during the cooking operation. By the use of this valve a constant pressure is maintained in the relief accumulator, and consequently the relief lines leading thereto are likewise maintained at a constant pressure so that all variations in the relief lines, which otherwise would affect the cooking operations in the digesters, are avoided.

The gases and liquids from the digesters are cooled preferably before admission to the recovery tanks. This cooling may be effected in any convenient way, for example, by heat interchange with a suitable cooling medium such as water. The cooling may be in the relief lines, in the small relief accumulator, or in the pipes connecting the accumulator to the recovery tanks. A convenient arrangement is a receptacle surrounding the relief accumulator through which cooling water is circulated. The accumulator may be made of suitable acid resistant metal such as the alloys of iron and chromium known as "Asocloy" or "Allegheny metal". This facilitates heat transfer to the water in the surrounding receptacle and ensures the durability of the apparatus. Alternatively a cooling coil of acid resistant metal may be provided in the relief accumulator so that cooling water can be circulated therethrough. Other cooling means may be employed similarly between the digesters and the recovery tanks.

From the relief accumulator the acid liquids and gases are conveyed into one or the other of the two recovery tanks and are therein subjected to further cooling, if desired, to a predetermined temperature. The cooling may be effected by a coil immersed in the acid solution in each recovery tank, or the acid may be withdrawn from each of the tanks, circulated through a cooling device, and returned thereto. The purpose of cooling the acid is to maintain a relatively low temperature, thus permitting the absorption and retention of a larger proportion of sulphur dioxide gas at the pressure maintained in each of the recovery tanks.

From the recovery tanks the acid may be withdrawn from time to time as may be required and delivered to the several digesters. The strong acid, at a predetermined temperature, can be introduced to the digesters at that temperature, thus permitting a further control of the operation of the digesters. The

cooling of the acid involves a loss of heat. For example, the acid may be cooled from an average of 185° F. to a temperature of approximately 115° F., involving a loss of approximately 1,000,000 B. t. u.'s per ton of pulp. The loss represents a cost of only 40¢ per ton of pulp. The advantage of operating, however, in the manner described in this application amounts to approximately $2.70 per ton of pulp, which offsets the loss of heat with a very wide margin.

Referring to the drawing, 5 indicates the digesters of a group, each of which is connected by a relief line 6 to the relief accumulator 7. The latter is a small tank adapted to withstand the pressure of the gases delivered thereto from the digesters. The relief lines may be connected thereto in any suitable manner, being arranged, for example, about the periphery of a cylindrical tank. A pipe 8 extends substantially to the bottom of the relief accumulator and is provided with openings 9 which permit both gases and liquids to enter the pipe which serves as an outlet therefor. A pressure regulating valve 10 is disposed in the pipe outside of the accumulator to maintain a constant pressure therein. I prefer to use a "Locke regulator" which consists of a diaphragm 11 connected by a pipe 12 to the top of the relief accumulator. The diaphragm is counter-balanced by a weight 13 to permit predetermination of the pressure to be maintained. The diaphragm is also connected to a pilot valve 14 which controls the water pressure in a cylinder 15. A piston 16 in the cylinder is connected to the operating lever 17 of the valve 10. Thus, as the pressure tends to vary in the accumulator, the valve 10 is opened or closed and a uniform pressure is maintained.

As both gas and liquid are relieved from the digester and it is desirable to have a fairly uniform mixture of the gas and liquid passing from the relief accumulator continuously, the pipe 8 is provided with perforations as described. This permits the maintenance of a gas space in the top of the accumulator. As the liquid level rises, the gas pressure will in effect atomize this liquid and force it out through the regulating valve. The relief accumulator 7 is surrounded, preferably, by a receptacle 7′ having an inlet 8′ and an outlet 9′ for water or other cooling medium. The circulation of water is maintained at a rate which will ensure the desired cooling of the gases and liquids in the accumulator. Alternatively, as shown in Fig. 2, a cooling coil 10′ may be disposed in the accumulator 7 and a cooling medium such as water may be circulated therethrough to cool the gases and liquids delivered to the accumulator.

The gas and atomized liquid are directed through either of the pipes 18 and 19 controlled by valves 20 and 21 into the recovery tanks 22 and 23. The latter are large tanks capable of withstanding pressure and of holding large quantities of acid which may be supplied thereto from the acid storage tanks through inlet pipes 24 and 25. They are provided with safety valves 26 and 27 and with pressure gauges 28 and 29, so that excess pressure may be relieved and the condition of the acid in the tanks may be readily determined. Outlets 30 and 31 controlled by valves 32 and 33 are provided to permit withdrawal of the acid and the delivery thereof to the respective digesters.

In the tank 22 I have shown a cooling coil 34 which may be supplied with cooling water from any suitable source by a pipe 35. The water may be withdrawn through a pipe 36. Suitable valves are provided to control the flow of water through the cooling coil. The purpose of the cooling coil is to reduce the temperature and to maintain the acid in the tank at a predetermined temperature. This is readily accomplished by modifying the flow of water through the cooling coil in accordance with the existing conditions and particularly the temperature of the gases entering the recovery tank. A recording thermometer 37 may be employed to indicate the temperature of the acid. Alternatively I may employ the cooling device illustrated in connection with tank 23, including a pump 38 connected by a pipe 39 to the tank and by a pump 40 to a cooler 41 from which the acid is returned through a pipe 42 to the tank. Normally one or the other of the cooling means described will be utilized in both of the recovery tanks, but such cooling means may be omitted if the cooling effected before the gases and liquids enter the recovery tanks is sufficient to maintain the desired low temperature in the tanks.

In practice the operation will be substantially as follows: The pressure in the relief accumulator as the digesters are normally cooking will be constant. The gas and liquor will be conducted into either one or the other of the recovery tanks as desired. If, for instance, the left hand recovery tank has just been emptied of its charge in order to fill a digester, the right hand tank will be filled to a predetermined level with acid and will be receiving the relief gases. The temperature will be maintained either automatically or by hand regulation at a constant point predetermined by experience but in the neighborhood of about 120° F. The relief will be allowed to continue into this recovery tank until the tank has reached a definite pressure also predetermined and based upon operating experience, probably about 40 pounds per square inch. With a given temperature the pressure will be an exact indication of the acid strength. When this pressure has been reached, the opposite recovery tank will be put into use by opening the proper valve leading into it and closing the

corresponding valve of the tank in which the acid has reached the desired strength.

It can be readily understood that the control of temperature and pressure and consequently of the strength of the acid permits uniformity in the acid supply to the digesters which could not be obtained by any previous method, and that at the same time uniformity of back-pressure against the relief valves of the respective digesters is assured, so that the cooking is uniform and the quality of the pulp can be maintained.

The uniformity of pressure in the relief lines is essential only during the actual cooking period, when the temperature control must follow a predetermined line or rate of advancement. When the period for blowing down the pressure in the digester is reached, that is to say, approximately an hour before the contents of the digester is blown into the blow pit, a connection into another relief line 43 can be made by actuating a suitable valve. Ordinarily this will be a common pipe into which short connections 43′ from each digester are conducted. This line is connected with suitable valves 44 with each of the pressure recovery tanks. By this arrangement it is possible to relieve during the blow-down period only into the pressure recovery tank which has been recently filled with fresh acid and which as a result will be at a lower pressure than the one which has been receiving gases for some time. These pipes may enter the recovery tanks at about their middle portion, but they can be in any position which may prove to be convenient.

This procedure of lowering the pressure before the digester is blown may be used, but I prefer to keep the pressure on the digester up to the regular cooking pressure until the end of the cooking and then blow the pressure all off from the digester by the method described in my Patent No. 1,699,556. The gas absorbed in the latter procedure will find its way to the storage tanks from which the pressure recovery tanks are filled before the relief gases are introduced thereto. It is to be understood that the storage tanks are supplied with fresh acid from the acid system, preferably the system described in my Patent No. 1,499,898 which permits the manufacture of acid much stronger than it can be made under the systems heretofore in use.

Among the advantages of the method as described are the recovery and storage of acid under predetermined conditions of temperature and pressure and consequently of acid strength, the improvement in cooking effected by the use of such acid, and particularly the avoidance of variations of back-pressure in the relief line which would otherwise interfere with the cooking operation. It is possible by employing the invention to operate more economically and to produce a much higher quality of pulp at a minimum of expense for installation, upkeep and operation of the necessary equipment.

Various changes may be made in the details of procedure and in the structure employed therefor, without departing from the invention or sacrificing any of its advantages.

I claim:

1. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line from the digester, cooling the gases and liquids and then discharging the gases and liquids from the relief line into an acid absorbing medium.

2. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line from the digester, cooling the gases and liquids, than discharging the gases and liquids from the relief line into an acid absorbing medium, and maintaining the acid absorbing medium under pressure.

3. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line from the digester, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, and cooling the acid absorbing medium to a predetermined temperature.

4. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line from the digester, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, cooling the acid absorbing medium to a predetermined temperature, and maintaining the acid absorbing medium under pressure.

5. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line common to a plurality of digesters, cooling the gases and liquids and then discharging the gases and liquids from the relief line into an acid absorbing medium.

6. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line common to a plurality of digesters, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, and maintaining the acid absorbing medium under pressure.

7. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line common to a plurality of digesters, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, and cooling the acid absorbing medium to a predetermined temperature.

8. The method of recovering acid in the

sulphite pulp process which comprises maintaining a constant pressure in the relief line common to a plurality of digesters, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, cooling the acid absorbing medium to a predetermined temperature, and maintaining the acid absorbing medium under pressure.

9. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line from the digester, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, and conducting the blow-down gases and liquids directly to a fresh supply of the acid absorbing medium.

10. The method of recovering acid in the sulphite pulp process which comprises maintaining a constant pressure in the relief line common to a plurality of digesters, cooling the gases and liquids, then discharging the gases and liquids from the relief line into an acid absorbing medium, and conducting the blow-down gases and liquids directly to a fresh supply of the acid absorbing medium.

11. The method of recovering acid in the sulphite pulp process which comprises cooling the gases and liquids discharged from the relief line of a digester, absorbing the gases and liquids in an acid absorbing medium under pressure and maintaining the acid absorbing medium at a reduced temperature by cooling.

12. The method of recovering acid in the sulphite pulp process which comprises cooling the gases and liquids discharged from the relief line of a digester, absorbing the gases and liquids in an acid absorbing medium under pressure and maintaining the acid absorbing medium at a reduced temperature by circulating water therethrough.

13. The method of recovering acid in the sulphite process which comprises cooling the gases and liquids from the relief line of the digester, absorbing the gases and liquids in an acid absorbing medium until a predetermined pressure is attained, the temperature of the acid absorbing medium being maintained substantially constant.

14. The method of recovering acid in the sulphite process which comprises cooling the gases and liquids from the relief line of the digester, absorbing the gases and liquids in an acid absorbing medium until a predetermined pressure is attained, the temperature of the acid absorbing medium being maintained substantially constant, and utilizing the acid absorbing medium in the digester at the strength determined by the contant temperature and predetermined pressure.

15. In an apparatus for manufacturing paper pulp, the combination of a digester, an accumulator, a relief line connecting the digester and accumulator, a recovery tank connected to the accumulator, means for maintaining a constant pressure in the relief line and accumulator, and means for cooling the gases and liquids discharged by the digester between the digester and the recovery tank.

16. In an apparatus for manufacturing paper pulp, the combination of a digester, an accumulator, a relief line connecting the digester and accumulator, a recovery tank connected to the accumulator and a pressure reducing valve between the accumulator and the recovery tank to maintain automatically a constant pressure in the relief line and accumulator, and means for cooling the gases and liquids discharged by the digester between the digester and the recovery tank.

17. In an apparatus for manufacturing paper pulp, the combination of a digester, an accumulator, means for cooling gases and liquids in the accumulator, a relief line connecting the digester and accumulator, a recovery tank connected to the accumulator, and means for cooling the liquid in the recovery tank to a predetermined temperature.

18. In an apparatus for manufacturing paper pulp, the combination of a digester, an accumulator, means for cooling gases and liquids in the accumulator, a relief line connecting the digester and accumulator, a recovery tank connected to the accumulator, and means for cooling the liquid in the recovery tank to a predetermined temperature, including a cooling coil in the recovery tank and means for controlling the flow of cooling liquid therethrough.

19. In an apparatus for manfacturing paper pulp, the combination of a digester, an accumulator, means for cooling gases and liquids in the accumulator, a relief line connecting the digester and accumulator, a recovery tank connected to the accumulator, means for maintaining a constant pressure in the relief line and accumulator, and means for cooling the liquid in the recovery tank to a predetermined temperature.

20. In an apparatus for manufacturing paper pulp, the combination of a digester, an accumulator, means for cooling gases and liquids in the accumulator, a relief line connecting the digester and accumulator, a recovery tank connected to the accumulator, means including a pressure reducing valve for maintaining a constant pressure in the relief line and accumulator, and means for cooling the liquid in the recovery tank to a predetermined temperature.

In testimony whereof I affix my signature.

ROBERT B. WOLF.