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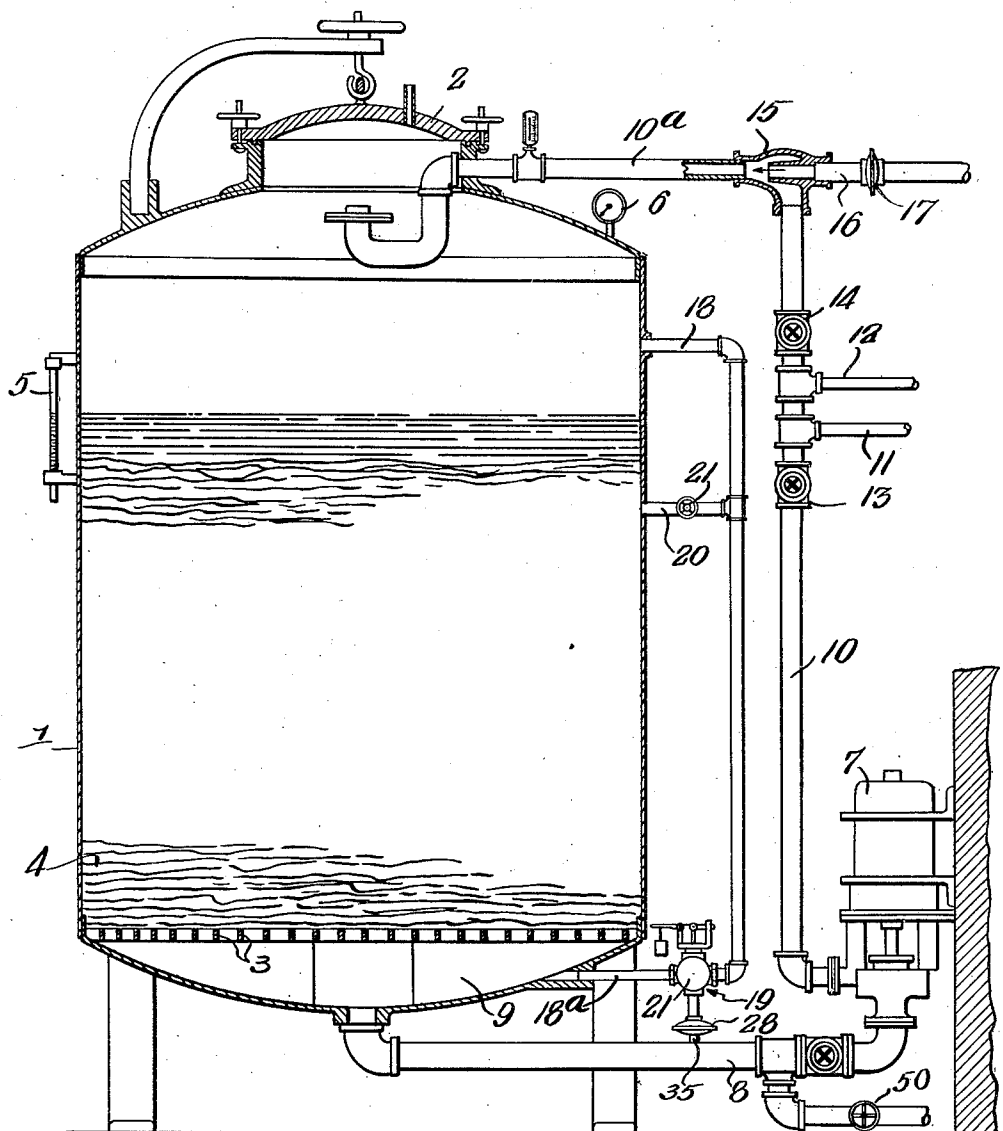
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APPARATUS FOR AND METHOD OF TREATING PERVIOUS MATERIAL WITH FLUID

Filed Oct. 31, 1936

2 Sheets-Sheet 1

Fig. 1



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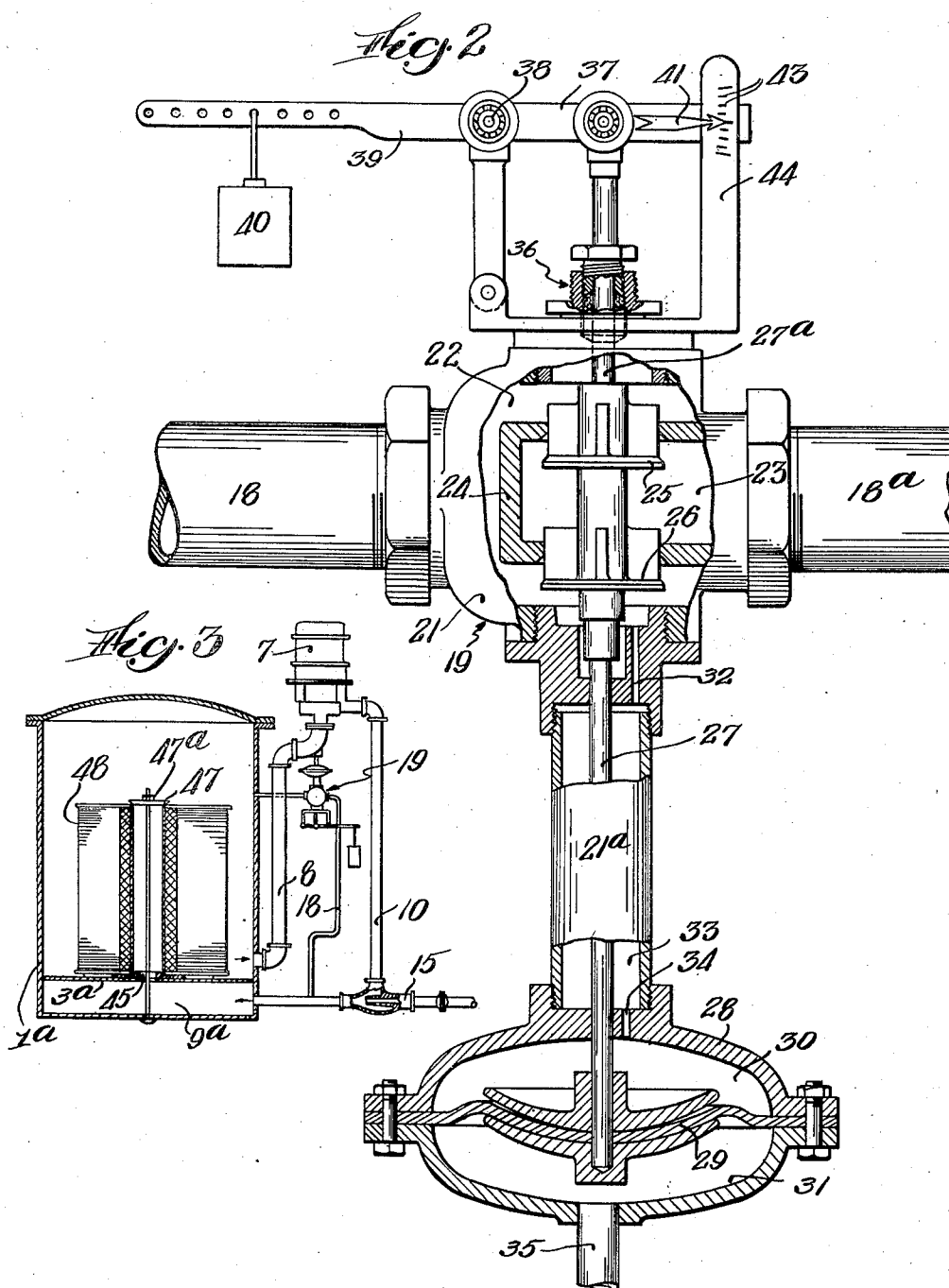
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APPARATUS FOR AND METHOD OF TREATING PERVIOUS MATERIAL WITH FLUID

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Application October 31, 1936, Serial No. 108,683

6 Claims. (Cl. 8—157)

This invention pertains to improved apparatus for and a method of treating material with fluid, for example for circulating a bleaching, dyeing or other treating liquor through textile material, paper stock, hides, leather or other substance, and relates more particularly to apparatus for and a method of circulating a fluid under pressure in such a manner as to insure substantial uniformity of action throughout the mass of material undergoing treatment.

In the bleaching of woven textile goods, for example, it is customary to place the goods to be bleached in a closed kier or vat, the goods usually resting upon a grid spaced from the bottom of the kier and the hot bleaching solution passes downwardly through the goods, being delivered into the top of the kier and withdrawn from the bottom. For most effective results it is common to treat the goods under some pressure in order that the temperature during the treatment may be greater than that attainable in an open kettle. When the fluid is delivered into the top of the kier and drawn out from the space below the fabric-supporting grid by means of the circulating pump, there is a tendency substantially to reduce the pressure in the space below the grid as compared with the pressure in the top of the kier. This difference in pressure above and below the goods and also the weight of the wetted goods tends to force the goods into the openings in the grid. The packing of the goods into these openings tends to retard circulation and thus progressively to lower the pressure in the space below the goods,—further accentuating the pressure differential until the packing of the goods in the lower part of the kier may become so pronounced that downflow of the fluid is substantially cut off. Even if not entirely stopped, the unduly low pressure at the pump intake causes cavitation, reducing the efficiency of the pump and producing foaming of the liquor at the delivery of the pump, and may even stop the effective action of the pump for a considerable period of time. All of these results are detrimental in one way or another, especially when the liquor being circulated is a dye solution, since any periodic stopping or slowing down of the circulation may result in uneven dyeing, and in any case the mechanical and thermal efficiency of the apparatus is lowered by such intermittent action while the packing of the goods into the openings in the grid makes removal very difficult and may occasion mechanical injury to the fabric. Moreover, when too great a pressure differential is developed between the top and bottom of the kier

the fluid tends to discover channels for itself, particularly between the goods and the wall of the kier, through which it selectively passes, instead of uniformly filtering through the goods themselves, this being particularly true when the material is of a more or less stiff character such, for example, as paper stock in bat or sheet form, leather, hides or the like, so that the material is not actually subjected to the treating fluid for the expected period and may show great unevenness in results. Furthermore, when goods are to be spool-dyed on perforated jack spools or the like, where the liquid is forced into the interior of the spool and escapes radially through the material wound thereon, any excessive pressure differential between the interior of the spool and the space external to the spool within the kier may result in too violent a circulation with consequent disruption of the material and loosening of its fibers or the formation of large blow holes, through which the liquor passes freely, leaving the bulk of the goods substantially unaffected.

A principal object of the present invention is to provide apparatus for and a method useful in such operation as bleaching, dyeing, tanning or the like, wherein a substance is to be treated with a reagent liquor under pressure whereby the above disadvantages commonly met with in prior practice are substantially eliminated and by means of which substantial uniformity in treatment and result are attainable and with a much higher degree of efficiency chemically, thermally and mechanically than is ordinarily obtainable.

Heretofore it has been common to heat the treating liquor either by circulating it through a heater external to the kier before delivering it to the latter, or by causing high pressure steam directly to enter the kier. However, either of these methods is thermally inefficient. In particular when high pressure steam is admitted directly to the kier almost constant supervision is necessary to prevent overheating and the kier must be strongly built to withstand the high pressure. Ordinarily the high pressure steam must be periodically cut off and thus the pressure within the kier varies very substantially during the operation. To avoid these difficulties and to insure high thermal efficiency the present invention provides for the employment of low pressure steam, that is to say, steam at a pressure of the order of ten pounds gauge. Such steam is usually available as exhaust from power-producing units or otherwise and is commonly wasted to the atmosphere. However, in accordance with this invention such low pressure steam is made ade-

quate to raise the temperature of the kier to the desired degree and to maintain it at substantially uniform temperature and pressure during the period of treatment without the requirement for any substantial amount of attention upon the part of the operator.

A further object of the invention is to provide improved pressure-regulating means operative automatically to maintain a predetermined substantially uniform pressure differential between the inlet and outlet of the kier, such pressure-regulating means preferably comprising a by-pass for the treating liquor and a pressure responsive valve for controlling the by-pass.

Other objects and advantages of the invention will be made manifest in the following more detailed description and by reference to the accompanying drawings wherein

Fig. 1 is a fragmentary diagrammatic vertical section illustrative of a bleaching kier equipped with the improvements whereby the present invention is attained;

Fig. 2 is an elevation partly in vertical section and to larger scale illustrating an improved automatic valve for controlling the by-pass of fluid between the top and bottom of the kier; and

Fig. 3 is a view generally similar to Fig. 1, but showing a kier useful for treating material wound on a spool.

Referring to the drawings, the numeral 1 designates a vertical closed kier such as is commonly used for bleaching or dyeing textile materials under pressure, the kier having a closure 2 at its top which may be removed to permit the goods to be deposited within the kier, the closure being provided with means whereby it may be clamped in position so as to seal the kier to prevent leakage during the bleaching or dyeing operation. As illustrated, the kier is provided with a horizontal transverse grid or perforate partition 3 designed to support the goods 4 while being treated, it being understood that the material to be treated will be placed upon the grid 3 in a unitary mass extending over the entire cross-sectional area of the kier so that fluid admitted to the upper part of the kier must normally seep down or filter through the mass of material before reaching the bottom of the kier. As illustrated, the kier is provided with a gauge glass 5 to show the level of the liquid within the kier and with a pressure gauge 6 to indicate the pressure.

The apparatus comprises a pump 7 of any desired type designed to deliver the treating fluid under the requisite pressure, the pump having an intake or suction conduit 8 leading from the space 9 beneath the grid 3. The pump also has the delivery pipe or conduit 10 with which are connected feed pipes 11 and 12 for hot and cold water, respectively, it being understood that these feed pipes will be provided with suitable controlling valves, not shown. Preferably the delivery pipe 10 is furnished with valves 13 and 14 below and above, respectively, the points at which the feed pipes 11 and 12 are connected into the delivery pipe 10. Above the valve 14 the delivery pipe leads into an injector device 15 comprising a nozzle through which steam, preferably at low pressure, is admitted through the pipe 16. The steam thus admitted may be exhausted steam from a power unit such, for example, as a steam turbine or engine and may be delivered into the injector 15 at a pressure, for example, of the order of ten pounds gauge. Preferably the steam supply pipe 16 is furnished

with some type of automatic pressure regulating apparatus, for example an orifice 17 so as to insure a constant steam pressure at the entrance to the injector regardless of fluctuations in the pressure in the steam supply. From the injector 15 the delivery pipe is continued, as shown at 10^a, and enters the upper part of the kier at a point preferably above the level of the treating fluid within the latter.

In accordance with the present invention a by-pass passage is provided, for example, in the form of a pipe 18 which extends from the upper part of the kier downwardly to a differential pressure regulator 19, hereinafter more fully described, the pipe 18 then being continued as the pipe 18^a and leading into the space 9 in the kier below the grid 3. The pipe 18 should lead from the kier at a point below the level of the liquid in the latter, and as this liquid level may vary considerably during the operation of the kier, it is preferred to provide a branch pipe 20 leading from the kier at a lower point than the main pipe 18 but connected to the pipe 18 with an interposed valve 21. Thus when the kier is first started into operation the valve 21 may be left open, thereby permitting fluid at a low level to pass outwardly through the pipe 20 on its way to the valve 19, but after the kier has been in operation some time and the liquid level has risen, the valve 21 may be closed and the fluid may thereafter escape through the pipe 18.

Referring to Fig. 2, a preferred form of differential pressure regulator is illustrated, such regulator comprising the casing 21 having threaded sockets for the pipe sections 18 and 18^a, respectively, the pipe 18 opening into the inlet chamber 22 and the pipe 18^a opening from the outlet chamber 23 in the casing. These chambers are separated by a septum 24 comprising substantially parallel spaced upper and lower members, each having a passage therethrough, said passages being in vertical alignment and being controlled by valve heads 25 and 26 so connected together as to constitute a balanced valve structure. These valve heads are connected to a valve stem 27 which extends downwardly through an extension 21^a of the casing 21, to the lower end of which is secured a motor casing 28. This motor casing contains a transverse flexible diaphragm 29 of a material capable of withstanding the pressure to which it may be subjected and also of resisting the action of the liquor which is used in the kier.

For most purposes a diaphragm of rubber or of one of the synthetic rubbers is found useful for the purpose. This diaphragm defines an upper chamber 30 and a lower chamber 31 within the motor casing, the chamber 30 being in communication with the inlet chamber 22 of the valve casing through a passage 32, a passage 33 through the extension 21^a of the casing, and a passage 34 in the motor casing 28. The chamber 31 is always in free communication with the interior of the suction conduit 8 by means of a pipe 35.

The valve stem is extended above the valve member 25 as an extension rod 27^a which passes up through a receiving box 36 at the upper end of the valve casing and which is pivotally secured at its upper end to a lever 37. This lever is fulcrumed at 38 and preferably has an arm 39 to which a weight 40 may be adjustably secured. The lever 37 also preferably is provided with a pointer or index 41 which cooperates with a scale 42 on a fixed support 44.

The kier above described is of a kind suitable for treating loose material, such, for example, as unspun cotton; wool; linen or silk fiber; rag stock such as is used in paper making; wood pulp in the form of laps or board commonly employed for paper making; textile fabrics; leather; hides or the like; or in fact any material which may be deposited as a more or less compact mass within the kier and which it is desired to treat under pressure with any reagent fluid, including water for washing; dye liquor; bleaching fluid; tanning solution; or chemical reagents designed to react with the material either for converting it to other forms, for dissolving it, or otherwise affecting its physical or chemical characteristics.

In Fig. 3 a slightly different form of apparatus is illustrated designed primarily for treating material such, for example, as spun yarn, roving or slivers of textile material or any other desired material or substance which is conveniently wound upon a spool and in this form is subjected to the fluid treatment. Thus in Fig. 3 the kier is indicated at 1^a, such kier having the transverse horizontal partition 3^a, which in this instance is imperforate except for an opening (such as the opening 45) with which the tubular barrel 46 of a spool may be registered, the spool being clamped in leakproof contact with the partition 3^a by means of a cover 47 and clamping nut 47^a. It is to be understood that the barrel of the spool is perforated and that the material 48 to be treated is wound upon the perforated barrel of the spool. In this instance the suction pipe 8 leading to the intake of the pump 7 opens out from the kier at a point above the partition 3^a, while the delivery pipe 10 leading from the pump enters the chamber 9 below the partition 3^a. With this arrangement the fluid enters the chamber 9^a under pressure and then passes up into the perforated barrel of the spool, thence radially out through the material 48 which is wound on the spool, and then flows outwardly through the suction pipe 8 and back to the pump.

Reverting again to Figs. 1 and 2—it being assumed that the material 4 has been packed into the kier and that the closure 2 has been clamped in place, cold water may then be admitted through the pipe 12 so as to flow upwardly to the injector 15 where it encounters a jet of steam from the pipe 16 and, being heated by this steam, is delivered into the upper part of the kier. The hot water is thus flowed into the kier until the water level has risen to the desired point for the beginning of the treating operation, whereupon the pump 7 is started, such pump tending to draw out water from the chamber 9 and to deliver it upwardly through the pipe 10. It is understood that after the supply of cold water has been cut off the pump continues to circulate the water in the closed path defined by the pipes 8 and 10 and the interior of the kier itself.

Since the material constitutes a very substantial obstruction to the free passage of the fluid, it is manifest that the operation of the pump tends to build up substantial pressure in the space above the material. This pressure, in addition to the weight of the material and the column of fluid, as well as the suction effect within the chamber 9, tends to press the material very firmly against the grid 3, and it is clear that the more firmly the material is pressed downwardly and compacted, the greater the resistance which it opposes to the passage of the fluid downwardly

through it, thus tending to increase the pressure differential between the upper and lower parts of the kier with consequent further compacting of the material. Eventually, except for the improvements herein disclosed, the material might become so compressed as to stop the openings in the grid 3 and completely cut off the circulation of fluid, thus intermitting the operation and, as above pointed out, so jamming the material into the openings in the grid that mechanical injury may result.

It is further to be noted that the treatment ordinarily is carried out at a fairly high temperature and that it is desirable to maintain as uniform a temperature throughout the entire mass of material in the kier as is possible in order that all parts of the material may be reacted upon to substantially the same extent. It is thus quite desirable to maintain a fairly rapid circulation through the material, but while this temperature is to be maintained as uniformly as possible, it is undesirable, on the other hand, to have the temperature in the chamber 9 rise too high, since otherwise cavitation at the pump inlet takes place, with consequent foaming of the liquid and highly inefficient operation of the pump.

In accordance with the present invention, these difficulties are obviated by the use of the differential pressure valve 19. When, for example, during the operation of the apparatus the pressure in the chamber 9 drops abnormally, the pressure in the chamber 31 of the motor device 28 is thus reduced and the valves 25 and 36 open to a greater or less extent, dependent upon the position of the weight 40 on the lever 39 and the drop in pressure in the chamber 9. As soon as the valves 25 and 26 are unseated, fluid is permitted to flow freely from the upper part of the kier through the pipe 18 and thence through the valve 19 and the pipe 18^a into the chamber 9 below the grid. This fluid, thus entering the chamber 9, tends to raise the pressure in the latter and thus to prevent too great a pressure differential between the top and bottom of the kier. For example, assuming that the steam which enters the injector 15 is at a pressure of ten pounds gauge with a corresponding temperature of approximately 240° F., and that after the kier has been heated up to the working temperature, substantially a ten pounds gauge pressure is maintained in the upper part of the kier, it may be found desirable, for example, to maintain a gauge pressure of eight pounds gauge in the chamber 9, the pressure differential between the top and bottom of the kier being calculated to compensate for the height of the column of liquid above the grid 3 and at the same time to provide for reasonably rapid flow of the fluid downwardly through the material. To maintain such a pressure differential, the weight 40 may be so disposed on the lever arm 39 that whenever the pressure in the chamber 9 drops below the eight pounds referred to, by way of illustration, the valves 25 and 26 will be unseated and fluid from the upper part of the kier flows into the lower part through the pipe 18 until the original pressure differential has been restored, whereupon the diaphragm 29 will rise, thus again closing the valves 25 and 26. Obviously any desired pressure differential may be provided for by the proper proportioning of the parts and by adjustment of the weight 40 on the lever 39.

While it is preferred, as above noted, to admit cold water at the start of the operation and to

heat such water by means of low pressure steam injected directly into the water, it is contemplated that under some conditions it may be preferred to supply preheated water in order that the temperature within the kier may be raised more rapidly at the beginning of the operation, and for this purpose the pipe connection 11 is provided whereby hot water may be supplied directly to the kier whether or not the injector 15 may thereafter be employed for supplying additional heat.

Since during the operation of the kier (when the injector is used) the liquid level rises due to condensation, it is desirable to provide the branch pipe 20 through which the fluid may enter the by-pass when the fluid is at a relatively low level in the kier at the start of the operation, such by-pass preferably being shut off by the valve 21 after the liquid level has risen substantially to the point which it attains during the final stages of the operation.

In the arrangement illustrated in Fig. 3 the operation is substantially the same as above described, except that the material 48 is wound upon the perforated barrel 46 of the spool and the liquid flows upwardly from the chamber 9^a under pressure into the interior of the spool and thence rapidly outward and is drawn off from the kier through the suction pipe 8; the by-pass for fluid with its regulating valve operates substantially in the same way as in the construction above referred to.

When the treating operation has been completed the pump is stopped, the steam inlet is closed, and an outlet valve, for example at the point 50, is opened and the treating fluid is permitted to drain away. Ordinarily it is necessary to wash the material to rid it of the treating reagent, and this is conveniently done by opening the valve in the cold water inlet pipe 12 so as to allow cold water to flow into the upper part of the kier while the discharge valve 50 is open so that the clear water slowly displaces the reagent fluid and gradually washes all traces of the latter from the material in the kier. If the treating reagent be alkaline and the cold wash water be hard, too rapid cooling of the material before the concentration of the reagent fluid has been sufficiently reduced may result in a deposit of an insoluble soap in the form of a scum in the interstices of the material, which in some cases, at least, may cause substantial damage. To avoid this action the outlet valve and the cold water inlet valve should be opened only to such an extent or for such short periods of time that the fresh cold wash water as it enters the kier will be rapidly heated by contact with the mass of hot material so as to maintain a temperature at which precipitation of insolubles will not occur. The wash water thus warmed by contact with the material displaces a substantially equal quantity of the treating fluid from the lower part of the kier and the operation is then repeated, either in the form of a slow continuous process or in intermittent steps, the level of the strong reagent solution gradually dropping in the kier. Although the temperature of the wash water may gradually drop, the reagent is also gradually diluted, so that during the last stages of the washing operation harmful precipitation of insolubles will not take place even at the low temperature of the incoming wash water. Obviously hot water could be used for washing, but from the thermal efficiency standpoint the use of cold water is preferable.

The valve for controlling the cold water inlet may be manually actuated or, if preferred, may be automatically controlled, for example by the provision of a float in the upper part of the kier designed to open and close the cold water inlet so as to maintain a substantially uniform level of water within the kier.

While certain desirable embodiments of the invention have been shown and described by way of example, it is to be understood that the invention is not necessarily limited to this precise arrangement, but that other and equivalent constructions and arrangements of parts may be employed without departing from the spirit of the invention.

I claim:

1. In that method of treating pervious material in a closed kier, wherein the treating fluid is continuously circulated throughout the treatment in a closed path and under pressure through such material, that improvement which comprises maintaining a substantially uniform pressure differential at opposite sides of such material throughout said treatment by by-passing a portion of the fluid around the material.

2. In that method of treating material with a fluid in a closed container and wherein, after depositing a batch of the material in a compact mass in the container, the treating fluid is circulated in a closed path and under pressure so as to percolate through the mass of material from one side to the other of the latter, that improvement which comprises introducing steam into the circulating fluid at one point in the path of the latter, thereby to maintain the temperature of the circulating fluid at a proper degree, and throughout the treatment maintaining a substantially constant predetermined pressure differential at opposite sides of the mass of material by by-passing a portion of the circulating fluid around said mass of material.

3. In that method of treating material with a fluid in a closed container and wherein, after depositing a batch of the material in a compact mass in the container, the treating fluid is circulated in a closed path and under pressure so that at one part of its path it percolates through the mass of material from one side to the other of the latter, that improvement which comprises introducing steam at a pressure of substantially ten pounds gauge into the treating fluid as the latter approaches the mass of material, thereby to maintain the temperature of the circulating fluid at the proper degree, and by-passing such proportion of the circulating fluid around the mass of material as at all times throughout the treatment to maintain a pressure of substantially eight pounds gauge at the side of the mass of material from which the fluid emerges.

4. Apparatus for treating previous material with a fluid, said apparatus being of the kind which comprises means defining a closed path for the circulation of the fluid, said path including a portion constituting a receptacle for the material to be treated, and in which a batch of the material is so disposed as to form an obstruction so that normally all of the fluid must percolate through the material from one side of the batch to the other, a circulating pump arranged to withdraw fluid from the receptacle at one side of the batch of material, and to deliver it under pressure into the receptacle at the opposite side of the batch of material, characterized in having by-passing means operative to permit a portion of the circulating fluid to pass around the batch

of material, and control means automatically operative to vary the capacity of the by-pass so as to maintain a substantially uniform pressure differential at opposite sides of the mass of material throughout the treatment.

5 5. Apparatus for treating pervious material with a fluid, said apparatus being of the kind which comprises a pressure kier having a removable closure, means for supporting a batch of
10 the material within the kier, fluid circulating means operative to force treating fluid through the batch of material in a given direction from one side of the batch of the material to the other, said circulating means comprising a pumping device having a delivery conduit and a suction conduit, characterized in having pressure regulating means including a by-pass operative to conduct
15 fluid around the batch of material from one side of the latter to the other during the treatment, a controller for the by-pass operative to vary the capacity of the latter, and a movable element exposed and responsive to variations in pressure in the suction conduit, said movable element being so connected to the controller as, by means
20 of the latter, to maintain a substantially constant

pressure differential between the inlet and outlet ends of the kier throughout the treatment.

6. Apparatus of the kind which includes a kier for the treatment of pervious material with a fluid under pressure, said kier having a trans- 5 verse horizontally perforated partition constituting a support for a batch of the material to be treated, a pump, a delivery conduit leading from the pump to a point near the top of the kier, a discharge conduit leading from out of the space
10 below the partition to the pump, characterized in having means providing a by-pass passage leading from the upper part of the kier above the level of the top of the batch of the material to be treated and around said batch to the space below
15 the partition, a valve for varying the capacity of said by-pass passage, and a motor device for moving said valve, said motor device comprising a pressure responsive element operative in response to slight variation from normal in the
20 pressure differential on opposite sides of said partition, thereby to actuate said valve so as to maintain a substantially constant pressure differential throughout the treatment.

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