Jan. 27, 1953 W. D. JUNG ET AL 2,626,627

APPARATUS FOR AUTOMATICALLY PROPORTIONING PULP STOCKS

Filed Jan. 3, 1951

4 Sheets-Sheet 1

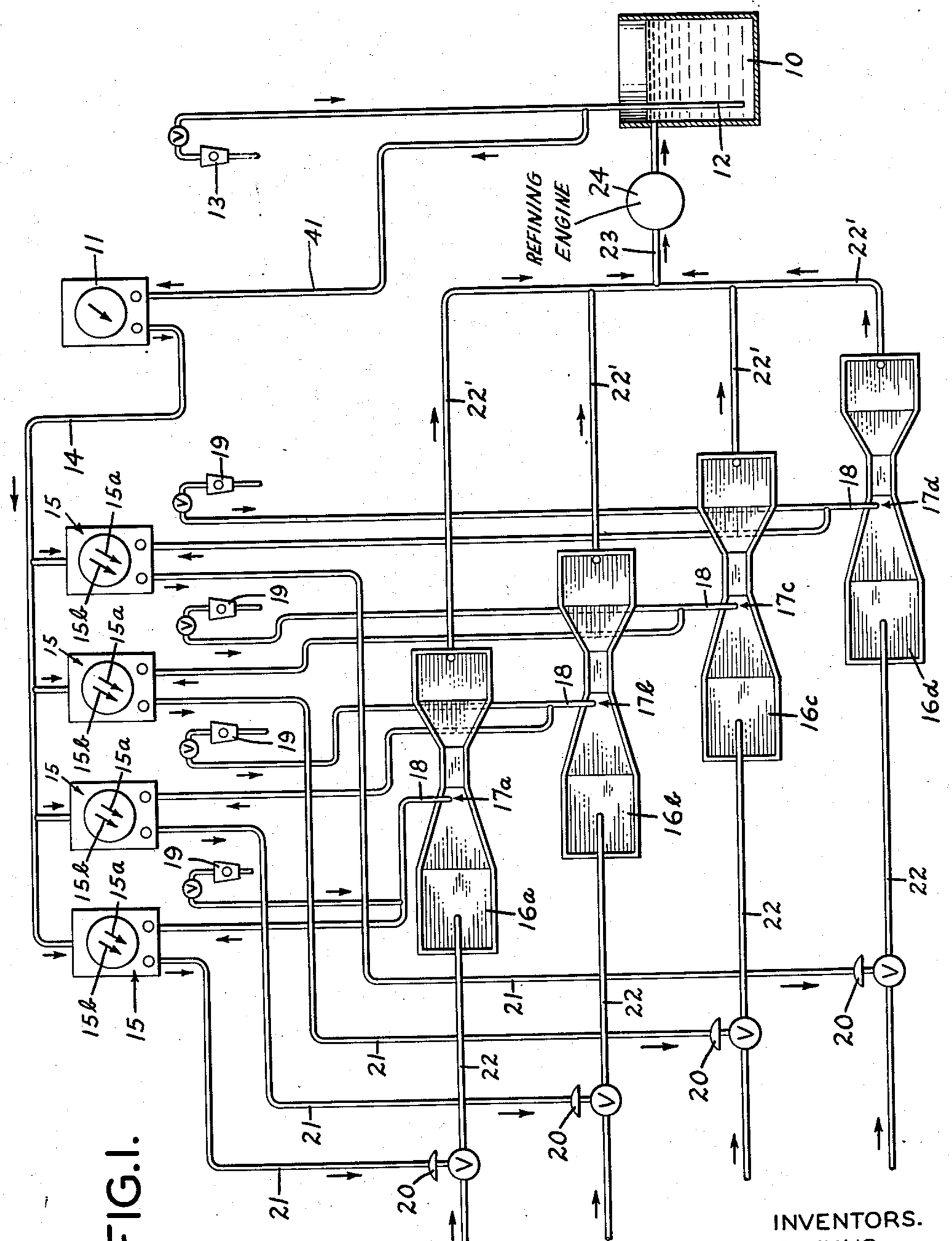

FIG. 1.

INVENTORS.
WERNER D. JUNG
CARLETON E. SAECKER
BY
Elizabeth Hunter
ATTORNEY.

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4 Sheets-Sheet 2

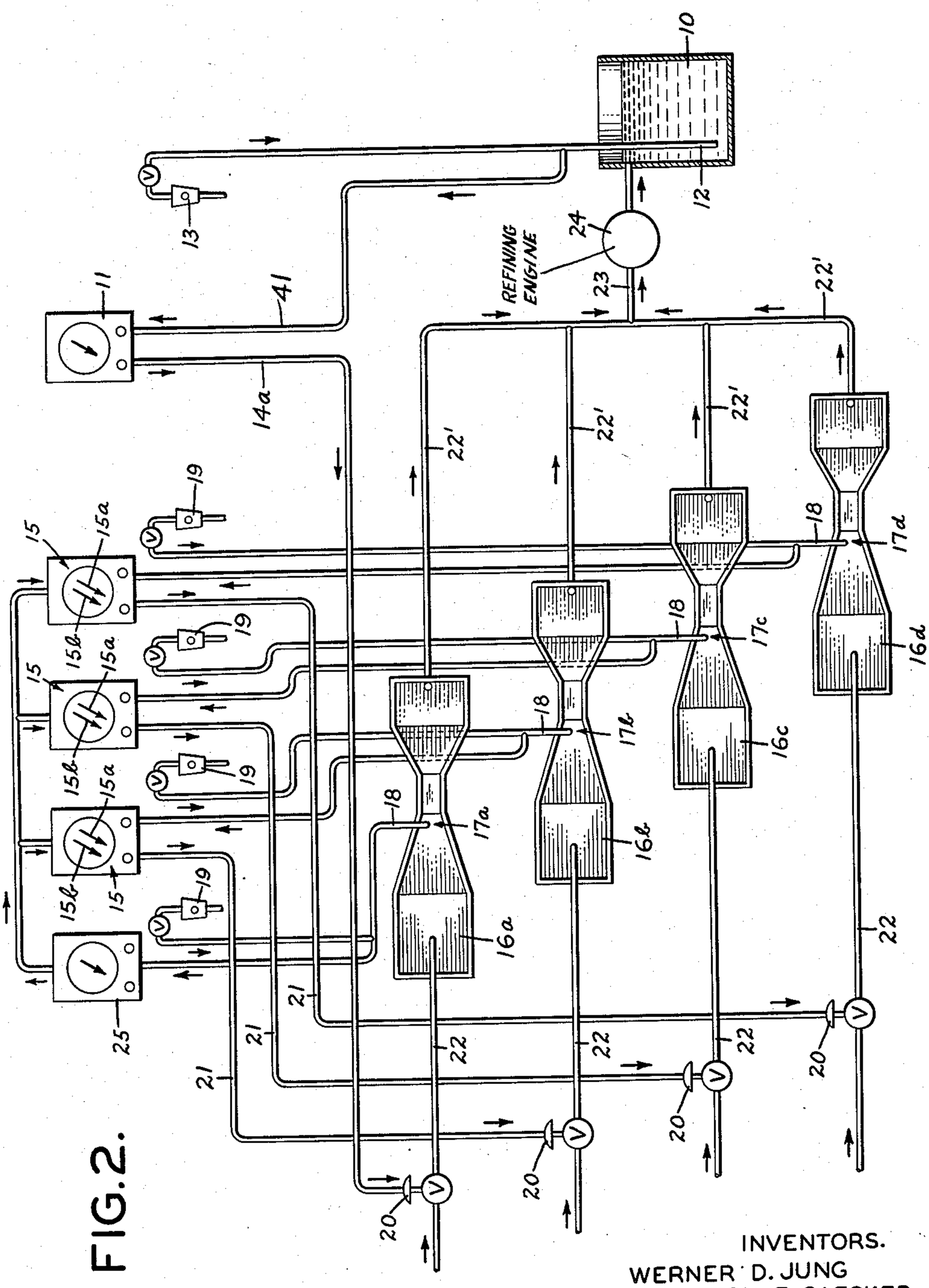

FIG. 2.

INVENTORS.
WERNER D. JUNG
CARLETON E. SAECKER
BY Elizabeth Hunter
ATTORNEY.

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4 Sheets-Sheet 3

FIG.4.

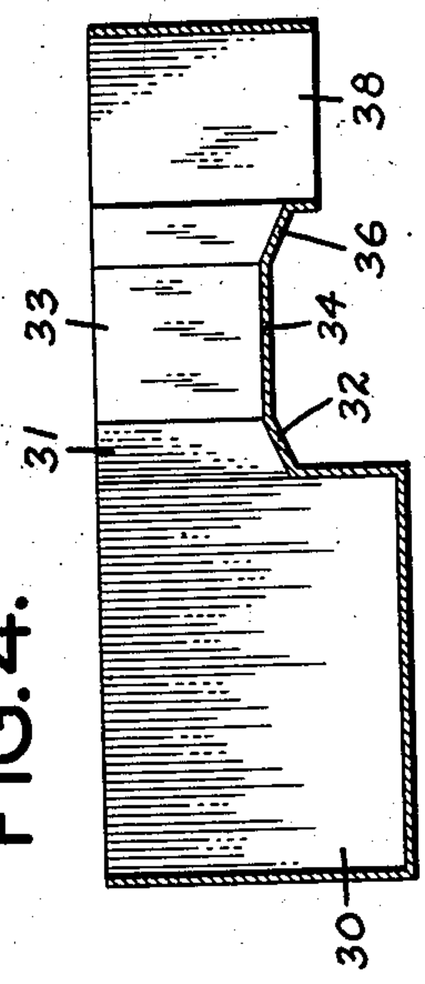


FIG.6.

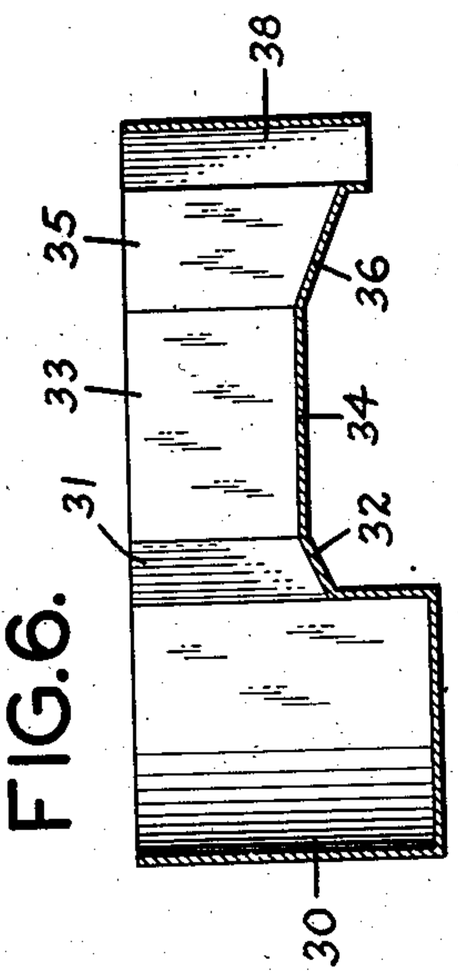


FIG.8.

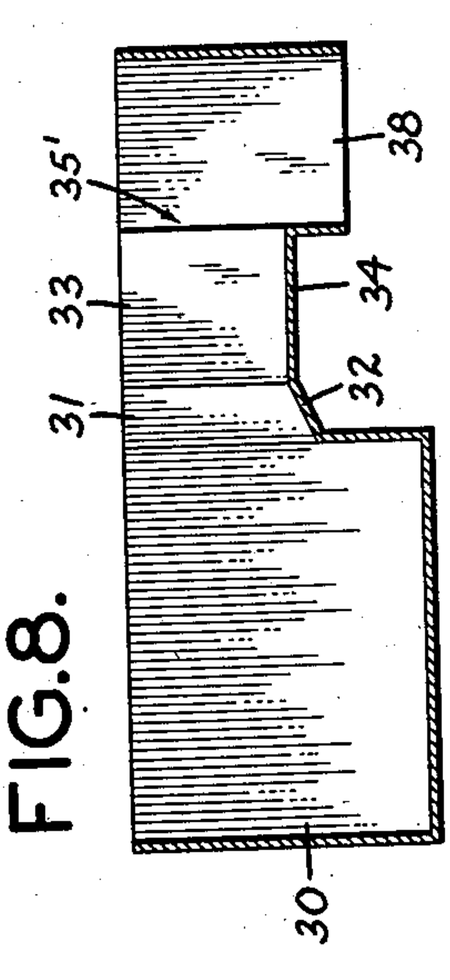


FIG.3.

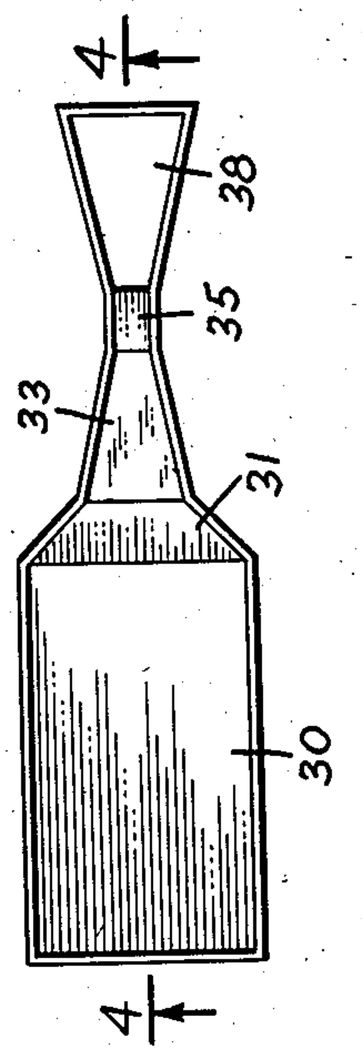


FIG.5.

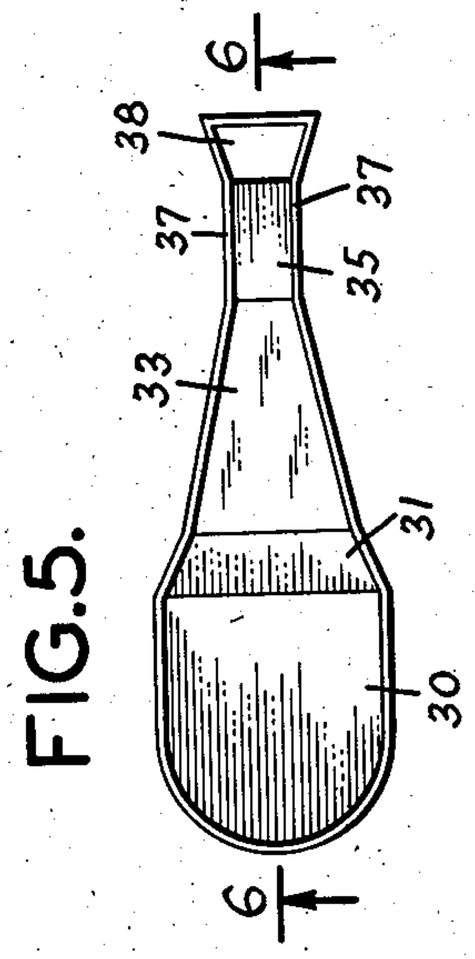
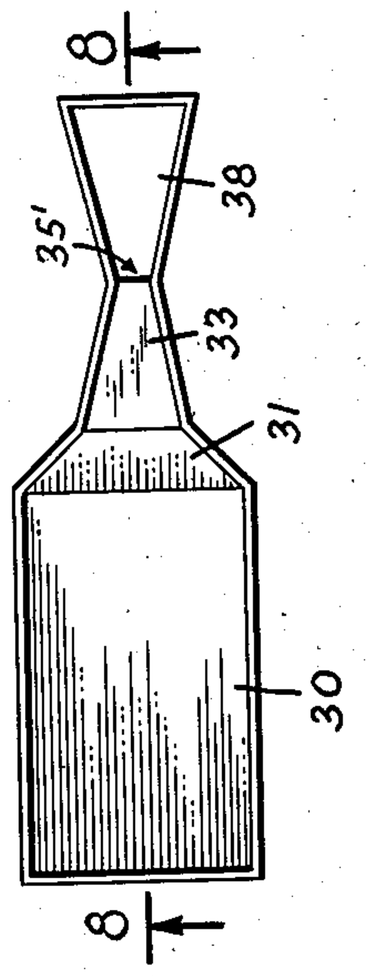


FIG.7.



INVENTORS.
WERNER D. JUNG
CARLETON E. SAECKER
BY Elizabeth Hunter
ATTORNEY.

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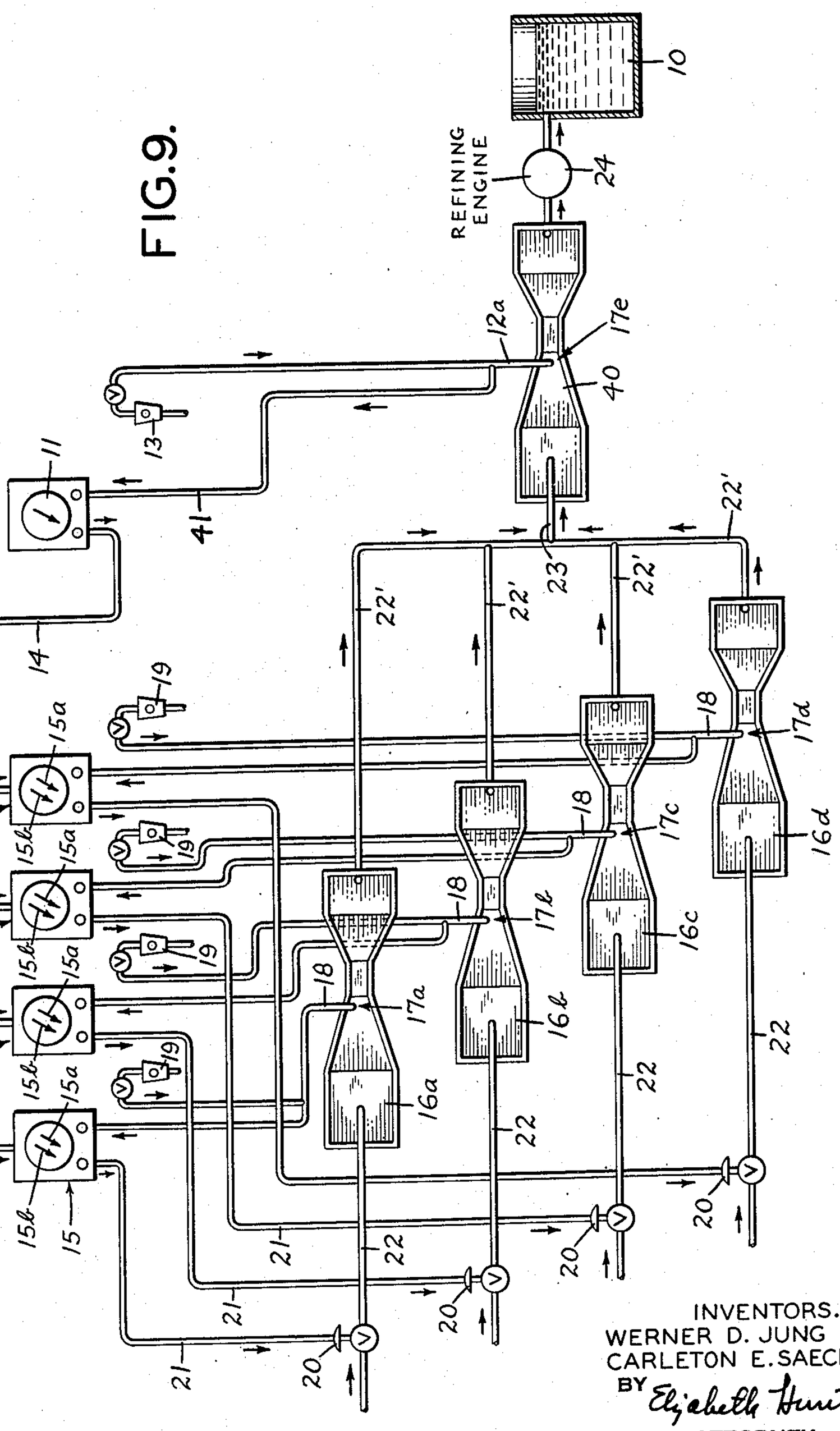
FIG. 9.



INVENTORS.
WERNER D. JUNG
CARLETON E. SAECKER
BY Elizabeth Hunter
ATTORNEY.

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UNITED STATES PATENT OFFICE

2,626,627

APPARATUS FOR AUTOMATICALLY PROPORTIONING PULP STOCKS

Werner D. Jung, Tafton, Pa., and Carleton E. Saecker, Teaneck Township, Bergen County, N. J., assignors to Allied Chemical & Dye Corporation, New York, N. Y., a corporation of New York

Application January 3, 1951, Serial No. 204,202

8 Claims. (Cl. 137—88)

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This invention relates to a paper pulp stock control and proportioning system, and more particularly to such a system adapted for automatically controlling the volume of flow of a plurality of such stocks in predetermined ratios to a paper forming machine.

Paper making furnishes are often composed of a plurality of pulp stocks of different types of fibres, used in predetermined specified proportions depending on the final characteristics desired in the finished paper.

In order to achieve uniformity in the desired characteristics of the finished paper in such cases the proportions of the several stocks must be maintained constant in their predetermined ratios.

Stock proportioning systems used in the past have been either entirely manually operated or have employed mechanical devices such as rotary vane or bucket type displacement meters, or, more recently, have employed various arrangements of rotameter type metering devices for example having a float within a vertical portion of the pipe line, with a relatively small annular space or orifice around the float through which the flowing stock material must pass. The flow through such devices was indicated or recorded on standard controllers which in turn actuated valves such as "butterfly" or damper type valves in advance of the flow measuring devices in accordance with the indicated or recorded flow rates through the metering devices, the valve control being effected by well known electrical or pneumatic means.

While certain of these prior art regulating mechanisms may operate satisfactorily in proportioning chemical solutions and fine paper pulp stocks, all are subject to serious disadvantages when used with coarse paper pulp stocks or fast draining stocks such as are often used in the furnishes employed in manufacturing paper board, roofing felt and the like, employing, for example, coarse rag stock, steam defibered wood, coarse waste paper, coarse broke, etc., which tend to pile up and plug the metering devices.

In such operations manual control of valves makes for fluctuations introduced by the human element particularly in the manipulation of such valves to relieve plugging. Any device involving a rotary element is subject to entanglement by rag fragments or other debris which not only may impair its operation but may render it completely inoperative. Mechanical devices such as rotameters result in periodic plugging caused either by the failure of the devices to pass portions of the coarse stock, or in the case of free stocks, by the dewatering tendency of such devices causing accumulations of thick stock dams at the regulators, with resulting irregularity or stoppage of the flow of stock through the plugged device thus

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upsetting stock proportions to the paper machines and demanding the continual attention of an attendant to remove stoppages and restore the system to its intended mode of operation.

Positive metering devices such as those of paddle or bucket type, require an extravagantly large and complex assembly and entail high installation and maintenance costs.

It is an object of the present invention to provide a completely automatic multiple stock metering and proportioning system which avoids the difficulties of prior art systems.

It is a further object of the invention to provide such a system which is free from plugging difficulties even when used to proportion coarse pulp stocks of the character used in the manufacture of roofing felts.

It is a still further object of the invention to provide such a system in which free and unrestricted flow of the several stocks is assured even when stocks of highly irregular composition and occasionally containing relatively large pieces of debris or undefibered fibrous raw material are involved.

It is a still further object of the invention to provide such a system in which the ratio of each stock to the total is separately metered and controlled.

A still further object of the invention is to provide such a system in which the predetermined quantity of each of a plurality of stocks may be regulated proportionately only to the total stock flow, or in which one master stock may be regulated by a level transmitter and the remaining stocks proportionately controlled through the flow of the master stock.

These and other objects are accomplished according to our invention by the automatic stock metering and proportioning system or arrangement illustrated in the drawings, wherein like characters designate like parts throughout.

In the drawings, Fig. 1 illustrates schematically one modification of the automatic pulp control and proportioning system of our invention in which the proportion of each of a plurality of stocks is controlled independently of every other stock and dependently only on the total stock flow. Fig. 2 illustrates another modification of the system in which the flow of one of the stocks regulated by the total stock flow acts to control the flow of all the other stocks. Fig. 3 is a plan view of one modification of an open channel flume which may be used in the system. Fig. 4 is a vertical section taken along line 4—4 of Fig. 3. Fig. 5 illustrates a plan view and Fig. 6 a vertical section along line 6—6 of Fig. 5, respectively, of another modification of open channel flume which may be used in the system. Fig. 7 illustrates a plan view and Fig. 8 a vertical section

along line 8—8 of Fig. 7, respectively, of still another modification of flume suitable for use in the system. Figure 9 illustrates a modification of the system in which total stock flow is measured at a common flume in which all the stocks are commingled.

Referring to the drawings, numeral 10 (Fig. 1) represents a mixed stock chest in which all the stocks are commingled, the stock level of which is a measure of the total flow of the several stocks. Numeral 11 represents a conventional recording level transmitter measuring the level of pulp in the mixed stock chest as by means of conventional compressed air bubbler pipe 12 supplied with compressed air from conventional compressed air measuring device 13 connected to an air source, not shown. Thus when compressed air is passed at a standard rate through air metering device 13 into tube 12 dipping below the surface of the commingled stock, the back pressure communicated through pneumatic tube 41 to recording level transmitter 11 is determined by the height of the stock above the bubble tube tip, so that this pressure furnishes a measure of the level of commingled pulp in the stock chest. Such measurement is transmitted through line 14 to the primary pens 15*a* of the several conventional ratio controllers 15, which measure and control the flow of each of the several stocks in a predetermined ratio to the whole in proportion to the level requirements indicated by the level transmitter 11 in a conventional manner. Open channel flumes 16*a*, 16*b*, 16*c* and 16*d* serve as metering devices in which the upstream head of each stock is measured in terms of flow at points 17*a*, 17*b*, 17*c* and 17*d*, respectively, of the flumes by air bubblers 18 fed through compressed air measuring devices 19 from sources of compressed air, not shown, and the respective flow readings are recorded on the secondary pens 15*b* of the several ratio flow controllers 15. Valves 20 of pinch-clamp, alligator or gate type are pneumatically actuated through air lines 21 controlled by the secondary pens 15*b* of controllers 15, to regulate flow of stocks through lines 22 and 22′ into common line 23, thence through refining engine 24 if desired, to stock chest 10 and eventually to the paper machines, not shown. Lines 22, 22′ and 23 are not drawn to scale, but for simplicity of illustration, are shown much reduced in size. In practice, they must be large enough to avoid any standing head of liquid in the downstream sections 38 of the flumes.

In the modification shown in Fig. 2, recording level controller 11 controls the flow of only a single pulp through line 14*a*, for example that flowing through open channel flume 16*a*. The rate of flow of this pulp is recorded on master flow transmitter 25, which positions the primary pens 15*a* of recording ratio flow controllers 15 which in turn control and proportion the flow of the remaining stocks to the flumes in a manner similar to that shown in Fig. 1.

In the drawings a stock chest is shown as a convenient location at which to measure the total flow of all the stocks through fluctuations in the stock level in the chest. If desired, however, the total flow measurement may be taken in any other convenient device or receptacle positioned at a point beyond which the several stocks have been commingled, and which provides a stock head or level responsive to total flow of the stocks. A particularly suitable device for this purpose is shown in Figure 9 and comprises a common flume 40, similar in all essentials to the flumes indicated in Figures 1–8 in the drawings, interposed at a

convenient location ahead of the stock chest 10 and beyond the point where the several stocks are commingled in common line 23. In such case, compressed air bubbler pipe 12*a* is introduced below the commingled stock level in the device, for example in the upstream section of the common flume 40 at the desired convenient location 17*c*.

In Figs. 3 and 4, numeral 30 represents a stilling chamber in advance of the flume proper; 31 is a first portion of the upstream converging section having an upwardly inclined floor 32; 33 is a second portion of the upstream converging section having a level floor 34; 35 is the throat section of the flume having a downwardly inclined floor 36 and parallel sides 37; and 38 is the downstream diverging section of the flume, which drops away vertically in cross section through a pipe or chute, not shown, or to a catch basin, not shown.

In Figs. 5 and 6, the characters illustrate the same features as shown in Figs. 3 and 4 with certain structural modifications, particularly rounded corners in the stilling chambers which are particularly effective in avoiding the accumulation of pockets of stagnant stock.

In Figs. 7 and 8, the same description applies except that the upstream section 33 converges to a throat 35′ of minimum width, and then diverges at 38.

In operation, the several pulp stocks, which, in the preparation of roofing felt, for example, may be four stocks, such as rag stock, stream defibered wood pulp, waste paper and broke from the felt machine operations, are defibered in conventional manner, and are preferably adjusted to the desired predetermined consistency by conventional means before feeding them to the proportioning system. The several individual stock suspensions are then separately passed through valves 20 whose openings have been regulated according to the indicated requirement for that stock. The stocks then flow through lines 22 and the respective open channel flumes 16*a*, 16*b*, 16*c* and 16*d*, where the head or level of each stock is measured by air pressure type metering devices, for example, by bubbler tubes 18 located at any convenient position in the upstream portion of the flume, for example in the converging section as shown, and the air pressure measurement is transmitted in terms of rate of flow to the secondary indicators or pens 15*b* of meters 15, which record and correct for any deviations from the desired predetermined flow rate for that stock. From the open channel flumes, the stocks may drop through a pipe or chute into a receiver such as a catch basin or pipe, and from thence flow through lines 22′ to a common stock line comprising a receptacle such as a pipe 23 for further mixing, and refining, if desired, as in Jordan engines, and a stock chest 10, and thence to the paper machine. The level of the commingled stock in the head producing device, such as stock chest 10 or the common flume 40 as described, is measured in terms of air pressure by bubbler tube 12 and this pressure value is transmitted through pneumatic tube 41 to, and recorded on level transmitter 11 and this level serves as an indicator of total stock requirements. These requirements are then transmitted to the primary indicators or pens 15*a* of the individual controllers 15, which are coordinated with secondary pens 15*b* through a ratio mechanism fixed at a predetermined desired set-

ting. Secondary pens 15b control the actuation of valves 20 in accordance with the position of the pens as regulated by the flow reading through the flumes, by well known means, for example, electrically or pneumatically, and change the size of the openings through the valves to increase or decrease the flow to the flumes as required.

Flow control of the several stocks may preferably be effected independently of each other as illustrated in Fig. 1, in which case each stock is controlled through individual subordinate controllers whose primary indicators are each individually actuated by the recording level transmitter acting as the master controller, or it may be effected by first regulating any one single stock through the recording level transmitter and using the rate of flow of this stock as communicated to a master controller, to regulate the flow of the remaining stocks through other subordinate controllers in accordance with the flow of the single pulp, as illustrated in Fig. 2.

The proportioning system of our invention provides unobstructed flow for all the stocks; being free from devices such as orifices, weirs, buckets, floats or other restrictions which might tend to cause dewatering, plugging or irregularities in the flow of stock.

The use of open channel flumes, especially when used in conjunction with compressed air, bubbler tube type metering devices and open flow type control valves, obviates the necessity for restrictive devices, and the combination of these features with the conventional automatic controller devices described, in the arrangement specified, is the crux of our invention.

The open channel flumes used in the novel combination of our invention are of the type comprising a laterally converging section leading to a constricted throat section which may have parallel sides as shown in Figs. 3 and 5, or the throat section may converge to, and diverge from, a line of minimum width as indicated in Fig. 7. A stilling chamber or stock accumulator positioned in advance of the converging portion serves to accumulate a pool of stock, and thus smooth out the flow to the flume and to provide a level or head of stock responsive to variations in rate of flow through the throat of the flume. The floor of the flume may be upwardly inclined in the initial portion of the converging section to assure ready flow of stock from the stilling chamber, then may be horizontal for the remaining portion of the converging section, is downwardly inclined at the throat portion, i. e. the section of maximum restriction and then drops away vertically. The downward inclination of the throat portion may be gradual for an appreciable distance as shown in Figs. 3 and 5, or may be an immediate vertical drop as shown in Fig. 7. The construction of the flume beyond the throat portion differs in our system from that of conventional Venturi flumes such as the "Parshall" flume in that this portion drops away vertically in cross section as shown in the drawings, instead of providing an upwardly inclined floor section beyond the throat as does the "Parshall" flume, so that in our system no further restrictions in flow are imposed on the pulp after it enters the throat of the flume.

While the precise dimensions of the flumes are not critical, the throat of the flume, i. e. the portion of maximum restriction, will be designed in accordance with known engineering principles to have dimensions appropriate for passing the desired quantity of stock per unit of time, and these dimensions will be coordinated with the dimensions of the stilling chamber to produce an appropriate variation in stock level therein in relation to variations in rate of flow through the flume, to produce the desired sensitivity of regulation through the controllers.

Variations in level of the stock are measured in the upstream portion of the flume, that is, at any convenient location in advance of the throat portion of the flume such as in the stilling chamber or in the converging section of the flume by means of a bubble pipe, the tip of which is submerged in the stock at a suitable vertical distance below the level of stock in the upstream portion of the flume. The pressure generated through the head of stock on the air or other gas remaining in the bubble pipe is transmitted to the secondary indicators of the controllers in a manner well known, to record changes in level or head in terms of stock flow through the flume, and, if such levels indicate a variation from the desired predetermined rate of flow, to bring about changes in the valve settings to increase or decrease the flow of stock in accordance with such indicated pressure. The direct measurement of stock level, by means of the air pressure type installation, is an important feature of our new combination, as metering of stock by devices such as depend on a take-off of stock from the flume through small orifices or the like, is unsuitable due to the danger of clogging of the take-off pipe with stock.

As pointed out above, dimensions of the flumes may be varied as desired, to adapt them to the use of various rates of flow and to various types of stocks. In general, the width of the flume throat governs the head of stock in the upstream portion, and this head in turn depends not only on the width of throat but to some extent also on the type of stock and on its specific gravity, its consistency and its freeness. A wider throat will, of course, pass a larger volume of stock than a narrow throat, and such dimensions may be readily varied by one skilled in the art to adapt them to the requirements of the particular stock proportioning system.

By way of example, in the preparation of a roofing felt which required the furnishing of four pulps of the character and in the amounts specified in the table below, it was found that throat dimensions indicated in the table were suitable in flumes of smooth surface stainless steel construction having a stilling chamber approximately 1′ 10″ wide by 3′ 5″ long by 2′ high and a converging section approximately 2′ long.

TABLE

Flume throat dimensions suitable for various flows of several pulp stocks

Stock	Flow Rate, gals./min.	Stock Consistency, Percent	Throat Dimensions	
			Width	Length
			Inches	*Inches*
Wood	250	2.4	4⅛	12
Waste Paper	160	2.8	4	6
Rags	95	2.8	3	6
Broke	45	2.8	2	6

This flow produced a 10″ head in the upstream section of the flow and was coordinated

with a controller instrument designed to record a 10'' head as 100% or maximum flow.

As used in the novel system of our invention, such flumes may be of any suitable construction material such as wood, metal, concrete or the like, and should preferably be smooth so as to offer as little frictional resistance to flow of pulp as possible. They may conveniently be positioned in one or more of the several pulp lines or ducts to measure and control its flow without restriction thereof.

The successful operation of the system containing the flumes depends also on the provision of valves of the open flow type, that is, valves which in their fully open position provide a straight line, substantially unobstructed passage, and which in their various settings as regulated by the controllers in accordance with indicated flow rates through the flumes, offer substantially no opportunity for clogging by heavy stocks. Such valves may be, for example, those of the pinch-clamp type or the well known "alligator" type valve equipped with a flat floor and a horizontal pivoted gate having its free end pointed downstream and adapted to be moved on its pivot upward to the top of the chamber to allow unrestricted flow beneath it, or to be moved downwardly toward the floor of the chamber to restrict or cut off the flow, or gate valves may be used if desired.

The recording level transmitter and the automatic ratio flow controllers are of standard conventional design of the type commonly used in recording and controlling flow of fluids, as are the various connections, the air lines, piping, etc.

The automatic proportioning system of our invention not only provides a substantially foolproof system free from surges, plugging or stoppages but also furnishes a continuous record of the pulp composition of the finished paper at all times.

While the above describes the preferred embodiments of our invention, it will be understood that departures may be made therefrom within the scope of the specification and claims.

We claim:

1. An apparatus for automatically controlling the proportions of a plurality of paper pulp stocks fed from separate stock supplies through a common stock line to a paper-forming machine, which comprises a plurality of stock ducts leading from said supplies to said paper machine, a flume having gradually converging side walls forming a restricted throat therein on each stock duct, an open flow type valve on each duct ahead of said flume, a valve control system, responsive to liquid level variation in a stock head producing device positioned in said common stock line, controlling the valve on at least one of said stock ducts to enlarge said valve opening upon fall of liquid level and reduce said valve opening upon rise of liquid level in said head producing device, and valve control systems responsive through air pressure type metering devices to liquid level variations at points ahead of the throats of a plurality of said flumes controlling the valves ahead of the corresponding flumes, the aforesaid valve control systems including a master controller and a plurality of subordinate controllers responsive to said master controller to vary the valve settings controlled by each subordinate controller in response to changes in liquid levels affecting said master controller.

2. An apparatus for automatically controlling the proportions of a plurality of paper pulp stocks

fed from separate stock supplies to a single stock chest, which comprises a plurality of stock ducts leading from said supplies to said stock chest, a flume having gradually converging side walls forming a restricted throat therein on each stock duct, an open flow type valve on each duct ahead of said flume, a valve control system, responsive to liquid level variation in said stock chest, controlling the valve on at least one of said stock ducts to enlarge said valve opening upon fall of liquid level and reduce said valve opening upon rise of liquid level in said stock chest, and valve control systems responsive through air pressure type metering devices to liquid level variations at points ahead of the throats of a plurality of said flumes controlling the valves ahead of the corresponding flumes, the aforesaid valve control systems including a master controller and a plurality of subordinate controllers responsive to said master controller to vary the valve settings controlled by each subordinate controller in response to changes in liquid levels affecting said master controller.

3. The apparatus of claim 2 wherein said stock ducts lead from said flumes to a refiner and a stock duct leads from the refiner to the stock chest.

4. The apparatus of claim 3 wherein said plurality of said flumes comprises at least all but one of the flumes.

5. The apparatus of claim 2 wherein the flumes comprises a stock receiving stilling chamber, a laterally converging section having a horizontal floor, a constricted throat portion and a vertically disposed exit portion.

6. In an apparatus for automatically regulating the volume of flow of a plurality of paper pulp stocks in predetermined ratios, the combination of a mixed stock chest, a recording level transmitter measuring the level in said mixed stock chest, a series of ratio flow controllers having primary and secondary indicators, said primary indicators being responsive to the level indicator of said recording level transmitter and being coordinated with said secondary indicators through a ratio mechanism fixed at a predetermined setting, a series of open flow type valves actuated by the said secondary indicators to change the size of the openings therein in accordance with the position of said indicators, a series of open channel flumes having a converging upstream section terminating in a restricted throat, connected to said valves, a series of air pressure type metering devices positioned in the upstream sections of said flumes to measure the head in said upstream sections, said metering devices being connected with the respective ratio flow controllers to actuate the secondary indicators thereof in response to said upstream head in said flumes, pulp conveying lines connected with the outlets of said flumes to convey the stocks therefrom, and a common receptacle for said stocks connected to the said mixed stock chest.

7. In an apparatus for automatically regulating the volume of flow of a plurality of paper pulp stocks in predetermined ratios, the combination of a mixed stock chest, a common open channel flume having a converging upstream section terminating in a restricted throat, a recording level transmitter measuring the level in the upstream section of said common flume, a series of ratio flow controllers having primary and secondary indicators, said primary indicators being responsive to the level indicator of said record-

ing level transmitter and being coordinated with said secondary indicators through a ratio mechanism fixed at a predetermined setting, a series of open flow type valves actuated by the said secondary indicators to change the size of the openings therein in accordance with the position of said indicators, a series of individual open channel flumes having a converging upstream section terminating in a restricted throat, connected to said valves, a series of air pressure type metering devices positioned in the upstream sections of said flumes to measure the head in said upstream sections, said metering devices being connected with the respective ratio flow controllers to actuate the secondary indicators thereof in response to said upstream head in said flumes, pulp conveying lines connected with the outlets of said flumes to convey the stocks therefrom, and a common receptacle for said stocks connected to the said mixed stock chest.

8. In an apparatus for automatically regulating the volume of flow of a plurality of paper pulp stocks in predetermined ratios, the combination of a mixed stock chest, a recording level controller measuring the level in said mixed stock chest, a primary open flow type valve actuated by said recording level controller, a primary open channel flume connected to said primary valve, an air pressure type metering device positioned in the upstream section of said primary flume to measure the head in said upstream section, a flow transmitter having a single flow indicator responsive to the flow through said primary flume, a series of ratio flow controllers having primary and secondary indicators, said primary

indicators being responsive to the indicated flow through said primary flume, and being coordinated with said secondary indicators through a ratio mechanism fixed at a predetermined setting, a series of secondary open flow type valves actuated by said secondary indicators of said secondary ratio flow controllers to change the size of the openings therein in accordance with the position of said indicators, a series of secondary open channel flumes connected to said secondary valves, a series of air pressure type metering devices positioned in the upstream sections of said secondary flumes to measure the head in said upstream sections, said metering devices being connected with the respective secondary ratio flow controllers to actuate the secondary indicators thereof in response to said upstream head in said secondary flumes, pulp conveying lines connected with the outlets of said primary and said secondary flumes to convey the stocks therefrom and a common receptacle to said stocks connected to the said mixed stock chest.

WERNER D. JUNG.
CARLETON E. SAECKER.

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