Jan. 6, 1953 P. L. PENDLETON 2,624,189

APPARATUS FOR FLUID TREATMENT OF FILAMENTARY MATERIALS

Filed Jan. 17, 1948 2 SHEETS—SHEET 1

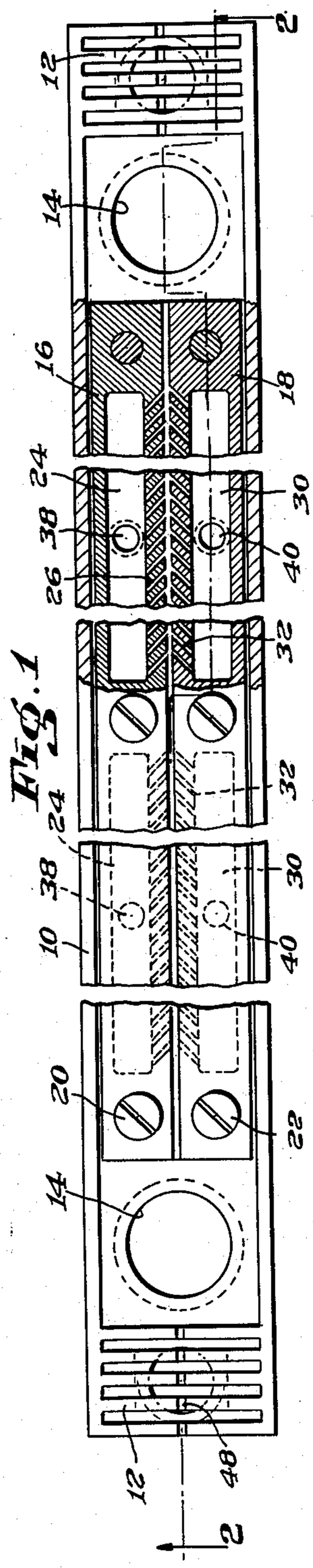

Fig. 1

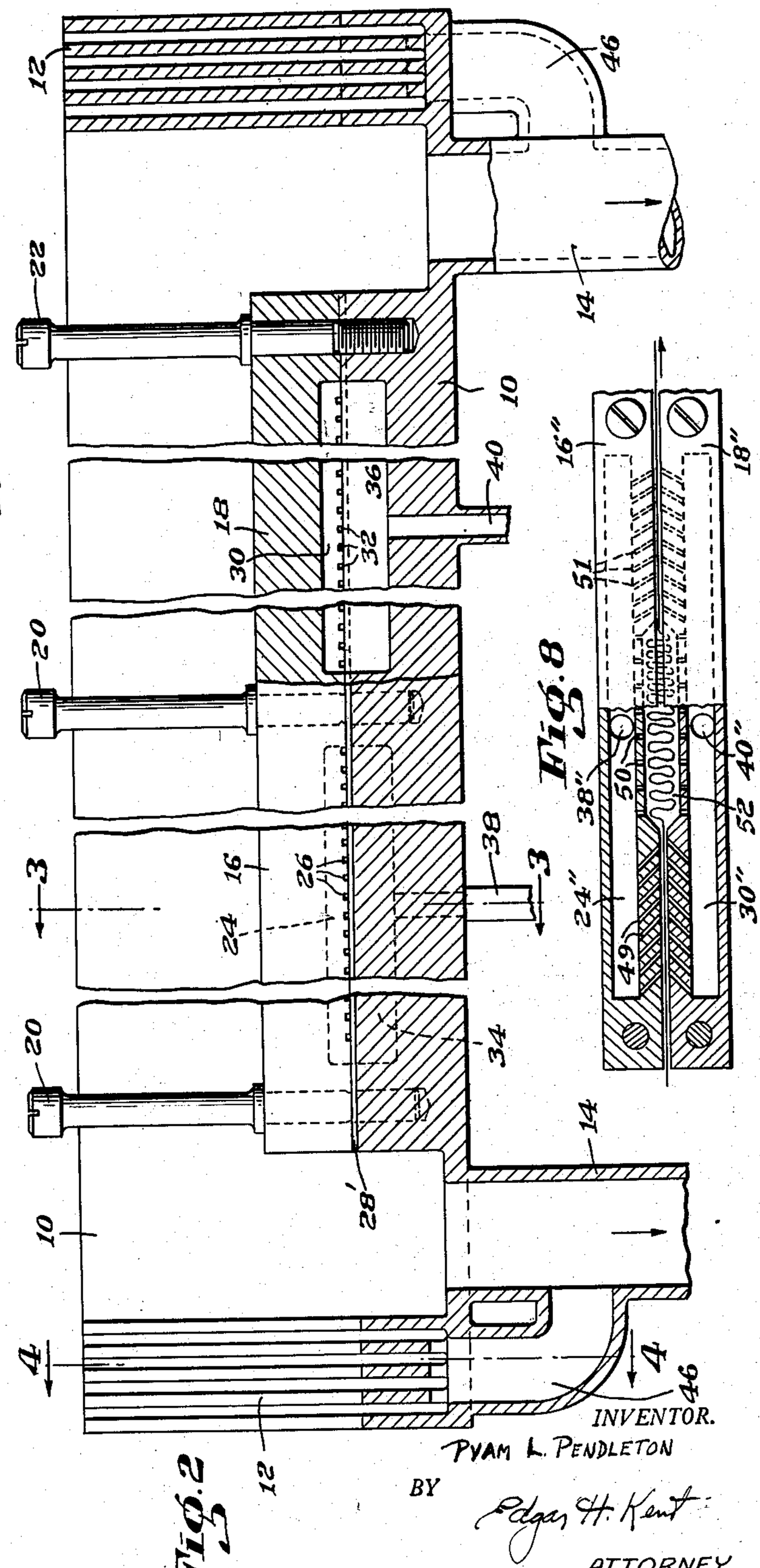

Fig. 2

Fig. 8

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Fig. 3

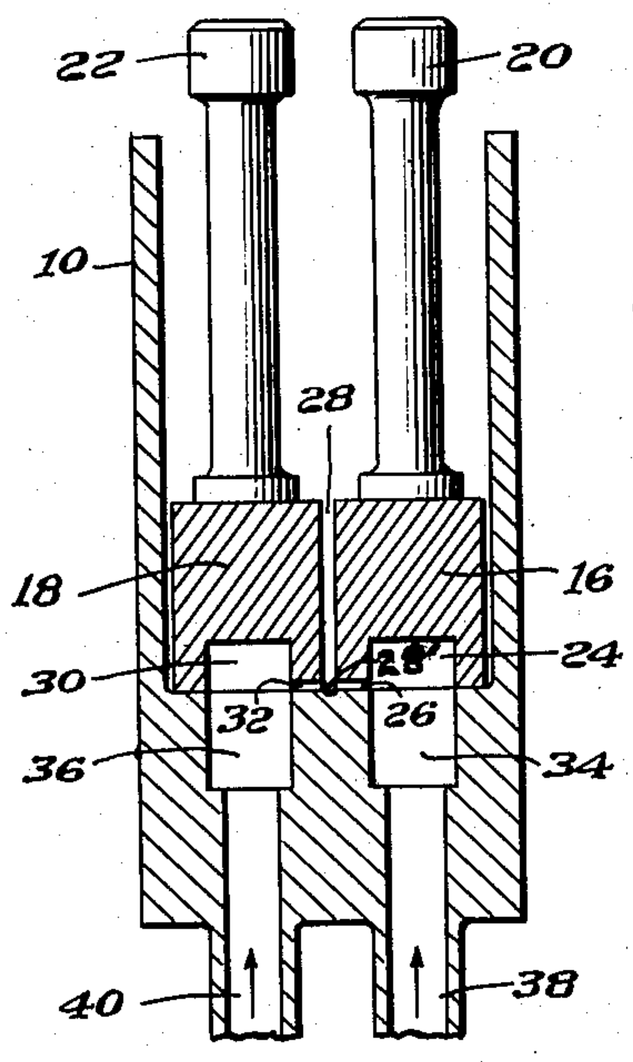


Fig. 4

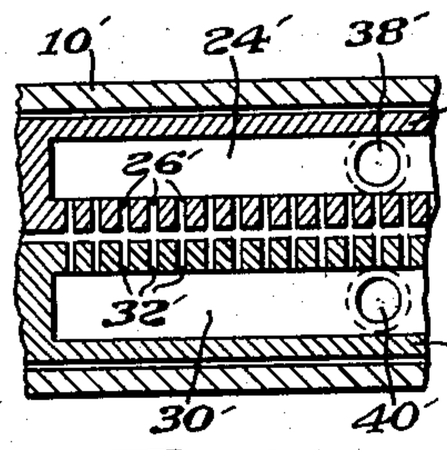


Fig. 7

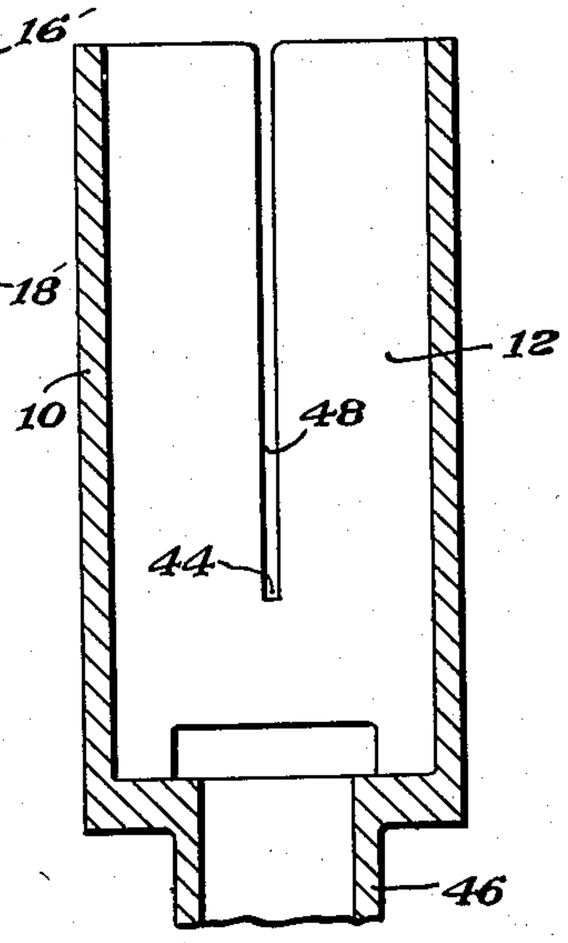


Fig. 5

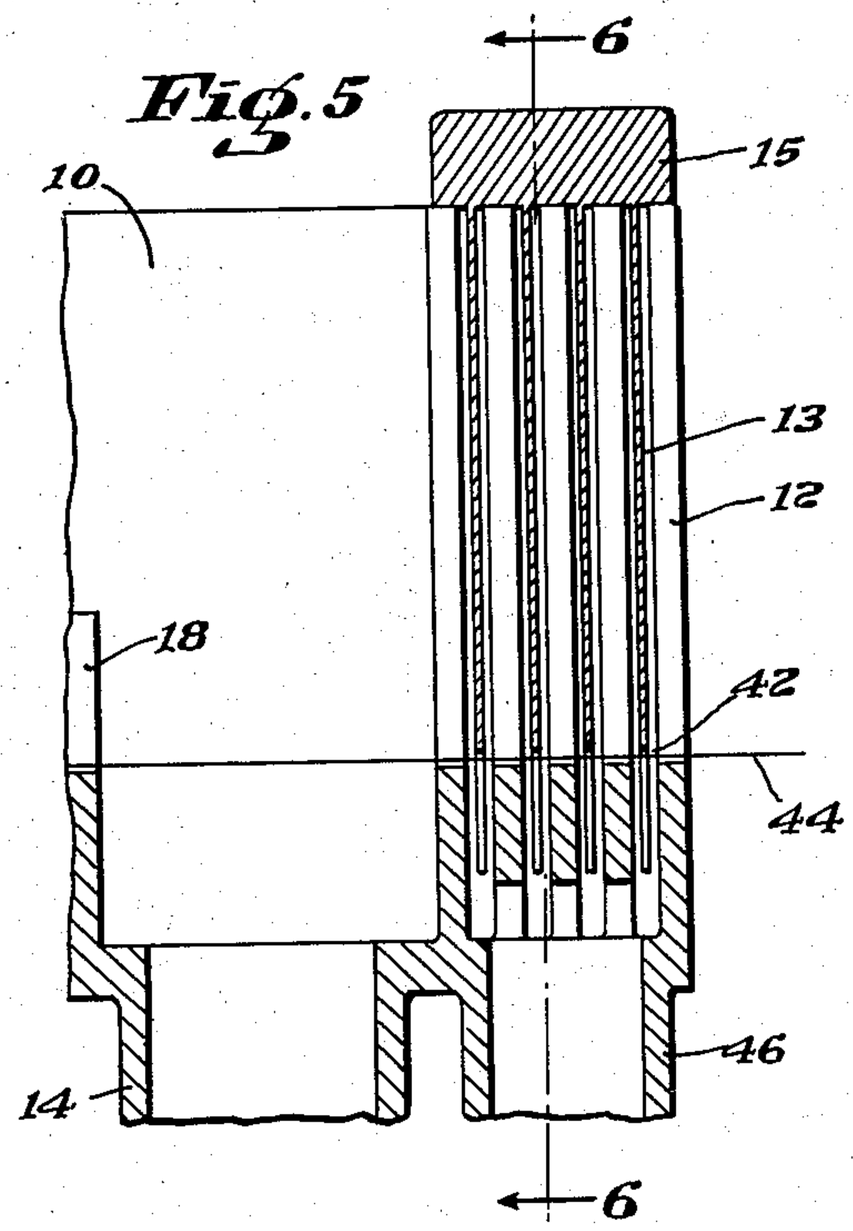
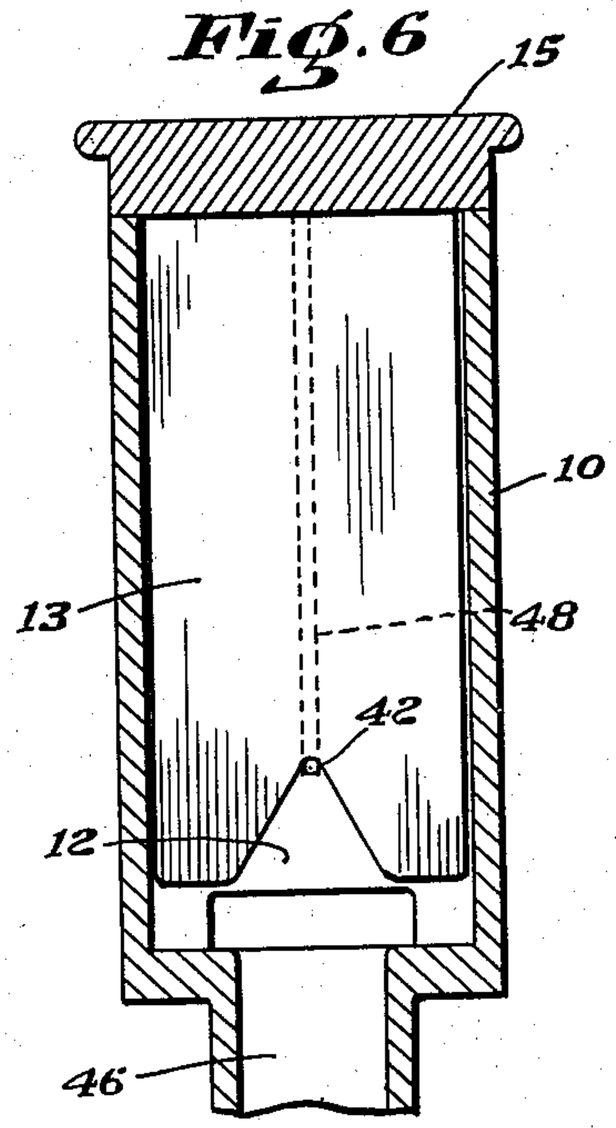


Fig. 6



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APPARATUS FOR FLUID TREATMENT OF FILAMENTARY MATERIALS

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Application January 17, 1948, Serial No. 2,947

8 Claims. (Cl. 68—19)

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This invention relates to the fluid treatment of filamentary materials.

More particularly, the invention concerns an apparatus for the treatment with active or inert fluids of one or more traveling strands or threads of textile fibers, or of an artificial filament, or bundle of artificial filaments, after formation by extrusion and coagulation.

In treating such materials, it is often desirable to apply the treating solution thereto under conditions of considerable pressure in order to achieve a more rapid, thorough and economical permeation thereof by the fluid or to induce a high and favorable circulation of the fluid in the vicinity of the material. For such purposes it has been heretofore proposed to provide within a sealed chamber a confined body of fluid, fluid pressure producing means and means for introducing and withdrawing the strand or filament from the fluid pressure zone without excessive fluid leakage. Such a structure must, of necessity, be adapted to withstand considerable pressures over a relatively large interior surface area of the chamber and be provided with complex sealing members to permit passage of the strand while preventing escape of fluid.

It is an object of the present invention to provide an apparatus for fluid treatment of continuous strands of traveling filamentary materials whereby in an open bath or vat of treating fluid a zone of relatively heavy fluid pressure may be created and a strand passed therethrough without the use of pressure retaining seals, covers or the like, the portion of the bath outside the pressure zone being under atmospheric pressure.

It is a further object of the invention to provide an apparatus for fluid impregnating or permeating of filamentary materials whereby a traveling continuous strand may be submerged in treating fluid open to atmospheric pressure, and while submerged, traverse a pressure zone in which the fluid pressure is usefully raised in the vicinity of the material to a degree over and above the static head with the rise in fluid pressure accompanied by a useful circulation of the fluid.

It is a further object of the invention to provide an apparatus of the type described containing a semi-restricted submerged area in which the fluid pressure may be substantially raised by means of multiple fluid pressure jets discharging into the area in the vicinity of the material under treatment and where by arranging the jets in opposed pairs the impact of the jets against the material will be balanced so that harmful collision or frictional contact of the material against the boundary faces of the area will be avoided.

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It is a further object of the invention to provide in an apparatus of the type described fluid pressure jets discharging into a channel with the interior faces of the channel acting to forcibly deflect and eject fluid from the channel after contact with the material.

It is a further object of the invention to provide in an apparatus of the type described a treating zone in which the application of fluid pressure to the material is of a rapidly pulsating nature, this being accomplished by causing the material to traverse a semi-restricted channel containing localized opposed pressure jets in alternate series with localized channel sections from which the jets are forcibly deflected, the result being a pumping action in the close vicinity of the filament favorable to the cross sectional flow of the treating fluid.

Another object of the invention is to provide an apparatus for the high pressure fluid treatment of filamentary materials wherein the yarn or filament to be treated may be readily initially threaded through the apparatus, or re-threaded after breakage. With filaments of sufficient strength there would be no necessity of shutting down or reducing the fluid pressure during the re-threading operation. With very weak filaments simple valve control of the fluid would be the only accessory operation beyond the temporary shutting down of mechanisms arranged to traverse the material through the apparatus, which would be a requirement in all cases.

It is also an object of the invention to provide a fluid treating apparatus having a fluid pressure zone created by opposing high velocity streams in which the passage of a strand therethrough may be assisted, retarded or neutrally affected by changing the angle of fluid impact or the fluid pressure or both to achieve a positive, negative or neutral tensile stress in the strand. It is to be understood that in the relief of tensile stress on the filament caused by passage through the apparatus which may be had by properly arranging the jet pressure and jet impact angle lies one of the principal features of the apparatus whereby yarn filaments may be fluid processed at extremely high speeds without being subject to damaging tensile stresses.

It is a principal object of the invention to provide in a fluid treating apparatus of the type described means for permitting the apparatus to act as a storage device in which the angle of impact of fluid pressure jets in a pressure chan-

nel would be locally altered to accelerate the material under the treatment at the entrance end of the pressure channel and to decelerate or retard the flow of material at the exit end of the channel, the result being a compression or storage of the material in the channel while in process and a realization of the useful benefits of such storage as exemplified in the class of devices known as storage reels.

It is a general object of the invention to employ in a fluid processing apparatus a plurality of mutually opposed fluid streams to cause the fluid more rapidly and effectively to permeate a continuous traveling strand of textile fibers or other filamentary material and to simultaneously control the movement of the strand through the apparatus, thereby providing in the combination a more convenient and practical means of fluid processing textile strands at high speeds and high fluid pressures than has been known heretofore.

A feature of the invention is the creation within a trough or channel-like member by means of a plurality of opposed high velocity streams of fluid and without the necessity for pressure retaining seals or covers of a zone of relatively high fluid pressure through which the filamentary material may be passed, said trough-like member being open to atmospheric pressure permitting the high velocity streams to diffuse and well up therein after contact with the material and to drain therefrom by gravity, said streams being so directed that a resultant of pressure arising from collision and deflection serves to assist in the retention of the filamentary materials in said pressure zone.

Other objects and features will become readily apparent from the following detailed description taken in connection with the accompanying drawings in which there is illustrated a preferred embodiment of the invention.

In the drawings:

Fig. 1 is a top plan view partly in section of the apparatus;

Fig. 2 is a vertical section view on line 2—2 of Fig. 1;

Fig. 3 is a transverse section on line 3—3 of Fig. 2;

Fig. 4 is a similar section on line 4—4 of Fig. 2;

Fig. 5 is a section in elevation showing in greater detail the baffle structure at the ends of the apparatus with the removable baffle plates in place;

Fig. 6 is a sectional view on line 6—6 of Fig. 5;

Fig. 7 is a fragmentary plan view of a modification of a portion of the apparatus shown in Fig. 1; and

Fig. 8 is a fragmentary plan view showing an arrangement of jets to facilitate the use of the device as a storage apparatus.

The form of device illustrated in Figs. 1 to 6 comprises an open trough 10 having fixed baffle plates 12 at either end and drains 14 at the bottom thereof. Jet carrying manifold-like members 16 and 18 are releasably affixed by bolts 20 and 22 respectively to the bottom interior of the trough 10 in parallel spaced relation. The member 16 is hollowed out to provide enlarged ducts 24 having a series of aligned outlet ports or jets 26 directed inwardly into the longitudinal slot 28 between the members 16 and 18. The member 18 is provided with similar ducts 30 and similar ports 32, said ports, when members 16 and 18 are bolted in place, providing diametrically opposed jets adapted to emit high velocity

streams of treating fluid which will converge at a plurality of points along the path of strand travel in slot 28. Member 18 is also provided with a longitudinal groove 28' of slight depth, mating with and forming a continuation of slot 28, for a purpose hereafter described.

In the bottom of the trough 10 there are formed two longitudinal ducts or chambers 34 mating with the corresponding chambers 24 formed in members 16. Corresponding chambers 36 are provided to supply fluid to ducts or chambers 30 in member 18. Inlet pipes 38 and 40, connected to a source of liquid supply under pressure (not shown), in turn furnish treating fluid under any desired pressure to the chambers 34 and 36, and through ducts 24 and 30 for emission in opposed streams from the jets 26 and 32.

As shown in detail in Figs. 5 and 6, the ends of the trough 10 are provided with a baffle construction to permit entry and exit of the traveling strand 44 with a minimum of fluid loss. The end structure comprises a series of fixed parallel baffle plates 12, spaced to interfit with removable baffle plates 13 carried in parallel spaced relationship by a supporting member 15. The plates 12 are provided with vertical slots 48 and have substantially the configuration shown in Fig. 4. The removable plates 13 have substantially the configuration illustrated in Fig. 6 and are adapted to be inserted between the plates 12 to provide a series of baffles having a plurality of openings 42 aligned with the bottom portion of the slot 28 so that the filament or yarn 44 may be passed in either direction directly through the trough 10. Fluid passing with the strand 44 from the trough 10 through the restricted openings 42 will be wiped from the strand by the baffle plates and drain by gravity through auxiliary drains 46. In the treatment of some materials it may be preferable to adjust the relationship of the plates 12 and 13 in such a manner that the openings 42 form a sinuous path or labyrinth through which the strand must pass whereby the volume of fluid carried through the baffles by the traveling strand may be substantially reduced.

It should be pointed out in this connection that other types of sealing closures may be substituted for the specific baffle system herein described for use at the ends of the trough 10, and the filament or strand may be introduced or withdrawn from the trough 10 in any suitable manner. For example, I may avoid the use of any strand passage openings below the liquid level in the trough by passing the strand downwardly into the trough and under submerged rollers, pulleys or rods and withdrawing it in a similar fashion so that leakage is effectually eliminated. Such an arrangement, however, lacks the ease of threading of the embodiment illustrated in the drawings.

It is a particular advantage of my invention that the treating fluid need not be confined under high pressure in a treating chamber but may be allowed to well up freely in the slot 28 and in the open trough 10 so as to drain by gravity through the drains 14 and 46 which are of sufficient cross-sectional area to accommodate any desired volume of fluid emitted by the jets. Thus, at the ends of the trough near the baffles, the fluid is no longer under high pressure and consequently the amount of leakage will be greatly reduced.

In this manner I have provided an apparatus in which a strand may be treated with rela-

tively heavy fluid pressure of say 100 lbs. per square inch, but which possesses none of the ordinary drawbacks incident to the use of such high pressure. Thus heavy pressure resisting construction, complex closures to permit the introduction and withdrawal of yarn and yet prevent leakage, difficulty of access to the interior for the purpose of cleaning and threading, etc., are all eliminated by my novel apparatus and method.

In the operation of the fluid treating device according to the invention, I may supply treating fluid, of whatever type may be desirable for the particular impregnating or washing treatment involved, through the inlet pipes **38** and **40**. Before introducing the fluid, member **15** is lifted out together with the removable baffle plates **13** affixed thereto, leaving a series of aligned openings constituting a narrow longitudinal slot extending the entire length of the trough. A strand or filament **44** may then be threaded from above through the slot **28** into groove **28'** and the plates **13** replaced. The yarn will continue to enter and leave the apparatus through the openings **42** while treating fluid, welling up in the trough, is drained through the outlets **14** and **46**. The accumulated discharge from the jets will cause a rise of fluid in the trough **10** to some point below its upper edge. There the accumulated static head, as related to the depth of the fluid in the trough **10** and the cross-sectional area of the drains **14**, will cause the fluid to flow out the drains as rapidly as it enters through the jets **26** and **32** and thereby maintain a liquid level sufficient to submerge the members **16** and **18** but not to overflow the edges of the trough **10**.

Groove **28'** is of sufficient depth so that the center of strand **44** is located below the center of the opposed fluid streams from the jets, although preferably not deep enough to remove the strand below a position of direct exposure to the streams. In this manner, the resultant downward pressure on the strand of the meeting, balanced, mutually deflecting streams, is greater than the upward pressure thereon, and lifting of the strand in or out of the slot **28** by the upward force and flow of the fluid is prevented.

If the filament **44** be passed through the apparatus of Figs. 1 to 6 from left to right in Fig. 1, the impacts of the liquid streams ejected through the jets **26** and **32** at an acute angle to the path of travel serve to propel the filament through the apparatus. If the filament is passed in the reverse direction, the streams through the jets are at an obtuse angle to the path of travel of the filament, so that the filament is retarded by the impacts of the high pressure streams of fluid. Drafting rollers or other suitable means may be provided at the outlet end of the trough to tension the filament against the retarding effect of rearwardly directed jets, such tension being desirable for certain operations such as washing of causticized yarn in a mercerizing process. In all cases the accelerating or decelerating effect of the streams may be altered by regulating the fluid pressure.

If desired, the manifold members **16** and **18** may be made easily removable by the use of readily accessible bolts **20, 22**. Interchangeable manifold members may be provided to replace the members **16** and **18**, such additional manifolds having ports directed at any desired angle. For example, as shown in Fig. 7, a neutral drafting effect may be obtained by arranging the ports

26' and **32'** to direct streams of fluid at right angles to the path of travel of the yarn.

The slots **48** in plates **12** are made very narrow for the treatment of strands or filaments of small diameter. For example with yarns having a diameter of not more than .01", the slots should be no more than .015" wide. The slot **28** between the manifold members is preferably also of similarly narrow width, only slightly in excess of the diameter of the filament or filaments being treated, although the slot should be of substantial depth.

Since there is no problem of retaining the fluid at high pressure the trough **10** may preferably remain open at the top throughout its length to facilitate cleaning and threading the strand, although a cover is optional. The fluid discharged will be effectively retained without the use of elaborate sealing closures and need not be shut off or reduced in pressure for re-threading in case of breakage of the strand unless the strand is of an extremely delicate nature. By arranging the ports **26** and **32** to discharge opposing streams and by narrowly confining the strand in the channel **28** so as to travel along a path defined by the points of impact of the streams, a balanced pressure condition is attained which reduces contact of the strand with the edges of the slot and protects the strand from disruption by the high velocity streams or by frictional engagement with the walls of the slot.

Where a series of manifold members is used as in multiple process operations, the jets may number a total of several hundred. In such an apparatus, if the ports are set at 90° to the path of travel of the strand, the total fluid friction on the strand may attain undesirable proportions. In these cases the jet angle can be modified forwardly to offset the effect of friction so that no effort is required to draw the strand through high pressure zones between the manifold members **16** and **18** whose combined length might total, for example, as much as 30 or 40 feet. Thus the strand may be processed under high fluid pressure while the longitudinal stress within the strand is kept substantially at zero.

Where it is desired to increase the length of time during which the yarn remains under fluid treatment or in other words to cause the apparatus to function as a storage device, the port impact angles may be varied in a single system as at **49, 50** and **51** in Fig. 8 where the yarn is accelerated by ports **49** upon entrance from a free running supply at a rate greater than the acceleration produced by ports **51** which have a greater angle of incidence. The result is a tendency of the yarn to accumulate in the pressure zone which may be slightly enlarged as at **52** and in which the ports would supply no acceleration but would be arranged to retain the yarn in the pressure zone in this section.

A moving strand passing through the trough encountering successive streams discharged at high pressure, will also pass through small areas of lower pressure between the streams, resulting in a favorable pulsating pressure condition conducive to effective permeation or washing. When the traveling strand passes through the zones near the drains **14** the fluid pressure will become very light, and when it enters the baffle system fluid will drain therefrom by gravity.

In my apparatus the strand is subjected simultaneously to a substantial static pressure of the body of treating liquid in the trough and a high kinetic pressure of the fluid streams projected

against the yarn. These combined pressures, together with the pulsating action of the kinetic pressure, produce a marked improvement over prior apparatus and methods in the efficiency of the action of treating fluids on filaments, strands, threads and yarns.

I have illustrated the invention as applied to the treatment of a single strand in a single passage between the manifolds but it will be understood that strands may be passed in multiple between a single pair of manifolds, or a single strand may be reversed on itself and passed back and forth between a single pair of manifolds. In either case, the number of lengths of strand passed between the manifolds at one time is preferably low in order that the width of the treating slot between the manifolds may be kept small.

It will therefore be seen that I have provided a new and improved apparatus for applying a treating fluid to filamentary materials under high pressure for the more convenient and effective permeation or impregnation thereof. In the foregoing description and the accompanying drawings I have disclosed a preferred embodiment of the invention, but it is to be understood that modifications and changes may be made therein by persons skilled in the art within the spirit and scope of my invention as defined in the appended claims.

I claim:

1. Apparatus for the high pressure liquid treatment of a traveling strand of filamentary material without harmfully disrupting the same, which comprises: a trough adapted to contain a bath of treating liquid at substantially atmospheric pressure, a manifold mounted within said trough, conduits for supplying treating liquid under high pressure to said manifold, said manifold having a pair of substantially vertical closely spaced opposing walls extending longitudinally within said trough and said trough having an upwardly facing surface beneath and intersecting said walls and defining therewith a narrow longitudinally extending channel, said manifold having a series of submerged ports arranged in line in each wall for admitting treating liquid to said channel, the ports of one of said series facing corresponding ports of the other series so that the resulting pairs of opposed jets will mutually impinge upon and counteract each other, said ports likewise being close to said upwardly facing surface whereby the portion of said channel substantially between said surface and the region defined by the points of mutual impact of said opposing jets and bounded by the intermediate portions of said walls will constitute a narrow longitudinal treating zone of high liquid pressure through which said strand may travel in the direction of its length.

2. Apparatus according to claim 1 in which at least some of said pairs of opposing jets are directed at right angles to the path of strand travel.

3. Apparatus according to claim 1 in which at least some of said pairs of opposing jets are directed at an obtuse angle to the path of strand travel.

4. Apparatus according to claim 1 in which at least some of said pairs of opposing jets are angled in the direction of strand travel for impelling said strand forwardly through said treating zone.

5. Apparatus according to claim 1 in which at least some of said pairs of opposing jets are angled in a direction opposite to that of strand travel whereby the forward movement of said strand will be retarded by the impacts of said jets, and in which said apparatus includes a device for drawing said strand through said treating zone against the resistance of said jets.

6. Apparatus according to claim 1 in which the ends of said trough comprise a series of spaced parallel slotted interfitting baffle members, the slots thereof being of different shapes but portions of the same being aligned with each other to provide a leak resistant opening at each end of said trough permitting the introduction and withdrawal therethrough of the traveling strand, the edges of at least the slots at the outlet end of said trough being arranged successively to contact said strand on different sides thereof and to wipe surplus liquid therefrom after it leaves said treating zone.

7. Apparatus for the high pressure liquid treatment of a traveling strand of filamentary material without harmfully disrupting the same, which comprises: a trough adapted to contain a bath of treating liquid at substantially atmospheric pressure, a pair of manifolds mounted within said trough, conduits for supplying treating liquid under high pressure to said manifolds, said manifolds being elongated and substantially parallel to each other and having opposed vertical closely spaced walls defining, with the bottom of said trough, a narrow longitudinally extending channel, said manifolds providing two opposed series of submerged ports in said walls for the admission of treating liquid to said channel, each of said series being arranged in line in its corresponding wall and the ports of one series facing corresponding ports of the other series so that the resulting opposed pairs of jets will mutually impinge upon and counteract each other, said ports likewise being close to the bottom of said trough whereby the portion of said channel between said bottom and the points of mutual impact of said opposing jets and bounded by the intermediate portions of said walls will constitute a narrow longitudinal treating zone of high liquid pressure through which said strand may travel in the direction of its length.

8. Apparatus for the high pressure liquid treatment of a traveling strand of filamentary material without harmfully disrupting the same, which comprises: a trough adapted to contain a bath of treating liquid at substantially atmospheric pressure, a pair of manifolds mounted within said trough, conduits for supplying treating liquid under high pressure to said manifolds, said manifolds being elongated and substantially parallel to each other and having opposed vertical closely spaced walls, said trough having an upwardly facing surface beneath and intersecting said walls and defining therewith a narrow longitudinally extending channel, each of said manifolds providing an aligned series of submerged ports in its corresponding wall for the admission of treating liquid to said channel, the ports of one series facing corresponding ports of the other series so that the resulting opposed pairs of jets will mutually impinge upon and counteract each other, said ports likewise being close to the bottom of said channel whereby the portion of said channel between said bottom and the points of mutual impact of said opposing jets and bounded by the intermediate portions of said walls will constitute a narrow longitudinal treating zone of high liquid pressure through which said strand may travel in the direction of its length, the ends of said trough being spaced from the ends of said manifolds and comprising a series of

spaced parallel slotted interfitting baffle members, the slots thereof being of different shapes but portions of the same being aligned with each other to provide a leak resistant opening at each end of said trough permitting the introduction and withdrawal therefrom of traveling strand, the edges of at least the slots at the outlet end of said trough being arranged to contact said strand on different sides thereof and to wipe surplus liquid therefrom after it leaves said treating zone, said trough being further provided with drains between the ends of said manifolds and said baffles.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
338,096	Meikle	Mar. 16, 1886
1,403,126	Lyth	Jan. 10, 1922
1,755,686	De Jahn et al.	Apr. 22, 1930
2,025,768	Nieman	Dec. 31, 1935
2,163,634	Schlumpf	June 27, 1939
2,192,303	Ferm	Mar. 5, 1940
2,223,355	Gonser et al.	Dec. 3, 1940
2,299,145	Hill et al.	Oct. 20, 1942
2,313,006	Ufnowski	Mar. 2, 1943
2,441,308	Bond	May 11, 1948

FOREIGN PATENTS

Number	Country	Date
3,645	Great Britain	1884