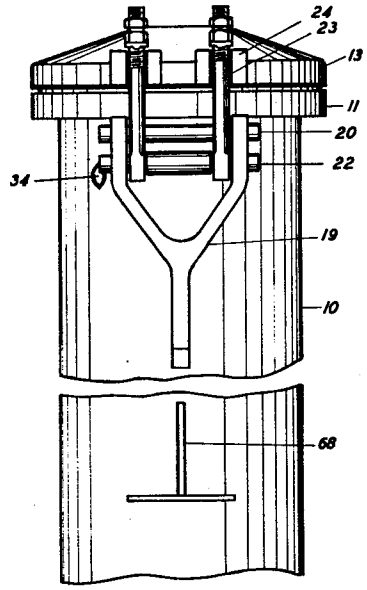
Sept. 13, 1932. H. H. CANNON 1,877,157

TUBULAR FILTER

Filed Oct. 2, 1929 3 Sheets-Sheet 1



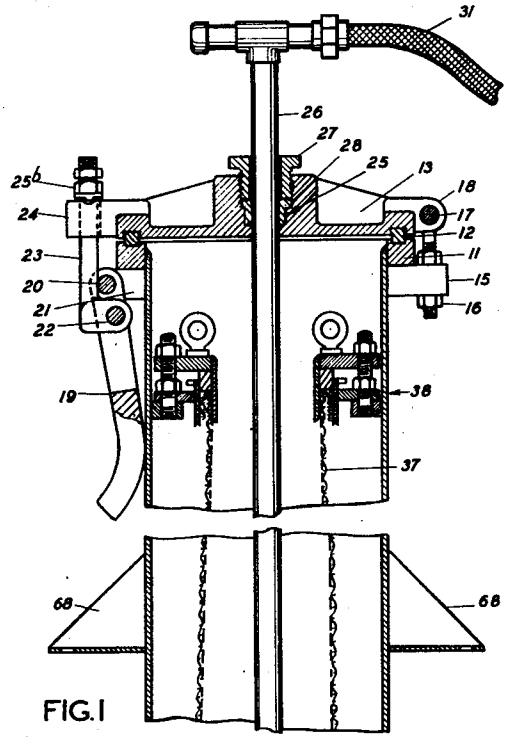


FIG. 1

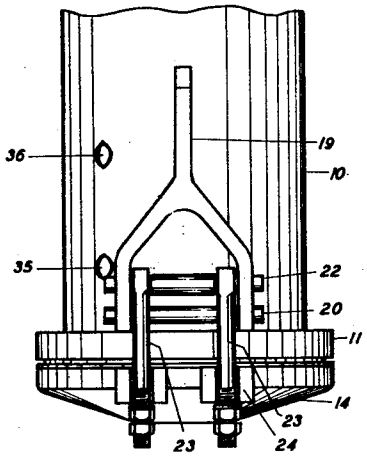
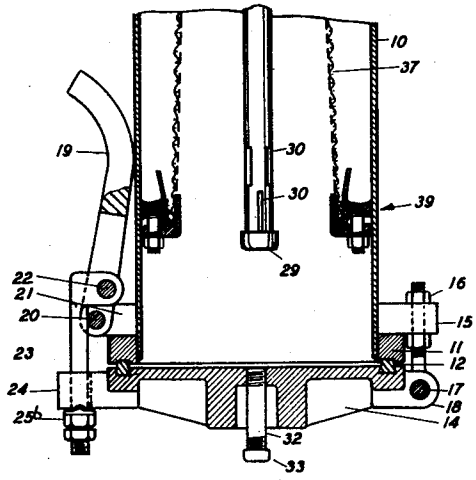


FIG. 2



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TUBULAR FILTER

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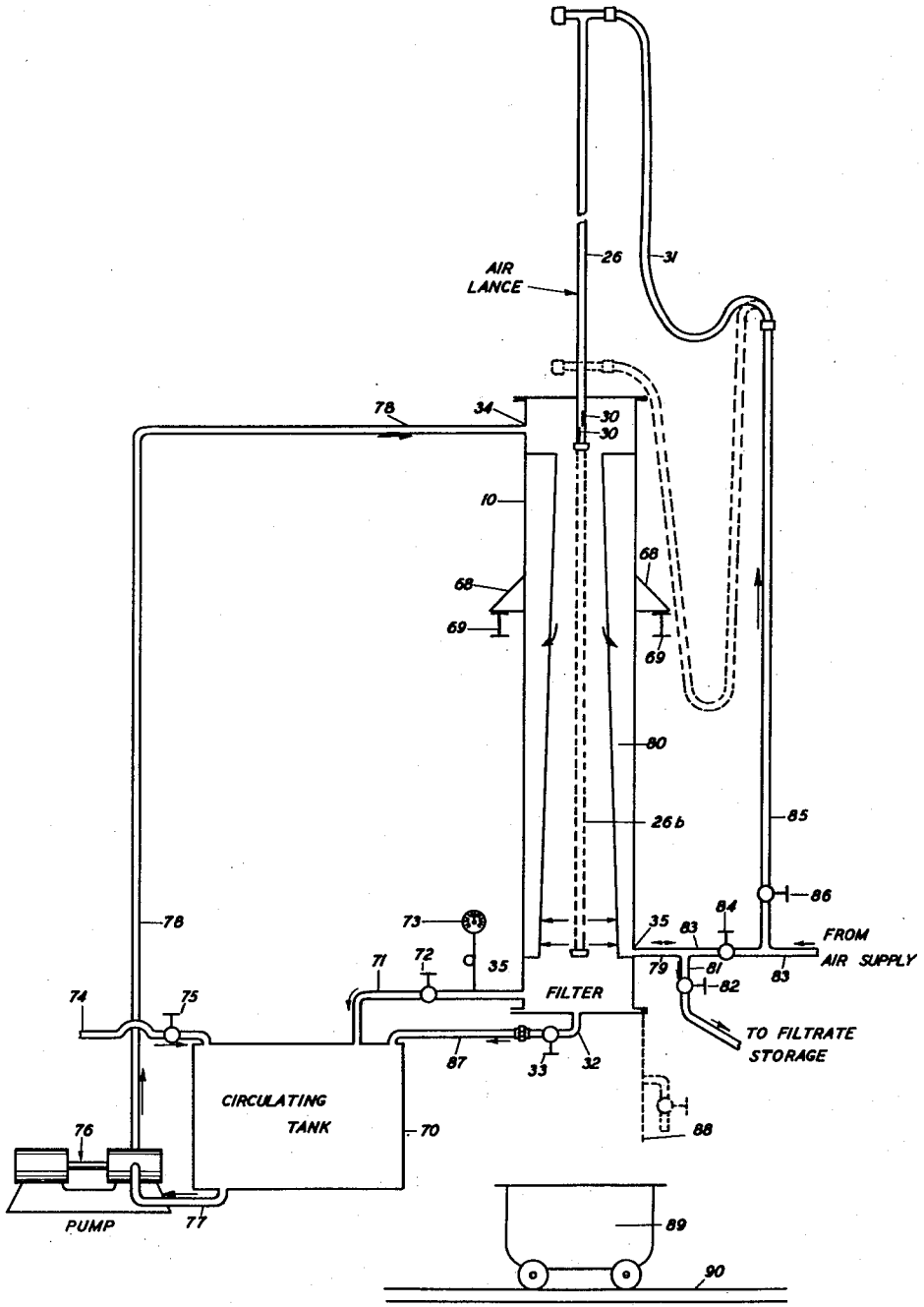

FIG. 5

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TUBULAR FILTER

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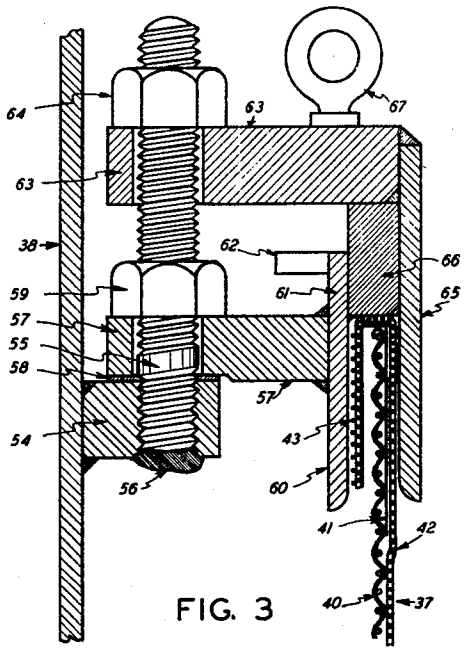

FIG. 3

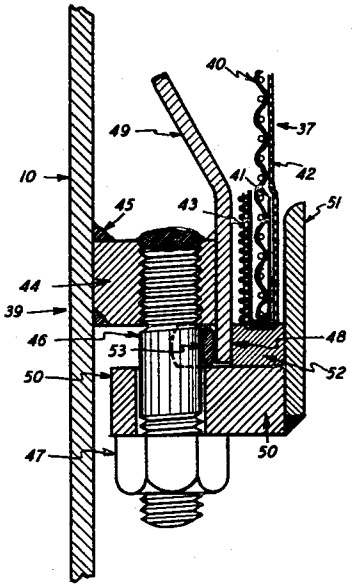

FIG. 4

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UNITED STATES PATENT OFFICE

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TUBULAR FILTER

Application filed October 2, 1929. Serial No. 396,901.

My invention relates to means for filtering suspended solids from the liquids with which they are mixed, and in particular to a type of filter having a foraminous tube fixed in a vertical position. The suspension being forced into this tube, the liquid constituent passes through its wall into a collecting chamber while the solid matter collects in the form of a tubular cake lining the foraminous tube.

My invention relates particularly to the type of filter in which a single tube is used, this tube being preferably of tapered or flaring construction, and to certain specific means for inserting, locking, and removing and cleaning the tube.

The objects and advantages of my invention will be evident from the attached drawings and the appended description thereof, in which

Fig. 1 shows a complete filter in vertical section;

Fig. 2 shows a complete filter in elevation, the apparatus being rotated 90° from the position in which it is shown in Fig. 1;

Fig. 3 is a section on an enlarged scale of the upper end locking arrangement indicated at 38 in Fig. 1;

Fig. 4 is a similar section of the lower end tube-locking arrangement indicated at 39 in Fig. 1, and

Fig. 5 is a diagram illustrating a preferred manner of operating my improved filter.

Referring to Figs. 1 and 2, 10 is a relatively long and narrow cylinder, preferably formed of light steel pipe. For example, the cylinder may be ten inches in diameter and eleven feet long, or in that proportion. To each end of this cylinder a narrow flange 11—11 is made fast in any suitable manner. These flanges are grooved for the reception of rings of soft packing 12—12, and mating grooves are formed in the upper head 13 and the lower head 14.

These heads, which are preferably of cast iron, are movably attached to the cylindrical shell by hinges consisting of the lugs 15, fastened to the shell, the eyebolts and nuts 16, the swivel pin 17 and the lug 18 formed on the head. By means of this arrangement, which is clearly illustrated in Fig. 2, the tension of the head on the packing may be adjusted at intervals as required without such adjustment being made every time the head is opened.

The heads may be locked on the side opposite the hinge by a hand lever 19 swinging on a pin 20 which is let into lugs 21, these lugs being fastened to the shell. The inner end of the lever carries a pin 22 on which swing the drawbolts 23 cooperating with the notched lugs 24 which project from the head. With the hand lever in the position shown the packing may be drawn tight on this side by adjusting nuts 25. To release the head and enable it to be swung on pin 17 the arm is merely drawn outward and downward, or upward as the case may be.

In the upper head 13 is formed a socket 25, the bottom of which is drilled through to fit snugly around the air lance 26. A gland 27 and the soft packing 28 prevent liquid from leaking around the lance when the filter is under pressure.

The lance consists of a turned and polished length of relatively small pipe, say 1″ to 1½″ pipe size for the filter dimensions above given. The lower end of the pipe, which should be long enough to reach to the bottom of the filtering tube, is capped or otherwise closed as at 29. Above this closure I form one or more slots or perforations, the total area of which should be materially less than the internal cross-sectional area of pipe 26. To the upper end of this pipe is attached an air hose 31 which is connected to any source of supply of air under pressure and is provided with the valve 86 for the control of such air.

In the center of the lower head I prefer to place a pipe nipple 32 with a cap 33, or a valve, for completely draining the head prior to dropping it.

At any convenient point near the upper end of the shell I provide a pipe-tapped opening 34 and near the lower end a similar opening 35. Into these openings are screwed pipes for conveying the suspension into and out of the press, the direction of flow being optional with the operator.

A valve may be placed in whichever pipe is

used for pumping suspension into the press, though this is necessary only when two or more presses are fed from a single pumping means. A valve or equivalent means for restricting the flow and thereby creating pressure within the press must be placed in whichever pipe is used as an outlet for suspension.

A similar threaded opening 36 is formed in the shell at a point near the lower end of the filtering tube, next to be described, to carry away filtrate passing through the wall of the tube.

The filtering tube 37 is preferably, though not necessarily, greater in diameter at the lower than at the upper end, and is held in position by the upper and lower retaining assemblies indicated at 38 and 39 in Fig. 1 and shown in detail in Figs. 3 and 4.

The filtering tube 37 is formed of at least two layers or concentric tubes, the outer of rigid perforate material and the inner of flexible foraminous material. The outer tube may be of perforated or slotted sheet metal or pipe, with or without a lining of wire mesh, or it may be rolled up from a sheet of stiff steel screen and a joint formed by crimping, soldering, welding or a combination of these operations. The joint must be strong enough to withstand press pressure as the inner tube has no inherent strength. The simple arrangement shown, in which the cloth tube is immediately within the screen tube, is satisfactory unless the mesh is so coarse that the cloth may punch through, in which case an intermediate layer of a finer screen should be used.

In Figs. 3 and 4 the outer tube is indicated at 40. It is desirable to form on each end of this tube a fold 41 of light sheet metal to protect the inner tube from damage by projecting wires and to form a smooth, square end. The inner tube 42, which may be of cotton, burlap, wool blanket or fine mesh metal cloth, is cut to a length greater than that of the outer tube and the ends are folded back over the protecting sleeve 41 and made fast by a winding of wire or cord as at 43. When thus tied at the ends the assembly constitutes a removable unit which may be made up in advance, ready for immediate insertion when a cloth replacement is required, and which can be placed in the press in a minimum of time.

The lower end of the tube unit is supported on a tube-sheet 44 attached in any suitable manner to the inside of shell 10. In the case of a single tube filter as here illustrated this tube sheet takes the form of a narrow ring, but where a plurality of tubes is desired the tube sheet would be the usual plate with a plurality of openings for the tubes. This ring carries a row of studs 46, which may be threaded in and then peened or welded over the end to prevent backing out, and which are provided with nuts 47. To the inner face of this ring is welded a tubular ring which projects downwardly to form a skirt 48 and which may also be projected upwardly and flared as shown to form a conical guide as at 49.

A second ring 50, somewhat smaller than the above, has holes adapted to fit freely over studs 46. To the inner face of this ring is welded another tubular ring 51, projecting upwardly to form with ring 48 an annular channel of a width suitable to receive the lower end of the tube unit. In the bottom of this channel is placed a ring of soft packing 52, to prevent leakage around the end of the tube, and when the lower ring is drawn toward the upper by means of nuts 47 a ring of soft packing 53 may be laid around skirt 48 to prevent leakage between the two rings.

If the filtering tube is to be of uniform diameter throughout or if the press is to be so situated that replacements may conveniently be made through the lower end, an identical or similar means for retaining the upper end may be used. But as the use of tapering tubes is desirable and as replacements must in most cases be made from above, I prefer to use the double retainer shown in Fig. 3 for the upper end of the filtering unit.

Referring to Fig. 3, 54 is a tube sheet or a ring attached inside the shell and 55 is one of a ring of studs made fast therein as by the screw thread and the weld 56. On top of this ring is placed a ring 57, of somewhat less diameter, this ring being drawn down solidly on the soft packing 58 by means of nuts 59. To the inside of this ring is attached a tubular ring forming a skirt 60 projecting downwardly and a short skirt 61 projecting upwardly. The latter is provided with two or more small lugs 62 for use in withdrawing ring 57 when nuts 59 are removed.

Above this second ring is placed a third ring 63, having substantially the same outside diameter as the second and an inside diameter approximating that of the upper end of the filtering tube. This ring is drawn downwardly by the nuts 64 placed on the upper portion of the studs 55. On the inner circumference of this third ring is formed a skirt 65 projecting downwardly. The upper end of the filtering tube is held in the annular channel formed between the two skirts 60 and 65, and in the bottom of this channel is placed a ring of soft packing 66, the compression of which against the end of the tube is sufficient to stop leakage at this point. A plurality of eyes 67 or equivalent means for lifting out the upper ring is provided.

To draw a tube from the lower end of the filter it is only necessary (after dropping head 14) to remove nuts 47 and ring 50, which will carry with it the packing rings 52 and 53 and allow the tube to drop out. To make

a replacement from the upper end it is necessary to first remove nuts 64 and the upper ring 63, then to remove nuts 59 and the middle ring 57, which leaves an opening of sufficient width for the withdrawal upwardly of the enlarged lower end of the tube.

While I claim my improved filter for any use to which it may be put and for any manner of operation of which it may be capable, I show in Fig. 5 a preferred manner of operation in which it is illustrated as adapted to the removal of comminuted materials, such as decolorizing or diatomaceous earths or solid reagents, from various petroleum products. Referring to this figure, the filter shell 10 is supported in a vertical position by means of the lugs 68 resting on I-beams 69. The bottom of the shell should be at least several feet above the ground or the floor of the building in which it is placed.

A circulating tank 70 is provided, the top of which is preferably below the bottom of the filter shell in order that the filter may drain into it. A pipe connection 71 is made between the top of this tank and the opening 35 already described, and this pipe is provided with control means, such as the valve 72 or its equivalent, and with a pressure gauge 73.

The feed of suspension to be filtered may be introduced into this tank through a pipe 74 provided with a control valve 75. A pump 76 takes suction through pipe 77 from any convenient point on the tank, preferably on or near its bottom, and discharges the suspension through a pipe 78 which is connected into an opening 34 in the upper portion of the shell, above the upper tube sheet.

A pipe 79 is connected into the opening 36 which communicates with the lowermost part of the filtrate receiving chamber 80 embraced between the tube sheets, the tube and the shell. This pipe divides into a branch 81 having a stop valve 82 and opening into a receiving tank for filtrate and a branch 83 having a stop valve 84 and communicating with a source of supply of compressed air or other gas. Pipe 83 again branches into pipe 85 having a control valve 86 and communicating with the flexible hose 31 by which air is fed to the air lance 26.

The nipple 32 in the bottom head is provided with a valve 33 and is thence connected into circulating tank 70. This connection may be made with a flexible hose or may be made up with pipe and a union as shown, but provision must be made in some way for permitting the lower head to be dropped at will into the position indicated at 88, and the connection must be quickly detachable as this head is dropped every time the cake is removed from a tube.

Below the filter a means for removing the solid cake discharged by the filter must be provided. This may be simply a platform from which the cake is shovelled into barrows, or it may be a conveyor belt, or it may be the car 89 running on track 90 as shown in the diagram, Fig. 5.

The filter being assembled with the foraminous tube or tubes in place, the circulating tank is filled with the suspension to be filtered and the pump 76 started, a sufficient feed being admitted to the tank through valve 75 to replace the liquid withdrawn by the pump. At this time the air lance is drawn up to the position indicated by the solid lines 26, the perforations or slots 30 being above the top of the filtering tube but below the upper head; the filtrate valve 82 is wide open, the air valves 84 and 86 are closed, and the bottom outlet valves 72 and 33 are partly or entirely closed. The filter is thus filled with suspension, the air previously contained in it being displaced through the cloth into the filtrate receiving chamber.

When the filter is full the outlet valve 72 and pump 76 are so regulated as to indicate a desired pressure on the pressure gauge 73 while allowing a liberal quantity of the suspension to return to the tank. By means of this pressure, which may be increased as the filtration progresses, a portion of the liquid constituent of the suspension is forced through the cloth tube, draining away through pipes 79 and 81 and valve 82, while a portion of the solid constituent collects in the form of a cylindrical cake lining the tube. The return to the circulating tank of a liberal proportion of the suspension introduced into the filter ensures a cake of uniform thickness from end to end of the tube, and does away with the possibility of a plug forming at the lower end of the tube.

Filtration is continued until the cake has attained a desired thickness or until the flow rate has dropped below an economical minimum. The pump is then stopped and drain valve 33 opened wide to allow the suspension remaining in the shell to drain back into the tank. Valves 33 and 72 are then closed and a small flow of air admitted to the tube by slightly opening valve 86, the cake being thus stripped of any liquid which can be blown through and rendered partially or entirely dry.

When the cake is thus dried so far as possible valves 82 and 86 may be closed and valve 84 partially opened, thus admitting air under pressure to the chamber outside the filtering tube. At the same time the lower head is dropped to the position indicated at 88 and a car or other means for conveying cake placed beneath the filter. This pressure coming on the outside of the cloth is communicated to the cake and, if the filtering tube is of the conical shape shown, the entire cake will often separate from the cloth by its own weight and drop out of the tube, thus leaving the filter clean and ready for the return of

the head to its closed position and the repetition of the cycle.

If the cake does not drop out, which is likely to be the case if the filtering tube is constructed with parallel walls, the air lance is brought into play. It is first slid down to the position indicated by the dotted lines 26*b*, that is to say, to a position where the lowermost slots or perforations 30 come opposite the lowermost part of the cake. A high velocity stream of air is then admitted by widely opening valve 86 and the lance is slowly raised and at the same time partially revolved so as to direct the jets of air issuing from the perforations against the lower parts of the cake. If the air pressure is sufficient the cake will thus be cut into fragments, dislodged from the cloth and caused to fall out of the filter tube. When this operation has been carried to the upper end of the tube the lance has returned to its idle position and the air supply is shut off by closing valve 86, after which the lower head is raised and locked and the filtering cycle may be resumed.

While some features of the construction shown are particularly adapted to single tube filters others are not so limited, and I do not limit my invention to the details of construction shown nor to the specific form, but only to the structures described in the appended claims.

I claim as my invention:

1. In a vertical filter having a shell, tube sheets therein and a perforate tube supported by said tube sheets, tube sheet construction comprising: a plate extending horizontally across said shell; an opening through said plate; a skirt fixed within said opening and substantially fitting the outside of said perforate tube; a ring concentric with said opening; a skirt fixed within said ring and substantially fitting the inside of said perforate tube, and bolts arranged to draw said ring toward said plate.

2. In a vertical filter having a shell, tube sheets therein and a perforate tube supported by said tube sheets, tube sheet construction comprising: a plate extending horizontally across said shell; an opening through said plate having substantially the diameter of said tube; an upwardly flaring skirt affixed to said plate within said opening, said skirt substantially fitting the outside of said perforate tube; a ring concentric with said opening; a skirt affixed to the inner circumference of said ring, said skirt substantially fitting the inside of said perforate tube, and means for removably attaching said ring to said plate.

3. In a vertical filter having a shell, tube sheets therein and a perforate tube supported by said tube sheets, tube sheet construction comprising: a plate extending horizontally across said shell; an opening through said plate; a flat ring concentric with said opening and removably attached to said plate; and an annular resilient base channel formed around the opening in said ring and adapted to receive the upper end of said perforate tube, and to hold said tube therein without deformation or leakage and to permit ready removal or insertion of said tube.

4. In a vertical filter having a shell, tube sheets therein and a perforate tube supported by said tube sheets, tube sheet construction comprising: a plate extending horizontally across said shell; an opening through said plate of sufficient diameter to pass a larger end of said perforate tube; a ring concentric with said opening and removably attached to said plate; a skirt fixed inside said ring, said skirt substantially fitting the outside of a smaller end of said perforate tube; a second ring concentric with said opening; a skirt fixed inside said second ring, said skirt substantially fitting the inside of said smaller end of said perforate tube, and means for drawing said second ring toward first said ring.

5. In combination with a filter having a shell, heads and a vertical foraminous tube which is easily removable from said shell, of frusto-conical form and spaced at a substantial distance from said shell when in position for use, means for removing accumulated solids from said foraminous tube, comprising: a closure for the lower end of said filter capable of being rapidly opened to expose the lower end of said tube, and an air pressure pipe closed at its lower end within said tube and having perforations above said closure, said pipe being slidably mounted in the upper head of said filter and being substantially centered within said foraminous tube, and means exterior to said upper head for supplying said pipe with air under pressure.

In witness that I claim the foregoing I have hereunto subscribed my name this 25th day of September, 1929.

HUGH HARLEY CANNON.