Aug. 6, 1963 J. C. SMITH ET AL 3,100,191

AUTOMATIC DRY CLEANING MACHINE

Filed Feb. 24, 1960 6 Sheets-Sheet 1

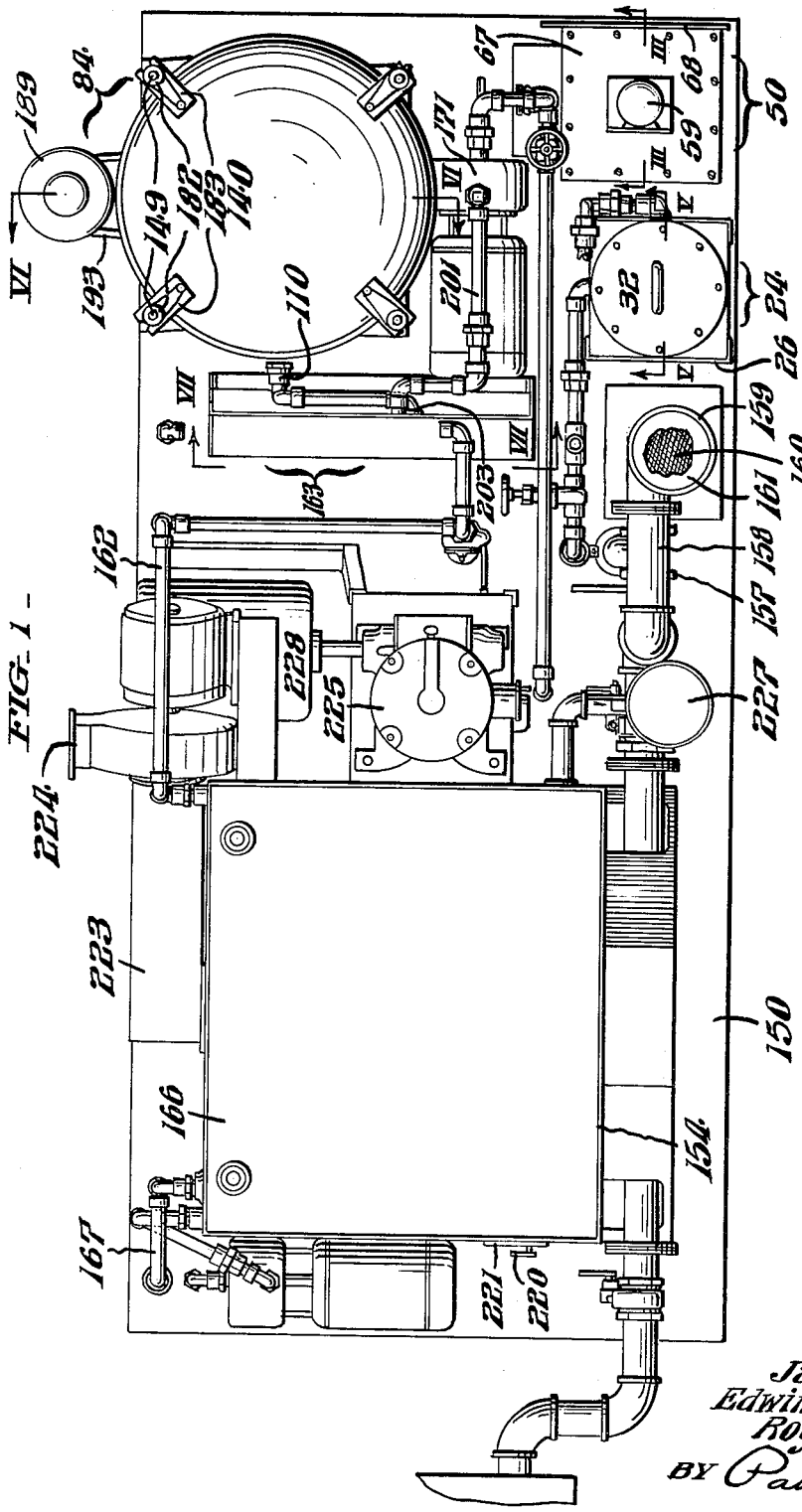

FIG. 1

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Filed Feb. 24, 1960 6 Sheets-Sheet 2

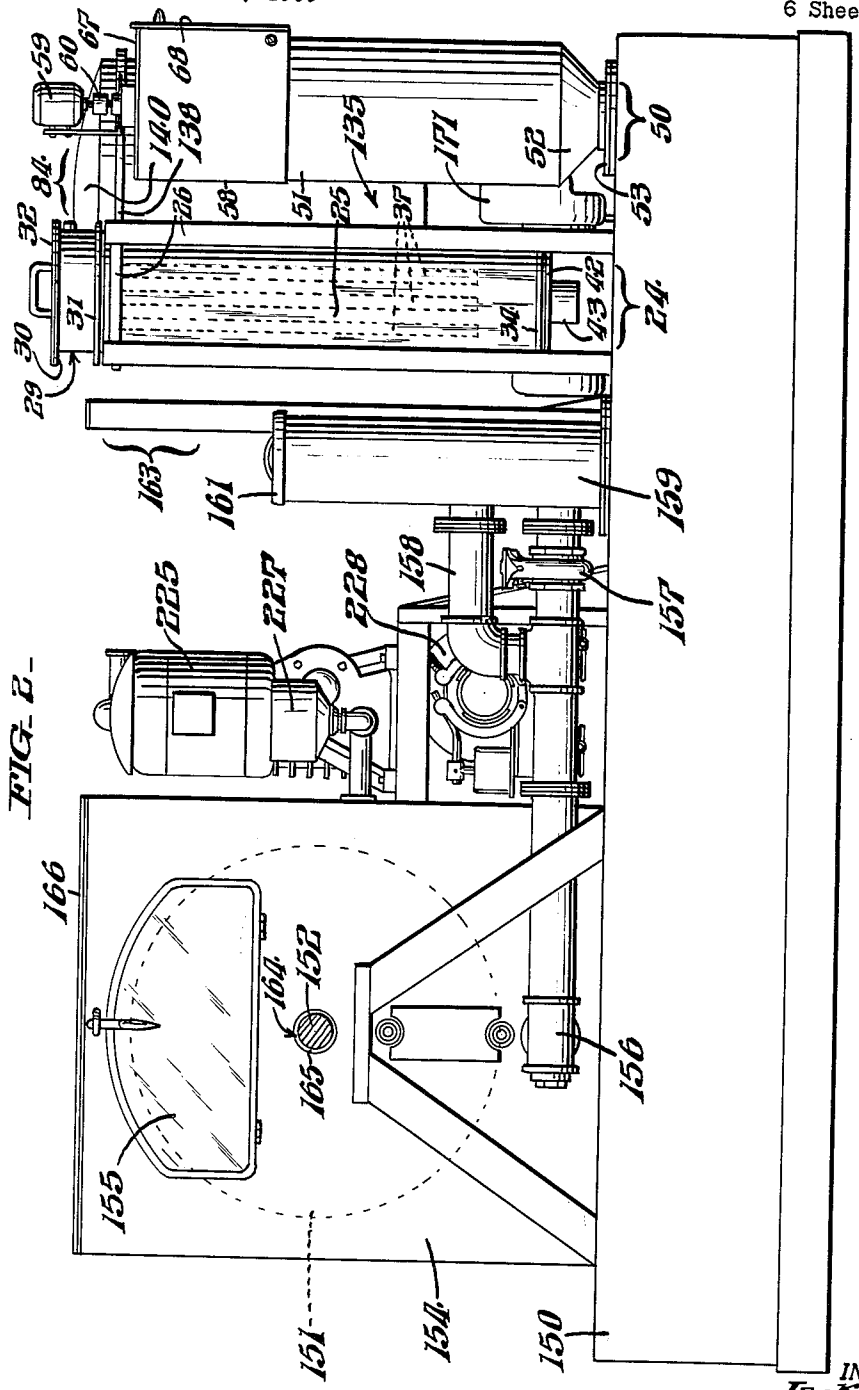

FIG. 2.

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AUTOMATIC DRY CLEANING MACHINE

Filed Feb. 24, 1960 6 Sheets-Sheet 3

FIG. 3

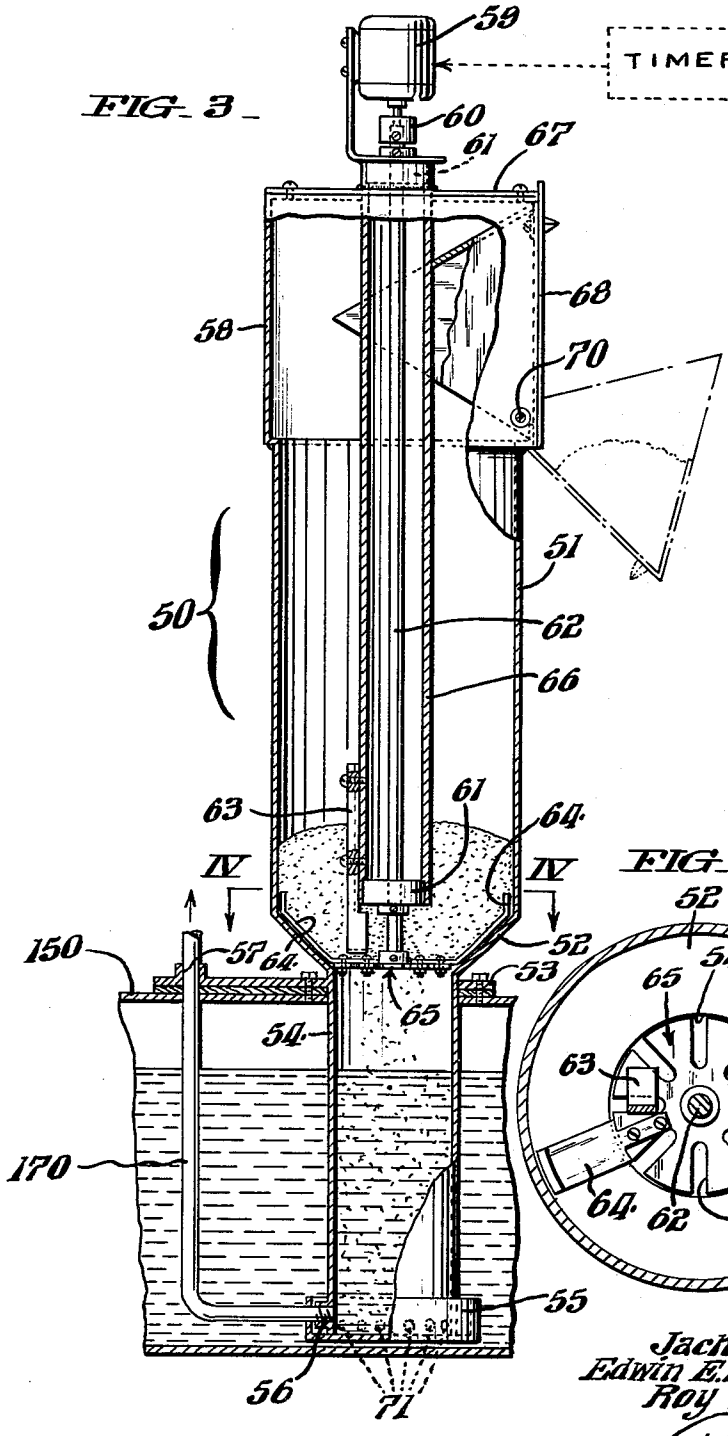

FIG. 4

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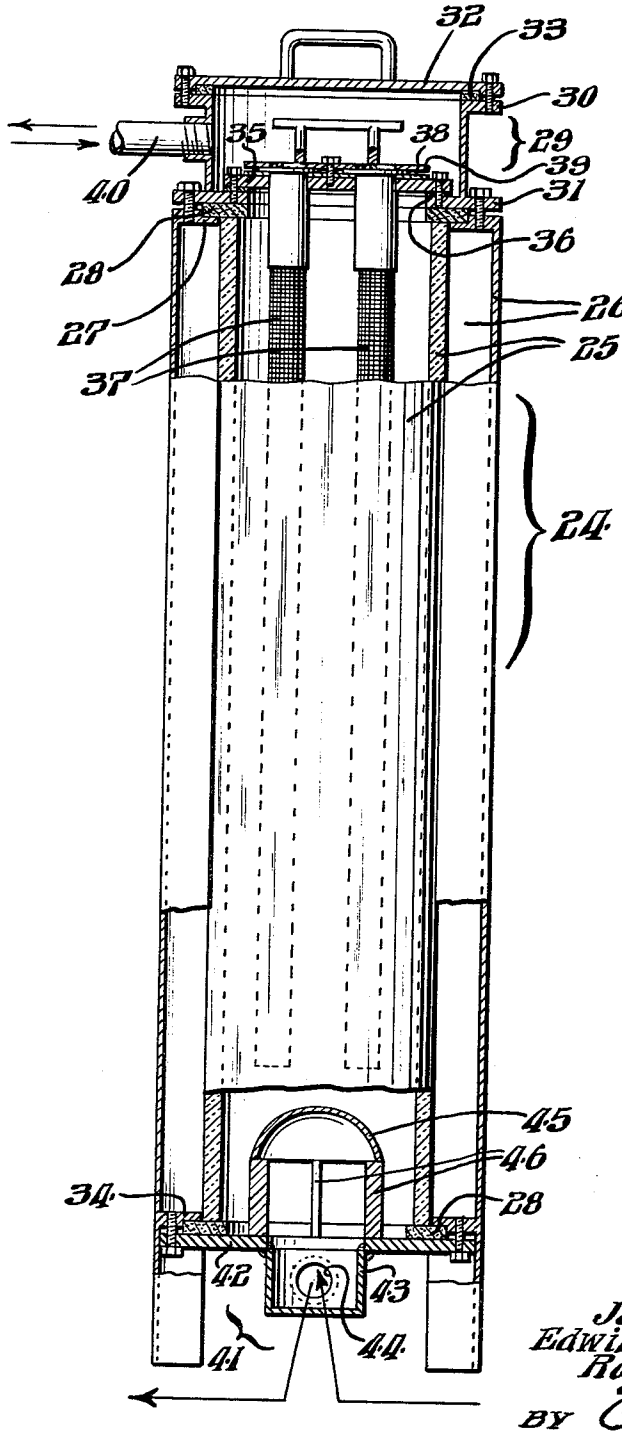
AUTOMATIC DRY CLEANING MACHINE

Filed Feb. 24, 1960 6 Sheets-Sheet 4

FIG. 5



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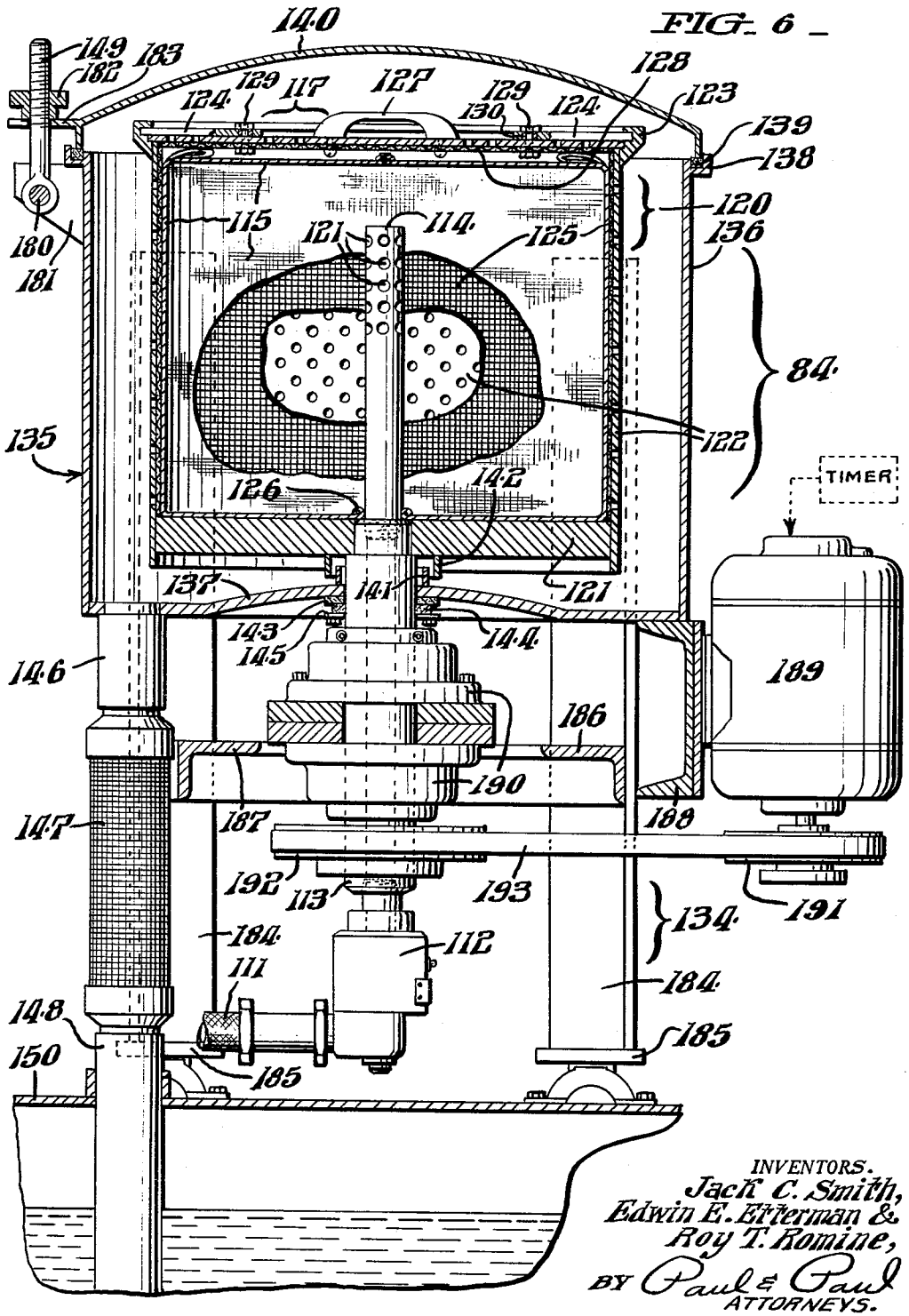
AUTOMATIC DRY CLEANING MACHINE

Filed Feb. 24, 1960 6 Sheets-Sheet 5

FIG. 6



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AUTOMATIC DRY CLEANING MACHINE

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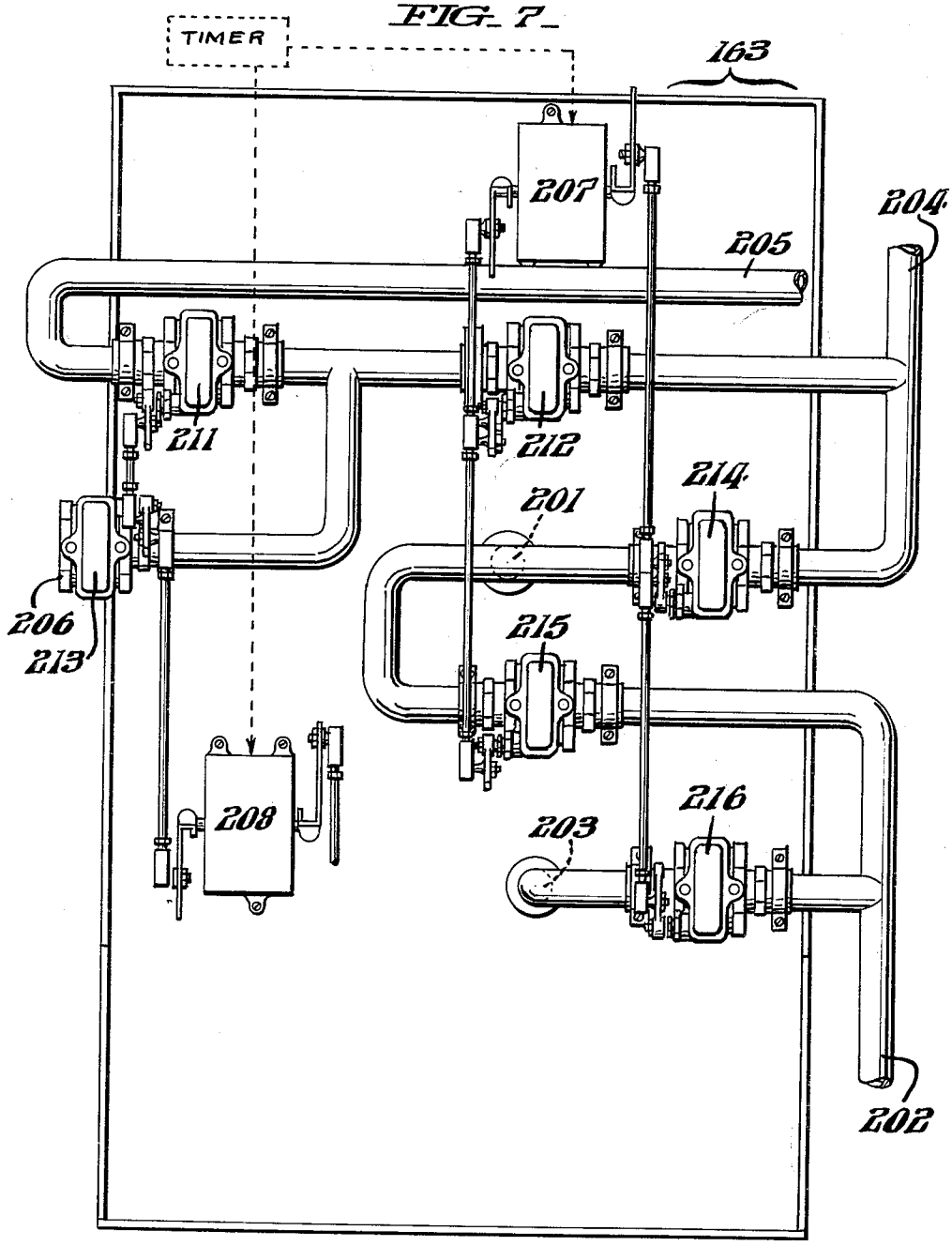
FIG. 7



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United States Patent Office

3,100,191

Patented Aug. 6, 1963

3,100,191

AUTOMATIC DRY CLEANING MACHINE

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Filed Feb. 24, 1960, Ser. No. 10,768
2 Claims. (Cl. 210—138)

This invention relates to an automatic dry cleaning machine particularly adapted for use by the retail dry cleaner for cleaning clothes and garments.

In the retail dry cleaning field there is a constant demand for ever better machines for use by the dry cleaner. There was a time when all dry cleaning was done in large central plants using petroleum solvents. This type of operation allowed close supervision by a few skilled operators of large volume dry cleaning. In the 1940's, dry cleaning plants began using synthetic solvents in their cleaning operations. A major advantage of this change in solvents was that it removed the fire hazard previously encountered in plants employing petroleum solvents. Another advantage was the elimination of the large underground storage tanks. Yet another was that it permitted a greatly reduced size of cleaning machine. The lack of fire hazard allowed the new synthetic-solvent machines to be installed wherever space was available. The old "pick-up" shop now became an operating dry cleaning plant. This made for faster customer service. In addition, the capital investment required to open a dry cleaning plant was substantially reduced, making it possible for small operations to start up with a minimum of capital investment. The shift in population to outlying districts opened the way for new operators. The advent of good streets and roads with dependable automotive transportation made it possible for the customer to switch from one cleaner to another when dissatisfaction arose.

Thus, as a result of the factors and forces summarized above, a highly centralized industry operating under close supervision with skilled operators became a decentralized one with a great many owners and a great many operators who lacked the skills required to turn out quality dry cleaning. In addition, the ever rising cost of labor demanded some type of at least semi-automatic dry cleaning machine which would reduce the skill level and attention to details previously required to turn out satisfactory dry cleaning.

The basic operation of dry cleaning is relatively simple. It consists of placing the soiled garments or materials to be dry cleaned in a container, agitating the container and the soiled garments in a solvent to remove the soils, draining the solvent and soils away from the now clean materials, spinning the container with the now clean materials at high speed to recover as much of the solvent as possible, passing the soil-carrying solvent through some type of filter to clean the solvent of the solid soils, distilling enough solvent from time to time to maintain the soluble soils therein at a low enough level to give satisfactory cleaning, and reusing the clean solvent for the next load of soiled materials. As a further step, the extracted clean materials are transferred to a second unit where the remaining solvent is recovered and the materials dried and then aerated to remove solvent odors.

The present prior art machine requires a large amount of piping, a multiplicity of hand operated valves, a filter large enough to hold at least the soil from a normal day's operation (due to the involved and time consuming procedure for cleaning said filter), and means for reclaiming as much solvent from the soil as possible (due to the high cost of the solvent) before throwing the soil away. The means employed for solvent reclaiming usually uses heat, and the process is both time consuming and expensive.

One of the major disadvantages of the present prior art machine is the large filter which is required since its efficiency and ability to pass cleaned solvent decreases as the dirt load builds up. The dry cleaning filters presently in use have a filter membrane on which is deposited a layer of powder sometimes referred to as "filter aid," which decreases the openings in the membrane without substantially reducing the flow through the filter. Thus, the filter powder decreases the size of the solid particles which the filter will allow to pass. The filter powder forms a loose base on which the solid soil is deposited during filtration. This base is also advantageous in that it permits the cake of solid soils to break away from the filter membrane when the flow through the filter is reversed, thus cleaning the filter.

As the cake of solid soils build up on the filter membrane, the resistance to flow is increased. Unless cleaned, it is possible for the flow therethrough to cease. It has been found that, other things being equal, the cleaning efficiency of a dry cleaning machine is directly related to the condition of the solvent to which the materials to be cleaned are subjected, and is also directly related to the amount of clean solvent that is flushed through the materials during the washing cycle. Therefore, to maintain consistent quality of cleaning, it is desirable that the quality and quantity of solvent should remain the same from load to load. This is difficult to accomplish with a large filter intended for once-a-day cleaning (of the filter) because the flow rate decreases with each load run. This may be remedied by increasing the length of the wash cycle to insure that the same amount of clean solvent passes through the materials being cleaned, but increasing the wash cycle is not a satisfactory solution to the problem since it reduces the number of loads which can be run in any given period which in turn reduces the total business done in the period. If some compensation is not made, however, for the fact that the flow rate decreases as the work day moves along, the quality of the work produced deteriorates and the operator is faced with dissatisfied customers and loss of business.

It is accordingly a principal object of the present invention to provide a machine which is capable of performing substantially uniform cleaning from load to load while requiring reduced skill for its satisfactory operation.

Other objects and advantages of our invention will be clear from a consideration of the following description of a preferred embodiment taken together with the drawing in which:

FIG. 1 is a plan view of a machine embodying our present invention;

FIG. 2 is a front elevational view of the machine of FIG. 1;

FIG. 3 is a detailed elevational view, partly in section, along the line III—III of FIG. 1 showing the structural details of the automatic filter powder dispenser;

FIG. 4 is a cross sectional view along the line IV—IV of FIG. 3;

FIG. 5 is a detailed elevational view in section along the line V—V of FIG. 1, showing the structural details of the small area filter;

FIG. 6 is a detailed elevational view in section along the line VI—VI of FIG. 1, showing the structural details of the centrifuge extractor; and

FIG. 7 is an illustration of the flow control center showing the valves and valve control motors, as viewed along the line VII—VII of FIG. 1.

In describing the preferred embodiment of the present invention illustrated in the drawings specific terminology has been resorted to for the sake of clarity. However, it is not our intention to be limited to the specific terms so selected, and it is to be understood that each specific

term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

Referring now to the drawing, the complete machine consists of a combination of a large number of components assembled in a definite and orderly fashion and interconnected and operated in such a manner as to form an operative machine or system for dry cleaning materials. The base **150** of the machine on which the majority of the components are mounted serves as a storage tank for the liquids used in the dry cleaning process.

The machine illustrated incorporates a container **151**, usually called a basket, for the soiled materials to be cleaned. Container or basket **151** is perforated to allow the solvent to mix through the materials and thus remove the contained soils. The basket is mounted on a shaft **152** which in turn is mounted in bearings. Thus, the basket **151** is free to rotate around the axis of the shaft **152**.

The basket **151** is enclosed in a liquid-tight housing or tub **154**. Tub **154** has an access door **155** to allow loading of the basket **151**. Tub **154** has at its lowest point a drain outlet **156** which incorporates a valve **157** which can be closed to trap solvent in the tub **154** so that incoming solvent will reach a level high enough to wet and wash the soiled materials. The drain line incorporates a drain-valve by-pass **158** which passes above the valve **157** and is open at all times, thus establishing the maximum level the solvent can reach in the tub **154**. The by-pass line **158** is referred to as the overflow line. Both the drain and bypass lines terminate in a vertical tube **159** known as a button trap. Button trap **159** contains a screen **160** through which all solvents draining or overflowing the tub **154** must pass. The screen **160** catches and retains large solid particles which might be injurious to the remainder of the machine. Button trap **159** is fitted with a gasketed cover **161** to prevent the escape of solvent vapors from the machine. Button trap **159** is mounted over an opening in the storage tank **150** into which the soil-carrying solvent is directed.

The tub **154** has also a connection **162** to the flow control center **163**. The line **162** conveys clean solvent to the tub **154** for washing the soiled materials. In addition, tub **154** has a vent line **167** which connects tub **154** to the storage tank **150** for equalizing the pressures between the two containers.

Due to the volatile nature of the solvent and the high cost thereof, special attention is given to sealing all openings against possible solvent or vapor losses. Therefore, where the basket shaft **152** emerges from the tub **154** special seals are provided. The seal at each end consists of an annular housing **164** surrounding the shaft **152** and through which the shaft passes. Housing **164** extends into the tub **154** and has a drain hole (not shown) at the bottom for draining back into the tub. The outer end of the housing **164** has affixed to it a flange **165** which compresses a gasket (not shown) between the flange and the wall of the tub. The shaft **152** has a slinger ring (not shown) around the shaft which is also encompassed by the housing **164** and which throws any liquid running out along the shaft to the wall of the seal housing from whence it drains back to the tub through the drain hole. In addition, a vapor seal is effected around the shaft **152** by means of a felt gasket (not shown) between the seal flange **165** and a matching retainer plate (not shown). Pressure is applied to the felt gasket and the flange gasket by means of screws.

The tub and basket assembly (**154, 151**) is sealed from the atmosphere by the tub cover **166**, thus confining the solvent in the tub **154**.

A source of clean solvent is required for washing the soiled materials in the basket **151**. Uniformity of cleaning from load to load is, of course, desired. In order to achieve this, and in accordance with our present invention, a "small area" filter **24** is employed. Such a filter

represents a departure from filters used by the prior art in that it is adapted to hold the soil load from one load of material only without substantially reducing the flow rate of the solvent through the filter.

The location of "small area" filter **24** and some of the connections thereto are shown in FIGS. 1 and 2. The details of filter **24** are shown in FIG. 5. As there shown, filter **24** comprises a glass cylinder **25** enclosed within a steel frame **26** with steel plates **27, 34** at the top and bottom, respectively, bored to receive the glass cylinder **25** and machined to retain gaskets **28** at each end of the glass. Mounted at the top is a cylinder assembly **29** of steel having flanges **30, 31** welded at either end. The top flange **30** has a plurality of tapped holes to receive screws through cover **32** which is machined to retain gasket **33** to effect a seal between the cover **32** and the cylinder assembly **29**.

The bottom flange **31** of cylinder assembly **29** has a plurality of tapped holes to receive screws which retain a filter septum plate **35**, compressing gasket **36** between the filter septum plate **35** and bottom flange **31**. The filter septum plate **35** is bored to receive a plurality of tubular screen elements **37** which function as filter septum elements. These elements have a flanged cylindrical ferrule at their top. Gasket **38** has holes to match those in filter septum plate **35** and is placed over the plate **35** after which the filter septum elements **37** are inserted so that their flanges abut gasket **38**. Retainer plate **39** having like holes is placed over the gasket **38** and pulled down with a plurality of screws to compress the gasket **38** and form a seal between the flanges of the filter septum elements **37**, the retainer plate **39** and filter septum plate **35**. Bottom flange **31** has a plurality of clearance holes through which screws are screwed into the top plate **27** of frame **26**. Bottom flange **31** presents serrated surfaces to gaskets **28** and **36** to effect a better seal. The cylinder assembly **29** is provided with screwed conduit connection **40** which functions as the filter outlet in the normal filter cycle and as the filter inlet during the backwash cycle.

The bottom assembly **41** comprises a plate **42** to which is affixed a cylinder **45** provided with a screwed conduit connection **44** which functions as the solvent inlet during normal filter cycles and as the filter outlet during backwash. Affixed to the bottom plate **42** on the opposite side of the solvent inlet **44** is a baffle **45** supported on bars **46** leaving openings between baffle **45** and bottom plate **42** several times as large as the area of the conduit opening **44**. Baffle **45** is provided to diffuse the solvent flow and minimize turbulence around the tubes so that the powder introduced coats the tubes evenly. Plate **42** has a plurality of clearance holes through which screws are fastened into the bottom plate **34** of frame **26**. Plate **42** presents a serrated surface to gasket **28** to effect a better seal.

When top cylinder assembly **29** and bottom assembly **41** are pulled up with the attaching screws, the glass cylinder **25** is effectively sealed against gasket **28**.

In the normal filtration cycle, solvent enters the glass cylinder **25** through conduit inlet **44**, passes through the filter septum **37** upward into cylinder assembly **29** and out the conduit outlet **40**. From there the solvent is directed either to the tank **150** or tub **154**, depending upon the machine cycle. Filter powder is introduced with the solvent entering the filter and coats the tubular screen or filter septum elements **37** to present the filtering media. It is important that a filter powder cake be established on the filter septum **37** prior to the introduction of soil, as any soil reaching the filter septum **37** will clog its openings. Additional powder is added along with the soil to keep the filter cake porous, as hereinafter described.

In the backwash cycle, the flow through the filter **24** is reversed. Solvent now enters the filter **24** through conduit connection **40**, passes downward through the inside of the filter septum elements **37** and leaves the filter through

conduit connection 44. From there it is directed to the sub-filter muck stripper, preferably of the centrifugal extraction type, as hereinafter described.

It will be noted that filter 24 incorporates a glass cylinder 25. It is not essential to the small area filter that cylinder 25 be of glass, but glass has the advantage of exposing the condition of the interior of the filter and the filter septum to observation at all desired times. If at any time, clogging, lack of filter powder, bridging, or any other filter failures are observed, immediate steps may be taken to correct the condition.

It will be understood that filter 24 provides a means for removing the solid soils from the solvent provided filter powder is added to the incoming solvent to coat the septum elements 37 to prevent their becoming plugged with soils. Since, in accordance with our present invention, filter 24 has a capacity sufficient to remove soil from only one load of material without substantially reducing the flow rate of the solvent through the filter, the filter septum requires cleaning and recoating after each load.

Means for automatically measuring and feeding filter powder has been devised and developed for use in conjunction with the small area filter 24, thereby eliminating the necessity of constant attention by the operator, and thereby insuring proper filter operation. The automatic means is shown in FIGS. 1 and 2 of the drawing and identified as powder feeder 50. Detailed construction of the powder feeder 50 is shown in FIG. 3.

Referring now to FIG. 3, the powder feeder is shown to comprise an upper cylindrical housing 51 affixed to a lower cylindrical housing 54 by a truncated section 52. Plate 53 attached to lower housing 54 provides means for mounting the powder filter on to the tank 150 in such manner that lower housing 54 extends into the storage tank 150. Lower section 54 has a coupling 56 for threaded engagement of a suction conduit 170 which passes through opening 57 in plate 53, then on to the suction inlet of the pump 171 (FIGS. 1 and 2), and then to the small area filter 24 by way of the flow control center 163 (all of the conduit not being shown in FIGS. 1 and 2).

Returning again to FIG. 3 a ring 55 surrounds the bottom of lower housing 54 having holes 71 spaced annularly on the outer diameter of housing 54.

At the top of the upper cylindrical housing 51 a housing 58 is attached having a side opening fitted with a door 68. Extending vertically through housings 51 and 58 is a cylindrical tube 66, centrally located. Mounted above tube 66 by means of a plate 67 secured to housing 58, is a drive motor 59 connected to a drive motor shaft 62 by a coupling 60. The drive shaft 62 is held in alignment by means of sealed bearings 61 pressed into the top and bottom of tube 66.

A stationary wiper 63 is attached to tube 66 near the bottom with its lower extremity just above a cutting plate 65. Cutting plate 65 is attached to the bottom of the drive shaft 62. Wiper paddles 64 are attached to cutting plate 65. Cutting plate 65 has equally spaced slots 69 cut from its circumference toward its center, as seen clearly in FIG. 4.

In operation, the automatic filter powder feeder 50 contains sufficient filter powder for a normal day's operation. The powder employed is diatomite or diatomaceous earth, and is dispensed by filter powder feeder 50 in quantities large enough to coat the tubular filter septum elements 37 (FIG. 5) after each cleaning or backwashing operation. In addition, the powder dispenser 50 is arranged to intermittently feed small amounts of the powder to incoming dirty solvent so as to maintain a porous cake on the filter septum elements during the entire filtration cycle.

The operation of the automatic powder dispenser 50 is as follows:

Filter powder diatomaceous earth is loaded into the upper housing 58 through the opened door 68. Door 68 opens outwardly to approximately 45° on hinge points 70 and serves as a chute for the filter powder.

Because of its peculiar properties, diatomaceous earth will not fall through the openings 69 in cutting plate 65 when stationary and hence the powder is retained in upper housing 51. However, when the drive motor 59 is energized, drive shaft 62, cutting plate 65, and wiper arms 64 all rotate and the entire column of powder within the housing 51 tries to rotate along with elements 62, 65 and 64, due again to the properties of diatomaceous earth.

The attempted rotational movement of the powder column is arrested, however, by the stationary wiper arm 63 which breaks up the column and causes the weight of the powder to force loose powder against cutting plate 65 where it is forced through the slots 69, is sheared off by the cutter plate 65, and spills into the lower housing 54. From there it is conducted through the pump-suction conduit 170 to the pump 171 and then to the small area filter 24 by way of the flow control center 163.

The vertical cylindrical shape of the upper housing 51 of the powder dispenser 50 so contains the filter powder that the weight of the powder always acts in a vertical plane to replace the powder forced through the slots 69 in cutting plate 65 into the lower housing 54.

Ring 55 is provided at the bottom of housing 54 to prevent the powder introduced into housing 54 from becoming dispersed into tank 150 by the turbulence created in the area of openings 71 at the bottom of housing 54.

The powder-dispensing action of the unit 50 is maintained as long as the drive motor 59 is energized. The rotational speed of motor 59 and the size and number of the openings 71 in cutting plate 65 determine the quantity of powder introduced into lower housing 54 in a predetermined period of time.

The advantages of the powder dispenser 50 are many. A most important advantage is that the necessary addition of filter powder from time to time during the day's operation is no longer among those things requiring operator attention and control, since in practice the drive motor 59 is cycled electrically, as required, by the operation of the machine.

It will be understood that the powder dispenser 50 is employed to establish the precoat on the filter septum elements and also to add powder to each load. In actual practice, the relatively large precoat charge can best be added to lower housing 54 with the pump 171 deenergized. After this addition of powder is made to lower housing 54, pump 171 is energized to cause this large quantity of powder to be conducted to the filter septum elements 37 (FIG. 5), there to form rapidly the powder cake. The powder-feeder drive motor 59 may then be energized intermittently to add powder to the filter with each wash load.

The basic machine thus far described consists of a basket 151 to hold the materials to be washed, a housing 154 for said basket, a drain 156, a tub overflow 158, a button trap 159, the small area filter 24, the powder dispenser 50, all mounted on the storage tank 150.

Since the small area filter 24 must be cleaned after each load, a secondary filtration and storage container must be provided for the combination of solvent, filter powder and solid soil, commonly referred to as "muck." This secondary container should also provide a means of recovering the costly solvent retained by the muck after transfer to said container.

In corporated in the system of the machine being described is a new and novel means for storing the muck and recovering the solvent therefrom. This means is shown in FIGS. 1 and 6 and is identified as the extractor 84. The extractor 84 is mounted on the storage tank 150. When it is necessary to clean the filter 24, the direction of solvent flow is reversed, thus washing the accumulated cake from the septum elements 37 of the filter 24. The removed cake then forms a slurry with the solvent. The muck slurry (comprising solvent, filter powder and solid soils) moves under pump pressure from the pump 171 from the filter 24 through the discharge line 110 of flow-

control center **163**, through the flexible hose **111**, the rotary union **112** which is fastened to the shaft **113** of basket **120**, up the hollow shaft **113** and out through holes **121** in the ejector pipe **114** which is located inside the sub-filter membrane or bag **115**. The bag **115** is quickly filled with the muck slurry and expands out against the basket **120** and cover **117**. The basket **120** is mounted rigidly to the shaft **113** at the bottom plate **121**. Attached securely to bottom plate **121** is a perforated shell **122** forming the walls of the basket **120**. The perforations allow the solvent to escape from the basket **120**. Affixed to the top edge of the shell **122** is a ring **123** which provides a seat for the perforated cover **117** and the cover latching arms **124**.

For extractors of the size adapted for use with the small area filter system presently being described, it is advisable to keep the size and number of perforations in the shell **122** of the extractor **84** down so as to provide sufficient strength to withstand the pressures encountered during the backwashing operation, and so as to withstand the force to which the basket is subjected during the extraction cycle. The size and spacing of the holes has a direct influence on the ability of the filter bag **115** to allow solvent to escape. It was also found that the bag **115** was forced into the perforations of the shell **122** by centrifugal force during the extraction cycle, subjecting the bag **115** to localized strain and at the same time making it difficult to remove the bag from the basket **120**, the bag being held by the perforations. Therefore, a basket liner **125** is provided of woven wire cloth to support the bag **115**, to increase the unrestricted open area of the bag **115**, and to provide inter-connecting channels or passages for the solvent between the perforations of the shell, thus decreasing the restriction to the flow of solvent through the bag **115** and from the basket **120**.

The filter bag **115** is preferably made of nylon cloth, but could be made of any material capable of retaining the muck solids and passing the solvent. The bag **115** has one end closed by means of a zipper or other suitable fastening device so that the solids may be removed from the bag after extraction. The bag is then cleaned by some suitable method, such as the dry cleaning process itself, preparing it for reuse. The bag **115** is fitted with a grommet **126** at the end opposite the zipper which fits over the solvent ejector pipe **114**, thereby forming a sealed container. To assist in the removal of the bag **115** from the basket **120** handles are sewn to the outside of the bag. In case of a disposable one-operation bag, the zipper or closure means can be dispensed with.

To place bag **115** in the extractor, the cover **117** is removed from the basket **120** and the bag is placed in the basket **120** by putting the ejector pipe **114** through the grommet **126** and sliding the grommet down the ejector until it is in contact with the basket bottom. The zipper is checked to be sure it is closed and the cover **117** replaced on the basket **120**. The cover assembly consists of the perforated plate **117** which fits in the seat in the basket ring **123**. Attached to the underside of the perforated plate **117** is a cover screen **128** serving the same function as the basket liner **125**. However, in the case of the cover **117**, the perforations, by allowing the solvent to escape, decrease the effective pressure of the solvent on the underside of the cover. The cover is fitted with a suitable handle **127** to assist in handling. The cover is held in place by latching arms **124** engaging in a groove machined in the basket ring **123**. These arms are attached to the cover **117** by means of pivots, in this case, cap screws **129** with nut and washer. To insure free movement of the latch arms **124**, a suitable bushing **130** is placed in the arm and around the shank of the cap screw **129**. The arms **124** are made longer than the distance from the pivot **129** to the bottom of the groove in ring **123**, with the ends cut off at an angle to provide maximum locking surface. In this manner, centrifugal force will cause the cover **117** to be self latching for safety.

With the cover **117** in place and locked, we have a container with a filter membrane suitable to act as a sub-filter for the muck slurry. As already described above, the muck slurry under pump pressure from the pump **171** moves from the filter **24** through the discharge line **110**, through the flexible hose **111**, the rotary union **112**, up the hollow shaft **113** and out through the holes **121** in the ejector pipe **114**. The bag **115** quickly fills with the muck slurry and expands out against the basket **120** and cover **117**. The solvent leaves the basket through the bag and the perforations in the basket, leaving the muck solids inside the bag. The discharge of the muck slurry under pump pressure through the perforations in the ejector agitate the slurry to help even the disposition of the slurry solids on the surfaces of the bag. When all the muck slurry has been discharged from the filter, the flow control center **163** (later to be described) shuts off the drain line and returns the filter to the filter cycle. When the drain line is closed, the source of continuing pressure is removed from the muck slurry. Hence, the pressure decreases to atmospheric pressure as the solvent passes through the bag. When this condition is reached, the free solvent will slowly drip from the bag due to gravity. This is a slow process due to the resistance of the cake now formed on the inside of the bag.

The solvent escaping from the basket **120** must be confined and collected for return to the storage tank **150** of the dry cleaning machine. To accomplish this solvent collection, the basket assembly is mounted on a frame assembly. In FIG. 6 is shown a frame assembly **134** suitable for use in the extraction recovery process. The frame assembly consists of a cylinder **135** with a solid shell **136** suitably fastened to a bottom **137** to give a liquid-tight seam. The upper or top edge of the shell **136** has affixed a ring **138** arranged to hold a gasket **139** which effects a seal between the cylinder **135** and a removable cover **140**. The bottom **137** has two holes, one centrally located through which the basket shaft **113** passes. Attached to the bottom **137** is a ring **141** so disposed as to mate with a similar ring **142** affixed to the bottom of the basket. These rings are so arranged as to provide a restriction to the flow of solvent from the cylinder **135** in the event of an abnormally high solvent level in the cylinder. Affixed to the bottom of the cylinder is a gasket pad **143** tapped to receive screws. A gasket **144** is compressed around the shaft **113** between the pad **143** and a loose pad **145** by the screws to cause a restriction to the escape of solvent and solvent vapors from the cylinder.

The cylinder **135** has the aforementioned second hole located near the outer edge to form an exit for the collected solvent. Affixed to the underside of the cylinder bottom **137** and surrounding said hole is a fitting **146** which serves as a coupling for a drain line **147**. The drain line **147** terminates in a fitting **148** on the storage tank **150**. It is preferable that the fitting **148** extend below the liquid level in the storage tank **150** to restrict any fan effect on the basket **120** during the extraction cycle.

A suitable sealing cover **140** is provided for the cylinder **135** with some means of securing the cover to the cylinder and exerting sealing pressure against the gasket **139**. In the illustration in FIG. 6, this is accomplished by securing eye bolts **149** by means of a pivot pin **180** held in ears **181** securely attached to the cylinder shell. Threaded on the eye bolt **149** are handle levers **182** which when screwed down against the pressure pads **183** affixed to the cover, effect a seal on the gasket. The locking system for the cover shown in FIG. 6 is only one of many suitable for this purpose.

The cylinder is supported in the example by four legs **184** which are affixed to the cylinder. These legs terminate in pads **185** which provide a means of securing the

extractor to a suitable base, in this case, the storage tank 150. Braces 186 and 187 are affixed to the legs to form a support for the bearing mounts. Also, affixed to the legs 184 and the cylinder 135 is a mounting 188 which serves as a mounting for a motor 189 which serves as the source of rotative force to the basket.

The basket 120 is mounted by bearings 190 affixed to the shaft 113. The bearings 190 in turn are mounted on the bearing mount and secured by cap screws to the bearing mount. Thus supported, the basket 120 is free to rotate in the cylinder 135.

The motor 189 is fitted with a sheave 191 and a second sheave 192 is fastened on the lower end of the basket shaft 113. The motor sheave 191 and the basket sheave 192 are connected by a belt 193 so that when power is applied to the motor the basket 120 is caused to rotate.

We now have a solvent extraction system which will work in conjunction with a dry cleaning system for the reclaiming of solvent from filter muck, when suitable electrical controls are used in conjunction with the motor 189.

It has been found that the efficiency of the extraction process is related to speed and time of spinning. The amount of vibration encountered is related to how the extractor is brought up to speed, the final speed of spinning, and motor characteristics. These factors have a greater influence on smooth operation than does the initial balance of the basket assembly.

In a typical extraction cycle, the muck slurry is transferred by pump pressure to the bag 115 inside the basket 120. Pump pressure is applied, causing a flow of solvent and slurry to the extractor, and clear solvent to drip out of the extractor as previously explained. The clear solvent, on passing through the bag 115 and basket 120, is collected in the cylinder 135 and from there it returns to the storage tank 150 through the outlet 146 and drain 147. At the completion of the backwash operation, the flow control shuts off the supply line 110 and the residual pressure is dissipated by solvent flowing through the bag 115 and from the basket 120.

The above operation has been explained with the basket 120 at rest. However, the basket could have been spinning, if so desired. The following is an explanation of what takes place when the basket 120 spins under the influence of the motor 189.

When the muck slurry is delivered under pressure upwards through the injector pipe and into the interior of the bag, the solids in the muck slurry have a tendency to plate out on the walls of the bag 115 as the solvent filters through. These solids will adhere to the bag 115 forming a concentric cake around the outside of the bag. When the basket 120 starts to spin, any solids remaining in suspension are forced to the outside of the bag 115 and become part of the cake.

It has been found that if the extractor basket is brought up to final speed in a series of steps according to a proper undulating acceleration curve, the final vibration of the unit will be kept to a minimum. This is believed to be due to the fact that as a result of the undulating acceleration curve the solids caked on the wall of the bag shift in a manner to produce a substantially even cake. At the same time the load on the motor 189 will be reduced by allowing most of the solvent remaining in the muck to be purged from the basket at low speed. In the table given below, the basket 120 is accelerated to the indicated high speed, power is then cut off from the motor 189 and the basket 120 allowed to coast down to the indicated low speed, at which time power is reapplied to the motor 189 to accelerate the basket to the next high speed. The speeds given are in revolutions per minute of a 16" diameter basket:

0 to 190 r.p.m., 115 to 305 r.p.m.,
225 to 415 r.p.m., 320 to 480 r.p.m.,
400 to 540 r.p.m., 445 to 590 r.p.m.,
510 to 635 r.p.m., 560 to 670 r.p.m.,
590 to 720 r.p.m., 620 to 735 r.p.m.,
655 to 750 r.p.m., 670 to 765 r.p.m.,
685 to 780 r.p.m., 700 to 780 r.p.m.,
720 to 800 r.p.m., 720 to 1380 r.p.m.

The particular acceleration curve given above is but one example of many such suitable undulating acceleration curves. The curve can be established by the electrical control circuit as a function of time, or of speeds, or can be designed into the motor.

It has been found that a maximum basket speed of approximately 1380 r.p.m. will recover almost all of the recoverable solvent in a spinning time of 15 to 20 minutes. The residue remaining has far less solvent than does the residue from a cooking operation carried out in the manner now customary in the trade. In fact, by this new recovery method, it is possible to extract solvent from muck which has been cooked for six hours in a modern muck cooker.

While the unit shown uses a rotary union to admit the muck slurry to the basket, other means of admitting the slurry to the basket will work. For example, the muck slurry can be brought in the top of the extractor, although this is not as satisfactory.

The operation of the extractor as described calls for spinning the extractor shortly after the completion of the backwash operation. However, this is not a requirement for satisfactory operation. It is possible to allow the basket to drain completely before extraction. It is also possible to backwash into the extractor a multiplicity of times before extracting. The limit in this case is the pressure differential between the extractor and the filter. A sufficient differential must be maintained to clean the filter and also to cause the slurry to flow from the filter into the extractor. Each successive charge of muck will plate out on the walls of the bag increasing the thickness of the deposited cake. As the thickness of the cake increases, the resistance to flow increases until the limits of the pump 171 are reached. The uniformity of deposit is maintained by the ejector pipe 114 mixing the slurry remaining unplated in the bag with the new charge of muck coming into the extractor.

Upon completion of the extraction cycle, the power is cut off to the motor 189 which causes the basket 120 to cease rotating. The lever handles are backed up on the studs 149 relieving the pressure on the gasket 139. When the levers have been backed up far enough to gain clearance, they are swung clear of the pressure pads. The cover 140 is then removed from the extractor body. The latches 124 on the basket cover 117 are swung clear of the groove in the basket ring allowing the cover 117 to be removed from the basket 120. Bag 115 is then removed by grasping the handles. The dry muck residue is removed with the bag, leaving the basket clear and ready to receive a clean filter bag.

To best utilize the advantages of the newly designed automatic powder feeder 50, small area filter 24, and centrifugal extractor 84, it would be most desirable to automate the valves controlling the flow of solvent during the filter and backwash phases of filter operation. Accordingly, in the system of the present invention, a flow control center 163 is provided and the liquid flow between the various components of the system is centralized in and under the control of the flow control center 163, as controlled by the timer (FIG. 7).

The flow control central 163 is illustrated in a preferred form in FIG. 7. Referring now to FIG. 7, point 201 is connected to the pressure side of pump 171 (FIG. 1); point 202 is connected to the inlet 44 at the bottom of the filter 24; point 203 is connected to the supply line 110 to the centrifugal extractor 84; point 204 is connected to the outlet 40 at the top of the filter 24; point 205 is connected to the inlet to tub 154; and point 206 is connected to the tank sweep piping on the inlet tank 150.

Considering first the filter precoat operation, the valve

control motors 207 and 208, in response to electric control signals from the timer (FIG. 7) and acting through suitable linkages, position valves 216, 214 and 211 closed, and valves 215, 213 and 212 open.

Now with the pump 171 running, solvent enters the flow control center 163 at point 201, and since the valve 214 is closed, the solvent is routed through open valve 215, past closed valve 216, and out point 202 into the inlet 44 at the bottom of the filter 24. The solvent then passes through the filter septum elements 37, is discharged from the filter outlet 40, and re-enters the flow control center 163 at point 204.

Since valve 214 is closed, solvent also passes through open valve 212, past closed valve 211, through open valve 213, into the sweep pipe and into the tank 150 to be again sucked up by the pump 171 and recirculated.

Considering now the "wash" cycle, in response to a signal from the timer (FIG. 7) valve control motor 208 runs 180° thereby, through suitable linkages, to position valve 211 open, and valve 213 closed, at the same time moving valve 157 (FIGS. 1 and 2), located in the drain line 156 to its closed position. The flow through the valve center 163 remains unchanged from that described above except that the solvent coming through open valve 212 now passes closed valve 213 and is directed through open valve 211 to point 205 and hence to tub 154 where a level is maintained while the overflow spills back into the storage tank 150 to be again picked up by the pump 171.

In the filter backwash cycle, in response to a signal from the timer (FIG. 7) valve control motor 207 travels 180° to position valves 215 and 212 closed and valves 216 and 214 open. Valve control motor 208 moves back to its normal position in which valve 213 is positioned open and valve 211 is positioned closed, while at the same time opening valve 157 in the drain line 156. Solvent now entering the flow control center 163 at point 201 is directed through open valve 214 to point 204 and hence into port 40 (which is the normal discharge outlet of filter 24 but which functions as an inlet during the filter backwash), through the inside of the filter septum elements 37 and out through the port 44 (the normal inlet of the filter) to point 202 of the flow control center, through open valve 216 to point 203 and thence to the centrifugal extractor 84. After passing through the inside of the filter septum elements 37 ,the solvent picks up the soiled filter powder and carries it through the piping of the control center 163 to the filter muck collector (basket 120 of extractor 84) where it is separated from the solvent by a filtering membrane (bag 115) and the recovered solvent returns to the storage tank.

Having thus far described the operation of the various major components of our new system, we now give a brief description of a full dry cleaning cycle using our new machine.

The operator opens the door 155 in the tub 154, thereby gaining access to the basket 151. He loads the garments to be cleaned into the basket 151. In the preferred machine, the basket 151 is divided into two compartments, so that one-half of the total load is placed in one side of the basket. The access door 155 is closed and the operator depresses a brake release button 220 on the face of an electrical control panel 221. This causes the electric hold brake (not shown) to release, freeing the basket 151 to be rotated by hand, making the second compartment accessible through the door 155. The operator then loads the second compartment with the remainder of the load, and closes the access door.

The tub 154 has a duct 223 located at the back which connects to an exhaust fan 224. This fan is energized by a door limit switch (not shown) so that whenever the access door 155 is opened, the fan 224 is energized and draws air into the door opening, through the tub 154 and out the duct 223, thus preventing solvent vapors from contaminating the breathing air of the operator. When the operator closes the access door 155, the fan 224 is shut off.

Assuming that the operator has been running the machine prior to the cycle being described, the pump 171 has been energized by a pump switch (not shown). The filter 24 is precoated on the filtration cycle as established by the flow control center 163.

The operator now dials the desired wash cycle on the wash cycle timer (not shown). From this point on, the operation of the machine is automatically controlled. The timer signals the flow control center 163 to close the valve 157 to tub drain 156, start the wash control motor 225, release the brake, and divert the solvent from tank sweep to the tub fill position. When the cycle is started by the timer, and the drain valve operator reaches fill position, an impulse timer referred to as the body feed timer impulses the motor 59 on the powder feeder 50 thereby feeding in small amounts of powder to the solvent to maintain a porous cake on the filter septum elements 37. The solvent flows through conduit 162 to the tub 154 under pump pressure after being filtered by filter 24. The garments being cleaned are wet by the solvent and the level in the tub rises till the solvent runs out the overflow 158 into the button trap 159 and thence into the storage tank 150 where the solvent is again picked up by the pump 171 and recirculated through the system leaving the solid soil in the filter 24. The garments are thus cleaned by rotating the basket 151 in the solvent by the wash motor 225.

An optional wash cycle is also available to the operator whereby he can use what is called a batch wash. When the tub 154 has been filled to overflowing, the operator can pull out a knob which operates a manual valve (not shown) diverting the output of the pump directly back to the tank 150. In this manner, the solvent now in the tub 154 remains there. A soap dispenser 227 is piped directly into the tub 154 into which the operator can pour additives to the trapped solvent for additional cleaning action. When sufficient time has elapsed to clean the garments to the operator's satisfaction, the knob is pushed in, closing the valve diverting the pump flow back to the tub 154. The flowing solvent rinses away the contaminated solvent in the tub 154 at the same time reducing the percentage of charge in the garments by dilution.

When the wash cycle as set on the timer expires, the timer signals the flow control center 163 to open the valve to drain 156 and divert the pump flow from filtration to backwash. At this time, the timer turns the backwash operation over to a backwash timer and the extract motor 228 is put under the control of an extract delay timer. The extract delay timer insures that the tub 154 is fully drained and that the easily extracted solvent has been removed from the garments by rotating the basket 151 at slow speed by wash motor 225. When the above has been accomplished, and the extract delay timer times out, the extract motor 228 is started. As the basket 151, picks up speed, the wash motor 225 ceases to drive the basket 151 due to an over running clutch.

The basket 151 rotates at high speed centrifugally extracting all solvent possible from the garments, which is returned through the drain to the tank 150. Both motors (225 and 228) continue to run until the timer times out, ending the cleaning cycle. The power is cut off to the wash and extract motors, and from the brake which clamps on its drum stopping the basket 151.

When the wash cycle timer turned the backwash operation over to the backwash timer it became independent of the cycle timer by means of a backwash relay. This relay also energizes a body feed relay to stop the powder feeder motor 59 and body feed timer during the backwash operation. In the backwash operation, the flow control center 163 diverts the flow of pump 171 to carry the muck slurry to the centrifugal extractor 84 where the

solvent is separated from the muck and returned to the tank **150**. When the preset backwash timer times out, it signals the flow control center **163** to divert the pump flow back to the filtration cycle. At the same time it turns control over to the precoat timer which in turn becomes independent by means of the precoat relay. The timer pulls in a second relay known as the drain valve relay which prevents the drain valve operator from operating. The precoat relay stops the pump **171** and starts the powder feeder motor **59** which runs continuously measuring out a preset amount of filter powder. When the precoat timer times out, the precoat and drain valve relays drop out allowing the pump **171** to start and at the same time returning control of the machine back to the wash timer.

The pump **171** picks up the powder in the powder feeder **50** plating it out on the filter septums **37**, restarting filtration. Thus, the machine is automatically prepared for the next load.

In the event an especially dirty load should be run in the machine overloading the filter, a manual backwash button is provided. When this button is depressed, control of the machine is taken away from the cycle timer and from the flow control center **163** and put under the backwash and precoat timers. The solvent flow to the tub **154** is thus stopped and is not restarted until the backwash and precoat cycles are completed, at which time control is returned to the cycle timer.

In normal dry cleaning operations, the garments are transferred to a recovery and drying tumbler to remove any solvent remaining in the garments after the extraction cycle in the machine, thus freeing the dry cleaning machine for the next load.

At the end of the day, the operator starts the centrifugal extractor **84** by means of a centrifuge switch. The extractor is allowed to run until all the solvent has been extracted from the filter muck. When this has been accomplished, the operator stops the extractor **84**, removes the cover **140** and the basket cover **117**, and removes the bag **115** with the now dry muck. He replaces the bag with a clean one, and closes the covers **117** and **140**, thus preparing the extractor **84** for the next day's operation.

The filter **24** incorporated in the machine will only remove insoluble soils. It will not remove the soluble soils in the solvent. Therefore, as part of the machine, is incorporated a steam still (not shown). A manually operated diverter valve is provided so that the flow from the pump **171** can be directed to the still. Periodic partial distillation of the solvent is all that is normally required to keep the solvent in usable condition.

The storage tank is fitted with a water cooled coil (not shown) to maintain solvent temperatures at optimum. The cleaning ability of the solvent is related to the temperature.

Since the solvent flow is from the tub **154** to the storage tank **150** and thence to the filter **24**, some means had to be provided to prevent the solid soils from settling out in the bottom of the tank **150**. Installed in the tank **150** is a pipe fitted with nozzles aimed towards a pump pick up. The tank sweep pipe is connected to the flow control center **163** in such a manner that whenever the flow is on filtration and the tub **154** is not being filled, the pump output is diverted to tank sweep. The suspended soils are then picked up by the pump **171** and caught by the filter **24**.

We have described a preferred embodiment of our new combination of components in some detail. It will be obvious to one skilled in the art that various modifications may be made without departing from the invention as hereinafter claimed.

The automatic filter powder dispenser described herein in some detail as a component of the new combination claimed in the present application is described and claimed per se in our separate patent application Serial No. 10,766, filed February 24, 1960, and now Patent No. 3,010,615, entitled "Automatic Filter Powder Dispenser."

Likewise, the centrifugal extractor, described herein in some detail, is described and claimed in a separate copending application Serial No. 10,767, filed February 24, 1960, and now Patent No. 3,063,564, entitled "Centrifugal Extractor."

Having described our invention, we claim:

1. An automatic dry-cleaning machine for garments comprising: a supply tank for solvent, said tank also serving as a base for said machine; a tub mounted on said supply tank and having therein a rotatable perforated work basket adapted to hold a batch of soiled garments to be cleaned; a main filter mounted on said supply tank, said filter having tubular septum elements; an automatic filter powder dispenser mounted on said supply tank and having a supply hopper and a motor-driven rotatable feed mechanism adapted to dispense a controlled amount of filter powder from said hopper into said supply tank for each rotation of said mechanism, said automatic filter powder dispenser comprising an elongated cylindrical vertically-disposed walled housing having an upper section and a lower section separated by a slotted plate forming the floor of the upper section for supporting a supply of diatomaceous earth filter powder the particles of which tend to cling together to form a cohesive columnar mass, a rotatable shaft extending axially through said upper section and attached at its lower end to said slotted plate, a pair of opposed upwardly-extending wiper arms secured to said slotted plate and adapted to sweep along the lower wall of said upper section when said shaft is rotated for cutting the lower portion of said columnar mass free of said lower wall, and at least one arm mounted to extend into said lower portion of said columnar mass for breaking up said mass and causing particles thereof to drop through the radial slots of said floor plate and into the lower section of said housing; filter powder feed impulse timer means connected to said filter powder dispenser motor for driving said motor intermittently during wash-cycle periods; a secondary filter comprising a vertically-disposed container having therein a rotatable perforated basket and a filter bag, said secondary filter being adapted to function as a stationary sub-filter and muck storage container and also as a centrifuge extractor, said secondary filter being mounted on said supply tank; a motor connected to said secondary filter for driving said filter rotationally during centrifuge periods; conduit means coupling each of said tub, main filter, and secondary filter to said supply tank and intercoupling said tub to said main filter and said main filter to said secondary filter, said conduit means from said main filter to said secondary filter entering said basket and filter bag upwardly through the bottoms thereof and terminating inside said bag in a perforated piping; pump means for forcing solvent through said conduit means and through said machine; a plurality of valves in said conduit means, including at least one valve in the conduit coupling said supply tank to said tub, at least one valve in the conduit coupling said supply tank to said main filter, at least one valve in the conduit coupling said supply tank to said secondary filter, at least one valve in the conduit coupling said tub to said main filter, and at least one valve in the conduit coupling said main filter to said secondary filter; electrically-operable valve operator means; mechanical linkages connecting said valve operator means to said valves; wash-cycle timer switch means coupled to said valve operator means for operating said valve operator means for placing said valves in such conditions during a period assigned to the wash cycle that said pump forces solvent in a first direction through said tub, work basket, and main filter and then back into said tub, the filter septum elements of said main filter having a total filter area of such size as to adapt said elements to filter out soil from a single batch of garments (but not from a plurality of batches)

without appreciably reducing the rate of flow of solvent therethrough; said filter powder feed impulse timer means being adapted during the period of the wash cycle to energize said filter powder dispenser motor intermittently to rotate the feed mechanism of said dispenser intermittently to add filter powder intermittently to the solvent in the supply tank; backwash cycle timer switch means coupled to said valve operator means and effective at the end of each wash-cycle period and during each following period assigned to a backwash cycle for actuating said valve operators for changing said valves to place said valves in such conditions that said pump during each backwash-cycle period pumps solvent in a reverse direction through said main filter to backwash said main filter and to pump the mixture of solvent and soiled filter powder into said secondary filter, a considerable portion of said solvent returning from said secondary filter when stationary through said conduit means to said supply tank; pre-coat-cycle timer means coupled to said pump means and to said motor-driven rotatable filter powder feed mechanism and effective at the end of each backwash-cycle period and during each following period assigned to a pre-coat feed period for shutting off said pump and rotating the feed mechanism of said filter powder dispenser to add a controlled quantity of filter powder to said supply tank following each backwash period according to the duration of said feed period; said wash-cycle timer switch means coupled to said valve operators being effective at the end of each pre-coat-cycle feed period and during each following period assigned to a pre-coat pump cycle for actuating said valve operators for changing said valves so that said pump during said pre-coat pump cycle pumps solvent having the controlled quantity of added filter powder therein from said supply tank through said main filter in said first direction to pre-coat said filter septum elements; said wash-cycle timer switch means coupled to said valve operators being effective at the end of each pre-coat pump cycle for changing said valves to place said valves in conditions corresponding to the wash cycle, thereby to place said machine in condition to repeat its cyclic sequence of operations; motor means connected to the basket of said secondary filter; and control means for said motor means for rotating the basket of said secondary filter at selected intermittent periods to recover the residual solvent from the mixture contained therein and to return said recovered solvent to said supply tank.

2. Apparatus as claimed in claim 1 characterized in that said control means is adapted to accelerate said basket from zero to maximum speed in accordance with an undulating acceleration curve.

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